BrewManiacEx Manual

Version 0.2.1 draft v2
Mar. 14 2017

1.Sensor Configuration

There are two configurations of BrewManiacEx: single sensor and multiple sensors.
It is necessary to assign and identify the sensors before use for multi-sensor configuration.
For single sensor configuration this is not necessary, you can however use just one sensor in multiple sensor configuration, but sensor setup is still necessary.
For multi-sensor configuration, the sensor setting must be configured before all other functions.

2.Settings

2.1 PID-PWM

Setting	Values	Description
Constant kP	-100~100	PID parameters (can be auto tuned.)
Constant kI	-100~155	PID parameters (can be auto tuned.)
Constant kD	-100~100	PID parameters (can be auto tuned.)
Sample Time	1500~3500	PID algorithm parameters
WindowSet	4000~7500	PID algorithm parameters. It should be greater than 2x Sample Time
Heat/PWM in Boil	0~100	The default PWM after Boil Point reached.
Sensor Calibration	-5 ~ +5	Calibration value of sensor(s)
PID Start	1 ~ 3.5	PID will be applied when the difference between the current and the set temperature is smaller than this value. For example, if set point is 65, and PID start is 1.5, then the PID will be applied when the temperature reaches 63.5. Before that, the heating is full-on.
PID when Doughing-In		If "NO", the heater will be turned off after temperature reached and "Continue? OK" is confirmed, before "Mash-in OK" is pressed. If "YES", the PID will be applied during doughing in, the setting temperature will be the temperature of first mash rest.

Note1: for multi-sensor configuration, the "calibration value" should be the the number of sensors.

Note2: PID is used to maintain the temperature of the mashing stages only. For the boiling stage, or when the setting point is greater or equal to boiling temperature, the heating is full-on until the boil temperature is reached. After reaching the boil temperature, the heating output is controlled by PWM.

2.2 Unit Parameters

Setting	Values	Description
Temperature Unit	°C/°F	Celius or Fahrenheit
Disable Delay Start	No/Yes	Yes: Disable Delay Start
Boil Temperature	80-120°C 176-248°F	The temperature regarded as "Boiling". Note: the set temperature must be greater or equal to this setting to be regarded as "boiling". PWM is enabled once the measured temperature is greater than the set temperature AND the Boil temperature.
Pump Cycle	5 ~ 15	
Pump Rest	0 ~ 5	Set to 1-4 to enable auto pump rest. During mash stages, pump will run for "Pump Cycle" time and stop for "Pump Rest" time.
Pump PreMash	OFF/ON	Turn on pump before Mash-in.
Pump on Mash	OFF/ON	
Pump MashOut	OFF/ON	
Pump on Boil	OFF/ON	
Pump Stop Temperature	80-120°C 176-248°F	The temperature at which to stop the pump.
PID Pipe	Passive/ Active	Active: PID control is effective during "Malt-Out". Passive: No PID temperature control after Mash-out and before "Malt-Out".
Skip Add	No/Yes	Skip asking "Add Malt", go direct into first Mash step after "Mash-in" temperature reached.
Skip Remove	No/Yes	Skip asking "Remove Malt", go direct into Boiling after mashout.

Skip Iodine	No/Yes	Skip iodine test, go directly to Mashout after last mash step.
Iodine Time	0-120	The time to wait for iodine test.
Whirlpool	Off/Cool/Hot	The time to run Whirlpool. Off: no whirlpool Cool: whirlpool after cooling phase. Hot: whirlpool before cooling phase.

2.3 Sensor Setting

Connect all the sensors, and run sensor setting before all other actions.
The maximum number of sensors supported is 5.
There are two steps in sensor setting, **identifying sensors** and assigning **sensor usage**. In the first step, the sensor is identified and assigned to a *number* as its ID. In the second step, the primary sensor for temperature control and the auxiliary sensor reading to be displayed are assigned for each step, including Pre-Mash, Mashing, Boiling, Cooling, Manual mode, and Main screen.

