Release Notes for CPAP Lite Software

Version 2.2.6

- BUG FIX: fix assignments of Pressure and FiO2 setpoints; use 3.0 and 21.0 as default (if nothing in FLASH), don't read setpoints from knobs unless knob selection is enabled.
- NEW BEHAVIOR: flow of states between "ready to run" to "ramping" to "running" now smooth; "Pause" button now shuts down system
- NEW BEHAVIOR: the "Self Test" screen will now start a "c_factor_calibration". The old behavior was to start a "power_on_self_test", which was wrong.

Version 2.2.5

- BUG FIX: when using the HeatPlate PID loop with maximum value of 10000, the standard board smokes. Reduce the PID maximum value to 2000 to prevent board damage.
- ENHANCMENT: handle states of "running" and "pause" in the state machine

Version 2.2.4

- NEW BEHAVIOR: The output stream from "avgStream", will now include 5 extra parameters at the end: HeatWireSetpt, HeatWireActual, HeatWireControl, HeatWireError, HeatWireIntegral. (NOTE: this may be removed in an upcoming release)
- NEW BEHAVIOR: The 2 output streams "avgStream" and "pidStream" can now work together or separately. If both are requested, they will alternate (avgStream,pidStream,avgStream, etc.). The output rate can still be set with "avgStreamRate(hz)".
- FIX: the "Self Test" feature will no longer be "blocking". It will be run as a state machine, reentrant, updated every 20msecs, allowing all other normal functions to run at the same time.

Version 2.2.3

- NEW FEATURE: Create state machine and LCD screen drivers, move through screens with button control.
- HOST SUPPORT: Host can change screen by sending button changes, e.g. "button(4)" for "Next", and Host can read back screen status to know which screen to display.
- BUG FIX: In the "avgStream" make sure that FiO2 is always less than or equal to "100".

Version 2.2.2

- NEW FEATURE: Support Windows Host App (called "FlowWorks") by uploading data and status on demand to support extensive GUI interface showing sensors and controls.

- NOTE: FlowWorks on the laptop won't work with any firmware version less than 2.2.1.

Version 2.2.1

- BUG FIX: heat wire PWM now working. Now all 6 PWM controls work together.
- Convert "calibration" and "wait for blower to stop" routines to all "re-entrant" code, so nothing stalls (hogs CPU) waiting for completion
- NEW FEATURE: sendStatus and sendData commands coming from Host App "FlowWorks" now supported

Version 2.1.20

- FEATURE CHANGE: Max plate heater control value in the heat plate PID is increased from 5000 to 10000 to get the full 6A of current running to the heater plate when under PID control.
- FEATURE CHANGE: Now support knobs using encoder instead of potentiometer. Signals KNOB1 and KNOB2 will now generate interrupts (`irq_FIO2_PB00_encoder` and `irq_PRESS_PB01_encoder`), and SW1 and SW2 are connected to the other 2 encoder signals, which are combined to sense "CW" and "CCW" rotation pulses.
- FEATURE: The "power" command now will include the battery voltage of the on-board watch battery (read through the ADC)
- KNOWN LIMITATION: The "heat wire" PWM control is not working, so it is disconnected. The heat wire will NOT work in this release.

Version 2.1.19

- FEATURE CHANGE: Instead of printing out the column headers in "avgStream" every 15 lines, only print them once on startup, and never again. Put a comma at the start of every line printed in avgStream to make Excel imports cleaner.
- Example Log from TeraTerm with timestamps and commas (no headers):

```
[2021-04-01 21:36:28.216] ,000.53,000.14,01.83,00.00,20.76,19.91,20.34,27.50,021.07,000.38,000.65,001.18
[2021-04-01 21:36:28.415] ,000.53,000.14,01.83,00.00,20.77,19.90,20.34,27.50,021.07,000.38,000.65,001.18
[2021-04-01 21:36:28.614] ,000.53,000.14,01.83,00.00,20.77,19.90,20.34,27.50,021.07,000.38,000.65,001.18
[2021-04-01 21:36:28.813] ,000.53,000.14,01.83,00.00,20.77,19.90,20.34,27.50,021.08,000.38,000.66,001.17
[2021-04-01 21:36:29.016] ,000.53,000.14,01.82,00.00,20.77,19.91,20.34,27.49,021.08,000.38,000.65,001.17
[2021-04-01 21:36:29.216] ,000.53,000.14,01.82,00.00,20.77,19.91,20.34,27.49,021.08,000.39,000.66,001.17
[2021-04-01 21:36:29.416] ,000.54,000.14,01.82,00.00,20.77,19.91,20.34,27.49,021.08,000.39,000.66,001.17
[2021-04-01 21:36:29.616] ,000.54,000.15,01.83,00.00,20.77,19.91,20.34,27.49,021.09,000.39,000.66,001.16
[2021-04-01 21:36:29.816] ,000.54,000.15,01.83,00.00,20.76,19.91,20.34,27.49,021.10,000.39,000.66,001.16
```

Version 2.1.18

- BUG FIX: Make the interval in printouts in "avgStream" more precise. There was a bug where a 5Hz output rate ("avgStreamRate(5)", the default) was resulting in 220msecs period instead of

200 msecs period. This is fixed, and should give more accurate intervals for all settings of avgStreamRate(x).

