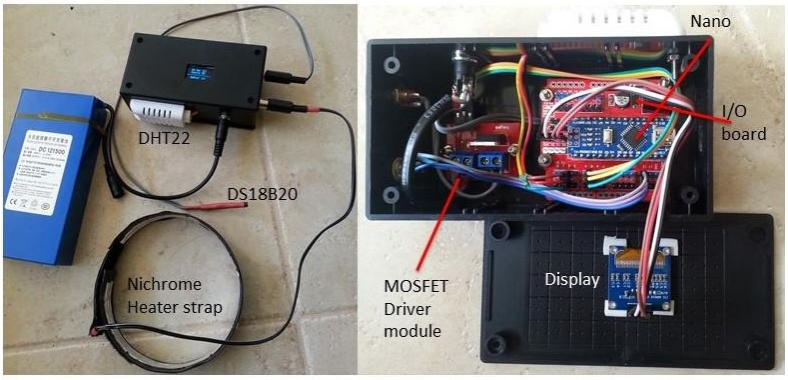
ARDUINO DEW HEATER CONTROLLER

This is relatively simple to make due to the great modular arduino units. For example, the Nano has a great extension I/O board so the components can be attached mostly with pre-made connectors. There is no circuit board making. The only soldering is for the plugs and sockets to connect it to the outside world, and a few resistors. Below are two different builds. The 1st shows it with an OLED display, DHT22 temp/humidity sensor, and just 1x heater/sensor. The 2nd with LCD display, AM2320 and 2x hater/sensors:

First build – Arduino Nano with DHT22, OLED display, 2x DS18B20/heater channels



Current build – Arduino Nano with AM2320, LCD display, 2x DS18B20/heater channels. NB: the other Arduino controller

How the controller works & software

The controller is Arduino based and feedback controlled, briefly:

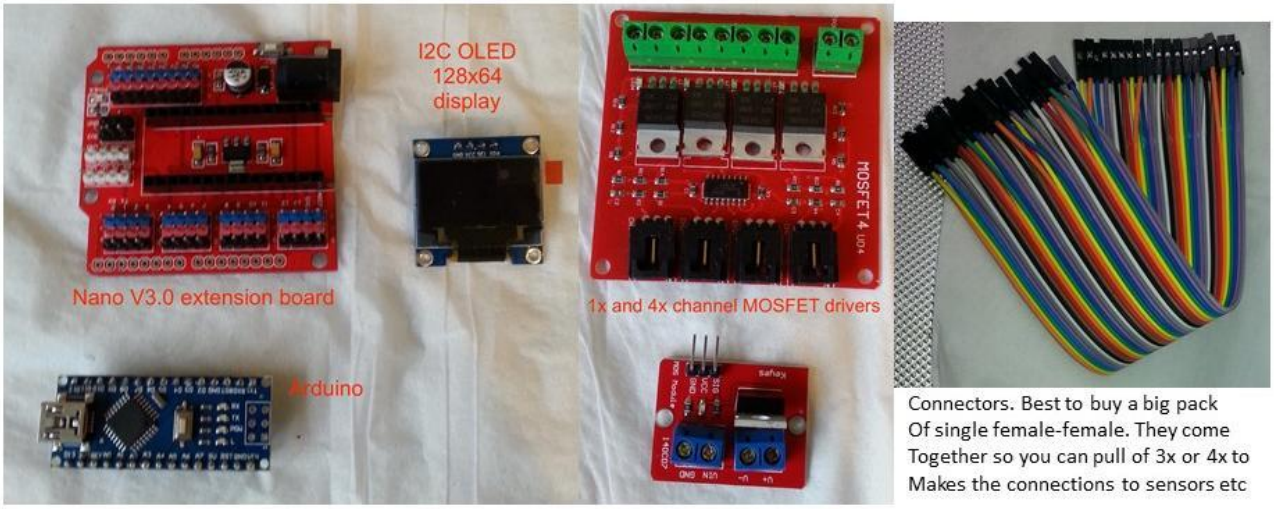
- DHT22/AM2320 senses ambient temperature & humidity. The dew point is calculated.
- DS18B20 temperature sensor placed inside the heater strap senses the temperature of the element to be heated. You'll need 1x for each item to be heated.
- Calculates the difference = heated element - ambient dew point (DS18B20 – AM2320).
- Send a PWM output to the heater strap via a MOSFET driver module from the Arduino based on this difference. I have used a threshold for activation of the heater of 5 or 6°C above ambient dew point (this can be changed in the software). So the PWM output = 0% when scope sensor is 5 °C or more above dew point, and increases to 100% when scope sensor is at, or below dew point.
- The display rotates between showing (1) the ambient temperature, humidity and dew point and (2) the heater temperature, difference to dew point, and heater drive level for each heater.
- The software will automatically determine which of the heater sensors are connected and control their heaters. The other heaters can either be turned off or set to a fixed level. These settings can be changed while it is running. To alter this press the control switch and follow the instructions.