Step 1: Assign sensors

Assign the sensor to the number displayed, #1 in this picture. Use up/down to change sensors. The last 8 digits of the sensor address and current temperature reading is displayed. *To get updated temperature reading, use UP/DOWN to change to other sensors and get lastest reading.*

Step 2: Assign sensor usage
Only two readings can be displayed on the 20x4 LCD, the **primary** one is used for temperature control while the **auxiliary** one is for display only. The primary and auxiliary sensors can be set for the following stages: Pre-Mash, Mashing, Boiling, Cooling, Manual Mode, and Main screen. The reading of primary sensor is always the number at *TOP* or *LEFT*.
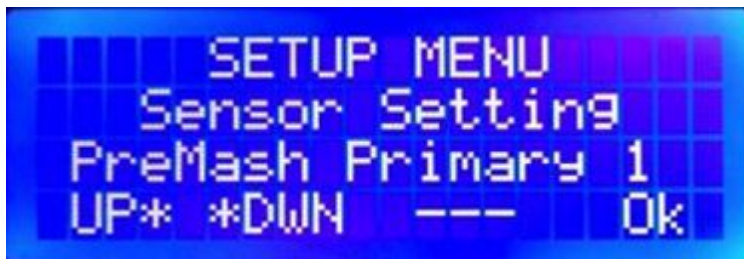
Note: if temperature controlled sparge water heating control is applied, the secondary reading is always the sensor assigned to the sparge water temperature during Mashing.

2.4 Sparge Water Heating Control

The advantage of using sparge water heating control is that the sparge heater and main heater will run **exclusively** so that they can share one 120V/20A GFI socket(loop) (American system)

The heating of sparge water can be temperature controlled if required. If temperature control is not applied, the heating is ON when the main heating is OFF, in this case the temperature of the sparge water should be controlled manually or by another controller. The temperature control options are only available in multi-sensor configuration.

Setting	Values	Description
Enable	No/Yes	disable/enable the sparge water heating control
Temp. Ctrl	No/Yes	Whether or not to control the temperature of spage water heating
Sparge Sensor	1-[max sensor id]	the sensor id for sparge water
Sparge Temp	75 ~ 80°C	the desired temperature for sparge water
Temp. Diff	0.5 ~ 2.0°C	the temperature range to keep

3. Manual Mode and PID autotune

3.1 Manual Mode

In manual mode, the heating system the and pump are controlled manually.
The time starts running when the temperature reaches the set point, and it will be reset when the set temperature is changed 1 degree away.

Press "Heat"(Enter) and "Pump"(Start) buttons to set Countdown timer. The time display will blink to indicate the edit mode. Press "Heat"(Enter) and "Pump"(Start) again to finish countdown editing mode. The countdown will begin when the set temperature is reached. After the countdown finishes, there will be a buzzing sound and the time starts to count "up".

3.2 PID AutoTune

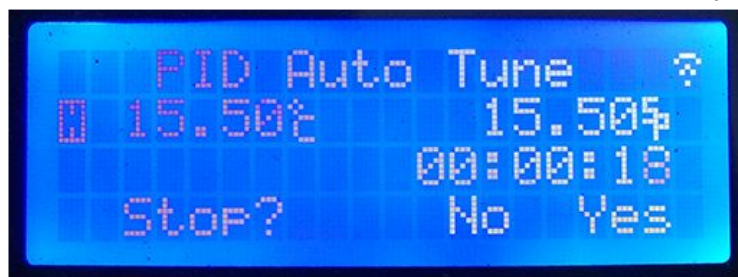The PID autoTune function is used to derive the kP, kI, and kP values. To run PID AutoTune:

