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Meltio Engine CNC Hybrid Process

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Meltio Engine CNC Integration

Hybrid Manufacturing Integration

The most affordable hybrid manufacturing solution, fitting almost any CNC machine in the market. Enable metal 3D printing and machining of complex geometries in a single process step.

Hybrid Manufacturing

Create highly complex parts with machining tolerances in the same process.

Retrofitting

Provide new capability to any CNC machine by turning it into an hybrid metal manufacturing system.

Part Repair

Cost-effective component repair, part augmentation and feature addition.

Geometry Freedom

No inherent constraints when the working envelope is only limited by the size of the motion system.


L 1600
LAGUN
MAKER HOLDING
MELTIO
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L 1600
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MAHER HOLDING
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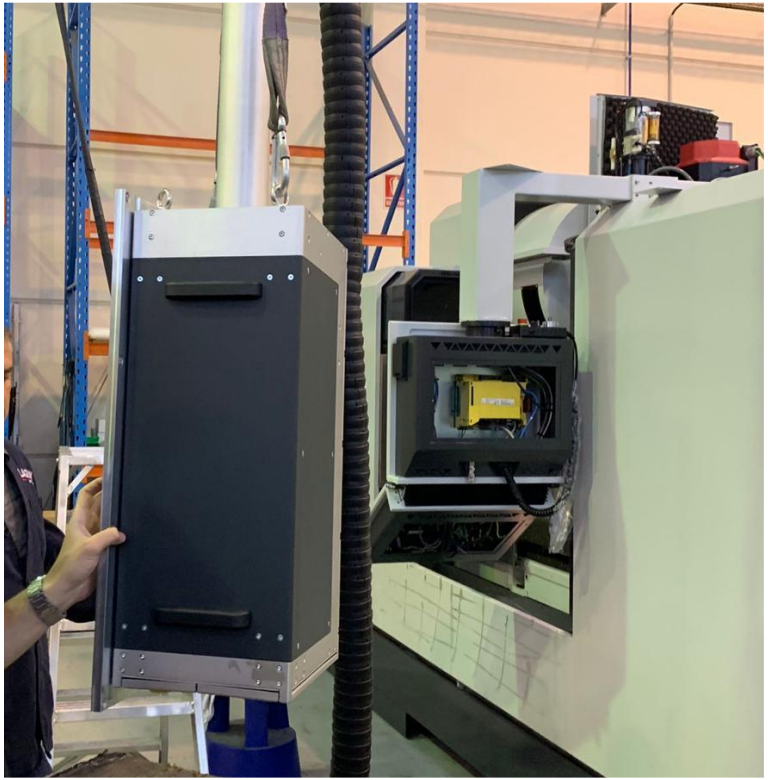
Bolt-on Hardware Integration



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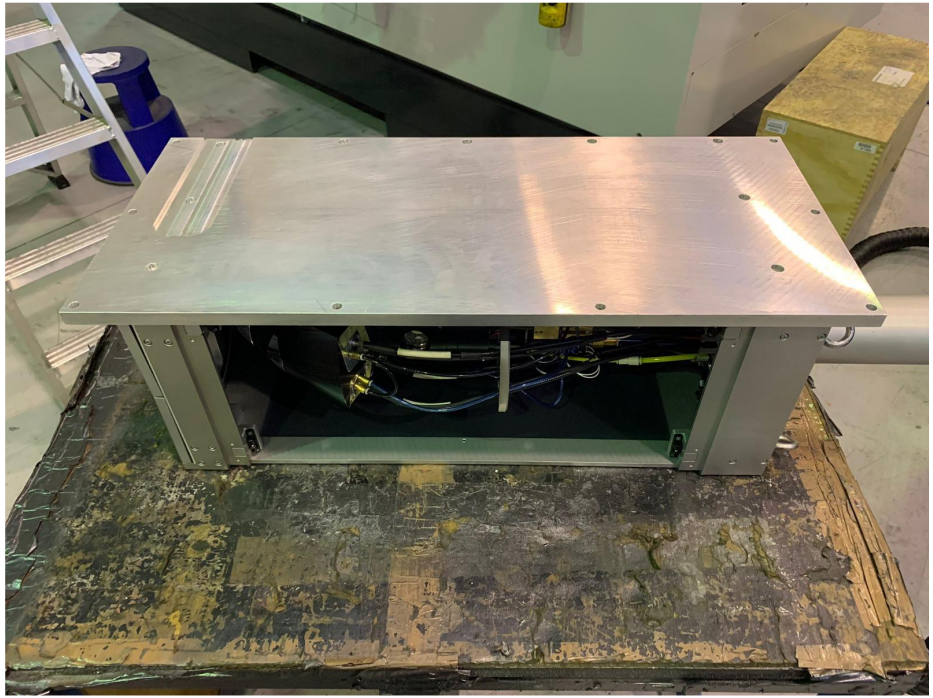
Adapter Plate



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Minimum requirements:

-Hybrid integration: Hardware + Safety + Mcodes

-Hybrid CAM software: (Example: Mastercam + Aplus)

-Specific training (CNC, hybrid product, Meltio).

Hybrid CAM Software:

Meltio Open platform

Meltio Software Partners Ecosystem for the Hybrid process

Examples of CNC hybrid software are: MasterCam + Aplus Additive plugin, Esprit by Hexagon; Fusion 360 or PowerMill by Autodesk; Hypermill by OpenMind; SiemensNX by Siemens; Hy5CAM by 1ATechnologies; and SprutCAM X by SprutCam.

CNC / Hybrid integrations: How does the integration work

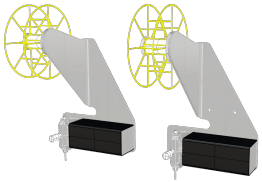
- Gcode goes in → then to machine →machine talks to engine → Engine supplies process information → then to part

- How does info flow
- Which Information is passed
- How is the information shared

Interfaces and easy integration

Argon
Cooling
Laser Fibers
Communication

Wire Feed



External Feeder
Communication

Process
Parameters
according
Aplus Code

Hybrid NC Code
Generation

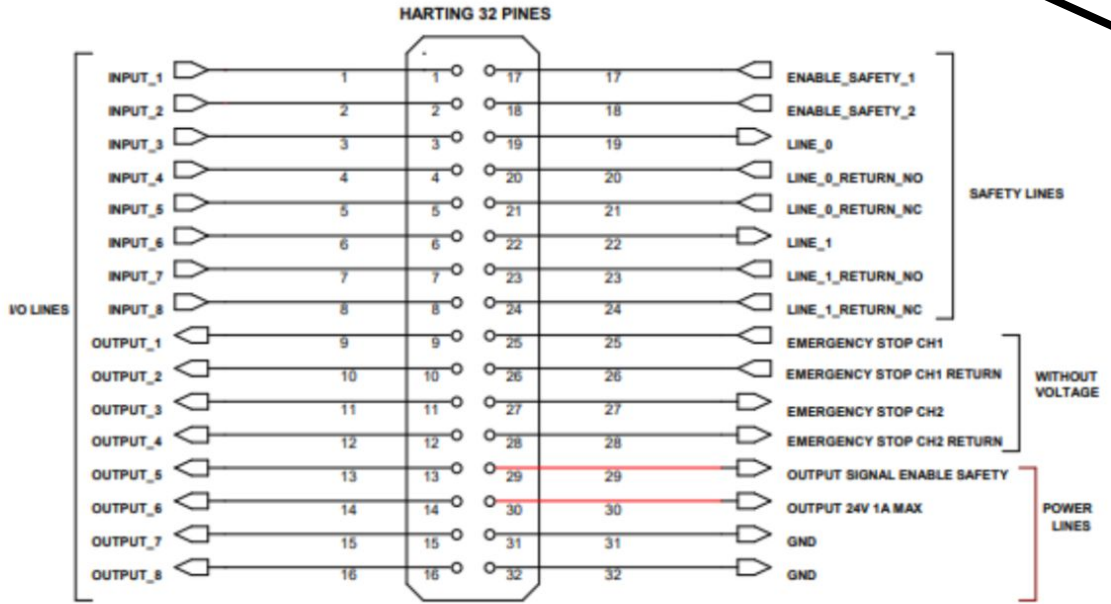
NC Code Run (Additive and Machining)

Safety & Communication
(MCodes)
Start/ Stop/ Material
Change / Deploy-Retract

Argon Inlet

Chiller &
Chiller Communication

I/O & Safety Cable



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

Pin 17 and 18: 24V constant signal sent from the CNC in case of no emergency (Channel 1 and 2). These 24V must fall in case of door opening.

Pin 19 and 22 (Channel 1 and 2): 24V constant signal from the CNC to our Engine (Input to safety relays controlled by the Engine electronics)

Pin 20 NO or 21 NC for channel 1 return

Pin 23 NO or 24 NC for channel 2 return

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: voltage free contact 2 without passing through the electronics (physical emergency stop button of the Engine)

Pin 29 and 30 - 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.

