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Explaining XK10 parallelism

Overview

The XK10 alignment laser system can measure both parallelism and parallel straightness. This document aims to explain the differences between parallelism and parallel straightness for machine tool assembly and alignment, and the traditional methods for performing these measurements.

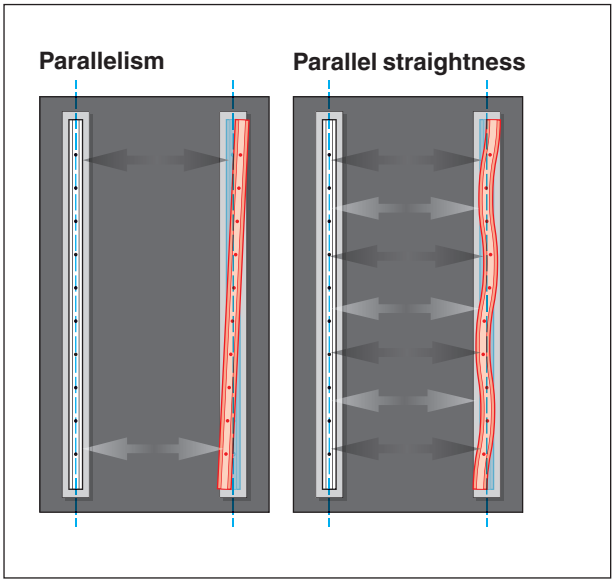
Parallelism

- In machine tool assembly and rail alignment, **parallelism** is defined as the **angle** between two nominally parallel rails or axes.
- The **parallelism** measurement method is useful for quick installation and alignment of long axes or rails. It is completed by taking two straightness measurements per rail; one at the beginning of the rail and one at the end of the rail.

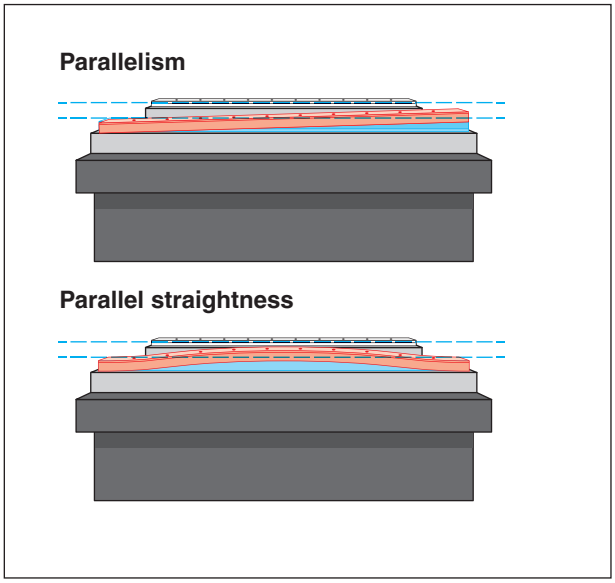
Parallel straightness

- Parallel straightness can be measured in the horizontal direction using the parallelism set-up and in the vertical direction using the flatness set-up.
- Parallel straightness is useful for straightness and parallel alignment of two rails.
- This is a more comprehensive measurement than parallelism because it also considers the straightness errors along each axis.
- This task is traditionally done using a bridge plate or a straight-edge/parallel.

