PLASMICS

Manual INo Trident

Hotend INo Trident

Plasmics GmbH
Zeltgasse 3-5
1080 Wien

This manual was created by:
Stefan Spor
CTO
V0
@ 2023

Updated by:
Ivee Sanasinh
V3
@ 10.01.2023

1. Introduction

1.1. Welcome words

Thank you for purchasing an INo Trident Hotend, the first induction heated hotend on the market, developed by Plasmics GmbH. This instruction manual has been created to describe the necessary steps to operate the hotend in the best possible way and to support them with pictures.

Even if you already have experience with the exchange and use of alternative hotends, the INo Trident hotend requires some additional steps, especially in the area of software, in order to be able to put the hotend into operation.

You can get further help and support at the following address:
- e-mail: **support@plasmics.com**

1.2. Validity

This operating manual is a document of the company Plasmics GmbH. It is addressed to engineers and technicians and provides essential information about the setup, commissioning, function and operation of the INo Trident hotend. Please read these operating instructions carefully before carrying out any actions with the hotend.

The contents, texts, drawings, pictures and other illustrations are protected by copyright and are subject to industrial property rights. Any misuse is punishable by law.

1.3. Application

1.3.1. Intended Use

The INo Trident hotend is designed for indoor use and is used to print components made of thermoplastic filaments with diameters of 1.75 or 2.85 mm. The electronics can be operated with 24 or 48V. The software supports current open source firmware versions of Klipper, RepRap Firmware 3 and Marlin.

The respective associated firmware can be found at:

Klipper: https://github.com/Plasmics-3D/klipper
RepRap Firmware 3:   https://github.com/Plasmics-3D/RepRapFirmware
Marlin: https://github.com/Plasmics-3D/Marlin

Observing all the handling instructions given in the operating manual as well as regular maintenance and servicing ensures maximum safety and usability for the operator. The operator is responsible for exact compliance with the instructions given in these operating instructions for operating, cleaning and maintaining the hotend.

1.3.2. Safety instructions

Symbols used in the manual:
Important notes are marked by the following symbols. It is absolutely necessary to observe these notes.

 Danger!

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

 Danger of burns!

Non-observance may be the cause of scalding or burns. Note: This symbol indicates advice and important information for the user.

Do not touch, electronic components

Touching the electronic components, especially during operation, can cause irreparable damage to the electronics.

Read the manual

Refers to information on components in the supplier documentation

Operating instructions

Please read these operating instructions carefully before using the device. Failure to follow these instructions may result in personal injury and equipment damage. The manufacturer is not liable for any damage caused by failure to observe these operating instructions. Note: Keep these operating instructions in a safe place. If you should assign this device to other persons, please also hand over these operating instructions.

1.3.3. Changes in Hard- and Software

Safety devices must not be put out of operation or rendered ineffective. Changes as well as adaptation to the software may only be carried out by Plasmics GmbH or require the express written consent of Plasmics GmbH. Safety-relevant changes require a reassessment of the safety and thus the CE conformity of the device. Changes must also be incorporated into the technical documentation.

1.3.4. Warranty

Plasmics GmbH is not liable for damages, in particular also consequential damages, which result from:

- Modification of the hotend by the operator without approval by Plasmics GmbH.
  - e.g. unapproved cable extensions
  - e.g. use of an alternative heat sink, causing cable and thermocouple to be bent or kinked beyond the dimensions.
- Modification of the software by the operator without approval by Plasmics GmbH.
- Operating the hotend with safety devices not functioning properly
- Operating the hotend when the system is not being used for its intended purpose
- Failure to observe the information and safety instructions in the operating manual
- Failure to carry out maintenance in accordance with the maintenance specifications
- Effects of force majeure (earthquakes, floods, etc.)

Such damage is also expressly excluded from the warranty.

1.3.5.   Disposal

DISPOSAL: The device must not be disposed of as household waste but must be taken to an official collection point.

2. Technical Data and Parts list

2.1. Technical Data

- Max printing temperature: 500°C
- Temperature sensor type: K-type thermocouple
- Nozzle material: tool steel
- Heatsink material: aluminium
- Voltage options: 24V or 48V
- Filament diameter: 1.75mm or 2.85mm
- Nozzle diameter: 0.4, 0.6 and 1.0mm
- Power: 60W or 120W

The maximum length of the VIN cable to the board and from the board to the coil is 3 m. The heat-up times and the maximum usable power depend on the cable length used. All performance values given are tested for a cable length of 75cm, longer cables increase the heating times and reduce the maximum usable power.

