Pellet Extruder

Introduction:

The Pellet Extruder is a granular fed extruder system. Depositing between 7kg to 15kg of material per hour, the Pellet Extruder allows for faster printing and high throughput of material deposition. The Pellet extruder operates as a motor with a gearbox coupled to a rotating screw. As the screw spins, the coupler allows for pellets to move down the nozzle and be extruded out of the barrel. Each extruder is set up with multiple melt zones. The barrel has three melt zones along its body, to begin melting the polymer as the screw force the pellets into the barrel. The tip is also heated to prevent freeze off and the ensure that the polymer is extruding at the desired temperature for optimal printing.

Before we get started, some requirements are:

Water tubing. The system has inlet and outlet holes of 1/4 inch ID and 3/8 inch OD. The system requires that the extruder body stay below 70C.

240V single phase power outlet.

The box currently requires a NEMA L6-30R

Figure 1. NEMA L6-30R power receptacle for the machine

The mounting pattern for the Pellet Extruder is as follows:

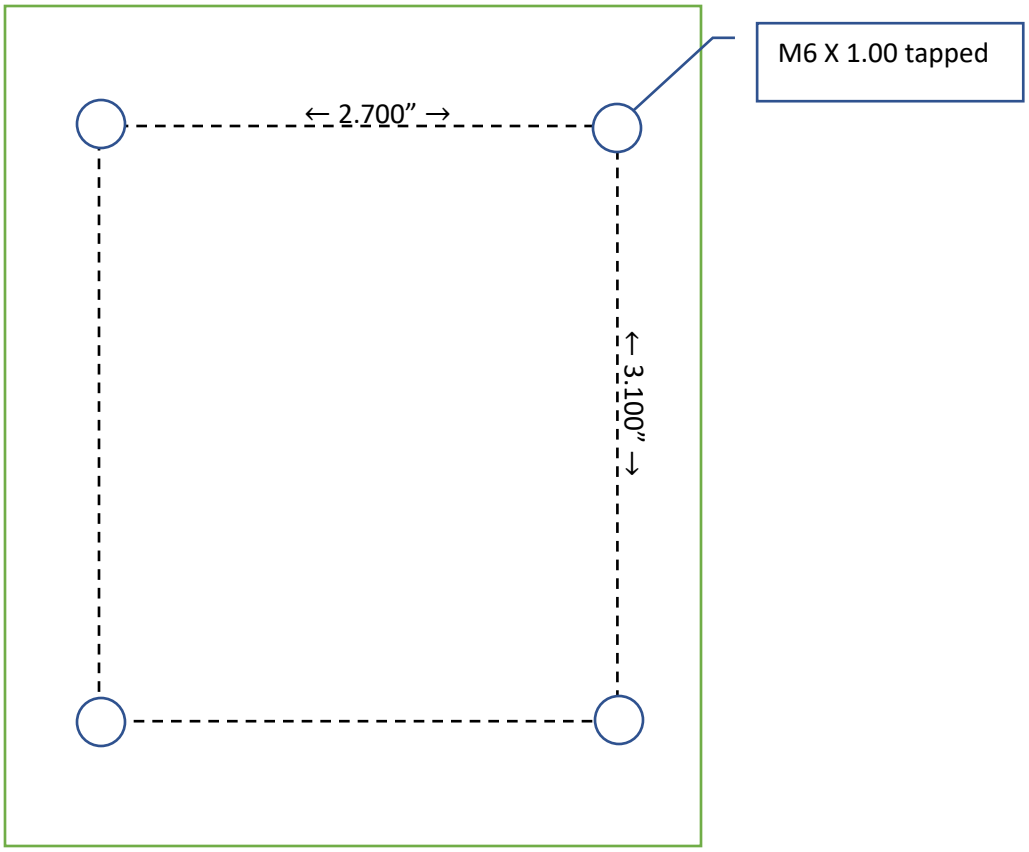

Figure 2 Mounting pattern for the Pellet Extruder. 4 M6 X 1.00 tapped holes.

