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MELTIO

Meltio Engine V3 Integration Manual

Applies to Meltio Engine - V4 March 2024

Contents

Engine V3 + CNC Lagun L1600

Summary

This document is to be used to provide general instructions on the integration and operation of a CNC and the Meltio Engine.

CNC is a type of machine that works by numerical control, which makes the process automatic. Thanks to this type of machine, it is possible to perform many machining operations with the help of a computer that meets the hardware requirements and communication requirements indicated in this document.

This document outlines the steps for integrating the CNC and the Meltio Engine together. The process steps include communication wiring, safety requirements and assembly of the CNC Integration Hardware.

What is included in the package

- Meltio Engine Control Unit
- Meltio Engine Integration Hardware CNC
- Industrial SMC Chiller HRS050-AF-20
- Chiller Water Tube Connections
- Starter Kit
- External Feeders
- Meltio Stainless Steel 316L Wire Spool
- Meltio Mild Steel ER70S Wire Spool

Unpackaging and Staging the Meltio Engine

1. Remove the screws shown in the following image on both laterals.

2. Extract IGUS tube from its packaging and extract Meltio Engine Control Unit palet using a forklift.

To extract the Engine V3 control unit from its packaging, we recommend the use of a forklift, before removing it we must unscrew the wooden supports placed under the equipment.

ATTENTION: As the IGUS tube contains the fibers, it is of utmost importance that the fibers are handled carefully, avoiding any possible tensions or twisting that could cause damage to the cabling, tubes and fibers in particular.

3. Extract the Meltio Engine robot or CNC Integration Hardware from its packaging.

ATTENTION ROBOT: Details of the unboxing process:

Place the packaging horizontally on a table, leaving the lid(thinner part of the packaging, on top.) remove the tongue and groove one by one, holding each male and pulling it out. After removing the lid, take the radius limiter from the Igus tube, and the other hand from the gas nozzle. Remove the equipment vertically without touching or damaging the fibers. Put it on a table avoiding that it can move because the Igus hose moves it by its own weight. To integrate the head in the tool flange or include it in the robot cell laser safe enclosure of the robotic arm it is recommended to disconnect the fibers from the head, and put plugs included in the starter kit on the fibers as well as on the collimators to protect them from the harmful dust and dirt. After the robot integration hardware is screwed on the robot, the fibers can be reconnected following the specific documentation of the fibers, since it is the most delicate material of the equipment.

ATTENTION CNC: For the correct handling of the head during its unboxing it is necessary to place its fastening rings on the upper part of the deployment and then help us with a forklift or similar machinery to move it from one place to another (always hooked to its rings). As it is hooked to the IGUS tube, it is necessary to be very careful as we indicated in the previous point.

Features to be considered IGUS tube

Distribution

1st Conduit

10,65 meters - Tube 10mm Blue water

10,65 meters - Tube 10mm Black water

10,65 meters - Tube 6mm Argon Yellow + reducer 6 mm to 4 mm + 200 mm - Tube 4 mm Argon Yellow at end A

6 meters - Tube 6mm Red Powder (Only in case of Wire + Powder)

2nd Conduit

10.65 meters - 25mm2 Red Hotwire positive x meters.

11.15 meters - Canbus IX (purple) 10 meters.

10.65 meters - Igus 3G2.5 (24V).

4 meters - 2 red metallic wire guides.

3rd Conduit (CONDUIT WITH BADGE)

10 meters - 6 Fibers

Fiber positioning

CNC

End A (Head) of the fibers should protrude from the Igus hose by 900 mm.

End B (Control Unit) of the fibers must protrude from the Igus hose 300-400 mm.

Correct position and how to check it

The correct position of the IGUS tube is linked to the position of the fibers. By differentiating the duct through which the fibers pass, we can quickly identify its correct position and check that there is no rotation on itself. To identify that the tube is in its correct position we only have to check that the duct through which the fibers pass starts from the back of the head and follows a uniform path (without rotation on itself).

How does the Meltio Engine work?

Meltio Engine

The Meltio Engine is a modular based system that, moved by a CNC, supplies laser heat and material in order to make the deposition process. On this point we can show the Meltio Engine as a device which depends on the CNC. Clearly, it is a slave of CNC's work and CNC users only have to make movement code including the orders to communicate to Meltio Engine when it must start or end the material deposition.

Inert gas

The metal deposition process needs to be inert due to oxidation. To this end, Meltio Engine includes an inert gas control system to create an inert environment around the melting point. Users must supply any inert gas for this system (Meltio recommends the use of Argon [grade 4]).

Caution: *Shield gas may pose a risk of suffocation. Ensure good ventilation of the workspace and install an external oxygen sensor on site.*

The Meltio Engine requires the connection of process gas to prevent oxidation during the printing process and to protect the sensitive optical system from dust and smoke. The gas can be argon (grade 4) or other shielding gasses. A standard gas cylinder or liquefied gas system can be used as the source for the shielding gas. Select the appropriate shielding gas based on the welding standards for each metal.

Argon can be used with all types of metals and is recommended to simplify the number of gas storage containers needed.

A pressure regulator is required between the printer and the gas bottle. We strongly recommend using a pressure regulator and not a flow regulator. The use of a flow type regulator may cause irregularities in the gas flow during printing. The gas flow is controlled internally by the Meltio Engine and requires a constant pressure connection of 2-4 Bar. The pressure regulator is connected to the shield gas inlet with a 6 mm outer diameter polyurethane tube. The use of a flow-type regulator may cause irregularities in the gas flow during printing.

Figure 1.7. Argon pressure regulator.

Note: *the manometer must be ready for installation in the customer's facilities. The argon tube inlet in the Meltio Engine has a 6mm outer diameter tube input. The majority of the manometers have an output of 6mm diameter. Note that for proper installation, you will need a tube that fits in the manometer (the outer diameter could be, for example, between 8 mm and 15 mm). In this case, you will need to use a tube reducer. For example: If the tube you have purchased for the manometer has an outer diameter of 10mm, you will need a tube reducer from 10mm to 6mm. An example of said tube reducer is shown next:*

Figure 1.8. An example of a reducer 10mm to 6mm.

Shield Gas Connection

- Connect the gas regulator to the gas supply. Ensure that the gas supply and the regulator are closed.
- Open the gas supply to the regulator. On a new gas cylinder, it should read over 200 bar.
- Perform a leak test. One approach is to turn off the supply on the gas cylinder and check after 10 minutes. If the input pressure in the regulator has dropped, it means there is a gas leak. If the pressure has not dropped, the connection is good to go.
- Connect the regulator to the printer with 6mm PU tubing.
- Open the regulator until the pressure reaches 2 bar.

- Perform a leak test by closing the regulator and checking if the output pressure has dropped after 10 minutes. If the pressure has not dropped, open the regulator until the pressure reaches 2.5 bar.
- The yellow line shows the shield gas input on the back of the printer. Please, make sure to use “push-fit” compatible PU tubing.

Checking the Shield Gas System

Caution: risk of suffocation. Please, perform these checks relatively quickly and do not leave the shield gas supply open when not in use.

- Open the inert gas supply with the regulator set to 2.5 bars.
- Observe that the “Argon pressure sensor” displays the correct pressure. A deviation of up to 20% between the regulator and the displayed value is normal.
- If the pressure sensor shows the correct value, continue by pressing the “Inert wire nozzle” button. Then, press the “Flow sensor” text field and enter a value of 10000 ml/min. After a few seconds, you should observe the “proportional gas nozzle valve” actuate and gas should flow from the print head nozzle.
- To make it easier to check, increase the “Flow Sensor" value to 20000 ml/min and observe the nozzle again. More gas should flow now. If this works correctly, turn off the gas flow by pressing the “Inert wire nozzle” again. Check that the “Flow sensor” now reads value of 0.

