Badge WX for BlocklyProp (#20300)

The feature-packed, battery-powered, WiFi-enabled Badge WX is ready for wireless programming with our free visual BlocklyProp or text-based C tools.

Energize your events by using the Badge WX to store and distribute schedules, identify participants, share contact info, and play interactive games.

In educational settings, the Badge WX encourages hands-on activities, student creativity, and collaboration while studying electronics and programming.

Features

- Propeller 8-core microcontroller, 64 KB EEPROM, and 5 MHz crystal oscillator
- Wireless module for programming and WiFi communication
- 128 x 64 OLED display
- 3-axis accelerometer (±1.5 g) for orientation and motion detection
- Two-way infrared communication
- MicroSD card slot
- Four super-bright, tri-color serial RGB WS2812b LEDs, and expansion port
- Two user-programmable status LEDs
- Two 3-way rocker buttons (left, right, press)
- Two passive touchpad buttons on the back
- Stereo audio and composite video output
- Convenient on/off push switch with status LED
- Supports long life rechargeable and non-rechargeable AAA batteries
- Reverse polarity protection if batteries are inserted incorrectly
- Access to I2C, 7 I/O's, RGB bus, Pwr controller, 3.3V, and battery voltage
- Protective acrylic cover may be customized or removed for alternative mounting
- Four mounting holes and two lanyard holes; lanyard included

Key Specifications

- Voltage requirements: +3.5V to +4.5V DC (3x AAA battery holder included)
- Communication: ESP8266 WiFi module
- Operating temperature: -13 to +158 °F (-25 to +70 °C)
- Mounting holes diameter: 2.2mm
- Lanyard holes diameter: 4.2mm
- PCB dimensions: 70 x 54 mm

Application Ideas

- Interactive lessons in programming, cyber security, and information diffusion in the classroom
- Interactive ID Badge for conferences, hackathons, and maker spaces
- Research and experimentation with parallel processing and social communication
- Develop portable games or interactive quizzes
- Expand existing projects with interactive OLED display and wireless control

Tutorial Support

The online tutorial Getting Started with the Badge WX and BlocklyProp will guide you through setting up your Badge WX for wireless programming with our free online visual programming tool. Tutorials and project links are under the Additional Resources tab on the 20300 product page at www.parallax.com.
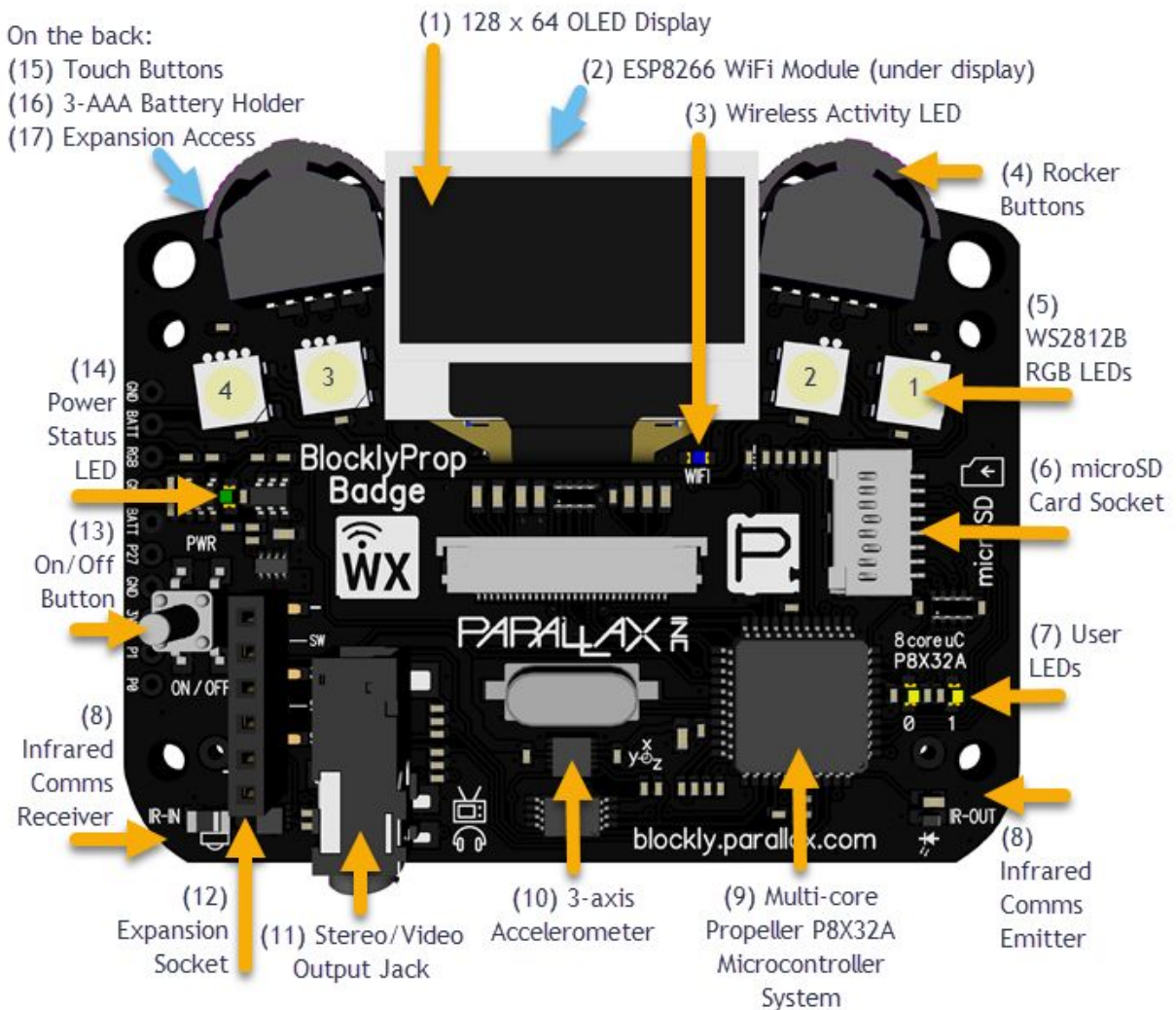
Read through this Product Guide for complete information about your Badge WX, and keep it handy as a reference for all of the Badge WX features.

For additional software tools, tutorials, projects, and videos, check the Downloads and Additional Resources tabs on the 20300 product page at www.parallax.com.

CAUTION! Do not wear a Badge WX with conductive materials, such as metallic cloth, metal jewelry or buttons, or metal-clip lanyards which may short out against the Badge WX PCB. Protect the Badge WX from your skin, moisture, fluids, lotions, and static discharge from the environment. Parallax Inc. is not responsible for damage to people or objects caused by electrically connecting with your Badge WX.

Feature Descriptions

On the back:
(15) Touch Buttons
(16) 3-AAA Battery Holder
(17) Expansion Access

(1) 128 x 64 OLED Display
(2) ESP8266 WiFi Module (under display)
(3) Wireless Activity LED
(4) Rocker Buttons
(5) WS2812B RGB LEDs
(6) microSD Card Socket
(7) User LEDs
(8) Infrared Comms Emitter
(9) Multi-core Propeller P8X32A Microcontroller System
(10) 3-axis Accelerometer
(11) Stereo/Video Output Jack
(12) Expansion Socket
(8) Infrared Comms Receiver
(13) On/Off Button
(14) Power Status LED

(1) OLED Display

The 0.96" OLED screen features a high-contrast graphics display with 128x64 pixels. Pixels are white on a dark background. The screen has a built in SSD1306 display driver, which the Propeller controls directly by SPI protocol on pins P18 through P22.

(2) WiFi Module

The Badge WX has its own ESP8266 WiFi module for wireless programming and communications. The WiFi module contains a special bootloader file which automatically uploads to the onboard Propeller microcontroller and runs when the Badge WX is powered up. This bootloader file manages the SD card integration and allows the user to search for (and connect to) WiFi networks.

If an SD card with valid WiFi settings or firmware is inserted, those files can be automatically Run or installed to the Propeller EEprom. Otherwise the bootloader will allow the user to join a network and then load or install Propeller code directly from BlocklyProp or SimpleIDE over the wireless connection.

User code can access the WiFi Module API to implement wireless applications. Refer to the WX module Firmware guide here:

https://www.parallax.com/downloads/parallax-wx-wi-fi-module-firmware-guide

(3) Wireless Activity LED

The Wireless Activity LED, also called the Associate or ASC LED, gives a visual indicator of the state of the WiFi module.

LED Behavior	OFF steady	long OFF, blink ON	ON steady	long OFF, long ON	long OFF, blink ON, long ON
WiFi Module State	STA (no IP) no connection	STA (has IP) connect via STA	AP connect via AP	STA+AP (no STA IP) connect via AP	STA+AP (has STA IP) connect via STA or AP

Any visible "ON" state of this LED indicates there is some kind of wireless access possible, either via the STA (Station) or AP (Soft AP) interfaces. When the AP interface is active, it always has an IP address. Therefore, wireless access to the module is always possible via the AP interface during any of the last three conditions shown.

(4) Rocker Buttons

The Badge WX has two rocker buttons at the top edge. Each button provides left, right and center (press-in) movement. The buttons are positioned such that they can be operated either when the Badge WX is worn, or when held in front view. The rocker buttons are used to navigate the boot-up menu and may also be repurposed in a user's application code.
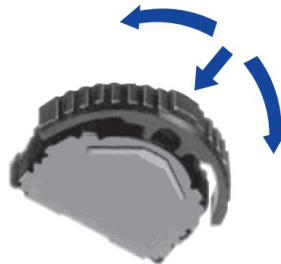
(5) WS2812B RGB LED Modules

The Badge WX has four RGB LED modules (type WS2812B) located either side of the OLED display and connected to the Propeller I/O pin P10. Each of these RGB LEDs contains three individual LEDS (Red, Green, Blue). By illuminating these LEDs in certain combinations, it is possible to make many colors appear.

