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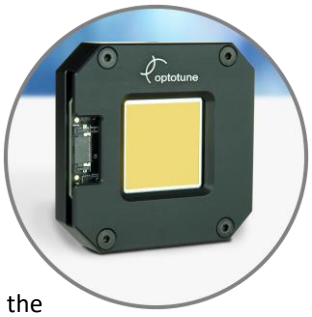
shaping the future of optics



Fine steering mirror FMR-20

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^2 they can scan various beam patterns at up to 250 Hz bandwidth with a ±2.3 mrad tilt range. Together with the Optotune ICC-4C-2000 Industrial Current Controller, the FMR-20 is a plug-and-play fine steering solution.

Main features:

- One large optical surface for 2 DOF motion
- Linear (current vs angle)
- Bearingless design – no particles generated, no wear, no friction
- Suitable for high power laser applications[1]

Tailoring to specific geometric, actuation, and optical requirements possible upon request.

Mechanical specifications[2]

Actuator type	Voice coil	
Mechanical tilt angle, single axis[3]	±5.2 ±0.3	mrad °
Mechanical tilt angle, simultaneous actuation of both axes[3]	±3.5 ±0.2	mrad ° Circular field of view
Mirror size	20 x 20	mm
Mirror thickness	2	mm
Device dimensions (width x height x depth)	50.8 x 50.8 x 12	mm
Weight	53	g

Performance specifications

Motion pattern	2D programmable	
Position control	Open loop	
External sensor for feedback control	Can be added	
Scale drift	1000	ppm/K
Resolution (with ICC-4C-2000)	4	µrad
Static motor constant	17.5 1.0	mrad/A °/A
Dynamic motor constant	$1.2 \cdot 10^4$	rad/(As^2)
Resonance frequency	130 ± 5	Hz

[1] For high-power laser applications, a standard dielectric coating or a custom coating is required. It is the responsibility of the customer to provide a beam dump for the transmitted light and to ensure system-level laser safety.

[2] All angles refer to mechanical angles.

[3] Higher mechanical tilt angles of up to ±0.4° can be reached, limited by mechanical tolerances. Please note that there is a risk of damaging the device at deflections larger than ±0.3°, as well as increased noise and reduced overall performance. If you would like to operate the FMR-20 at such deflections, please contact sales@optotune.com.

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Bandwidth (sine wave, ± 2.3 mrad)	250	Hz
Typ. transition (rise) time[4]	1.3	ms
Settling time[4]	4	ms

Optical specifications

Surface finish	Protected gold, dielectric NIR, 1064 nm high-power, custom	
Reflectivity Protected gold Dielectric NIR 1064 nm high-power	 >95% for 800-2000 nm >98% for 750-1100 nm >99.9% for 1060-1100 nm	 0-45° AOI 0-45° AOI 58-70° AOI
Surface quality	5/ 5x0.4; L1x0.06; C3x0.25	ISO 10110, equivalent to scratch-dig 60/40
Mirror flatness	2 λ (1100 nm)	P-V
Damage threshold (LIDT) for 1064 nm high-power coating	10 J/cm²	10 ns, 10 Hz, 1064 nm ISO 21254

Electrical specifications

Max. continuous current (RMS)	single axis: 300 both axes: 200	mA, per channel
Max. peak current (10 ms duration)	1	A
Power consumption (average)	< 4	W
Nominal actuator resistance per channel	9.8	Ω
Temperature sensor	ILM75BTP,147 or compatible	I2C-address: 1001100x (R: 0x98 / W: 0x99)
EEPROM	M24C64-FMC6TG or compatible	I2X-address: 1010000x (R: 0xA0 / W: 0xA1)

