

Lemoptix MEMS Scanning Micromirrors

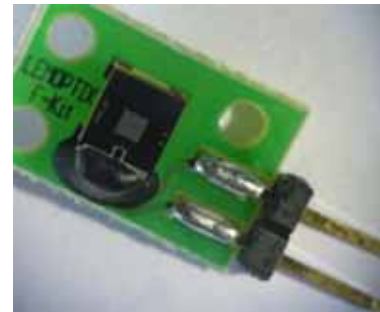
MEMS Technology

MEMS (MicroElectroMechanical-Systems) technologies are derived from the classic microelectronics industry. MEMS components are today fabricated and integrated in a large range of applications (e.g. in the automotive industry to control airbags). Excellent long-term reliability of silicon-based MEMS is one of the main reasons for adoption.

MEMS Scanning Micromirrors: Resonant or static operation

Lemoptix's micromirrors made of single-crystal silicon demonstrate very high robustness and long-term stability. Unique features of MEMS scanning micromirrors are:

- **Ultra-small size**
 - **Low operating voltage (below 5V)**
 - **Very large scanning angle**
 - **High operating frequency**
 - **Static operation**
 - **Low power consumption**
 - **Linear mirror deflection with applied signal**
 - **Insensitive to radiation**
 - **Insensitive to ESD (ElectroStatic Discharge)**
 - **Insensitive to dust (from electronics side)**
 - **No Hysteresis behavior**
- The surface reflectivity is enhanced by a thin coating of metal material. The fabrication being highly flexible, a large variety of materials can be coated, depending on the wavelength used.
 - Lemoptix's resonant and static scanning micromirrors are designed to periodically rotate and deflect light.



Chip on 3mm x 10mm standard PCB board with Pin connectors (including magnets)

Suitable Applications

Due to the unique combination of performance and size, many optical applications can benefit from Lemoptix's scanning micromirrors:

- **Barcode scanners:** MEMS scanning micromirrors are ideal for long range laser barcodes and small scanning module heads.
- **Laser printer:** Suitable to replace optical scanning system in laser printer, providing higher resolution printing, lower size system and higher reliability.
- **Endoscopy/confocal microscopy:** Tiny scanning micromirrors can be used in endoscope heads or in confocal microscopes.

- **Medical imaging:** Suitable for high speed high resolution medical imaging.
- **Optical sensing:** 3D distance measurement sensing
- **Laser pointing:** Steering laser beam light to any suitable position

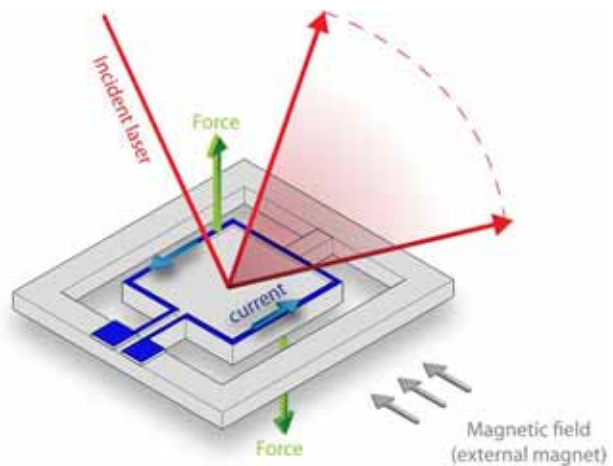
Lemoptix MEMS Scanning Micromirror Technology

Magnetic actuation principle and characteristics

MEMS mirror actuation does not use gearing effects or any other mechanical contact-based effects. It uses an innovative fatigue-free magnetic actuation: an electric current flowing on the mirror itself, under a magnetic field, induces mechanical displacement, advantageously used for optical scanning.