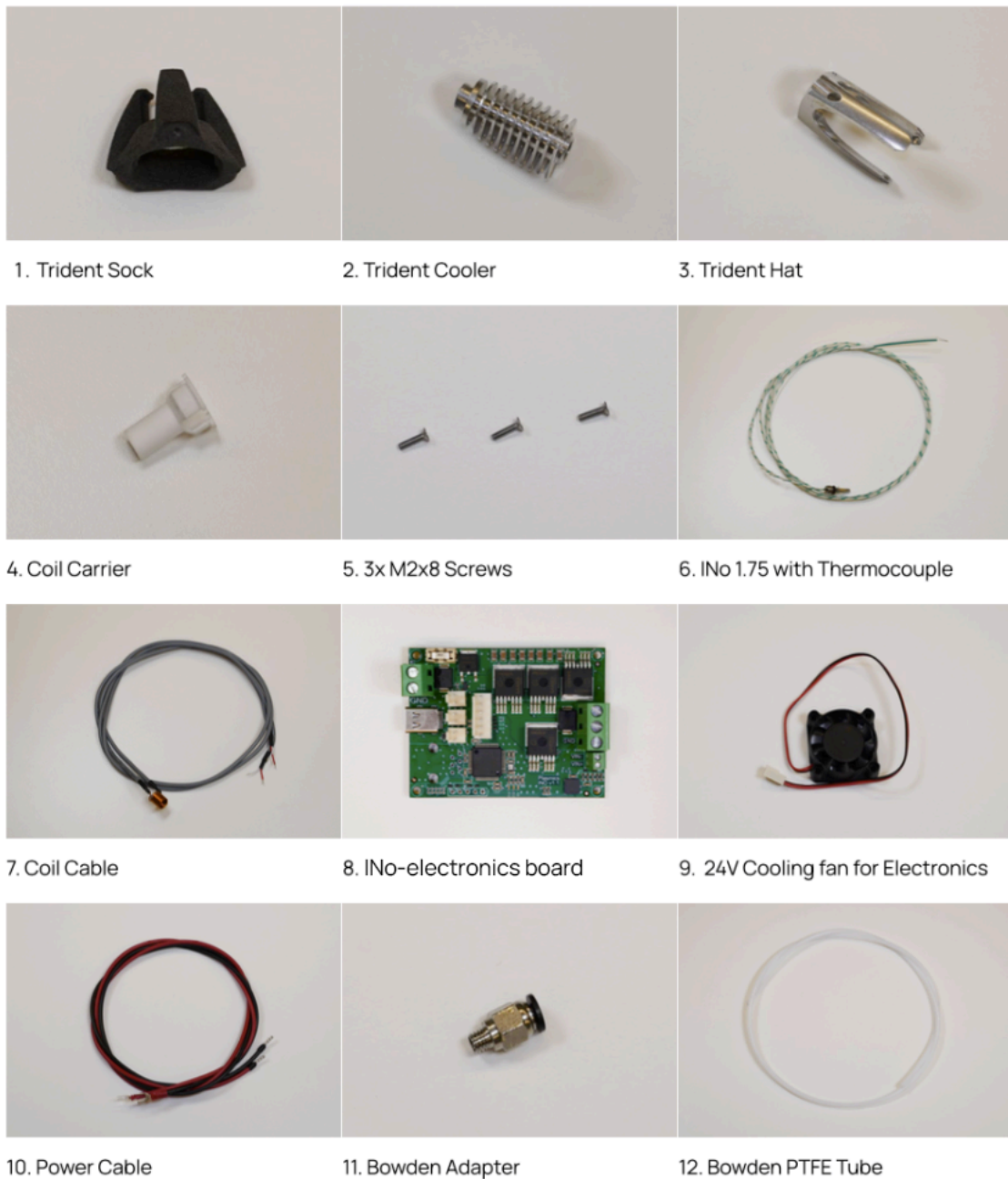## 2.2. Parts list

The following Parts are included in delivery.