Overview of available standard products

Standard Product	Version	Coating
FMR-20-PG-0.2x0.2D-M	Mounted in housing	Protected gold
FMR-20-DNIR-0.2x0.2D-M	Mounted in housing	Dielectric NIR
FMR-20-1064HP-0.2x0.2D-M	Mounted in housing	1064 nm high-power
FMR-20-PG-0.2x0.2D	Unmounted	Protected gold
FMR-20-DNIR-0.2x0.2D	Unmounted	Dielectric NIR
FMR-20-1064HP-0.2x0.2D	Unmounted	1064 nm high-power

Control

The FMR-20 is controlled with Optotune's ICC-4C-2000 industrial 4-channel controller, together with the ICC-4C-2000 extension kit (adapter board). One ICC-4C-2000 has four output channels and supports two FMR-20 devices. See separate datasheet for more information.

For the device control, please install the latest software and firmware from our website:

- Optotune Cockpit (GUI)
- ICC-4C-2000 Firmware
- ICC-4C SDK in Python or C#

[4] The transition time is the time it takes from one setpoint to the next, within a 12.5% margin. The shortest transition times are reached with an optimized current input, available on the ICC-4C-2000. The settling time can be as small as three times the transition time. The transition time depends only moderately on the step size, here given for 3.5 mrad (half range).

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For optimized operation with arbitrary trajectories, a smart filter for the input signal is available in a function called SmartStep. For access to SmartStep, either within Optotune Cockpit or as part of the Python SDK, please contact sales@optotune.com.

Mechanical layout

The FMR-20 is offered in two configurations – mounted in a housing, and unmounted. The mechanical layout of the FMR-20 in a housing (product name FMR-20-PG-0.2x0.2D-M or FMR-20-DNIR-0.2x0.2D-M) is illustrated in Fig. 1. The housing supports mounting on standard optical posts (M4).

The mounted version of the FMR-20 facilitates plug-and-play operation of the device.

