

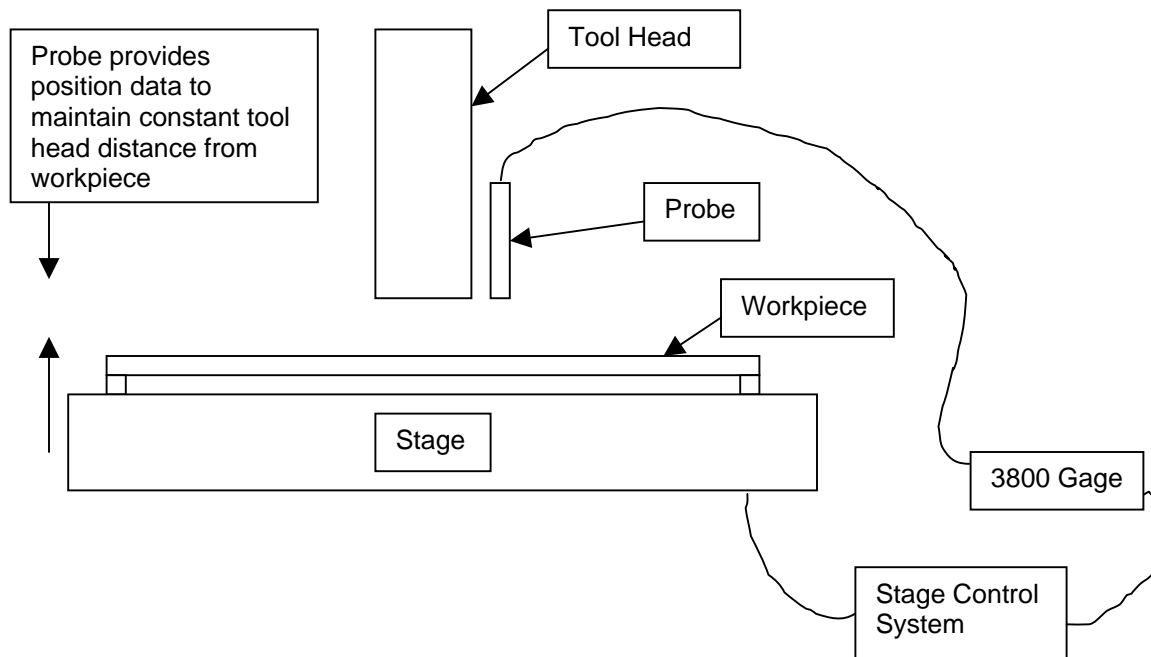
Using Capacitive Gages for Tool Head and Focal Plane Control

Capacitive gages are frequently used in applications where excellent linearity and repeatability are required to make very precise measurements. A slightly different use is one in which a user wants to repeatably position a tool or quickly reestablish focus after moving a workpiece. These are often referred to as nulling applications because the probe is used to bring the tool-to-workpiece distance to the same (null) value. Therefore, stability and repeatability are of prime importance, but linearity is not. There are a number of such applications in the semiconductor and other industries. In a typical example, a tool head such as a wafer-stepper lens column must be moved over a wafer and be brought into focus with respect to multiple areas on the surface of the wafer. The required positioning repeatability is often in the micron or submicron range. The time required to set up the tool head can be a major productivity robber, but by using ADE Capacitive gages as nulling sensors, machine productivity and accuracy can be greatly improved.

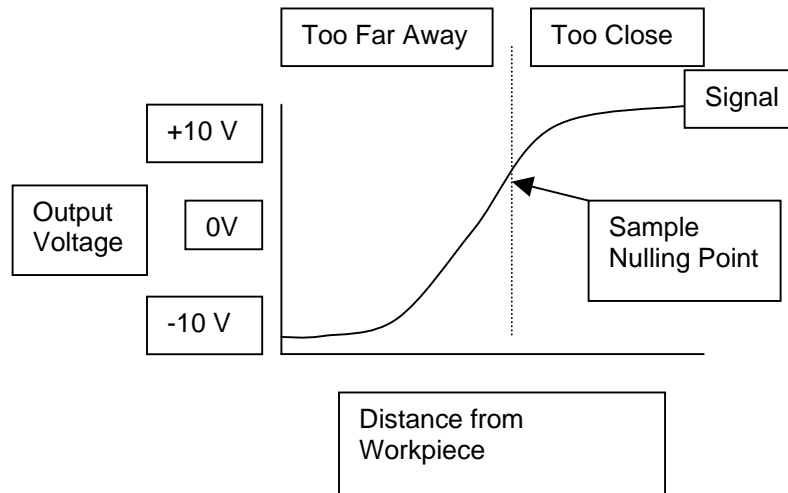
The range of operation of an ADE Capacitive Gage can be greatly expanded in this type of application. Typically, the linearity of a capacitive displacement gage begins to degrade when the sensor's total range exceeds about 25% of the sensor diameter. Although the linearity declines, the resolution, stability, and repeatability can remain excellent. In addition, most nulling applications do not require the full bandwidth of the gage, allowing signal filtering to improve resolution. Measurement range in this type of application can be as high as 50% to 200% of the sensor diameter.

In a typical nulling application, the tool head is brought into a known position with respect to the workpiece by an external means. This can be by a focus routine or other set up procedure. The output of the ADE Capacitance gage is recorded, and as the tool head is moved around the workpiece, the output of the gage is used in a servo loop to bring the tool head back to this position with respect to the workpiece. Because ADE Technologies capacitive gages are fast and stable, this technique can lead to substantial equipment productivity improvements.

1.1 Nulling Sensor Concept Diagram



1.2 Sample Nulling Application Signal Level



1.3 Special Considerations

Vacuum – Many high-precision operations take place in a vacuum. Capacitive gages work well in vacuums, requiring only a single standard bulkhead connection. Depending on requirements for outgassing, standard probes may be adequate. ADE Technologies can also provide custom-designed low outgassing probes if they are required.

Bandwidth – Field-programmable filters on all ADE equipment allow the user to tailor the bandwidth and settling time to his measurement requirements. ADE Technologies' standard gages have bandwidth settings to 5kHz or more.

Range – The sensor range is not unlimited. As range increases repeatability declines. ADE Technologies partners with its customers to determine the optimal sensor size and shape.

Target Angle – There is no particular requirement that the target be parallel to the sensor. The only requirement is that the angle with respect to the sensor be constant.

Edge Effect -. As the sensor reaches the edge of the workpiece, its signal will distort. This effect can be managed by using a smaller sensor closer to the workpiece, using multiple sensors, modeling edge behavior, or by "flying blind" near the edge. The severity of the edge effect is a function of the range, sensor diameter and workpiece geometry. ADE Technologies has experience developing special sensor arrays that can effectively manage this effect.

Products: The ADE 3800, 4800 Gaging System or ADE High-Stability Gaging System are especially suited for nulling applications. Where extremely wide bandwidth is required, the ADE 5810 gaging system provides frequency response to 100 kHz.



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