Pinouts for the motor is as follows:

Motor Power Pinout	
Color	**Purpose**
Green	Earth Ground
Red	U Phase
Black	V Phase
Blue	W Phase

Figure 3 Motor Power Pinout based off of color of wires exiting the Pellet Extruder Motor

Motor Encoder Pinout		
Pin Number	**Purpose**	**Color**
1	Encoder A Non-Inverted	Gray
2	Encoder B Non-Inverted	Green
3	0VDC	Black
6	Shield / Earth Ground	Stranded
7	Z+	Yellow
8	Z-	Yellow //
11	Encoder A Inverted	Gray //
12	Encoder B Inverted	Green //
13	5VDC	Red

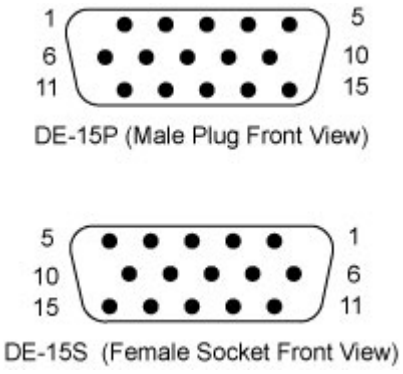

Figure 4 Motor Encoder Pinout based from DB connection from Pellet Extruder Motor

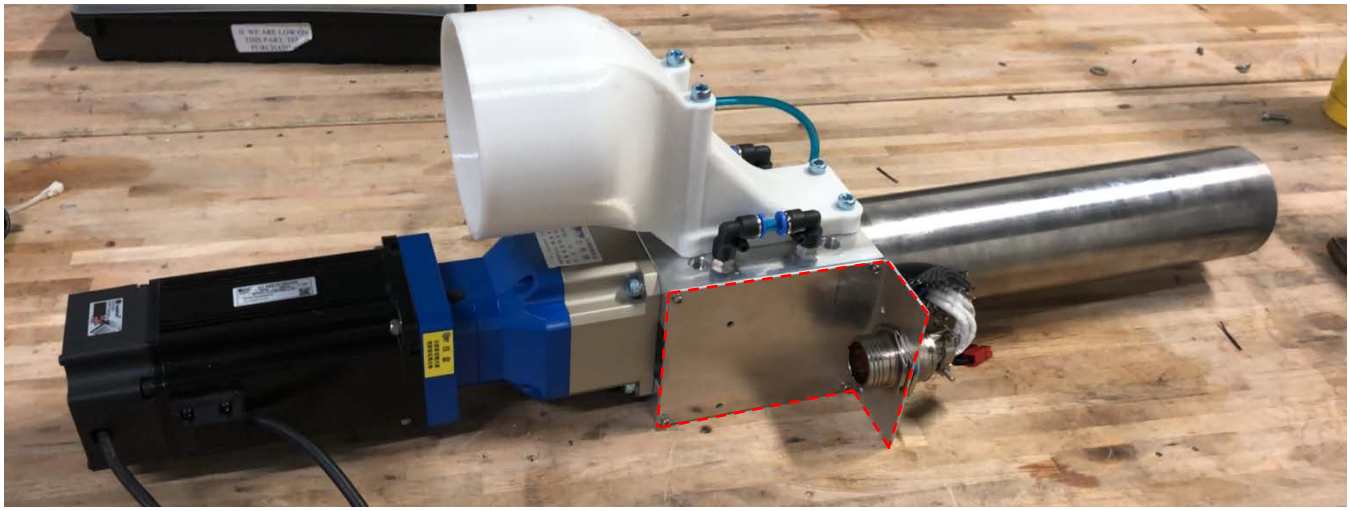

Figure 5 Pellet Extruder with Electrical Panel Outlined

Removing the electrical panel noted in the Figure 5 will allow access to the K type thermocouple connectors. Below the panel are three type K thermocouple connectors (Figure 6). Plug these male type K thermocouple connectors into the female type K thermocouple connectors exiting the pellet control box.

