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Measure to Standard with Minimum Scrap

Use the Full Potential of the New ISO Standard for Profile Deviations

Werth Messtechnik GmbH

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Use the Full Potential of the New ISO Standard for Profile Deviations

PRACTICAL TIP The ISO 1101 (2017) standard greatly expands the drawing specifications for tolerances on profile deviations. In order to make full use of this potential, measurement software must provide simple solutions for a wide variety of measurement tasks. If the measurement not only conforms to the standard, but is also appropriate for the function, then scrap will be reduced.

Michael Lee

IN ORDER TO ENSURE FUNCTIONALITY of the workpiece, many geometric properties must be referenced to other elements. In a complete reference system, every degree of freedom is defined and "locked" once the alignment is complete. In this case, the references must be measured without further alignment of the actual data to the specified data. If no reference system is given, then a Gaussian alignment can be applied without limiting the degrees of freedom in order to achieve uniform alignment to the specified geometry. If the reference system is incomplete, the references provided must be measured first. Then the profile measured on the workpiece must be aligned to the specified contour, using the open degrees of freedom. The most common Gaussian fitting methods, however, systematically produce bad results. Good workpieces can be declared as scrap under some circumstances. This is avoided when the Tolerance-Fit method described below is applied.

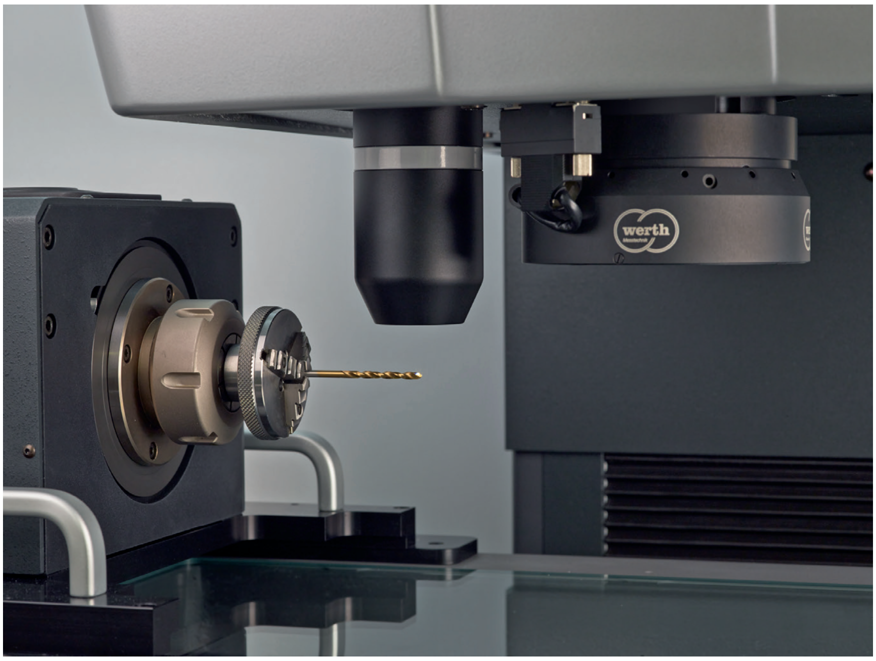

Figure 1. Multisensor systems on the coordinate measuring machine: Chromatic Focus Line sensor (left) and image processing sensor with integrated laser distance sensor (© Werth)

Capturing Profile Form with Multisensor Systems

Workpiece profiles can be measured using various sensors. For example, fast and easy measurement "in the image" of profile sections is possible with optical coordinate measuring machines such as the Werth QuickInspect or FlatScope. Optical distance sensors, such as the Werth Laser Probe (WLP) or chromatic focal sensors allow line profile forms to be determined non-destructively. The WLP is integrated in the beam path of the Werth Zoom optics, also patented, so that multisensor measurements can be taken with minimal sensor offset. The Chromatic Focus Point (CFP) achieves low measurement uncertainty, even on reflective or transparent surfaces, while the Chromatic Focus Line (CFL) enables fast, highly accurate 3D measurement with an additional intensity image for orientation and measurement (Figure 1). In addition to line profiles within the measurement range, scanning can also be used to capture surface profiles. The line or surface profile form can be measured in the same coordinate system for surfaces that are inaccessible to optical sensors, without re-fixturing, using tactile sensors such as