Gas Consumption and Usage

Calculation and inputs

The recommended gas for our LMD printing process is argon, as it is an inert gas that will not vary the internal structure of the materials that are printed with our technology. To properly select the argon and calculate the amount of argon that you will need in your prints, follow the next recommendations and calculations:

- Meltio recommends an argon of a quality between grade 4 and 5.

$$Ar\ quality\ = 4 < Grade\ \leq 5 \quad (1)$$

- The calculation of the amount of argon used in the prints is as follows:
  - The argon amount that you have in a bottle or installation is as follows:

$$Bottle\ of\ (X)\ liters\ of\ capacity\ \times Pressure\ of\ the\ bottle\ = Argon\ (l) \quad (2)$$

  - The amount of argon used in a print can be calculated as follows:

$$Amount\ of\ gas\ used\ (l/min)\ \times Time\ printing\ (min)\ = Consumption\ (l) \quad (3)$$

- The bottles of argon that are commonly used in welding (cylindrical ones[the gas distribution is better in them]) tend to have about 50 L of capacity. Other capacities are available. Liquified gas installations are also used for our printing process. For our examples, we are going to use the argon cylindrical bottle option of 50L and 200 bar of pressure, so:

$$Capacity\ of\ the\ bottle\ \div\ Consumption\ of\ the\ part\ =\ Maximum\ parts\ per\ bottle\ (4)$$

- The amount of gas that is used in the Meltio systems to print is as follows:

Material used	**Minimum amount of gas (in liters/min)**	**Recommended amount of gas (in liters/min)**
Stainless Steels	5	10
Titanium	15	20
Inconel	5	10
Mild steels	5	10

Following these recommendations, the **minimum** consumption per hour is:

Material used	**Consumption per hour:**
Stainless steels	$5\ l/min\ \times 60\ min/h\ =\ 600\ l/h$
Titanium	$15\ l/min\ \times 60\ min/h\ =\ 1200\ l/h$
Inconel	$5\ l/min\ \times 60\ min/h\ =\ 600\ l/h$
Mild steels	$5\ l/min\ \times 60\ min/h\ =\ 600\ l/h$

Examples:

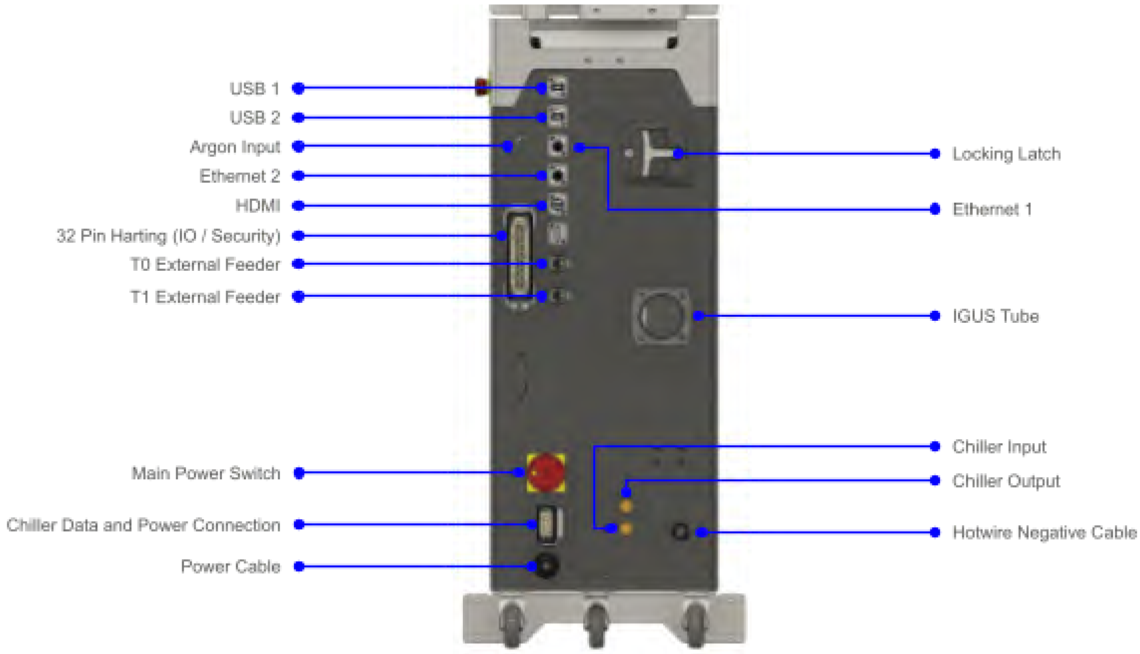
For the examples, as mentioned above, the simulated argon bottle will have a capacity of 50L and a pressure of 200 bar of gas.

$$50\ l\ \times\ 200\ bar\ =\ 10.000\ l/bottle$$

Cooling system Setup

Heat is radiated by the laser system in order to create the melting point. This heat must be controlled by a cooling system which comes included with the Meltio Engine. It is vital to ensure good connections of the water lines, otherwise, significant leaking may occur.

***Note**: The water connectors on the back of the Engine Control Unit lock into it and will hold water when unplugged. However, water can flow out of the non-locking side, so please be careful when handling these connections.*



Rear connection panel of the Meltio Engine.

- Connect the water lines from the chiller to the Engine Control Unit according to the diagram shown above.
- Prepare a solution of distilled water.
- Ensure the chiller power switch is in the "Off" position and the Meltio Engine is powered down.
- Connect the Chiller Harting (consisting of the power cable and the chiller data cable) to the printer and the chiller, respectively.
- Double check all the connections, and that the water level is correct in the chiller.
- Check that the temperature on the chiller is set to 16°C and that the chillers reach the temperature after a few minutes of operation. If the temperature does not default to 16°C, please contact the Meltio customer support for instructions on how to change it.

It is important to keep in mind that humidity and the room temperature can cause condensation. If you operate the printer in an area with high humidity and/or temperature, please ensure the temperature is not causing condensation. If it does, you may raise the temperature up to 18°C. Room temperature should be maintained as stable as possible. If the temperature is more than 30ºC in the room and the chiller is set to a low temperature, condensation can happen.

- It is not necessary to keep the chiller on while you are not printing. To avoid condensation, turn on the chiller 5 minutes before the print and turn it off 5 minutes after the print is finished.

Ambient Conditions

Storage Conditions

The following conditions need to be met for storing the Meltio Engine.

Temperature	0 - 50 Degrees Celsius
Altitude	< 4000 m ASL
Humidity	< 70% - Non-condensing
Boundary Conditions	Stored inside in dry conditions on level flooring.

Table 1. storage conditions for the cell

When preparing the cell for storage or shipment, please follow the uncrating instructions in reverse. If the device is to be stored in a cold environment it is important to ensure the cooling system is filled with the correct mixture of coolant (See Maintenance Section).

Note: Never store the system dry for prolonged periods. Circulate water for at least 30 minutes every 14 days.

Operating Conditions

The conditions for operation of the machine are stricter than those for storing. Particular care must be taken to ensure that no condensation occurs due to the active refrigeration of the cooling system in hot and humid environments. Operating the system at high ambient temperatures further increases the load on the cooling system and will increase the electrical consumption of the system.

Operating Conditions	
Temperature	5 - 40 °C
Altitude	< 3000 m ASL
Humidity	See Dew-point-chart below - Non-condensing

Cooling system Temperature	18-22 °C

Table 2. Operating conditions of the Robot cell

The maximally permissible humidity depends on two additional factors, the ambient temperature and the temperature set point of the chiller. The chiller temperature may be set between 18 and 22 degrees celsius. A lower temperature is preferable for the longevity and performance of the laser system, however condensation must be avoided as it can seriously damage the system. It is therefore recommended to select the lowest chiller temperature possible while maintaining a safe margin (3 °C) to avoid condensation.

The below chart may be used to select the ideal chiller temperature and determine if additional measures for humidity control of the operating environment are necessary.

Dew Point Table							
Air Temp	Relative Humidity						
	40%	50%	60%	70%	80%	90%	100%
16°C	2°C	6°C	8°C	11°C	13°C	14°C	16°C
18°C	4°C	7°C	10°C	12°C	15°C	16°C	18°C
20°C	6°C	9°C	12°C	14°C	16°C	18°C	20°C
22°C	8°C	11°C	14°C	16°C	18°C	20°C	22°C
24°C	10°C	13°C	16°C	18°C	20°C	22°C	24°C
26°C	11°C	15°C	18°C	20°C	22°C	24°C	26°C
28°C	13°C	17°C	20°C	22°C	24°C	26°C	28°C
30°C	15°C	19°C	21°C	24°C	26°C	28°C	30°C
32°C	17°C	20°C	23°C	26°C	28°C	30°C	32°C
34°C	19°C	22°C	25°C	28°C	30°C	32°C	34°C

Legend	
Light Blue	18°C Best
Dark Blue	20°C ok
Yellow	22°C limit
Red	**Do not Operate in these conditions**

Table 3, 4 dew point of the coolant.