Version 2.1.17

- IMPROVEMENT: Change the blower open loop startup accel from .22 to 57 to reduce startup lag. Change the closed loop accel from .04 to .77 to speed up blower speed changes. This decreases the blower lag on startup from 7 seconds to 2 seconds, and speeds up the movement between blower speeds.
- INTERLOCK IMPROVEMENT: Add a feature to limit the blower output depending on the pressure setpoint. By measuring typical blower vs. baby pressure values, I created a zone of possible blower settings, and limit the output of the pressure PID loop to these values to prevent blower run-away when the circuit is opened.
- BUG FIX: the zero_press_baby calculation is fixed to work now
- INTERLOCK: if the temperature sensors are disconnected, the heater PID loops are disabled for both the heat plate and heat wire
- INTERLOCK: if the blower isn't running, the heat wire PID loop is disabled (need air moving through the tube to reach the temperature probe near the baby, or the heat wire could run away)
- FEATURE: the up-arrow will now go through the last 10 commands (the down-arrow moves the opposite way in the buffer)

Version 2.1.16

- BUG FIX: if the temperature probe is removed, or the circuit is completely removed from the humidifier, while the baby pressure is being controlled by the PID loop, we will now just hold the blower at whatever value it was at until normal pressures are restored, then continue the PID loop. We use the baby pressure < -1.0 as the indicator that the pressure is not valid to indicate we should NOT run the PID loop for baby pressure, just leave the blower at whatever value it was at.
- BUG FIX: as a backup to the previous fix, the PID integral term for baby pressure will be limited to 511. There were situations (like opening the circuit) where the integral term would keep increasing out of control, which means the PID loop took minutes to respond while the blower was at maximum and the integral term was greater than 3,000.

Version 2.1.15

- BUG FIX: wait for blower speed to drop to 0 before continuing. Avoids problem of trying to zero pressure sensors before blower has a chance to drop to 0.
- LED strip color fully adjustable. Using command "leds(x,y,z)" the three colors R, G, B, can be adjusted, with the range in percent, 0-100. For instance bright white is "leds(100,100,100)",

dim yellow is “leds(10,10,0)”, medium blue is “leds(0,0,50)”. The 3 LED controls are now controlled by PWM signals.

Version 2.1.12

- Add “F_LEAK” to avgStream printout (at the end)
- Add “zeroBabyPress” command so if the baby pressure at “no pressure” is -0.3, this command will figure out the offset and use that to make the calculation of baby pressure more accurate
- (Move the state machine from “main.c” to new module “states.c”)
- (Fix bug in “calibratePress” routine.)

Version 2.1.9

- New repo using AtmelStart tool: EqualizeHealth_CPAP
- RTC and date and time implemented (using internal 32kHz oscillator)
- Power monitoring:
  - Bus: 24.15V, shunt: 3.711mV, current mA: 74.22mA, power: 275.42mW
- Command “calibrateFiO2” figures out the bias in the Prop Valve control for a given O2 tank pressure, typically around 73% at 50PSI.
- Tuning of FiO2 PID loop for less overshoot

Version 2.1.4

- New terminal interface
- Features:
  - Help screen, type “?” or “help”
  - Input ignores case (capitalizations don’t matter)
  - Arguments for commands are given within parentheses, e.g. “PressSetpt(2.5)” will interpret the argument as value 2.5 for the baby pressure setpoint.
  - “Backspace” and “up-arrow” supported, allows backing up to delete inputs, and up-arrow will return last command
  - Help screen shows firmware version (e.g. Version: 2.1.4) and Board Serial Number (e.g. B100104)
  - “rawStream” will output raw sensor readings at 50mS interval (e.g. 958 for pressure); inputting “rawStream” a 2nd time toggles the output off

- Typing anything will momentarily halt the stream
- “avgStream” will output converted sensor readings at 200mS interval (e.g. 1.57 for pressure)
- All output devices can be driven directly:
  - blower(200) – runs the blower (open-loop) at 200 out of maximum 511
  - propValve(50) – opens the O2 proportional valve at 50%
  - heatPlate(5000) – turns on the heater for the humidity chamber at 5000 out of 10000
  - heatWire(6000) – turns on the heater for the wire in the circuit at 6000 out of 10000
- For PID control, first set the setpoint for the 4 parameters:
  - FiO2Setpt(50) – sets the desired FiO2 reading to 50% oxygen (range 20 – 100)
  - heatPlateSetpt(50) – sets the desired heat plate temperature to 50 degrees C.
  - heatWireSetpt(30) – sets the desired circuit temperature to 30 degrees C.
  - PressSetpt(2.8) – sets the desired baby pressure to 2.8 cmH2O
- To engage active PID control:
  - toggle PIDHeatPlate – will actively servo on the heatPlateSetpt
  - togglePIDHeatWire – will actively servo on the heatWireSetpt
  - togglePIDFiO2 – will actively servo on the FiO2Setpt using the proportional valve
  - togglePIDPress – will actively servo on the Baby Pressure using the blower
- “pidStream” will output the control and setpoint values for all the PID loops
- “pidDump” will output the PID loop values once, plus the PID constants: kp, ki, and kd.
- “showFlash” will show all the values that are primed to be stored in FLASH, or have been loaded from FLASH at startup
- “saveAll” will save the parameters in FLASH, e.g. c_factor, pressure offsets (from zeroSensors), and setpoints
- “SerialNumber(B100104)” will set the board serial number to the argument (e.g. B100104) and will be permanently stored in FLASH after the command “saveAll”.
- Reboot – will allow the board to be reset from the terminal (e.g. to abort all PID functions)
- “calibrate” – runs the “zeroSensor” command to calculate the pressure sensor offsets at no pressure, then runs the blower at several different speeds and calculates c_factor for the given disposable rig. These calibrated values will be permanently stored in FLASH with the “saveAll” command
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