Pin 31 and 32 -GND: 24V common from Meltio

Macros/Mcodes

M104-Initialize Print: Initialize the Meltio Engine for printing, including security checks as well as turning on the chiller and the defined argon flow.
M105- Finalize Printing Process - Reset Signals: Set every Digital Output to low(0) at the beginning of the program to ensure a clear communication and finished the printing process.

M106-Start Deposition: Begins the extrusion of the filament and turns on the lasers.

M107-Start Deposition 2: Allow you to have different Laser Power and Wire Feeder Speed

M108-End Deposition: Ends the extrusion of the filament and turns off the lasers.

M109-Change to T0: Begins the change of material, retract the ACTIVE material 60 mm and extrude T0 material 60 mm.

M110-Change to T1: Begins the change of material, retract the ACTIVE material 60 mm and extrude T1 material 60 mm.

M111-Deploy: Extends the CNC Hardware integration and continues the argon flow.

M112-Enclose: Enclose the CNC Integration Hardware for a Hybrid process. When is enclosed it will stop the use of argon, this allow the Engine to have only one print log for the Hybrid process.

Communication Protocol

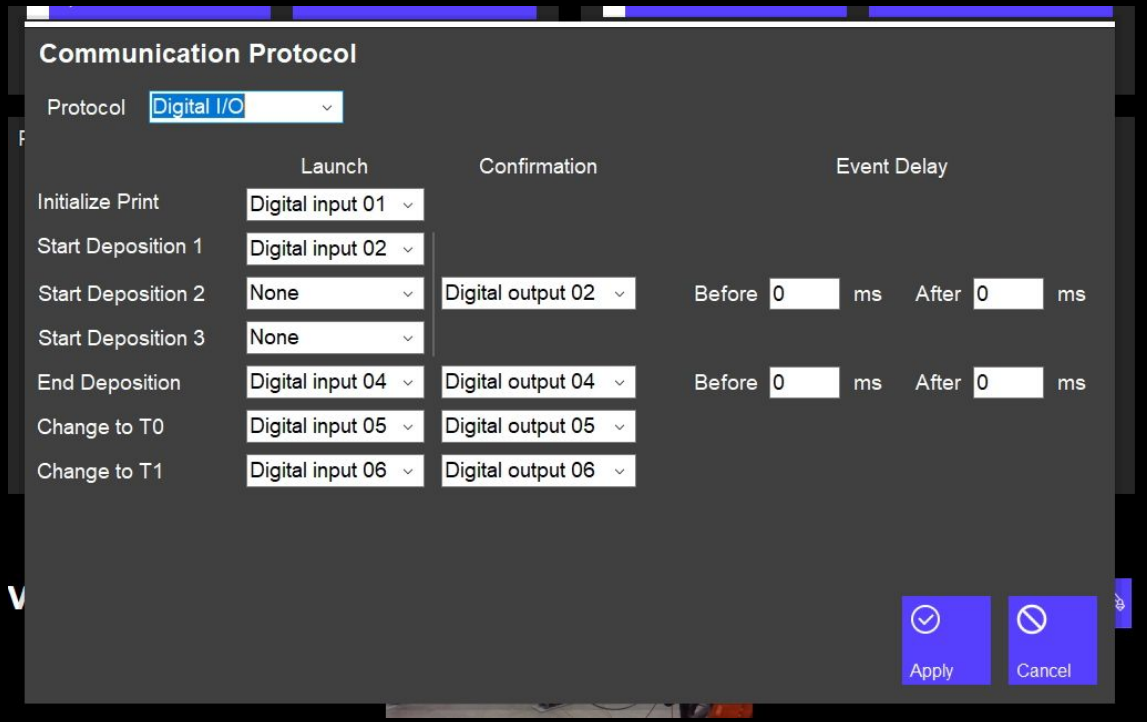
Default Communication is based as **Digital I/O:**

Any digital input or output can be assigned, including same output for all confirmations if necessary **just selecting from the list.**

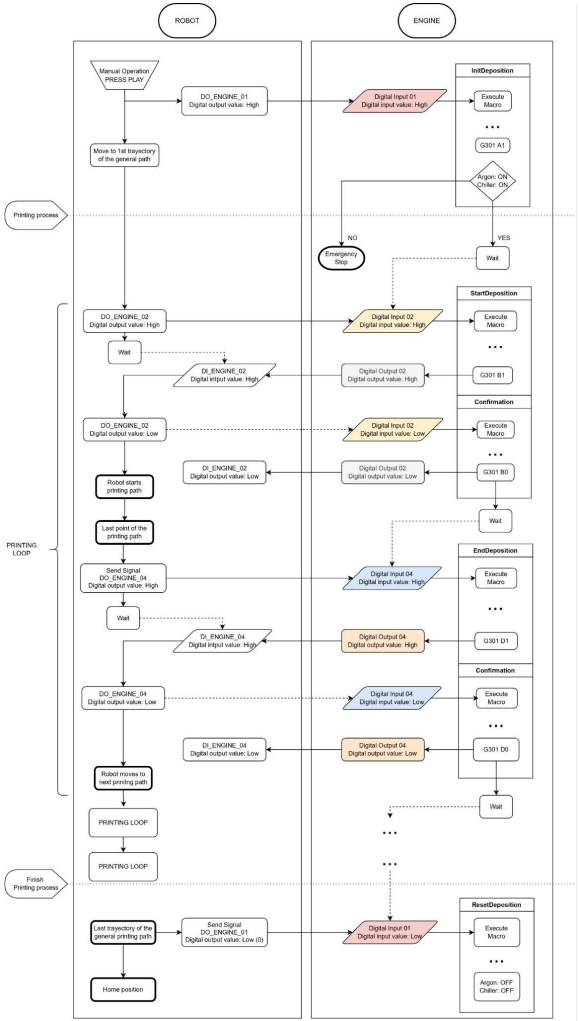
On **CNC Integration Hardware,** includes the option to **enclose and extend** the deployment calling for a signal too.

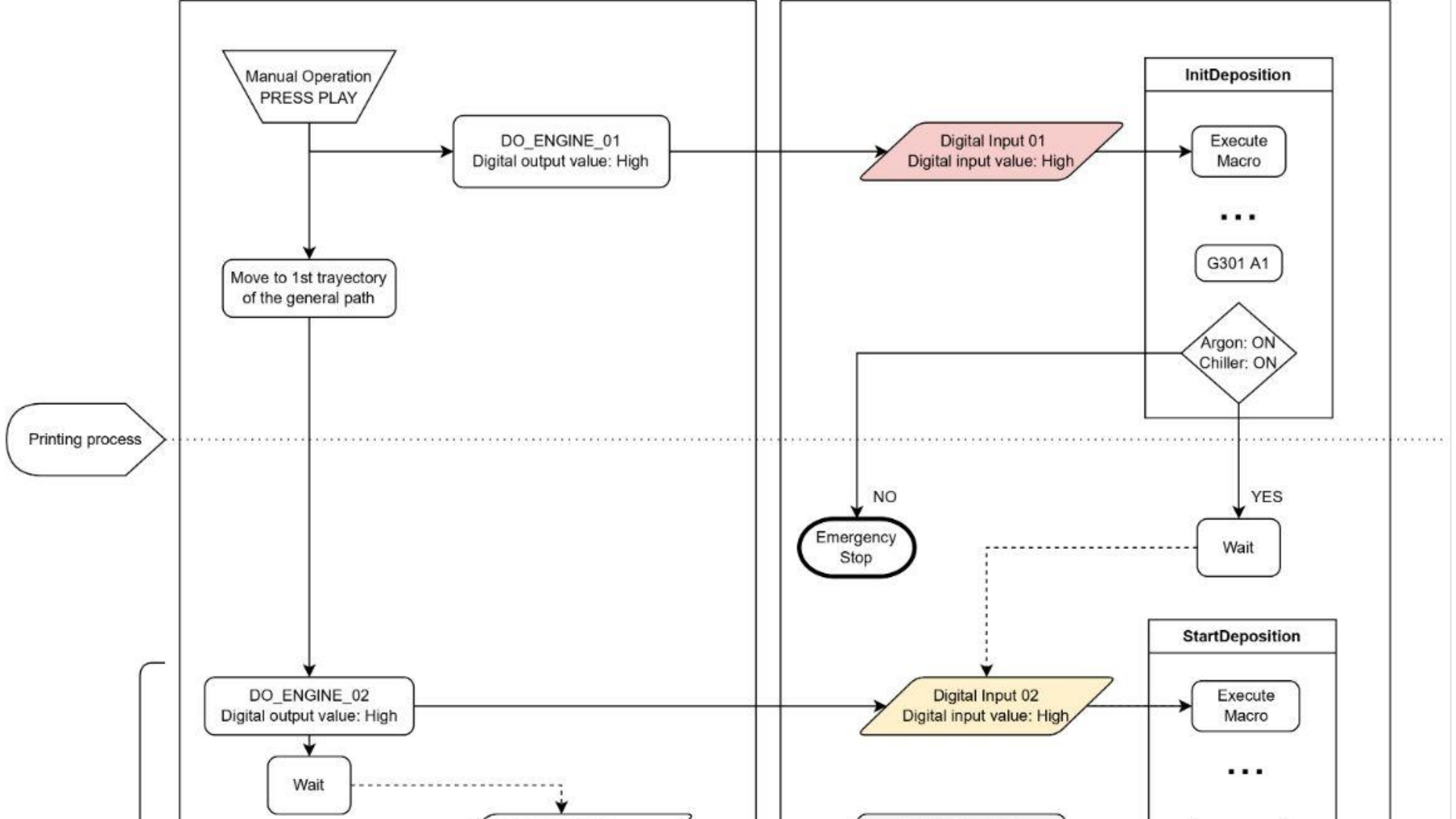
Exist the possibility to add a delay, by default this is set to 0.