These RGB LED modules are operated by a serial protocol and can be connected in a very long chain of modules of the same type. Therefore, an expansion pad has been provided on the side of the Badge WX for users to connect external RGB LED modules.

Tip! Due to the limited battery power source of the Badge WX, and also the normal voltage drops which occur between the RGB LED modules, it is recommended to connect an external power source to external modules.

WARNING! Do NOT connect any external power source to the RGB BATT header! The RGB header is to provide limited battery power OUT to a small number of external RGB LED modules. If you are connecting more than 4 external RGB LEDs, use an external power source. Hook up the connections as shown. Use a common ground, but DO NOT connect the external positive voltage to the BATT header pad on the BadgeWX.

Connect External 5V Power Supply for External RGB LED Modules
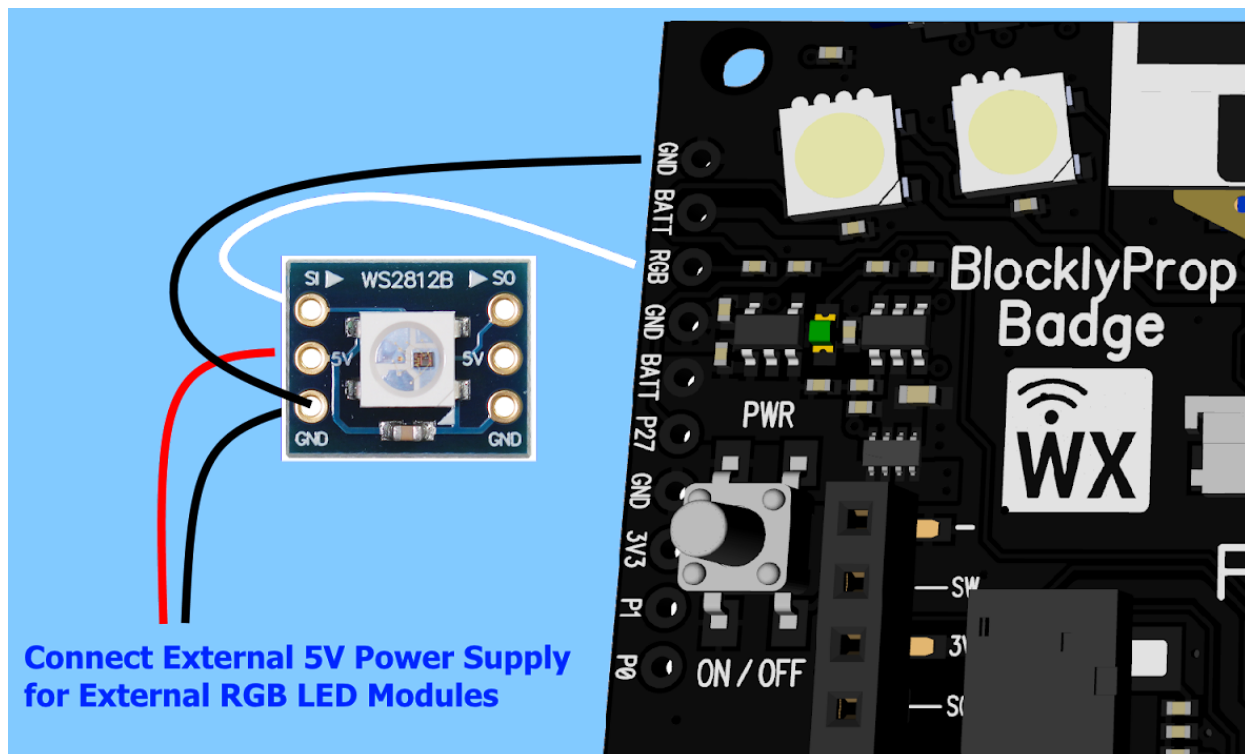
(6) MicroSD card socket

The Badge WX has a microSD card socket to the right side of the board. There are markings to indicate the correct polarity of the card; when inserting the card, pins will be facing down toward the board. Once inserted correctly, the SD card will align with the board edge. If it is sticking out, then something is wrong!

The socket allows applications to access files from a microSD card. Uses include:
- Setting WiFi access-point login information (SSID and password)
- Deploying auto-run Propeller firmware files
- Storing user settings or contact information
- Accessing large lookup tables
- Playing audio files
- Data logging

This socket is hardwired to Propeller I/O pins:
- P5 - /CS (active low chip select & card detection)
- P6 - MOSI (data out from microSD card, data in to Propeller)
- P7 - CLK (clock)
- P8 - MISO (data in to microSD card, data out from Propeller)

(7) User LEDs (Yellow)

The Badge WX includes two yellow LEDs near the bottom right of the board, labelled 0 and 1. These LEDs share a single I/O pin (P9), and are controlled according to this lookup table:

P9 State	LED 0	LED 1
Input	Off	Off
Low	**On**	Off
High	Off	**On**
Fast repeating high-low cycle (toggle)	**On**	**On**

This technique takes advantage of the one-way current flow properties of diodes (including Light Emitting Diodes), along with the tri-state properties of the Propeller I/O pins.
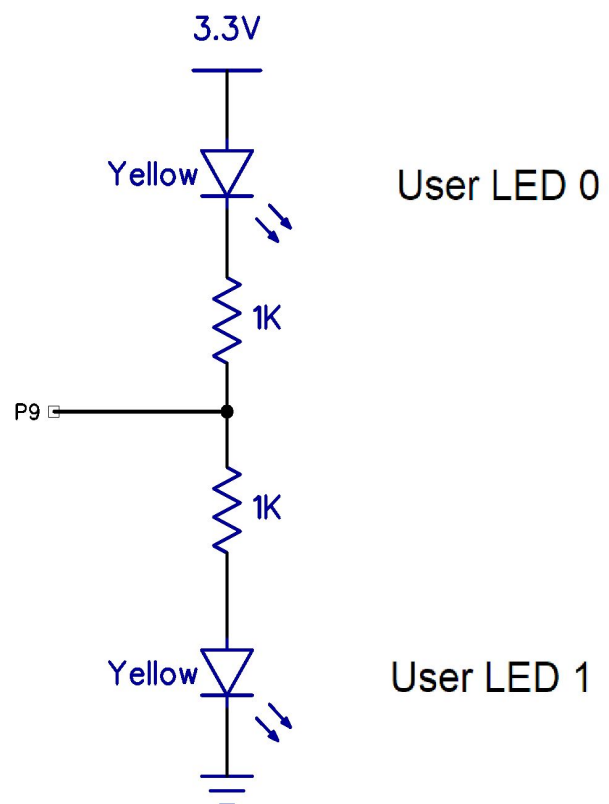
To have both LEDs lit at the same time, you would toggle P9 high then low in a loop. Microcontrollers are really good at switching I/O pins very quickly, and if you switch the P9 pin state fast enough your eye will see both the LEDs as being permanently on. This method also saves battery power, as only 1 LED is drawing power at a time! BlocklyProp Example:

```
repeat forever ▾
do    make PIN 9 ▾   high ▾
      make PIN 9 ▾   low ▾
```

(8) Infrared Communications

The Infrared Communications system includes an infrared transmitter and an infrared receiver.

The infrared transmitter is directly driven by Propeller I/O pin P3, modulated at 36 kHz to work with the Badge WX Infrared Receiver. It can also work with modulation schemes for other receivers. Use it to transmit to other Badges or to various infrared receivers such as TVs, cameras, LCD shutter glasses, and printers.

The infrared receiver, connected to Propeller I/O pin P23, includes a built-in 33 kΩ pull-up resistor and drives the I/O pin low when it receives a signal. It can receive signals from devices that transmit an infrared signal modulated at 36 kHz. This includes signals from the Infrared Transmitter on the same Badge WX, on another Badge WX, or from many TV and camera remotes.

(9) Multicore Propeller Microcontroller System

- 8-core Propeller P8X32A microcontroller
- 64 KB I2C EEPROM for non-volatile program and data storage
- 3.3 V, 250 mA voltage regulator
- 5.00 MHz crystal oscillator

The Propeller provides the 64 KB EEPROM's I2C clock through I/O pin P28 and communicates with its I2C data line through I/O pin P29. The EEPROM's lower 32 KB contains the program image that the Propeller loads on reset. The upper 32 KB can be used for non-volatile data storage. The Propeller microcontroller can multiply the 5.0 MHz crystal oscillator signal by up to 16x for a system clock frequency of 80 MHz.

(10) Accelerometer

The 3-axis accelerometer (Freescale MMA7660FC) senses motion up to ±1.5 g. It is connected to the common I2C bus on P28 and P29. The accelerometer can be used to determine a change in orientation or for tap and shake detection. This can be useful input for games or for detecting

the physical activity of the wearer. To learn about the advanced configuration options of the accelerometer, refer to the MMA7660FC datasheet. Data rate is configurable from 1 to 120 samples per second.

(11) Video and Stereo Output Jack

This convenient port provides stereo audio output for speech synthesis, music, and other audio applications. I/O pins P0 (left channel) and P1 (right channel) are hardwired to the output jack as well as the audio breakout header and can drive headphones, earbuds, speakers with built-in amplifiers, or line-level inputs.

Propeller microcontroller applications that display data and graphics on devices with composite video inputs are also possible, such as projectors and televisions. The signals are all line-level signals with a 75 Ω impedance, controlled by I/O pins 24, 25, and 26. The jack socket is compatible with both TRS (audio only) and TRRS (audio and video) cables with the following pin-outs:

- TRS (audio): Tip = left-channel audio, Ring = right-channel audio, Inner ring = ground return path.
- TRRS (audio and video): Tip = left-channel audio, Outer ring = right-channel audio, Inner ring = ground return path, Sleeve = video.