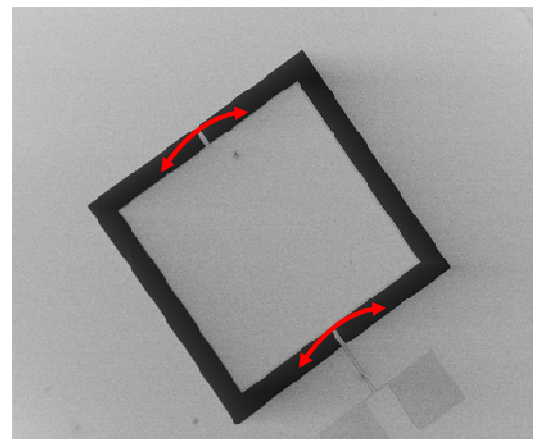
Resonant actuation: specifically designed MEMS mirrors to be actuated at their mechanical resonant frequency. The maximum intrinsic silicon material gain is used to obtain the widest possible scanning angle at an ultra-low power consumption level.

Static actuation: specifically designed MEMS mirrors to be actuated in static operation, meaning that the mirror is tilted and the position is held stable.



Achievable performance range

Actuation	1D (1 axis) or 2D (2 axis)
Micromirror size	Up to 6mm
Scanning angle	Up to 60° (optical)
Light reflection	> 90% in visible and IR
Shock resistance	> 2000g
Actuation voltage	< 5V
Resonant Frequency	From 500 Hz to 70 kHz
Static actuation	From fix steps to 400Hz
Consumption	From 0.1mW to 100mW
Chip size	Down to 3mm x 3.5mm



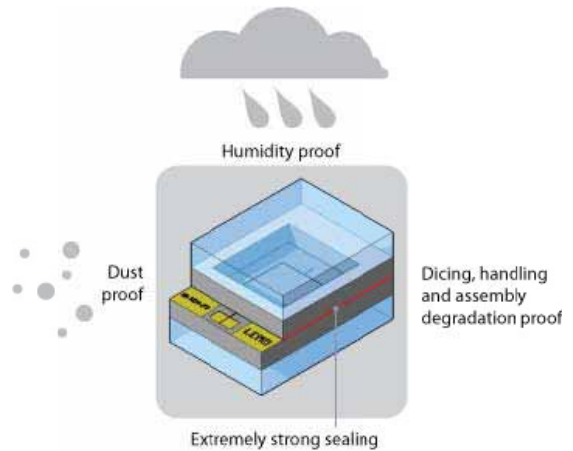
200µm EHT = 3.00 kV Signal A = SE2
WD = 6 nm Stage at T = 0.8° File Name = MIMAG_1

1D magnetic micromirror (deflection around central axis)

Fully Hermetic Packaged MEMS Mirrors

Lemoptix has developed unique and proprietary fully hermetically packaged MEMS scanning mirror technology. Packaged MEMS devices are a key requirement for high volume / low cost manufacturing, generating a high fabrication and assembly yield. Lemoptix packaged MEMS scanning mirrors are therefore totally protected:

- No manipulation damages
- No humidity
- No dust and particle contamination



Lemoptix Services and Products

Customized scanning micromirrors design

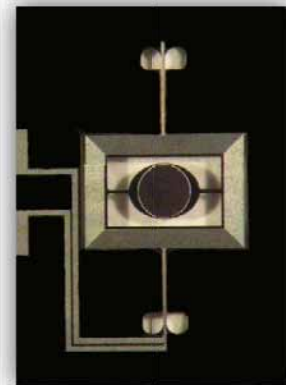
- Specific design of 1-Dimensionnal or 2-Dimensionnal MEMS micromirrors to suite exactly your needs
- Micromirror frequency and size design. Various possible reflective materials (Al, Au) depending on wavelength.

Assembly and mounting

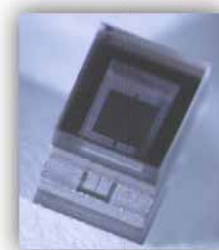
- MEMS micromirror can either be delivered fully encapsulated or not encapsulated, depending on the application
- MEMS micromirrors are usually mounted as a standard on a rigid PCB
- Other assembly options are compatible with Lemoptix MEMS micromirrors processes, including mounting on ceramic or flexible PCB

Driving and sensing electronics

- Lemoptix can provide high performance driving electronics to drive the MEMS mirror and sensing electronics to provide information of the mirror tilting position at any time.
- Analog and Digital electronics can be provided to ensure rapid and easy implementation of Lemoptix MEMS micromirror on any existing electronics platform.