The chart marks the dew point for various combinations of temperature and humidity. Setting the chiller temperature below the dew point will lead to condensation on critical surfaces within the deposition head and can cause severe damage to the electro-optical assembly. The colors mark the recommended chiller set point.

Note: Select chiller temperature for worst case conditions. i.e. highest temperature and highest humidity. Beware of seasonal changes in humidity and temperature and re-evaluate continuously.

Tools required for Meltio Engine + CNC Integration

- Starter kit shipped with Meltio Engine.
- Heat protectant gloves.
- All purpose cleaner or isopropyl alcohol.
- Paper towels.
- Pallet truck or similar for unpackaging (350 kg of load).
- Drill with phillips and flat head drill bits.
- Or manual screwdrivers.
- Tape measure.
- 15 L of distilled water.

Wiring And Tubing Dimensions For Integration

- External Feeder 1: **7,70 m**
- External Feeder 2: **7,70 m**
- Chiller tubes: **4,65 m**
- Sleeves Material: **3,90 m**
- Integration cable: **4,00 m**
- TDK Negative Cable: **10,00 m**
- Power Supply Cable + Data Cable (Chiller): **7,00 m**
- Argon tube: **10,00 m**

Interface Cable - Engine - Robot - Engine v3 Version

Wiring and connector

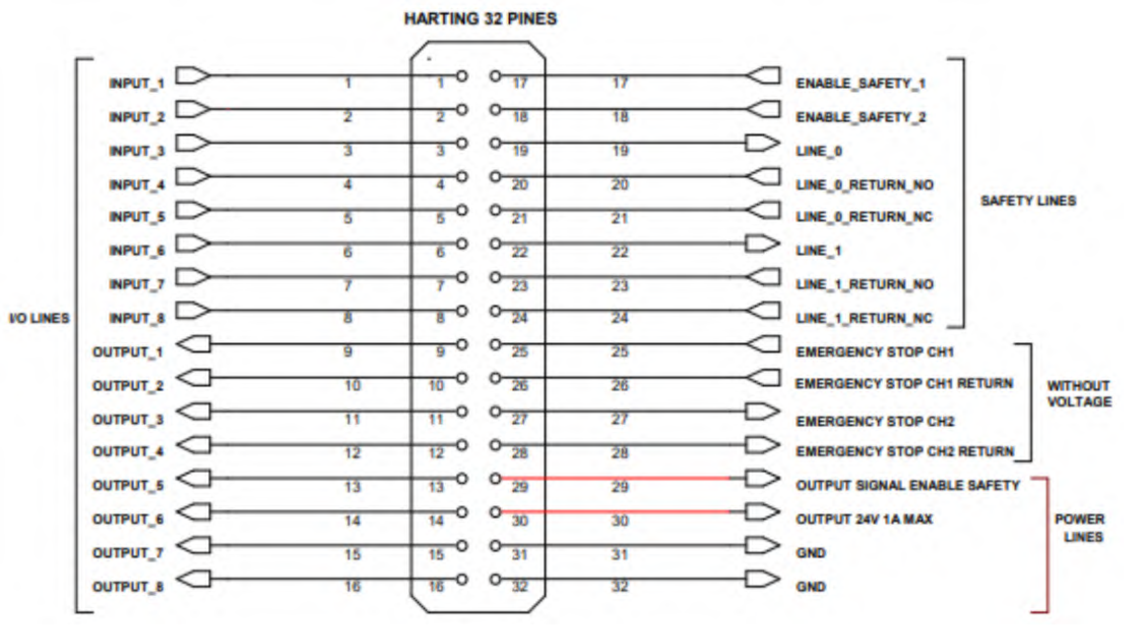
19000005098 Cable gland HARTING Han CGM-M Metal , thread M40, IP68

19301320528 Harting Han L32 B-HSE-HC-DL-M40

09330322601 Harting Han L32 E-SMC-MI-SCT-0.75 - 2.5mm², M40 thread, IP68

CF77.UL.07.36.D chainflex control cable CF77.UL.D (36G0.75)

Pinout



Pins 1 to 16 are for I/O communication (32p harting pinout attached).

Pin 17: 24V constant signal sent from the CNC in case of no emergency (Channel 1).

Pin 18: 24V constant signal sent from the CNC in the event of no emergency (Channel 2).

These 24V must fall in case of door opening.

With respect to the common (0V) of your CNC that is linked to these two pins it is not necessary since we use them to feed some relays of a PCB.

Channel 1 for engine safety CNC

Pin 19

24V constant signal from the CNC to our Engine (Input to safety relay 1 controlled by the Engine electronics)

Pin 20 (you can choose to use pin 20 or 21 depending on the CNC)

Return to the CNC via a normally open contact of the safety relay linked to the 24V supplied by the CNC on pin 19 (Relay 1).

In this case door safety is not checked as this is an indispensable point for supplying 24V on pin 17.

Pin 21

Return to the CNC by a normally closed contact of the safety relay linked to the 24V supplied by the CNC on pin 19 (Relay 1).

In this case door safety is not checked as this is an indispensable point to supply 24V on pin 17.

Channel 2 for CNC of the engine safety

Pin 22

24V constant signal from the CNC to our Engine (Input to the safety relay 2 controlled by the Engine electronics)

Pin 23 (you can choose to use pin 23 or 24 depending on the CNC)

Return to the CNC via a normally open contact of the safety relay linked to the 24V supplied by the CNC on pin 22 (Relay 2).

In this case door safety is not checked as this is an indispensable point to supply 24V on pin 18.

Pin 24

Return to the CNC by a normally closed contact of the safety relay linked to the 24V supplied by the CNC on pin 22 (Relay 2).

In this case door safety is not checked as this is an indispensable point to supply 24V on pin 18.

Disclaimer: The NC and NO state for the Engine's safety relay refer to the relay in an unpowered state. Therefore NC for a red state and NO for a blue state.

Pins 25 and 26: voltage free contact 1 without passing through the electronics (physical emergency stop button of the Engine)

Pins 27 and 28: contact 1 voltage free contact without passing through the electronics (physical emergency stop button of the Engine)

29 - 24V power supply of the engine with active safety (up to 1A) Meltio provides 24V if there is no emergency on ENGINE, e.g. to switch on peripherals such as cameras only when the Engine is ready.

30- 24V power supply provided by the engine if needed (up to 1A).

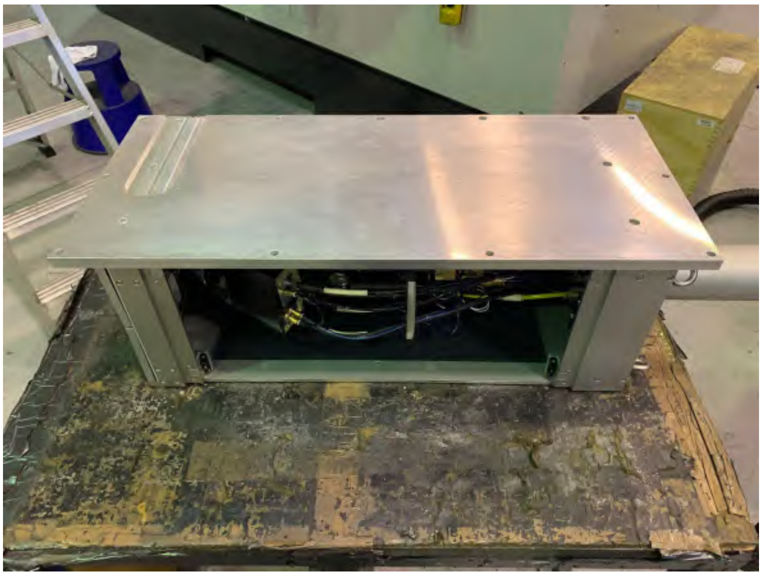
31-GND: 24V common from Meltio

32-GND: 24V common from Meltio

Set-Up

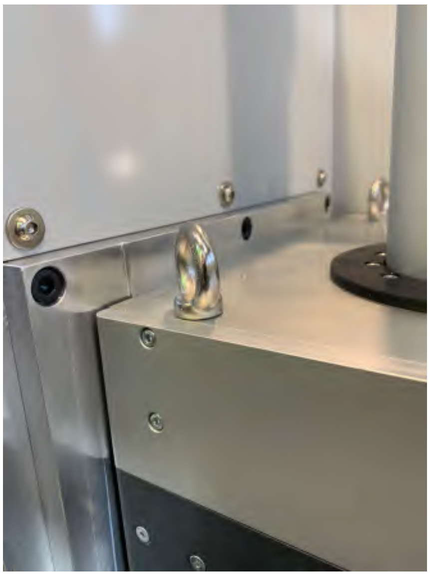
A. Deployment Assembly

To mount the deployment, the adaptor plate for mounting with the L1600 CNC spindle is required. In addition to 9 **M6x20** screws for fastening.