Ø3.5mm, 4 pole
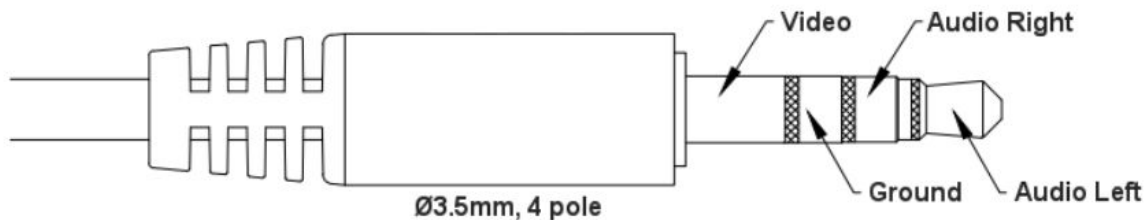
Warning! Not every AV cable is the same! Check carefully that you use a cable matching this diagram. This AV jack pinout matches those used with the Propeller Activity Board WX, but not the original Hackable Electronic Badge (#2000, #20100, and #20200).

(12) Expansion socket

The Badge WX has a flexible power source connector and expansion socket (0.1") located next to the on/off switch. Custom user boards can be plugged into this socket from the top, or from the bottom of the Badge WX when the battery holder is removed. The expansion socket has pins for VIN & GND, I2C bus, 3.3V LDO output, and Pwr-Remote Control. This implies that when the battery holder is removed, the custom application would provide power to the board through the VIN pin in the range of 3.5 V to 4.5 VDC. More details about this socket along with the other expansion pads can be found in (17) Expansion Access.

(13) On/Off Button

The pushbutton on the front of the Badge WX is accessible through a small hole in the acrylic cover. This pushbutton turns the Badge WX on and off, and also locks and unlocks its WiFi

programming access. Refer to the table below for the list of pushbutton functions. The Power Status LED (labeled pwr) will blink to confirm the action chosen.

Starting state	Button presses	LED feedback	Action
Badge OFF	1 press	6 blinks	Normal start. Badge WX powers up, and will display loading message on the OLED display, followed by the main menu.
	4 presses, each within 150 ms	4 blinks	BadgeWX powers up with WiFi module in STA+AP recovery mode.
	Press and hold > 10 seconds	No blinks	Easter Egg.
Badge ON	1 press (If badge doesn't respond, press the button longer.)	2 slow blinks	Normal stop. Badge WX powers off.
	2 presses, each within 150 ms	2 quick blinks	Normal power cycle. Badge WX will power off, then power on again.
Badge ON and Locked	6 presses, each within 150 ms	6 quick blinks	Badge WX will unlock so that files can be uploaded, or settings can be changed, in the WiFi admin webpage.
Badge ON and Unlocked	6 presses, each within 150 ms	6 slow blinks	Badge WX will lock to prevent files being uploaded, or settings changed, at the WiFi admin webpage.

(14) Power Status LED

The Power Status LED blinks in response to On/Off Button presses to confirm that the desired state has been set; refer to the table above.

The Badge WX has a co-processor which takes input from the On/Off Button and controls the Power Status LED and a power supply MOSFET switch. The MOSFET switch provides polarity protection in addition to on/off control of the Badge WX circuits.

(15) Touchpad Buttons

The Badge WX has two passive touchpad buttons, labeled A and B, on the back of the PCB under the rocker buttons. Touchpads work because the capacitance of the pad will change when a human body comes very close to or touches the pad. By sampling the capacitance of the pads, the Propeller microcontroller can determine when they are pressed.

Each pad is connected to GND with a fixed-value 470 kΩ resistor. This allows the Propeller to use the RC-Time (Resistance/Capacitance) method to sample the pads and determine the difference in capacitance when the pad is touched.

To read the state of a touchpad button, set its I/O pin to a high output, immediately switch it to an input, and then measure the amount of time before the I/O pin falls low. If nothing is touching the pad, the parasitic capacitance of the I/O pin and the PCB will hold the input high for several milliseconds. Alternately, instead of measuring the fall time, measure the input state 1 millisecond after the touch-pad pin was switched to an input.

(16) 3-AAA Battery Holder

The recommended voltage source is in the range 3.5 V to 4.5 V. The Badge WX comes with a AAA battery holder, suitable for three 1.2 V rechargeable NiMH or 1.5 V alkaline cells. The Badge WX includes protection against reverse polarity installation of the batteries. Although this helps to prevent potential damage from shorting out the battery, the user must also take common sense precautions to prevent short circuits, shocks, or burns.

Advanced option: The PCB includes through-hole pads suitable for a Li-ion power source. In this case, remove the AAA battery holder and attach a Li-ion holder which is compatible with a 3.6 V or 3.7 V Li-ion battery. This advanced customization is at the user's risk!

(17) Expansion Access

The Badge WX features a number of header pads and sockets for users to add their own circuits. The labels on the bottom of the Badge include short pin names to help with identification, and all the available pins are shown in the diagram below. The pads, holes, and sockets are spaced at 0.1" pitch, suitable for standard 0.1" headers (#451-04001) or sockets for easy experimentation. You may also solder components or cables directly to the board.

The Badge WX battery pack is held in place by sticky pads and could be removed for custom projects. For example, the Badge WX could become a plug-on control panel for an existing PCB that has the Badge WX headers in the right places!

Tip! The white blocks around the edge pins could be color coded with a marker pen!
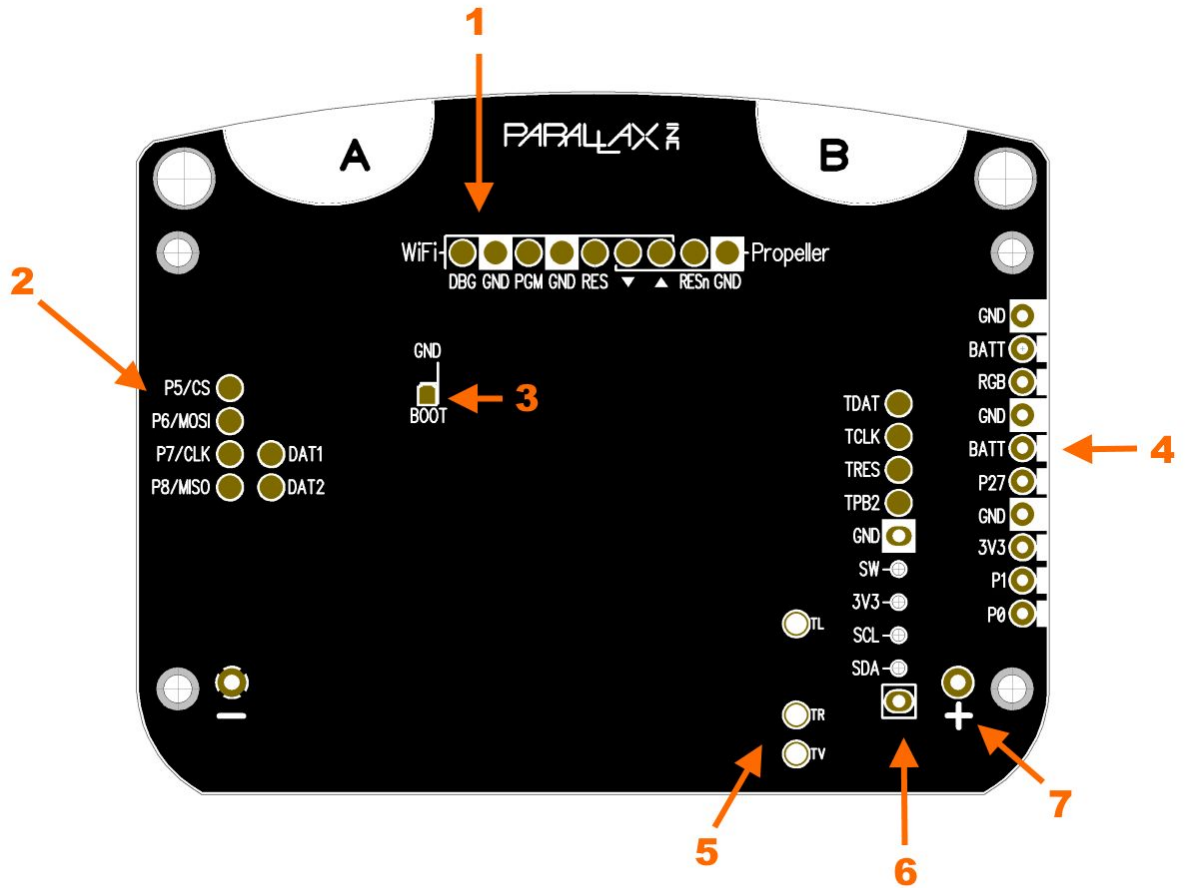
Pin label	Type	Function
(1) WiFi and Propeller Programming Pads		
DBG	I/O	WiFi debug output (ESP IO2)
GND	Power	Ground connection
PGM	I/O	WiFi configure (ESP IO0)
GND	Power	**Tip!** PropPlug VSS pin when recovering the WiFi module
RES	I	WiFi reset (set low to reset)
▼	I/O	Serial data in/out (WiFi in, Propeller out)
▲	I/O	Serial data in/out (Propeller In, WiFi out)
RESn	I	Propeller reset (set low to reset)
GND	Power	**Tip!** PropPlug VSS pin when programming the Propeller EEPROM

