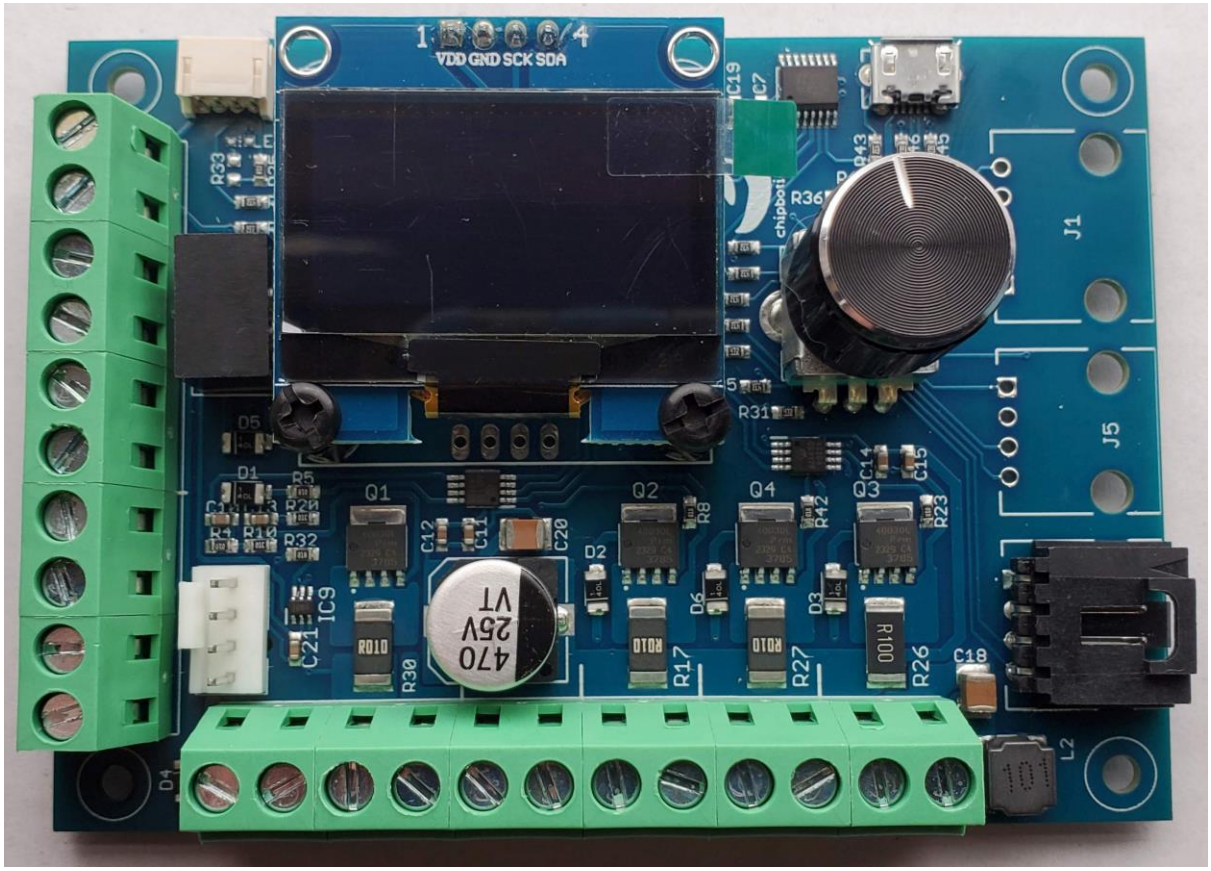
Incubot User Manual

Environmental Controller



Description

Incubot is a closed loop environmental controller designed to control temperature, air flow and humidity within small and medium grow chambers such as plastic tubs and grow tents. Heater and fan outputs are variable power, rather than on/off, thus providing more stable conditions.

Temperature and humidity sensors, fans and heaters can be connected. The system accepts a nominal 12V power supply, which is used to power the fans and heaters. The sensors are powered 3.3V.

An OLED screen displays the current environmental conditions and using the rotary knob, targets and other settings can be adjusted.