Fig. 2: Overview of all 12 components of the INo Trident system

2.3. Dimensions

PCB Box

M3x14 Screw

Grill

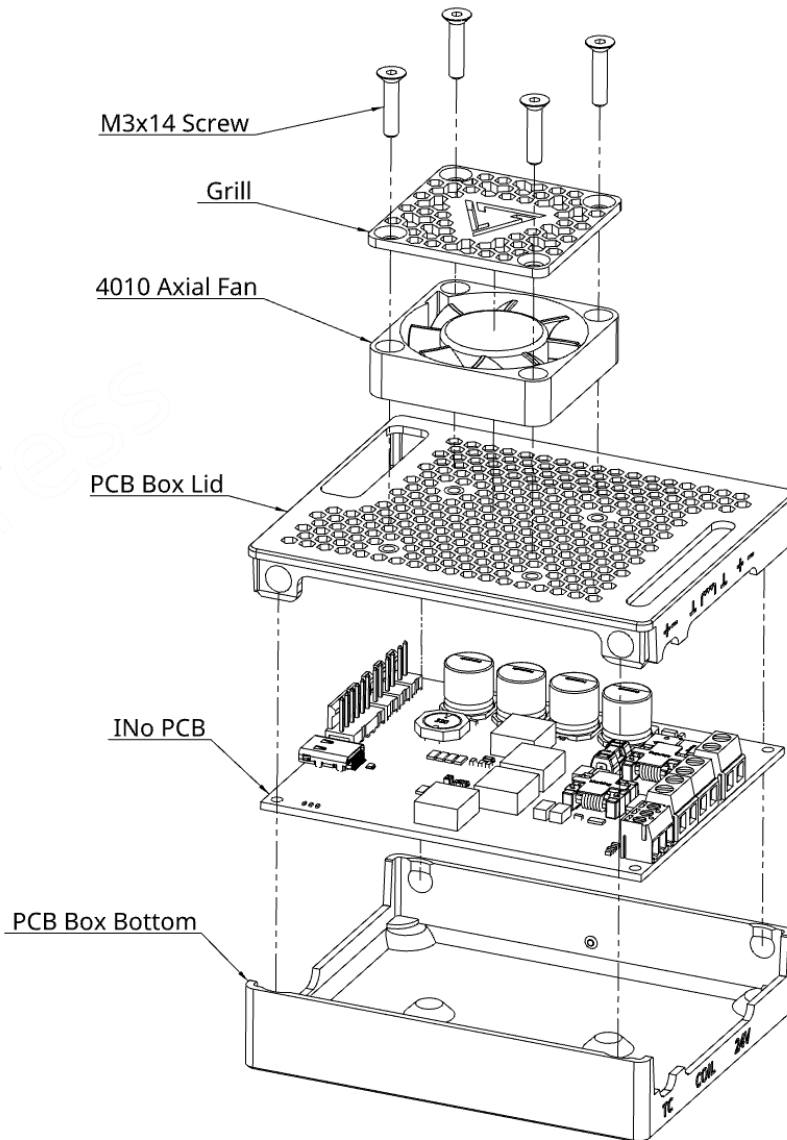4010 Axial Fan

PCB Box Lid

INo PCB

PCB Box Bottom

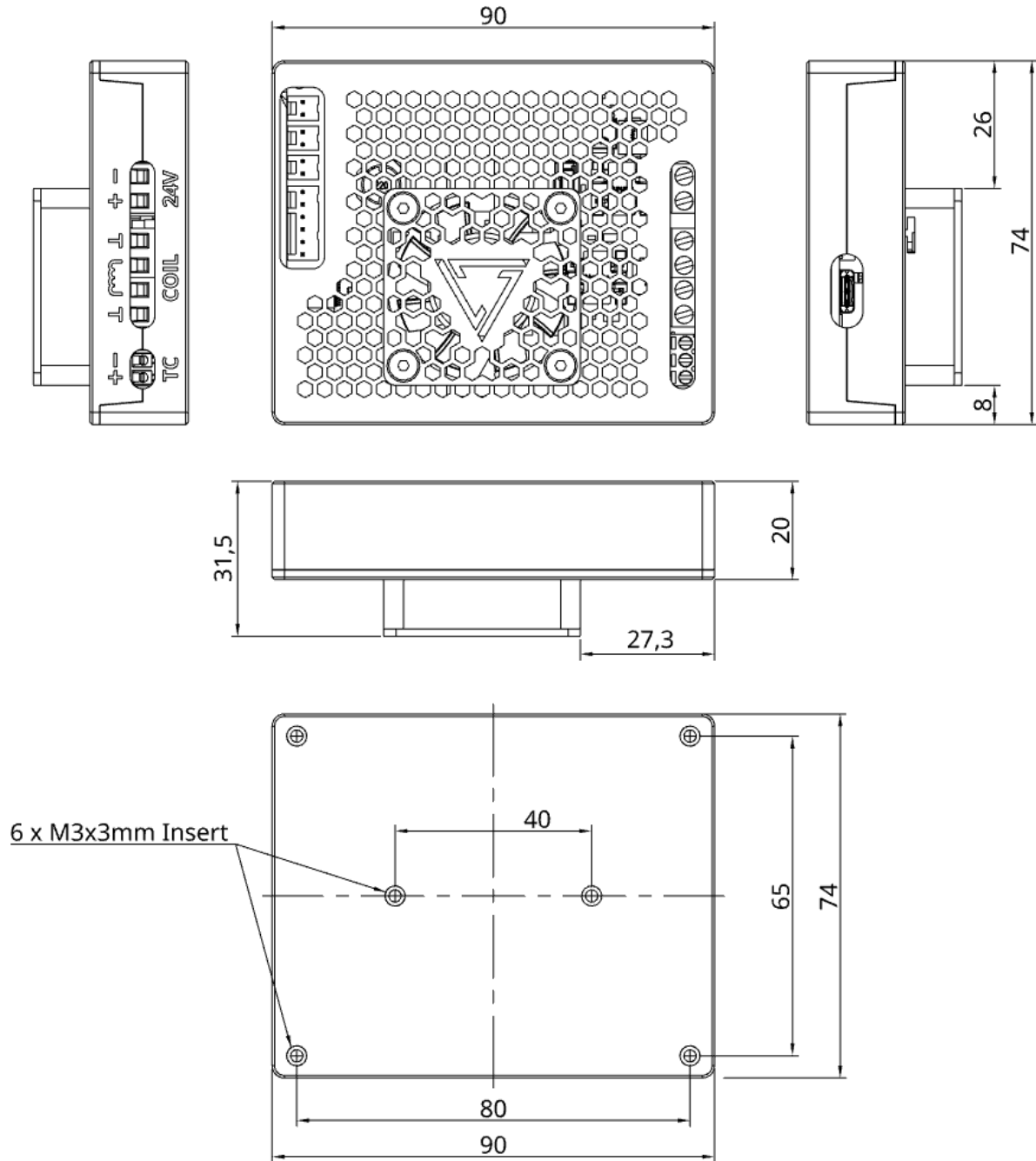Fig. 3: Schematic assembly of the PCB box

Fig. 4: Main dimensions of the assembled PCB box incl. connection dimensions
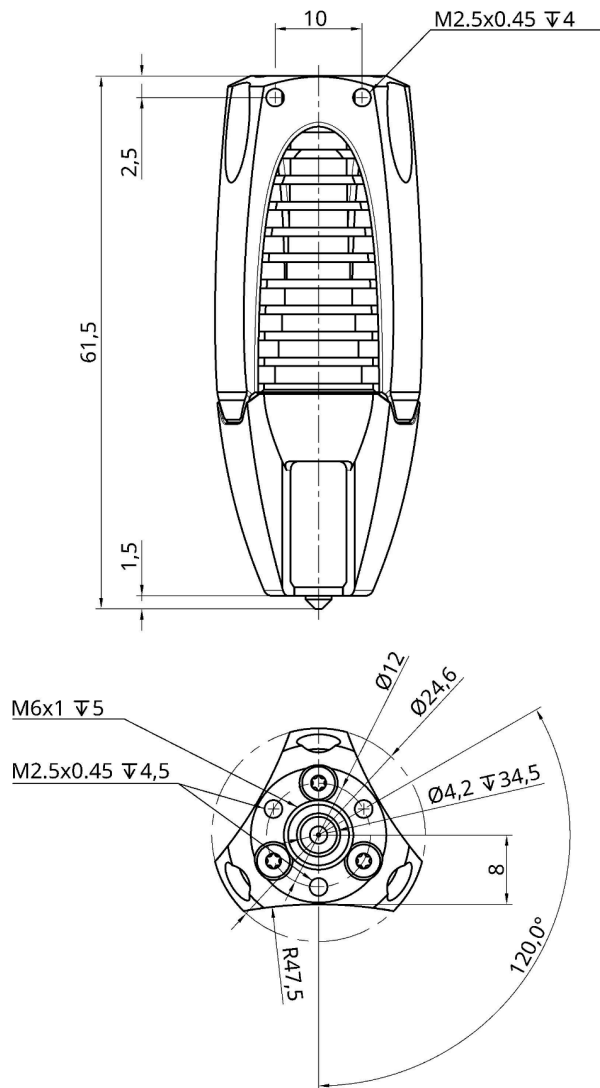
INo Trident

Fig. 5: Main dimensions INo Trident Hotend incl. connection dimensions
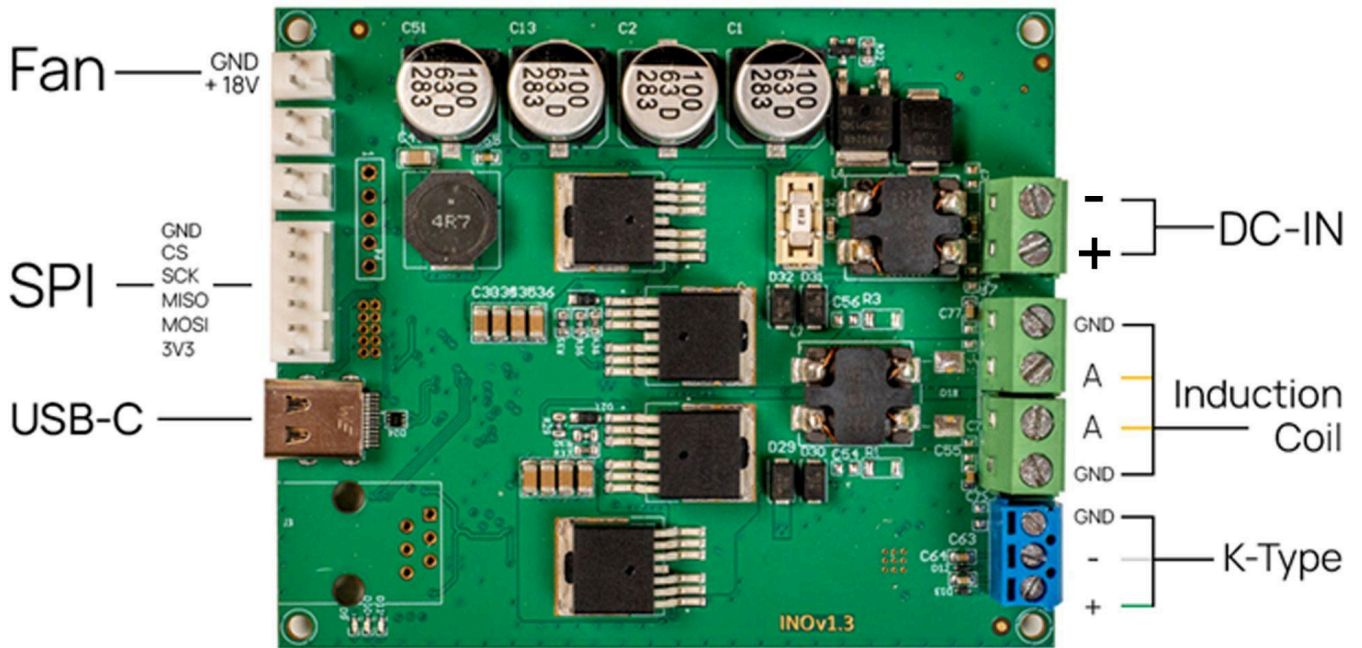
2.4.   Assembly Guide