1. Add water
2. Enter Manual Mode, set the desired temperature to the temperature you usually mash at.
3. After the set point is reached, **LONG PRESS the "Heat" button**, and answer "Yes" to enter PID AutoTune.
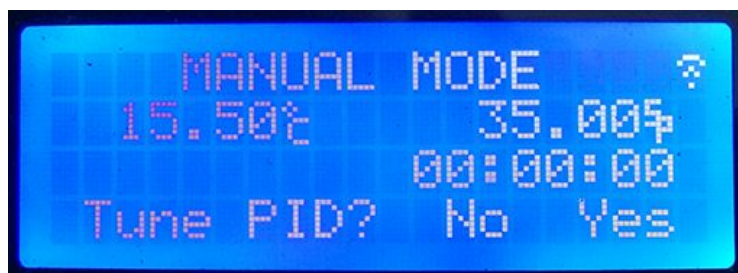
4. The PID AutoTune function will run to get the optimal parameters which can keep the temperature steady at current temperature.

5. When the process is finished, the parameters are stored automatically. The controller will return to Manual mode. You can stop the auto tune anytime before it finishes.

Note:
The PID AutoTune function derives the optimal parameters by kicking the target either way and seeing how far and how quickly it goes. Therefore, the parameters derived are best for the conditions in which it runs. To get the best result, use the same volume of water as your brew size, and put your device in the place where you usually brew. Running the PUMP is also recommended if the pump is on during mashing, which is usually true.

4. Brew with Automatic mode

Automation is the heart of BrewManiacEx controller. The brew process starts from heating strike water to optional whirlpool and cooling. It prompts for user interactions, including:
-Malt In
-Malt Out
-Iodine test
-Hop throwing

4.1 Setup Automation

Before starting automation, the mash schedule, boil time, and hop time need to be specified. To edit the automation procedure, enter "Setup" then select "Automation".
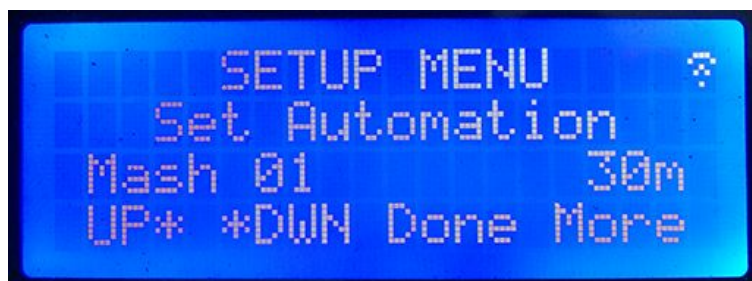

The first item to edit is the temperature of "Mash In", or the temperature of the strike water.

Then, specify the first mash step temperature:

and, the rest time.

After entering the time by **Up/Down** buttons, press "**Done**"(Start button) if this is the final mash step(rest), or "**More**"(Enter button) if more rests are needed.
Repeat the input of temperature and time until all steps are input or the maximum 6 steps are input.

Then mashout temp and time:

Input number of hops, **Boil Time,** and the time of each hop.

The automation settings are saved. Therefore, if the same recipe is brewed, it is not necessary to setup again.

