Application Note:
Precision Alignment of CNC Gantries and X-Y Tables

Introduction

A great many machine shops and fabrication facilities utilize X-Y tables, CNC gantries, and other precision linear motion control systems. In some cases these systems position parts, while in others they position tools such as routers or water jet cutters. The longitudinal travel of these machines can be quite large, often 50 feet or more. The question naturally arises: "are the rails running straight and square?"

Traditional methods for performing these geometric checks involve mechanical or visual systems. Mechanical methods, such as straight edges or piano wire, are cumbersome and ill-suited for such large machines. Visual systems, such as optical sights, are also time-consuming and highly dependent on operator skill.

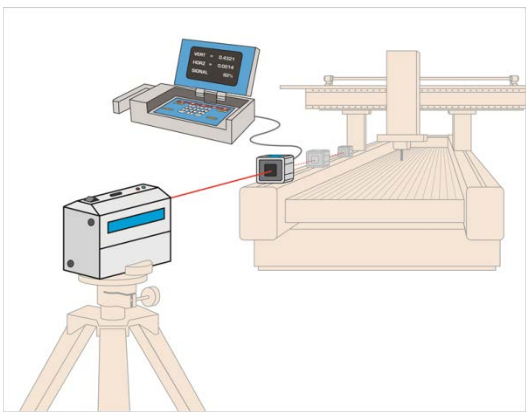
The Pinpoint Gantry Kit is ideally suited for checking straightness, squareness, or parallelism of X, Y, and Z axes. This kit is based on the Microgage Pro, which can detect misalignment in both the horizontal and vertical direction. The laser transmitter projects a perfectly straight reference beam, running parallel to one axis. The receiver is then placed at critical check points. The remote processing unit displays the alignment data in real time, allowing adjustments to be made on the fly.

Rail Straightness

The first alignment check that should be performed on a CNC gantry or X-Y table is rail straightness. The same basic procedure applies for all three linear axes (X, Y, and Z) plus a secondary X axis, if applicable. For brevity, we discuss here only the X axis (longitudinal rail).

To measure straightness of a longitudinal rail, begin by identifying two reference points along it. These will typically be at the near and far ends. Using the 4-axis mount and tripod, position the laser so that the beam hits the receiver at both the near and far references (see Figure 1). Next, you will “buck in “ the laser, which means adjusting the beam so it is exactly parallel to the line formed by the reference points. To buck in, move the fine adjustments on the 4-axis mount until both the horizontal and vertical outputs read the same at both reference points.

After bucking in the laser, press “zero” on the control unit to zero out the display. Now place the receiver at any location along the rail. The horizontal and vertical readings will show any misalignment with respect to the reference line.

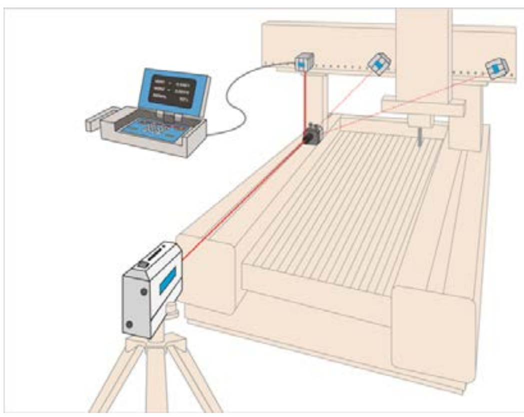


Squareness

After ensuring that all rails are straight, any two axes can be checked for squareness. The same basic procedure applies for X –Y, X-Z, and Y-Z. The sketch here shows X-Y (longitudinal rail and cross bridge).

Position the laser as before and buck in to the X axis. Then place the 90-Line Right Angle into the laser beam path (Figure 2). The 90-Line contains an optical element called a pentaprism that reflects the incoming laser beam at a precise right angle. The nosepiece of the 90-Line rotates to direct the beam to any point along the Y axis.

To measure squareness of the Y axis (cross bridge), position the receiver near one end and rotate the 90-Line nosepiece so the laser hits it. Zero the display. Then move the receive near the opposite end and rotate the nosepiece. The Vertical reading will indicate the distance that the Y axis is out of square. You may take additional readings at other locations along the Y axis. If the cross bridge rail is straight, then these readings should scale with distance from the zero point. For example, if the Vertical reading at the far end of the rail was 0.006”, then the reading halfway between should be 0.003”.



Rail Parallelism

If your CNC gantry has two longitudinal rails, they can be checked for parallelism. Before beginning, make sure they are both straight using the procedure outlined above.

Reposition the laser to the side of the rail, and place the 90-Line Right Angle in the path of the beam (Figure 3). Perform the bucking in procedure as before, using the fine adjustments on the 4-axis mount. This will ensure that the segment of the laser beam exiting the 90-Line is parallel to the X axis. Zero the display.

Reposition the 90-Line to the opposite rail, and place the receiver at any location along it. The Horizontal and Vertical readings will indicate the distance that the secondary rail is out of parallel. You may take additional readings at other locations along this axis. If the secondary rail is straight, then these readings should scale with distance from the 90-Line. For example, if the Horizontal reading at the far end of the rail was - 0.006", then the reading halfway between should be -0.003".