The Application Determines the Sensor: VAST Scanning Probe Systems

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Carl Zeiss offers various scanning probe systems. The VAST (Variable Accurate Scanning Technology) line consists of the VAST XXT passive scanning system for the RDS articulating probe holder and the VAST XT gold and VAST gold active scanning systems, which are integrated into the shaft of a coordinate measuring machine (CMM). Both VAST systems have special features and, thus, areas of application.

Touch trigger and scanning systems

The DIN EN ISO 10360-1 standard describes probes as touch probe systems. The standard differentiates between "touch trigger" and "scanning" systems depending on the type of measuring point acquisition. Touch-trigger systems record the measuring point at the moment of contact through a mechanical switch or through an electrical pulse transformer element, e.g. a Piezo sensor or wire strain gages. The scanning system captures the deflection of the probe system when contact is made with the workpiece surface utilizing the integrated measuring system, and determines the deflection. It is used to correct the measuring point coordinates delivered by the measuring system of the axes of motion [1, 2].

The VAST scanning systems from Carl Zeiss use the "sliding determination of mean values" procedure in conjunction with the ZEISS Intelligent Scanning Controller (ISC) during measuring point acquisition. During this process, the measuring machine is stopped after it registers a probe pulse due to the deflection of the probe. The system then checks whether the sum signal from the probe deflection and positional data of the measuring machine axes remain constant. A probing point is only accepted if the signal remains constant within a short interval. The mean value from the deflection signals recorded during this period is used to correct the probe deflection. Sliding determination of mean values automatically dampens noise pulses caused by vibrations, for example. As a result, the probes of the VAST line are less affected by electromagnetic interferences than a touch-trigger probe, which have an effect the moment contact is made with the workpiece. This technology permits the reliable use of VAST probes also under difficult environmental conditions and reduces sensitivity to outliers.

VAST line:	VAST XXT on RDS	VAST XT gold	VAST gold

Single point	○	○	○
Passive scanning	○		
Active scanning		○	○
Rotatable/ tiltable	○		

Passive and active scanning systems

Scanning systems are distinguished by the type of measuring force generation. With a passive system, the measuring force is generated by a mechanical spring. An active system consists of a linear drive that generates the probing force electrically. This is also known as an „electrical spring". The use of electrical springs enables the operator to set the measuring force over a large force range, largely independent of the deflection, thus permitting a larger measuring range which is required for a high scanning speed [1].

The measuring range of a passive system is limited by the linearity range of the mechanical springs in which the deflection and the force are proportional. It is two to four times smaller on a passive system than an active system. It is important not to confuse the measuring range with the deflection range which represents the mechanical range of motion of the

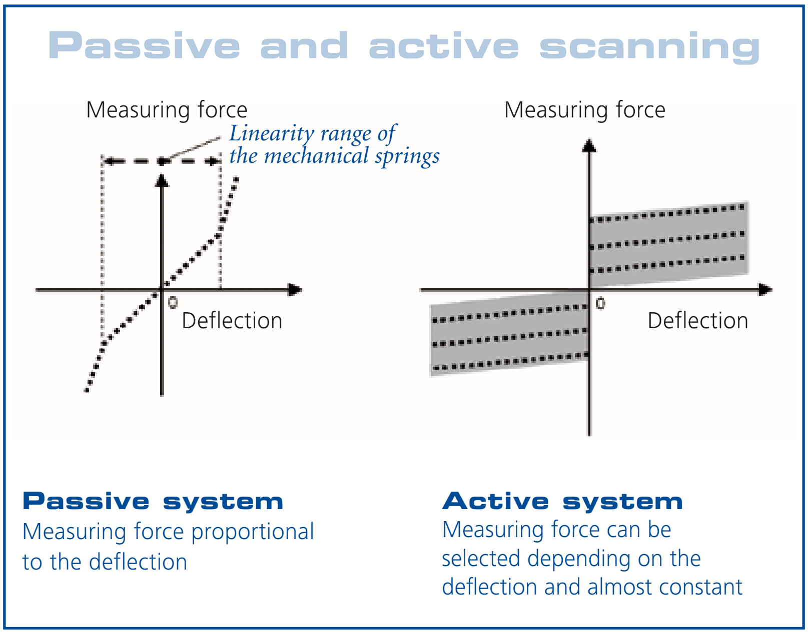


Fig. 1:
Active and passive systems according to [1]

probe and is usually larger than the measuring range. It is necessary to ensure that the probe does not move directly against its mechanical stop and trigger an emergency stop following a slight collision, for example.