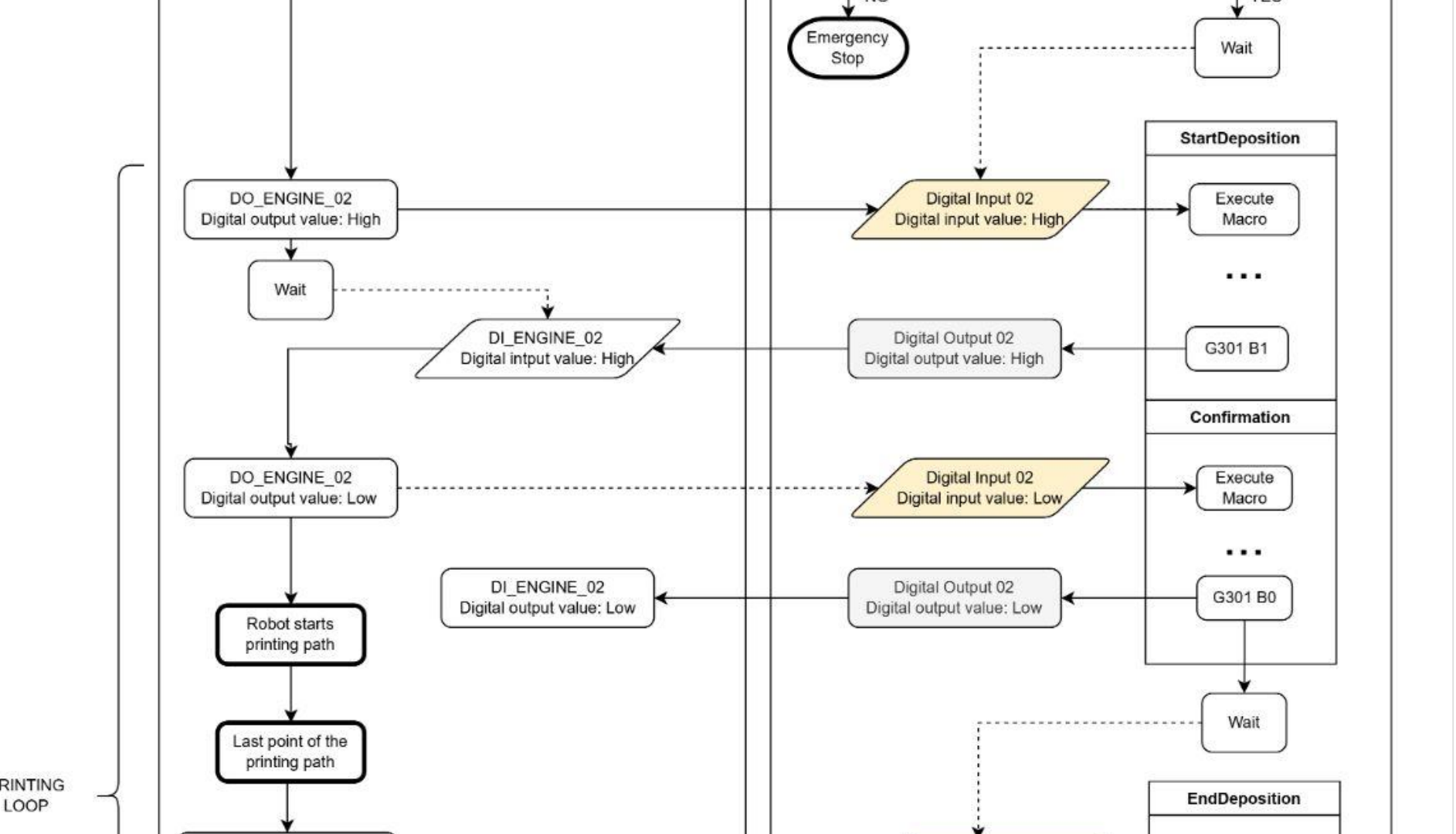
OPC DA and Socket, also available with logic as in previous versions.