(2) MicroSD Breakout Pads		
P5/CS	I/O	Propeller I/O P5 and MicroSD CS pin
P6/MOSI	I/O	Propeller I/O P6 and MicroSD MOSI data-out pin
P7/CLK	I/O	Propeller I/O P7 and MicroSD clock pin
P8/MISO	I/O	Propeller I/O P8 and MicroSD MISO data-in pin
DAT1	I/O	MicroSD DAT1 pin
DAT2	I/O	MicroSD DAT2 pin
(3) Boot Override Pads		
GND	Power	
BOOT	I/O	Custom application only. Bootloader control, Propeller P17 and ESP IO14. Fit 1K resistor to GND to enable bootloader, or connect 1K resistor between BOOT pin and 3V3 to disable bootloader.
(4) Edge Features Header		
GND	Power	RGB LED serial bus expansion port allows the Badge WX to control external WS2812B LEDs. BATT is connected to the battery pack when Badge WX power is on. **Tip!** As Badge WX power is limited, an external power source is recommended when adding more than 4 external LED modules.
BATT	Power	
RGB	O	
GND	Power	Standard Parallax servo header (BRW). P27 is connected to the Propeller via a 3.9K series resistor. P27 is free for user application; it is not shared with any other Badge WX features. BATT is connected to the battery pack when Badge WX power is on.
BATT	Power	
P27	I/O	
GND	Power	
3V3	Power	3.3V regulated output from onboard 600 mA LDO. Tip! LDO current is shared with Badge WX; do not overload!
P1	I/O	Audio Right breakout; connected to the Propeller pin via 1K resistor, and via a DC blocking capacitor to the AV audio jack. There is also a 100nF capacitor to GND, making this a handy pin for RCTIME measurements.
P0	I/O	Audio Left breakout; connected to the Propeller pin via 1K resistor,

		and via a DC blocking capacitor to the AV audio jack. There is also a 100nF capacitor to GND, making this a handy pin for RCTIME measurements.
(5) AV Audio Jack Pads		
TL	I/O	Audio Left connection to the on-board audio jack socket
TR	I/O	Audio Right connection to the on-board audio jack socket
TV	I/O	Video connection to the on-board audio jack socket
(6) Power and Data		
TDAT	I/O	Power coprocessor PB0 (TPIDATA) and WiFi module IO0
TCLK	I/O	Power coprocessor PB1 (TPICLK) and Power on/off switch remote control. Set low to simulate the power button being pressed.
TRES	I/O	Power coprocessor PB3 (TPIRES). Set low to force the Badge WX off immediately.
TPB2	I/O	Power co-processor PB2 (T0) and Badge WX MOSFET gate pin. Set low to force the Badge WX on immediately.
GND	Power	Ground connection
SW	I/O	Power on/off switch remote control. Set low to simulate the power button being pressed.
3V3	Power	3.3V regulated output from onboard 600mA LDO. Tip! LDO current is shared with Badge WX; do not overload!
SCL	I/O	I2C bus clock
SDA	I/O	I2C bus serial data
(7) Battery pack pads		
+ **-**	Power	The 1.2mm diameter holes marked + - are directly connected to the battery pack pins. They are spaced to accept a Li-ion battery holder (BCAAPC), if that is preferred instead of the NiMh AAA battery holder. You can also supply or source power here. Recommended VIN range is 3.5 V to 4.5 V. DO NOT exceed the Absolute Maximum Voltage of 5.5 V, and note that the onboard RGB LEDs will not function when VIN exceeds 4.8 V.

Propeller I/O Pin Assignments

| I/O Pin	Function
P0	Audio output left channel
P1	Audio output right channel
P2	Touch pad B
P3	IR OUT (Infrared transmitter)
P4	Touch pad A
P5	MicroSD socket CS (SPI active-low chip select)
P6	MicroSD socket MOSI (SPI data-out from microSD, data-in to Propeller)
P7	MicroSD socket SCLK (SPI clock)
P8	MicroSD socket MISO (SPI data-in to microSD, data-out from Propeller)
P9	Status LEDs (0 / 1)
P10	WS2812B RGB LEDs
P11	Rocker buttons - Right
P12	Rocker buttons - Center
P13	Rocker buttons - Left
P14	Rocker button common - Left
P15	Rocker button common - Right
P16	WiFi reset
P17	WiFi security lock
P18	OLED display CS# (SPI active-low chip select)
P19	OLED display RES# (low to reset display)
P20	OLED display SCLK (SPI clock)
P21	OLED display SDIN (SPI data in)
P22	OLED display C/D# (Command / Data select)
P23	IR IN (Infrared receiver)
P24 - P26	Composite Video output to 3.5mm AV jack
P27	Unused IO pin, for user expansion
P28	EEPROM / Accelerometer / I2C clock
P29	EEPROM / Accelerometer / I2C data
P30	TX (WiFi programming / terminal)
P31	RX (WiFi programming / terminal)

Programming your Badge WX

The Badge WX's Propeller microcontroller can be programmed wirelessly from BlocklyProp or SimpleIDE. The steps to follow are:

1. Prepare your code! Write some Propeller code in BlocklyProp or SimpleIDE.
2. Power on your Badge WX and get connected to a WiFi network. Refer to the Badge WX Menu System sections below.
3. Unlock your Badge WX, ready for programming wirelessly. Refer to the Locking and Unlocking the Badge WX sections below.
4. Upload your code from BlocklyProp or SimpleIDE, by selecting your Badge WX in the com-port dropdown, and then choosing Run or Load.

Badge WX Menu System (Overview)

Badge WX has two rocker buttons on either side of the OLED display. These buttons are used to navigate the Badge WX startup menu, and can be moved in three directions: left, right, and when at the center position, inwards.

When you see the <> scroll symbol at the top left or top right of the OLED display, that indicates that moving the corresponding rocker button to the left or right will scroll through menu choices shown at the bottom left or right of the OLED display. Pressing the rocker button once inwards will select that menu choice.
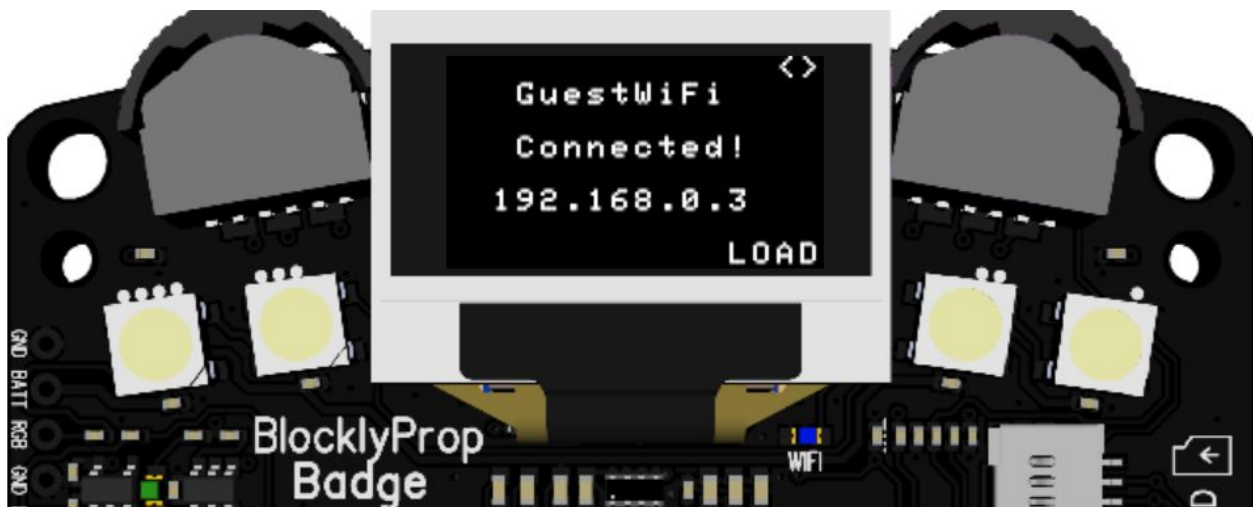
In this example, the LOAD menu option is currently visible at bottom right. You could press the right-rocker button inwards once to select LOAD, or move the rocker button left or right to scroll through different menu options.

Sometimes the scroll symbol will appear with text in between. In this case, the corresponding rocker button will perform the function defined by the text. Let's look at the following example:
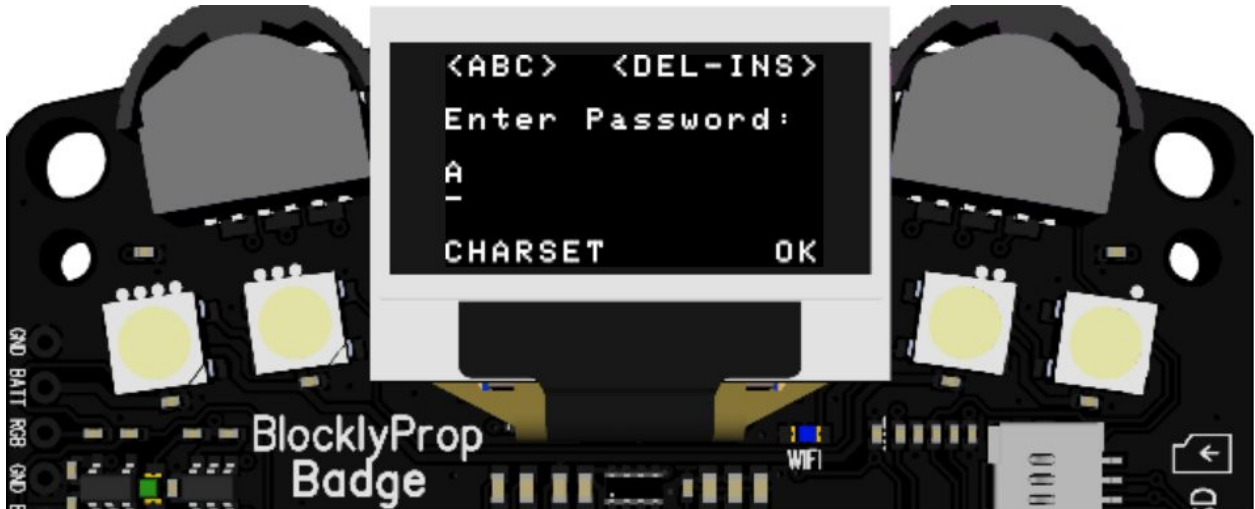
In this example, the rocker buttons will be used to enter a password. The <ABC> symbol means that moving the left rocker button left or right will scroll the "A" character, which is currently visible on the display, to the next character in the alphabet. The command shown at the bottom of the screen "CHARSET" would be selected by pressing the left rocker button once inwards. Similarly, you would select "OK" by pressing the right rocker button once inwards.