Features

- Closed loop temperature control with auto-tune.
- Closed loop air flow control using main fan.
- Closed loop humidity control using main fan and optional fan-based humidifier.
- Environmental conditions and targets shown on screen.
- Easily adjustable targets and parameters using screen and rotary knob.
- Supports SHT2x I2C combined humidity & temperature sensors.
- Supports 1-wire DS18B20 temperature sensors.
- Drive up to 10A heaters.
- Drive a standard 12V fan for air flow control; either 3-wire or 4-wire.
- Drive a standard 12V fan for humidity generation; 2-wire, 3-wire or 4-wire.
- Software updates over USB.
- Safety features include current limiting / fault protection, input power monitoring and disabling outputs in case of a sensor fault.

Chamber Setup

The grow chamber is an enclosed space containing a heating element such as a reptile mat, a fan that draws in external air (to be exhausted elsewhere), optionally a humidity generator as well as temperature and humidity sensors. Here are some considerations for laying out a grow chamber.

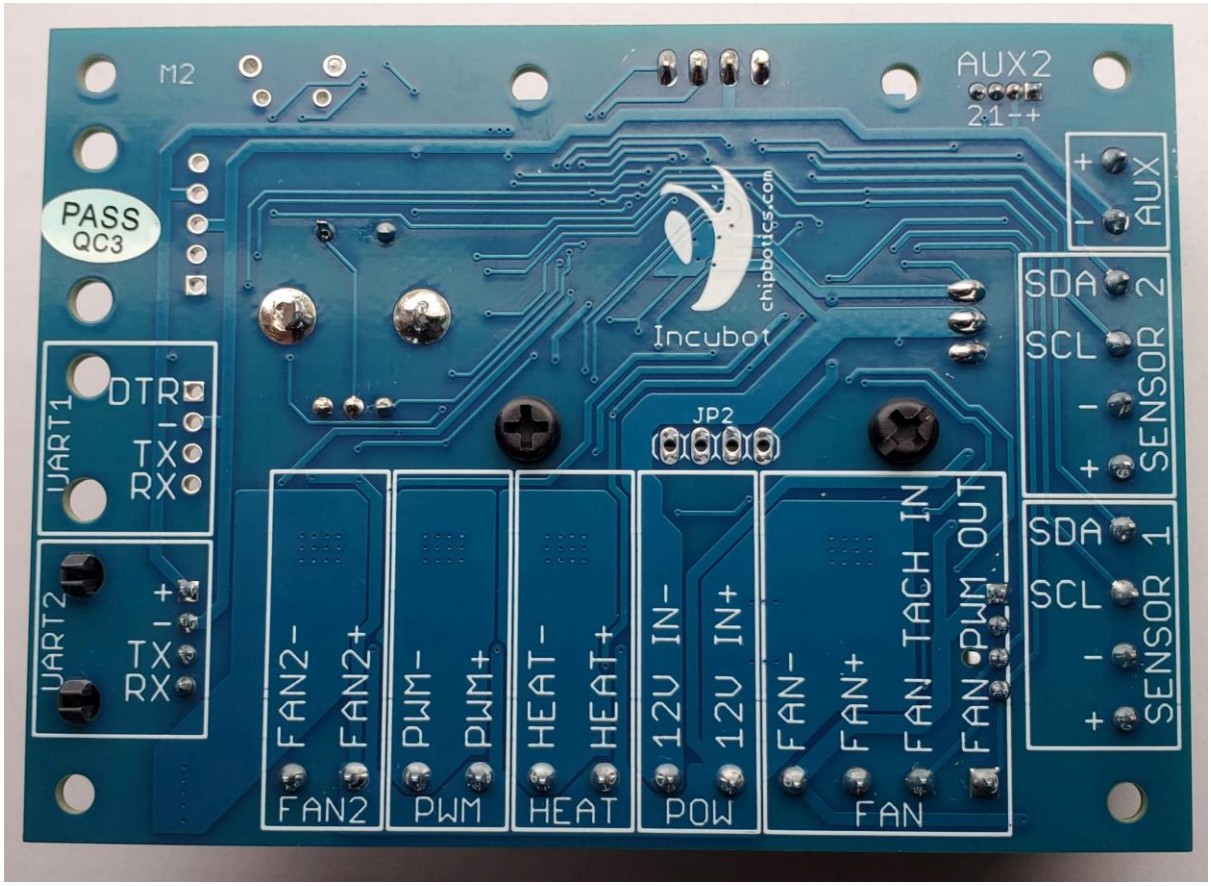
The temperature and humidity within such a chamber are never perfectly distributed and the layout of above components affect this distribution. To maintain 20 degrees Celsius within the chamber, for example, the heating mats may be 30-40 degrees and thus placing a mycelium bag directly on top would be unwise. Consider placing the heating mats against the sides of the chamber or raise the mycelium bag using a baking cooling rack, for example. Consider adding a recirculation fan.