4.2 Running Automation

The automation will run through the brew process that is specified by the automation setup. When user interaction is needed, it will alert the user.
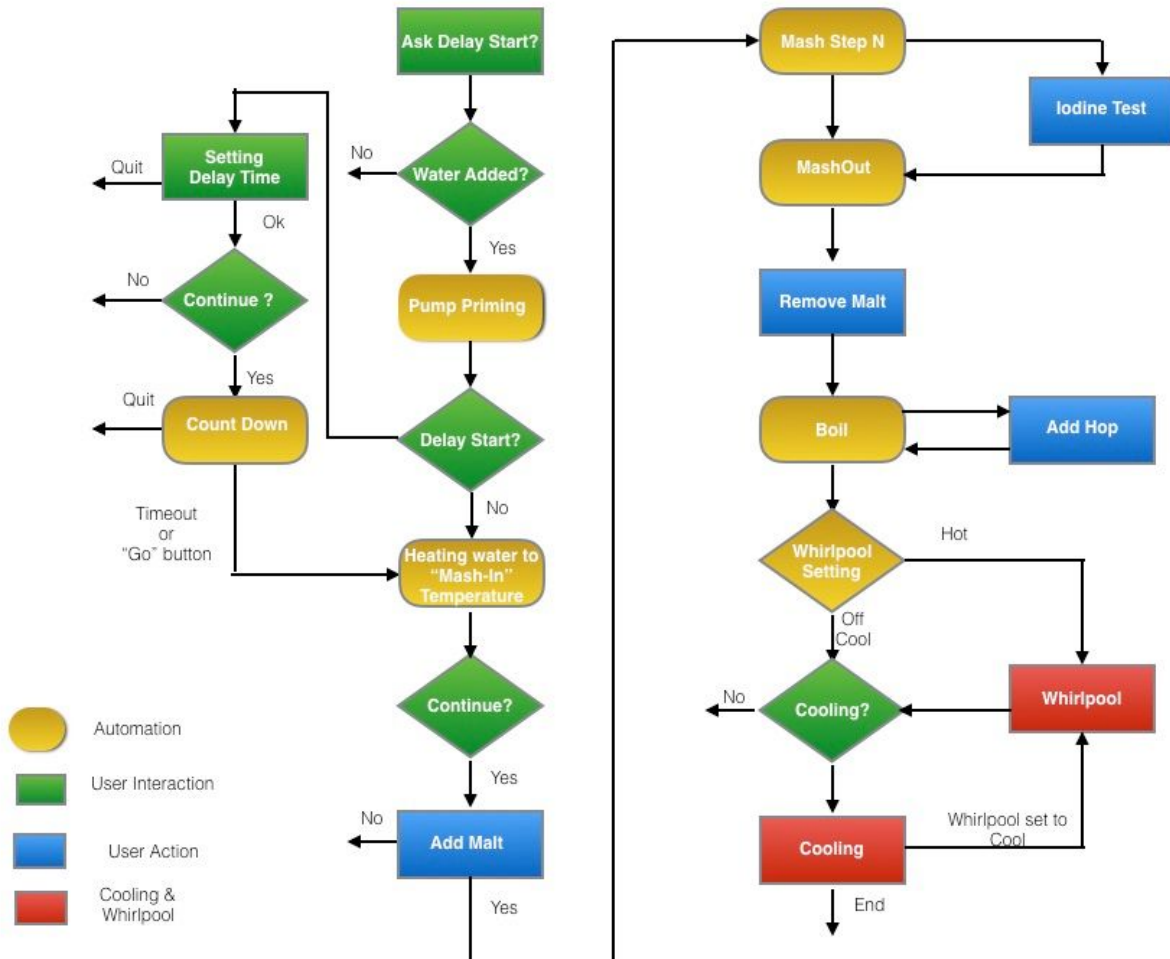
During automated processes, like mashing and boil, additional control is possible. For example, the mash step can be skipped, and the pump can be controlled manually during mashing and boiling.

Automatic Brewing Screens:

- Delay Start

AUTOMATIC MODE
Delay Start?

No Yes
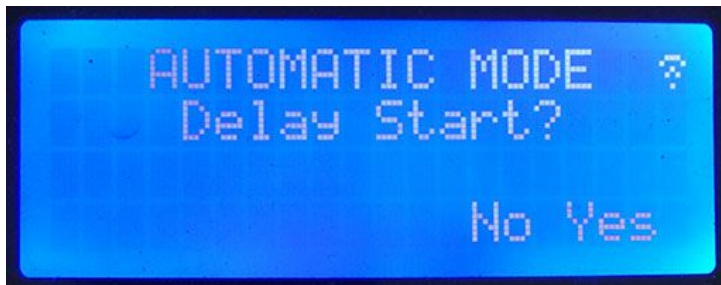
If "Disable Delay Start" is set to "NO", you will have the option to delay-start the brew.

- Edit Delay Start Time

AUTOMATIC MODE
Setting Delay
00:30:00
Up   Dwn   Quit   Ok

Use Up/Down to change the delay time. 15min a step.