Sometimes you might see only one of the scroll symbols, < or >, which means you can only scroll in that direction.

In this example, Badge WX has completed a WiFi network search and is showing the list of discovered WiFi network names. "<WiFi" means you can scroll the list of WiFi network names to the left but not to the right. This will happen when you have scrolled all the way to one end of a list, so the only possible direction is to scroll back again.

As with previous menus, you could also press either of the rocker buttons once inwards to select either the left or right command shown at the bottom of the display, "CONNECT" or "CANCEL".

Finally, there is a special type of menu option that might appear, which has a countdown timer attached. The command shown will be executed automatically when the timer reaches zero. To stop the countdown, move the corresponding rocker button to the left or right and then back again.

These two images demonstrate a typical countdown timer, whereby the first image has the RUN command with a value in brackets representing the countdown time in seconds, and the second image shows the countdown timer has been removed from the RUN command, as the user moved the rocker button.

Badge WX Menu System (Step-by-Step)

When Badge WX is powered on, or power-cycled, the green power LED will blink 6 times to indicate Badge WX is booting up, and within 3 seconds the "HELLO Loading" message will appear on the OLED display.
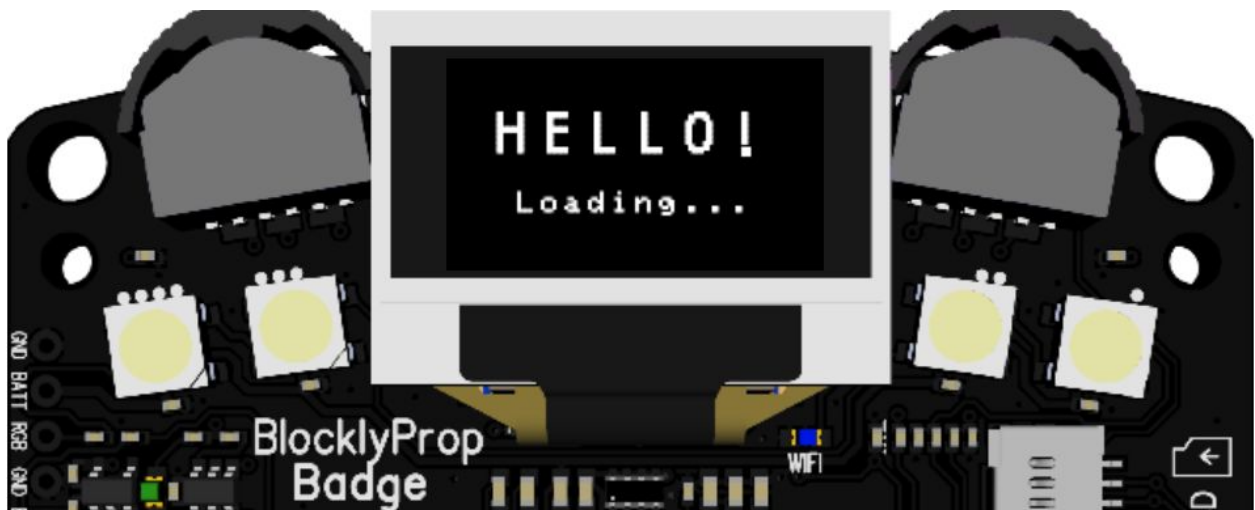
Tip: The OLED screen remembers it's last state, so you may briefly see what was last displayed on the OLED before the Loading message appears.

If an SD card is inserted, it will be checked for valid settings and code.

The SD card could include WiFi credentials, so that the Badge WX can automatically connect to a specific WiFi network.

The SD card could also include a standard Propeller binary image file, which will be automatically run when the Badge WX starts.

Refer to the section Starting the Badge WX with an SD Card for more details.

HELLO!
Checking SD...

HELLO!
Reading SD...

If no SD card is inserted, the next screen will indicate that the Badge WX is searching for WiFi networks.

It can take 20 seconds to search for WiFi networks. This will depend on the number of networks operating in the area, the signal quality and strength.

HELLO!
Searching WiFi..

If a known network was found, the Badge WX will attempt to automatically connect.

You can cancel this process at any time, by pressing the right rocker button inwards while CANCEL appears at the bottom right menu.

<>
Badge-WX
Connecting
*****.....
CANCEL

If WiFi network connection was successful, the Badge WX will show the connected network name and IP address.

Use the right-rocker button to choose and select menu options.

```
                               <>
        GuestWiFi
        Connected!
        192.168.0.3

                            LOAD
```

If the Badge WX is unable to find or connect to any WiFi networks, you will see this screen with the SEARCH option.

SEARCH will help you connect to a WiFi network.

```
                               <>
        Badge-WX
        WiFi Offline
        Try SEARCH menu!

                          SEARCH
```

The Automatic RUN menu option (with countdown timer) will appear when there is valid user code already stored in the Propeller EEprom.

If you press nothing else, the countdown will reach zero and then execute the user code.

Abort the countdown timer by pushing the right rocker button left or right.

The timer will appear if the Badge WX is connected to a WiFi network, or not.

```
                               <>
        Badge-WX
        WiFi Offline
        Try SEARCH menu!

                          RUN(4)
```

```
                               <>
        GuestWiFi
        Connected!
        192.168.0.3

                          RUN(6)
```

This is the LOAD menu. The unique Wireless Programming Identity of the Badge WX is displayed here, and the Badge WX is unlocked and enabled for programming wirelessly while this screen is visible.

Refer to the section on programming your Badge WX. Press ABORT when finished.

```
WiFi Programming
    activated!

   wx-123456




          ABORT
```

Here is the SEARCH menu is progress. You should wait up to 20 seconds for searching to complete.

You can choose to cancel by pressing the right-hand rocker button inwards, or wait for the search results menu to appear.

```
                    <>
   Badge-WX

   Searching for
   WiFi networks
   *********...
           CANCEL
```

This menu shows the search results, and allows you to connect to a WiFi network.
The number of networks found is displayed near the top right- in this example "2". You can scroll through the networks with the left-hand rocker button.

For each network you will see the encoding type, signal strength %, and the Access Point name.

CONNECT with the left-rocker button, or CANCEL with the right-rocker button.

```
   WiFi>           <>
                    2
OPEN           52%

     FreeWiFi

CONNECT    CANCEL
```

```
<WiFi            <>
                  2
WPA2           82%

    GuestWiFi

CONNECT    CANCEL
```

If the wireless network requires a password, you will see this menu screen next.

Use the left-rocker button to scroll through characters, and the right-rocker button to move the blinking cursor left or right.

As you scroll backward you will DEL (delete) characters, and as you scroll forward you will INS (insert) characters.

The default character set is upper case, but you can choose from upper, lower or symbols.

Notice the bottom left menu option is "CHARSET". With each press of the left-rocker button, the charset will change and the top left menu name will update to indicate which charset is active.

Supported upper-case, lower-case, and symbols character sets are shown below (though not in the actual font used).

```
<ABC>    <DEL-INS>
Enter Password:
A
_
CHARSET         OK
```

```
<abc>    <DEL-INS>
Enter Password:
a
_
CHARSET         OK
```

```
<_#%>    <DEL-INS>
Enter Password:
%
_
CHARSET         OK
```

ABCDEFGHIJKLMNOPQRSTUVWXYZ 0123456789

abcdefghijklmnopqrstuvwxyz 0123456789

_.,:;?!@#&$%`'"=+-*/|\^<>()[]{}~

When you have entered the WiFi network password, press the right-rocker button to select the "OK" option.

If you need to cancel this menu, you can also click OK at any moment.

```
<abc>    <DEL-INS>
Enter Password:
my8SecretWord
_

CHARSET           OK
```

After choosing a WiFi network, and if required a password, the Badge WX will try to connect.

You can CANCEL at anytime with the right-rocker button. Or wait up to 20 seconds for the Badge WX to connect.

```
                    <>
      Badge-WX
      Connecting
      *****.....

             CANCEL
```

If connection was successful, you will see a message similar to this.

The connected WiFi network name and the Badge WX IP address will be shown.

```
                    <>
      GuestWiFi
      Connected!
      192.168.0.3

               LOAD
```

This is the Admin menu, from which you can erase user code stored in EEPROM, and logout from a WiFi network.

The first screen will ask if you want to erase the user EEPROM. Answer YES or NO by pressing the corresponding rocker button inwards once.

If you answered YES, you will be asked to confirm again.

EEPROM Admin

```
Admin              <>
---------------
ERASE EEPROM ?

YES               NO
```

If you answered YES a second time, the lower 32KB of the EEprom will be invalidated. This means that any user code stored there will not be executable by the Propeller, and so will be ignored.

The upper 32KB of the EEprom, which is an optional memory area often used for user data and settings, will not be cleared.

The next admin option will clear the currently connected WiFi network from memory, and logout immediately. This means that the WiFi network will be forgotten. If you wanted to re-connect to the same network later, you will need to perform a WiFi Search, and re-enter the password.