Fig. 6: INo-electronics board v1.3

2.4.1.   What you need

- Screwdriver Torx M2.5

2.4.2.   **Warnings - Please read!**

- **The heatbreak is fragile. Tighten the nozzle with a maximum of 1 Nm.**

- The static bending radius of the K-type cable must not be smaller than 4 times the outer diameter of the thermocouple, which corresponds to about 6mm.

- The nozzle can reach up to 500°C, direct contact can cause injuries.
- Be sure to check all wiring and rating of your power supply. Do not make any changes to the hotend while it is connected to active power electronics.

1. Fix the thermocouple, the coil cable with shielding cable and 24 Volts to the slots provided.
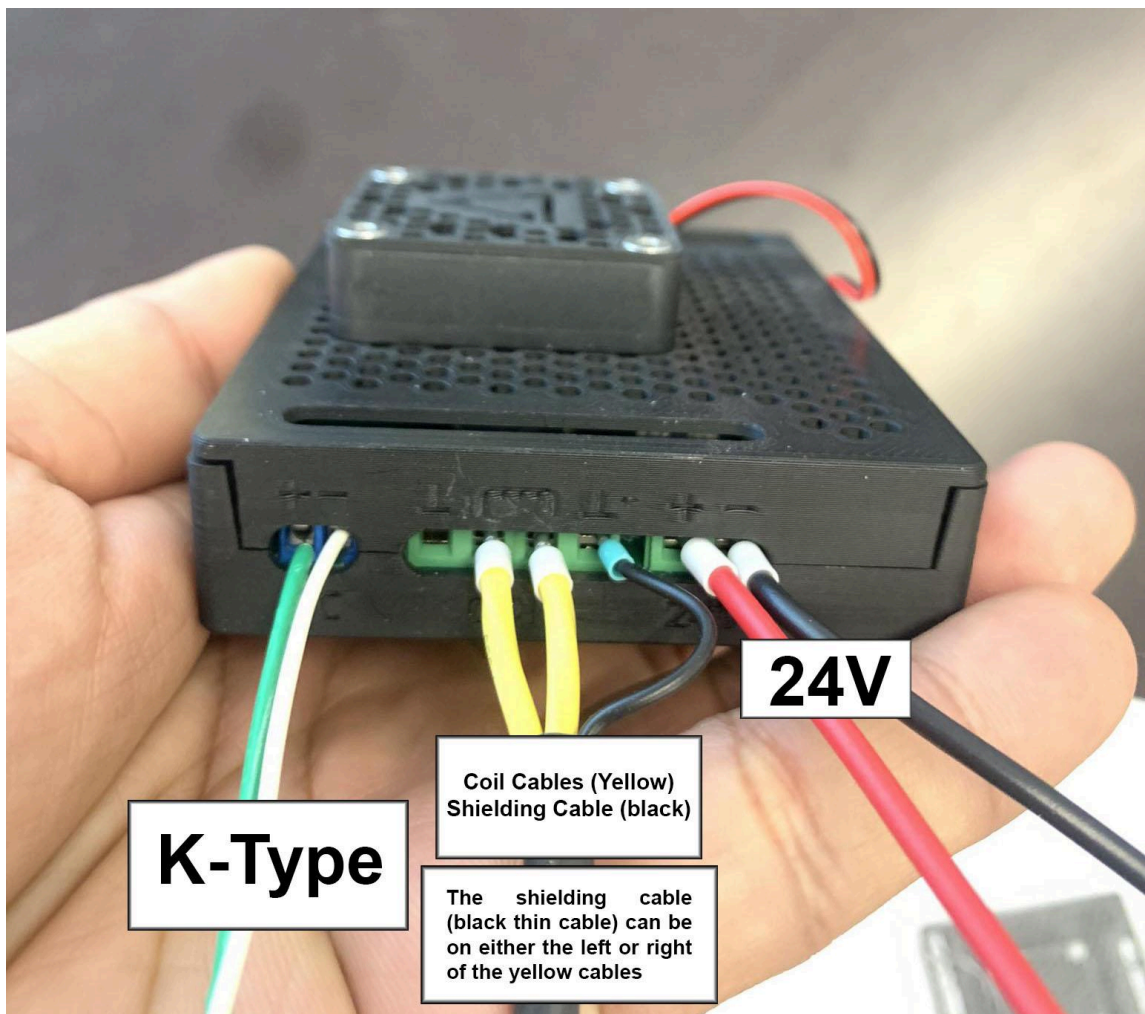

Fig. 7: Connecting the cables to the INo board. The shielding cable can be grounded on either side of the coil cables. These cables power the board.

2. Make sure that the nozzle does not come into contact with the coil carrier, as this can lead to temperature deviations.

