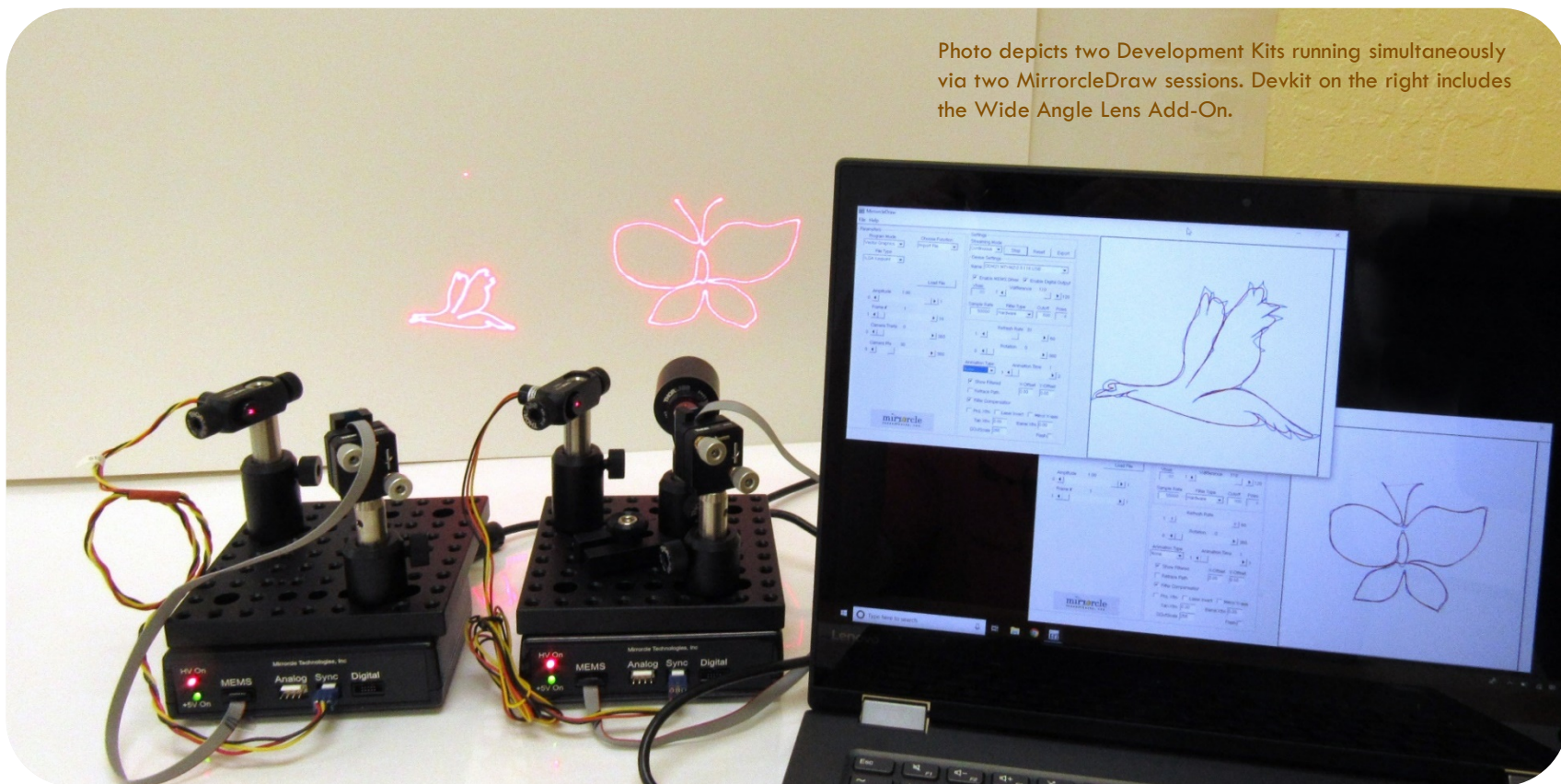


The products discussed in this guide are intended for development and prototyping purposes as **OEM** subsystems for incorporation into customer's prototypes and end products. Therefore, they do not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser products.

Photo depicts two Development Kits running simultaneously via two MirrorcleDraw sessions. Devkit on the right includes the Wide Angle Lens Add-On.



# MEMS MIRROR DEVELOPMENT KIT



Last Revised: Dec. 2022

OVERVIEW

Mirracle Technologies, Inc.

# Table of Contents

- **MEMS Mirror Development Kits**
  - DK-015: Standard Development Kit
  - DK-016: Semi-Custom Development Kit
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  - DK-026: LiDAR/Imaging MEMS Dev Kit I
  - DK-027: LiDAR/Imaging MEMS Dev Kit II
- **Development Kit Add-Ons**
- **Development Kit USB MEMS Controller**
- **Development Kit Software**
  - Mirrorcle Software Suite
  - Software Development Kits
- **Pricing and Availability**

Many of the listed products include lasers and are offered as components and intended for development and prototyping purposes as an **OEM** subsystem for incorporation into customer's prototypes and end products. Therefore, they does not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser products.

# Development Kits

The listed products in this section are intended for development and prototyping purposes as an **OEM** subsystem for incorporation into customer's prototypes and end products. Therefore, they do not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser products.

