Fine Steering & Fast Steering Mirrors

Make optical innovation happen
Established in Switzerland in 2008 and privately owned

250 employees in Switzerland, Slovakia, Taiwan and Korea

R&D spend exceeding 25% of revenue

5000 m² production & cleanroom capacities exceeding 300 Ku/year

28 sales partners and distributors in 30 countries

More than 1 million products sold worldwide

Innovative award winning products

MARKETS

Industrial, medical, AR/VR and automotive markets

360° Design skills: from optics simulation in Zemax to mechanical and electrical design to software, our R&D team enables our customers to access a one-stop-shop for our liquid lenses and optical actuators.

360° Design skills:

In-depth research capabilities: Optotune is continuously investing in material characterization and testing to deliver state-of-the-art products that solve the most challenging applications such as high-frequency vibration environments or ultra-portable systems.

Scalable manufacturing: having different manufacturing sites at various levels of automation enables our customers to access our products with a top-class delivery performance from sampling through to mass production in class 1000 cleanrooms.

Application & customer support team: application diversity in fast changing markets has increased the challenge to identify the appropriate solution; our application engineering team will carry out extensive feasibility studies to select the right Optotune products to solve your challenge.

Custom design: demanding applications have often specific requirements (coatings, optical power ranges, dimensional constraints, certificates), which call for customization. Optotune’s know-how in design, manufacturing and quality assurance enables the delivery of future-proof custom products.
Fine Steering Mirrors

Optotune’s FMR devices have been designed with fine-tilt, high-angular resolution applications in mind. With a large clear aperture of 20 x 20 mm they can scan various beam patterns at 250 Hz bandwidth, with ±2.3 mrad tilt range. With the Optotune ICC-4C-2000 controller they are a plug and play fine steering solution.

Main features:
- One large optical surface for 2 DOF motion
- 2D wobbling of low- to high-power laser beams
- Mrad angular range with μrad resolution
- Long lifetime thanks to bearingless design
- Customizable in a small footprint

Applications:
- Laser soldering and welding
- Fine 2D beam alignment (e.g. in laser cavities)
- Lissajous scanning

Fast Steering Mirrors

Whether in R&D or in product development, Optotune’s disruptive 2D fast steering mirror solutions offer completely new design and integration possibilities.

Key features:
- Large clear apertures and beam angles
- 2D beam deflection with a single optical element
- Robust voice-coil actuation
- Optical real-time position feedback
- Compact & lightweight
- Customized coatings available

Dual axis fast steering mirror with position feedback

Optotune’s dual axis fast steering mirror (FSM) offers the benefit of large deflections and large mirror size in a compact package. The actuator is based on proven voice-coil technology. A built-in position feedback allows it to be accurately controlled with a standard PID controller. The virtual rotation point of our 2D mirrors is close to the mirror surface which makes 2D scanning straightforward. We offer either two non-resonant axes or a non-resonant axis in combination with a resonant axis. The first option is ideally suited for vector scanning and point & shoot applications, the latter is ideal for fast raster scanning.

Applications:
- Automotive (LiDAR, dynamic headlights, ADAS)
- Machine vision (field-of-view expansion)
- Free-space communication
- Biometric (eye-tracking)
- Diagnostics (e.g. OCT, Fundus camera)
- Metrology

For detailed information about Optotune’s fine steering mirrors, please visit www.optotune.com/fmr20

For detailed information about Optotune’s fast steering mirrors, please visit www.optotune.com/fast-steering-mirrors
Combining a 2D mirror for x/y with an electrically focus tunable lens allows you to direct your laser beam spot precisely and fast at any point within the addressable volume.

Applications:
- Diagnostic/ophthalmic devices
- Spectroscopic devices
- 3D printing

The FOV expansion kit featuring a MR-15-30 dual-axis fast steering mirror enables field of view expansion and area of interest (AOI) selection. The standalone camera on the left is equipped with a wide-angle objective to capture the overall scene. The camera on the right, equipped with a narrow-angle tele lens, looks onto the mirror, and allows you to “zoom-in” and select a small AOI out of a 100° optical FOV.