After the correct assembly of the deployment adaptive plate, it will be necessary the help of an overhead crane or similar machinery to lift the deployment from its fastening rings, passing it over the CNC **(it is very important to be careful with the IGUS tube while doing this step, it must follow a free path and without generating any type of torsion or excessive tension)**.

Once the deployment is inside the CNC, the adaptive plate will be fixed to the CNC spindle.

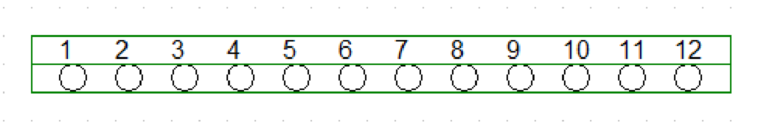


B. Preparation Cooling System

For the preparation of the cooling system of the control unit, the 10-pin HARTING cable **(power supply cable + data cable)**, 12 mm diameter tubes with quick connector **(male)** at both ends are required.

The first step to follow to assemble the refrigeration system is to disassemble the upper plate of the chiller. Once disassembled, the power cables are inserted and then screwed to their corresponding terminals **(BROWN-LINE; BLUE-NEUTRAL; GREEN/YELLOW-GROUND)**.

After this process, the top cover is replaced and the data cable connector is mounted. The layout for mounting the data cable connector is as follows:



1 Green-Black	**5 Black**	**9 Black (Jumper)**
2 Gray	**6 Brown**	**10 White**
3 Black-Black	**7 EMPTY**	**11 Black (Jumper)**
4 Yellow	**8 EMPTY**	**12 Pink**

Once this is done, proceed to connect the cooling pipes according to the following arrangement **(Length 4.65 m)**:

Inlet (Chiller) - Outlet (Control Unit)

Outlet (Chiller) - Inlet (Control Unit)

Once the above steps have been completed, we have finished preparing the refrigeration system.

C. Power Supply Cable Control Unit

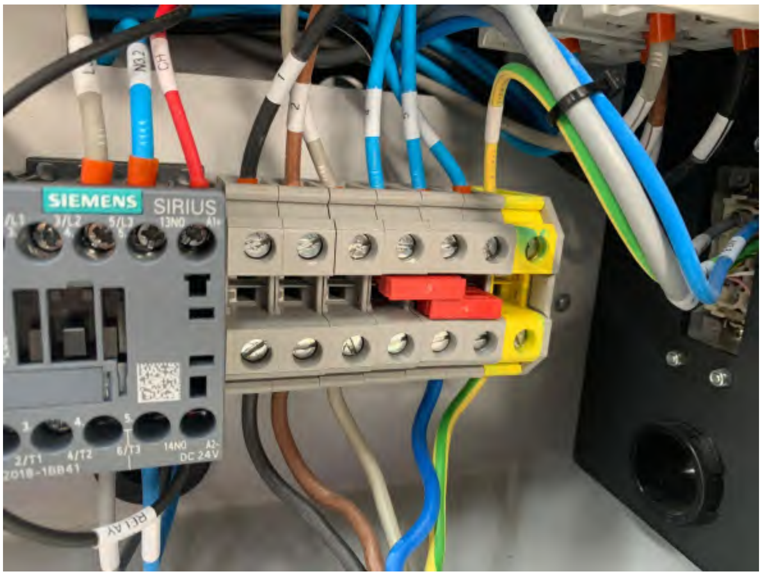
The power cable used for the Engine V3 control unit is 4 wires + ground **(3 phases, 1 neutral, 1 ground)**.

In the case of our integration with the CNC Lagun L1600 it is necessary to remove the neutral as they do not have it.

To connect the power cable, the cable must first be passed through the cable gland of the control unit and then screwed to the respective terminals.

Black-Line 1 **Gray-Line 3** **Green/Yellow-Ground**

Brown-Line 2 **Blue-Neutral**



D. Negative TDK Cable

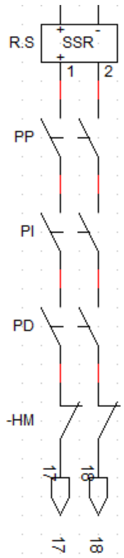
For the connection of the negative cable of the TDK **(10 m long)**, one of the ends will go with its connector for the control unit and the other end will be left so that the necessary terminal can be added to fix it to the telescopic arms of the CNC Lagun L1600.

E. Harting Security-Communications Cable x32 Pins

This cable is indispensable for the integration between machines, the cable integrates the I/O and safety of our control unit with that of the CNC **(length 4 m)**.

Please note:

- For the correct operation of the safety bottom the connection of the pins of the Harting must be the following: **(25-27) (26-28)**.



- For the correct operation of the safety implementing **(Dead Man)** the following configuration must be added in the safety relay of the CNC.

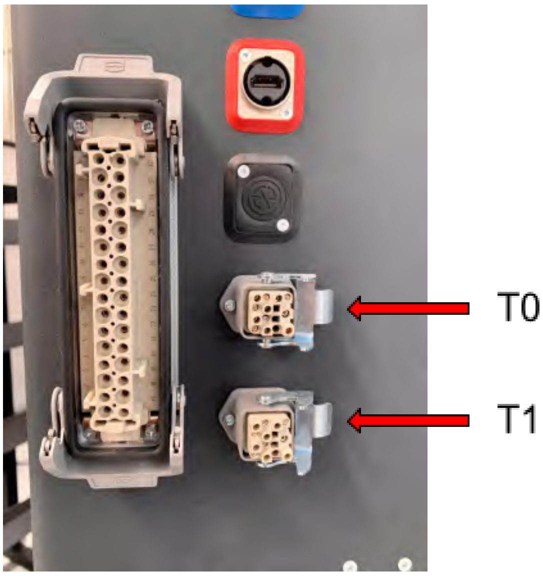
R.S (Safety Relay), PP (Main Door), PI (Left Door), PD (Right Door) and HM (Dead Man).

F. External Feeders

The Engine V3 is equipped with 2 bottom feeders **(external motors)**, for their operation it is necessary to connect the 2 Harting cables x12 pins **(length 7.7 m)**.

In addition to this, the plate for fastening the external feeders will be required once the external feeders have been fitted. The sleeves from the IGUS tube to the wire conduit mount have to be fitted **(length 4 m)**. For this purpose, the plastic part of the sleeve has to be cut off **(just enough to be flush with the conduit)**. Afterwards, the stud bolts of the wire conduit mount sleeves should be tightened to prevent the sleeves from slipping out of the wire conduit mount.

The position of the connectors on the control unit is as follows:



G. Argon Flow System

For the argon flow system it is necessary to fit the argon cylinder with an 8 mm diameter reducer, connect the tube to the cylinder and to the control unit fitting, it is important to ensure that the argon pressure is in the range of 3.5 - 4 bar pressure. **(Length of argon tube 10 m)**.

