COMPONENTS OF 3D PRINTER

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ABSTRACT:- 3D printers are device which create a 3-dimentional solid objects from a digital file .3D printing is a rapidly developing and cost optimized form of rapid prototyping.The creation of a 3D printed object is achieved by additive manufacturing processes. In this modern world, there are various 3D printing methods but fused deposition modelling(FDM) is commonly used method because it is cheapest and FDM based 3D printers are small in size. By knowing the main components of FDM 3D printers, how they work and what they are capable of, they can achieve better quality, strenght and speed, easily maintain the 3D printer when needed to choose the right machine for our needs, upgrade and modify the parts fro the specific applications. Here are all the components of the 3D printer that includes the Stepper motor, Stepper motor drives, RAMPS controller, Heated Bed, Hot End, Bowden Extruder, Limit Switches, Belt drive and pulley drive, Lead screw, Cooling fans for hot-end and print cooling and also Display Screen and SD card reader module. The working, specifications, configurations, etc has been explained and also the limitations and the precautions to be taken has been explained. The software required to run the machine, software to convert the designed product into machine understandable format is described.

I. INTRODUCTION

There are various machining processes like turning, milling, drilling etc. We are using these methods from many years they help us to build things. The technology of traditional machining has many limitations so, manufacturing world has changed and involve non traditional machining such as electric discharge machining or electric chemical machining ,and at present every industry require computer and robot technology . This process involves removal of material, from larger mass of block to get the required shape of desired product. There are drawbacks of such production processes are fixtures and assembly for many traditional designs which are also expensive, as Compared to traditional machining 3D printing is process of creating object using digital model is more beneficial. This technology allows the design of complex components therefore avoiding assembly requirement at no additional cost.

3D printing is also known as desktop fabrication which is a process of prototyping where the structure is synthesis from its 3D model. The 3D design is stored in STL format and after that forward to 3D printer. The 3D printer printers the CAD design layer by layer creating real object 3D printing process is derived from inkjet desktop printers in which multiple deposits jets and the printing material layer by layer derived from CAD 3D data.3D printing is diversifying and accelerating our life getting various qualities of product to be synthesize easier and faster .3 dimensional printing has the ability to impact the transmission of information in way similar to the influence of such earlier technology as such photocopy. This identifies sources of information on 3D printing, its technology required software and applications. Along 3D printing companies are able to extract and innovate new ideologies and various design applications with no time or tool expenses. The term 3D printing originally referred to a process that deposits a binder material on to powder bed with inkjet printer heads layer by layer.

II. STEPPER MOTOR

We selected stepper motor for the actuators as they have a good combination of power, holding torque and precision.

This hybrid bipolar stepping motor has a 1.8° step angle (200 steps/revolution). Each phase draws 1.7 A at 2.8 V, allowing for a holding torque of 3.7 kg-cm (51 oz-in). The motor has four color-coded wires terminated with bare leads: black and green connect to one coil; red and blue connect to the other. It can be controlled by a pair of suitable H-bridges (one for each coil), but we recommend using a bipolar stepper motor driver. Our MP6500 stepper motor driver carrier is a good choice for this stepper motor.