3. INo connection with Klipper

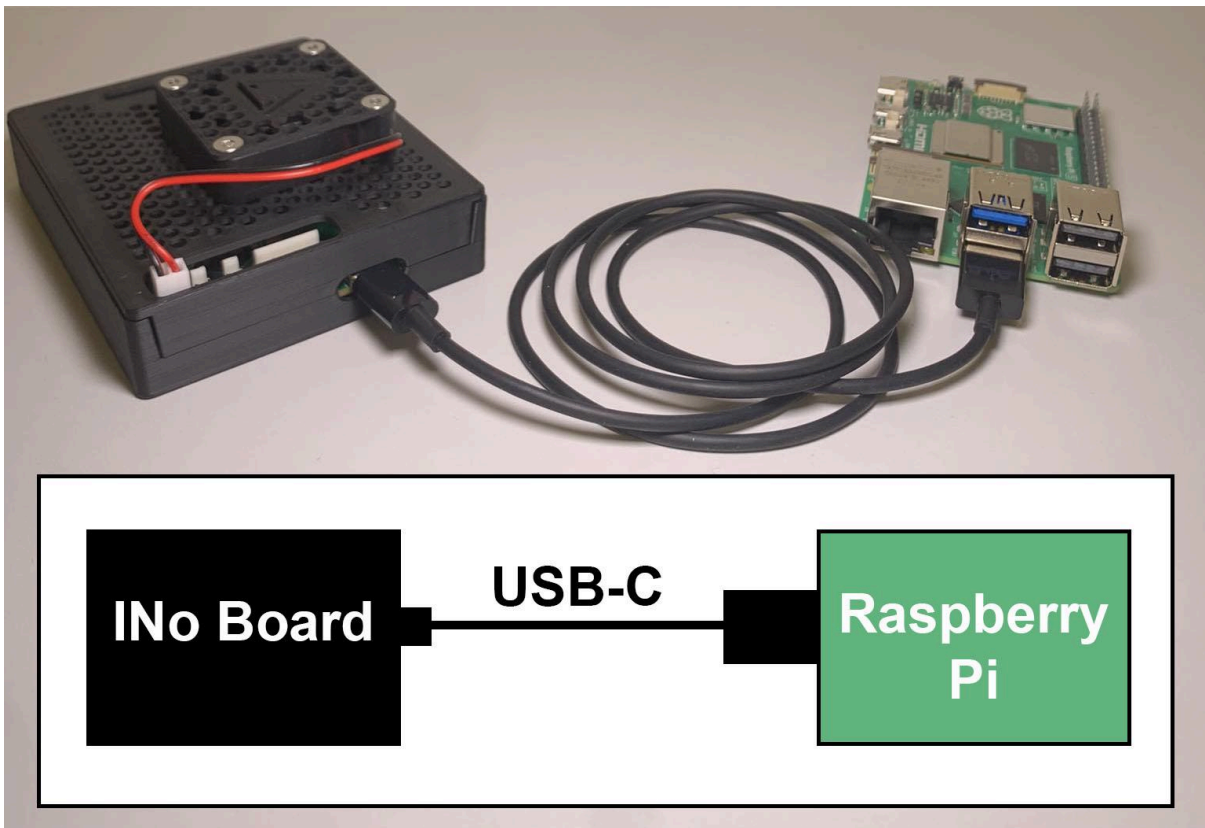- Connect INo board with USB-C cable to Raspberry Pi.

Fig. 8: How to connect the INo board to the Raspberry Pi.

4. Klipper INo software configuration

This will guide you through the setup of the Ino Trident for Klipper. It will replace your current Klipper Version with ours.

This guide assumes that you already have a working Klipper installation.

- Go to the GitHub link for the newest drivers and instructions. You can follow the instructions in this manual or the GitHub. They are the same:
  https://github.com/Plasmics-3D/klipper

Step 1: Install the Custom Klipper Version

1. Reboot your Raspberry Pi
2. Execute the following commands to replace your existing Klipper with our version:

```
Unset
rm -rf ~/klipper
cd ~/ && git clone git@github.com:Plasmics-3D/klipper.git
```

3. Run the following command to identify the USB serial port:

```
Unset
ls /dev/serial/by-id/*
```

- Make a note of the USB serial port that looks like this for later use:

    /dev/serial/by-id/usb-STMicroelectronics_INO_Virtual_ComPort_XXXXXXXXXXX-if00

Step 2: Update Printer Configuration

1. Open your `printer.cfg` and make the following changes:

```
[extruder]
sensor_type: PLA_INO_SENSOR
heater_type: PLA_INO
control: pid
# Important first PID Values
pid_Kp: 13.41
pid_Ki: 30.91
pid_Kd: 1.46
min_temp: 10
max_temp: 450
serial:
/dev/serial/by-id/usb-STMicroelectronics_INO_Virtual_ComPort_XXXXXXXX
XXX-if00  # Use the serial name you copied earlier
PLA_INO_report_time: 0.1
```

- After a reboot of your Raspberry Pi, your Ino should work correctly.

Step 3: PID Tune

1. Run the following gcode:

```
INO_PID_TUNE PID=250
```

2. Once completed, execute:

```
INO_READ_PID_VALUES
```

3. Replace the old PID values in the `printer.cfg` [extruder] section with the new ones

5. RepRap firmware INo software configuration

GitHub: https://github.com/Plasmics-3D/RepRapFirmware

This is firmware for controlling 3D printers and related devices using electronics based on ARM Cortex main processors. The current processors supported are the ATSAM4E, ATSAM4S, SAME70 and SAME5x. There is a fork of this firmware that supports LPC1768/1769 and STM processors.

After you have flashed the Duet board with INo-RepRapFirmware, you should only define the Config.g to Ino.

```
Unset
;Heaters
M308 S1 P"spi.cs1" Y"inotrident" K"K" ; configure sensor 1 as inotrident via
CS pin spi.cs1 and K stands for Thermoouple Type
M950 H1 C"out1" T1   ; create nozzle heater output on out1 and map it to sensor 1
M307 H1 B0 S1.00     ; disable bang-bang mode for heater  and set PWM limit
M143 H1 S450         ; set temperature limit for heater 1 to 450C
M302 P1
M301 H1 P13.41 I30.91 D1.46 ; This where you define PID values for INO

M308 S2 P"spi.cs3" Y"inotrident" K"K" ; sensor 2
M950 H2 C"out2" T2
M307 H2 B0 S1.00
M143 H2 S450
M302 P2
M301 H2 P13.41 I30.91 D1.46
```

But you have to be careful, here that **H**, **T** and **S** (as well as in M308 and M950) must have the same numbers when you define the sensor. Y "inotrident" must also always be written when naming INO as sensor.
Next you should define tools in Config. S "ToolName" can be anything you want to write. Here we have written INO_TOOL.

```
Unset
; Tools
M563 P1 S"INO_TOOL" D0 H1 F0  ; define tool 1 with heater 1
G10 P1 X0 Y0 Z0               ; set tool 1 axis offsets
G10 P1 R0 S0                  ; set initial tool 1 active and standby temperatures to 0C
```

```
M563 P2 S"INO_TOOL2" D0 H2 F0 ; define tool 2 with heater 2
G10 P2 X1 Y1 Z1               ; set tool 2 axis offsets
G10 P2 R0 S0          ; set initial tool 2 active and standby temperatures to 0C
```

6. Security information

6.1 General safety informations

Since the device is operated with electricity, electric shocks cannot be ruled out. Therefore, please adhere to the following safety instructions:

- Never touch the device with wet hands or feet.
- Do not touch the power plug with wet hands.
- Do not spill any liquids on the plug connection.
- Make sure that the connection used to the 24/48V power supply is always properly accessible, as this is the only way to disconnect the INo electronics from the power supply if necessary.
- Live wires must not be routed over sharp edges.
- To switch off the device completely, disconnect the connected power supply.
- If the device is defective, please do not attempt to repair it yourself. Turn off the device, disconnect it from the power supply and contact the technical support service.

