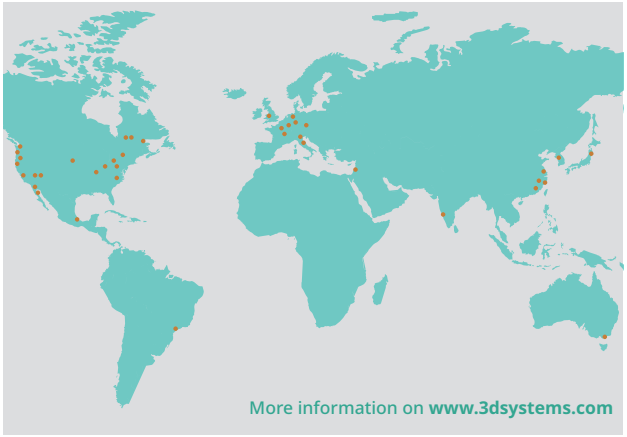
3D SYSTEMS

DMP Factory 500

Scalable metal additive manufacturing for seamless large parts

3D Systems: Advancing Industries with Additive

More than 30 years ago, 3D Systems brought the innovation of 3D printing to the manufacturing industry. Today, as the leading additive manufacturing solutions partner, we bring innovation, performance, and reliability to every interaction - empowering our customers to create products and business models never before possible. Thanks to our unique offering of hardware, software, materials, and services, each application-specific solution is powered by the expertise of our application engineers who collaborate with customers to transform how they deliver their products and services. 3D Systems' solutions address a variety of advanced applications in healthcare and industrial markets such as medical and dental, aerospace & defense, automotive, and durable goods. More information on the company is available at www.3dsystems.com.



Additive Manufacturing Solutions

Metal

Direct Metal Printing (DMP): a metal additive manufacturing technology in which a high-powered laser scans over a bed of fine metal powder to micro-weld particles in the pattern prescribed by a cross-section of the CAD file. 3D Systems' precision metal manufacturing solutions integrate DMP with thoroughly tested print parameters for LaserForm materials, 3DXpert all-in-one software, and expert application support.

Plastic

Selective Laser Sintering (SLS): a high-powered laser selectively fuses powdered material, layer-by-layer. SLS machines are available in large build sizes and compatible with robust materials to enable durable, high-heat and chemically resistant applications.

Stereolithography (SLA): a UV laser scans over a layer of liquid photopolymer material to build up a part. SLA delivers the highest accuracy and smoothest surface finish of all 3D printed parts and is available in large build platforms with high resolution settings.

Figure 4 Technology: a projector images each layer of a build within a UVcurable, liquid material. Figure 4 offers precise, cost-efficient printing at fast throughput speeds, with six sigma repeatability.

MultiJet Printing (MJP): a printing process that uses piezo printhead technology to deposit either photocurable plastic resin or wax casting materials, layer-by-layer. These high resolution printers are economical to own and post-processing is virtually hands-free, enabling delicate and complex features to be printed and cleaned without damage.

Full Color

ColorJet Printing (CJP): a binder is selectively jetted from inkjet print heads onto a powdered core material, causing the core to solidify. The build platform lowers with each subsequent layer, and CMY or CMYK color is applied to the outermost surfaces resulting in a full-color 3D model.

Software Solutions

Geomagic Design X™, Geomagic Wrap® and Geomagic for SOLIDWORKS® Scan-to-CAD Software Reverse engineering with 3D scanning and can introduce dramatic time savings in product design and yield more accurate and customized final products.

Geomagic Freeform®, 3DXpert for SOLIDWORKS, 3DXpert and 3D Sprint®
3D Systems' design products help accelerate and optimize designs across organic shapes, tooling design and dedicated solutions for Design for Additive Manufacturing (DfAM). Robust and diversified toolsets help users bring new and innovative ideas to life with application-specific tools to fast-track and fine-tune projects.

