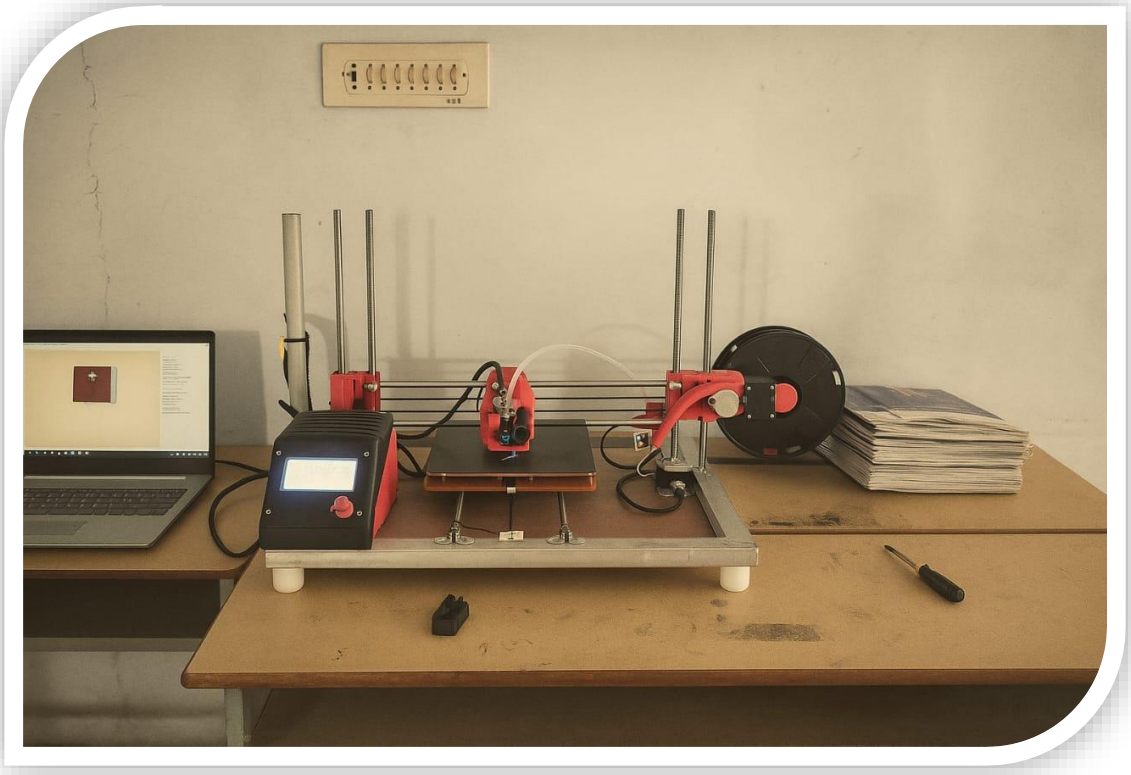
USER MANUAL

LOW COST 3D PRINTER



Designed by:

SAKTHI RAJA V(950322106012)

MOHAMMED ZAHEER K(950322106009)

PARTHIBAN N(950322106011)

INTRODUCTION:

This user manual is intended to guide anyone who wants to operate our custom-built Fused Deposition Modeling (FDM) 3D printer. It is specifically created for team members, lab technicians, or any other users who are not familiar with the design and operation of the machine.

The 3D printer was designed and assembled by our team from scratch using widely available components such as the Arduino Mega, RAMPS 1.4, and A4988 stepper drivers. The goal was to create a low-cost, fully functional 3D printer that can produce quality prints with PLA filament and be easily maintained or upgraded in the future.

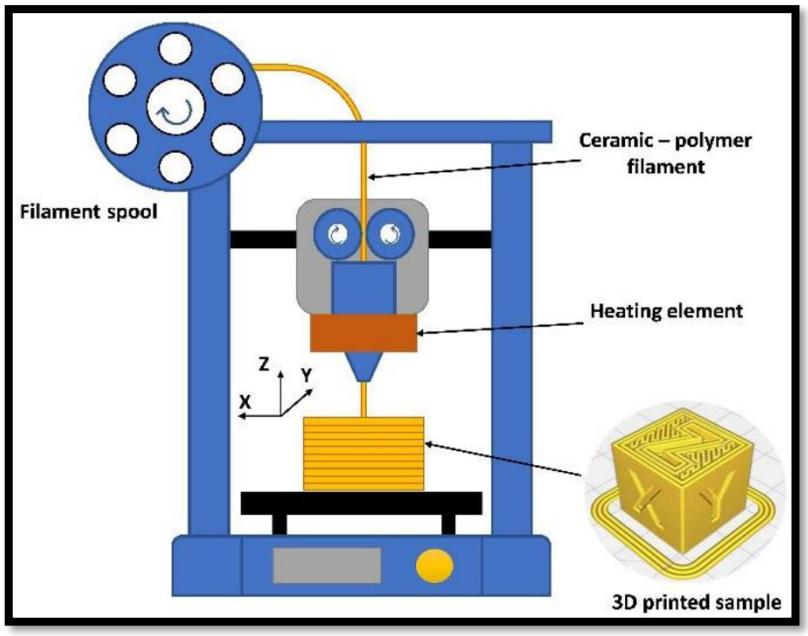
This manual covers the printer's technical specifications, setup instructions, daily operation, maintenance, and troubleshooting tips. Whether you're printing for a project, prototyping, or just learning, this manual will help ensure safe and efficient use of the machine.