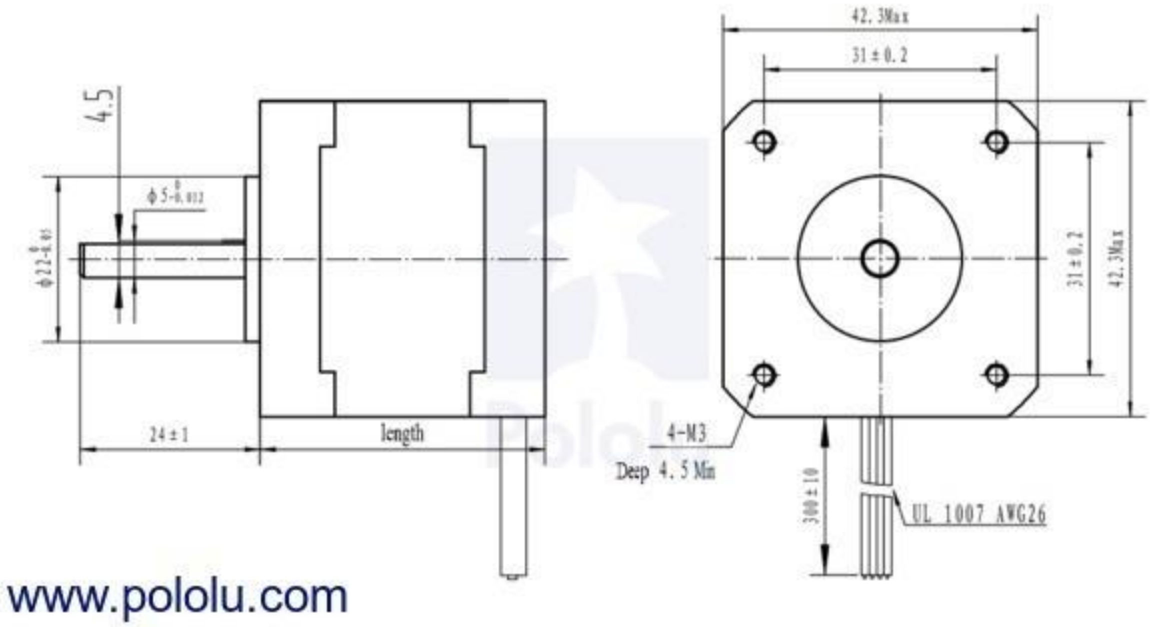
Our 5mm universal mounting hub can be used to mount objects on the stepper motor's 5 mm-diameter output shaft, and our NEMA 17 aluminium bracket offers a variety of options for mounting this stepper motor in your project. This NEMA17 stepper motor is also available with threaded rod output shafts in lengths of 18cm, 28cm, or 38cm at convert its rotations into linear motion of the included traveling nut.

Specifications

- Size: 42.3 mm square × 38 mm, not including the shaft (NEMA 17)
- Weight: 285 g (10 oz)
- Shaft diameter: 5 mm "D"
- Steps per revolution: 200
- Current rating: 1.68 A per coil
- Voltage rating: 2.8 V
- Resistance: 1.65 Ω per coil
- Holding torque: 3.7 kg-cm (51 oz-in)
- Inductance: 3.2 mH per coil
- Lead length: 30 cm (12″)
- Output shaft supported by two ball bearings

Dimensions

The following diagram shows the stepper motor dimensions in mm. The dimension labeled "length" is 38 mm. The output D-shaft has a 5 mm diameter with a section that is flattened by 0.5 mm. This shaft works with our 5 mm universal mounting hub.



Stepper Motor Applications

Stepper motors are generally used in a variety of applications where precise position control is desirable and the cost or complexity of a feedback control system is unwarranted. Here are a few applications where stepper motors are often found:

- Printers
- CNC machines
- 3D printer/prototyping machines (e.g. RepRap)
- Laser cutters
- Pick and place machines
- Linear actuators
- Hard drives

III. DRV8825 Stepper Motor Driver Carrier

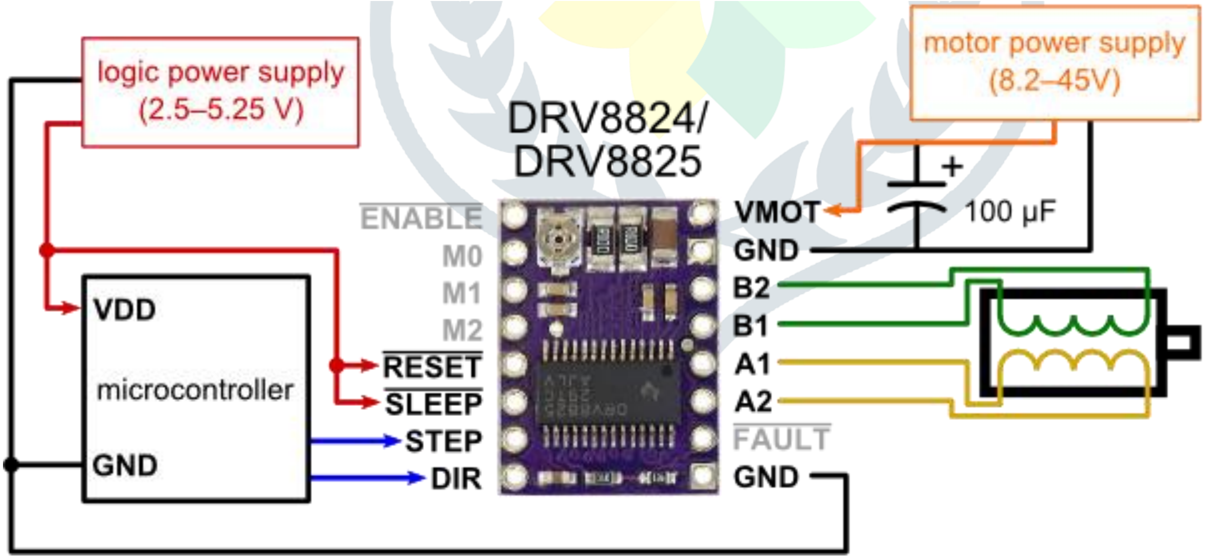
The steppers motor require proper drivers to control the motor. We have used pololu DRV 8825.