Geomagic Control X™ 3D Inspection Software 3D metrology and automated digital inspection tools verify design intent, ensure quality outcomes, and facilitate reporting in a streamlined process that can save significant time and money.

AIG Professional Services

Application Innovation Group
3D Systems' Application Innovation Group can help you solve your most difficult design and production challenges with additive manufacturing solutions. This team of experienced applicaton experts can help identify your needs, working with you to optimize your designs, prototype, validate and define a manufacturing flow.

Healthcare & Dental Solutions

3D Systems partners with surgeons, healthcare professionals, medical device manufacturers, and medical teaching staff to offer a range of precision healthcare solutions, including virtual reality simulators, 3D printed anatomical models, VSP® (Virtual Surgical Planning), patient-specific surgical guides, instrumentation and implants. In the world of digital dentistry, 3D Systems offers a broad range of clinically validated technologies and materials that allow dental labs to access advanced digital workflows, driving speed, efficiency and precision of a range of indications delivered to patients.

Customer Support

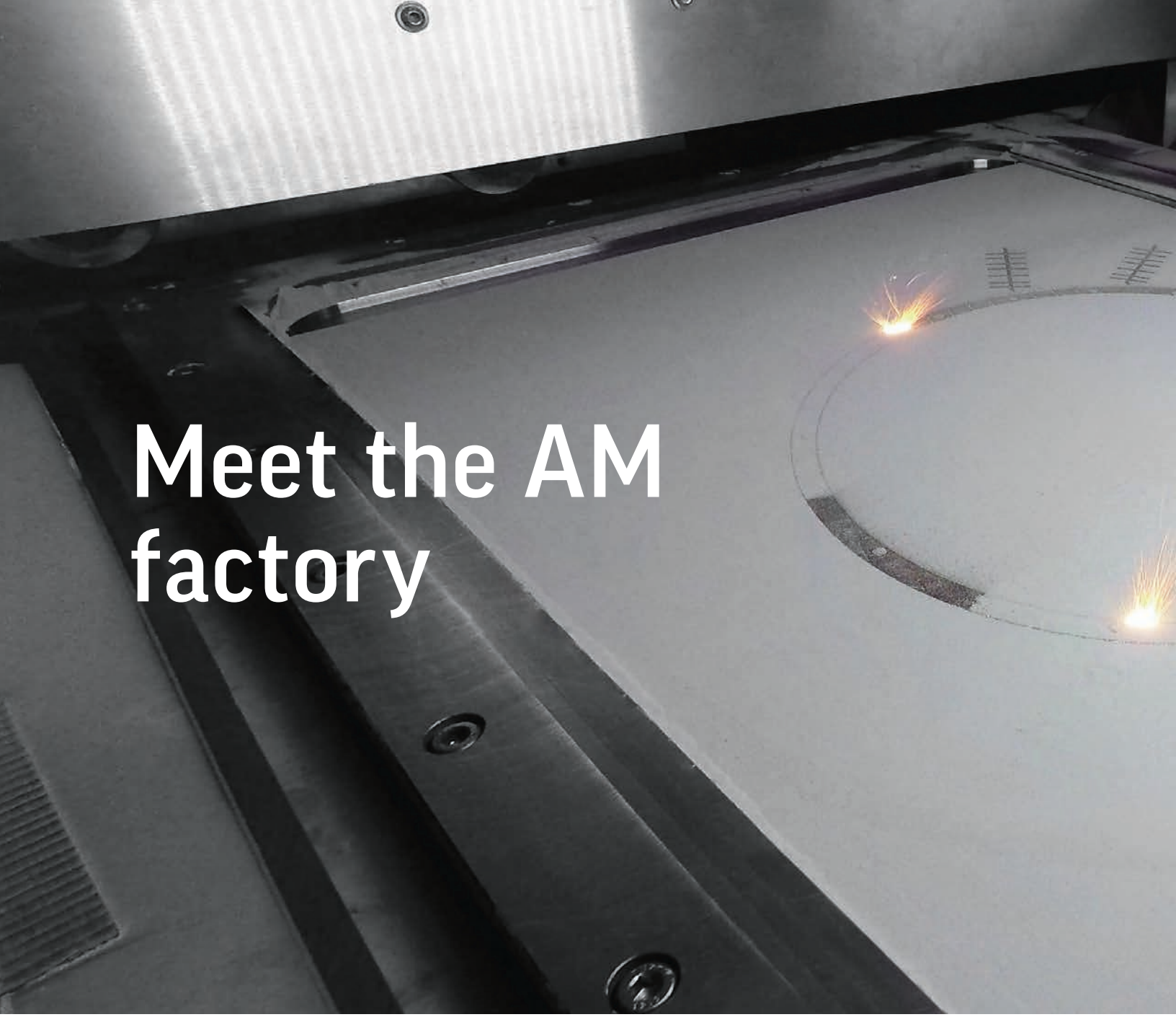
With locations worldwide, 3D Systems offers best-in-class end-to-end support and services across the globe. 3D Systems' highly trained application engineers and field service technicians are available to assist customers at any stage: from the design phase and technology selection, to machine installation and maintenance.