TECHNICAL SPECIFICATIONS:

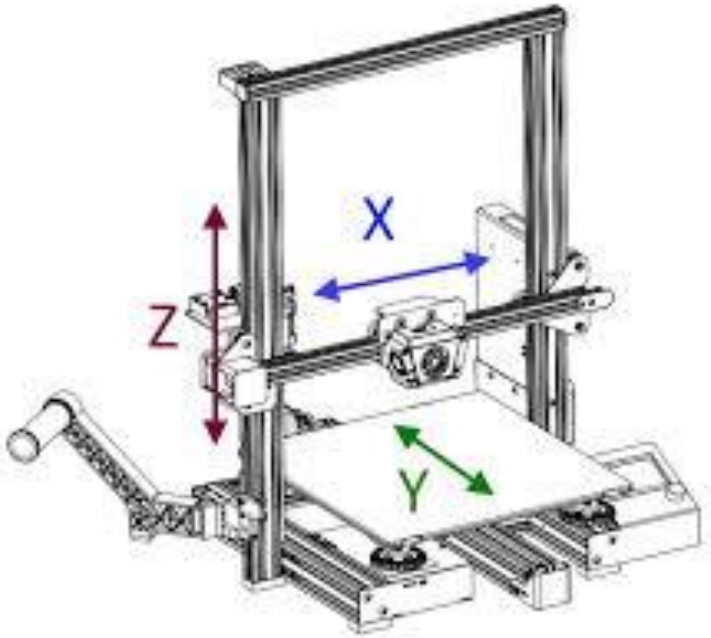
PARAMETER	SPECIFICATION
Motion System	COREXYZ motion
Build Volume	200 x 200 x 170 mm
Controller Board	Arduino Mega 2560 with RAMPS 1.4 Shield
Stepper Drivers	A4988
Stepper Motors	NEMA 17 motors (1 for X, 1 for Y, 2 for Z, 1 for Extruder)
Power Supply	12V 30 amps
Firmware	Marlin 2.1.2.5
Printer Type	FDM(Fused Deposition Modelling)

Fused Deposition Modeling (FDM) Technology

Fused Deposition Modeling (FDM) is one of the most common and accessible 3D printing technologies. It is the core principle behind our custom-built 3D print



XYZ Motion System (Cartesian Motion):



 The XYZ motion system is based on the Cartesian coordinate system, where movement happens along three axes: X (left–right), Y (front–back), and Z (up–down).

 Motors and belts control movement along each axis for precise positioning of the print head and bed.

 In most FDM printers, the print head moves along X and Y axes, while the bed or print head moves along the Z-axis.

Electrical Components Used:

1. Arduino Mega 2560:

 Acts as the main controller for the printer.

 Based on ATmega2560 microcontroller.

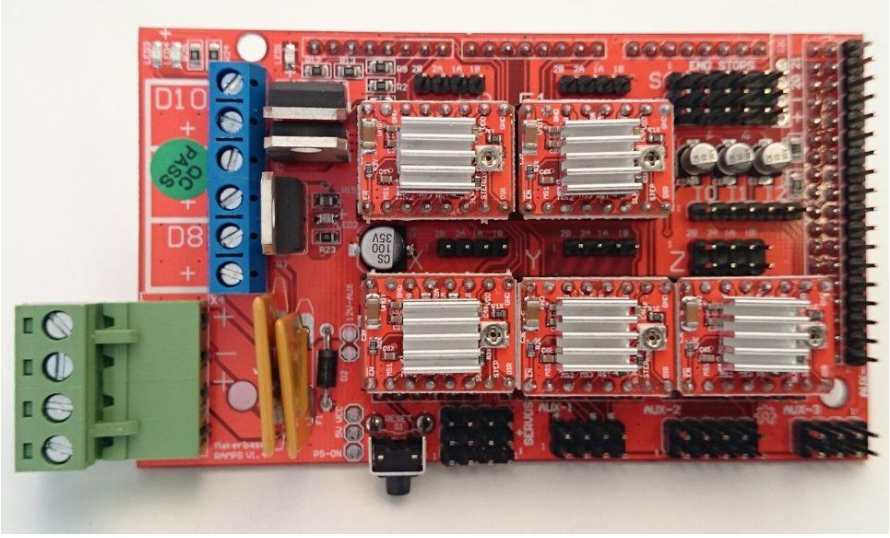
 Interfaces with RAMPS 1.4 to control motion, temperature, and inputs.

2. RAMPS 1.4 (RepRap Arduino Mega Pololu Shield):

 Sits on top of the Arduino Mega.

 Provides motor driver slots and terminals for heater, thermistor, endstops, and fans.

- Designed for modular expandability.

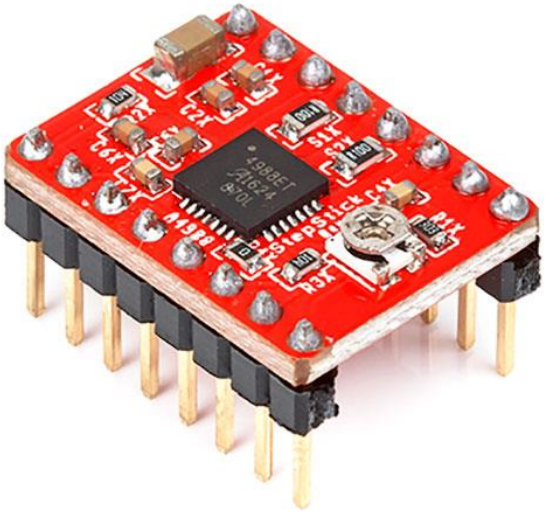


3. A4988 Stepper Motor Driver Modules:

Controls the stepper motors for X, Y, Z axes and extruder.

Includes adjustable current control and microstepping.

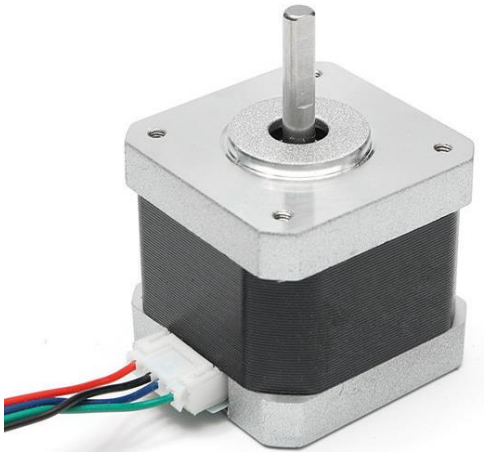
Each driver can control one stepper motor.



4.NEMA 17 Stepper Motors:

- Drives the motion of X, Y, Z axes and extruder.
- Offers high precision for positioning.

- Typically rated for 1.2A to 1.8A per phase.



5.Power Supply(12volt 30amps):

Industrial SMPS type with short circuit protection and cooling fan.

X AXIS COMPONENTS:

 The X-axis moves the extruder assembly side to side (left to right) across the frame.

 Driven by a NEMA 17 stepper motor, connected via timing belt (GT2) and pulleys.

 Ensures high-speed travel and precise positioning of the nozzle.

 Supported by smooth rods or linear rails with linear bearings for stable motion.

