motion and position of a solid body in space. These six degrees of freedom are the basis of describing the alignment of an optical component and are the foundation of the kinematic principle—the number of points of contact for a body to be constrained fully should be such that each degree of freedom be constrained, but only once. Using the common Cartesian frame of reference, the degrees of freedom are specified by the three Cartesian axes; \( x \) (the optical axis), \( y \), and \( z \); together with the angular rotations about these axes; \( \theta_x \) (roll), \( \theta_y \) (pitch), and \( \theta_z \) (yaw).

The stages described in this chapter all mate together with a common hole pattern. All have been designed to be as compact as possible and to have heights conforming to the 2.5-mm incremental height guideline. The stages can be used individually or combined to provide positioning and alignment of component holders with from one to six degrees of translation or rotation.
Single-Axis Translation Stages

- Micrometer or fine-threaded thumbscrew drive
- 6 mm of travel
- Stackable for x-y or x-y-z configurations

These compact translation stages provide 6 mm of linear positional adjustment of a 25 × 25-mm mounting platform. Two drive types are available: the 07 TMC 501 and 07 TMS 501 are driven by a stainless steel, 0.35-mm-pitch (73-TPI) thumbscrew with 1.5-μm resolution; the 07 TMC 502 and 07 TMS 502 are driven by a precision micrometer with a 10-μm graduated scale and 1.5-μm resolution. Both have locking thumbscrews. The stages are made of black-anodized aluminum.

These stages can be combined to provide x and y motions. The 07 ACE 501 angle bracket, described on pages 24.43-24.44, 27.23-27.24, can be used to combine three single-axis translation stages to provide x, y, and z motions.

Single-Axis Translation Stages

<table>
<thead>
<tr>
<th>Drive Type</th>
<th>PRODUCT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center-Mounted Thumbscrew Drive</td>
<td>07 TMC 501</td>
</tr>
<tr>
<td>Center-Mounted Micrometer Drive</td>
<td>07 TMC 502</td>
</tr>
<tr>
<td>Side-Mounted Thumbscrew Drive</td>
<td>07 TMS 501</td>
</tr>
<tr>
<td>Side-Mounted Micrometer Drive</td>
<td>07 TMS 502</td>
</tr>
</tbody>
</table>

Single-axis stage with goniometer for “roll”
Integral \(x\)-\(y\) Translation Stages

- Micrometer or fine-threaded thumbscrew drive
- 6 mm of \(x\) and \(y\) travel
- Low-profile design

These compact translation stages provide 6 mm of adjustment along two orthogonal axes. Two drive types are available: the 07 TMC 511 and 07 TMS 511 are driven by a stainless steel, 0.35-mm-pitch (73-TPI) thumbscrew with 1.5-\(\mu\)m resolution; the 07 TMC 512 and 07 TMS 512 are driven by a precision micrometer with a 10-\(\mu\)m graduated scale and 1.5-\(\mu\)m resolution. Both have locking thumbscrews. The stages are made of black-anodized aluminum.
Integral x-y-z Translation Stage

- Fine-threaded thumbscrew drives
- Precision helix-threaded vertical motion
- 6 mm of travel in x and y; 3.5 mm of travel in z

This very compact translation stage provides 6 mm of adjustment in two orthogonal axes parallel to a 25 x 25-mm mounting platform and 3.5 mm of vertical travel perpendicular to the platform. Adjustment in the x and y axes is obtained with stainless steel, 0.35-mm-pitch (73-TPI) thumbscrews with 1.5-μm resolution. Vertical motion is accomplished by turning the knurled lower section of the stage. The precision helix threads provide smooth vertical motion. These x-y-z stages are made of black-anodized aluminum.