Contents

Redefining the AM Factory

GF Machining Solutions, a leading global provider of complete solutions to the precision machining industry and manufacturers of precision components, and 3D Systems, a leading global provider of additive manufacturing solutions and the pioneer of 3D printing, have partnered to introduce new metal 3D printing solutions that empower manufacturers to develop their own dedicated Additive Manufacturing (AM) factories.

The DMP Factory 500 offers manufacturers in energy, semiconductor, aerospace, automotive, motorsports and other high-tech industries, increased productivity, part quality, repeatability, high uptime and process safety and facilitating seamless integration of metal AM technology into the entire manufacturing chain.



Meet the AM factory

Scalable metal additive manufacturing for seamless large parts

The DMP Factory 500 is a workflow-optimized metal 3D printing solution for massive scalability, repeatable high-quality parts, high throughput and low TCO, producing parts with a build volume up to 500 x 500 x 500 mm, height inclusive of build plate.

Engineered using 3D Systems' proven precision metal additive technology, along with GF Machining Solutions' technical and industrial knowledge, the DMP Factory 500 solution is a fully-integrated, streamlined metal AM platform.

This advanced metal production system is powered by 3DXpert® software, LaserForm materials, workflow-optimized Direct Metal Printing (DMP) production modules and expert application support.

Companies that have identified a preferable metal AM application in an in-house laboratory setting will realize the complications of scaling with a stand-alone printer. Very often, the costs and human resources required make this a difficult approach for volume parts production. In order to arrive at a viable factory solution, it must be possible to control part quality, cost, workflows and to scale operations easily.

3D Systems' technicians produce more than 100,000 high quality metal AM parts in-house every year through the 3D Systems parts manufacturing services.

Informed by their ongoing insights and experiences, our materials scientists and experts driving the product development teams have developed the DMP Factory 500 as a modular factory solution that enables users to:

- Build large parts
- Produce repeatable, high quality parts for serial production
- Simplify process workflows
- Scale in a factory environment

Modular concept for optimal efficiency

The DMP Factory 500 is a scalable manufacturing solution comprised of function-specific modules designed to maximize efficiency by optimizing utilization. Each module of the DMP Factory 500 is fully integrated with a Removable Print Module (RPM) that delivers a controlled, inert print environment and is engineered to move between printer and powder modules for a continuous production workflow. Customers can configure a custom metal AM factory by choosing the right combination of modules to optimize their specific production application.