HOTEND:(E3D V6)

The hotend is a crucial part of the 3D printer responsible for melting and extruding the filament with high precision. It ensures consistent material flow and directly affects print quality.

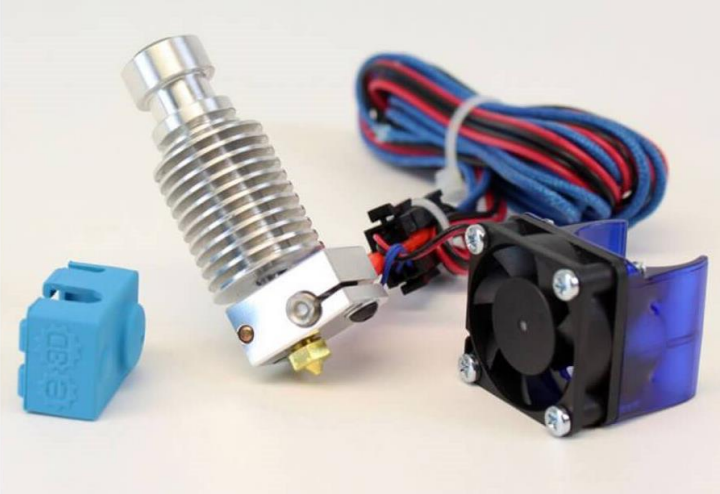
🔧 Key Points:

- The hotend is where the filament is heated and pushed through a nozzle to form layers.
- Consists of key parts:
    - Heater block (heats the filament)
    - Nozzle (controls extrusion size)
    - Heat break (prevents heat creep)
    - Heat sink (cools the upper part of the hotend)
- Controlled by a thermistor and heater cartridge to maintain precise temperature.
- Typical operating temperature range: 180°C – 260°C

NOZZLE:

Nozzle Size are: 0.4, 0.6, 0.8

Recommended size: 0.4



Y AXIS COMPONENTS:

The Y-axis in a 3D printer defines the front-to-back movement of either the print bed or the printhead, depending on the printer's motion system.

In a Core XYZ or Core XZ Printer:

- The Y-axis typically controls the linear movement of the bed (back and forth).
- The printhead is fixed along the Y-axis and only moves in X and Z directions.

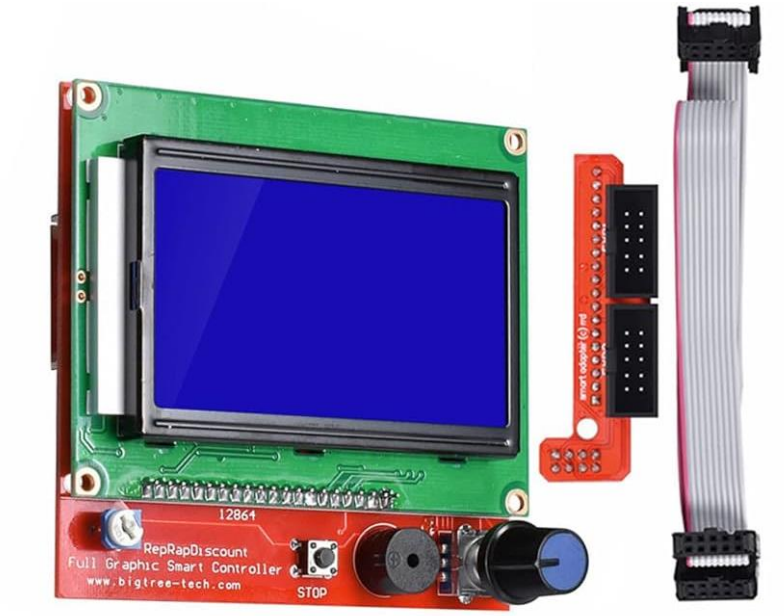
HEAT BED:(RepRap 12volt, 10 amps)

The heatbed is the part where the objects prints layer by layer. The top layer is sticked with pei sheets.

- Size: 200 mm × 200 mm
- Operating Voltage: 12V DC
- Current Rating: Up to 10A
- Thermistor Used: 100kΩ NTC Thermistor (usually EPCOS B57560G104F)
- Maximum Temperature: Up to 110°C (recommended)

Display(12864 LCD Display):

- Resolution: 128 × 64 pixels (Graphical LCD)
- Controller: ST7920
- Interface: SPI
- Input: Rotary encoder with push button
- Features: SD card slot, buzzer, navigation menu
- Voltage: 5V (from controller board)



MECHANICAL PARTS USED:

1. SS Rod(8mm)
2. Lead Screw (8mm2 start)
3. Linear Bearing (8mm)
4. Flexible Coupling(5x8mm)
5. Lead Screw Nut
6. EndStop
7. GT2 pulley
8. GT2 Timing Belt

SS Rod- 8mm

Lead Screw with Nut – 8mm

GT2 Pulley – 8mm

GT2 timing belt – 8mm

End Stop

Linear Bearing- 8mm

Flexible Coupling -5 x 8mm

For z axis

SOFTWARE USED:

MARLIN FIRMWARE (version:2.1.2.5)

 Marlin is an open-source firmware used to control 3D printers, CNC machines, and laser engravers.

 It runs on 8-bit and 32-bit microcontrollers like Arduino Mega 2560 (with RAMPS), SKR, and others.

 Widely used in FDM 3D printers for its flexibility, features, and community support.

Setting	Value	Description
MOTHERBOARD	BOARD_RAMPS_14_EFB	RAMPS 1.4 with Extruder, Fan, Bed
BAUDRATE	250000	Serial communication speed
DEFAULT_AXIS_STEPS_PER_UNIT	X: 102, Y: 103, Z: 400, E: 95	Steps/mm for each axis
INVERT_X_DIR	true	Reversed X-axis direction

INVERT_Y_DIR	false	Normal Y-axis direction
INVERT_Z_DIR	true	Reversed Z-axis direction
ENDSTOP_INVERTING	false	Endstop signal type
DEFAULT_MAX_FEEDRATE	X: 300, Y: 300, Z: 5, E: 25	Maximum feedrate
DEFAULT_MAX_ACCELERATION	X/Y: 1000, Z: 100, E: 1000	Acceleration settings

Marlin Firmware Configuration – Key Points

- To configure this printer, edit the following files inside the Marlin firmware folder:
    - Configuration.h
    - Configuration_adv.h
- Basic settings like bed size, steps/mm, thermistors, and endstop behavior are modified in Configuration.h.
- Advanced features like babystepping, junction deviation, and SD card support are set in Configuration_adv.h

APPLICATION SOFTWARE:

1. **Slicing Software- Ultimaker Cura / Prusa slicer.**
2. **Printer Host Software – Pronterface.**

Slicing Software:

Slicing software is a tool used in 3D printing to convert a digital 3D model into instructions (called G-code) that the printer can understand and execute.