The first screen will ask if you want to logout wifi. Answer YES or NO by pressing the corresponding rocker button inwards once.
If you answered YES, you will be asked to confirm again.

If you answered YES a second time, the network logout will occur, and on completion you will be returned to the Badge WX main menu.

```
Admin           <>
--------------
    ERASE EEPROM

ARE YOU SURE ?

YES             NO
```

```
Admin           <>
--------------
ERASING EEPROM

PLEASE WAIT!
```

WIFI Admin

```
Admin           <>
--------------
LOGOUT WIFI ?



YES             NO
```

```
Admin           <>
--------------
    LOGOUT WIFI

ARE YOU SURE ?

YES             NO
```

```
Admin           <>
--------------
LOGGING OUT WIFI

PLEASE WAIT!
```
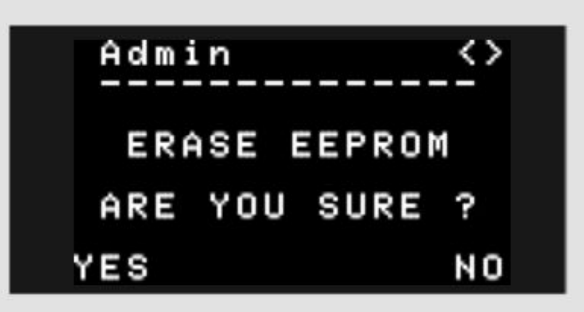
Badge WX Menu System (RUN and Automatic RUN features)

There is a special menu command "RUN" which will only appear when the Badge WX has valid Propeller user code stored in EEprom memory. That would be the case when the user has saved code to EEprom from BlocklyProp or SimpleIDE, as explained elsewhere in this document.
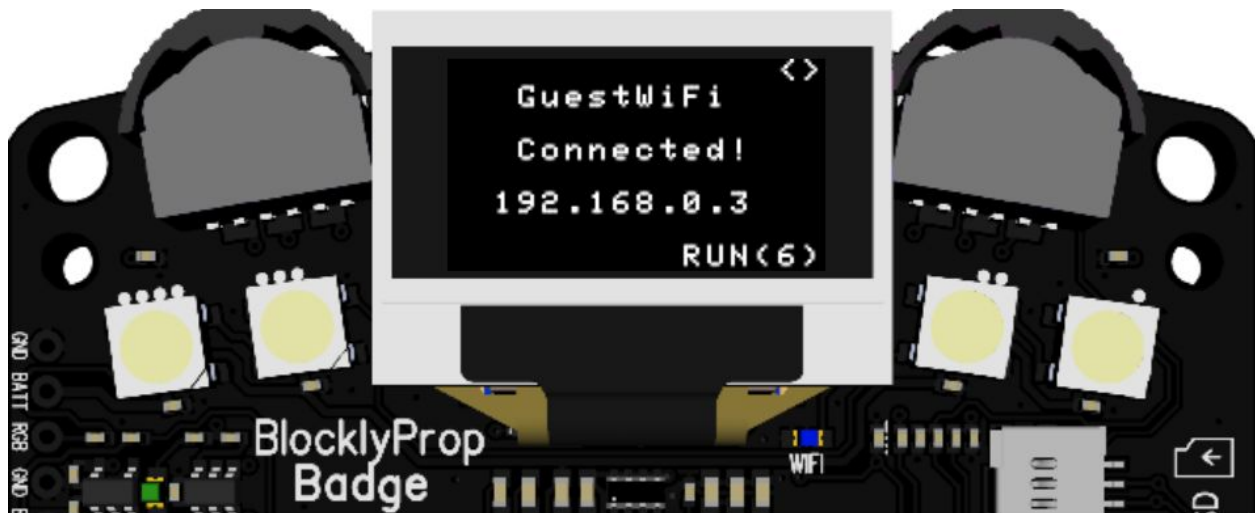
There are two ways to RUN code from the Badge WX menu: automatically and manually.

Automatic RUN

When the Badge WX first starts, and if it finds valid user code stored in the Propeller EEprom, the automatic RUN menu option will appear, identified by numbers in brackets afterwards, counting down from 9 in one second intervals. Once this automatic RUN timer gets to zero, the code stored in the Propeller EEprom will be automatically executed. This means the Badge WX will start running the user code without the need for any user interaction after power-on.

To stop the automatic countdown and code execution, move the right hand rocker button to the left or right. This will change the menu option displayed and stop the timer.

Manual RUN

If you wanted to RUN the code manually, after having stopped the timer, then use the right rocker button to scroll back to the RUN menu option, as shown here, and then press the rocker button once inwards to select RUN, which will execute the user code stored in the Propeller EEprom.

Disable Automatic RUN

To prevent the Badge WX from attempting to automatically RUN code at startup, either do not save user code to the Propeller EEprom, or remove it.

To remove previously stored user code from EEprom, power on the Badge WX and wait until the first menu appears. Using the right rocker button, scroll until you find the "ADMIN" menu option, then press the button once inward to select.
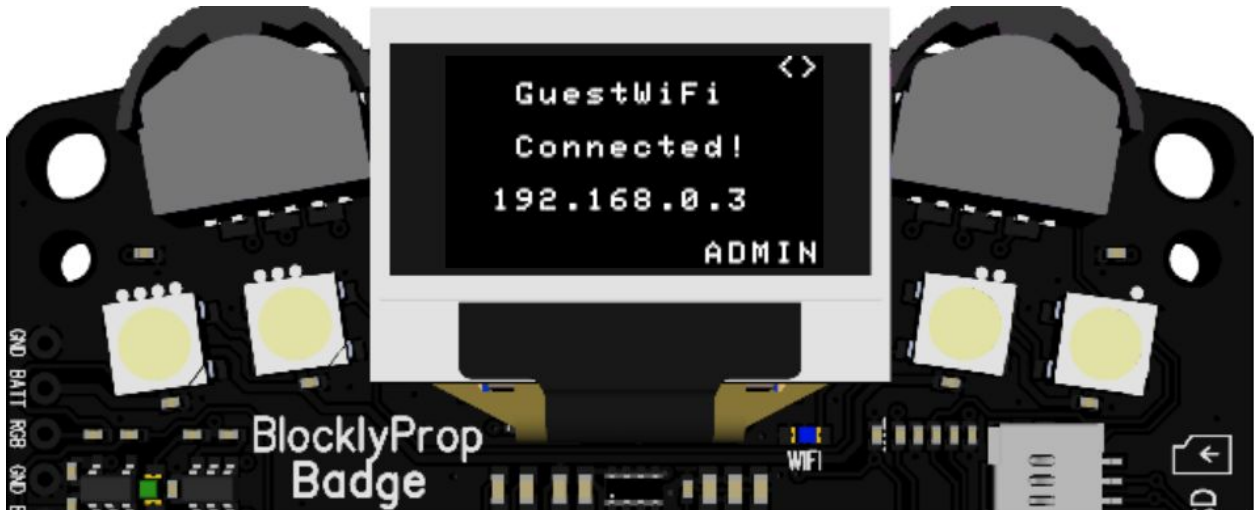
The Admin menu will appear, and when asked to ERASE EEPROM? press the left rocker button once inward to select YES. You will then be asked to confirm "ARE YOU SURE?", before the lower 32KB of EEprom is invalidated, where the user code is stored.

Note: The upper 32KB of EEProm is not cleared by this process. Upper EEprom is sometimes used for user data and permanent configuration settings for user code. That memory will be kept intact, and users should use their own code to clear that memory area if required.

Locking and Unlocking the Badge WX

While connected to a wireless network, your Badge WX will be accessible by anyone else on the same network! This means that without some sort of locking control, it is possible for your Badge WX settings or stored files to be changed without your knowledge.

There are three ways to unlock your Badge WX, and allow files and settings to be uploaded.

Method One - Unlock the Badge WX using the menu option

To temporarily unlock your Badge WX and allow programs to be uploaded from BlocklyProp or SimpleIDE, or to allow access to the Badge WX Configuration Website, you can use the LOAD command in the Badge WX menu.
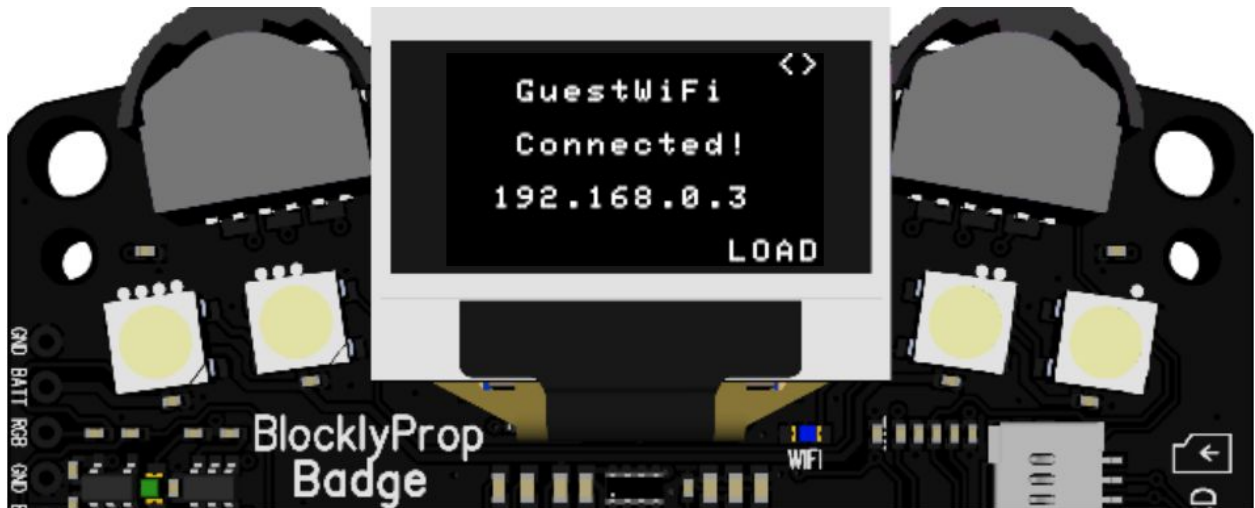
The LOAD menu option will appear when the Badge WX is connected to a WiFi network, and has a valid IP address. The two arrows (top right of the OLED display) mean that the right hand rocker button can be scrolled left or right to choose different menu options.