Printer Module (PTM)
Designed for the ongoing, 24/7 printing of parts

Removable Print Module (RPM)
Engineered to move between printer and powder management modules for a continuous production workflow

Depowdering Module (DPM)
Efficiently depowders parts on build platforms

Powder Recycling Module (PRM)
Prepares the RPM for future print jobs and automatically sieves powder materials

Transport Module (TRM)
Efficiently transports RPMs between printer and powder management modules using a precision positioning system to facilitate easy loading and unloading of RPMs into all modules

Parking Module (PAM)
Interim storage of RPMs until ready for further progression in the workflow (e.g., stores a fully prepared RPM for its next print job while the Printer Module is finishing the previous print job)

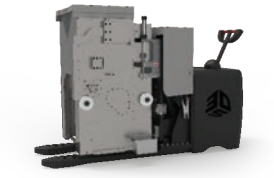
Build Changeover Station (BCS)
Cost-effective and flexible station to turnaround build. Changeover multiple printers running different materials and retaining the option to upscale to a DPM and PRM configuration

Consistent inert environment for improved part and powder quality
All operations with powder and parts in the respective modules can be performed under inert conditions.

Parking Module

Printer Module

Depowdering Module



Removable Print Module

Transport Module

Powder Recycling Module

Build Changeover Station (BCS)

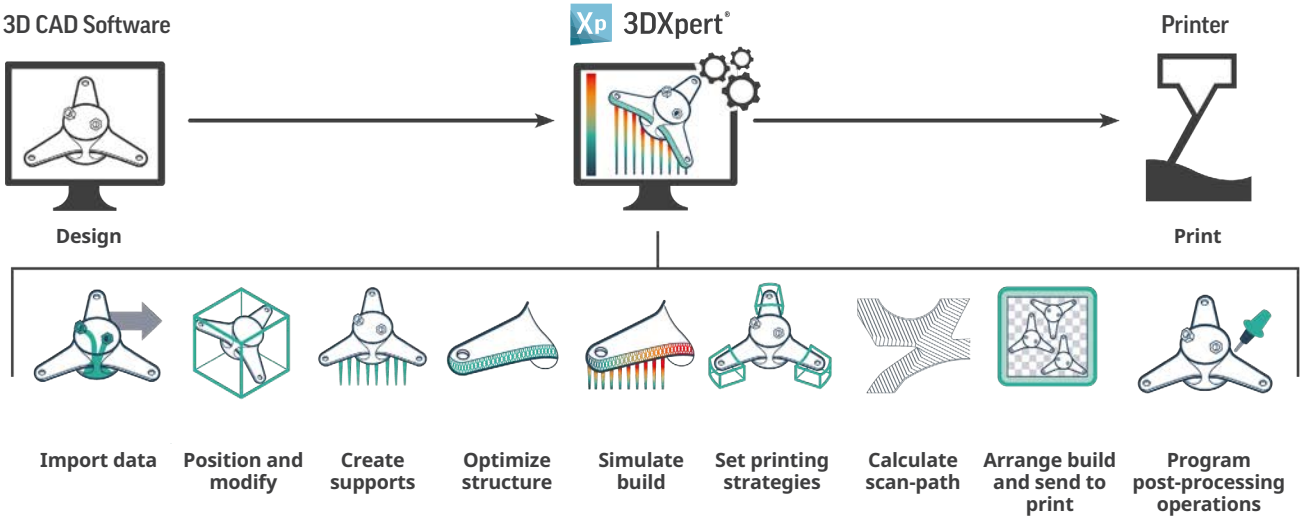
The vacuum chamber concept

3D Systems has developed a unique vacuum chamber for the Printer Module to improve process efficiency and part quality and reduce overall manufacturing costs in metal AM. In order to consistently achieve these benefits throughout the workflow from printing to material recycling, the resulting inert environment is also present in other modules of the DMP Factory 500.