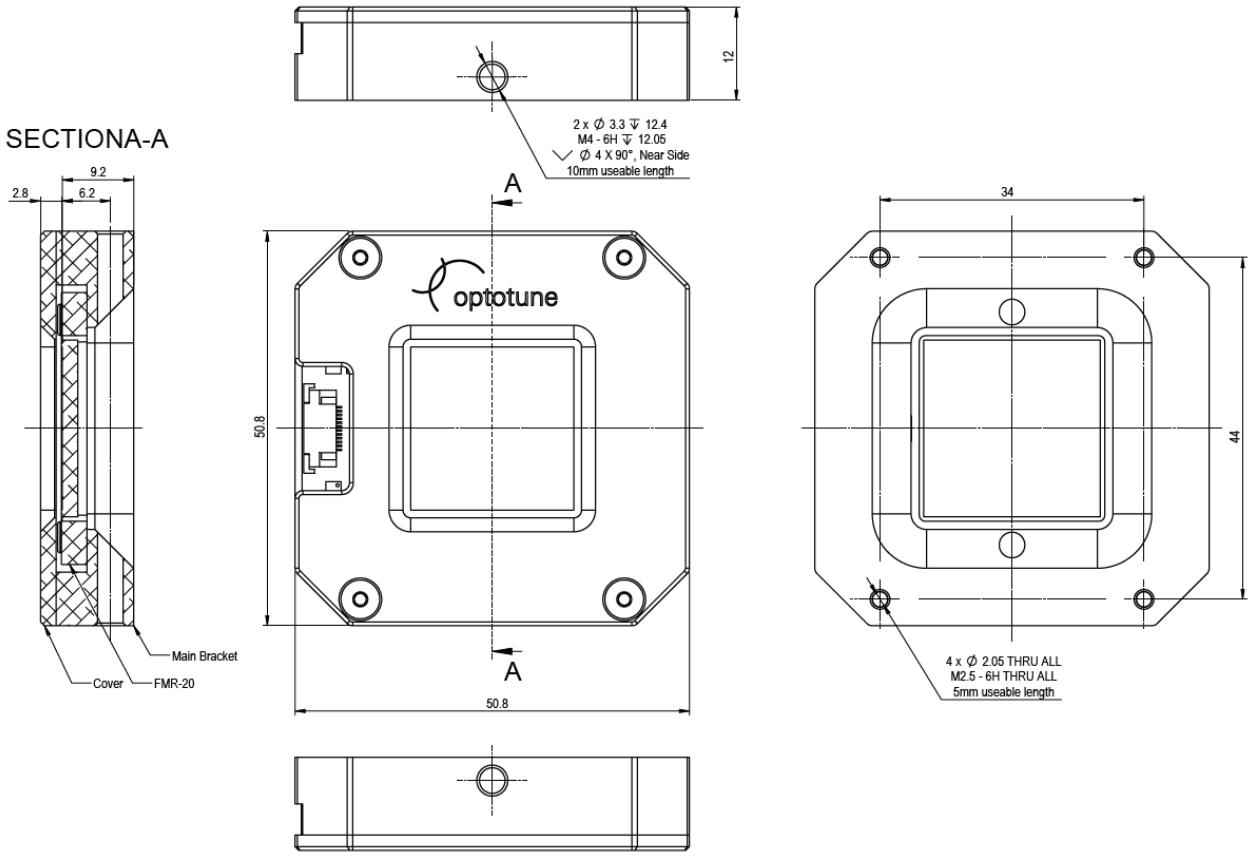

Figure 1: Mechanical drawing of the FMR-20 mounted in a housing. Units: mm.

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The housing of the FMR-20 is compatible with the kinematic mount #58-861 from Edmund Optics (not included), shown in Fig. 2. This tip-tilt stage allows to do a manual angular coarse adjustment. The item is to be purchased directly from Edmund Optics.