H. Laser Safe Windows:

a. https://protect-laserschutz.de/en/products/laser%20protection/laser%20protection%20windows

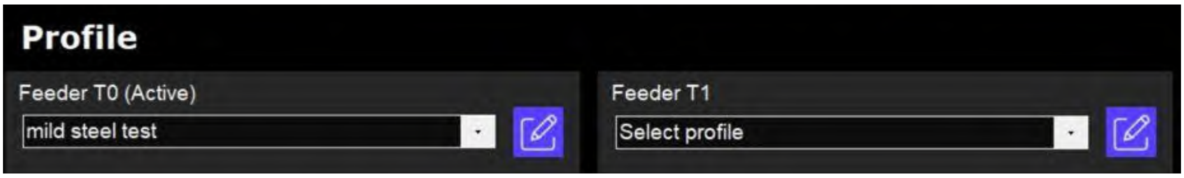
b. https://www.uvex-laservision.de/en/laser-safety-windows/plastic-laser-safety-windows/laser-safety-window-p1p21-3mm/?number=000P1P212007

Configuration Engine V3 And Verification Of I/O

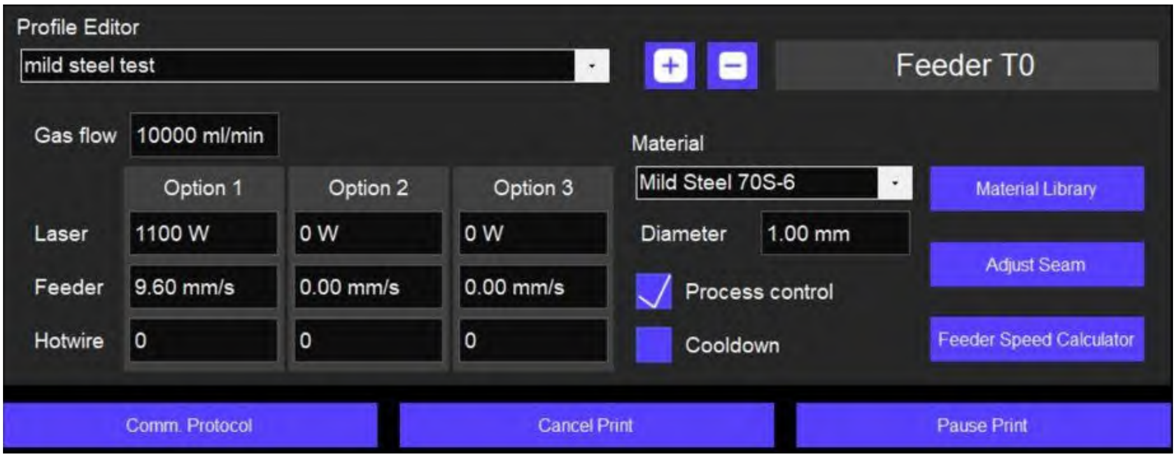
A. Configuration of I/O Engine V3

For the configuration of our Engine V3 it is necessary to configure the Digital I/O in the interface of the Engine v3, to configure it we must follow the following steps:

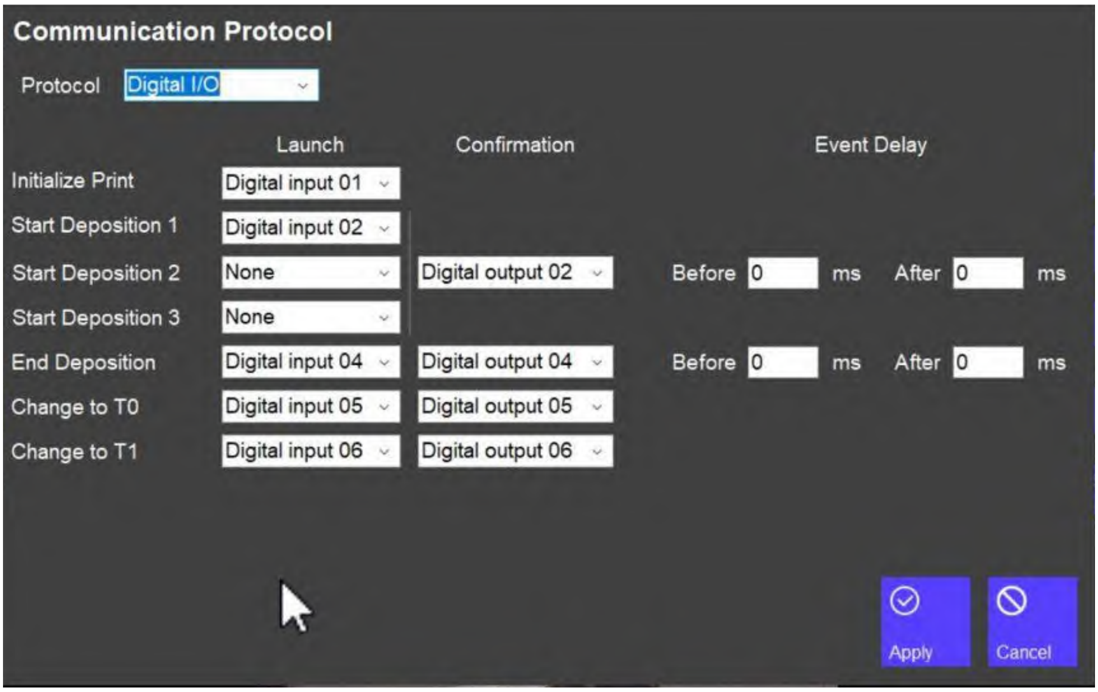
a. Select a profile



b. Open the Communication Protocol drop-down menu



c. Configure Digital Inputs and Outputs



Initialize Print - Digital Input 01

M23 -Start Deposition - send Digital 02 to the engine - then Engine Digital Output 02(Input) DO2 back to 0

End Deposition - Digital Input 04 - Digital Output 04

Change to T0 - Digital Input 05 - Digital Output 05

Change to T1 - Digital Input 06 - Digital Output 06

Extend Deployment - Digital Input 07 - Digital Output 07

Enclose Deployment - Digital Input 08 - Digital Output 08

B. Verifications of I/O (M-Codes)

To verify the correct operation of the digital communication between Engine and CNC, it is necessary to verify that the digital signals sent and received by both the CNC and the Engine have a response in both devices.

In this case, the M-Codes of the Lagun L1600 CNC that correspond to the I/O of our Engine V3 are shown below:

M104 (Initialize Meltio Engine)

M105 (Finalize Meltio Engine - Reset Signals)

M106 (Start Deposition)

M107 (Start Deposition 2)

Set DO2 - ON

DI2 -ON

DO2- OFF

M108 (End Deposition)

M109 (Meltio T0 Material)

M110 (Meltio T1 Material)

M111 (Deploy Meltio Engine)

M112 (Enclose Meltio Engine)

Start Up

Machine Integration

A. Define Meltio head height

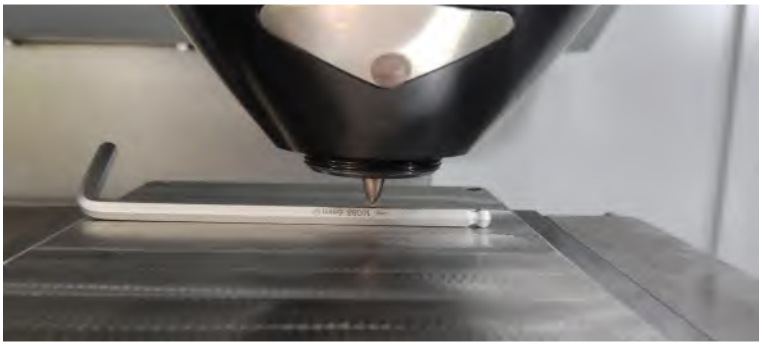
To define Meltio head height it is needed:

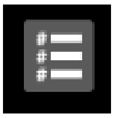
- Tool with exact height
- 6 mm Key height.

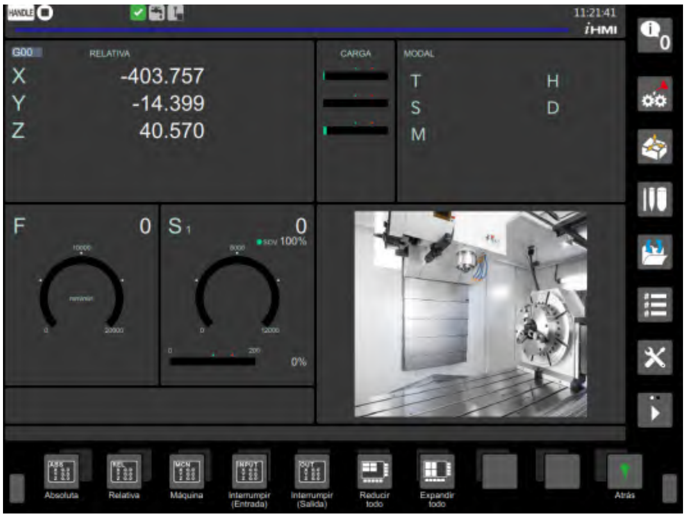
Process

On a planar surface, the machining head of the CNC with the tool with exact height. This value is the distance between the planar surface and the machining head, setting the relative machine coordinates. In this case 114,97mm.