The vacuum concept allows for the lowest possible oxygen (O_2) content in the build chamber protecting chemical composition and reducing moisture content of the metal powder alloys during manufacturing. This ensures optimal operating conditions for consistent part quality , e.g. mechanical properties and surface homogeneity. Printing in a vacuum chamber eliminates material waste and directly reduces TCO by protecting powderfrom deterioration through oxygen exposure. By maximizing the utilization of consumables, the DMP Factory 500 solution offers shorter setup times and fewer material change-overs compared to competing products.

3DXpert: from 3D CAD model to best-in-class prints

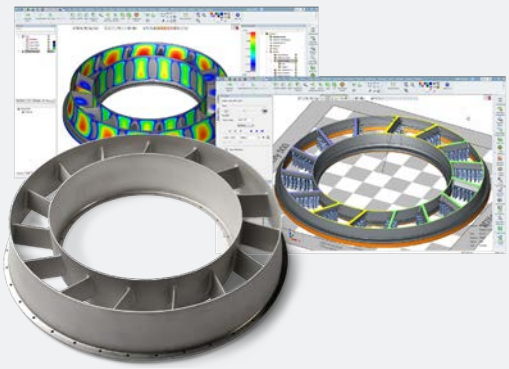
Empowering the DMP Factory 500, 3DXpert® is an all-in-one integrated software handling the entire spectrum of the AM workflow. 3DXpert allows you to leverage the full potential of AM with complete control over the preparation, optimization and manufacturing process. Supporting every step of the AM workflow from design to post-processing, 3DXpert streamlines your process to quickly and efficiently transition from a 3D model to successfully printed parts.



3DXpert's auto-balancing control enables the best quality at minimum printing time for the multi-head DMP Factory 500. Intelligent multi-laser control ensures best utilization and balancing of multiple print heads for high throughput production of multiple parts or large parts, up to the size of the full build volume.

3DXpert also ensures there is a perfect merging of volumes printed by different print heads, from the inner layers to the outer surface. This results in seamless large prints with outstanding material properties and highest surface quality for metal 3D printed parts.

- All-in-one integrated software for the entire AM workflow
- Hybrid CAD for greater agility, quality and speed
- History-based approach facilitates changes at any stage
- Controlled automation with the ultimate combination of automation and full user control
- Built-in simulation minimizes trial and error
- Optimized printing strategies to shorten print time and to ensure quality



Build higher quality large parts

Metal 3D printing emerged as a technology best suited for producing small, intricate metal parts. As part sizes go up, achieving consistent, high quality parts becomes a challenge that requires deep expertise and clever engineering solutions.

Intelligent seamless scanning via unique 3DXpert - print strategies

3D Systems' metal printing specialists devised multiple software-enabled build techniques to eliminate seam lines and internal weak points, including overlapping and bricking. They also developed strategies to minimize splits by enabling specific print heads to be assigned to specific zones. One laser can also reach the entire platform and ensure the best quality for large part contours.

Thoroughly-developed and tested print settings

An expert team of material scientists and metal AM application specialists develop and test extensive databases of print parameters to enable users to consistently achieve the material properties specified by the LaserForm material datasheets. The extensive print settings available can significantly shorten the time it takes to get the metal AM factory up and running.