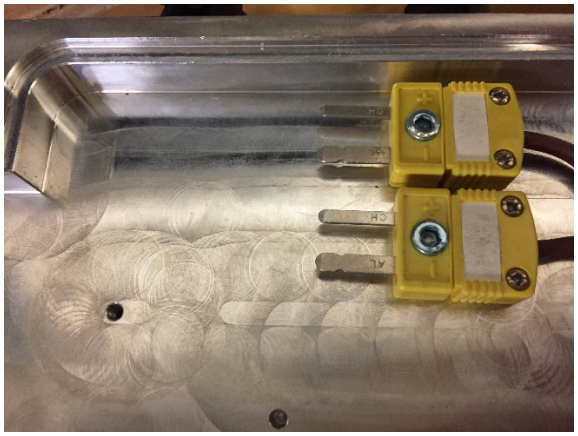

Figure 6 Type K Thermocouple connections hidden underneath the Pellet Electrical Panel

Once the thermocouple connections are secure, reinstall the electrical panel and plug in the heater power with the connector leaving the control box to the connection mounted onto the outside of the electrical panel.

Wiring Schematic for the Pellet Control Box

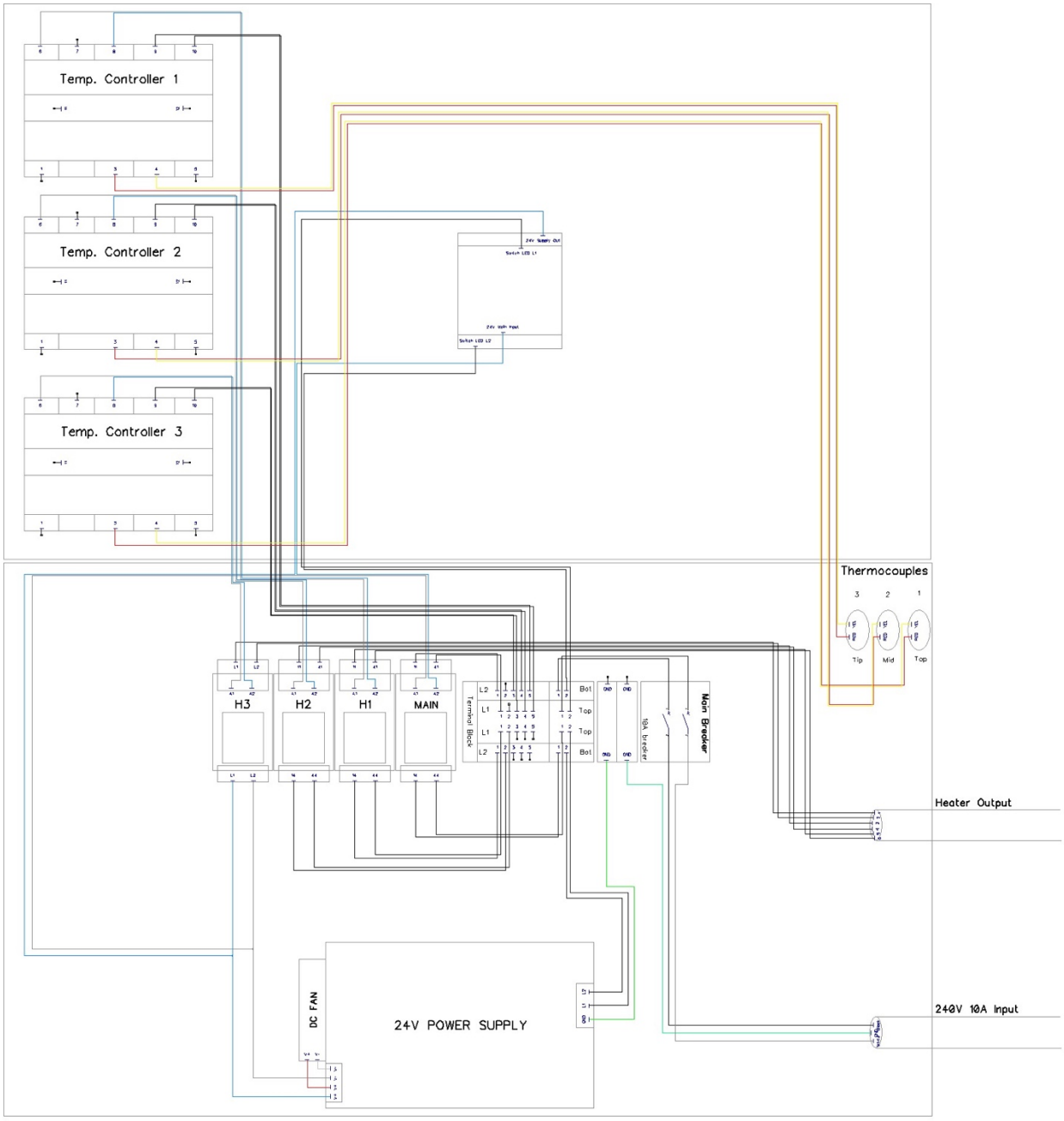

Figure 7 Wiring Schematic for the Pellet Control Box

The temperatures for the extruder melt zones are controlled by the temperature modules located on the face of the control box.

Material	Temperatures	
Material	Body	Tip
ABS	230	230
PETG	240	255
ASA	240	240
Polypropylene	210-290	210-290
Asaclean	210-290	210-290

Figure 8 General Ballpark Temperatures for the Extruder.

General Usage of the Pellet Feed Extruder for Starting a Print

1. Preheat the extruder to a desired temperature
    a. The temperatures for the pellet extruder are controlled via modules located on the front face of the pellet extruder control box.
2. Feed pellets into the hopper.
    a. For best results, use dried pellets.
3. Once the extruder has reached the target temperatures, let sit for 10 minutes to ensure temperature is at steady state.
4. Purge the extruder to ensure steady flow rate of material.
    a. If **purge material** is sitting in the barrel, vacuum out the hopper and extruder body (remove the hopper to access the inner extruder body), doing a 1 min purge at 5 screw rpm to make sure there is no material sitting near the top of the screw. Reinstall the hopper and start "priming" the extruder with your build material. Start at 5 screw rpm for 5 min, 10 screw rpm for 5 min, and then 15 screw rpm for 5 min. If the extruded material still doesn't seem to have switched to the new material, keep extruding at 15 screw rpm until the new material seems to be flowing well. Once the new material seems to start flowing well, purge at 15 screw rpm for another 5 min to ensure that there are no leftover pellets from the purge material.