Remove the tool with exact height and extrude the Meltio head. On the planar surface it is measured 6 mm with the key. Remember that the measure is taken without a nozzle. The distance is the height of Meltio's head. In this case 40,570 mm



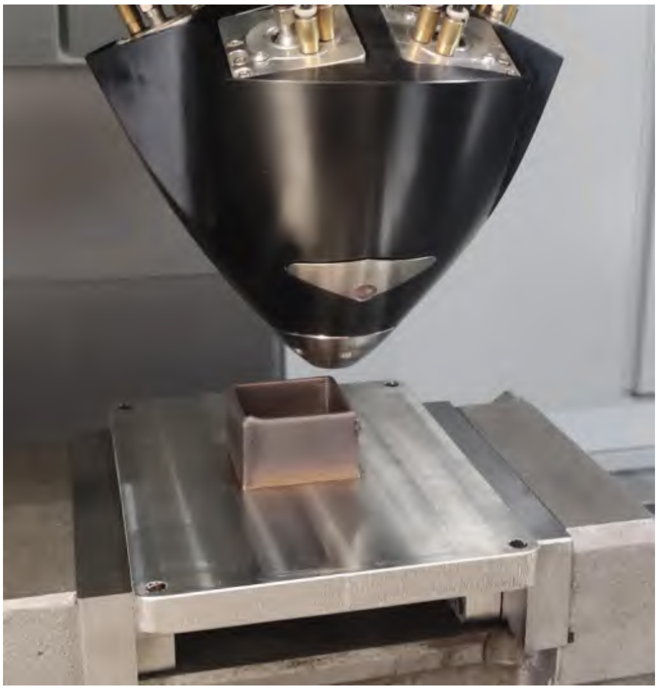
The value of the height must be defined in macro windows. 



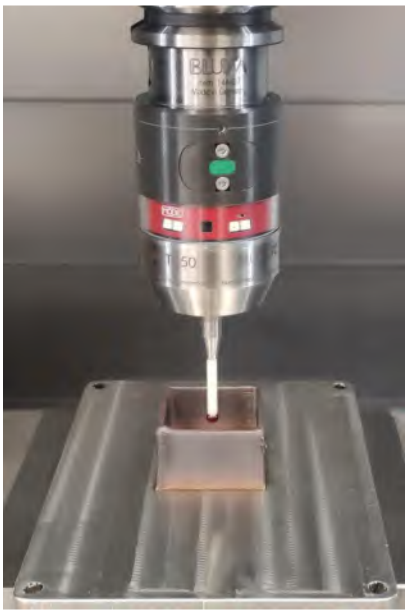
The macro value is defined in 562.

B. Define Meltio head distance.

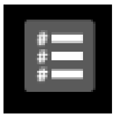
To define Meltio head distance, it is necessary to print a square in G54 origin. The measure could be 50 x 50 x 30 mm.



After printing, cool the part with the machine's own coolant. Once the part is at room temperature, use the part measuring probe to obtain the center of the part in G55. This measure data will be X0 and Y0 in G55 but it must be a different value in G54.



The differences in measurement between the origin G54 and G55 will be the distances X and Y that the Meltio head is displaced.

The values of displacement must be defined in macro windows. .

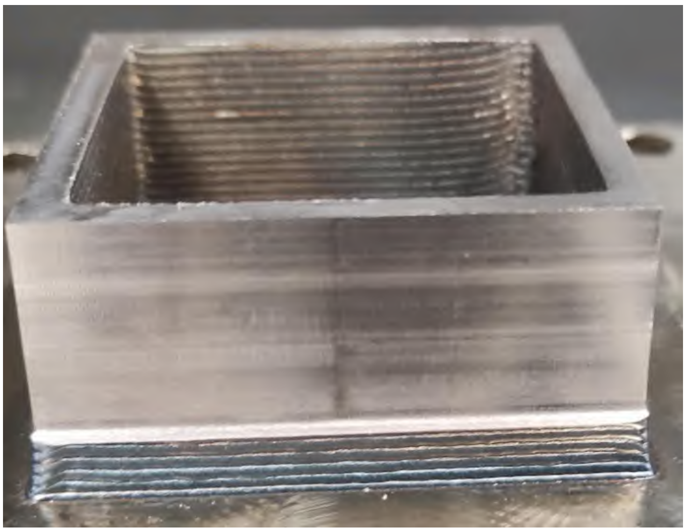
The value must be the negative value that it is obtained in G54

(example: In G54 the X value is 330.653, in macro value must be -330.653)

X dimension value macro 560

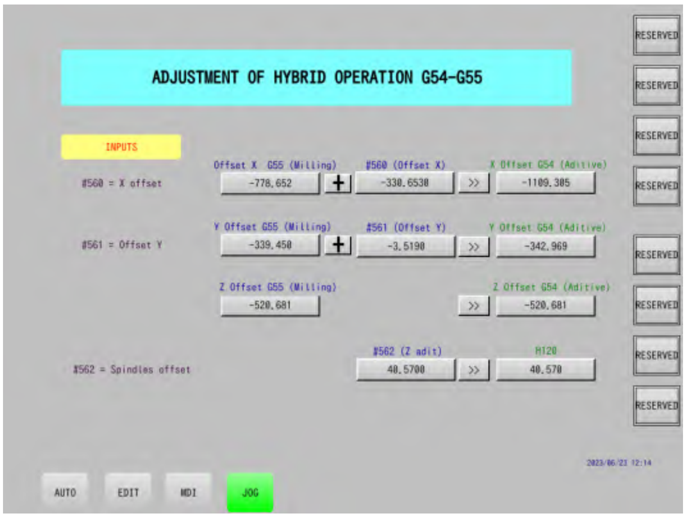
Y dimension value macro 561

To check the clearance setting, machine the part and perform a visual inspection.



C. Parts with a hybrid process.

For the hybrid process, it is necessary to define the machining origin ever in G55 and modify the values in G54 with the Meltio window. Once the zero point is defined in G55, it is necessary to go to the Meltio window.



The value in G55 is defined with the distance difference in G54 pulsing for all  for all axes.

The corrector H120 is defined too pulsing 

In the additive process, Meltio must be defined as T0 in the code and the height corrector is always H120.

Example of code

```
<CUADRADO50>
(POSTABILITY LAGUN L1600 APLUS)
(MACHINE GROUP-1)
(MCAM FILE - T)
(POST      - MPPOSTABILITY_LAGUN_L1600_FANUC_APLUS.PST)
(PROGRAM   - T.NC)
(T0   - MELTIO STANDARD CALIBRATION - H0   - D0   - D2.032mm)
(T3   - 8 FRESA PLANA        - H3   - D3   - D8.000mm)
G00 G17 G21 G40 G80 G90
G91 G28 Z0.
N1
T0 M06
T3
G54 G17 G90
M105 (FINALIZE MELTIO ENGINE - RESET SIGNALS)
M104 (INITIALIZE MELTIO ENGINE)
M111 (DEPLOY MELTIO ENGINE)
G04 X15
M110 (MELTIO T1 MATERIAL)
G00 X24.5 Y24.045
G43 H120 Z3.
Z0.
```

Troubleshooting

Control Unit Display

The meltio control unit display is a touch screen display and it functions just like a tablet. For the explanation about all the functions of the display you will find in the document called "*Engine v3 Control Unit Software"*.

Security Button

The button next to the emergency stop on the Meltio Engine, is the security indicator and trigger. This indicator has 3 different states:

GREEN	Security is enabled. Lassers can fire.
BLUE	Security is disabled (standby). If we enable the external security (from the robot, supplying 24 V to the Harting x32 connector) the system will change automatically to green.
RED	Security is totally disabled due to issue detection(for example, chiller not detected, argon pressure too low, security button pushed). After the user checks everythings is ready to enable security he has to push the button to turn led to blue.

Laser Alignment

The alignment procedure is to focus the laser to a distance between the printing surface and the wire nozzle at a constant working height of (h). The value of h should be 6.0 mm.

TCP Calibration Procedure

Before the laser calibration process we must have calibrated the TCP, Positioner and WorkObject of the robot. For more information and how to do these processes check the following manual ***"How to define and calibrate Robot and Positioner"***.

Alignment Laser Procedure

For the explanation about the alignment Procedure you will find in the document called ***"Engine Laser Alignment Camera Manual"***.

How to replace a fiber optic cable in case of damage?

In the event that any of the fiber optics are damaged, the following steps should be taken to replace them:

1. The damaged fiber in both the head and the control unit must be disconnected. For this we will need an 8 mm spanner and also plugs for fibers, collimators and diodes.