The location of sensors within the chamber should also be considered. The air near the inlet fan will likely be cooler and drier than the rest of the chamber and the air near the humidity generator more humid. Also consider if the temperature sensor is accidentally outside the chamber, then the heater will run at full power and overheat the chamber, because it is measuring the cool air outside. (A catastrophe could be alleviated by limiting the maximum heater power output in the menu.)

Locating both what you are growing and sensors away from any extremes is a good approach, as well as air flow ventilation.

Experiment and let us know if you have any suggestions we can add in this section.

Physical Connections



Connecting It Up, Step By Step

1. Safety first. Always keep in mind that this device drives heaters that get hot and has components that can get hot and thus fire risk must be considered and negated. Take care to connect wires to the correct terminals, double check the polarity and avoid shorts.
2. Make sure the circuit board is not placed on anything metallic, which could cause a short.
3. Connect a 12V supply to the screw terminals marked “12V In +” and “12V In -”. The wires must be thick enough to carry the required currents without producing a substantial voltage drop. Simply, thicker is better. We recommend at least 16 AWG (1.29mm core diameter). **Double check the polarity - this device will not tolerate incorrect polarity!** The display should come on and show the environmental conditions screen.
4. To avoid mistakes, turn off the power before connecting each new device below, double check and turn on the power to test one device at a time.
5. Connect a SHT2x combined humidity & temperature sensor to the 4-pin I2C port labelled “Sensor 1”. Check the sensor documentation to confirm which wire is which. Turning on power should display temperature and humidity readings.
6. Connect the main air flow fan to the 4-pin port terminals labelled “Fan …”. Check the fan documentation to confirm which wire is which. If you are using a 3-wire fan, the “Fan PWM Out” terminal will not be connected. Alternatively, a standard 3-wire or 4-wire fan connector can be plugged into the 4-pin fan header on the board instead of

using the screw terminals. Turn on power. Hold down the rotary knob for 1s to access the menu and navigate to the “Fan Type” setting. Select “” if using a 3-wire fan and “” for a 4-wire fan. Navigate to the “Fan Mode” setting and select “Air” if only the air flow target should be maintained, “Hum” if only the humidity target should be maintained, “Air&Hum” if both targets should be maintained or “Off” to disable the fan.

7. Connect a resistive heater (such as a reptile heating mat) to the 2-pin port terminals labelled “Heat+” and “Heat-”. Polarity is irrelevant for resistive heaters. If your environmental chamber is already set up with heater, fan and sensor mounted, you can perform a temperature autotune at this point.
8. For humidity generation, optionally connect a standard 2-wire to 4-wire 12V fan to the 2-pin port terminals labelled “Fan2 +” and “Fan2 -”. For 3-wire and 4-wire fans, only the positive and negative wires will be connected. Navigate to the “Hum Generator” setting and select “On” if using humidity generation or “Off” otherwise.
9. Alternatively generate humidity by filling the bottom of the tub with perlite and water.

Sensors

Sensirion SHT2x Combined Humidity and Temperature Sensor

- Sensirion SHT2x sensors are supported to provide humidity and temperature information. Specifically, SHT20, SHT21 and SHT25.
- This sensor must be connected to the port labelled “Sensor 1”.

DS18B20 Temperature Sensor

- If a Sensirion SHT2x is not present, a DS18B20 sensor can be used for temperature-only control. In the future it will be possible to use a combination of Sensirion SHT2x and DS18B20 temperature sensors together to use temperature data from multiple places in the grow chamber.
- This sensor must be connected to the port labelled “Sensor 2” where “+” and “-” and positive and negative, “SCL” is the data wire and “SDA” is not connected.