🔍 Why is Slicing Software Used?

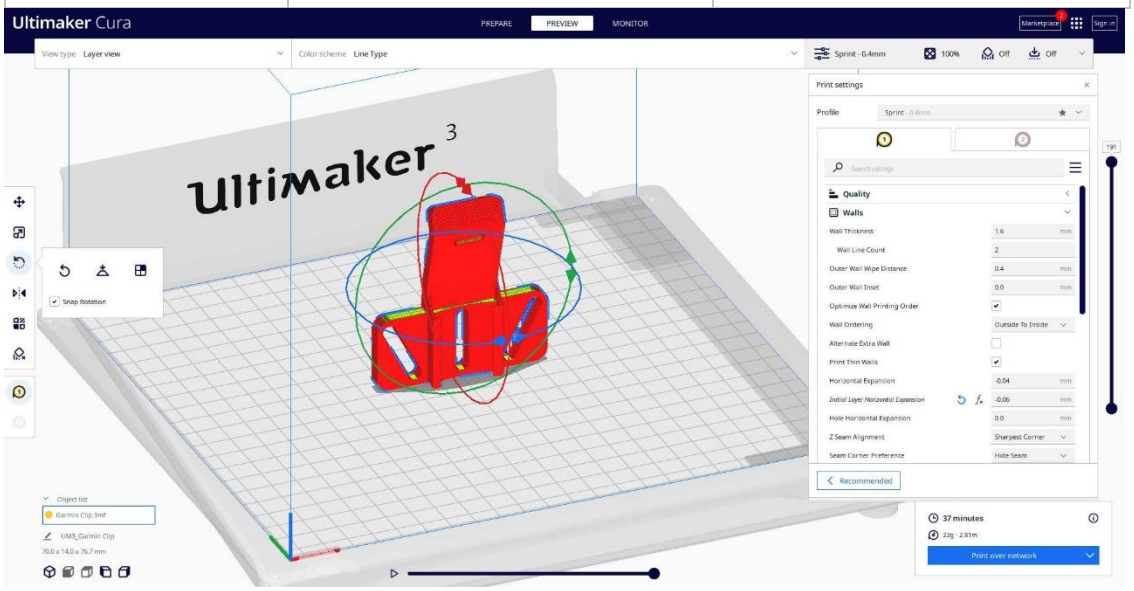
- ✅ Converts 3D models to printable layers
  It slices the model into hundreds or thousands of horizontal layers, which the printer builds one at a time.
- ✅ Generates G-code instructions
  The output file (.gcode) contains movement commands, temperatures, speeds, and more.
- ✅ Controls print settings
  Users can adjust:
  - Layer height (print resolution)
  - Print speed
  - Infill percentage and pattern
  - Support structures
  - Nozzle and bed temperature
- ✅ Previews the print
  Most slicers provide a 3D preview of the print path to help users catch issues before printing.
- ✅ Optimizes printing for material and printer type
  Slicing software includes profiles for different materials (PLA, ABS, PETG, etc.) and printer configurations.

ULTIMAKER CURA:

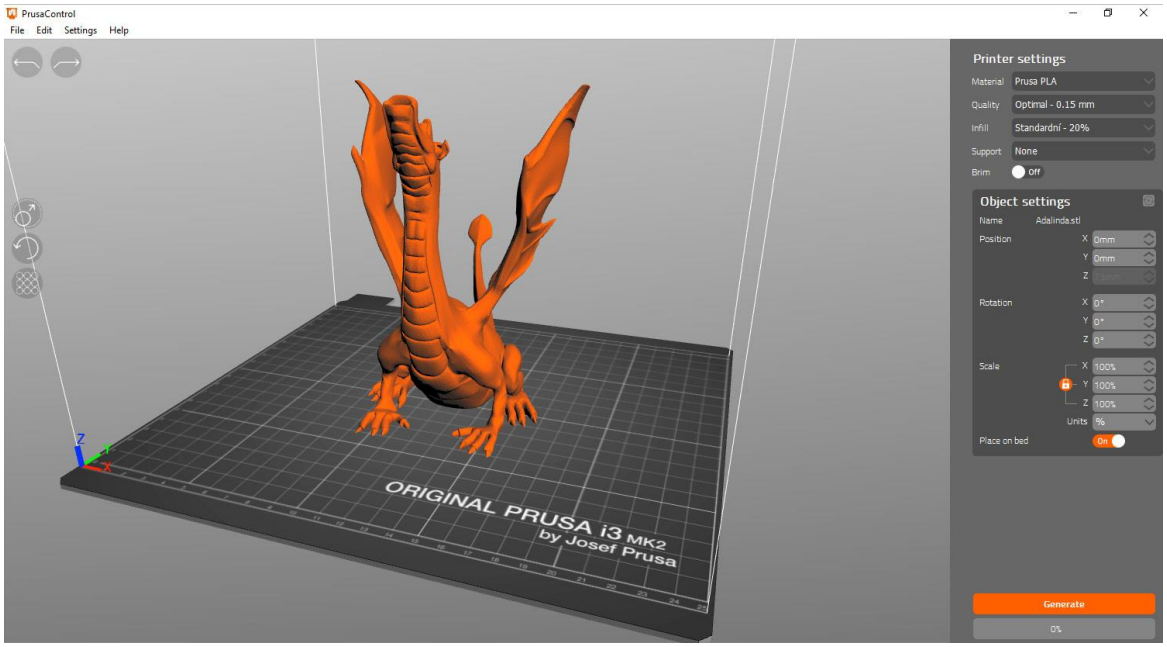
Cura Slicer Settings – Standard Quality (0.2 mm):