- Delay Start Waiting

AUTOMATIC MODE
To be started in
00:29:54
Quit   Go

The brew process will begin after the time counts to zero.
Go: start immediately.
Quit: quit the brew.

- Mashing

Up/Down: adjust the setting temperature.
PmPus (Pump & Pause): Press to toggle pump.
Long press to Pause the brew.
STP: long press to skip this step.

- Paused

Paused mash step. The brew is paused until "Exit" pressed. The timer is stopped, as well as the pump and temperature control(heating).

- Skip Mash Step
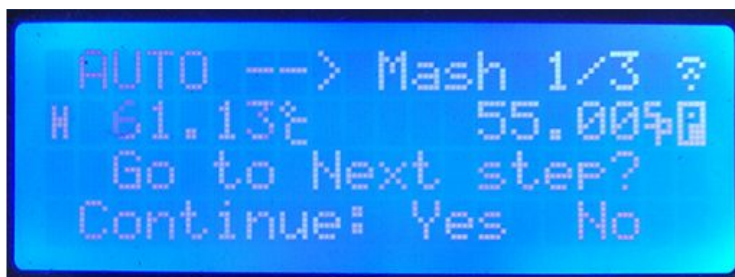
The mash step can be skipped by LONG PRESS the "STP" button. Press "YES", and the step is skipped.

- Before Boiling

Up/Down: adjust target temperature.
Pmp: toogle pump.

- Boiling
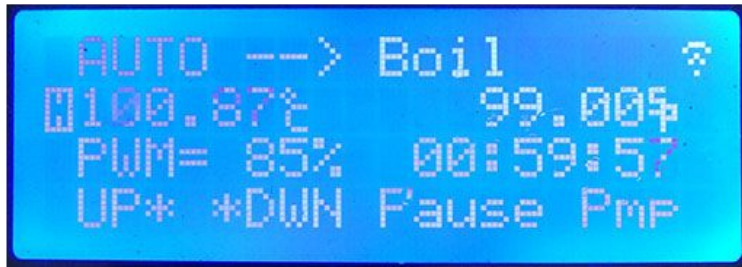
Up/Down: adjust target temperature or PWM.
Pause: pause timer. The timer will paused, but the heating control remain active. Use this to extend boil time when needed.
Pmp: toogle pump.

Note: Only when the temperature is higher than **Target Temperature and the Boil Temperature** will the heating be controlled by PWM, the PWM value will be shown.

4.3 Automation Resumption

If a brew is not ended "normally" before the Boiling stage finishes, the brew is considered "unfinished", and BrewManiacEx will ask for resumption when entering automation.
The system will try to resume from last step.

5. Web Interface

5.1 Serving page

BrewManiacEx will try to connect to the previously connected network at startup. If the connection is successful, the IP address will be shown. If it can't connect to the network, it will stay at the "Setup Network.." screen and setup a network named "bm". Using a computer or phone to connect to that "bm" network, and specify the WiFi network and optional password. If BrewManiacEx connects the network successfully, it will show the IP address on LCD.

The web interface can be accessed by browsers that support HTML5 and SSE(ServerSideEvent), like **Chrome** and **Safari**. Microsoft IE and Edge are **not** compatible due to lack of SSE support at the time of writing.

The hostname which by default is 'bm', can be used if mDNS is supported by your phone or computer, which is true for Apple's products. The serving page can be accessed from

http://bm.local
or
http://*[IP Address]*

5.2 Main/Panel

This tab is used to control and watch the status of BrewManiacEx. There is a "cover" above the buttons to prevent fat fingers.
NOTE: it is not recommended to control the brew remotely.