Active scanning and self-centering probing

As already shown, active systems allow significantly higher scanning speeds. Scanning speeds of up to 300 mm/s with the VAST gold probe are possible together with procedures to correct the dynamic bending of the device structure and the compensation for centrifugal force – Navigator technologies [3]. Navigator achieves the parameters for scanning performance in accordance with DIN EN ISO 10360-4 [4] in less than 30 seconds. An essential feature: this Navigator scanning performance can be utilized for all stylus configurations used in everyday measuring operations (see example in Fig. 4). Other manufacturers specify scanning speeds higher than 300 mm/s, but these are only available for certain applications and only for one stylus in the axis direction of the sensor. The actual existing flexibility of a CMM (Fig. 4) is thus not always available.

The large measuring range and the better probe force regulation of active systems have also proven to be advantageous with self-centering probing. Self-centering probing is a procedure in which the stylus is placed in a largely spherical or cylindrical bore which is smaller than the diameter of the stylus tip. Probing occurs in the direction of the axis and perpendicular to this direction at the same time. In doing so, the stylus centers itself in a way that the position of this bore can be determined. To begin the centering process, the stylus must be positioned so exactly that it is located within its measuring range during probing. Therefore, active systems can use their larger measuring range to compensate for deviations during positioning of the stylus in front of the bore. During the centering process, the better probe force regulation of the active system leads to exact centering of the stylus at the lowest point. With passive systems, the centering process can be halted as a result of friction before the lowest point is reached. In such cases, this point is not reached and the measuring result is inaccurate. The effect also applies to self-centering scanning.

Beneficial: articulating probe holder

There are numerous applications in which many features must be measured at very different angles (e.g. metal parts). In such cases, it is advantageous to mount the probe to an articulating

Fig. 2:
Self-centering probing with active probe

Fig. 3:
Application for articulating probe holders

probe holder, allowing you to avoid a variety of stylus configurations. The overall size of an active probe that is required to generate the probe force prevents the use of an articulating probe holder. A passive probe system that utilizes only one mechanical spring, however, can be so small and lightweight that it can be mounted to an articulating probe holder.

Characteristic of a small passive probe system intended for attachment to an articulating probe holder is the lacking stylus counterweight. Thus, these systems are only suitable for very light and, compared to active systems, short styli. The mounted stylus deflects the measuring force spring with its own weight, thus further reducing the small measuring range of a passive sensor. This effect can be somewhat minimized with modules of varying spring stiffness for different stylus lengths. With active systems from Carl Zeiss, the counterweight is achieved via the corresponding control of the electrical spring.

Limitations of the articulating probe holder

Even if the use of an articulating probe holder enables you to avoid the many different stylus configurations, it should not be overestimated. There are several features that cannot be reached by an articulating probe holder. Suitable stylus configurations on an active probe enable the operator to reach almost any feature as illustrated in the "all-sides" measuring task in Fig. 4.

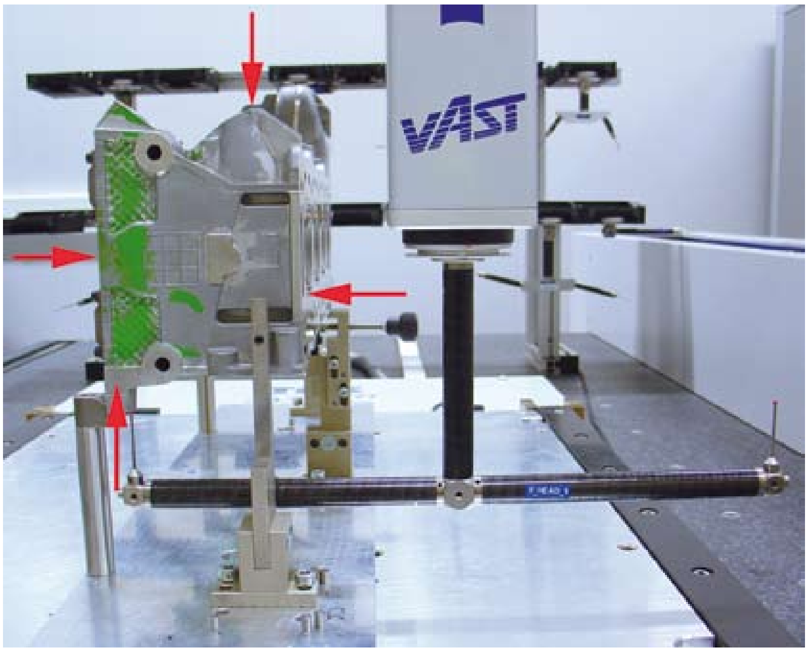
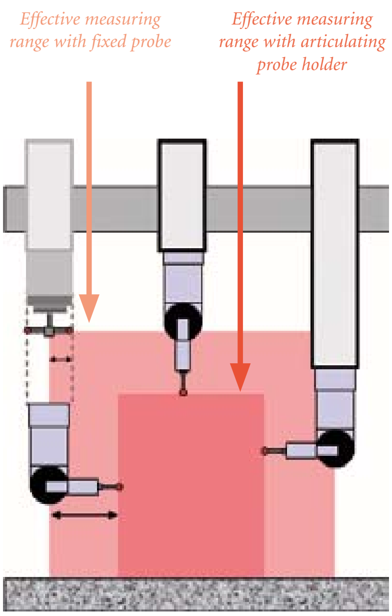