Horizontal

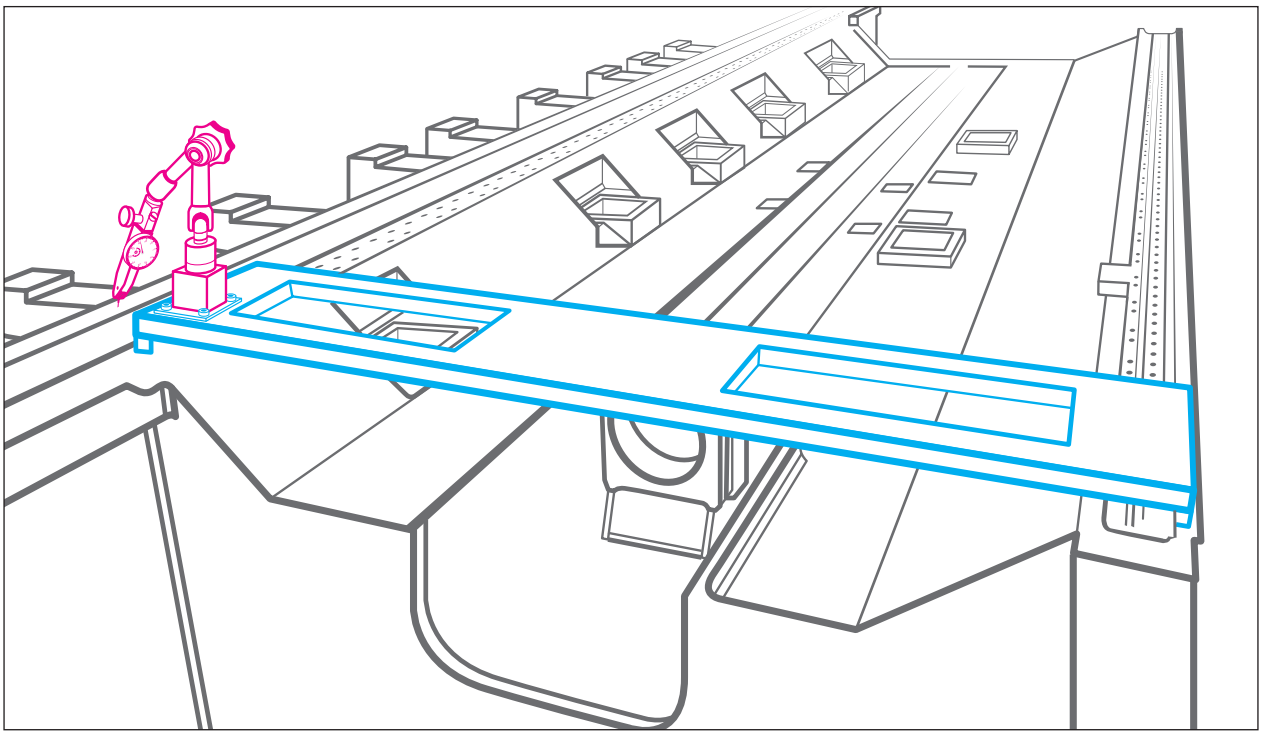


Vertical



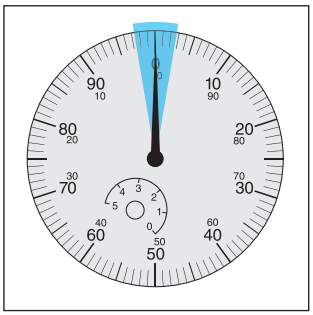
Traditional methods

- The traditional method for measuring parallelism/parallel straightness is using a **bridge plate** in combination with a **dial test indicator** and digital levels.
- The bridge plate is made up to span the nominally parallel faces on a machine casting. One end of the bridge is butted up against the reference face, and the other end has a dial test indicator mounted to it, with the indicator touching the other machined face.
- The bridge plate is moved along the casting at various positions and the reading of the dial test indicator gives the horizontal parallelism relative to the opposite reference face.



Considerations

Dial test indicator



- The highest accuracy dial test indicators have an uncertainty of up to ±3 µm, even if the repeatability is ±0.5 µm.
- This means that if a user sees a reading of 0 µm, the true error could be anywhere between –3 µm and +3 µm.

Footprint

- The bridge plate is likely to have a wide footprint which affects the resolution of the measurement. This reduces the accuracy of the measurement.

Size limit

- Machines with larger width spans between the rails are very difficult to measure using a bridge plate; the size of the plate is likely to cause the bridge to twist as it moves along the axis.