Consistent, low O_2 environment

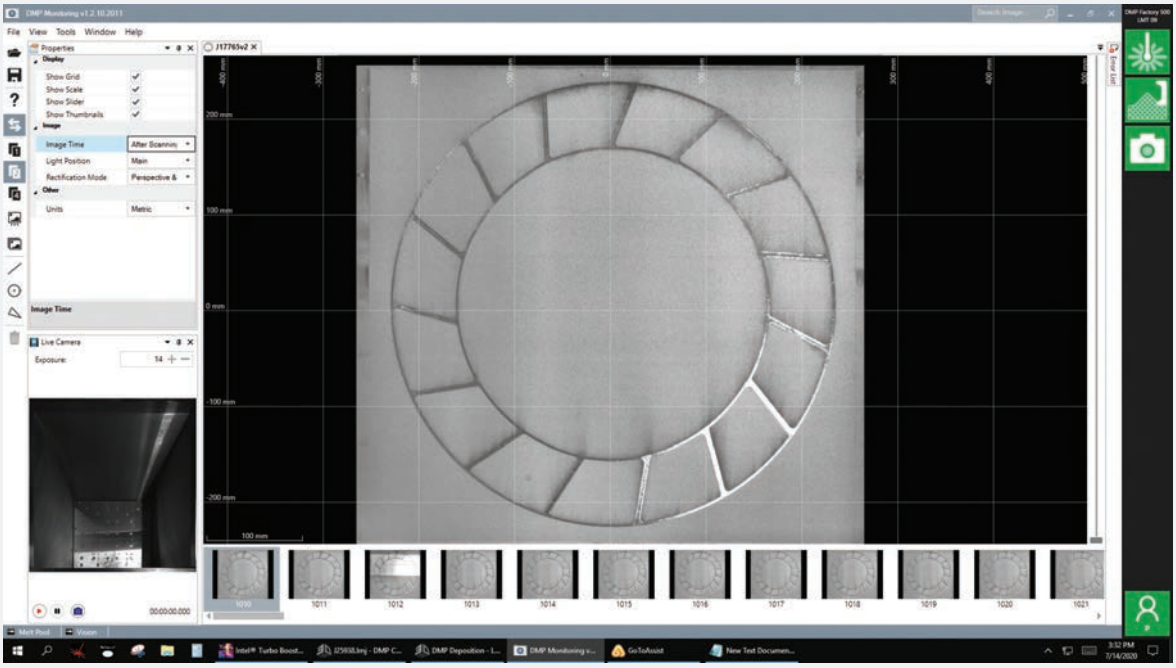
The consistently low O_2 environment of the vacuum chamber in the Printer Module and inert environments in all modules guarantee consistent powder quality for high quality parts. The closed powder concept maintains material integrity and allows for printing of very reactive alloys.

High precision laser quality, control and in-line verification capabilities

Tools for in-line scanner calibration checks allow users to control laser precision throughout the build process of large parts.

DMP VISION: REAL-TIME PART BED MONITORING

DMP Vision allows DMP Factory 500 users to further increase precision in their metal printing workflow by analyzing images and videos of the part bed, captured in real time during the build process. A benefit to highly regulated industries, the images and videos provided can serve as a permanent record of the build.



Repeatable results at economies of scale

TCO and final per-part costs are important factors, especially when you need to scale to series production. The modularity of the DMP Factory 500 solution allows manufacturers to define a factory setup that is tailored to their application and capacity requirements and maximizes the use of each module. This includes configuring an optimal workflow for machine operators with smooth integration of post-processing steps. The DMP Factory 500 enables consistent-quality parts production and nearly eliminates waste and scrap, thereby optimizing part costs and TCO.

High printer utilization

Short set-up times guarantee high printer availability with fast changeover times. In addition, the modular configuration of the DMP Factory 500 solution ensures that the Printer Module can be used 24/7 to print high-quality parts, every time.

Optimized productivity of three high-precision lasers

Multiple lasers in a printer have to be carefully controlled to deliver to expectation. The intelligent print strategies enabled by 3DXpert allow for optimized productivity of the three lasers based on intelligent overlapping scan fields.

High powder recyclability

Unlike any other available systems, the vacuum chamber and inert environments of the Printer Module, Removable Print Module, Depowdering Module and Powder Recycling Module secure the LaserForm powders against quality deterioration throughout printing, depowdering and powder recycling to enable effectively almost 100 percent powder recyclability.

Fast bidirectional recoating

A high-performance, bidirectional recoating system consistently and accurately deposits a fresh layer of powder at each pass. This increases productivity by reducing the time in which lasers are inactive.