Category	Setting	Value
Printer Setup	Printer Type	Custom FDM Printer
	Build Volume	200 × 200 × 200 mm
	Nozzle Diameter	0.4 mm
	Material	PLA
Quality	Layer Height	0.2 mm
	Initial Layer Height	0.2 mm
Shell	Wall Line Count	2
	Wall Thickness	0.8 mm
Infill	Infill Density	20%
	Infill Pattern	Grid
Speed	Print Speed	50 mm/s
	Travel Speed	120 mm/s
	Initial Layer Speed	20 mm/s
Temperature	Nozzle Temperature	200°C
	Bed Temperature	60°C
Retraction	Retraction Distance	5 mm
	Retraction Speed	45 mm/s

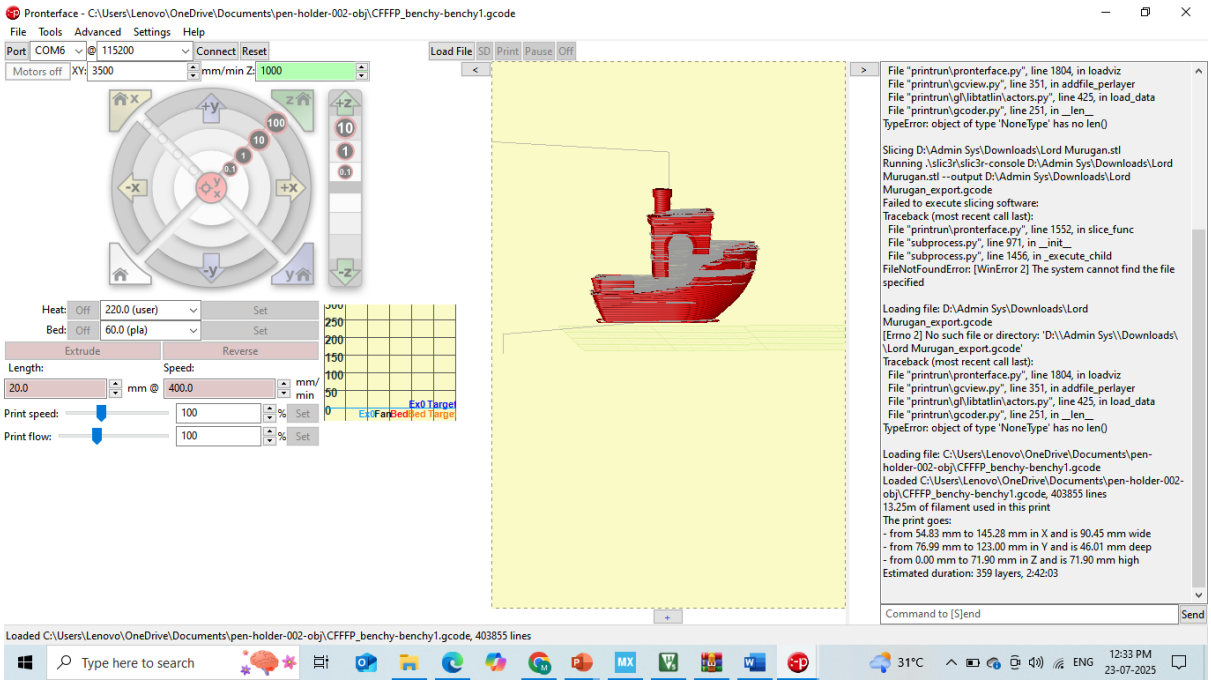
Cooling	Cooling Fan	Enabled (100%)
Adhesion	Build Plate Adhesion	Brim
	Brim Width	5 mm



PRUSA SLICER:



2.Printer Host Software – Pronterface.



Pronterface (also known as Printrun) is a host software used to control and monitor 3D printers via a USB connection from a computer.

It provides a graphical user interface (GUI) that allows users to communicate directly with the printer by sending G-code commands.

What Can Be Done Using Pronterface?

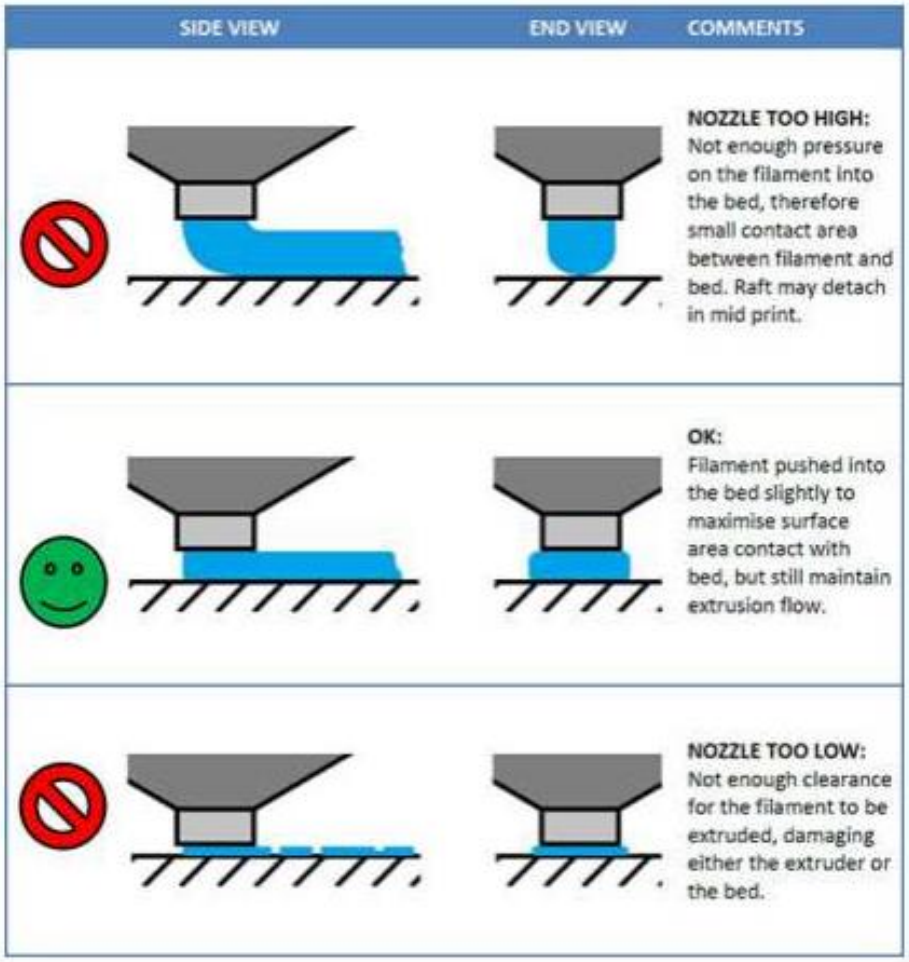
- ✅ Connect to the 3D printer via USB using a COM port.
- ✅ Manually control printer movements (X, Y, Z axes and extruder).
- ✅ Send G-code commands directly to the printer for testing and configuration (e.g., G28, M503, M104, M500).
- ✅ Monitor real-time temperatures of the hotend and heated bed.
- ✅ Start, pause, or stop a print from a G-code file.
- ✅ Test motor direction and calibration during setup.

