

The Ultimate Guide to Industrial 3D Printing

Exploring the depth and breadth of industrial 3D printing: from core technologies to industry-wide impacts.

Introduction

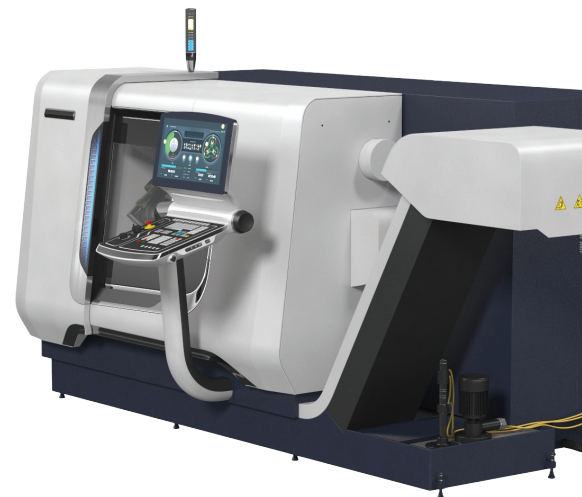
In an era marked by rapid technological advancements and an ever-evolving manufacturing landscape, industrial 3D printing represents a significant step in innovation and efficiency. By building objects layer-by-layer from digital designs, this process allows for the creation of complex and customized products with unprecedented efficiency and precision. It's a stark contrast to traditional manufacturing methods, which often involve subtractive processes like cutting or drilling.

The implications of 3D printing for commercial industries are vast and transformative. It enables rapid prototyping, reduces waste, cuts costs, and opens up new possibilities in design and functionality. From aerospace to automotive, healthcare to consumer goods, businesses are leveraging this technology to gain competitive advantages, innovate more rapidly, and meet ever-changing market demands.

This blog offers an extensive exploration of industrial 3D printing and its transformative effects across multiple commercial industries. It delves into the critical role that reliable power conversion solutions, provided by Advanced Energy, play in the functionality of industrial 3D printers. These components are essential for enhancing printer uptimes, minimizing operating costs, and maintaining the consistent quality of printed parts.

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APPLICATIONS IN COMMERCIAL INDUSTRIES

Industrial 3D printing has found applications across a wide range of industries due to its flexibility, efficiency, and the high quality of its output.

- **Aerospace and Defense:** 3D printing is used for producing lightweight, strong components that are difficult to achieve with traditional manufacturing methods.
- **Automotive:** From prototyping to production of end-use parts, industrial 3D printing offers the automotive industry the ability to innovate rapidly and customize components.
- **Healthcare and Medical:** 3D printing is revolutionizing this sector by enabling the production of patient-specific implants, prosthetics, and even bioprinting tissues.
- **Industrial Machinery:** Manufacturers use 3D printing to create parts and tooling, reduce inventory costs, and speed up the production process.
- **Architecture and Construction:** 3D printing in construction is emerging as a method to produce architectural models and even actual building components.
- **Education and Research:** Universities and research institutions use industrial 3D printing for experimental designs, prototypes, and research projects.

In each of these industries, industrial 3D printing brings a unique set of advantages, including reduced lead times, lower costs, design flexibility, and the ability to produce complex geometries that are not possible with traditional manufacturing methods. This versatility is driving innovation and efficiency across the commercial sector.

Field Application Engineers

Advanced Energy has experienced Field Application Engineers (FAEs) available globally to provide design-in support and solve power design challenges faced by industrial 3D printer OEMs.



EXPLORING THE TECHNOLOGIES BEHIND 3D PRINTING

Industrial 3D printing encompasses a variety of technologies, each with its unique capabilities and applications. Understanding these technologies is central to success for professionals in manufacturing and related fields, as it helps to determine the right process for specific applications.

Fused Deposition Modeling (FDM)

- **How It Works:** FDM works by extruding thermoplastic filaments, which are heated and then deposited layer by layer to build the desired 3D object.
- **Applications:** It's widely used for prototyping, manufacturing aids, and even in producing end-use parts in industries like automotive and aerospace

Stereolithography (SLA)

- **How It Works:** SLA technology uses a laser to cure liquid resin into hardened plastic in a process known as photopolymerization.
- **Applications:** It's highly valued in the dental, medical, and jewelry industries for producing detailed prototypes, models, and production parts.

Selective Laser Sintering (SLS)

- **How It Works:** SLS uses a laser to sinter powdered material, bonding it together to form a solid structure.
- **Applications:** SLS is often used for parts that require high strength and durability, such as in automotive and aerospace industries.