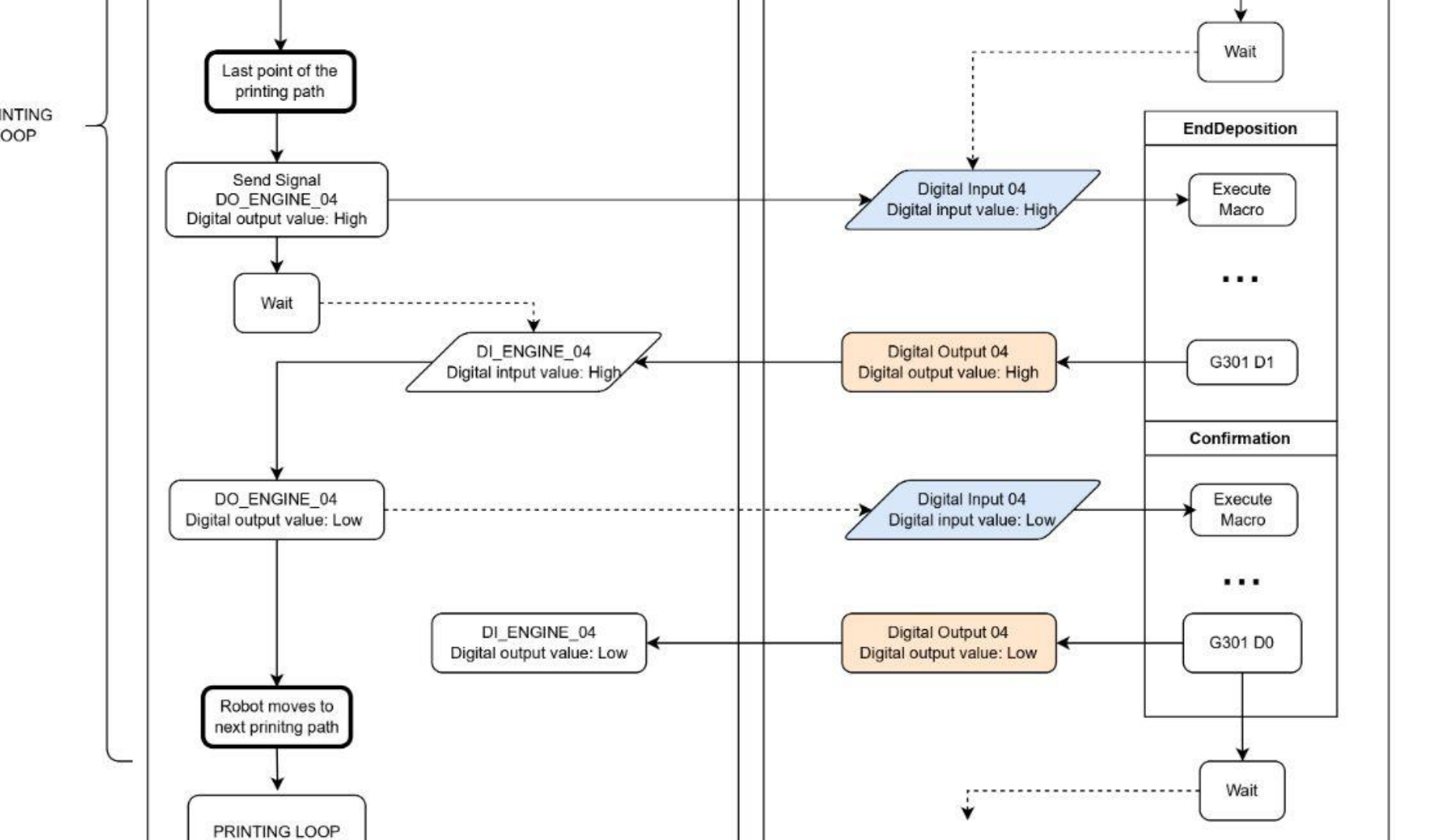


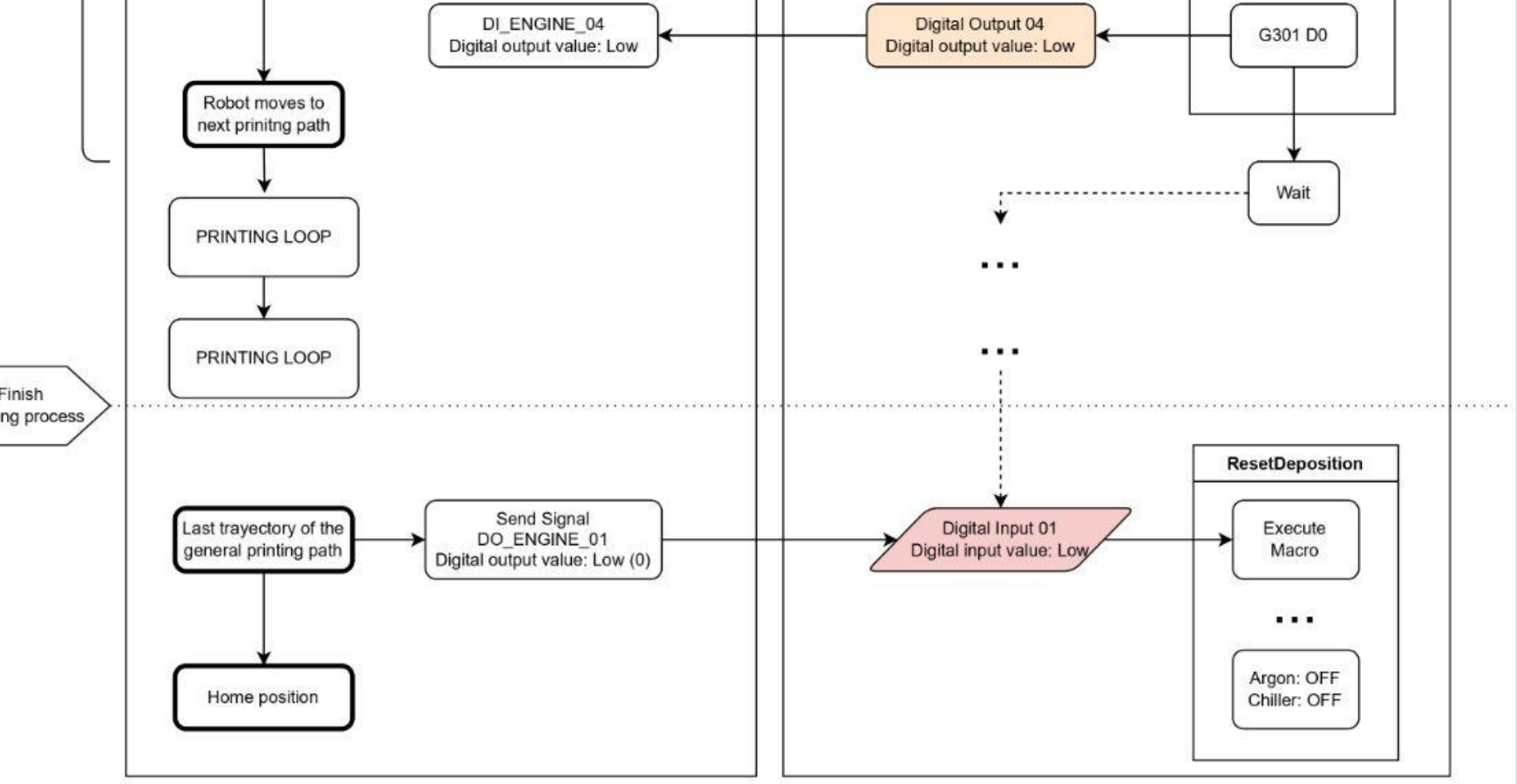
Communication FlowChart CNC/Engine




Manual Operation
PRESS PLAY
DO_ENGINE_01
Digital output value: High
Digital Input 01
Digital input value: High
InitDeposition
Execute
Macro
G301 A1
Move to 1st trayectory
of the general path
Argon: ON
Chiller: ON
Printing process
NO
YES
Emergency
Stop
Wait
StartDeposition
DO_ENGINE_02
Digital output value: High
Digital Input 02
Digital input value: High
Execute
Macro
Wait


Emergency Stop
Wait
StartDeposition
DO_ENGINE_02
Digital output value: High
Digital Input 02
Digital input value: High
Execute Macro
Wait
DI_ENGINE_02
Digital intput value: High
Digital Output 02
Digital output value: High
G301 B1
Confirmation
DO_ENGINE_02
Digital output value: Low
Digital Input 02
Digital input value: Low
Execute Macro
DI_ENGINE_02
Digital output value: Low
Digital Output 02
Digital output value: Low
G301 B0
Robot starts printing path
Last point of the printing path
Wait
EndDeposition
RINTING
LOOP


INTING
OOP
Last point of the printing path
Send Signal
DO_ENGINE_04
Digital output value: High
Wait
DI_ENGINE_04
Digital intput value: High
DO_ENGINE_04
Digital output value: Low
DI_ENGINE_04
Digital output value: Low
Robot moves to next prinitng path
PRINTING LOOP
Wait
Digital Input 04
Digital input value: High
Digital Output 04
Digital output value: High
Digital Input 04
Digital input value: Low
Digital Output 04
Digital output value: Low
Wait
EndDeposition
Execute Macro
G301 D1
Confirmation
Execute Macro
G301 D0
Wait


DI_ENGINE_04
Digital output value: Low
Digital Output 04
Digital output value: Low
G301 D0
Robot moves to
next prinitng path
Wait
PRINTING LOOP
PRINTING LOOP
Finish
ng process
ResetDeposition
Last trayectory of the
general printing path
Send Signal
DO_ENGINE_01
Digital output value: Low (0)
Digital Input 01
Digital input value: Low
Execute
Macro
Argon: OFF
Chiller: OFF
Home position

Timeline

Understand more about the Meltio process following everything that occurs in the same Timeline. It includes Macros launch and duration, as well as, sensors as the continuity within the Integration Hardware and the part as being printed together with the Load Cell.

G00 G17 G21 G40 G80 G90
G91 G28 Z0.
N1
T0 M06 (Tool Change)
T4
G54 G17 G90
M105 (FINALIZE MELTIO ENGINE - RESET SIGNALS)
M104 (INITIALIZE MELTIO ENGINE)
M111 (DEPLOY MELTIO ENGINE)
G04 X15
M109 (MELTIO T0 MATERIAL)
G00 X1.276 Y-48.472
G43 H120 Z3.
Z0.
M106 (START DEPOSITION)
G94 G01 X1.266 F600.
X-1.039 Y-48.489
X-3.805 Y-48.35
X-6.559 Y-48.054
X-43.37 Y-21.709
X-44.538 Y-19.198
X-45.562 Y-16.624
...
X27.09 Y-39.017
X24.818 Y-40.5
X4.403 Y-47.295
X2.159 Y-47.439
X2.149 Y-47.44
M108 (END DEPOSITION)

Printing Loop

...
G00 Z23.4
G49
G91 G28 Z0.
G28 X0. Y0.
M01 (Conditional Program Stop)
N2
M112 (ENCLOSE MELTIO HEAD)

Milling

T4 M06 (63 ENDMILL)
T10
G54 G17 G90
G00 X-103.727 Y48.14 S632 M03
G43 H4 Z46.
Z31.
G94 G01 Z20.813 F600.
X103.727 F758.4
…
G01 Z20.813 F600.
X116.804 F758.4
X103.727 Y-48.14
X-103.727
G01 X33.5
G00 Z46.

G49
M09 (End Water and Air Cooling (CNC))
M05 (Spindle Stop)
G91 G28 Z0.
G28 X0. Y0.
M105 (FINALIZE MELTIO ENGINE - RESET SIGNALS)
M30
%

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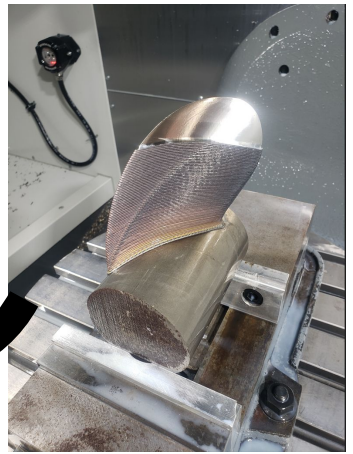
Hybrid Manufacturing process flow

Hybrid manufacturing processes seek to combine the strengths of additive manufacturing (3D printing) with those of traditional CNC Milling / Subtractive manufacturing, to create a single manufacturing workflow that effectively uses both at once.

