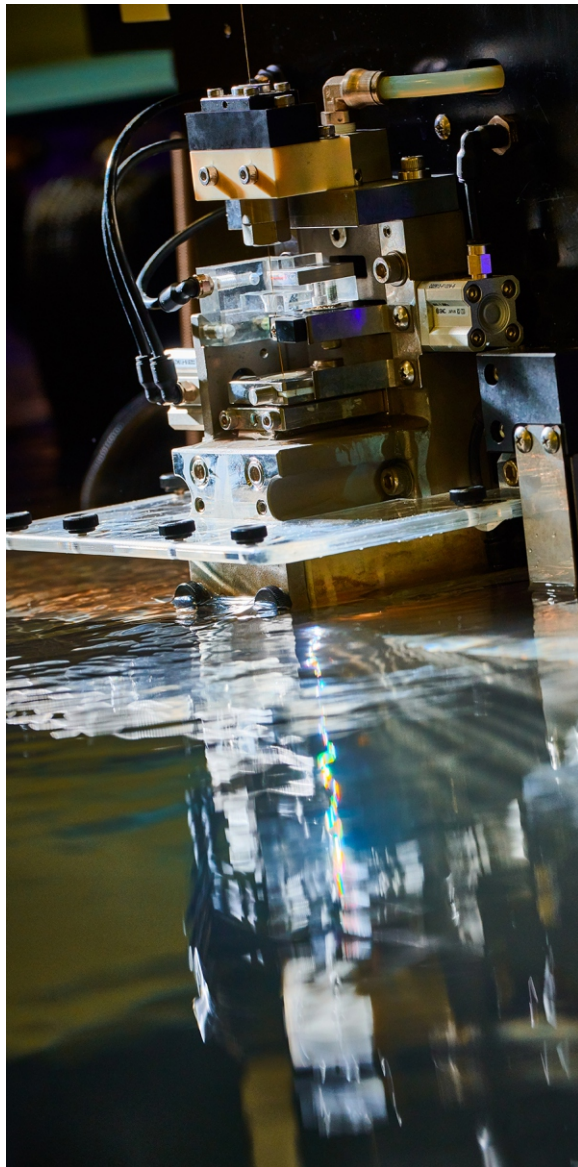


# The Next Big Thing in Wire EDM

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Wire EDM machining technology has seen continuous development to improve the reliability and efficiency of the process. These efforts have nurtured this non-traditional machining process to grow in use to become a mainstream method of manufacturing for an increasing number of industries. From its humble beginnings that revolutionized the Tool and Die building process, Wire EDM has matured and expanded its use to direct parts production, especially in the Medical and Aerospace fields.



The latest generation Wire EDM machines are better in almost every way compared to their predecessors, which has helped elevate the Wire EDM process to become a daily relied upon manufacturing method. In recent years, many Wire EDM manufacturers have focused developments on items that address and enhance the reliability of the process. This includes items such as simplifying the control interface, improving automatic wire threading capabilities, reducing machine maintenance requirements, and reducing wire consumption costs. While these are all important and critical machine improvement points, Wire EDM machining speeds have remained relatively flat over the past decade... until now!

Makino has introduced a new Wire EDM machine, the U6 H.E.A.T. Extreme, that has been developed to take Wire EDM machining speeds to new levels of performance and efficiency. At the core of these new capabilities is the use of a larger diameter wire...0.016" (0.4mm) diameter wire, elevating the U6 H.E.A.T. Extreme as the fastest Wire EDM machine on the planet.

## Is Bigger Better?

The key benefit in using a larger diameter wire is that it allows higher power levels to be applied, which result in increased machining speeds. There is a physical limit to how much power a particular wire size can withstand (Spark Density – the maximum amount of power that can be applied to the electrode over a specific area), as exceeding this level will result in a wire break, although there are other factors that contribute to wire breakage. Comparing 0.016" diameter wire to the traditionally used 0.010" diameter wire, the cross-sectional area is 265% larger.





### Comparison of Wire Size

Using a larger diameter wire alone will not necessarily achieve higher performance. A larger wire supports higher power levels, but the 0.016" diameter wire size exceeds the power output capability of most machines, as Wire EDM generators are commonly configured and optimized for 0.010" diameter operation. Stated differently, a standard Wire EDM generator does not have a sufficient amount of additional/reserve electrical power to apply to the cut to operate at optimum levels with 0.016" diameter wire and will therefore starve and impede the process from achieving faster speeds.