Metal 3D Printing Technologies

- **How It Works:** Metal 3D printing encompasses several techniques, but they all generally involve the use of a heat source, such as a laser or electron beam, to fuse metal powder or wire. In processes like direct metal laser sintering (DMLS) and selective laser melting (SLM™), a laser selectively sinters or melts metal powder to build a part layer by layer. Electron beam melting (EBM) uses an electron beam under vacuum for the same purpose. Metal binder jetting (MBJ), on the other hand, involves depositing a liquid binding agent onto metal powder to create a part, which is then sintered in a furnace.
- **Applications:** These technologies are key in creating high-strength, and durable metal components for aerospace, automotive, medical implants, and tooling industries.

Each of these technologies—FDM, SLA, SLS, and various metal 3D printing methods—boasts unique strengths and ideal applications. Understanding the capabilities and limitations of each enables industry professionals to choose the most suitable technology for their specific requirements. However, the success of these technologies also hinges on the reliability and versatility of the power supply, a critical component where Advanced Energy's solutions excel.

Multi-output, configurable AC/DC power solutions from Advanced Energy are designed to cater to the diverse needs of industrial 3D printer OEMs. These power supplies can meet the varying voltage and power demands inherent in FDM, SLA, SLS, and metal 3D printing technologies. This adaptability ensures that OEMs can utilize AE's power supplies regardless of the 3D printing technology employed in their printers.

Advanced Energy's expertise and capabilities provide OEMs with the reliable power necessary for all these technologies. Our Field Application Engineers (FAEs) simplify the process of identifying the precise power supply solution tailored to each technology's requirements. This support allows OEMs to concentrate more on advancing their technology and market presence, thereby accelerating their time to market and rapidly scaling up to capture a larger share of the 3D printing industry.

BEHIND THE SCENES: EQUIPMENT AND SOFTWARE

The success of industrial 3D printing relies not just on the printing technology itself, but also on the sophisticated equipment and software that support it. This behind-the-scenes look offers insights into the hardware and software integral to the additive manufacturing process.

Hardware Overview: Printers, Lasers, and Scanners

- **Printers:** The core of 3D printing technology, industrial printers vary widely in terms of size, speed, and material capabilities. They range from smaller desktop models suited for prototyping to large-scale systems designed for production. Key factors include build volume, resolution, and material compatibility.
- **Lasers:** In technologies like SLS and SLM, the quality and precision of the laser play a critical role. Lasers must be able to accurately melt or sinter materials, which requires precise control and stability.
- **Scanners:** In the context of 3D printing, scanners play a crucial role by directing the laser beam across the surface of the print bed. This precise movement is essential for the additive manufacturing process, ensuring accurate layering and formation of the 3D object.

Software for Design and Simulation

- **CAD Software:** Computer-aided design (CAD) software is vital for creating the digital models that are the blueprints for 3D printing.
- **Simulation Software:** Simulation software is used to predict and optimize the printing process. It can simulate the behavior of materials under various conditions, helping to identify potential issues like thermal stress or distortion.
- **Slicing Software:** Once a model is designed, slicing software breaks it down into layers and generates the path for the printer to follow. This software determines the parameters like layer height and fill density.

Understanding the equipment and software that drive industrial 3D printing helps in making informed decisions about implementing this technology. From choosing the right hardware to leveraging advanced software for design and production, each component plays a vital role in the efficiency and success of 3D printing in a commercial setting.



THE HEART OF THE MACHINE: KEY COMPONENTS

Industrial 3D printers are intricate machines composed of various key components that work together to achieve precision, efficiency, and reliability.

Lasers, Optics, and Precision

- **Function:** In technologies like SLA and SLS, lasers are used to cure resin or sinter powder. The precision of the laser, along with the quality of the optics system, directly impacts the quality and accuracy of the printed object.
- **Significance:** High-quality lasers and optics yield finer detail, smoother surface finishes, and more accurate replication of the digital model.

Nozzle Jets and Extruders

- **Function:** In FDM printing, the extruder and nozzle jet are responsible for depositing the melted material.
- **Significance:** The precision of the nozzle jet in depositing the material, and the efficiency of the extruder in melting and pushing the filament, are critical for achieving consistent layering and overall part quality.

Motors, Actuators, and Sensors

- **Function:** These components facilitate the movement of the printer head and platform. They also play a key role in maintaining precision during the printing process.
- **Significance:** Accurate and reliable motors and sensors are essential for ensuring that each layer of material is precisely deposited, which is vital for the integrity and accuracy of the final product.

Heaters, Chillers, and Temperature Control

- **Function:** Maintaining the right temperature is essential in 3D printing processes, especially in maintaining the properties of the material being printed.
- **Significance:** Proper temperature control promotes material integrity, avoids warping or deformation, and can impact the strength and finish of the printed object.