Applications:
- Security applications
- Surveillance and face-tracking in airports and other public spaces
- Inspection
- Gigapixel imaging

For detailed information about the FOV Expansion Development Kit and Gigapixel Imaging, please visit www.optotune.com/gigapixel-imaging
Overview of Mirrors

<table>
<thead>
<tr>
<th>Model</th>
<th>MR-10-30</th>
<th>MR-15-30</th>
<th>FMR-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan direction</td>
<td>2D</td>
<td>2D</td>
<td>2D</td>
</tr>
<tr>
<td>Control</td>
<td>Closed loop on quasi-static and amplitude control on resonant axis</td>
<td>Closed loop on both axes</td>
<td>Open loop on both axes</td>
</tr>
<tr>
<td>Mech. tilt angle</td>
<td>±25° (slow axis) ±12.5° (fast axis)</td>
<td>±25° both axes</td>
<td>±0.2° both axes</td>
</tr>
<tr>
<td>Mirror size</td>
<td>Ø10 mm</td>
<td>Ø15 mm</td>
<td>20x20 mm²</td>
</tr>
<tr>
<td>Resolution (closed loop)</td>
<td>22 μrad (with MR-E-2)</td>
<td>22 μrad (with MR-E-2)</td>
<td>4 μrad (with ICC-4C-2000)</td>
</tr>
<tr>
<td>Repeatability RMS (typical)</td>
<td>– 40 μrad</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Full scale bandwidth</td>
<td>20 Hz (slow axis) 250 Hz (fast axis)</td>
<td>20 Hz both axes</td>
<td>250 Hz both axes</td>
</tr>
<tr>
<td>Settling time</td>
<td>3 ms (0.1° mech. step) 13 ms (2° mech. step)</td>
<td>3 ms (0.1° mech. step) 13 ms (2° mech. step)</td>
<td>4 ms (0.2° mech. step)</td>
</tr>
<tr>
<td>Mirror coatings</td>
<td>Protected gold</td>
<td>Protected silver</td>
<td>Protected gold</td>
</tr>
<tr>
<td>Mirror flatness P-V @549nm</td>
<td>λ/2</td>
<td>λ/2</td>
<td>2λ</td>
</tr>
<tr>
<td>Connectivity</td>
<td>2 coils, 4 analog sensor channels, DC (temperature sensor, EEPROM)</td>
<td>2 coils, 4 analog sensor channels, DC (temperature sensor, EEPROM)</td>
<td>2 coils, DC (temperature sensor, EEPROM)</td>
</tr>
<tr>
<td>Compatible controller</td>
<td>MR-E-2</td>
<td>MR-E-2</td>
<td>ICC-4C-2000 with Extension kit</td>
</tr>
</tbody>
</table>

Mirror Reflectivity [comparison for different coatings]

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Reflectivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>80</td>
</tr>
<tr>
<td>1000</td>
<td>90</td>
</tr>
<tr>
<td>1500</td>
<td>95</td>
</tr>
<tr>
<td>2000</td>
<td>100</td>
</tr>
</tbody>
</table>

Overview of Development Kits and Controllers

<table>
<thead>
<tr>
<th>Model</th>
<th>MR-E2 Development Kit</th>
<th>MR-E-2 OEM Kit</th>
<th>FOV Expansion Development Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible mirror controller</td>
<td>MR-E-2 Base unit</td>
<td>MR-E-2 OEM version</td>
<td>MR-E-2 Base unit</td>
</tr>
<tr>
<td>Tunable lens</td>
<td>–</td>
<td>–</td>
<td>EL-16-40-TC-VIS-5D (-2 dpt to +3 dpt)</td>
</tr>
<tr>
<td>Tunable lens controller</td>
<td>–</td>
<td>–</td>
<td>EL-4-4</td>
</tr>
<tr>
<td>Camera</td>
<td>–</td>
<td>–</td>
<td>Daheng 1/1.8” 3MP</td>
</tr>
<tr>
<td>Wide angle lens</td>
<td>–</td>
<td>–</td>
<td>4mm (8° HFOV)</td>
</tr>
<tr>
<td>Narrow angle lens</td>
<td>–</td>
<td>–</td>
<td>58mm (8° HFOV) or 75mm (5° HFOV)</td>
</tr>
<tr>
<td>Image system angular resolution</td>
<td>–</td>
<td>–</td>
<td>4 m degrade (50mm lens) or 2.5 m degrade (75mm lens)</td>
</tr>
<tr>
<td>Use cases</td>
<td>Evaluation, R&amp;D, plug-and-play</td>
<td>Prototyping, integration into OEM equipment</td>
<td>Gigapixel imaging, ACO selection, face recognition</td>
</tr>
<tr>
<td>Advantages</td>
<td>Electronics fully protected in housing</td>
<td>Compactness</td>
<td>All-in-one</td>
</tr>
<tr>
<td>Thermal management</td>
<td>Assured by kit</td>
<td>By customer</td>
<td>Assured by kit</td>
</tr>
<tr>
<td>Connectivity</td>
<td>USB UART SPI Analog input (±5 V)</td>
<td>USB UART SPI Analog input (±5 V)</td>
<td>USB</td>
</tr>
</tbody>
</table>
## Overview of Applications for Mirrors and Kits