- It is currently set up to control 1 - 2 heaters (can be altered to increase this to 4, see code for details).

Except for the heater it uses very little power. In fact, you can disconnect heater elements and their temperature sensors and it will just monitor ambient temp & humidity.

The Parts

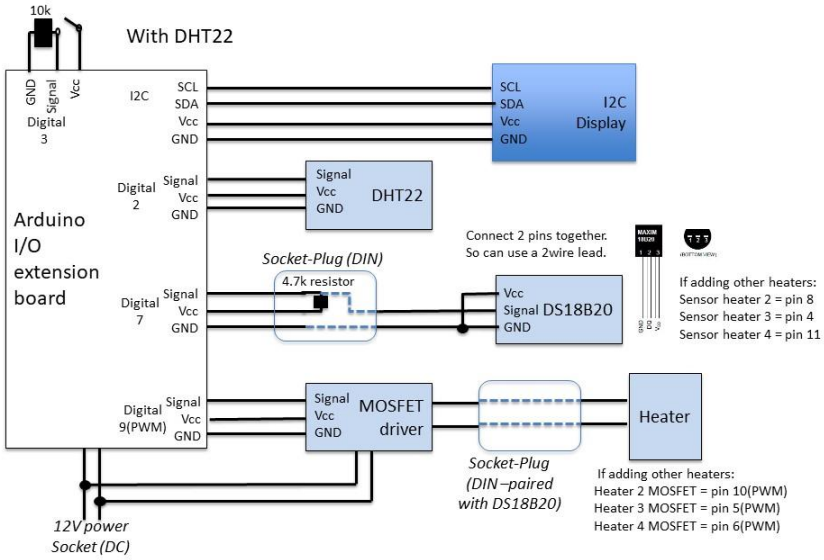
Most of these bits are available on ebay or your local electronics store.

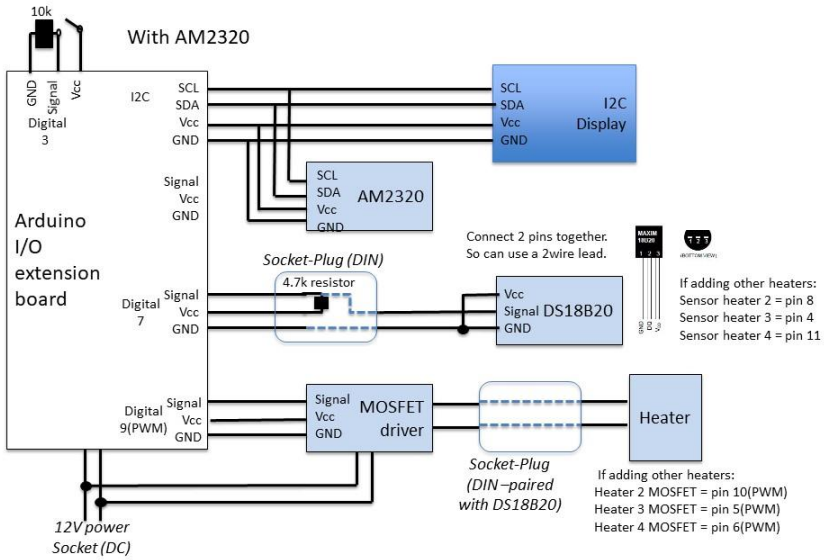


- Arduino: Arduino Nano; Nano V3.0 prototype shield I/O extension board expansion module. I've also used an Uno and Mega – both are fine.
- The ambient temperature/humidity sensor: there are a few options –
    - DHT22 Digital temperature/humidity sensor. This 1-wire sensor was the original that I used.
    - AM2320. Similar to the DHT22 but uses I2C instead.
    - BME280. This is probably better than the AM2320. I will add it in the near future.
- The heater temperature sensor: DS18B20 digital temperature 1-wire sensor (need 1x DS18B20 for each heater that you want feedback temp control).
- Display:
    - 0.96" I2C SPI serial 128x64 OLED display - it is small, so if you only want 1x heater channel it all fits in a small light (box) that I Velcro onto the scope. This was the original, but I have stopped using it
    - LCD display, 16x2, I2C. This is the current one.
    - For the displays I bought a sheet of red acetate to cover it and make it suitable for night vision.
- MOSFET driver for heater: If you only want 1 channel get a single channel module. If you want 2/4 channels there are 2/4 channel modules. I have found these deliver adequate power for guidescopes and up to an 8" SCT. ***NB: if you are worried about power and overheating, use a heatsink on the mosfet, or try a higher power MOSFET. They are available from lots of places.***
- Hardware: Jiffy box, plugs/sockets, wires and resistors.
- Heater strap: Whatever you want. You can buy commercial ones. I make my own from nichrome. Its much easier than resistors (and not difficult to connect to wire as some would have you believe). See end for building heater straps.

