

# MFG-100/MFG-100-i

## MagnebotiX桌面磁场和梯度控制系统

MagnebotiX MFG-100/100-i系统包括桌面磁场产生单元、电力电子设备和控制软件用户界面(MBX Pro)。该系统能够在直径约为10毫米的球形工作空间内产生任意方向的磁场和场梯度。该系统在平移自由度和旋转自由度上均不受约束,可实现5自由度(3-DOF位置, 2-DOF方向)悬浮和控制粘性液体中的磁性物体。通过应用时变信号,实现了磁性物体的旋转或步进驱动。使用我们的MBX控制软件及其基于插件的架构,可以采用多种控制策略,从手动开环控制到定制解决方案,用于沿预定义路径对磁性物体进行全自动伺服。MagnebotiX MFG-100-i适用于倒置配置,例如倒置显微镜。



### 磁场产生和控制模式

- **磁场控制:**在工作空间内产生任意方向的磁场矢量,用于磁化铁磁性物体。可以自由移动的磁性物体将与外部磁场对齐
- **梯度控制:**对磁化物体施加一个力,使物体沿磁场梯度向任意方向移动或使物体悬浮在液体中
- **旋转控制:**可控制地改变磁场方向,对磁化物体施加转矩,使磁化物体偏转时重新定向,移动时随外场自由旋转
- **用户特定的控制:**定义场和梯度作为时间的函数使用标准的数学符号:方波,锯齿,处理场矢量,指数递减-如果你可以定义它的数学,你可以产生与我们的新软件。

### 建议应用领域

- 通过对空气或液体中的小磁性物体施加磁力和力矩的影响来研究磁微致动策略
- 从粘性液体中选择性地分离和提取自然磁性或磁性标记的生物和非生物物体
- 利用无系留的磁性末端执行器对液体中非磁性物体进行机械操作和提取
- 小物体与无系留磁末端执行器相互作用的力学特性研究
- 单细胞或工程组织水平的机械生物学研究,例如与微生物和细胞的直接机械相互作用,以及使用无系绳磁性末端执行器研究它们的行为反应
- 在小动物水平的体内研究,如斑马鱼

## System Components

### MagnebotiX MFG-100 / 100-i magnetic field and gradient generation unit

- Maximum working volume diameter: 1 cm
- Max. magnetic field strength (center): 20 mT in any direction
- Max. magnetic field gradient (center): 2 T/m
- Max. magnetic field frequency: 300 Hz at 2 mT, 80Hz at 10 mT
- Max. slew rate per coil at 20 A step input: 20 T/s
- Dimensions (W x D x H): 250 mm x 275 mm x 110 mm
- Weight: 4.5 kg



### MagnebotiX ECB820 power unit

- Number of channels: 8
- Max. current per channel: 20 A
- Max. voltage per channel: 48 V
- Max. power consumption: 1008 W
- External power requirements: 110 - 240 VAC / 50 - 60 Hz
- Dimensions (W x D x H): 440 mm x 325 mm x 130 mm
- Weight: 10 kg
- Connection to control computer: Ethernet



System safety features: over-temperature and over-current monitoring of all coils; controller shutdown upon loss of communication with coil unit; external emergency shutdown switch.

### MagnebotiX HID100 human input devices

- Input devices: Keyboard, mouse, SpaceNavigator (3Dconnexion), PlayStation3 controller

### Microscope, cameras and lenses not included

- Microscope or lenses are determined by the user according to experiments to be performed. Basler USB3 cameras are compatible with our MBX Pro software (plug-and-play (e.g., Basler USB3 ACE or Pulse series).
- Tested products : Stereo (dissecting) microscope with a suitable stand to accommodate the MFG-100 (Olympus, Leitz, etc.)
  - : Edmund VZM 200i 2x zoom lens (WD: 90mm, DOF: 1.5mm) optics.
  - : inverted fluorescence microscope models: Olympus IX 71, 73, 81 and 83; Nikon Eclipse TE2000/Ti-S/Ti2

The principle of the magnetic field generating technology is protected by patents WO 2011029592 A1 and WO 2013127516 A1 to ETH Zurich and sub-licensed to MagnebotiX AG. For more details on the MFG100 / MFG100-I systems see S. Schuerle, S. Erni, M. Flink, B. E. Kratochvil, B. J. Nelson, "Three-Dimensional Magnetic Manipulation of Micro- and Nanostructures for Applications in Life Sciences", *IEEE Transactions on Magnetics*, Vol. 49, No. 1, January 2013, pp. 321-330.

The MBX Control software was originally developed ("daedalus") in the Institute of Robotics and Intelligent Systems, Multiscale Robotics Lab, ETH Zürich.

All specifications are subject to change without notice.