<table>
<thead>
<tr>
<th>LiDAR</th>
<th>Free-space Communication</th>
<th>Surveillance / Face Detection</th>
<th>Gigapixel Imaging</th>
<th>Adaptive Headlights</th>
<th>OCT</th>
<th>Cosmetic Lasers</th>
</tr>
</thead>
</table>

### The Challenge
- **LiDAR**: Galvo scanners are bulky and power hungry. MEMS scanners suffer from limited scan angle/mirror size.
- **Free-space Communication**: Turbulences in the atmosphere and movement of communication towers require real-time adjustments. Coarse steering units and fine steering units are bulky and complex.
- **Surveillance / Face Detection**: Need to select small AOI with high enough resolution within a large FOV.
- **Gigapixel Imaging**: Limited camera resolution.
- **Adaptive Headlights**: The headlight needs to be bright and directed into the curve. Existing solutions are slow and not compatible with laser-based headlights.
- **OCT**: When scanning the retina, normal galvo heads are too bulky to be placed close to the eye and introduce beam-shifts due to the different rotation points of the 2 axes. As a workaround they often require complex optical relay systems.
- **Cosmetic Lasers**: Bulky handpiece is difficult to hold. Heavy handpiece leads to strain on the doctor’s arm. Existing scan mechanisms are power-hungry.

### Our Solution
- **LiDAR**: Our Fast steering mirrors allow to build compact and reliable LiDAR systems with large FOV.
- **Free-space Communication**: Our MR-15-30 2D fast steering mirror in combination with our FMR-20 fine steering mirror offer a compact solution to ensure a stable communication link.
- **Surveillance / Face Detection**: Our MR-15-30 2D fast steering mirror in combination with a standard camera, an electric lens, a widefield and a narrow field lens and 2 cameras, allow you to select a face from a large distance.
- **Gigapixel Imaging**: Our MR-15-30 2D fast steering mirror in combination with a standard camera and an electric lens allow you to generate high-resolution images.
- **Adaptive Headlights**: Our MR-15-30 2D fast steering mirror combined with a laser light engine could be the next generation headlight.
- **OCT**: Our MR-15-30 2D fast steering mirror.
- **Cosmetic Lasers**: Our MR-15-30 fast steering mirror for fast and compact point and shoot laser beam-steering.

### Key Benefits
- **Compact**
- **Combination of large mirror size and large FOV**
- **Long lifetime (>1 billion cycles)**
- **Designed for high vibration and shock resistance**
- **Wide choice of coating options (including dielectrics)**
- **Customizations are available on a project basis**
- **Gigapixel resolution through image stitching**
- **Large FOV**
- **Compact**
- **Fast**
- **Large FOV (100°)**
- **Robust (>1B cycles)**
- **Compact and light-weight handpiece for better comfort**
- **Up to 15 mm mirror size for small spot size**
- **Up to 100° FOV**
- **Simpler optics (no beam-shift)**
- **Reduced reflection losses (single mirror surface)**

### Products
- **MR-10-30**
- **1D mirrors upon request**
- **MR-15-30**
- **FMR-20**
- **FOV expansion development kit**
- **MR-15-30**
- **MR-10-30**
- **MR-15-30**
THE NEW WAY OF LIGHT CONTROL

OPTOTUNE’S VERSATILE AND COMPACT FAST STEERING MIRRORS

Fast steering mirrors outperform MEMS and galvos when it comes to the combination of mirror size, tilt angle and compactness

www.optotune.com