This breakout board for TI's DRV8825 microstepping bipolar stepper motor driver features adjustable current limiting, over-current and over-temperature protection, and six microstep resolutions (down to 1/32-step). It operates from 8.2 V to 45 V and can deliver up to approximately 1.5 A per phase without a heat sink or forced air flow (rated for up to 2.2 A per coil with sufficient additional cooling). The driver has a pinout and interface that are nearly identical to those of our A4988 stepper motor drive carriers, so it can be used as a higher-performance drop-in replacement for those boards in many applications. This board ships with 0.1″ male header pins included but not soldered in.

This product is a carrier board or breakout board for TI's DRV8825 stepper motor driver; This stepper motor driver lets you control one bipolar stepper motor at up to 2.2 A output current per coil. The DRV8825 stepper motor driver carrier ships with one 1×16-pin breakaway 0.1"male header. The headers can be soldered in for use with solderless breadboards or 0.1"female connectors. You can also solder your motor leads and other connections directly to the board.

Here are some of the driver's key features:

- Simple step and direction control interface
- Six different step resolutions: full-step, half-step, 1/4-step, 1/8-step, 1/16-step, and 1/32-step
- Adjustable current control lets you set the maximum current output with a potentiometer, which lets you use voltages above your stepper motor's rated voltage to achieve higher step rates
- Intelligent chopping control that automatically selects the correct current decay mode (fast decay or slow decay)
- 45 V maximum supply voltage
- Built-in regulator (no external logic voltage supply needed)
- Can interface directly with 3.3 V and 5 V systems
- Over-temperature thermal shutdown, over-current shutdown, and under-voltage lockout
- Short-to-ground and shorted-load protection
- 4-layer, 2 oz copper PCB for improved heat dissipation
- Exposed solderable ground pad below the driver IC on the bottom of the PCB
- Module size, pinout, and interface match those of our A4988 stepper motor driver carriers in most respects.



IV. CURRENT LIMITING

To achieve high step rates, the motor supply is typically much higher than would be permissible without active current limiting. For instance, a typical stepper motor might have a maximum current rating of 1 A with a 5Ω coil resistance, which would indicate a maximum motor supply of 5 V. Using such a motor with 12 V would allow higher step rates, but the current must actively be limited to under 1 A to prevent damage to the motor.

The DRV8825 supports such active current limiting, and the trimmer potentiometer on the board can be used to set the current limit. You will typically want to set the driver's current limit to be at or below the current rating of your stepper motor.

V. POWER DISSIPATION CONSIDERATIONS

The DRV8825 driver IC has a maximum current rating of 2.5 A per coil, but the current sense resistors further limit the maximum current to 2.2 A, and the actual current you can deliver depends on how well you can keep the IC cool. The carrier's printed circuit board is designed to draw heat out of the IC, but to supply more than approximately 1.5 A per coil, a heat sink or other cooling method is required.