Attention:

- After unpacking, make sure that the device is intact and no accessories are missing.
- Keep the packing material (plastic bags, styrofoam) away from children.
- Improper use can lead to injuries.
- In case of visible damage, do not use the device under any circumstances. Contact the technical customer service.
- Make sure that the housing is tightly closed before operating the unit.

6.2 Security concept

In the following, implemented safety features are described to prevent an uncontrolled temperature rise of the nozzle. The safety concept refers to the following 4 sub-areas of the nozzle control:

Heartbeat
- The INo has a heartbeat safety function to detect the loss of communication between the INo and the controller. If there is no communication between the controller and the INo electronics for more than 100 milliseconds, the INo switches to error mode.

Watchdog
- The use of a watchdog timer ensures that the firmware of the INo is restarted if an unplanned state is reached.

Thermal Runaway
- The steepness of the heating curve is checked by continuously monitoring the temperature curve. If this is outside the predefined parameters, the Plasmics INo goes into error mode.

Open Circuit Detection
- Detects if the thermocouple is connected, if it is not, the INo Trident goes into error mode.

6.3 Hot Surfaces

In addition to cooling the heatbreak, the heat sink of the INo Trident also serves as strain relief for the coil cable and the thermocouple. The heat sink is designed in such a way that if the air-cooling fails and the nozzle temperature is set at 250°C, a maximum of 75°C plus ambient temperature is reached at the heat sink. With a set nozzle temperature of 450°C, the cooler becomes a maximum of 95°C warmer than the ambient temperature.

The individual components of the hotend reach the following temperatures during operation:

Component	maximum surface temperature
Nozzle	500°C
Copper-induction	85°C (at 500°C Nozzle temperature / 23°C RT)

Heatsink	10°C above RT (with Cooling), 75 °C above RT (@450°C nozzle temperature)
Coil wire	10°C above RT

7. Maintenance and software update

7.1 General information

The hotend has a steel nozzle, which makes it significantly more wear-resistant than brass. When using non-fiber-reinforced plastics, wear should be minimal and the nozzle should have a service life of at least 2 years.

With fiber-reinforced filaments, wear is very dependent on the fiber length, type of fiber and also the plastic matrix. The service life of the nozzle is significantly lower when extruding fibre-reinforced PEEK compared to fibre-reinforced PET. Therefore, it is very difficult to estimate durability and it is also not feasible to test it for each filament. It is recommended to carry out reference prints at regular intervals to check the dimensional accuracy of the extruded filament strand.

Firmware updates can be performed via USB-DFU. The most recent firmware as well as the instructions how to perform the update are available on Plasmics' homepage as well as on github.

7.2 Maintenance

The INo electronics do not have to be removed from the box for maintenance, all necessary connections are accessible in the installed state. In the case you do have to disassemble the INo, the following set of instructions are for reassembling the INo:
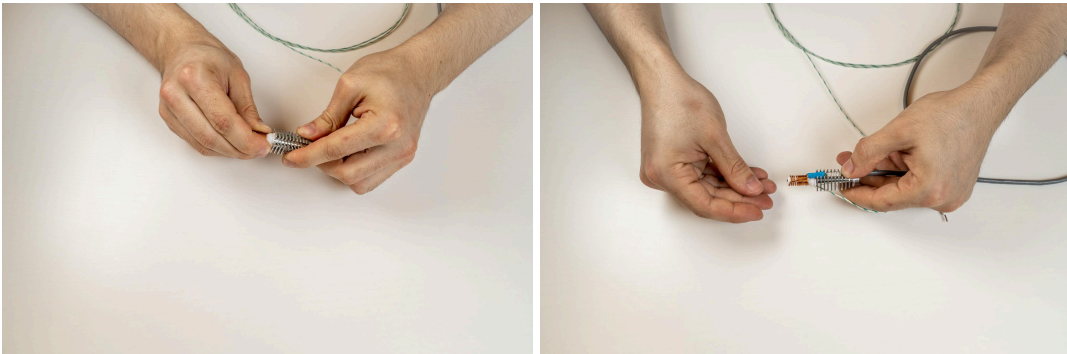
1. Turn the INo 1.75 by hand into the Trident Cooler.
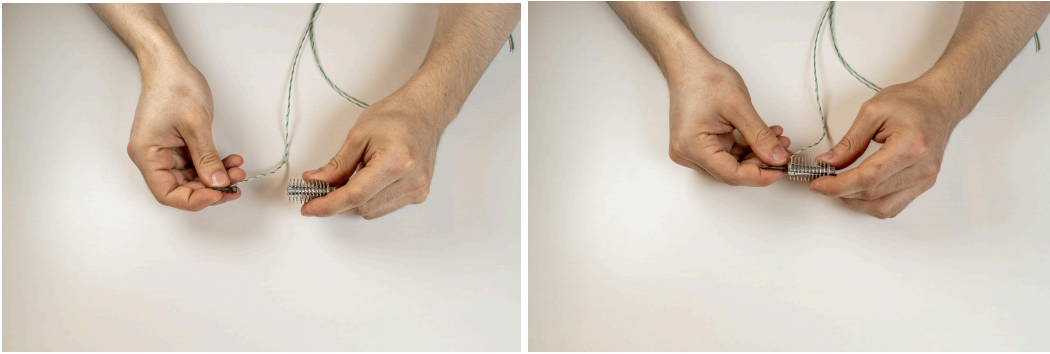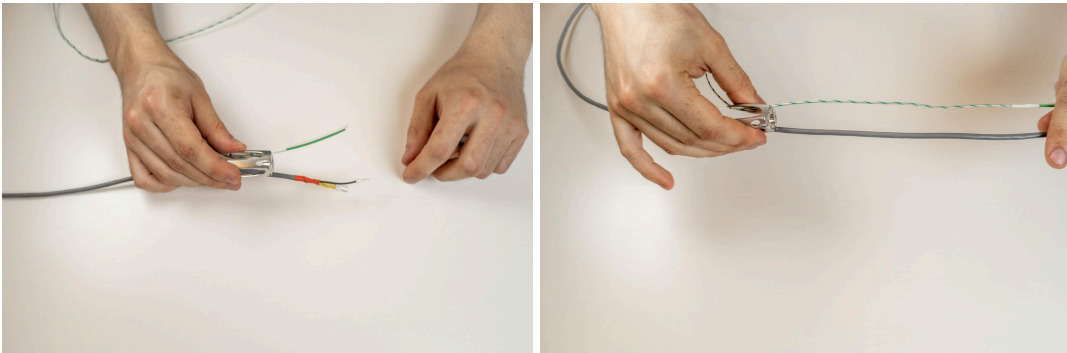