2D MEMS micromirror



Fully hermetically encapsulated MEMS micromirror

Lemoptix standard 1D Scanning Micromirror Performances

1. Resonant MEMS mirrors

Characteristics	F3	F4	F5	F6	F7	F8
Mechanical resonant frequency (+/- 4%)	2.7 kHz	4.5 kHz	9.5 kHz	15kHz	19 kHz	24kHz
Max total optical tilt angle (+/- 4%)	70° (+/-35°)	65° (+/-32.5°)	34° (+/-17°)	38° (+/-19°)	40° (+/-20°)	36° (+/-18°)
Max mechanical tilt angle	+/-17.5°	+/-16.25°	+/-8.5°	+/-9.5°	+/-10°	+/-9°
Mirror size, rectangular shape (X,Y) in mm ²	1 x 1	1x1	1 x 1	1 x 1	1 x 1	1 x 1
MEMS chip size with magnets (Width, Length, Height)	All similar: 3mm x 3.5mm x 2.3mm					
PCB mounted size (Width, Length, Height)	All similar: 3mm x 10mm x 3.1mm					
Reflectivity (450 to 700 nm)	> 85%	> 85%	> 85%	> 85%	> 85%	> 85%
Shock resistance	>4'000g	>4'000g	>4'000g	>4'000g	>4'000g	>4'000g
Input impedance (+/- 5%)	~125Ω	~125Ω	~125Ω	~125Ω	~125Ω	~230Ω
Power consumption at the max. scanning angle (instantaneous)	0.04mW (at 0.2V)	0.25mW (at 0.25V)	3.25mW (at 0.65V)	30mW (at 2V)	80mW (at 3.5V)	95mW (at 4.7V)
Reliability testing	> 10 ¹¹ cycles	> 10 ¹¹ cycles	> 10 ¹¹ cycles	> 10 ¹¹ cycles	> 10 ¹¹ cycles	> 10 ¹¹ cycles
Product part number	1D1-F3	1D1-F4	1D1-F5	1D1-F6	1D1-F7	1D1-F8

- These standard available micromirrors are optimally actuated with AC voltage, at mechanical resonance
- These standard available micromirrors are delivered on rigid PCB with electrical connector and without glass packaging

2. Static MEMS mirrors (steering mirrors)

Characteristics	DC2	DC3
Max optical tilt angle (in static mode)	40° (+/-20°)	35° (+/-17.5°)
Max mechanical scanning angle	+/-10°	+/-8.75°
Mechanical resonant frequency (+/-4%)	600 Hz	400 Hz
Mirror size, rectangular shape (X,Y) in mm ²	4.1 x 1.1	2.6 x 2.6
MEMS chip size with magnets (Width, Length, Height)	All similar: 4.9mm x 7.8mm x 2.3mm	
PCB mounted size (Width, Length, Height)	All similar: 4.9mm x 12mm x 3.1mm	
Reflectivity (450 to 700 nm)	> 85%	> 85%
Input impedance (+/- 5%)	~275Ω	~275Ω
Power consumption at the maximum scanning angle	42mW (at 3.5V)	25mW (at 2.6V)
Reliability testing	> 10 ¹¹ cycles	> 10 ¹¹ cycles
Product part number	1D1-DC2	1D1-DC3

- These standard available micromirrors are usually actuated outside of their mechanical resonant frequency with DC applied signal, but can also be actuated at their mechanical resonant frequency (lower actuation signal level will then be applied)
- These standard available micromirrors are delivered on rigid PCB with electrical connector and without glass packaging

Lemoptix

Your partner for innovative and reliable optical scanning solutions