The circuit

The circuit and how you put it together – versions using AM2320, DHT22.





A few things to note:

- The AM2320 (or DHT22) attaches to the outside of the box. So get a 4x wire connector, cut off one end, solder to the AM2320/DHT22 leads and cover soldering with heatshrink. You'll have to solder some cut-off connectors together as there are two I2C devices and the Arduino has only one socket for I2C.
- DS18B20 is in parasitic mode - so only need 2x wires instead of 3x. So you can't go wrong wiring it up.
    - On the DS18B20 connect the 2 outside pins together and this goes to GND; the central one goes to the signal of its digital pin. If you cover up all the solder joints and its connections to the 2 core wire with heat shrink it is nice and watertight (see above pic).
    - On the I2C pins run a 2 wire connector to the socket. On the Nano board you can solder the resistor to 12V on the board.

- MOSFET driver connections = easy. But note that the mosfets require direct 12V power to them. I just use a cigarette plug/cable (to plug into a battery), run the 2 wires to a terminal block inside the box, and two separate to the Arduino & mosfet driver.
    - On the latest version I use DIN plugs/sockets. This allow you to have just one socket for each DS18B20/MOSFET heater line
- The I2C display – just needs 4x wires.
- A single pole push on button – push it to change mode, manual power etc
- Power – run the 12V input to both the Arduino extension IO board and the MOSFET driver(s).

Getting it going

Before you do the whole build its best to put it together in stages and test each bit.

1. First put Arduino on your PC or Mac.

2. Put the whole folder DewHeaterController into the folder with the other Arduino sketches

3. You'll need to upload the libraries used by this program. To do this: start Arduino & select Sketch/Include Library/Manage Libraries. An easy way is to just click on the tick to verify the program (see step 3). It will come up with errors on the #include statements for the libraries that need to be installed. You can simply type in the name into the search bar, and install it. All the libraries are:
    - LiquidCrystal_I2C – for the 16x2 LCD display (if used)
    - DHT. For the DHT22
    - Adafruit_sensor & Adafruit_AM2320 for the AM2320
    - Adafruit_SSD1306 & Adafruit_GFX. – for the OLED display (if used)
    - DallaTemperature. For the DS18B20
    - OneWire. 1-wire for the DS18B20s

4. Next you will have to select which ambient temp/humidity sensor (AM2320, DHT22), display (LCD, OLED) you want to use. Its all at the start of Globals.h.

5. Before uploading it to your arduino you need to tell it what Arduino you have. So under Tools – select Board/Arduino Nano; Processor/ATmega238 & the COM Port (this will be different on a Mac.

6. Before you install it into a case, its best to put it all together in stages to check each bit works. I have sketches that test each bit individually if you have big problems. Try it without a heater strap connect. Blow in the AM2320 – should see temp and humidity go up and power output should increase. Then connect a heater strap – check that it heats up.

7. Put it all together in a jiffy box. It has 3 modes, selected by the mode button on digital pin 3:
    - Automatic mode: heater output set by difference between scope temperature and ambient dew point. For heaters without sensors – the heater power can be set manually
    - Manual mode: heater mode manually set to 0 – 100% of maximum power
    - Off mode: heaters off, only displays ambient temp/humidity

- Reset: set back to automatic mode/0% manual power.

Heater Straps

Building heater straps is cheap and simple. Everyone has their own way of doing it, so I not going to go into detail (can put up detail if needed). I use nichrome wire – much simpler than resistors and its relatively easy to connect nichrome to wire (unlike some make out):

1. Get the correct length of nichrome (comes in 4 metre lots for $4-5 from well known electronic store) so that 12V makes its really warm but not rediculous. The size/wattage really depends upon you scope and how bad your conditions get. Connect a heater strap – check that it heats up. Later on, you can run multiple wires in parallel if you feel that it needs more heat
2. You want the nichrome nice and straight (no kinks) – to do this pull it straight by making it red hot over your stove.
3. Cover the nichrome with 1.5mm heatshrink except for 5-10 cm at each end – this will electrically isolate it. Again easier to do it over your stove.
4. Connect the nichrome to wire leads by twisting them together, soldering (it wont solder, it'll just hold it in place) then putting 2x layers of heatshrink over the top to hold the connection together. This works fine – mine has been good for a few years so far.
5. Lay the nichrome on aluminium tape - this will be on the scope side – holds it together & passes heat efficiently. You can get this from any hardware store.
6. On the other side a few layers of good gaffer tape then adhesive felt tape to keep in the heat.
7. Put a bit of Velcro on the ends to hold it together.