When you find the LOAD option, press the same right rocker button inwards once, to select the option.

Once LOAD has been selected, you will see the WiFi Programming activated message, followed by this Badge WX unique identification code. The two LED's labelled 0 and 1 near the bottom

right of the Badge WX will also blink alternately. This confirms that the Badge WX is unlocked and ready to accept wireless communications, such are loading code or changing settings.

The unique identification code is used to select this Badge WX, for example, in the BlocklyProp or SimpleIDE port or device selection list.

When you are ready to re-lock your Badge WX, press the ABORT button. Alternatively, if you had downloaded some code to your Badge WX, the lock will automatically be re-asserted after approximately 5 seconds.

Method Two - Unlock Badge WX using the power button

To persistently unlock your Badge WX at any time while the Badge WX is powered on, follow these steps:
1. Wait until the power LED is not lit and not blinking
2. Press the power button rapidly 6 times
3. While the power button is pressed in, the power LED will light to confirm
4. After pressing 6 times, the power LED will blink 6 times rapidly to confirm your Badge WX is unlocked.

With the Badge WX persistently unlocked, you are able to upload code multiple times from BlocklyProp or SimpleIDE, which is especially convenient when developing code and making many changes.

The Badge WX will remain unlocked until power-cycled, or you lock the Badge WX again with these steps:
1. Wait until the power LED is not lit and not blinking
2. Press the power button rapidly 6 times
3. While the power button is pressed in, the power LED will light to confirm
4. After pressing 6 times, the power LED will blink 6 times slowly to confirm your Badge WX is locked.

Method Three - Unlock the Badge WX from user code
The Badge WX lock state can be controlled from user code by setting the state of Propeller I/O pin 17, the "WiFi security lock" pin. I/O Pin 17 has an external 3.9 kΩ pull-down resistor to GND to ensure that the Badge WX will always be locked by default, until user code in the Propeller purposefully sets pin 17 high to signal the unlocked state.

In normal use, leave Propeller I/O Pin 17 as an input or set low, which will keep the Badge WX locked, and protected from unexpected wireless programming.

To allow the Badge WX settings to be changed, or to accept wireless program downloads from BlocklyProp or SimpleIDE, Propeller I/O Pin 17 must be set to a high state.

To re-lock the Badge WX, set Propeller I/O Pin 17 back to an input or low state. The locking can take up to 5 seconds to occur, to ensure any active wireless transactions are completed.

Note that trying to download a program that contains unlock code won't work on a Badge WX that is currently locked! First unlock your badge by one of the other methods, and then upload your code containing unlock code which will unlock the badge for future programming attempts until power is cycled or you run locking code.

In addition, you may, store a program with unlock code in EEPROM and run it from the Badge WX boot menu, or store it in an SD card as described in the advanced topic below.

Advanced Topics

Starting the Badge WX with an SD Card

The Badge WX can read WiFi network credentials to automatically connect to a wireless network, and/or run Propeller code stored on an SD card. The SD card type must be MicroSD or MicroSDHC, and must be formatted as FAT, FAT16 or FAT32. Parallax #32328 is compatible.

If the Badge WX detects a valid SD card inserted, with a valid wifi.txt file and/or autorun.bin file when booting up, you will see these messages briefly while the Badge WX is powered on:

After loading you will be automatically connected to your WiFi network, if in range and the password was entered correctly.

Your Badge WX will remember the last valid WiFi connection, so you could remove the SD card at this point and your Badge WX will continue to attempt connection to the same WiFi network at startup. Use the Admin menu to Logout WiFi to credentials if you no longer wish to use the auto-connect.

This functionality allows the Badge WX to operate without any user interaction, as the WiFi connection will be managed automatically, and the user code run immediately. Especially useful for distributing Badge WX's quickly to large groups of people.

Network Credentials

This is an example file containing WiFi network credentials:

```
GuestWiFi
happy-guest123
```

The file must be saved to the root of the SD card with filename: wifi.txt

The first line of the file must be the WiFi Access Point name, and the second line of the file must be the password (if required).

You must have at least one control character after the first line, so either <CR> or <CR><LF> is acceptable. This means you can create the wifi.txt file using any text editor in any computer, and simply press the "enter" key between entering the access point name and password.

You do not need to press "enter" after the password, but it will still work if you do!

Propeller Code

The code must be a standard Propeller binary file, and saved to the root of the SD card with filename: `autorun.bin`

If this file is detected, the Badge WX will attempt to run the code immediately after startup, bypassing the Badge WX menu system.

Start the Badge WX as an Access Point

This special technique will be required by some of the recovery methods explained in this user guide. When required, follow these steps to unlock the Badge WX and activate the WiFi module in Access Point mode.

1. Ensure the Badge WX is powered off, and has a fresh set of batteries installed.
2. Press the power button 4 times quickly, to power on the Badge WX in WiFi Recovery Mode. Notice that after pressing the button 4 times, the power LED on the Badge WX will blink back 4 times to confirm that WiFi Recovery Mode is starting.
3. Wait until the green power LED starts to repeatedly blink 4 times quickly, and the blue WiFi LED blinks occasionally on and off.
4. Using a WiFi enabled device (such as a laptop, tablet, smartphone), search for the Badge WX WiFi network and join it. The name of the network will be in the format wx-X123456.
5. Once connected, the Badge WX will be ready on IP address 192.168.4.1, and your computer device will be automatically allocated an IP address from the Badge WX in the range 192.168.4.x.
6. From now on, it is recommend to ensure your Badge WX is stationary, and that your WiFi signal is good. Moving the Badge WX may impact the signal quality and cause unexpected problems during data transmissions.

> ⚠️ **WARNING! While in Access Point mode, the Badge WX is unlocked and can accept connections from any WiFi enabled device. This means other users could connect to your Badge WX and potentially change settings or upload rogue files!**

When you have finished with Access Point mode, power off the Badge WX by holding the power button down for about 1 second. When you release the button, the Badge WX will power off, and you will notice all the LEDs will be off.

Tip! If your Badge WX doesn't appear to power off, then try holding the power button longer before releasing it.

## How to install WiFi module firmware

> ⚠️ **WARNING! This procedure is probably not required for most users! Only follow these instructions if you really want to completely replace the WiFi module firmware, and understand that no guarantee can be given as there is a risk of leaving your Badge WX unable to communicate!**

Some users may wish to install custom WiFi module firmware, or re-install the original firmware in certain situations. There are two methods which can be used to install firmware to the ESP8266 WiFi module on the Badge WX, described here in order of simplicity:

One: Use a browser to upload firmware via Badge WX configuration website

This method is recommended if your WiFi module has working Parallax Badge WX firmware already installed. You will need the new firmware file in .ota format. Follow these steps:

1. Start your Badge WX in Access Point mode (above).
2. Once your Badge WX is configured as an Access Point, and you are connected to your Badge WX WiFi network, open a browser and go to the Badge WX configuration website at this url: http://192.168.4.1 You will see the Parallax Wi-Fi Module Configuration page appear:
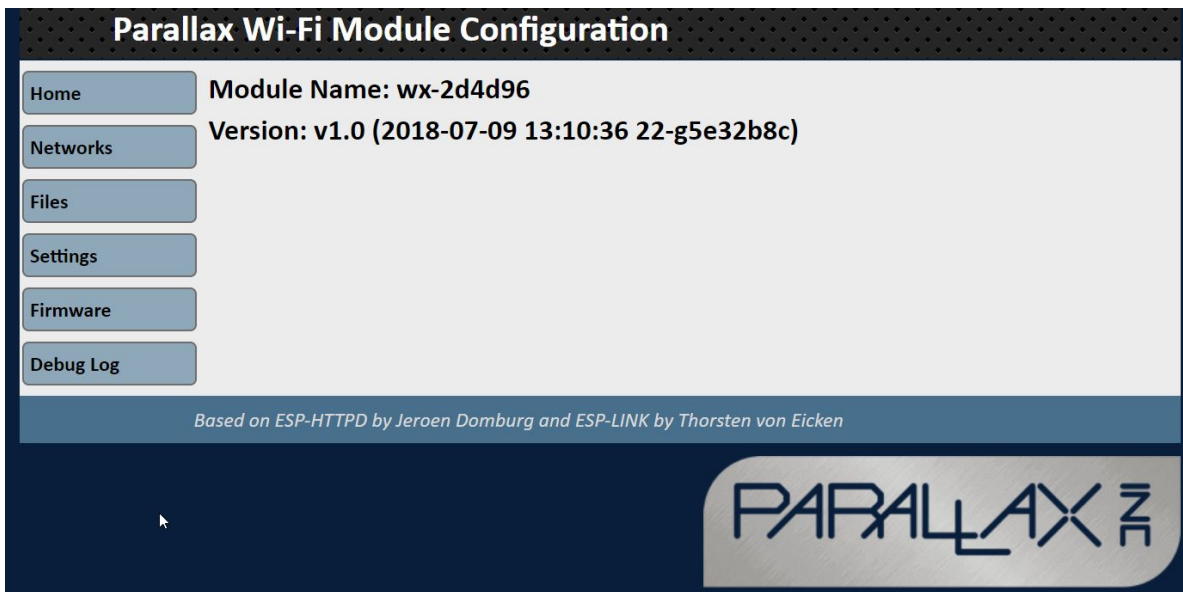
3. Select the Firmware menu on the left, and you will see the Update Firmware page appear.
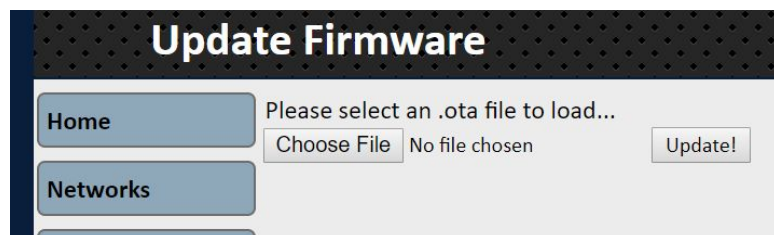
4. Click the **Choose File** button and select the new firmware file (.ota format), then click the Update! button to begin the process. You will be prompted when the firmware update has completed. DO NOT turn off your Badge WX until the update process has completed!