Heaters

Heating Mats

- Reptile heating mats are a good option for heating a small grow chamber such as a plastic tub, since they have a large surface area and thus do not need to get as hot as a small coil heater for example and require less air flow.
- When purchasing a heating mat, ensure it is a low voltage mat such as a USB, 5V or 12V mat. A 230V AC mat will not produce enough heat with this 12V system.
- Cut off the plug, expose the two wires and connect them to the heater screw terminals. Polarity is irrelevant. If the mat has a control device (allowing to set low / medium / high, for example), cut this off first.
- Multiple heating mats can be used together. Connecting them in parallel will allow a higher maximum temperature than if they are connected in series.
- The maximum heater power output can be limited in the menu.

Operation

Temperature Control

- Temperature is maintained using PID closed loop control. This requires three parameters (P, I and D) to be set correctly for each chamber setup, depending on various factors such as volume, heater resistance, external temperature and air flow. These parameters can be automatically calculated using the “Autotune” function one time once the chamber is set up.
- To initiate autotune, navigate to the “Autotune” menu setting. Specify an autotune temperature, which is typically 5 degrees above ambient temperature. If the target is below ambient temperature, autotune will not succeed. Specify an air flow target, typically the minimum air flow you expect to have. Air flow both brings in cold air, which requires the heaters to work harder, but also mixes the warm and cool air in the chamber.
- The autotune maximum power can be limited in the menu.
- Autotune can take a substantial amount of time as it warms and cools repeatedly around the autotune temperature. Best to keep an eye on it during this process as the heater will get hotter than during normal operation.
- Autotune will automatically stop when done and report success or failure. Pressing the rotary knob earlier allows accepting the current tuning progress as the new PID parameters before tuning finishes (not normally needed).

Humidity Control

- Humidity can be reduced by the main fan blowing external air into the chamber, assuming the external air is dryer than the air in the chamber. See the “Fan Type” setting.
- Humidity can be increased using a second fan blowing over a container with water. See the “Hum Generator” setting.
- Using both of the above methods together form an effective humidity control system.
- Humidity will also be increased if a water container is warmed up in close proximity to the heater, but this is a side effect, not controlled humidity generation. However, this method of increasing humidity in combination with the main fan in humidity control mode, can form an effective humidity control system in some cases.

Air Flow Control

- If the “Fan Type” setting is “Air&Hum”, the system will prioritise humidity control and once the humidity target is reached, raise the humidity generation (if enabled) and air flow in concert until both air flow and humidity targets are reached.

Display

Main Screen (Environmental Conditions)

- To change the target temperature, air flow or humidity, short press the rotary knob repeatedly to cycle through the targets. Turn the knob to adjust the target and short press again to accept. Or alternatively, long press the rotary knob to turn on/off (temperature or air flow) or select the operational mode (humidity).

Menu Settings

The menu is used to configure the system and can be accessed by long pressing the rotary knob from the main screen. Navigate by rotating the rotary knob, select an option by short pressing the rotary knob or exit the menu by long pressing the rotary knob.

To edit a number in the menu, first select a digit using the rotary knob, short press, then adjust the digit using the rotary knob and short press again. Navigate to “OK” or “Cancel” and short press the rotary knob.

Software Updates

The Incubot software can be updated over a USB connection.

At this stage the process requires the use of serial terminal software. In this example we use the Tera Term software on Windows, which can be downloaded online.

1. Connect Incubot to a computer using a Micro USB cable and power up the board while holding down the rotary knob. The Incubot screen should stay blank while in the bootloader. The computer should automatically detect the board as an FTDI USB to Serial device.
2. Launch Tera Term. Select “File->New Connection”. Select “Serial”. Select the correct serial port from the drop down box. If you have multiple serial ports, you may need to try each one.
3. From the menu select *Setup->Serial Port*. Select Baud Rate = 115200, Data = 8 bit, Parity = none, Stop = 1 bit, Flow Control = hardware.
4. In the terminal window, type “ver” and press Enter. Incubot should respond with something like “Incubot, HW 2, Bootloader v1.00”.
5. From the menu select *File->Send File*. Select the provided firmware file. The terminal should respond with:
   “0000 OK”
   “0001 OK”
   …until finally…
   “[All OK]”
6. The update is now complete and you can repower the board.