   Important: It is important during the disconnection of the fibers to make sure that the plugs are well placed, because if they are not placed or not well placed they could suggest severe damage to the fibers, collimator and other parts of the fibers.

2. After the previous step, it will be necessary to position the deployment in such a way that the IGUS tube is stretched and without any twist for later opening.
3. Once the deployment with the IGUS tube is stretched, the tube is opened **(the tube has a distinctive color to distinguish the links through which the fibers pass)**.

4. Once the IGUS tube has been opened, the damaged fiber is removed and the new fiber is inserted **(the fiber must not be subjected to any type of exaggerated twisting or bending during handling as this may damage it)**.
5. With the new fiber in place, the IGUS tube should be resealed and the fibers reconnected to both the diode and the collimator.
6. This point is the most important of all, since it is necessary to connect the fibers in a correct way, for its correct connection the plugs of the diode or the collimator must be unadjusted, then the plug of the fiber and finally place the fiber **(for the correct placement of the fibers it must be taken into account that the tip of the fiber can not touch any surface and must enter into its hole without exerting any pressure or forcing it)**.

7. Finally, the fiber will be slightly adjusted with a fixed 8 mm wrench **(in case of adjusting too much we could damage the fiber)**, with the fiber adjusted we will
8. finish placing the thermistor.

Adjustment Of The Material Sleeves And External Feeders Position

For the adjustment of the sleeves we have to have the position of the sleeve slicer in the reservoir, this must have enough freedom to be able to move in both directions (up or down).

The measurement of the sleeves must be 4 meters long.

Position of the external feeders

The position of the external feeders will be in the front part of the CNC, together with an adaptive plate in which both feeders will be fixed vertically oriented to the material sleeves.

Material Sleeves Replacement

In case of replacement, the following steps are to be followed:

1. Open the IGUS tube conduit through which the sleeves pass.
2. Loosen the Wire Conduit Mount screws to remove the B end of the sleeve.
3. Untighten the screw of the slicer used to hold the sleeve in the reservoir (metric screw M3x10 and grover washer) to be able to remove the end A of the sleeve.
4. Remove the liner from the IGUS tube (cut the IGUS tube fastening flanges).
5. Insert the new sleeve
6. Trim the plastic part of the liner so that the slicer fits correctly, adjust the slicer to the liner with metric studs (M3x2), put the slicer in the reservoir and replace its screw and washer.
7. Make sure that there is free movement of the liner silicer in the reservoir.
8. Cut off the other plastic end of the sleeve and insert it into the Wire Conduit Mount of the External Feeder.
9. Tighten the screws of the Wire Conduit Mount, make sure that there is no possibility of the sleeve slipping out of the part.

ATTENTION:

The sleeves must be parallel, without crossing each other or other wiring.

The sleeves are flanged to the center of the IGUS separately to ensure the correct distance and being to the center make up the neutral fiber avoiding traction and bending of the same, tightened and fixed separately to avoid intertwining between them reducing friction up to 1 meter from the end.

From 1 meter from the end to 0.55 m from the end there are flanges without being tightened to allow movement but not contact with other cables.

It is convenient that when flanging the sleeves to the root of the igus tube to leave a space of separation between both sleeves, that they are not flanged in the same part of the root.

Engine V3 + Robot System

Summary

This document is to be used to provide general instruction on the integration and operation of a Robotic System and the Meltio Engine V3.

The Robotic System is a robot or robot with more additions (table, external movement axis …) of any brand on the market with at least 3 axes covering the hardware requirements and communication requirements indicated in this document.

In this document are the steps for integrating the Robot and the Meltio Engine together. Steps of the process include communication wiring, safety requirements and mounting of the Robot Integration Hardware. Technical information for maintenance, troubleshooting and operation are included to support technicians executing the integration of the Meltio Engine V3 with Robot.

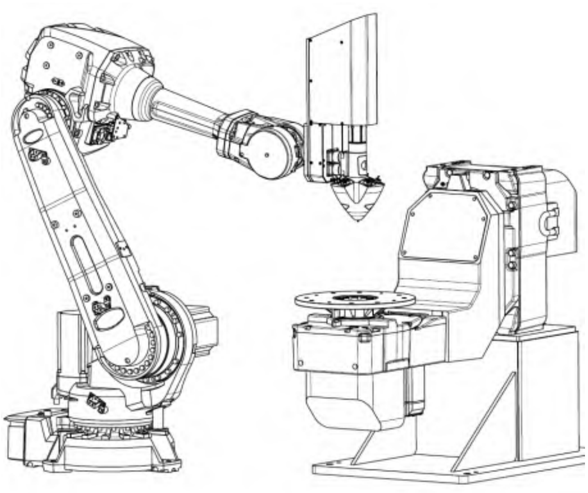
What is included in the package

- Meltio Engine Control Unit
- Meltio Engine Integration Deposition Head
- Industrial SMC Chiller HRS050-AF-20
- Chiller Water Tube Connections
- Starter Kit
- External Feeders
- Meltio Stainless Steel 316L Wire Spool
- Meltio Mild Steel ER70S Wire Spool

How does the Meltio Engine work?

Meltio Engine V3

The Meltio Engine V3 is a modular based system that, moved by a robot, supplies laser heat and material in order to make the deposition process. On this point we can show the Meltio Engine as a device which depends on the robot. Clearly, it is a slave of robot's work and robot users only have to make movement code including the orders to communicate to Meltio Engine V3 when it must start or end the material deposition.



Inert gas

The metal deposition process needs to be innertized due to oxidation. For this, Meltio Engine V3 includes an inert gas control system to create the innertized environment around the melting point. Users have to supply any inert gas for this system.

Cooling system

Heat induced in the system in order to create the melt point must be controlled by a water cooling system which comes with the Meltio Engine. We include an industrial chiller with the machine.

Tools Required For Meltio Engine + Robot System Integration

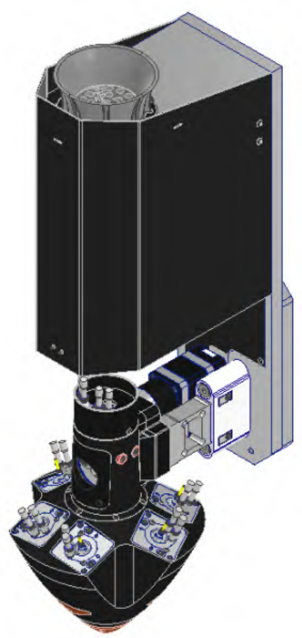
- Starter kit shipped with Meltio Engine.
- Heat protectant gloves.
- All purpose cleaner or isopropyl alcohol.
- Paper towels.
- Pallet truck or similar for unpackaging (350 kg of load).
- Drill with phillips and flat head drill bits.
- Or manual screwdrivers.
- Tape measure.
- 15 L of distilled water.

Set-Up

A. Machine Integration

The system consists of four main modules: the robot, the Meltio motor, the Meltio head and the cooler. As we showed in the introduction, each component has a specific purpose and function in the complete integrated system. The Robot provides the stable gantry system to the addition of the new additive manufacturing system (Meltio deposition head) installed on it. The Meltio engine houses the control, laser source and material feed necessary for the additive process. The integration mechanism consists of the Meltio deposition head, which enables precise wire feeding and laser placement in the printing process. The chiller provides cooling to the lasers and the Meltio deposition head during operation. The integration process below merges these four components, creating an integrated system that provides additive manufacturing methods.

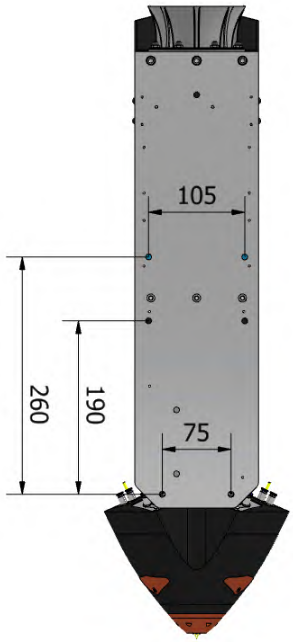
B. Robotic Integration Hardware



C. Meltio Engine Integration Mechanism Connection

We mechanically fix the integration system to the robot by means of a fixing piece to the standard Robot's bracket. The image shows an example, in this case, compatible with various Robot models (ABB, KUKA,YASKAWA,FANUC). Each integrator will be able to modify this part if necessary to fit the system to his robot model.