5.3 Settings

Panel			
Settings			
Automation			
Recipes			
Brew Logs			
Network			
Calculators			
About			

BrewManiacEx

Settings Set Save

PID — PWM	
Constant kP	-
Constant kI	-
Constant kD	-
Sample Time	-
WindowSet	- ms
Heat/PWM in Boil	- %
Sensor Calibration	-°C
PID Start	- °C
Unit Parameters	
Temperature Unit	°C
Disable Delay Start	-
Boil Temperature	- °C
Pump Cycle	- minutes
Pump Rest	- minutes
Pump PreMash	-
Pump on Mash	-
Pump MashOut	-
Pump on Boil	-
Pump Stop Temperature	-°C
PID Pipe	-
Skip Add	-
Skip Remove	-
Skip Iodine	-
Iodine Time	-
Whirlpool	-
Sparge Water Heating Control	
Control Sparge Heating	-
Temperature Control	-
Sensor Index	-
Target Temperature	-°C
Temp. Difference	-

5.4 Automation

5.5 Recipes

Recipes are created by the import of BeerXML files. The imported BeerXML should have the following information so that it can be used and translated into automation settings:
- Boil time
- Mash profile

The following fields are also referenced if available
- Hop and other additions schedules
    - The information will be translated into time of "Hop#1", "Hop #2", etc.
- Water amount of first mash step
    - If the mash-in temperature is set to "calculated", this field is used in the formula to derive mash-in temperature.

Other fields are display only.

5.5.1 Recipe Options

- Mash-in temperature will be inserted automatically based on the settings. The formula to calculate mash-in temperature is based on Palmer's formula.
- Temp = R * [Grain weight] / [Water amount] * ([First rest temp] – [Grain temp]) + [First rest temp] + [Equipment Adjustment]
- R: is the heat capacity coefficient of grain.
- General speaking, the "Equipment Adjust" should be a minus value because the kettle is at the "mash-in" temperature when doughing in.
- A mash-out is necessary for BrewManiacEx. If the last mash step in the BeerXML recipe is in the mash-out range(>75°C), it will be regarded as the Mashout step. Otherwise a "Default Mash Out" will be inserted automatically.

5.5.2 Import

Used to import the beer.xml file

- Your BeerXML file may contain more than one recipe, if so you can select your desired recipe.
- You can "Save" or "Brew" your recipe only if it specifies at least the Boil Time and Mash Profile.
- The saved name can't contain special characters and spaces. The maximum length is 28.
- Caution: Using the same recipe name as an existing saved recipe will overwrite the existing saved recipe.

- You can "Brew" a recipe without having used "Save". Pressing "Brew" button will set the automation settings.
- The "Mash-In" temperature is derived from the settings at the time it is shown. The "Mash-out" is set to a default if it is not present in the imported BeerXML file. **The original BeerXML is saved**, and you can have different Mash-In and Mash-out(if not present in the BeerXML) if you change the options before "viewing" a recipe

5.5.3 Saved recipe view

BrewManiacEx

Options
Import

BurtonAle
DryStout
HoneyAle
Porter

Recipe

Delete   Brew

Name	Porter					
Style	15A-Robust Porter					
Batch Size	5.00Gal					
Boil Time	60Min					
Efficiency	OG	FG	ABV	Color		IBU
72%	1.054	1.018	4.7%	● 44.9		29.5

Fermentables				
Fermentable	Weight	PPG	Color	Note
Pale Malt (2 Row) Bel	8.00lb	37	3.2L	
Black (Patent) Malt	1.00lb	25	500L	
Caramel/Crystal Malt - 10L	1.00lb	35	10L	
Chocolate Malt	0.50lb	28	350L	
Munich Malt - 10L	0.50lb	36	10L	

Hops & Misc					
	Time	Name	Weight	alpha	Note
Hop#1	60Min	Fuggles	2.00oz	4.5%	
Hop#2	10Min	Irish Moss	0.04oz		Fining
		Gypsum (Calcium Sulfate)	0.35oz		Mash

Mash Profile						
	Name	Temperature	Time	Type	Water
Mash In		167.8℉			
Mash Step 1	Mash In	154.0℉	60Min	Infusion	13.75qt
Mash Out	Mash Out	168.0℉	10Min	Infusion	8.80qt