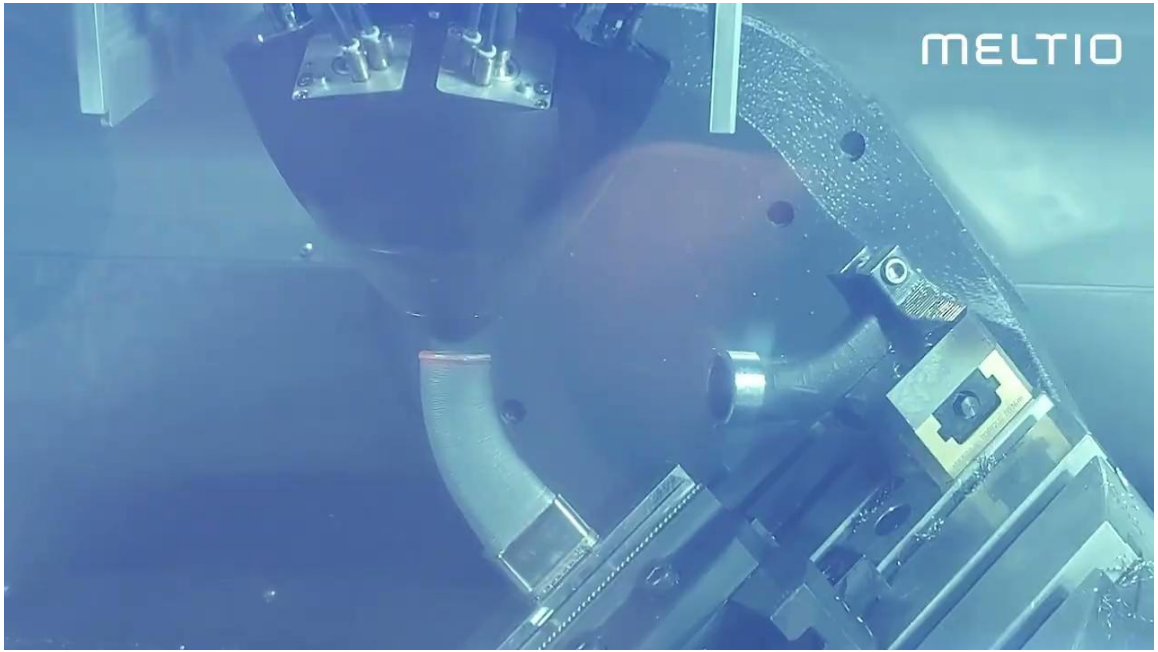


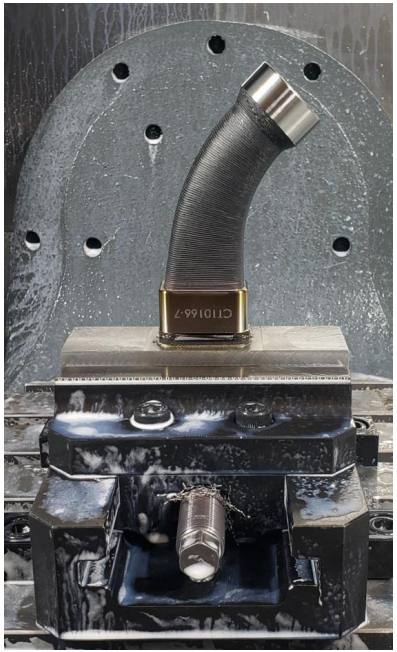
1. Hybrid Toolpath

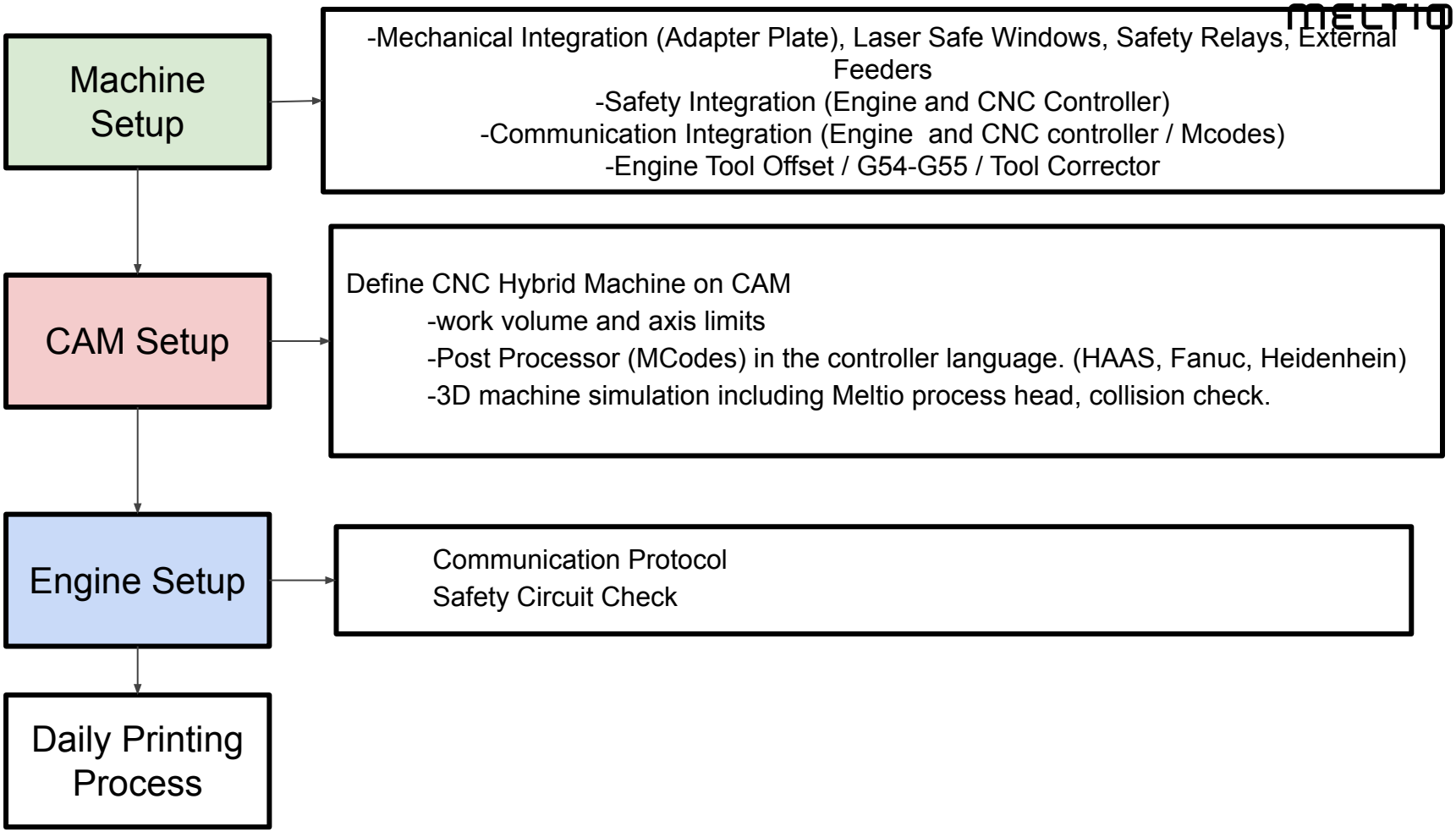
2. Metal 3D Printing

3. CNC Machining

Hybrid Manufacturing of Complex Parts






Machine Setup
-Mechanical Integration (Adapter Plate), Laser Safe Windows, Safety Relays, External Feeders
-Safety Integration (Engine and CNC Controller)
-Communication Integration (Engine and CNC controller / Mcodes)
-Engine Tool Offset / G54-G55 / Tool Corrector
CAM Setup
Define CNC Hybrid Machine on CAM
-work volume and axis limits
-Post Processor (MCodes) in the controller language. (HAAS, Fanuc, Heidenhein)
-3D machine simulation including Meltio process head, collision check.
Engine Setup
Communication Protocol
Safety Circuit Check
Daily Printing Process

Machine Setup

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Define Meltio Head Height

- Use an exact height tool (pattern)
- Setting the machine coordinates with the pattern
- Measure the height of the Meltio Head
- Defined height in macro windows