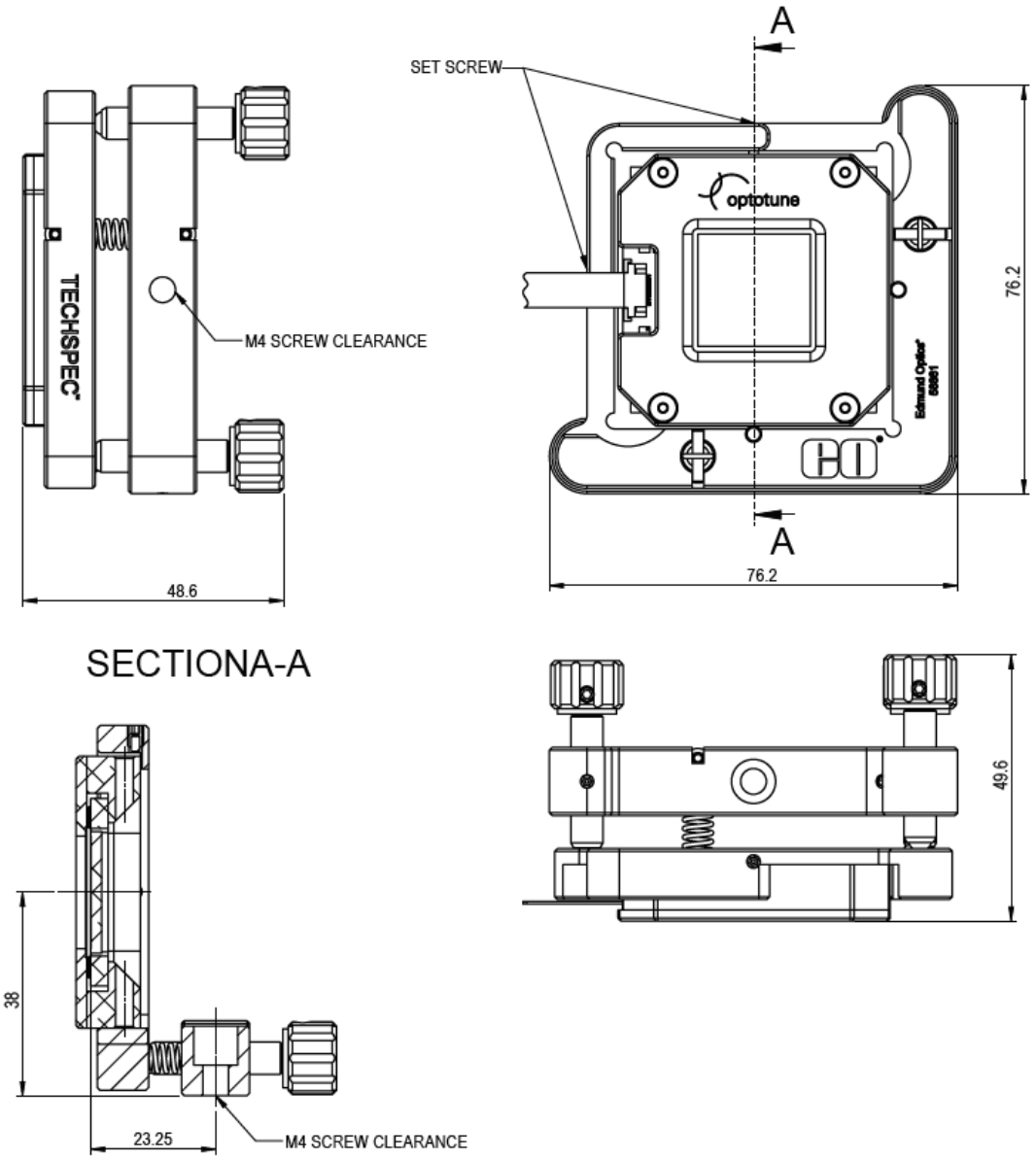

Figure 2: Compatible kinematic mount for the FMR-20.

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The mechanical layout of the FMR-20 without the housing (product name FMR-20-PG-0.2x0.2D or FMR-20-DNIR-0.2x0.2D) is illustrated in Fig. 3. For more details on this configuration, please contact Optotune.

The unmounted version of the FMR-20 simplifies the integration of the device into other systems.