    b. If **build material** (same material that you want to print with), purge the extruder for 15 minutes to ensure steady state flow with reheated material.

End of Day procedures

1. If the material can safely sit in the barrel for an extended period of time, just cool down the extruder (4 heaters total) and bed and then turn off the pellet extruder motor by right clicking the green circle icon next to "Pellet:" on the right side of the dashboard and choose "off".
2. If your material needs to be purged, you will first have to vacuum out the extruder body and hopper (remove the hopper to access the inner extruder body), doing a 1 min purge at 5 screw rpm to make sure there is no material sitting near the top of the screw. Different purge materials will need to be used based on your build material. If it's a material that isn't highly crystalline and doesn't have any aggressive fillers (e.g. carbon fiber, etc.), then 3 cups of polypropylene should work. If the opposite is true, we recommend using a glass filled purge material (we use Asaclean products in house and they have a wide variety). This will be able to "scrub" the extruder and better remove any filler material. Two cups of the scrubbing purge material (not supposed to sit in the barrel for an extended period of time) followed by one cup of polypropylene should be used. For the screw rpm of all end-of-day purging, start with 10 screw rpm for 5 min, 20 screw rpm for 5 min, and then 30 screw rpm continuously until there is no material left in the hopper. Again, it's okay to leave polypropylene idle in the barrel. After this, **follow option 1** for the end of day procedure above.