- ✅ View printer status messages and debug output in the terminal.
- ✅ Calibrate Z-offset, PID values, and step/mm settings.
- ✅ Use it during firmware setup to verify endstops, motor movements, and heating elements.

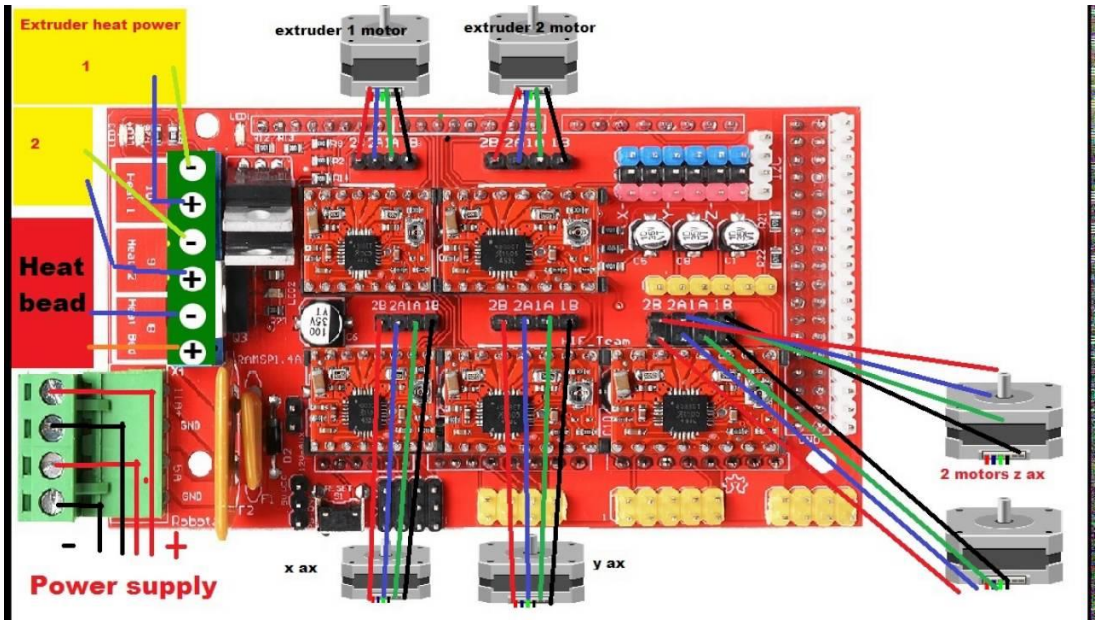
Why Use Pronterface?

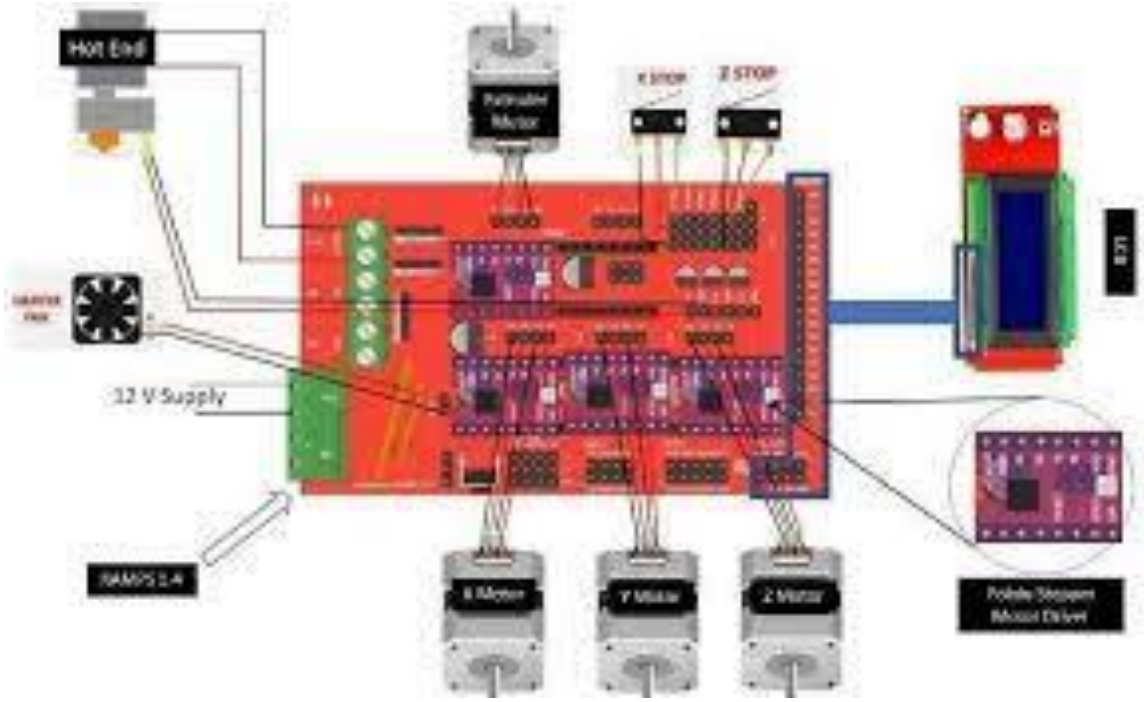
- Simple and lightweight interface
- No need for SD card to test or control the printer
- Ideal for initial calibration, troubleshooting, and firmware testing
- Compatible with Marlin, Repetier, and other firmware types