Two: Use a programming adapter to upload firmware directly to the WiFi module

This method is more complicated as it requires that a serial programming adapter is connected directly to the row of programming pins on the back of the Badge WX.
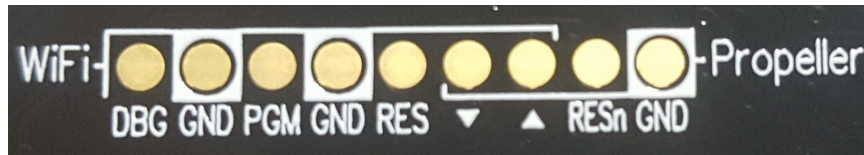
Typically a row of 0.1" spaced header pins would be soldered to the row of 9 WiFi and Propeller pads on the back of the Badge WX, and then connections made as follows:

1. Place a jumper across PGM and GND to join the pins together.
2. Place a jumper across Propeller RESn and GND to join the pins together.
3. Plug in a Prop Plug USB programming adapter (#32201) such that the Plop Plug RES pin goes to the Badge WX RES pin, and the Prop Plug TX/RX arrows go to the Badge WX arrow pins.
4. Power on the Badge WX (or power-cycle if it was already on)
5. Use ESPTOOL to flash the latest Parallax-ESP firmware. Refer to the Parallax Badge WX GitHub site for the latest ESPTOOL loading instructions:
   https://github.com/parallaxinc/Badge WX
6. Power off the Badge WX
7. Remove the jumpers and Prop Plug, and optionally remove the soldered-on header

Replacing the Badge Bootloader Code Files

The Badge WX bootloader code files run automatically when the Badge WX is powered on (or power cycled), and provide support for the SD card, and the menu system that interacts with the WiFi module allowing the user to connect to wireless networks.

The bootloader code consists of standard Propeller binary files, which are stored in the Badge WX WiFi module flash memory. The files are split into three parts, and are executed in the following order:

autorun.bin	(Loading message and bootstrap for following files)
autorunSD.bin	(Check SD card, load settings and/or run Propeller code if found)
autorunBL.bin	(Badge menu system)

These files can be replaced with future updates or user developed code. If developing your own code, the important thing to note is that the Badge WX will automatically run "autorun.bin" if it exists, so that filename cannot be changed. The other two files are executed by the code in autorun.bin, so you are free to select your own filenames, add additional files, or even combine your code into a single file!

Tip! The reason the Badge WX bootloader code is split into three files is to speed up the initial loading time, as loading a larger single code file would take longer.

To replace the default Badge WX bootloader code, you will need to follow this procedure:

WARNING! This procedure is probably not required for most users! Only follow these instructions if you really want to completely replace the Badge WX Bootloader Firmware, and understand that no guarantee can be given as there is a risk of leaving your Badge WX unable to communicate!

1. Start your Badge WX in Access Point mode (above).
2. Once your Badge WX is configured as an Access Point, and you are connected to your Badge WX WiFi network, open a browser and go to the Badge WX configuration website at this url: http://192.168.4.1 You will see the Parallax Wi-Fi Module Configuration page appear:

3. Select the **Files** menu on the left, and you will see the File Uploads page appear.

4. Click the Choose File button and in the pop-up window select the file you want to upload, followed by Open when you are ready to start the upload, or Cancel if you change your mind!
5. If you want to upload more files, then click Choose File again for each file.
6. When you are finished, close your browser and power-cycle your Badge WX to start up with the new bootloader code.

Note: Bootloader code must be in Propeller <u>binary format,</u> and saved with the abbreviated .bin file extension (not .binary). For example, the main bootloader code filename must be "autorun.bin"

Tip: If your file fails to upload, first try again. If the second attempt doesn't work, it could be that your Badge WX is locked, so either refer to the procedures for unlocking your Badge WX and try the upload again, or power-cycle your Badge WX and start this procedure again from step 1.

WARNING! In the previous image there is an option to <u>Empty the Filesystem</u>. This will completely empty the file system, which includes all of the bootloader code files! This will leave the Badge WX in a state whereby it cannot be programmed wirelessly until this procedure is followed again to upload valid bootloader code files. Do not click Empty unless you really understand what you are doing!

Troubleshooting

| Symptoms	Suggestion
Badge WX powers up and pwr led flashes, but OLED display remains blank	Check battery voltage. OLED display is not guaranteed to work if battery voltage drops below 3.5V. Refer to Key Specifications for correct battery voltage range.
Badge WX powers on and all features seem to work except the RGB LED's	Check battery voltage. RGB LED's are not guaranteed to work if battery voltage exceeds 4.7V. Refer to Key Specifications for correct battery voltage range.
Cannot program or communicate with Badge WX	Badge WX has a lock feature to prevent unauthorised programming of your Badge WX over the wireless network. Refer the the section on Programming your Badge WX.

Open-source Design Files

The Badge WX is an open-source hardware project. The schematic, bill of materials, and DipTrace design files are available from the Downloads section of the 20300 product page at www.parallax.com.

Refer to the Badge WX schematic to take full advantage of the Expansion socket, and the many Expansion Access pads on the back of the board for hacking.

The battery pack is held onto the Badge WX with double-sided sticky foam tape. It may be removed, allowing the Badge WX PCB to be physically integrated to a project using those thru-holes.

If creating custom acrylic covers, perhaps, to include branding, graphics and colors, choose a material that is 1.5 to 1.6 mm thick with 2.5 mm mounting holes, and at least a 4 mm hole for the pushbutton.

PCB Dimensions
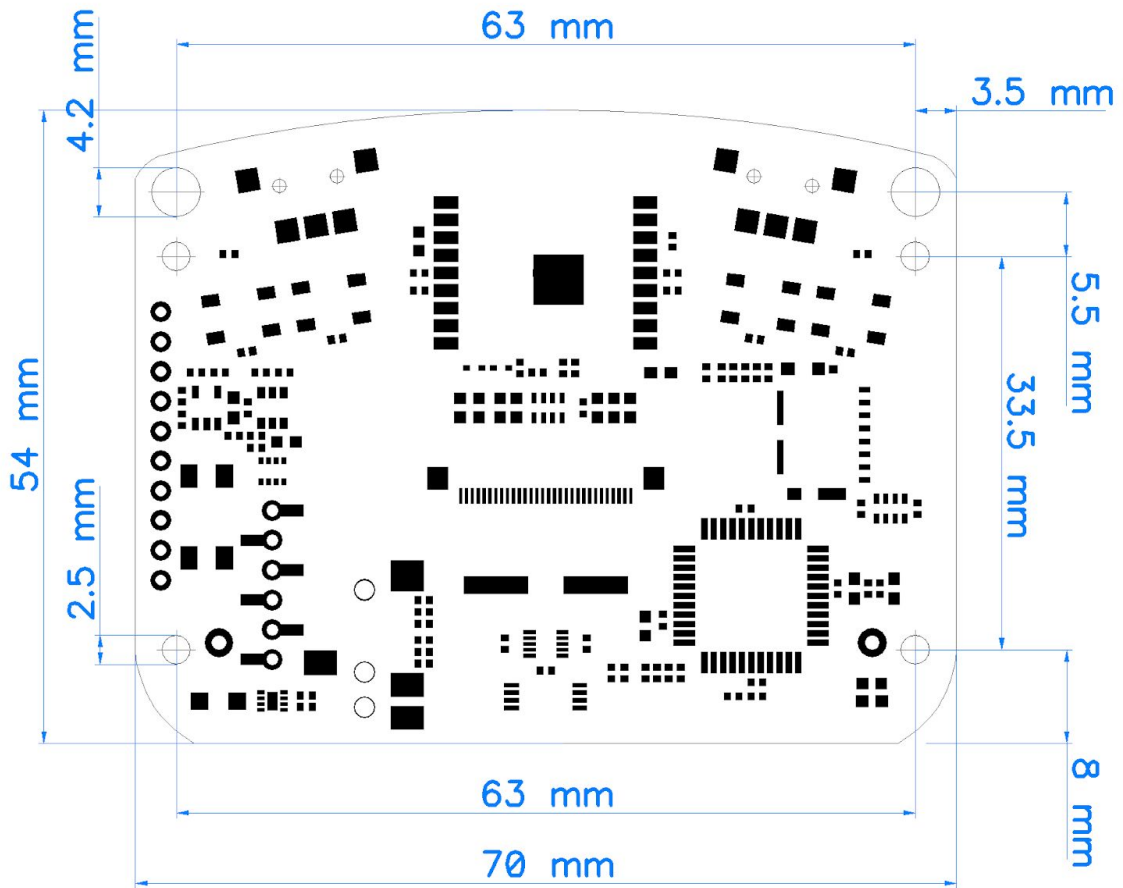
Revision History

Version 1.0: original release.

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