Human error

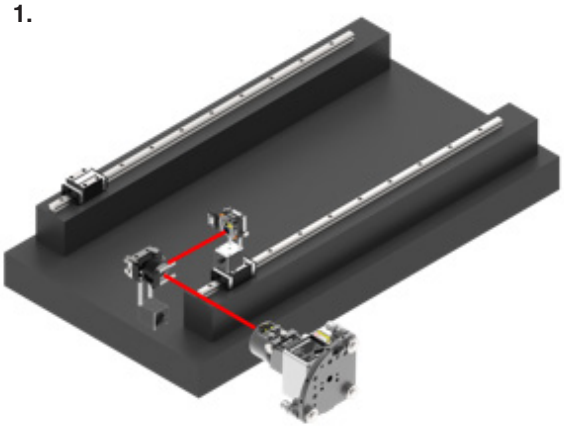
- The use of the bridge plate relies on operator experience. The accuracy is dependent on how accurately the operator can keep the bridge plate against the reference face of the surface. Different operators are likely to get different results.

Parallelism measurement

Horizontal

- Using the **parallelism set-up** and the parallelism application on the display unit, two points are captured at the ends of each rail and the system calculates the horizontal angle between the two axes.
- The resultant angle is based on the straightness deviation at each point and the length of each axis.

1.



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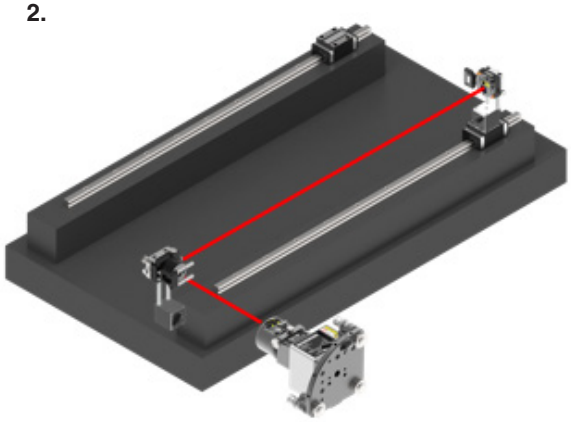

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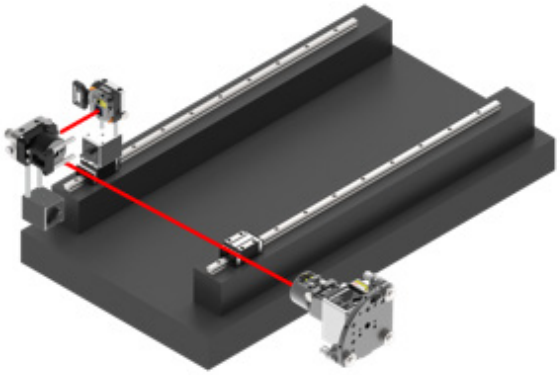

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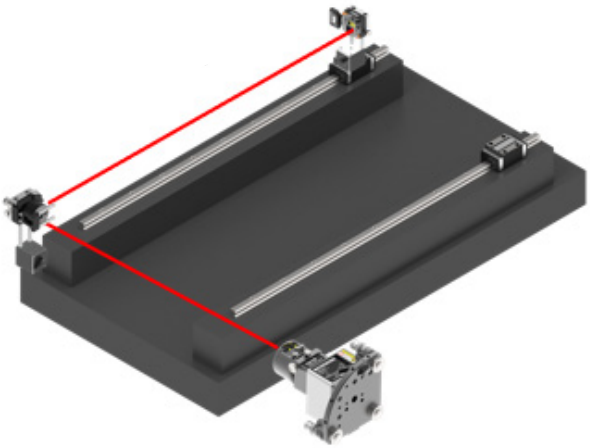
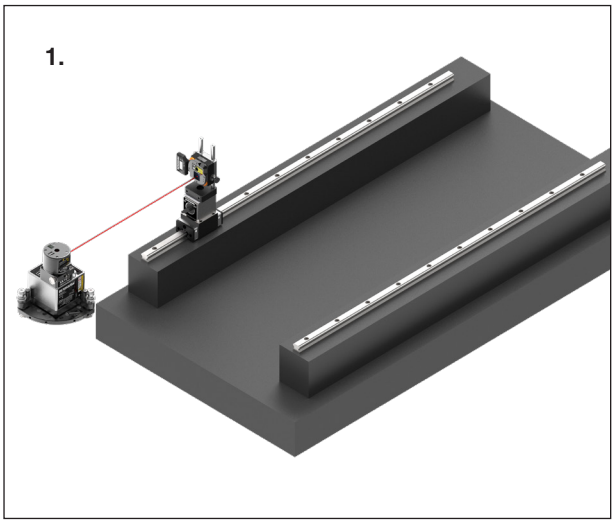
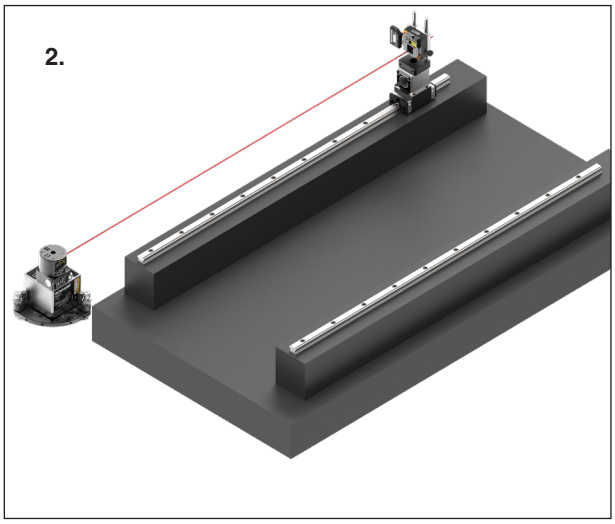