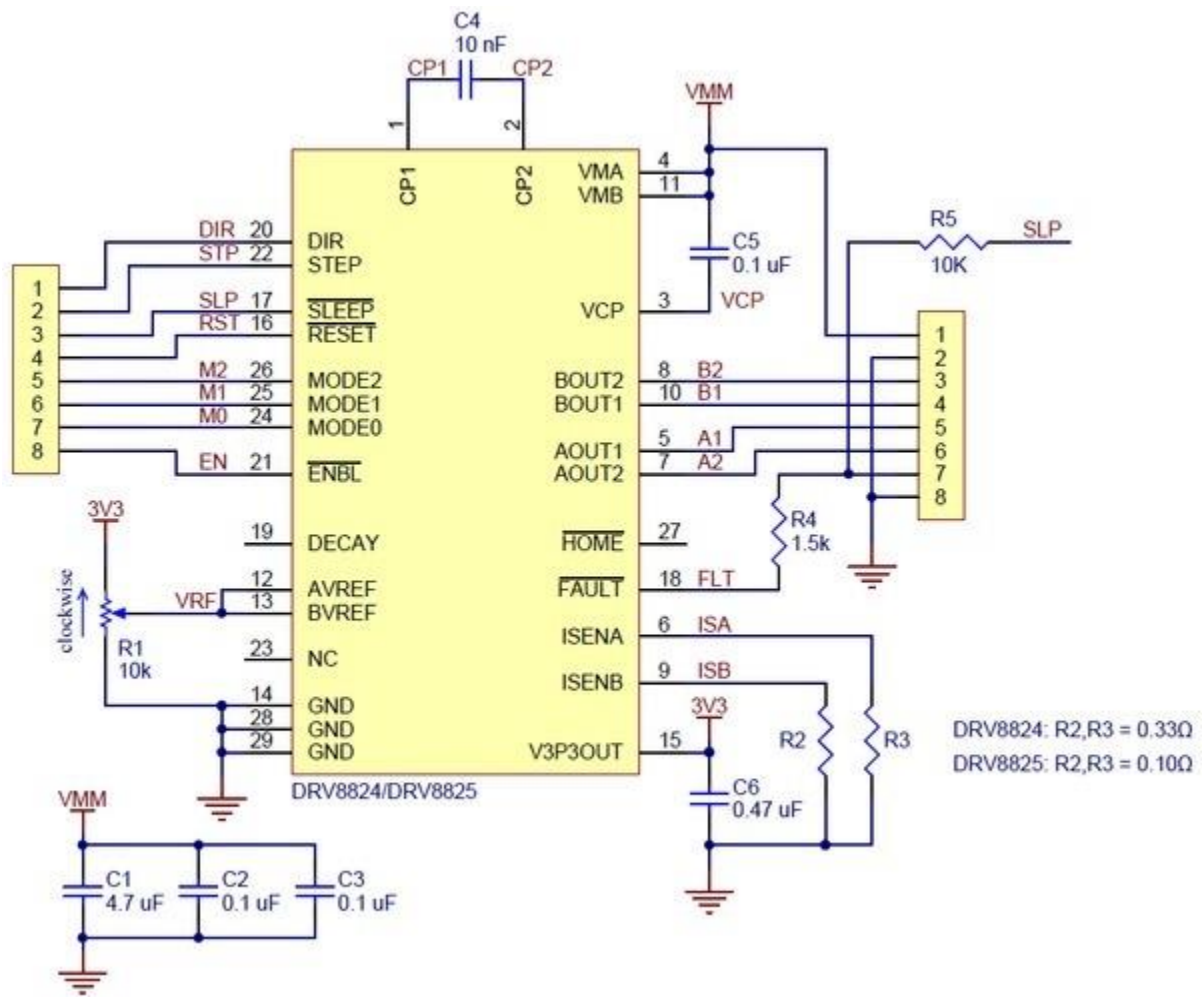


Fig:- Schematic diagram of DRV8825 stepper motor driver carrier

RAMPS CONTROLLER

We are using the open source RAMPS shield to control the 3D-printer. It provides appropriate number of outputs for each axis.

The 3D-printer requires 2 stepper motors for the Z-axis, 1 motor for x-axis and 1 motor for the Y-axis.

An extra motor is required for the extruder, it feeds the filament into the extruder.

There is also a heater element in the extruder that is PID controlled by the Microcontroller so as to maintain an effective flow of liquid filament.

Single board solution, Remix of Arduino mega2560 and RAMPS1.4, support A498,DRV8825 stepper driver.

Features

- Arduino MEGA compatible Atmega2560 and FT232 processors are compatible with all RAMPS class firmware.
- Firmware can use the same configuration as ramps1.4
- Easy DISPLAY + SD-CARD connector,RepRapDiscountSmartController compatible pin header on board
- All extra pins broken out the same as ramps1.4(AUX-1,AUX-2,AUX-3,Servos1)
- 3x temperature ADC connectors for thermistors
- up to 5 motor driver with easy micro stepping setup (micro switches)
- 4x PWM capable power mosfet outputs with voltage selector for MainPower.(Bed,Extruder0,Extruder1, Fans)
- 4 layers PCB, optimize heat dissipation.
- 6x end stop connectors with power supply Xmin/Xmax/Ymin/Ymax/Zmin/Zmax
- 3* 5V output, 3* 12V-24V output interface.
- Recoverable fuse for short-circuit protection.