Define Meltio Head Distance

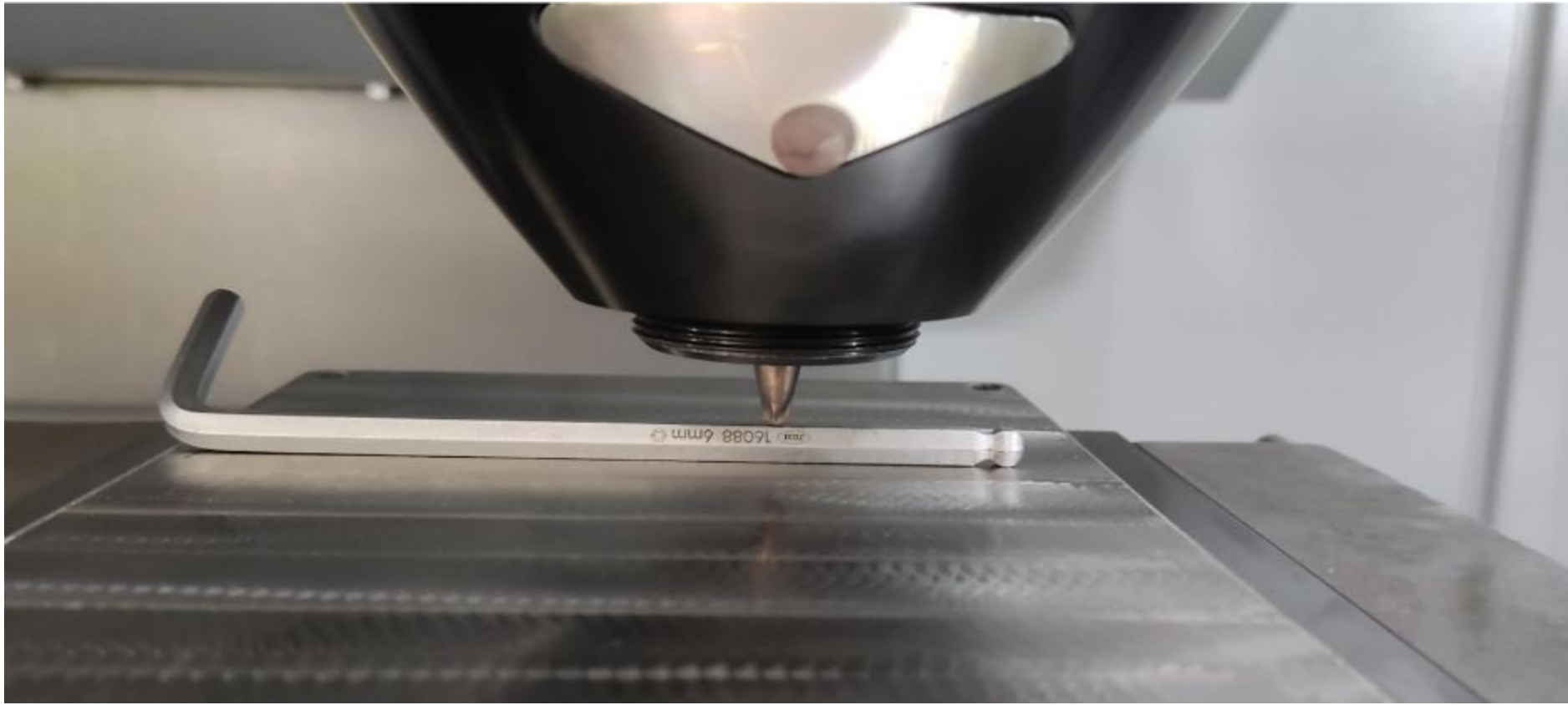
- Print a square of 50 x 50 x 30 mm at the G54 origin.
- Use the part measuring probe to find the center of the part at G55.
- Set X0 and Y0 at G55, with different values at G54.
- Calculate the measurement differences between G54 and G55 to determine the X and Y displacements of the Meltio head.
- Define the displacement values in macros, using negative values from G54.

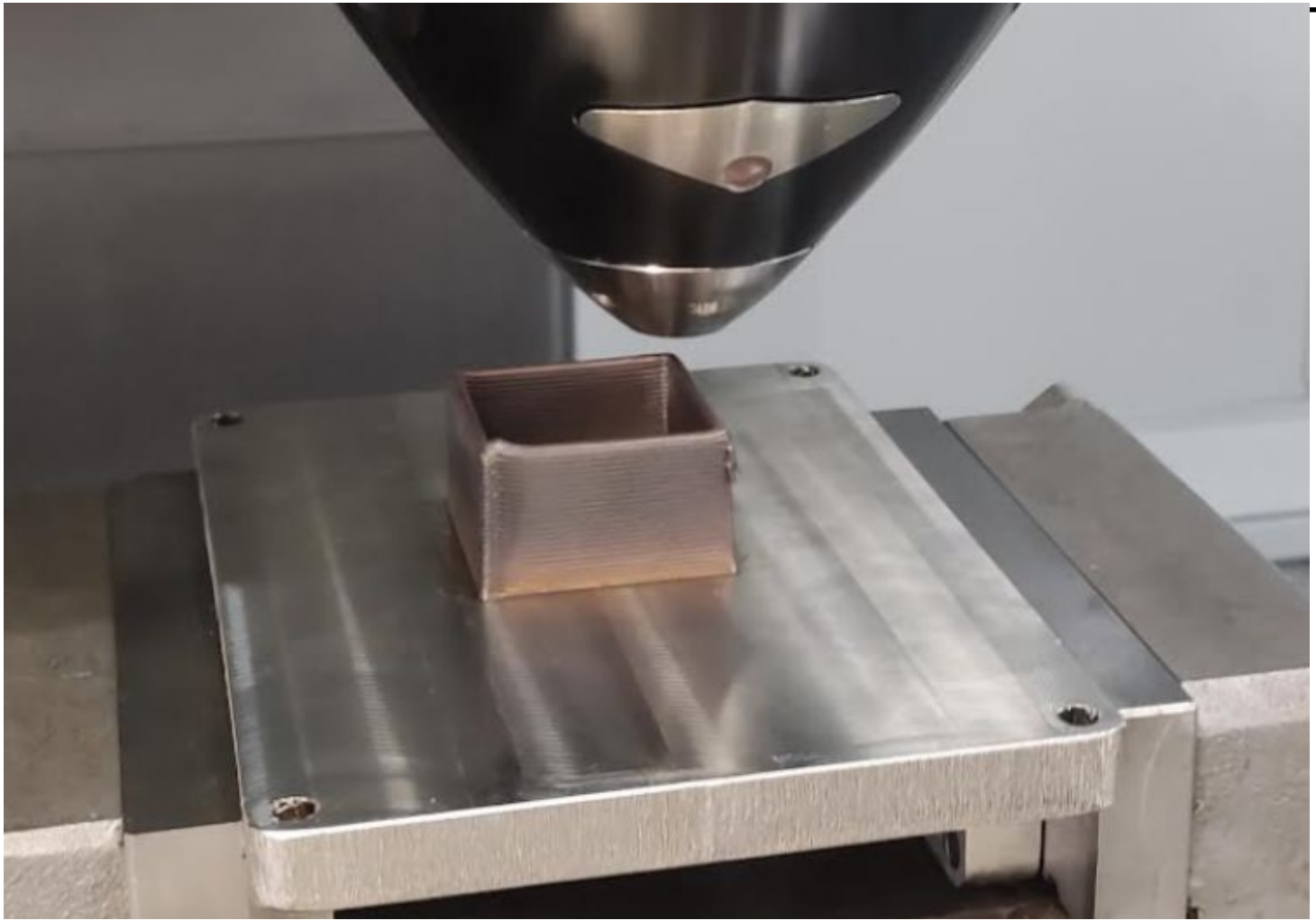
Hybrid Process

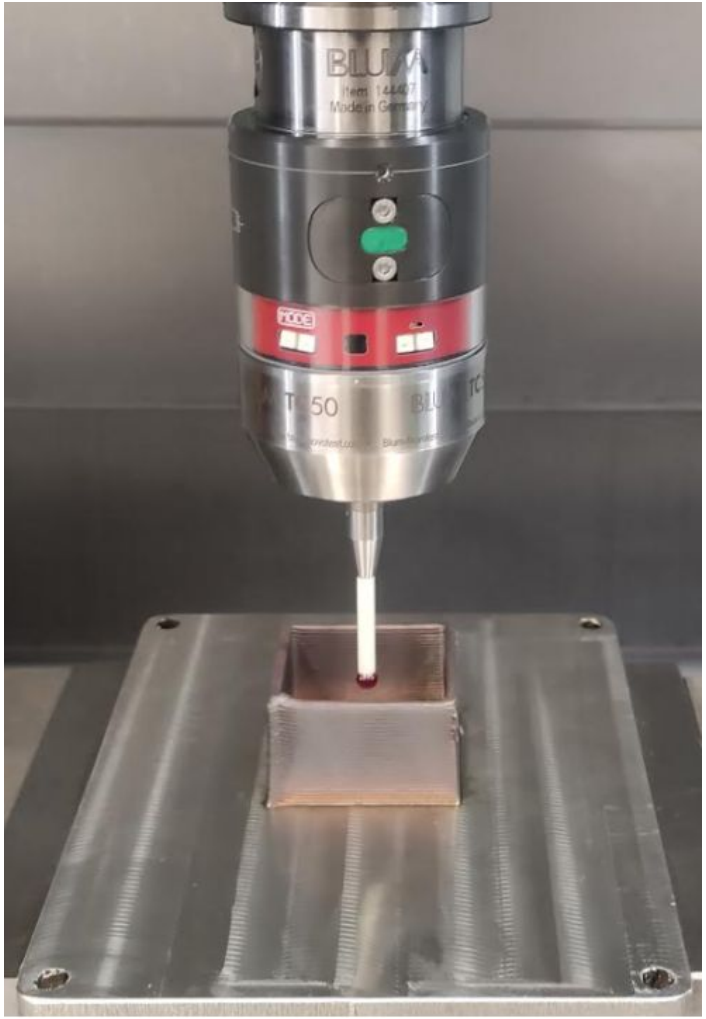
- Set the machining origin in G55.
- Modify values in G54 using the Meltio window.
- Define the zero point in G55
- Define the value in G55 with the distance difference in G54 for all axes.
- Define the corrector H120.
- Ensure Meltio is defined as T0 in the code.