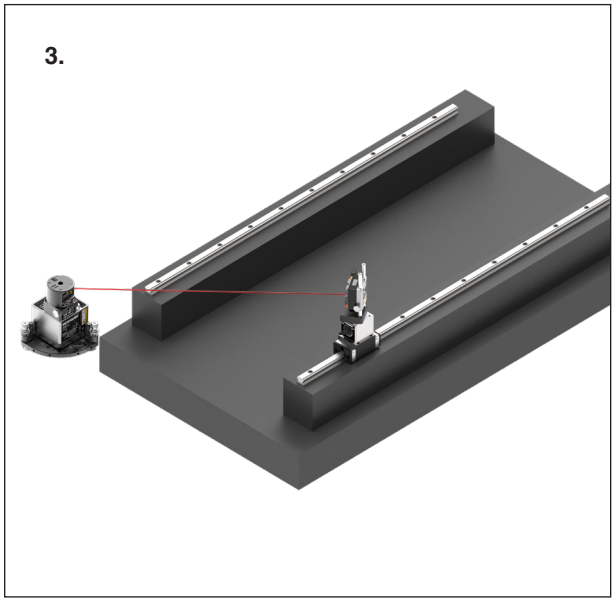
Parallelism measurement

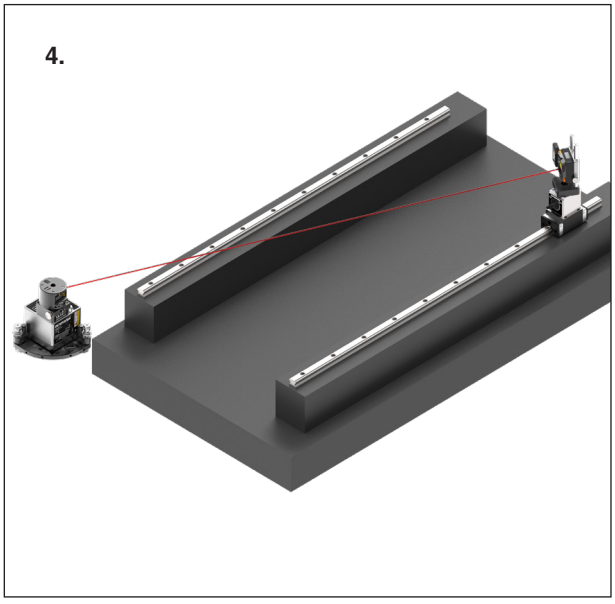
Vertical

- Vertical parallelism measurements are taken using the **flatness set-up** and the parallelism application on the display unit.
- The laser plane is aligned and datumed at positions **1**, **2** and **3**. The deviation measured at position **4**, in combination with the axis length, is used to calculate the vertical angle between the two axes.