LIMIT SWITCHES

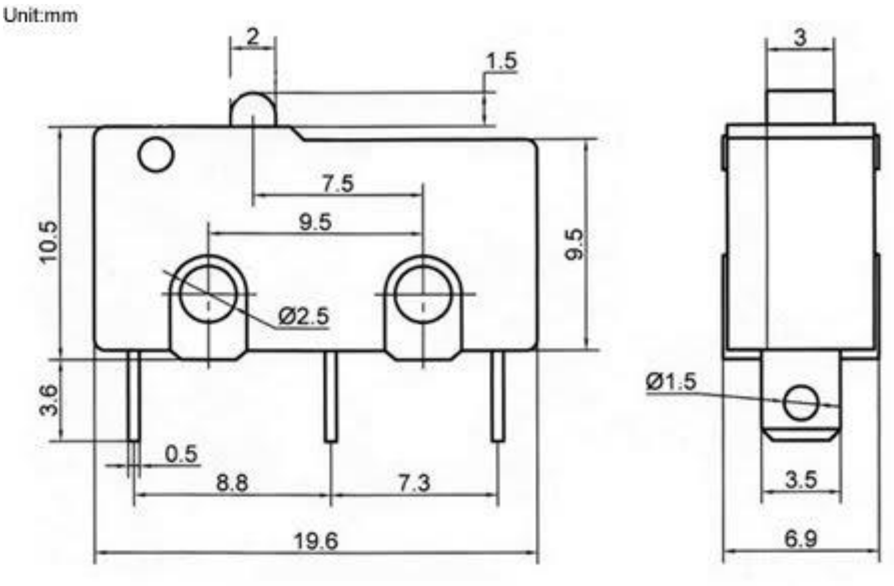
Limit switches are used to send the location of the printer head to the microcontroller. The limit switches are basic switches that get in contact with the moving heads and send a signal to the controller.

Product Specification

Current Rating (Amps)	10 Amp
Power/Voltage (V)	600 VAC
Switch Type	Micro Limit Switch
Operating Temperature	-20 Degree C to +85 Degree C

The micro end-stop RAMPS 1.4 limiting switches for 3D Printers can be used in various mechanical applications to control the position of moving parts of machines and plant. It is suitable for both AC control circuits and DC control circuits.

Widely applied in home appliances, medical devices, office facility, instrument and apparatus, electric motion tools, packing machinery, auto electronics etc.



HEATED BED

TEVO 3D Electronic Technology Co. is a 3D printing manufacturer focused on making 3D printers accessible and affordable for Makers worldwide. They offer competitive quality printers at very affordable prices, with a plethora of upgrades and accessories aimed to greatly enhance the 3D printing experience.

TEVO's range includes the TEVO Tarantula, Black Widow, Tornado, Little Monster and Michelangelo, catering to a wide range of budgets and build volume needs in both Cartesian and Delta styles. This has garnered them a good reputation amongst manufacturers and Makers alike, making them one of the most popular manufacturers of desktop and home-use 3D printers.

If you're looking for a 3D printer that is affordable, easy to build and even easier to use, there are few choices better than TEVO's range. With dual extruder upgrades, laser engraving kits, and even their own version of BuildTak, they continue to prove their value time and time again as they keep bringing out new printers, upgrades and accessories for Makers to enjoy experimenting and fabricating with.
TEVO are certainly some of the best 3D Printers on the market, but even these machines can suffer from wear and tear or small faults over time, since they are designed to reach high temperatures for long periods of time.

3D Printing Heatbeds like this TEVO Tarantula Heated Bed, ensures that you can easily replace the part if it breaks. It is relatively inexpensive compared to many other Available Heatbeds, and even features an aesthetically stylish white silkscreen print of the TEVO logo, the TEVO spider imagery, as well as protective warnings.
The heatbed is 220x220mm big with a build volume of 200x200mm, with an extra 20mm designed for enhanced heat dissipation and heat protection for the connecting cables. It is made from aluminium, making it capable of reaching and maintaining high temperatures, with strong mounting points to help keep the level and rigidity of the bed even through numerous prints.

TEVO TARANTULA HEATED BED - TECHNICAL SPECIFICATIONS:	
Material	– Aluminium
Size (Length x Breadth)	– 220 x 220mm
Build Volume (Length x Breadth)	– 200 x 200mm
Thickness	– 3.5mm
Colour	– Black with White TEVO Branding
Voltage Input	– 12V / 24V

HOT END

The hotend is that tube that heats up the plastic and deposits it on the print bed.