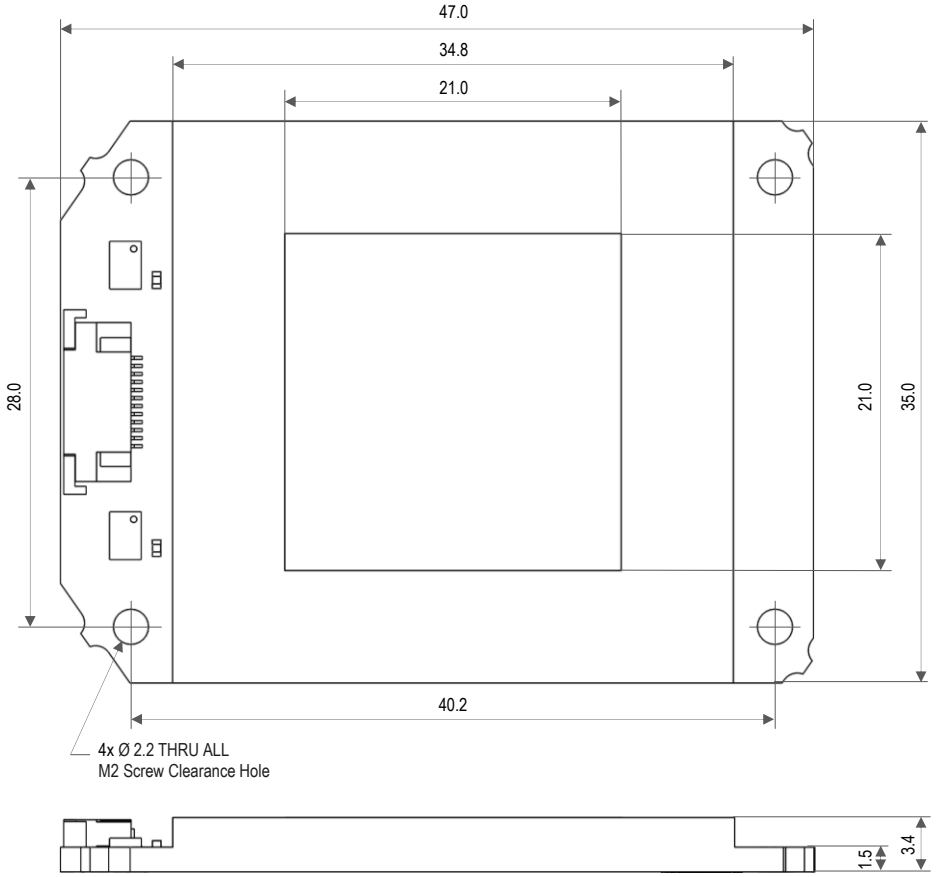

Figure 3: Mechanical drawing of the unmounted FMR-20. Units: mm.

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Electrical layout

The FMR-20 connection is a standard FFC cable (Molex 12 pin, 0.5 mm pitch). The cable can be plugged directly into the connector of the adaptor board, following Fig. 4: open the connector clamp with tweezers, insert the flex cable fully with the copper pads facing upwards, and close the black clamp by pushing both sides simultaneously.

IMPORTANT: Do NOT hotplug the flex cable from the device!

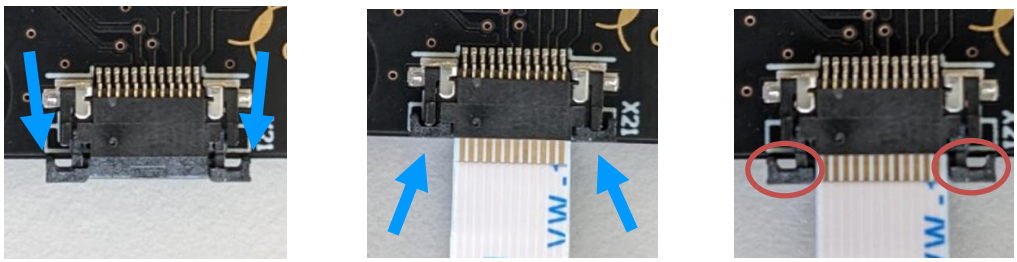
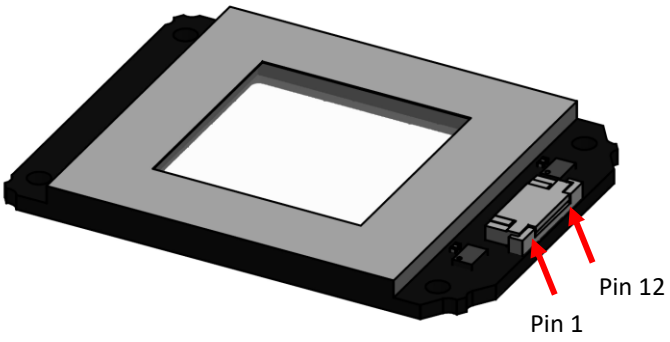


Figure 4: FFC cable connection. From left to right: open the connector clamp, indicated by blue arrows; insert the cable and close the connector clamp; connection cannot be guaranteed if the clamp is still open.

The pinout of the FMR-20 is shown in Fig. 5.



Pinout: FMR-20		
Position	**Function**	**Value**
1	Axis X+	0-300 mA
2	Axis X-	0-300 mA
3	Axis Y+	0-300 mA
4	Axis Y-	0-300 mA
5	Vcc	3.3 V
6	I²C SDA	Digital signal
7	I²C SCL	Digital signal
8	GND	-
9	N.C.	-
10	N.C.	-
11	N.C.	-
12	N.C.	-

Figure 5: Pin assignment of the FMR-20. RMS values are stated for the X/Y axis current control.