Fig. 4: All-side measurement with special stylus configuration on active probe

This also once again illustrates how the use of an active fixed probe and a probe on an articulating probe holder affects the available measuring range (Fig. 5). Because it is possible to approach the workpiece directly with a properly designed stylus, the active fixed probe requires a considerably smaller measuring range.



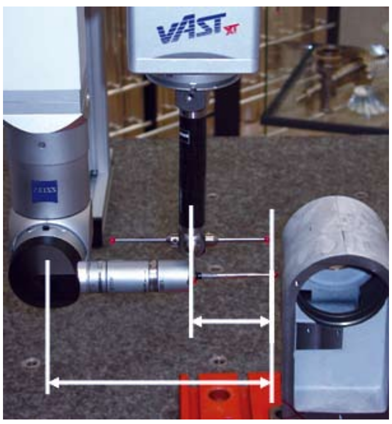


Fig. 5: Utilization of measuring range with active fixed probe compared to articulating probe holder

Furthermore, you must consider that the highly precise determination of positional deviation with the use of an articulating probe holder often requires a rotating or swiveling motion as the workpiece must be measured from different sides. This motion generates additional measuring uncertainty as a result of the limited reproducibility of the articulating probe holder. This effect does not exist with an active probe with a T stylus configuration. The effects on the error of dimension in determining the positional deviation is illustrated in the comparison in Fig. 6.

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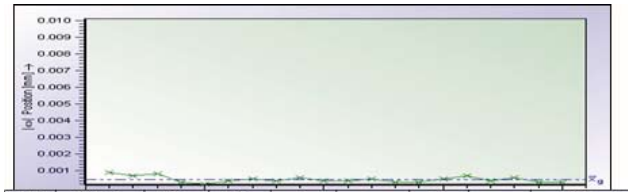
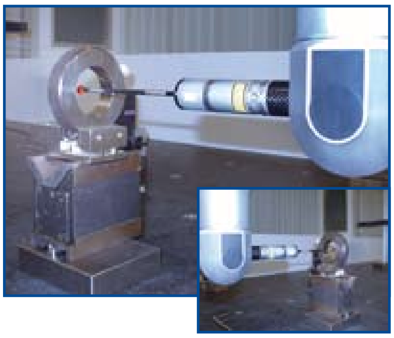
*Range of results: **0.7 µm** -> **capable** for tolerance of 0.01 mm*



Merkm.Nr.	Merkm.Bez.	Nennm.	OSG	$\bar{x}_g$	s_g	R_g		Index
3	Position	0.0000	0.0100	0.000475	0.00018883	0.0007	☺	$C_g = \frac{0.2 \cdot T}{4 \cdot s_g}$ 2.65



*Range of results: **6.3 µm** -> **not capable** for tolerance of 0.01 mm*

Merkm.Nr.	Merkm.Bez.	Nennm.	OSG	$\bar{x}_g$	s_g	R_g		Index
3	Position	0.0000	0.0100	0.002328	0.0016859	0.0063	☹	$C_g = \frac{0.2 \cdot T}{4 \cdot s_g}$ 0.30

Fig. 6:
Inspection of the capability to determine positional deviation (simulation of the measurement of a part from two sides with a ring gage)

Advantages

From CONTURA G2 to ACCURA to PRISMO navigator, Carl Zeiss offers instruments that are able to work with both systems, providing users with a selection of sensors for their specific measuring tasks.

VAST (XT) gold

- High scanning speed
- Function-oriented measurements through self-centering probing
- Long and complex stylus configurations reach every feature
- Precise determination of the position with the T stylus

VAST XXT on RDS

- Use on an articulating probe holder reduces the number of stylus configurations with many features in angular positions
- Suitable for small and sensitive components as a result of the lower moving masses

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