I've been trying to learn more, and many hotends out there don't look quite as simple. My Printrbot hotend probably isn't as simple as it looks, either.

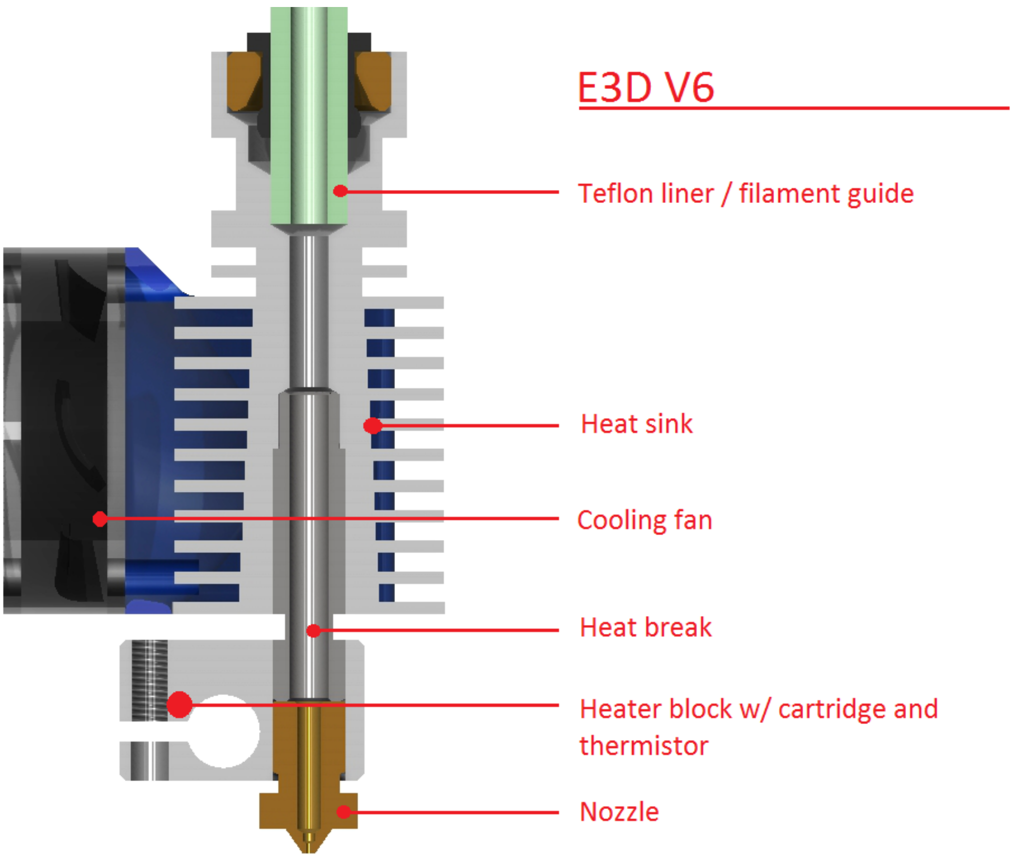
What are the parts that make up a hotend, and what do they do?

This varies by hotend design. The following is a list of components which you might find in a typical hotend, but note that different designs may integrate these components to some extent. For instance, on the J-head the heat block, nozzle and heatbreak are all one and the same component whereas on the E3D hotends these are all separate parts.

- **Nozzle**: This is the part where the filament comes out. It takes in the molten filament (typically as a bead of 1.75mm/3mm) and tapers down to the nozzle size (typically around 0.4mm). These are typically made of brass for its good heat conductivity, but brass is not suitable for printing abrasive materials (such as glow in the dark and metal-filled filaments) so sometimes (hardened) stainless steel is used.
- **Heater Block**: Usually made from aluminium, the heater block joins the nozzle to the heat break and holds the heater cartridge and thermistor.
- **Heater Cartridge**: most hotends use a ceramic heater cartridge, though some older designs use power resistors or nichrome wire. This component is, as the name suggests, responsible for heating up the hotend. The heat block usually clamps around the heater cartridge to provide good contact.
- **Thermistor**: This part senses the temperature of the heat block. It is usually a small glass bead with two wires attached (which are typically insulated with glass fiber or teflon). For high-temperature printing, a thermocouple may be used in stead.
- **Heat Break**: this is the part where hot meets cold. It usually takes the form of a thin tube and is made of stainless steel for its low thermal conductivity. The goal is generally to have the transition be as short as possible so as little of the filament is in a molten state as possible. It connects the heat block to the heat sink.
- **Heat Sink**: the purpose of the heat sink is to cool down the cold side of the heat break. It is typically cooled with a fan. Most heat sinks also have a standard groove-mount for mounting to your printer. The heat sink usually has grooves to increase its surface area and cooling capability.
- **Teflon Liner**: some hotends have a PTFE liner that guides the filament through the heat break into the nozzle. This makes it easier to print PLA, but compared to an all-metal hotend, limits the temperatures at which you can print (making it difficult to print PETG and impossible to print polycarbonate).

