Optical Measuring
IVU (Integrated Vision Unit)
Visionary EDM

Today’s wire EDM technology gives manufacturers a productive way to meet continually growing demand for smaller and more complex parts. Most recently, newly-developed vision-based measurement and contour scanning technology, integrated into the wire EDM machine itself, is further improving the productivity, accuracy and cost efficiency of micron-scale wire EDM operations.

The process characteristics of wire EDM are well matched to the production requirements of micron-scale parts. Since wire EDM is a non-contact metal removal method, it cuts small features and thin, tight sections without inducing distortion or stress. The effectiveness of wire EDM for micro-scale machining is especially evident in areas such as electronic and medical manufacturing, where part features can be in the range of 0.01mm to 0.1mm, surface roughness requirements finer than 0.1 µm RA, and permissible dimensional deviations less than +/- 1 µm.

Producing micro-scale features and tolerances is no problem on top-level wire EDM machines that can “split tenths,” consistently meeting tolerances of better than +/- 0.0001” (+/- 2.5 µm). This is essentially CMM-level accuracy. Machine accuracy, however, is only part of the equation; excellent accuracy does not guarantee immediate exact reproduction of micron-level form dimensions.

Often, the initial part machined via wire EDM often doesn’t match blueprint or CAD file specifications. The reason is that a wide variety of variables affect the results of the wire EDM process. Those factors include the wire type, diameter, conductivity and bending behavior; dielectric type, temperature and flow characteristics; workpiece material and thickness, wire feed conditions, spark voltage and duration; and other such factors.

Machine accuracy and the consistent cutting performance of the continually advancing EDM wire ensure that when all the variables are compensated for and an initial acceptable part is produced. The key, however, is producing that first acceptable part prior to running the rest of the job.

Machining any part begins with accurately locating the workpiece. The complex nature of many small parts, as well as their small size, can make this difficult on a wire EDM machine.

Determining a part’s position on a wire EDM machine has typically involved using the wire itself to find the part center, edges and corners. That method can achieve accuracy within +/- 0.0001” (2.5 µm), but the process is unable to measure continuous part contours, tapers or wall straightness.

In addition to those limitations, determining part location with the EDM wire can be expensive. Wire capable of producing micro scale features may be 0.0008” (about 20 µm) in diameter, and usually is drawn from tungsten or molybdenum. When finding part edges with this expensive fine wire, wire cost can add significant expense to the operation.

In a simplified example, a 3,000 m spool of 0.0008”-dia. EDM wire costs $500 or $0.167/m. If finding the nose of a part requires 14.4 m of wire, the wire cost alone for locating one part is $2.40, and locating ten parts on a fixture will cost $24, before the EDM process even begins.

Integrated Vision-Based Measurement

A non-contact, vision-based measurement system integrated into the EDM machine can overcome both the limitations and cost issues of on-machine part location with the EDM wire. An integrated vision unit, such as the IVU system from GF Machining Solutions, locates the part edges and scans contours with a charge coupled device (CCD) camera featuring a light-sensitive pixel array. The camera employs two light sources – an incidental source at the camera lens, and a backlight source to enhance contrast – and converts the light intensity value for each pixel into an electronic signal with a corresponding value for each pixel.

The CCD cameras are available with either 56X or 156X magnification, and the IVU system is most often paired with AgieCharmilles CUT 2000 and CUT 3000 high-precision wire EDMs from GF Machining Solutions. At 56X magnification, the field of view is 0.24” x 0.14” (6 mm x 3.5 mm) and measurement accuracy is +/- 0.00006”, or 1.5 µm. The 156X camera has a 0.078” x 0.05” (2 mm x 1.3 mm) field of view and provides measurement accuracy of +/- 0.00004”, or 1 micron.

With its larger field of view, the 56x magnification
camera is appropriate for measurement of larger parts, while the 156X magnification provides accuracy essential for measuring micron-scale parts. Typical users of the system, such as manufacturers in the microstamping industry, most often choose the higher-magnification camera to maximize precision.

Using a vision system to locate parts eliminates having to use the EDM wire. Additionally, the accuracy of wire-based location measurement can be affected by other factors such as contaminants on the part edge. Consequently, costs (wire) are lower when employing the vision system, repeatability and reliability are better and the measuring process is faster as well. The considerations unique to the vision system are keeping the elements of the optical system clean and ensuring that the camera is calibrated before beginning the location process.

**Breakthrough Capability**

Beyond its on-machine measurement function, the GF Machining Solutions IVU system has the breakthrough capability to scan the contours of a machined part. And, in a closed-loop arrangement, instruct the machine’s CNC how to modify the wire EDM process to produce an acceptable part without further tests.

The traditional steps in machining an acceptable part are cutting a test part, moving it to a contour-scanning CMM, determining the deviations from the part dimensions and/or DXF file, then making changes in machine parameters to meet part requirements. Determining exactly what changes are needed, however, is challenging. Skilled and experienced operators may be able to make appropriate changes without excessive expense or loss of time, but less experienced operators may struggle and generate multiple scrap parts while consuming costly shop hours.

The Advanced version of the GF Machining Solutions IVU system is linked to the CNC of the EDM machine. The CCD camera scans the contour of the test part and compares it to the part’s DXF CAD file. If the part is out of specification, the system will employ what is called a contour modifier that corrects the EDM contour path to produce a part that is within 0.0001” (2.5 µm) of required dimensions.

In addition to ensuring that the part meets dimensional requirements, use of the integrated vision
system supports lean manufacturing initiatives because it eliminates the time spent moving the part to a separate contour-scanning CMM and returning the part to the EDM machine and refixturing it.

It should be noted that contour scanning data is usually not employed to rework an out-of-specification part. If the part is out of specification because too much stock has been removed, the material of course can’t be replaced, and accurately removing only a micron or two of excess stock is next to impossible.

For today’s ever shrinking part sizes and tolerances, integrated vision-based measurement and scanning systems on wire EDM machines provide efficient, automatic, accurate and contact-free process measurement with repeatability better than 1µm and accuracy ±1.5µm, independent of operator skills. The powerful contour scanning capability of systems, such as the IVU from GF Machining Solutions, can accurately map even the most complex shapes, allowing machining results to be checked before the next operation commences.

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