Simplify process workflow

An efficient factory is streamlined from end to end. In metal 3D printing, workflow optimization relies on the integration of hardware and software. With extensive experience in the production environment, our engineers have packaged their production workflow expertise into functional modules that enable maximum uptime and efficiency. 3DXpert all-in-one software for metal AM supports every step of the AM workflow with complete control over preparation and manufacturing process.

CAD-based build setup with 3DXpert

With CAD-based 3DXpert AM software, customers benefit from having all the design for additive tools available in a single solution. Engineers do not have to revisit several software solutions to make edits and can easily apply all required changes at any stage of the process.

System 3R referencing and clamping system

A clamping system optimized for use in additive manufacturing (PBF – Powder Bed Fusion) machinery can be integrated. It facilitates the link to subsequent machining processes and results in a drastic reduction of setup and changeover time, thus enabling companies to produce at much greater scale and efficiency. Ask us if this solution is available for your application.

Modular design enables full automation

With its five function-specific modules, the DMP Factory 500 is ready to be tailored to customers' specific production requirements and manufacturing plant layouts.
The modules allow incremental scaling and increased automation up to a complete factory system, depending on customer requirements.

Designed for the factory floor

Setting up an AM factory relies on scalable solutions to adjust increasing demands. DMP Factory 500 is designed to start and grow a factory setup, with the flexibility to configure the function-specific modules to meet the customer specific requirements. To intelligently deliver a true metal additive factory, the system also delivers on Overall Equipment Efficiency (OEE), safety standards and data integration to meet customer needs.

Configure the modules to meet production requirements and optimize individual equipment effectiveness

The architecture of the DMP Factory 500 solution with its function-specific modules delivers on two key conditions: flexibility to define an individual factory workflow based on specific aplications, as well as productivity for the highest possible OEE to achieve additive manufacturing key performance indicators (KPIs).

Enable parallel workflows

The modularity of the DMP Factory 500 allows for increased throughput as key workflows occur in parallel: printing the parts, depowdering the parts, recycling the material, and preparing a new build. By comparison, non-modular systems are limited to each part of the workflow occurring in the same system, extending wait times and reducing production efficiencies.

Full powder management and containment

We defined our solution so that individual modules allow you to optimize your factory layout to match material flow. All powder is contained in the RPMs between prints, so no powder stays idle in the printer, the DPM or PRM.

Highest safety standards for the equipment

The individual modules of the DMP Factory 500 solution are TUV-certified and comply with CE, NRTL and the highest safety standards. Powder handling throughout the workflow takes place in an inert atmosphere, which further increases safety. Filter changes, a potential safety risk in metal AM solutions, are completed with one, easy and safe operation.

Smooth data connectivity with all major enterprise resource planning (ERP) systems

Whichever ERP system you use, we provide you with easy access to data to feed it, whether it is data for job reports, user log on, log off, job execution status, parameter changes, and many more. You can count on simplified traceability as a key building block of this effective factory solution.

Technical specifications

DMP Factory 500 Printer Module

Specifications

Laser power type	3 x 500 W / Fiber laser
Laser wavelength	1070 nm
Layer thickness	Adjustable, min. 5 µm, max. 200 µm, typically or 120 µm
Build volume (x x y x z)	500 x 500 x 500 mm (19.7 x 19.7 x 19.7 in)*, height inclusive of build plate
Material deposition	Soft tube recoater, Optional soft blade recoater
Repeatability	x, y and z = min. 50 µm
Minimum feature size	300 µm
Typical accuracy	≤ 0.2% with ± 100 µm minimum

Metal powders

Available materials	LaserForm Ni718 (A), LaserForm Ti Gr23 (A), LaserForm AlSi10Mg (A), Certified HX, other materials available upon request

Space requirements

Dimensions uncrated (W x D x H)	3010 x 2350 x 3160 mm (118.5 x 92.5 x 124.5 in)
Weight uncrated:	
Printer (exluding RPM)	8232 kg (18148 lb)
RPM (excluding metal powder)	1318 kg (2906 lb)
Powder	250 - 1000 kg (660 - 2210 lb), dependent on material type