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Reflectivity

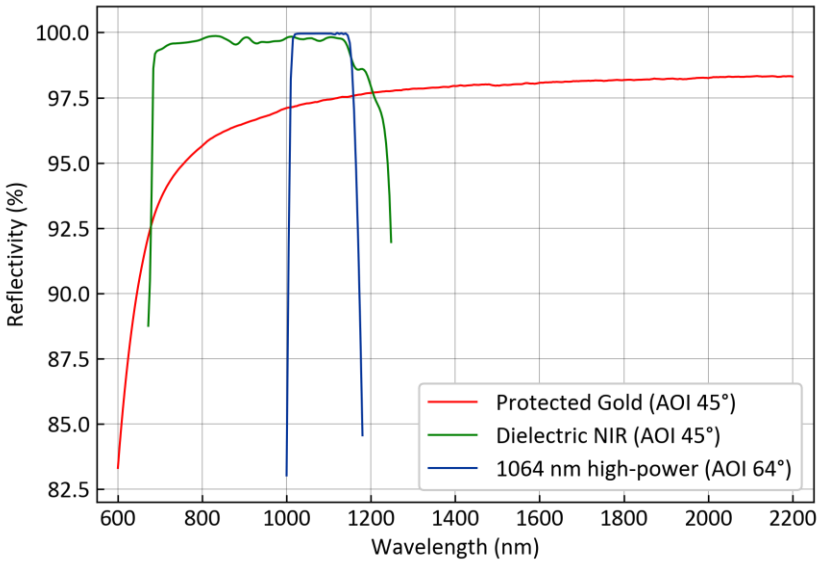

Figure 6: Reflectivity of the FMR-20 standard coatings.

Static response

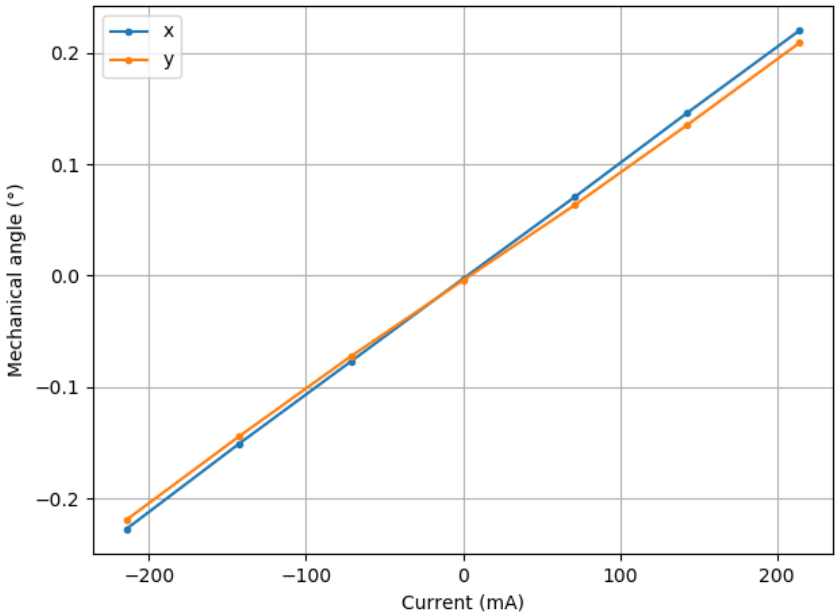

Figure 7: Typical static response as a function of current for the two axes of the FMR-20.