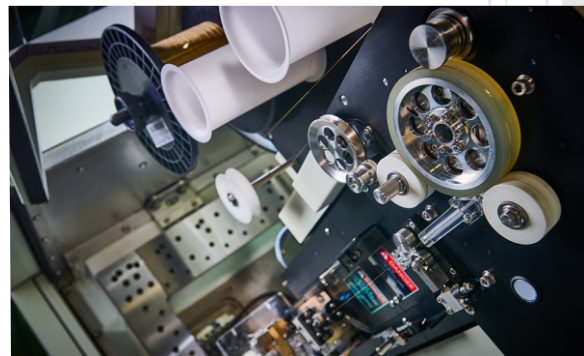
To achieve faster cutting speeds using 0.016" diameter wire, the U6 H.E.A.T. Extreme machine is configured with an additional generator booster that increases the maximum average machining power from 30 amps to 60 amps. This booster unit increases the machine's kVA power consumption by about 50% over the base U6 H.E.A.T., but this increase in power consumption is fully justified and offset by the gains in rough machining speed. The generator booster unit is an external cabinet that is located on the left-side of the U6 H.E.A.T. Extreme machine.

### More Enhancements

The U6 H.E.A.T. Extreme builds and expands on the existing U6 H.E.A.T. machine and retains all the standard machining capabilities to achieve high accuracy and fine surface finish with wire sizes down to 0.004" (0.100mm) diameter. The "Extreme" portion of the U6 H.E.A.T. Extreme

entails special enhancements that focus on the operation of 0.016" diameter wire. Beyond the need for increased machining power, additional development and modifications are necessary to achieve reliable automatic wire threading with 0.016" diameter wire, which represents a severe technical challenge.

As the wire diameter increases, so does the wire's memory and resistance to bending, causing the wire to have a high tendency to want to curl itself out of the water threading jet. A larger and stiffer wire will also face added resistance in making the 90 degree turn in the Lower Head of the machine during threading. Even functions as simple as annealing or cutting the wire become more difficult with the added heat resistance imposed with a larger diameter wire. To overcome these obstacles and achieve reliable automatic threading with 0.016" diameter wire, which is a critical function for productivity, Makino modified and refined the HyperDrive Extreme wire threading system for the U6 H.E.A.T. Extreme. The HyperDrive Extreme name identifies a new wire drive and wire threading system used on the U6 H.E.A.T. Extreme machine. This unit is an enhanced PICO round guide system that utilizes a new AC motor tension control system that provides a wider range and more precise control over wire tensions than the prior magnetic powder clutch system. The HyperDrive Extreme system has been engineered to reduce and simplify maintenance requirements and features a convenient Tool-less Energizer Indexing design, and the wire guides can be removed and replaced without the need for vertical alignment calibration.



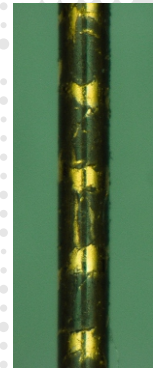
With the many improvement merits of the HyperDrive Extreme design, the system's ability to perform Jet-less wire threading is one of the most important. This design provides the machine with the capability to perform Jet-less (no water jet column) threading, which allows rethreading of the wire at a break point during operation. A key attribute in achieving Jet-less wire threading with traditional wire sizes (0.010" diameter) is the annealing preparation of the wire over a greater length to straighten the wire and remove the wire's memory, making wire threading without a water jet column possible. The Jet-less wire threading capability does not apply to 0.016" diameter wire operation, but the enhanced annealing system is a critical element in achieving reliable wire threading with 0.016" diameter wire.

The wire annealing system has had its power boosted on the U6 H.E.A.T. Extreme to properly anneal and straighten the larger diameter wire...much for the same reason behind the generator booster Unit. The Upper and Lower Heads of the machine contain additional modifications that aid in the reliable automatic threading of the 0.016" diameter wire, and it was also necessary to change the wire threading filter canister from a plastic to a stainless steel canister to support the increased water jet pressures used for automatically threading 0.016" diameter wire.

### Settings Development

To achieve the highest level of machining productivity, Makino worked in cooperation with bedra to develop a specialized H.E.A.T. Extreme coated wire that is optimized for the U6 H.E.A.T. Extreme machine. This new wire has a double layer outer coating that is a hybrid mix of Beta and Gamma Phase enriched zinc, and the wire interior utilizes an 80/20 copper-zinc core. The rough exterior surface of coating enhances the wire's capability to handle higher machining power without breaking and improves flushing/debris evacuation. These combined characteristics provide a clean running wire that supports reliable automatic wire threading while attaining optimal cutting speeds. Development of the 0.016"

diameter wire machine settings (Machining Conditions) focused on achieving "Practical Economy," meaning that the settings are designed with an optimal mix of increased machining speed with low wire consumption. These development targets are more representative of real-world application and use, especially since the larger 0.016" diameter wire has a far shorter length of wire on the spool. A 22# pound spool of 0.010" diameter wire contains a total of 14.8 miles of wire, whereas a 22# pound spool of 0.016" diameter wire contains a total of 7.6 miles of wire...a 48% difference!