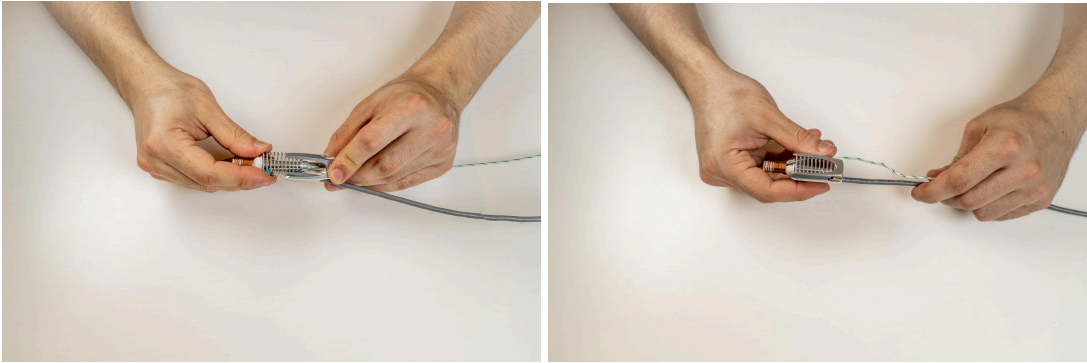2. Slide the coil carrier including coil over the nozzle up to the heat sink.
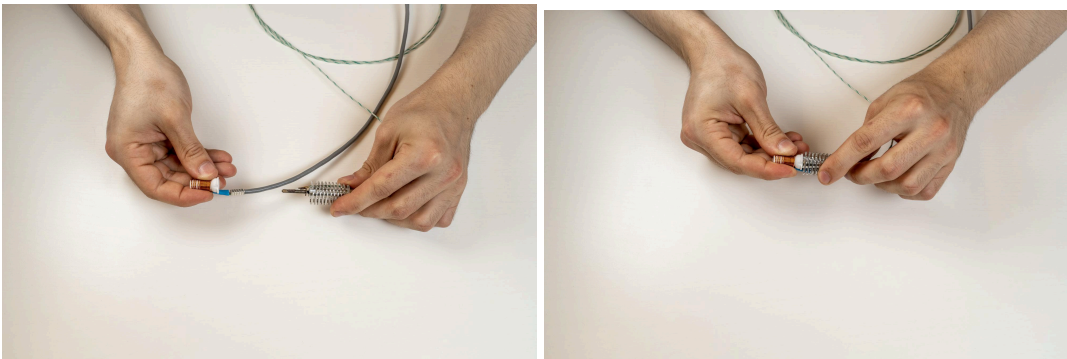
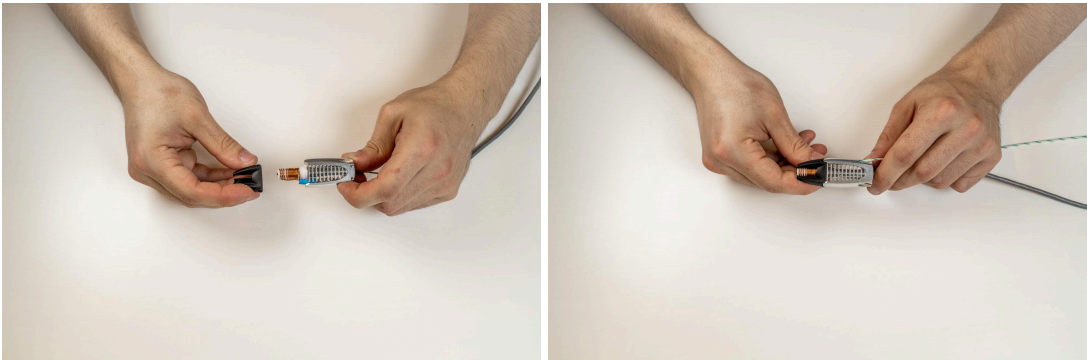3. Press the grounding of the coil cable into the heat sink.

4. Feed the thermocouple and coil wires through the holes in the Trident Hat.

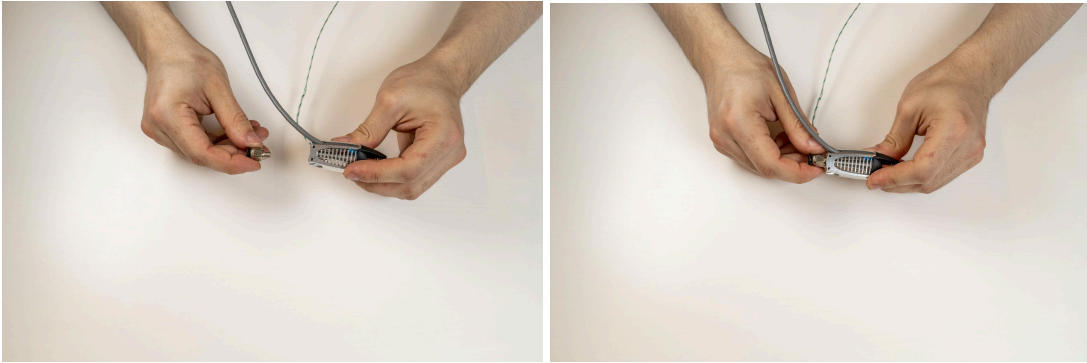5. Slide the Trident Hat onto the Trident Cooler.