This stage can be used to position optics held in component holders. It can also be combined with a low-profile tilt stage, one of the rotation stages, or a goniometer to provide four, five, or six degrees of freedom.
Vertical Translation Stage

- Precision helix-threaded vertical motion
- 5 mm of vertical travel
- Locking thumbscrew

This compact translation stage provides 5 mm of linear vertical adjustment to a 25 × 25-mm mounting platform. Height adjustment is accomplished by turning the knurled midsection of the stage. The precision helix thread provides smooth vertical motion, and a thumbscrew locks the position. The stage is made of black-anodized aluminum.

07 TMZ 501 vertical translation stage

<table>
<thead>
<tr>
<th>Drive Type</th>
<th>PRODUCT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helix Drive</td>
<td>07 TMZ 501</td>
</tr>
</tbody>
</table>

Dimensions in mm

x-y-z configuration with θz rotation (yaw)
Miniature Rotation Stages

- Micrometer or fine-threaded thumbscrew drive
- 360 degrees of manual rotation
- 15 degrees of precision adjustable rotation

These rotation stages combine a full 360-degree range, with 18-arc-second resolution in a single compact unit. When the locking thumbscrew is engaged, 15 degrees of precision adjustment are available, driven by a stainless steel, 0.35-mm-pitch (73-TPI) thumbscrew for the 07 TRT 507 and by a micrometer for the 07 TRT 508. A 360-degree scale, equipped with a vernier, can be read to 1 degree. The resolution is 18 arc seconds.

The stages are made of black-anodized aluminum. Component holders or other stages can be attached to the rotation platform, and the rotation stages can be attached to other stages or bases. Using the other stages described in this chapter, multiaxis positioning systems, with both linear and rotational adjustment, can be assembled.

Miniature Rotation Stages

<table>
<thead>
<tr>
<th>Drive Type</th>
<th>PRODUCT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine-Threaded Thumbscrew Drive</td>
<td>07 TRT 507</td>
</tr>
<tr>
<td>Micrometer Drive</td>
<td>07 TRT 508</td>
</tr>
</tbody>
</table>

Rotation stages with prism and lens holders
Miniature Goniometers

- Precision rotation at a fixed height above the platform
- Stackable for two-axis rotation about a common point

Goniometers allow partial rotation (tilt) of a mounted optical component about an axis at a fixed height above the top surface. These two goniometers have been designed to stack as a pair. Their different rotational radii are exactly matched to produce motion about a point at which the two rotational axes intersect. Each goniometer is 20-mm high. The model 07 GON 507 stage has a rotational axis 12.5 mm above its top surface; the 07 GON 508 stage has a rotational axis 32.5 mm above its top surface.

Both stages are driven by a geared knob and have locking thumbscrews. An angular vernier scale on the side of the goniometers provides an angular resolution of 0.2 degree over a ±30-degree range for the 07 GON 507 or 0.1 degree over a ±15-degree range for the 07 GON 508. The goniometers are made of black-anodized aluminum and brass.
**Low-Profile Tilt Stage**

- Fine-threaded thumbscrew drives
- Both drives conveniently located on one side
- Low-profile design

This very compact stage provides tilt about two orthogonal axes parallel to a 25 × 25-mm mounting platform. Adjustment is provided by two stainless steel, 0.35-mm-pitch (73-TPI) thumbscrews conveniently located on one side of the stage. The tilt-adjustment range is ± 2.5 degrees in each axis. The stage, which is 10-mm high, is made of black-anodized aluminum. This stage can be used as a low-profile tilt stage or as a narrow-profile mirror mount. When used as a tilt stage, its base is attached to other stages or bases with one M2 screw and one M4 screw. When the stage is used as a narrow-profile mirror mount, the three M2-threaded holes along one edge are used for mounting.

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**Prism assembly with low-profile tilt stage**

**07 TMT 501 low-profile tilt stage**

**Low-Profile Tilt Stage**

<table>
<thead>
<tr>
<th>Drive Type</th>
<th>PRODUCT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thumbsscrew Drive</td>
<td>07 TMT 501</td>
</tr>
</tbody>
</table>

Tilt stage may be mounted vertically or horizontally.