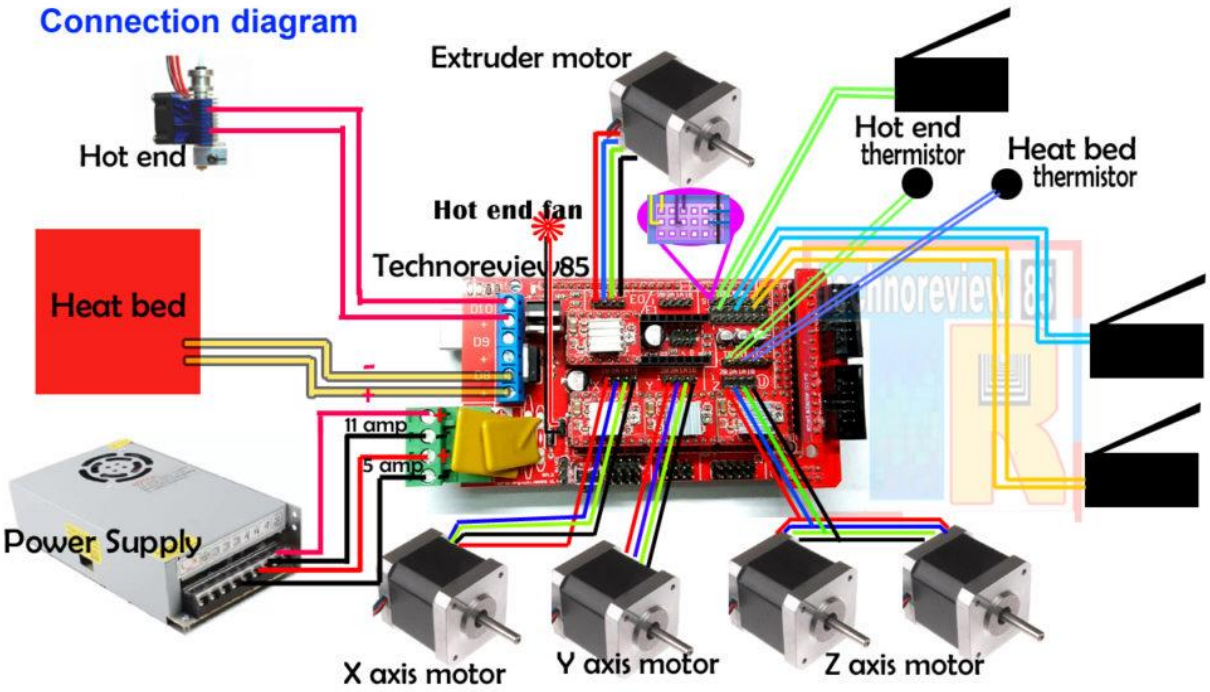
BED LEVELLING:

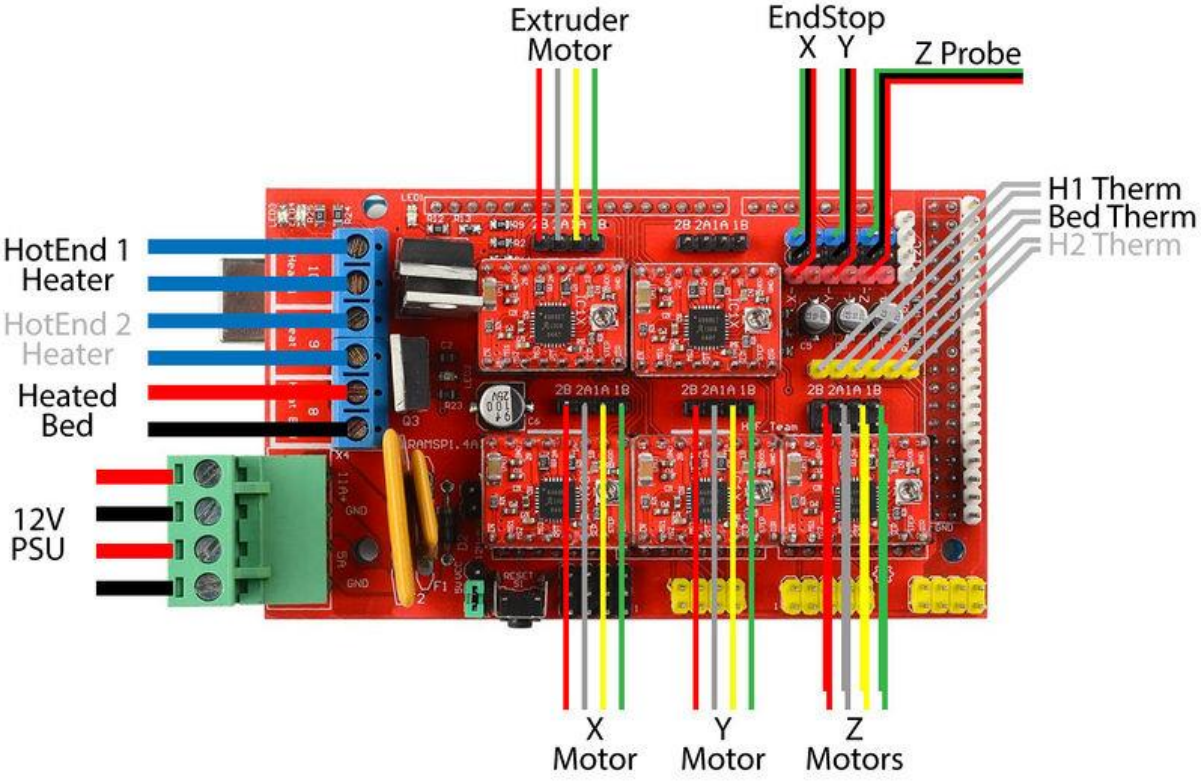


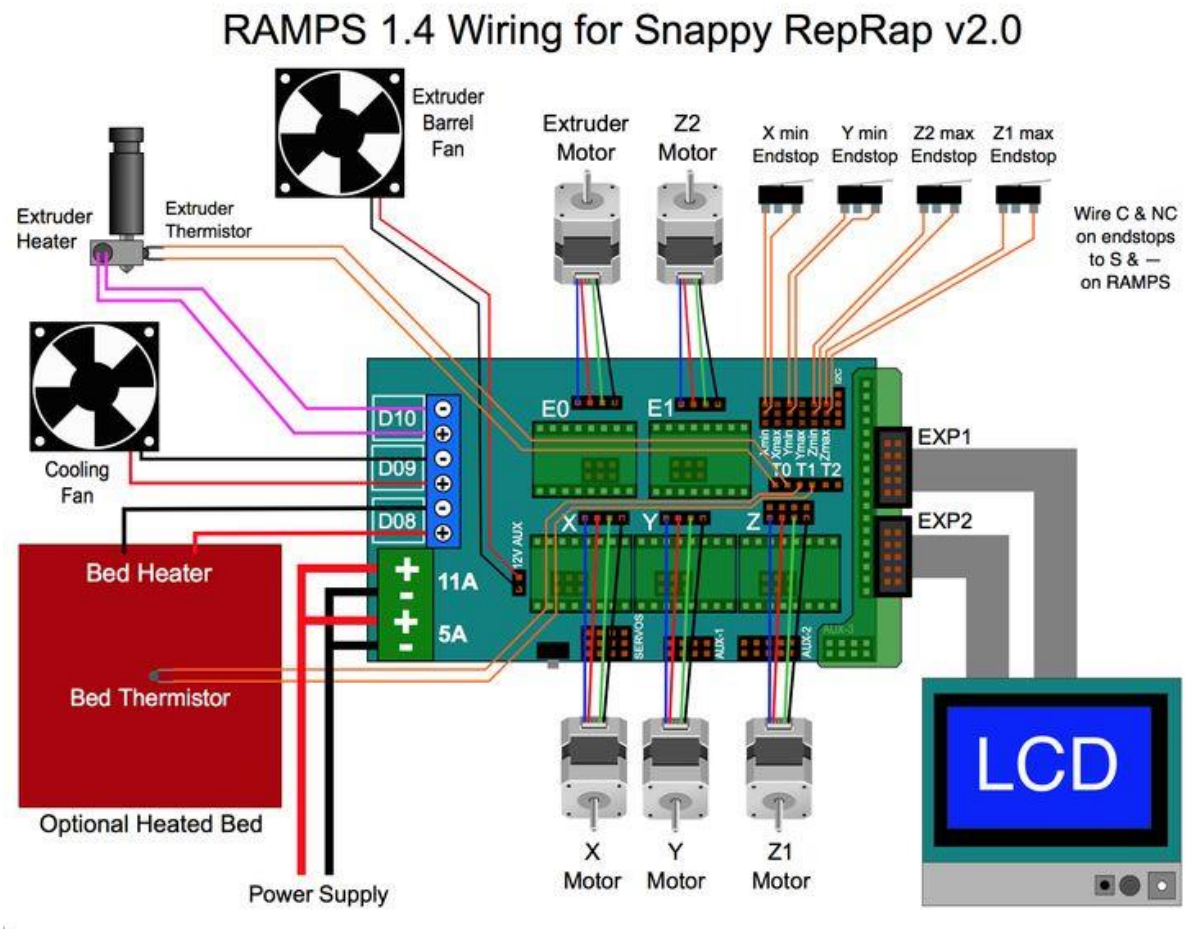
WIRING CONNNECTION:






Connection diagram
Extruder motor
Hot end
Hot end thermistor
Heat bed thermistor
Hot end fan
Technoreview085
Heat bed
11 amp
5 amp
Power Supply
X axis motor
Y axis motor
Z axis motor


Extruder Motor
EndStop X Y
Z Probe
H1 Therm
Bed Therm
H2 Therm
HotEnd 1 Heater
HotEnd 2 Heater
Heated Bed
12V PSU
X Motor
Y Motor
Z Motors



Printing Instructions (Step-by-Step)

1. Turn ON the 3D Printer
    - Power on the machine using the main switch.
2. Preheat the Nozzle and Bed
    - Use the control panel (LCD/Pronterface) to preheat:
        - Nozzle temperature (e.g., 200°C for PLA)
        - Bed temperature (e.g., 60°C for PLA)
3. Load the Filament
    - Insert the filament into the extruder until it extrudes cleanly from the nozzle.

4. Insert the SD Card / Connect via USB
    - SD card: Insert the card with the G-code file exported from slicer software.
    - USB: Open software like Pronterface if printing via computer.
5. Level the Bed (if required)
    - Manually or automatically level the bed to ensure proper first-layer adhesion.
6. Start the Print Job
    - Navigate to Print from SD (LCD) or Send Print (via Pronterface).
    - Select the correct file (usually .gcode).
7. Monitor the First Layer
    - Ensure that the filament adheres well and lines are even.
    - Pause or stop the print if issues appear (like warping or stringing).
8. Wait for the Print to Complete
    - Do not move the printer during operation.
    - Monitor occasionally for any errors or print failures.
9. Cool Down and Remove the Print
    - Let the bed cool down.
    - Gently remove the object using a spatula or scraper.
10. Turn OFF the Printer
    - Once done, power off the printer and clean the bed if needed.

Common Issues and Troubleshooting Guide:

Issue	Possible Cause	Solution
First layer not sticking	Bed not leveled, cold bed, dirty surface	Re-level the bed, increase bed temp, clean surface with IPA/alcohol
Filament not extruding	Nozzle clogged, extruder gear loose, filament tangled	Heat nozzle and clean it, tighten gear, check filament spool
Layer shifting	Loose belts, stepper driver overheating, frame not rigid	Tighten belts, check driver cooling, reinforce frame
Warping at corners	Bed too cold, poor bed adhesion, cooling fan too strong	Increase bed temp, use adhesive (glue/hairspray), reduce fan speed early on
Stringing or oozing	Retraction settings incorrect, nozzle too hot	Adjust retraction distance/speed, lower nozzle temperature
Under-extrusion	Nozzle partially clogged, incorrect flow rate	Clean nozzle, increase flow rate slightly
Over-extrusion	Flow rate too high, filament diameter not calibrated	Calibrate flow and filament diameter settings
Layers not aligned (Z-banding)	Lead screw bent, inconsistent Z movement	Check and straighten Z-screw, lubricate Z-axis
Nozzle dragging through print	Z-offset too low, over-extrusion	Re-adjust Z-offset, lower flow rate

Print stops mid-way	SD card issue, overheating board, power fluctuation	Use a good quality SD card, improve cooling, use UPS or stable power source

SAFETY INSTURCIONS:

- Use the printer in a well-ventilated area.
- Do not touch the hot nozzle or heated bed while printing.
- Keep hands, hair, and tools away from moving parts.
- Turn off power before doing any wiring or maintenance.
- Keep the printer away from flammable materials.
- Wait for parts to cool before touching after a print.
- Do not leave the printer unattended for long prints.
- Keep children and pets away from the printer during operation.