6. Press the Trident Sock from the nozzle side against the radiator until it snaps into place.
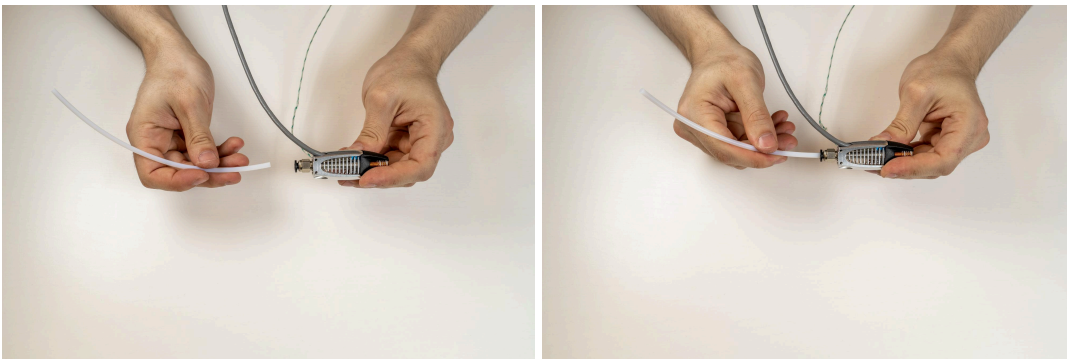

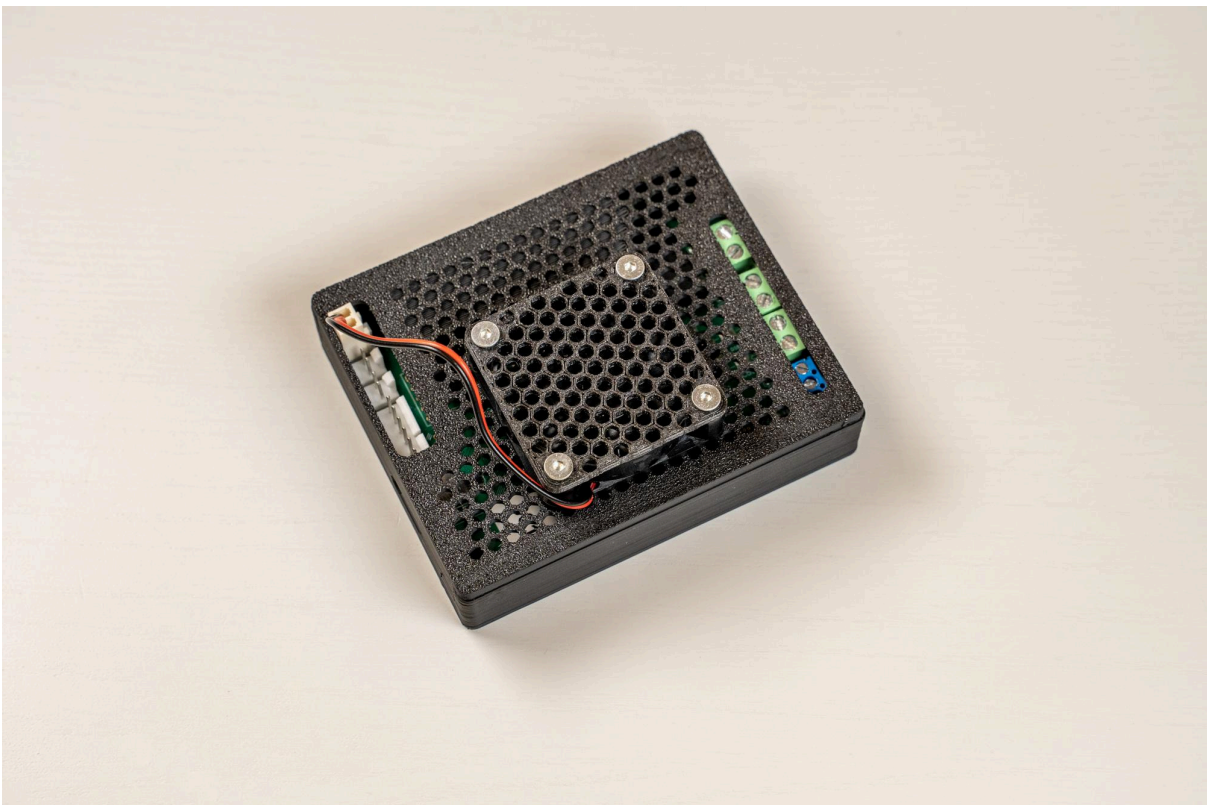7. Screw M2x8 countersunk screws into the radiator from above.

8. Screw the Push-Fit bracket into the cooler from above.

9. Insert the Bowden as far as it will go.

10. Insert the fan into the designated slot on the INo electronics.

8. Transportation

8.1 What's in the box

The package generally contains:

- INo Trident hotend
- INo PCB Box
- PTFE Tube
- 1 spare Sock
- Appropriate additional cables for the respective type of communication:
  - Clipper: USB-C cable
  - SPI: 5-pin connector with 20cm cable and different crimps

8.2 Spare parts

- 1.75 0.4mm INo Nozzle
- 1.75 0.6mm INo Nozzle
- 2.85 0.6mm INo Nozzle
- 2.85 1.0mm INo Nozzle
- Cooler
- Hat
- 1.75 Sock
- 2.85 Sock
- 1.75 Power Cable incl. Coil
- 2.85 Power Cable incl. Coil
- PCB Box incl. Fan
- Fuse

9. Appendix - Declaration of Conformity

KONFORMITÄTSERKLÄRUNG

nach ISO / IEC 17050-1 und EN 17050-1

Hersteller: Plasmics GmbH

Herstelleradresse: Plasmics GmbH
Zeltgasse 3-5
1080 Wien
Österreich
www.plasmics.com

Bevollmächtigter: Konrad Schreiner, CEO

Produkt: INO Trident

Produktbeschreibung: 3D Druck Hotend

Hiermit zertifizieren wir, dass das beschriebene Gerät allen einschlägigen Vorschriften der Europäischen Maschinenrichtlinie 2006/42/EG entspricht sowie allen nationalen gesetzlichen Bestimmungen, die diese Richtlinie umsetzen. - Typ-A-Normen: EN ISO 12100:2010 - Typ-B-Normen: EN 60204

Norm:

| EN IEC 61326-1:2021 | EMV |
| FCC Part 15 (eCFR,January 1, 2022) | Radio Frequency Devices |

Konrad Schreiner, CEO

Ausstellungsdatum: 05.05.2023

Ausstellungsort: Plasmics GmbH, Zeltgasse 3-5, 1080 Wien, Österreich

| 1 | Hotend INO Trident | 30.05.2021 |