Displays and Control Systems

- **Function:** Displays and control systems allow operators to monitor and adjust the printing process, providing essential feedback and control.
- **Significance:** User-friendly interfaces and intuitive control systems enhance the efficiency and ease of operation, allowing for quick adjustments and real-time monitoring.

Power Requirements and Solutions

- **Requirement:** Industrial 3D printers demand stable and reliable power sources to operate effectively, especially for high-energy processes like laser sintering or metal printing.
- **Solutions:** Guaranteeing a consistent power supply encourages uninterrupted operations and maintains print quality.

Power Solutions for 3D Printer Components

In industrial 3D printing, the esoteric nature of power management is evident in the diverse and highly-engineered electromechanical components that constitute the printers. These components, ranging from lasers and nozzle jets to extruders, motors, heaters, chillers, actuators, optics, sensors, and displays, each require specific voltages and power levels to function optimally. As such, the power solutions for these printers must be highly adaptable, capable of providing a broad range of power conversion and control.

ADVANCED ENERGY'S ROLE IN 3D PRINTING

At Advanced Energy, we support industrial 3D printing with our precision power solutions. Recognizing the growing demand for customized parts, we focus on providing the necessary power and control for the highly-engineered components at the core of these printers. Our multi-output, configurable AC/DC power solutions are designed to meet the varied power requirements of 3D printers.

We offer a comprehensive range of power conversion and process control solutions, leading to printers that can deliver the required precision and performance for industrial applications, all while optimizing efficiency and power density to reduce the total cost of ownership.

Case Studies and Product Integration

- **Industry:** Manufacturing
- **Solution:** uMP
- **Equipment:** 3D Printing

CHALLENGE

A leading 3D printer manufacturer faced challenges in designing a powder bed fusion printer. The design incorporated diverse components each needing unique DC voltages and power levels. Using multiple off the shelf AC-DC power supplies was not cost-effective for this application.

SOLUTION

The company implemented Advanced Energy's uMP (microMP) Gen II series configurable power supply. This compact solution enhanced multiple DC output voltages and power levels. Key features included a broad input voltage range, active AC inrush control, adjustable output modules, and active power factor correction. The unit also met safety and durability standards.

RESULT

The uMP Gen II series provided a comprehensive power solution, meeting the project's cost and design requirements. Its compact size, combined with high power density, efficiency, and reliability, were key considerations in the selection process. Additionally, the ConfigPro software facilitated quick and easy configuration.

KEY TAKEAWAY

The uMP Gen II series compact, flexible design allowed the designers to pinpoint system requirements, delivering high reliability and performance. Additional features of the uMP Gen II series are:

1. Market leading density at 22.7W/in³
2. Market leading efficiency of 91.5% at full load

Advanced Energy's solutions contributed to the fast development and deployment of the new 3D printer for unmatched efficiency in challenging conditions.

Advanced Energy meets the requirements, and when needed, test the PSU under alternating load conditions, as they are also the case in the real printer.

“We have a broad portfolio of reliable power conversion and process control solutions, making them the ideal single-source provider for industrial 3D printer manufacturers.”

WRAPPING UP: THE TRANSFORMATIVE POWER OF 3D PRINTING

The impact of 3D printing stretches across multiple sectors, from aerospace and automotive to healthcare and education. The advancements in technology, materials, and sustainability practices are shaking the very foundation of manufacturing and design processes—in a good way. The ability of 3D printing to customize, reduce waste, and overcome traditional manufacturing constraints exemplifies its transformative power.

Looking towards the future, 3D printing promises even greater integration into industrial applications, pushing the boundaries of what's possible in manufacturing. As this technology continues to

revolutionize efficiency, sustainability, and design, Advanced Energy is at the forefront, developing power solutions that precisely align with the specific needs of different 3D printers. By contributing to the efficiency and precision of the printing process, our solutions facilitate reliable and high-quality outcomes.

Advanced Energy remains committed to powering the evolution of 3D printing with reliable, innovative solutions that cater to the dynamic needs of this transformative technology. Our dedication to enhancing the capabilities of 3D printers ensures that as the sector grows, it does so with the support needed to maintain its groundbreaking momentum.



uMP Gen II

ABOUT THE AUTHOR



Haydar Kartal is a Senior Strategic Marketing Manager at Advanced Energy.

Haydar has degree in industrial engineering. Haydar started his career in factory and process automation, gaining a deep understanding sensors and actuators.

At Advanced Energy Haydar identifies emerging markets with growing needs for power supplies.

With Haydar's technical expertise and product understanding he helps customers identify the AE products that meet their exacting demands.

**Connect with
Advanced Energy
and power up your 3D
printing capabilities!**

**Meet our 3D printing power supply
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ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. We design and manufacture highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

PRECISION | POWER | PERFORMANCE | TRUST

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