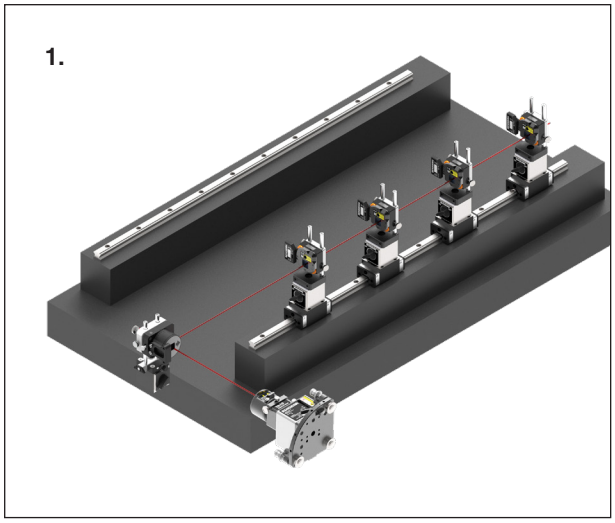
Analysis – Parallelism

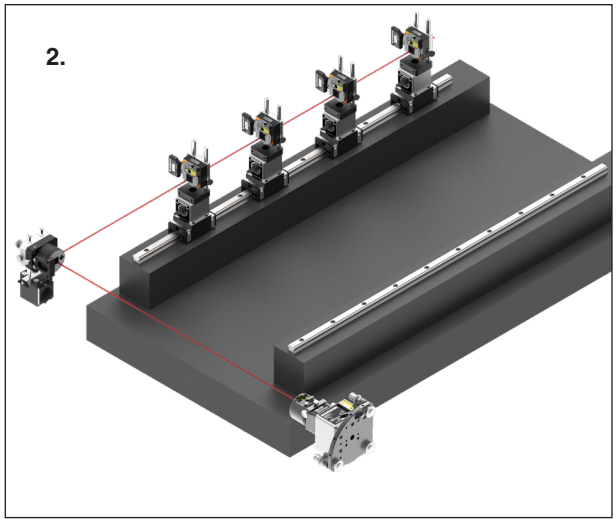
- Parallelism can be viewed on the display unit when the measurement is complete.
- The analysis displays the overall angle of the measurement rail against the reference rail.
- Error is shown as µm/m.

Parallel straightness measurement

Horizontal

- Horizontal parallel straightness is measured using the **parallelism set-up** and the straightness application on the display unit.
- A straightness measurement is taken on both rails and the difference between them is plotted.
- **CARTO Explore** displays the parallel straightness and parallelism error.