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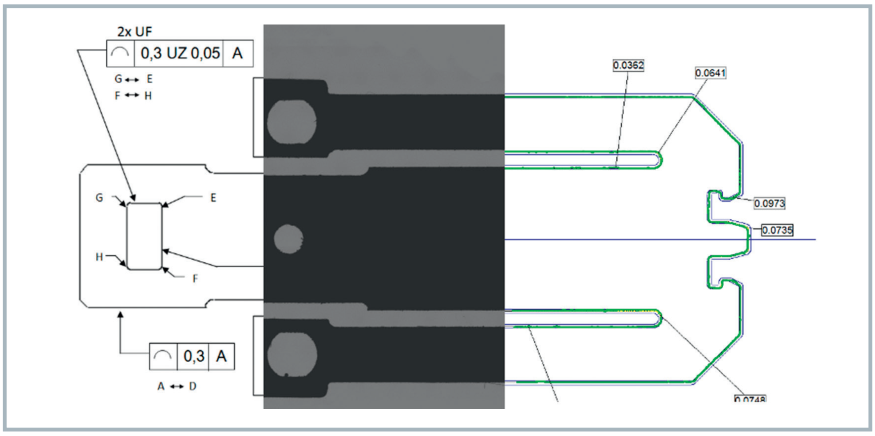

Figure 2. Left: drawing with line profile tolerances; center: automatic capture of the entire workpiece at high resolution with raster scanning; right: adjustment into the tolerance zones using ToleranceFit

(© Werth)

conventional touch probe systems capable of scanning, or the patented Werth Fiber Probe (WFP). Due to its small stylus tip diameter, the WFP enables measuring of micro-geometries such as injection nozzles on fuel injectors, and due to its very low probing force, it can be used on elastic components or sensitive surfaces such as optical elements. The Werth Contour Probe (WCP), also patented, scans profiles on shafts or tools, for example, and can replace a contour tracer instrument with roughness and form measurements in the workpiece coordinate system.

In addition to determining profile deviations, the combined application of multisensor systems allows other geometric properties to be measured using the same coordinate measuring machine, such as dimensions, position deviations, or roughness,. The selection of the ideal sensor for a particular measurement uncertainty or measuring speed dramatically enhances quality assurance.

ToleranceFit Method Allows a Variety of Tolerances

When fitting the measured contour to the nominal contour using a Gaussian method, the root mean square deviation between the captured points and the nominal profile is minimized. The different tolerances of various regions of the object are not considered. This means that the Gaussian fitting method can sometimes exceed tolerances in ways that do not reflect reality, because the tolerance could have been met by shifting the coordinate system.

The patented ToleranceFit method adjusts the captured points into the tolerance zones instead of onto the specified contour. If the tolerances cannot be met, then the actual contours are shifted so that the amount by which the tolerance is exceeded is as small as possible.

This method corresponds to a linked assessment of all the investigated dimensions using the maximum material principle. It should be used as frequently as possible, because only those workpieces that are actually not functional will be rejected. ToleranceFit is the fitting method that allows functionally correct inspection using the maximum material principle. The complex relationships are applied in a way that it is easy for anyone to understand. As a result, either scrap is reduced or production tolerances can be expanded. In both cases, production costs are reduced.

Analysis in conformance with standards is also made possible for the various functional requirements for lines and surfaces according to ISO 1101 (2017). For example, all profile sections labeled with CZ (combined zone) and located in the same reference system are aligned together. For the "all around" drawing specification, all profile sections are adjusted individually, and the same tolerance specification applies to all of them. If CZ is also requested, then the profile deviation is output for each individual segment. For UF (united feature), in contrast, only one result is obtained for the entire profile.

The continuously changing tolerance zone is a funnel-shaped area between a defined fixed starting and ending point. For the UZ (unequally disposed tolerance zone), an offset from the center of the tolerance to the nominal profile is indicated. All of these drawing entries can be combined with each other.

In Conformance with Standards and Functionally Correct

The line profile form can be captured using the image processing sensor, optical distance sensors, or tactile sensors. With scanning-capable point sensors or line sensors, such as the CFL, the surface profile form can also be determined. ToleranceFit allows functionally correct analysis in conformance with the ISO 1011 standard for all of the above-named functional requirements.

To determine the profile deviation, only a few entries are needed. Even in difficult cases, such as large deviations of the profile on one side, the ToleranceFit method that is integrated in the WinWerth software shifts the captured actual profile into the tolerance zone, applying the principle of a virtual gage. This method allows unambiguous assessment of functionality. It is a way to use economical quality assurance to reduce scrap or to expand production tolerances and avoid redundant costs. ■

Translated by Werth Messtechnik GmbH

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