The ubis hotend you mentioned is a bit simpler than this, and simply uses a big chunk of PEEK in place of the heat break/sink. PEEK has very low thermal conductivity and thus passive cooling is sufficient. However, PEEK limits the temperatures at which you can print.

Here is an illustration outlining these components on an E3D V6 hotend:



BOWDEN EXTRUDER

The Bowden cable lets you reduce the moving mass of the extruder and thus allowing faster controlled motion, less shaking of your machine, less energy use and importantly: faster printing! Normally the mechanism that drives the filament into the hot end (where it melts) is directly on top of the extruder. This creates problems of balance and oscillations with faster motion which you can see in your printing results and hear and feel when your machine is shaking.

If the filament drive mechanism is placed on a non-moving part of the 3D printer, it can be pushed into a tube. PTFE (Teflon™) is useful because it is slippery: it has little friction with the plastic. This limits wear and loss of energy. The tube's other end is connected to the extruder's hot-end.

- It also allows you to use a decent plastic driving motor or more 'space consuming' complex gearing arrangement. This makes sure that you can not only speed up motion, but also output more plastics. So this is especially a good way towards faster printing.
- It can help make printing slightly more reliable. If the nozzle orifice is jammed for just a short while (e.g. too close to a part of the object that curled up a little bit), without the Bowden extruder the drive mechanism will have stripped the filament and not recover because it loses grip when it has stripped it too much. With the Bowden extruder, short blockages are not causing failure of the build. This is useful when you're just starting with printing, because you may have some problems getting large objects to stick to the platform very well.
- Reversing the extruder motor very quickly allows you to have less oozing. The beneficial effect of reversing is more pronounced for the Bowden cable setups than for regular extruders.
- Fast changes in Z-height are helpful if you don't want to get a small seam where it changes layers. So make sure your bot can go fast in that direction too, or optimize it to have zero oozing.
- The Bowden extruder is not as helpful if you have a fixed printing head (or moving in Z-only) and a XY-moving platform. There are still, however, multiple advantages to be gained even in these cases. By physically separating the extruder from the hot end you eliminate potential physical incompatibilities between the two, it becomes much easier to disassemble and fix either component in the event of failure in one part, and you eliminate the problem of the hot end potentially melting the extruder body.

Belt drive

The most commonly used technology for 3D printers, it consists of a timing belt with teeth that is used to connect to a moving carriage which guides a payload. A rotating pulley with mating teeth is connected to a motor. Rotating the motor shaft rotates the pulley that pulls the belt in the direction it needs to go. There are several benefits belt drives provide in this application:

- a less expensive design and build
- better suited for longer travel lengths
- low maintenance(and less lubrication required over time)
- compact design
- easy integration into machine structure..

The greatest risk is that belts can stretch over time, producing a ringing/oscillatory effect which increases the difficulty of maintaining tight tolerances. To mitigate this stretching, system accelerations and decelerations must not overtax the belt.

Screw driven solutions

A higher precision and better performing system, the screw drive couples a rotary motor to a linear spindle (ball screw or lead screw). As the motor turns, a nut rigidly fixed to a carriage (where the printer head or payload is located) moves either toward or away from the motor based on the shaft's rotation. There are multiple types of screw technologies, but we will focus on two; lead screws and more efficient ball screws.

Lead screw

A great lead nut can't perform without a top quality lead screw. These screws are constructed of 300 series stainless steel and offer a high luster surface finish with excellent corrosion resistance. Standard sizes are available from 3/16" to 3" diameters. All lead screws are precision rolled to achieve lead accuracies of up to .003 inch per foot. We use optimized thread forms on most sizes to achieve the best possible performance when used with our polymer nuts. We also configure the ends of the majority of the screws we ship to customer requirements.