In developing the machine settings for 0.016" diameter wire, it was imperative to reduce the hourly wire consumption rate to minimize the impact a significantly larger wire size has on the total amount of consumed wire and total operational costs. Makino has determined an efficient medium where the 0.016" diameter settings achieve an excellent increase in machining speed while maintaining reasonable accuracy. The actual hourly wire consumption amount running 0.016" diameter wire is almost identical to operating with 0.010" diameter wire, which is in the range of 0.6 ~ 0.7 pounds of wire per hour. The wire unspool speed during machining using 0.016" diameter wire is considerably slower than operating with 0.010" diameter wire. If the wire unspool speed was to remain the same as 0.010" diameter wire, the machine would consume about 1.5 pounds of wire per hour operating with 0.016" diameter wire, which needlessly increases manufacturing costs. The total improvement to efficiency using

0.016" diameter wire is off the charts, as this wire size is able to achieve two to three times faster machining speeds over 0.010" diameter brass wire while maintaining similar hourly wire consumption rates.

The machining conditions for 0.016" diameter wire have been developed for up to Two-Pass Machining and have been optimized for Sealed-Off (good flush) and Detached (poor flush) nozzle conditions. Ideally, the use of 0.016" diameter wire will be used predominately for One-Pass Machining applications to capitalize on the enhanced speed benefit. The Two-Pass settings have been developed favoring greater speed and will provide a slight improvement to dimensional accuracy and surface finish. The most notable benefit of the Two-Pass machining process is the improved cleanliness and quality of the workpiece.

#### Attention to Manufacturing Costs

The goal of 0.016" diameter wire operation is to double the machining speed and productivity over traditional 0.010" diameter wire without a dramatic increase in operational costs (wire consumption). There is an obvious increase in the purchase price between traditional brass wire and the specialized highspeed coated H.E.A.T. Extreme wire, but the key is to focus on the cycle time savings and total costs to manufacture a specific part. The use of 0.016" diameter wire can complete a part with the same manufacturing costs as using 0.010" diameter brass wire, but at half the cycle time. This increases the capacity to make more parts and generate additional revenue, allowing a shop to gain extra billable shop hours...which is every shop's most valuable commodity!

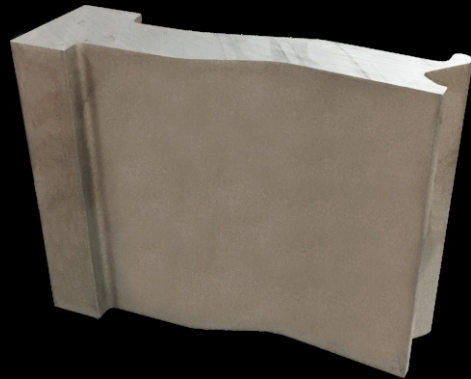
The cost of the consumed wire is a substantial expense in operating a Wire EDM, and Makino has addressed this element in the 0.016" diameter machining conditions, but there are other consumable items to consider. Operation of the 0.016" diameter wire does increase power consumption, but this increased power minimally

impacts the index life of the Carbide Energizer Plates by roughly 20%. The main dielectric filter life should also see a decrease in life, as the larger 0.016" diameter wire is creating more debris. The U6 H.E.A.T. Extreme is configured with a high capacity four filter filtration system to provide extended filter life, and preliminary testing has not shown a significant decrease in filter life.

A case study was performed comparing One-Pass Machining using 0.010" diameter brass wire and the 0.016" diameter coated wire on a 4.0" (100mm) thick D2 Tool Steel Stamping Punch detail. The resulting data is shocking...the 0.016" diameter wire was significantly faster and provided a lower manufacturing cost. The accuracy achieved on both parts yielded similar results, which was a total straightness of 0.001" (0.025mm) or 0.0005" per side. The final evaluation saw the 0.016" diameter wire slash Cycle Time by 57% and cut the part 2.3x faster!

### Stamping Punch

Machine: U6 H.E.A.T. Extreme  
 Material: D2 Steel  
 Thickness: 4.0 Inches  
 Details: Sealed Off 1 Pass Machining



Wire Diameter	Cycle Time	Wire Consumption	Wire Cost
0.010" Brass	4 hours, 59 minutes	3.320 lbs (0.66 lbs/hr)	\$19.92 (\$6.00/lb)
0.016" H.E.A.T.	2 hours, 8 minutes	1.547 lbs (0.73 lbs/hr)	\$18.56 (\$12.00/lb)

### Final Thoughts

The U6 H.E.A.T. Extreme machine delivers an unparalleled combination of capability and flexibility. The machine's technology provides the best of both worlds...it can achieve the most productive machining speeds using 0.016" diameter wire, yet still produce high accuracy details with very fine surface finishes - using traditional wire sizes down to 0.004" diameter.

The use of 0.016" diameter wire applies to every industry (die/mold, job shop, aerospace, medical, etc.), but production applications have the greatest potential of cost savings, especially for Poor Flush machining such as the cut-off operation of 3D printed parts.

The new speeds and increase to productivity using 0.016" diameter wire are the most exciting enhancements, and there has been a tremendous amount of thought and attention to the development of this unique technology to strike a usable and practical real-world balance of speed and economy. One thing is for certain: the future of Wire EDM will be FAST!



## Resources



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### Learn About Makino's U6 H.E.A.T. Extreme :

[www.makino.com/extreme](http://www.makino.com/extreme)

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