Yeast			
Name	Lab/Product	Temperature	Attenuation
English Ale	White Labs WLP002	65.0 ~ 68.0℉	66.5%

Fermentation		
Stage	Temperature	Duration
Primary	68.0℉	4.0 days
Secondary	68.0℉	7.0 days

Note:
Used For: General purpose bittering/aroma for English Ales, Dark Lagers Aroma: Mild, soft, grassy, floral aroma Substitute: East Kent Goldings, Williamette Examples: Samuel Smith's Pale Ale, Old Peculiar, Thomas Hardy's Ale

- You can "Delete" and "Brew" the saved recipes.
- You can change the options to get a different Mash-In temperature just before you "Brew" it.

5.6 Calculators

For convenience when brewing a series of calculators are provided as follows

5.7 Brew Logs

5.8 Network

The serving page can be password-protected if "Always need password" option is checked. It is not protected by default.

The username, password, and hostname can be changed in "Network Settings" page. To change the setting in "Network Settings" page, the correct username and password must be provided. *The change of network settings will be effective after next power on.*

Default values: Host Name: bm
                             UserName: brewmaniac
                             Password: rdwhahb

5.9 Update page

5.9.1 Firmware update

!!BE CAREFUL!! Uploading the wrong image might brick your controller.
The firmware can be updated by uploading new *.bin file from browser at this url

http://bm.local:8008/systemupdate

5.9.2 Web file update

!!BE CAREFUL!! Messing up the files might result in misbehavior of BrewManiacEx.
To access the SPIFFS file sytem, use the url,

http://bm.local:8008/filemanager

Take care not to mess up the files.

Be Warned! Dangerous!!!
Dangerous!!! Don't read the following content
There is a way to format the file system by which all the files and logs will be gone. The url is at http://bm.local/format-spiffs
Dangerous!!! Don't read the content brefore

5.9.3 Automatic OTA Update
Functionality currently unstable

By accessing the url below, BrewManiacEx will check the availability of new firmware and new web page files.
http://bm.local/update

If BrewManiacEx can't find the files, the update page will be present when main page is accessed. The data files can be downloaded from the network instead of using SPIFFS tool.

Appendix

A1.Q&A
Q1: PID AutoTune.
A1: Check the detail at this page:
http://brettbeauregard.com/blog/2012/01/arduino-pid-autotune-library/

Q2: First Wort Gravity?
A2: The first wort gravity is calculated based on 80% yield of grain, so it's a approximate value.

Brix of First Wort = (grain in kg) * 0.8 / [(grain in kg) * 0.8 + (water in L)]
Convertion from Brix to Gravity:

SG = 1 + (Brix/(258.6-((Brix/258.2)*227.1)))

Q3: Zero crossing relay and heater switch.
A3:
   Zero crossing relays switch ON/OFF when the voltage crosses zero, which introduces a lag or delay. If both the main heater and sparger heater are controlled by zero crossing relays, it should be fine because they will be turned on and off at the same time when the voltage crosses zero. However, if one of the relay isn't zero crossing and switches immediately, it

might result in overload of power when the turned-off zero crossing relay "waits" for the voltage to cross zero and the non zero crossing relay turns on immediately.

A minimum 10ms delay between heater switch is introduced to solve this issue. The delay might sometimes extends over 100ms because of the limitation of software structure.

Q4: Time in brew logs.

A4: The real clock time will be recorded in the brew log as long as the time is known when the brew starts. BrewManiacEx will try to get time from the internet, NTP servers, at startup. If that fails, it can still get time from the computer or phone that connects to it. Therefore, connect to BrewManaicEx before the brew starts so that it can get the time of your computer or phone if it doesn't have internet access.

Revision:

Dec 7, 2016	0.1 draft V1	Vito Tai
Jan 19, 2017	0.1 draft V2	Iain Hay
Mar 8, 2017	0.2 draft V1	Iain Hay
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