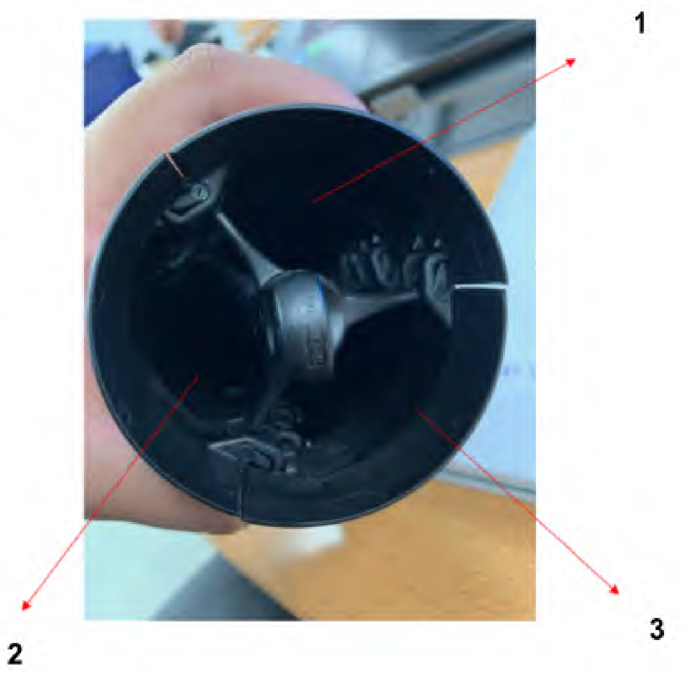
Important: It is necessary to take into account the position of the holes of the adaptive plate, as it depends on the correct fastening of the head and the printing quality in the future.



Wire connection to the deposition head from the control unit

Three-dimensional energy chain

This three-dimensional energy chain is composed of the following elements:



Conduit 1:

- x1 Cooling tube 10mm (blue).
- x1 Cooling tube 10mm (black)
- x1 Argon distribution tube (yellow) 6mm + Reducer 6mm-4mm + Pipe 4mm

Conduit 2:

- 10,65 m Positive Hotwire cable 25mm (red).
- 11,15 m Cable CanBus IX (purple)
- 10,65 m Igus 3G2.5 cable (24V)
- x2 Metal filament sleeves (red)

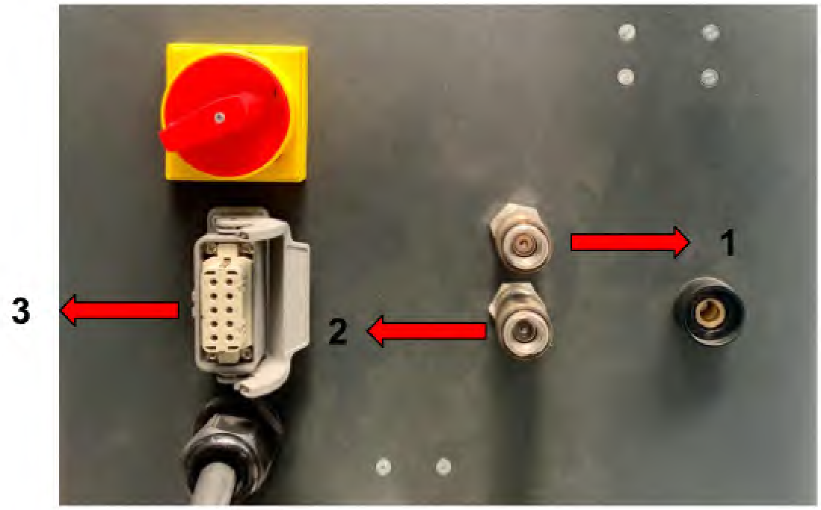
Conduit 3:

- x6 (10 m Fiber Optics)

Coolant

Connect the supplied chillers using the quick-connect hoses. Ensure that the input of the chiller is connected to the output of the Meltio Engine, and the output of the chiller is connected to the input of the chiller.

The Chiller is connected in the following way:



1. Water Inlet Chiller
2. Water Outlet Chiller
3. Harting x24 Communications/Power Chiller

Setup and use

Please read chiller manual to setup:

-Min temperature setup: 18 °C

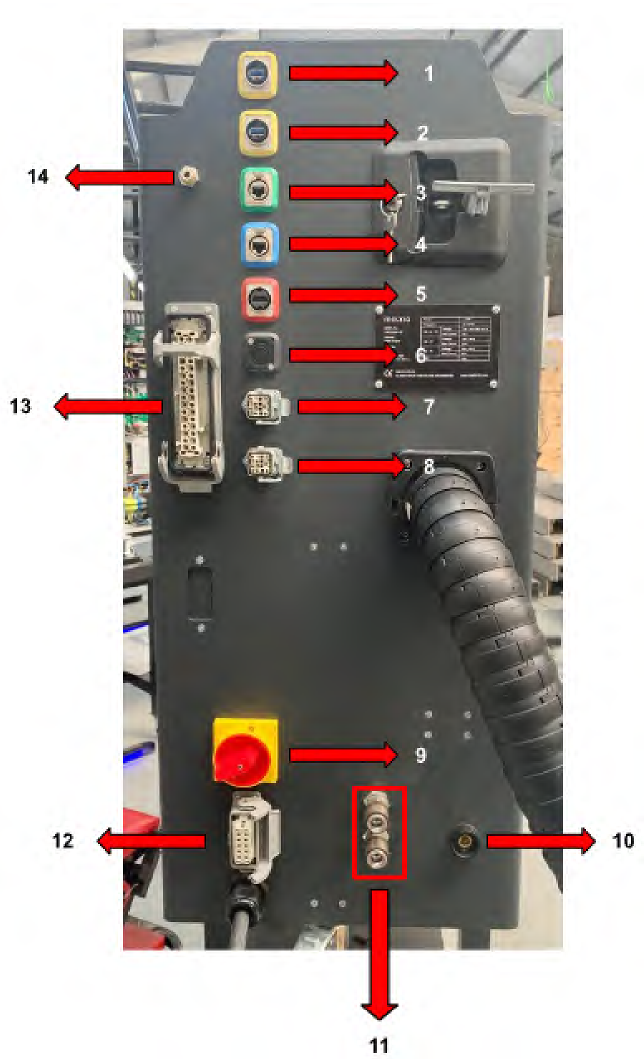
-Max temperature setup: 20 °C

The chiller must be powered a few minutes before starting printing. Moreover, the chiller must be powered off if the Meltio Engine is not printing for more than 15 minutes due to condensation issues on the head.

Inert Gas Source

Use a 6 mm quick connect pneumatic line, connect a line from the inert source to the lower inlet port.

Control Unit Connections



1. USB 3.0
2. USB 3.0
3. Ethernet
4. Internet
5. HDMI
6. EMPTY
7. External Feeder T0
8. External Feeder T1
9. Switch ON/OFF
10. Negative TDK
11. Inlet/Outlet Chiller
12. Harting x24 Communications Chiller
13. Harting x32 Communications/Security
14. Inert Gas Inlet

Running the first printing test

When all parts of the system are ready to work we are able to run the first deposition program.

1. Make the robot code by CAM software. We recommend using 2 25 mm cubes in order to use the parameters shown in the table below.
2. Ensure you have in the robot station a ‘frame’ defined in the position of the built plate
3. Ensure your robot has the tool defined at 6 mm of this frame.
4. Load the Robot code into the robot station
5. Ensure:
    a. Inert gas bottle is opened
    b. Chiller is ready to work or turned on
    c. Correct PROFILE is selected in the Meltio Engine Control Unit
    d. There aren't collision issues in the robot code
    e. Robot Code start 6 mm upper to the built plate
    f. Wire is correctly loaded
    g. Laser alignment is right
6. Enable security on the Robot (it must Enable the security on the Meltio Engine too)

7. We recommend having a way to see as well as you can the deposition process (windows, cámeras, etc)

Control unit parameters	
Laser power	750 W
Feeder Speed	15.3 mm/s
Ar 99% Flow	10 L/min
Robot code parameter	
Robot Speed (deposition process)	10 mm/s
Robot Speed (traveling)	60 mm/s
Layer height	1.2 mm
Extrusion with	1 mm
Number of perimeter	2
Infill	100%

MELTIO

www.meltio3d.com