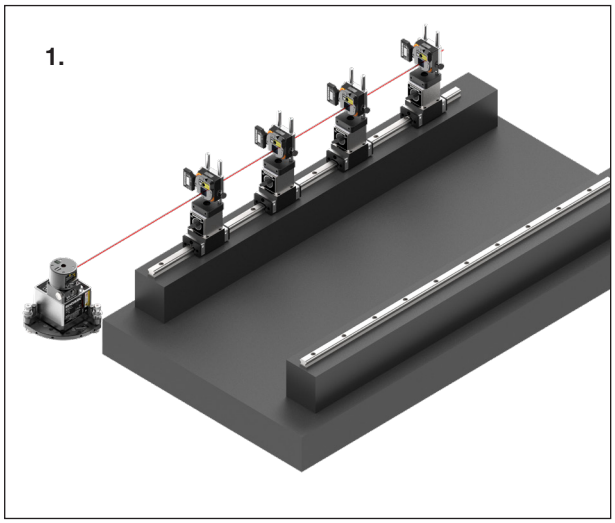


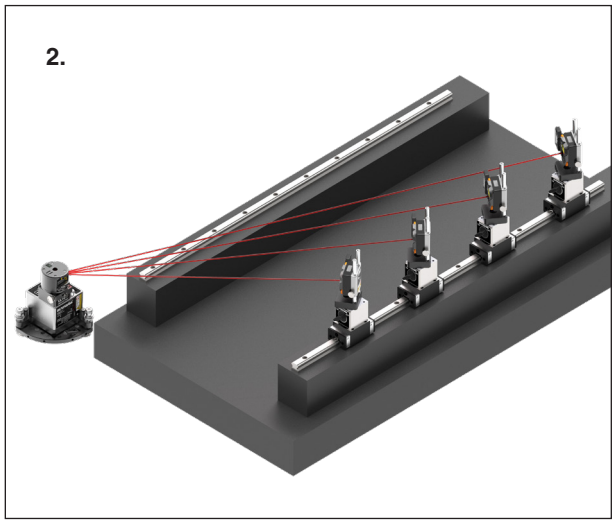


Parallel straightness measurement

Vertical

- Vertical parallel straightness measurements are taken using the **flatness set-up** and the straightness application on the display unit.
- The laser plane is aligned and datumed at positions **1**, **2** and **3**. Multiple straightness measurements are taken along each axis.
- As with the horizontal measurement, the difference between the two straightness results is plotted, giving the form and the maximum straightness difference between the two axes.





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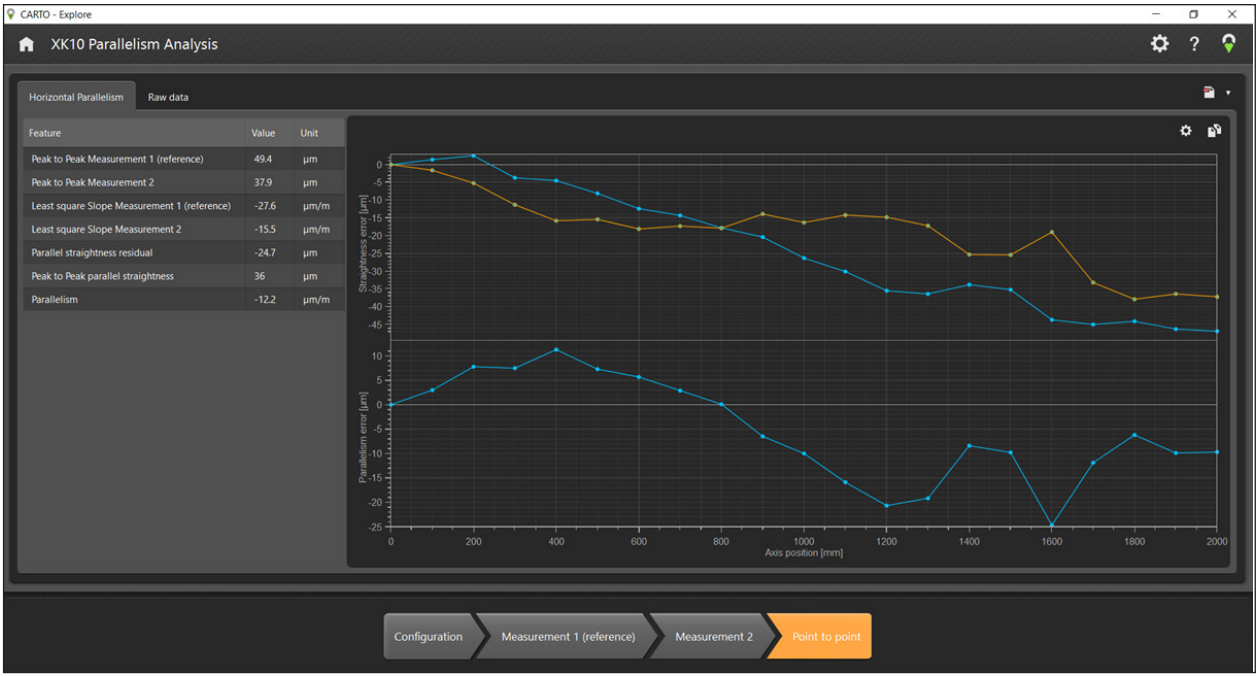
Analysis – Parallel straightness

- Parallel straightness data can be analysed in **CARTO Explore**.
- The top graph shows the actual measured error for each rail.
- The bottom graph shows the parallel straightness of the measurement rail against the reference rail.



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