Facility requirements

Electrical requirements	400 V AC 3 phase + N + PE - 50/60 Hz
Compressed air requirements	6-10 bar (87-145 psi)
Argon requirements	6-10 bar (87- 145 psi)
Water cooling	2 chillers supplied with printer

Control system and software

Software tools	DMP Software Suite + 3DXpert
Control software	DMP Software Suite
Operating system	Windows 10 IoT Enterprise
Input data file formats	Native CAD files, STEP, IGES, ACIS Parasolid, STL
Network type and protocol	Ethernet 1 Gbps, RJ-45 plug

*Please check material printing specifications

DMP Factory 500 Printer Module

Handling

Material loading	Manual or Semi-automatic
Interchangeable build modules	Yes

Accessories/peripherals

Modules	Depowdering Module / Powder Recycling Module / Parking module / Transporter module / Removable Print Module / Build Changeover Station

DMP Factory 500 Modules

Electrical requirement

All modules except Removable Print Module (RPM) and Build Changeover Station	400 V AC - 3 phase + N + PE - 50/60 Hz electrical cable

Depowdering Module (DPM)

Dimensions uncrated (W x D x H)	3000 x 2530 x 3300mm (118 x 100 x 130 in)
Weight uncrated	5000 kg (11025 lb)

Powder Recycling Module (PRM)

Dimensions uncrated (W x D x H)	1935 x 2262 x 2521 mm (76.5 x 89 x 99.5 in)
Weight uncrated (empty powder cartridge on the side)	2735 kg (6030 lb)

Parking Module (PAM)

Dimensions uncrated (W x D x H)	1450 x 1780 x 1685 mm (57 x 70 x 66.5 in)
Weight uncrated	1250 kg (2760 lb)

Removable Print Module (RPM)

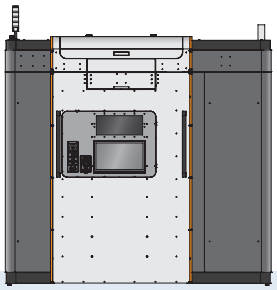
Dimensions uncrated (W x D x H)	1120 x 850 x 1400 mm (44 x 33.5 x 55.5 in)
Weight uncrated (excluding metal powder)	1318 kg (2906 lb)

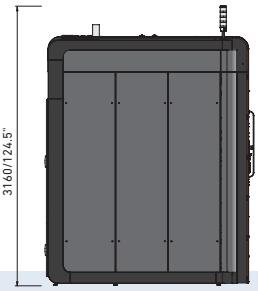
Transport Module (TRM)

Dimensions uncrated (W x D x H)	1100 x 2450 x 1460 mm (43.5 x 96.5 x 57.5 in)
Weight uncrated	1350 kg (2980 lb)

Build Changeover Station (BCS)

Dimensions uncrated (W x D x H)	2700 x 1480 x 1650 mm (106 x 58 x 65 in)
Weight uncrated	500 kg (1100 lb)





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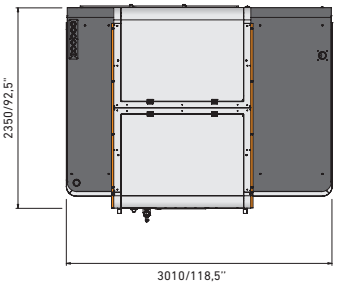

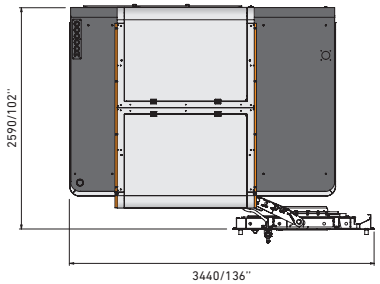

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