Frequency response

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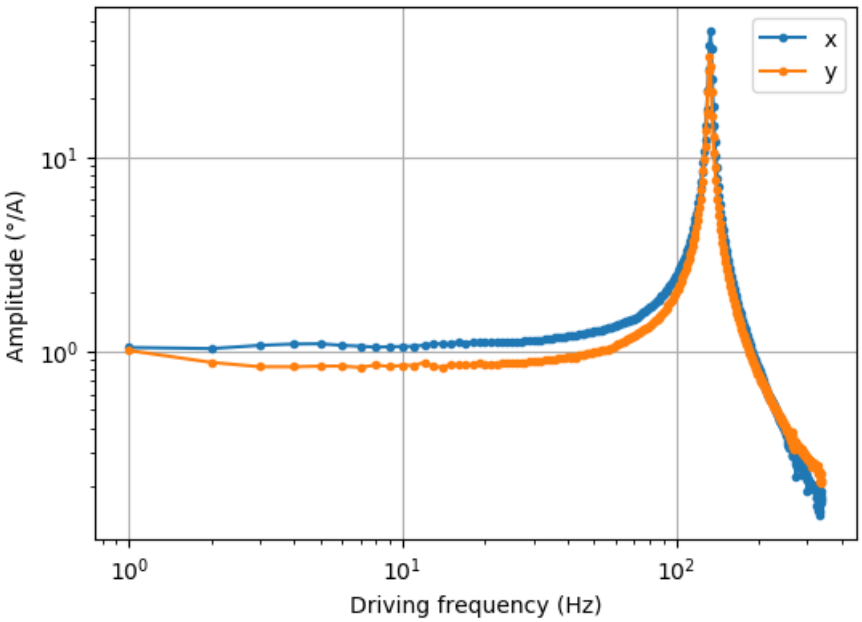

Figure 8: Typical frequency response for the two axes. The resonance frequencies for x and y are at 132 Hz and 133 Hz, respectively.

Step response

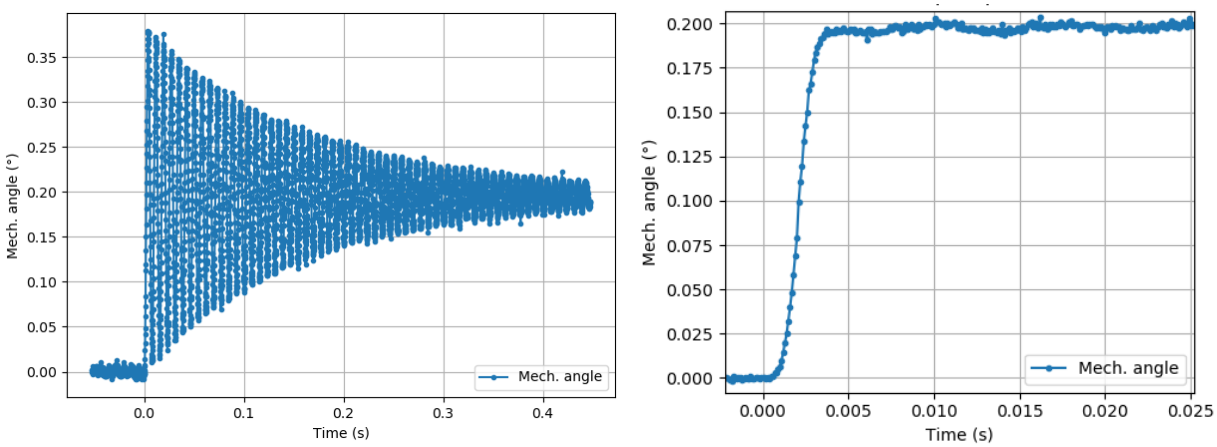

Figure 9: Step response of the FMR-20 with a sharp current step input (left) and optimized current input (right). Exciting the resonance can be avoided by filtering the input (available on the ICC-4C-2000 controller), which reduces the step response time from about 1 s to about 4 ms.

Safety and compliance

The product fulfills the RoHS, REACH, CE and UL94 V-0 compliance standards. The customer is solely responsible for complying with all relevant safety regulations for integration and operation.

For more information on optical, mechanical, and electrical parameters, please contact sales@optotune.com.

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