Big vs. Small

Attached to the end of the large extruder is a screw on nozzle. This nozzle is interchangeable, allowing switching between larger nozzle sizes and smaller nozzle sizes. The extruder comes pre-equipped with a 4 mm nozzle (Figure 9). Large nozzle sizes are good when:

- Speed is more of a priority than print resolution
- The part is intended on being cleaned on the mill or other post processing.
- High resolution is not required due to the large nozzle diameter
- The print is intended to be large and dense with less detail.

Figure 9 Left: Large Nozzle Screwed onto Extruder Barrel. Right: Large Nozzle Taken off the Extruder Barrel

Large nozzle sizes are good for laying down mass quantities of plastic. Depositing large amounts of plastic also leads to large depositions of heat as well as the plastic to retain a lot of heat as it is printing.

To change between the large nozzle and the smaller nozzle sizes, take off the Large Nozzle that is screwed into the barrel and screw the Small Nozzle (Figure 10) into the Pellet Barrel.

Figure 10 Tip Heater of Small Nozzle for Pellet Extruder. This was included with the Pellet Extruder but was not installed

Smaller nozzles are preferred when:

- Print time is not sensitive.
- The resolution of the part is higher priority than speed
- The model contains small details
- Small walls are contained in the model.

The Pellet extruder comes with a tip heater that screws onto where the large nozzle is attached. The tip heater contains (Figure 11):

- Large extruder attachment
- 0.25in OD Tube to 0.5NPT male locking adaptor
- Heated locking nut
- Nozzle (for the large extruder it comes with a 3mm nozzle)

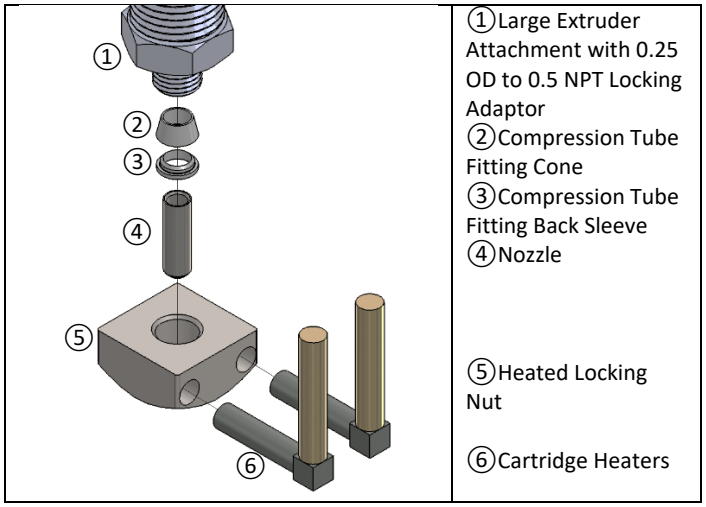

Figure 11 Exploded view of Small Nozzle Assembly. Note the configuration of the ferrules.

Switching Small Nozzles Sizes

When **switching between nozzle sizes**, it is best to do this in the beginning of the day before the pellet extruder is preheated (you don't want molten plastic falling on you while doing this procedure).

1. A 7/8" wrench for the barrel tip and 1" wrench for the square-pyramid shaped heated nozzle is required for this procedure. Heat resistant gloves are also highly recommended.
2. Heat up only the nozzle to the material's melting temp and wait for 10 min. After this, unscrew the nozzle about a quarter turn to loosen it. The extruder hopper may need to be removed to continue.
3. Reduce the nozzle temp back to 0 degrees, unplug the nozzle heater and thermocouple wires, and then proceed by unscrewing the nozzle completely.
4. Use needle nose pliers and a small flathead to remove and scrape out any material that may be remaining in the barrel tip (only up to the inner lip).
5. Apply anti-seize to the barrel tip threads and then install the nozzle with the inner tip in the configuration found in Figure 11.