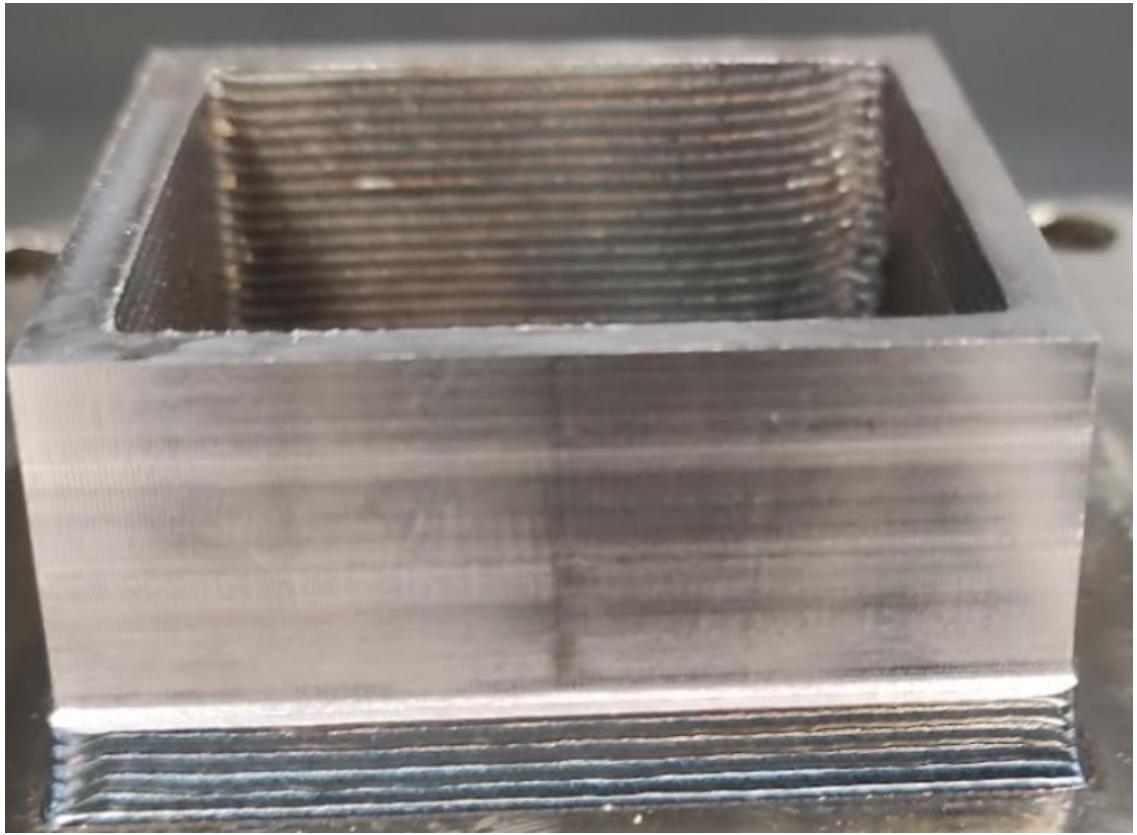
Programming Process


D=11,999
H=10,007
L2=14,97


16088 6mm




BLUM
Item 14407
Made in Germany



More details of machine setup as performed on Lagun L1600 Powered by Meltio with FANUC 0imf-Plus controller

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Meltio Engine V3 Integration Manual

Applies to Meltio Engine - V3 February 2024

CAM Setup

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Select CNC Machine →
- Select the CNC machine you will use for the hybrid process

Import the part →
- Import the part to printing and machining process.

Mastercam APLUS

Select printing strategy →
- Take into consideration the 3D Printing Reference Manual for Engine and the guidelines for printing with Meltio technology.
- Generate Toolpath.

Machining Process →
- Select the machining process that interests you for the part and according to your tools

Generate Hybrid Program → **Define Printing Parameters**


A-PLUS

Engine Setup

MELTIO

Check Communications Protocols →

- Define communication protocol
- In case to use the Digital I/O protocol you must check if the DI launch match with the correct confirmation DO

Select Engine Printing Profile →

- Define Power Laser
- Define Feeder Speed
- Define Gas Flow
- In case to use the predefined profiles you must select if your part is solid (Fully Density/ Utility) or hollow (1P, 2P, +3P)

Check Adjust Seam →

- Define adjust seam for single wire
- Define adjust seam for dual wire

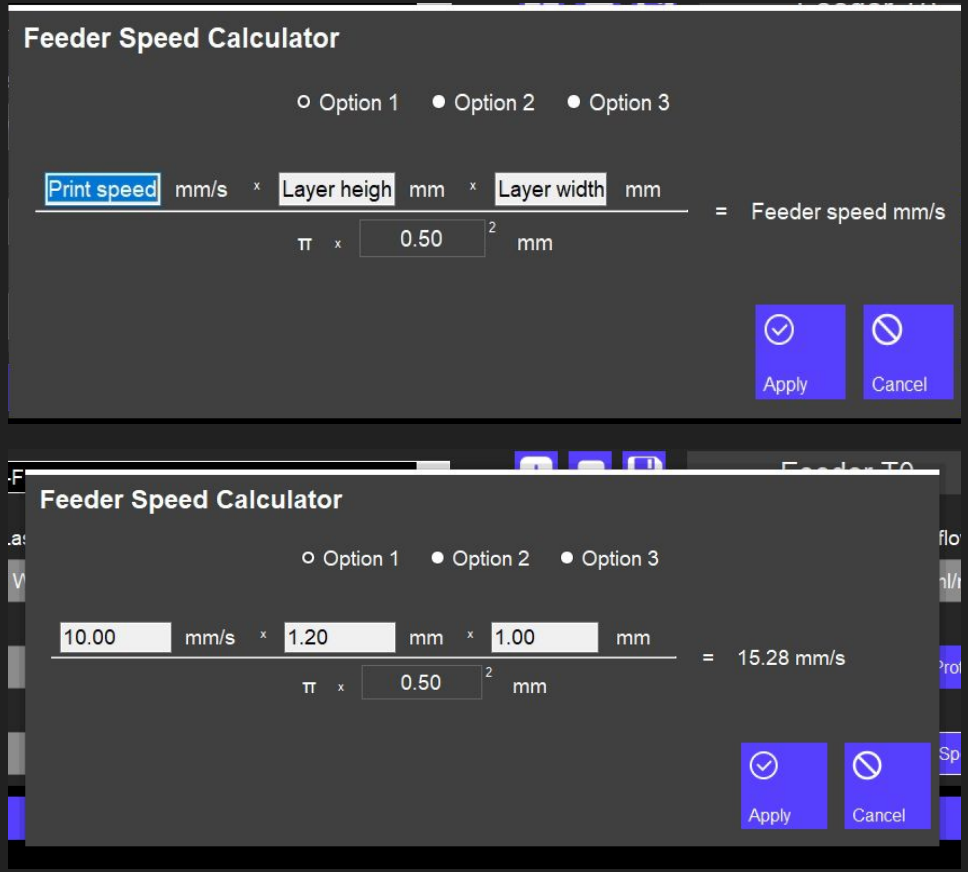
→ **PRINTING!**

Feeder Speed Calculator

We included a very helpful tool to ensure the feeder speed is calculated correctly in case you are using a Custom Print Profile.

Defining the Print Speed (movement), Layer height and Layer width, together with the material wire radius (important to define it in the profile editor) will calculate the Feeder Speed, to be used in any Option for printing.

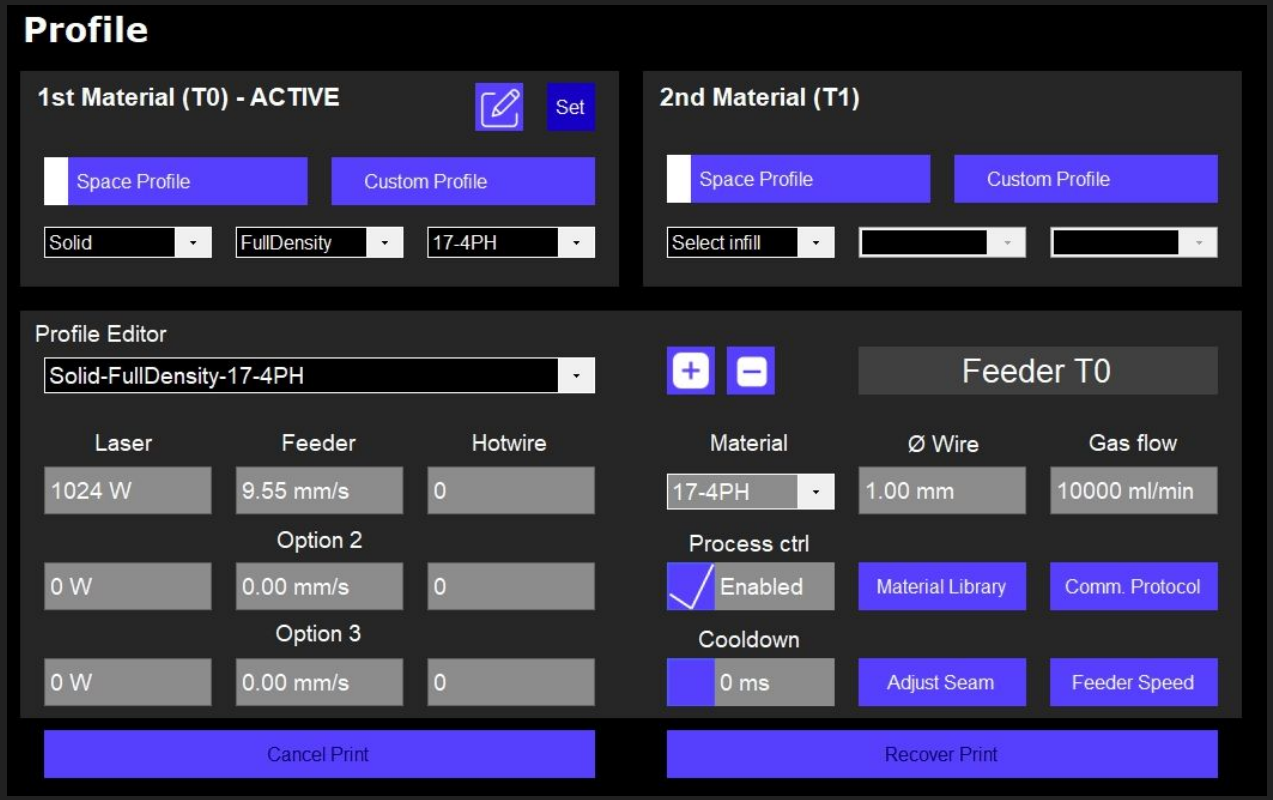
See the example to obtain 15.28mm/s as the speed of the wire for a 10mm/s robot movement speed, 1.2 mm layer height, and 1mm layer width. Using 1mm wire, hence 0.5 its radius.