Cooling fans for hotendnd print cooling

The cooling fan plays a really important role in the 3D printing process and it's a must have feature. Not all 3D printing materials require active cooling, but it's truly beneficial for most 3D prints. Some machines use only one fan, where others can have up to 3. The cooling fan will dramatically improve overhanging features, will crisp the sharp edges, and will result in good bridging capabilities.

Something important to understand here is that not all cooling fans are created equal. Some machines use a 25mm, others – 40mm. Some fans are designed to blow at the mid hot end area, some are focused at the tip of the nozzle and some have a different shaped ducts.

Display Screen and SD card reader

The LCD Display controller allows you to 3D print without the need of a computer connected or using a software host such as Cura. It needs a SD card to read the G-code instructions. The display allows more efficient space usage and frees up your computer for other tasks. It's perfect for day-to-day printing and will be used in the majority of your print jobs.

SOFTWARES

Marlin 3D Printer Firmware

Marlin is the world's most popular open source firmware for Replicating Rapid Prototyper (RepRap) machines, commonly referred to as "3D printers." Marlin Firmware is highly efficient, running even on modest 16MHz embedded AVR processors. While Marlin 1.1 only supports ATmega AVR (Arduino, etc.) and AT90USB (Teensy++ 2.0), Marlin 2.0 also adds support for several ARM processors, including the SAM3X8E (Arduino Due), NXP LPC1768/LPC1769 ARM Cortex-M3 (Re-Arm, MKS SBASE, Smoothieboard), and ARM Cortex-M4 (Teensy 3.5/3.6, STM32F1/4/7).

A monumental amount of talent and effort goes into Marlin production, and thanks are due to many volunteers around the world. We work closely with the community, contributors, vendors, host and library developers, etc. to improve the quality, configurability, and compatibility of Marlin Firmware with a huge variety of boards. For the final 1.1 release we focused on code quality, performance, stability, and overall user experience. Several new features were added, many of which require no extra hardware.

Cura

This is the new, shiny frontend for Cura. Check daid/LegacyCura for the legacy Cura that everyone knows and loves/hates. We re-worked the whole GUI code at Ultimaker, because the old code started to become unmaintainable.

Logging Issues:-

For crashes and similar issues, please attach the following information:

- (On Windows) The log as produced by dxdiag (start -> run -> dxdiag -> save output)
- The Cura GUI log file, located at
  - %APPDATA%\cura\<Cura version>\cura.log (Windows), or usually C:\Users\\<your username>\AppData\Roaming\cura\<Cura version>\cura.log
  - $USER/Library/Application Support/cura/<Cura version>/cura.log (OSX)
  - $USER/.local/share/cura/<Cura version>/cura.log (Ubuntu/Linux)

If the Cura user interface still starts, you can also reach this directory from the application menu in Help -> Show settings folder

For additional support, you could also ask in the #cura channel on FreeNode IRC. For help with development, there is also the #cura-dev channel.

Dependencies:-

- Uranium Cura: is built on top of the Uranium framework.
- CuraEngine: This will be needed at runtime to perform the actual slicing.
- fdm_materials: required to load a printer that has swappable material profiles.
- PySerial: Only required for USB printing support.
- python-zeroconf: Only required to detect mDNS-enabled printers.

VI. CONCLUSION

Creating a part layer by layer, instead of substractive methods of manufacturing leads 3D printing lowor cost in raw material. Instead of starting with a big chuck of plastic and carving away (millingor turning) the surface in order to produce our product.Additive manufacturig only prints what we want , where we want it. 3D printing is the ultimate just in time method of manufacturing. No longer do we need a warehouse full of inventory waiting for customers. Just have a 3D printer waiting to print our next order .We can also offer almost infinite design options and custom products. The sky is the limit for additive manufacturing .Additive manufacturing open up our designs to a whole new level because undercuts, complex geometry and thin walled parts are difficult to manufacture using traditional methods , but are sometimes a piece of cake with 3D printing.In addition, the mathematics behind 3D printer are simpler than substractive methods .For instance the blades on a centrifugal super charger would require very difficult path planning using a 5-axis CNC machine. The same geometry using additive manufacturing techniques is very simple to calculate, since each layer is analysed separately and 2D information is always similar than 3D. This mathematical difference, while hard to explain is the fundamental reason why 3D printing is superiour to other manufacturing techniques.It almost always better to keep thing simple and additive manufacturing is simple by its very nature.

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