Profile Editor

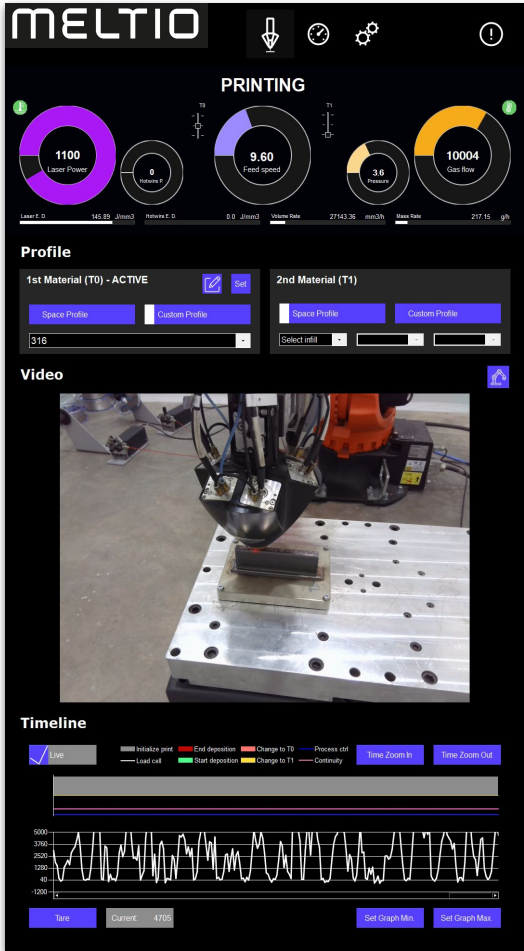
New interface offers every option parametrized, being able to apply different profile to Tool 0 and Tool 1.
It includes Option 2 and Option 3, to allow, with the same profile to have different Laser, Feeder and Hotwire values, to be applied for Infill, perimeters or even to apply preheating.
To be called with extra inputs and outputs.
Cooldown allow you to include extra wait times for part cooldown if necessary.

We offered also sub menus to define easily the best parameters match.



What offers the new software update?

- **Updated and renewed** User Interface
- **Custom profiles without the need of writing macros,** every possibility **parametrized.**
- **Live 3D model** based on **reading TCP positions** from robot
- Timeline for **Sensors Analysis**
- 4K Webcam Integration
- Compatible with **Welding Camera**
- **Profiles** for **Meltio Materials** and **Meltio Space**



Adjust Seam

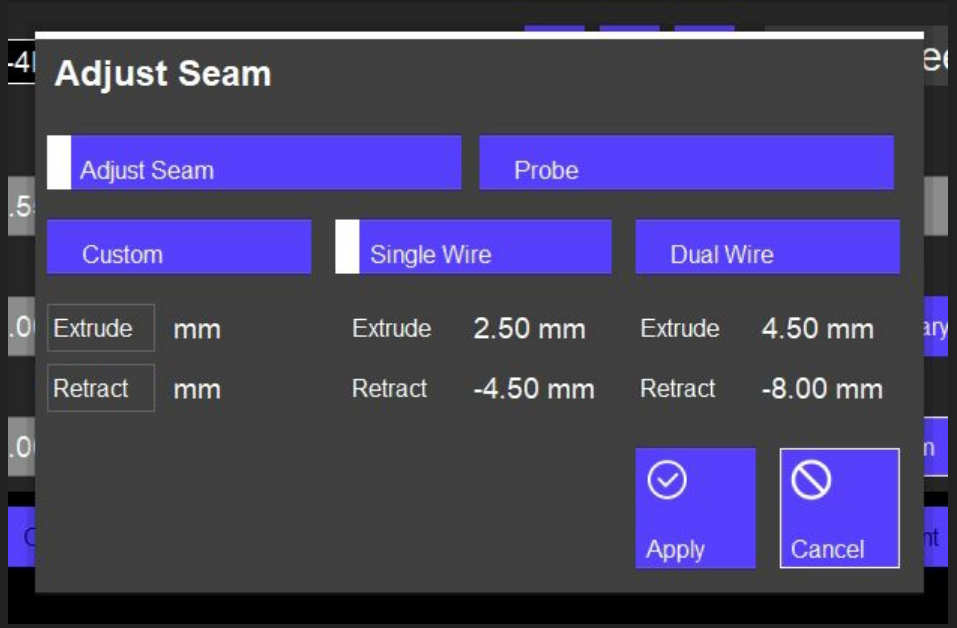
Recommended extrusion and retraction values for single wire and dual wire.

By default is set to :
Adjust Seam + **Single Wire**

Set to **Dual Wire** when combining different materials.

Probe is used for probing rather than a fixed extrusion distance.

Custom allow you to define any value within a safe range to adjust the seam as much as possible having always reference values for Single and Dual.



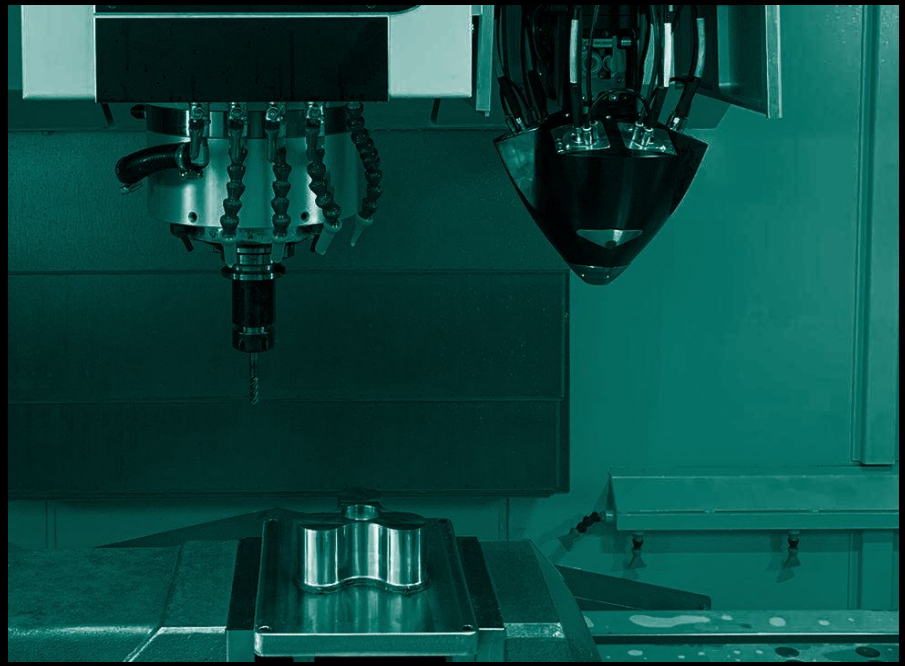
Webcam or Welding Camera Integration

Connect your USB Web Camera to the Meltio Engine Control Unit to follow the print through the Meltio Engine together with the Timeline.

Meltio Offers for purchase the 4K Vision Kit, including tripod, 15 meters USB extension cable and 4K Webcam, please request it through technical support.

We have as an alternative to the USB camera, the welding camera.

Video



Live 3D View

Connect your ABB Robot (WAN) and Meltio Engine to your local network.
Engine will read live TCP position and will show a 3D view as the program starts including colours according to the Load Cell values. Minimum (blue) and maximum (red) can be modified in configuration.

Currently only available for ABB, under development Kuka.
Regarding CNC controllers Haas, Fanuc and Siemens are in the development timeline too.