# Mirrorcle Development Kits Overview

- Standard Development Kit (P/N: DK-015)
  - Standard Dev Kit has the three mirror sizes. The MEMS Mirrors are preselected and premanufactured to **reduce cost and delivery time**.
    - Customers choose window and window mounting (see [Packages and Mounts](#) guide)
- Semi-Custom Development Kit (P/N: DK-016)
  - Semi-Custom Dev Kit allows **users to select** from **various available actuator, mirror size** and **coating** combinations to best suit their application.
  - Contact [sales@mirrorcletech.com](mailto:sales@mirrorcletech.com) for more details on various options.
- Development Kit with a Scan Module (P/N: DK-030)
  - Dev Kit with Scan Module includes the EaZy4.0G scan module, a **pre-assembled optomechanical cell** with MEMS mirror, laser module and wide-angle optics, for rapid prototyping as a **complete optical laser beam steering solution**.
  - The combination of the Scan Module, the USB-SL MZ Controller, and Mirrorcle Software Suite allows users to create programmable illumination (e.g. for 3D Metrology) and synchronize that laser scanning with other systems.

# LiDAR/Imaging MEMS Development Kits Overview

- LiDAR/Imaging MEMS Dev Kit 1 (P/N: DK-026)\*
  - Large diameter, large angle MEMS mirrors, typically used in coaxial imaging designs (both transmit and sense/receive paths going through the MEMS mirror).
    - Customers choose window and window mounting (see [Packages and Mounts](#) guide)
- LiDAR/Imaging MEMS Dev Kit 2 (P/N: DK-027)\*
  - Medium diameter, large angle MEMS mirrors, fastest and most robust, typically used in biaxial/bistatic imaging designs only on illumination/transmit paths, or in shorter distance coaxial designs.
    - Customers choose window and window mounting (see [Packages and Mounts](#) guide)

\*LiDAR/Imaging MEMS development kits are for developers of systems such as **OCT/Confocal** imaging systems, **LiDARs**, **3D Scanning**, and include MEMS Mirrors and supporting hardware and software to assist developers with integration into complete prototypes and/or products. When combined with **user's own ToF or FMCW receiver**, they offer a very short route to a complete LiDAR reference design / prototype system. Similarly, developers of bio-imaging (OCT and other modalities) systems will find these a perfect fit. For a fully functional 3D LiDAR demonstrator kit see **DEMO-07** Demonstrator Kit ("SyMPL 3D LiDAR") [on Mirrorcle's website](#).

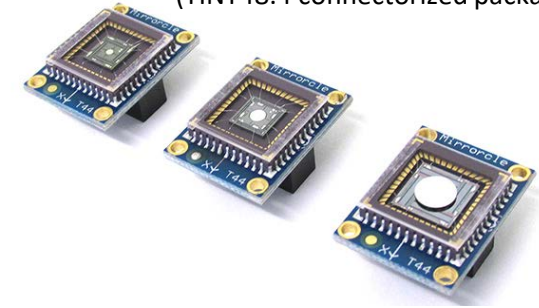
**Note on Kit Pricing:** as bundled, the LiDAR/Imaging Kits offer a nearly **\$1400 discount** from the list pricing of equivalent items (in a Semi-Custom kit with identical selections). This is offered along with **shorter lead times** however contents **cannot be modified**.

# Standard Development Kit



# Standard Development Kit - Contents

MEMS Mirrors in DK-015  
(TINY48.4 connectorized packages)



- **Three Gimbal-less Dual-Axis MEMS Mirrors**
  - 1.0mm diameter, AL-coated (P/N: A7M10.2-1000AL-TINY48.4-[cover])
  - 2.0mm diameter, AL-coated (P/N: A7M20.2-2000AL-TINY48.4-[cover])
  - 4.2mm diameter, AL-coated (P/N: A8L2.2-4200AL-TINY48.4-[cover])
    - For cover options (window coating, mounting) options (see [Packages and Mounts](#) guide)
- **USB MEMS Controller**
  - Includes all necessary cables and connectors
- **Mirrorcle Software Suite**, with comprehensive documentation & support hours
- **Laser and Optical Breadboarding**
  - Red Laser module – with TTL modulation input
  - 90° optical mount for the laser module on a 1/2"-diameter post
  - 4.5" x 4.5" optical plate and two post holders
  - MEMS Mount "Horseshoe" (anodized aluminum) mounted on a kinematic mount (2-axis) and a 1/2"-diameter post. Includes screws and L-key.
- **10-Pin Header Breakout PCBA** allowing simple break out of the 10-pin connectors
- **OPTIONAL Add-ons listed on Development Kit Optional Add-Ons section**

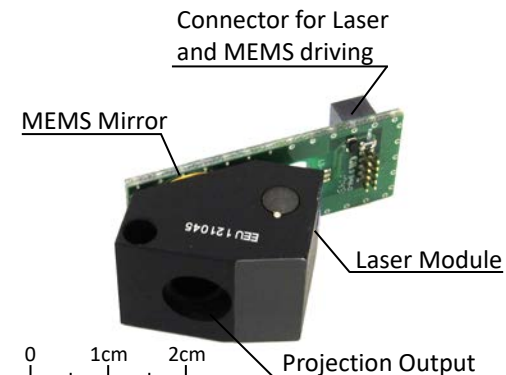
# Development Kit with Scan Module





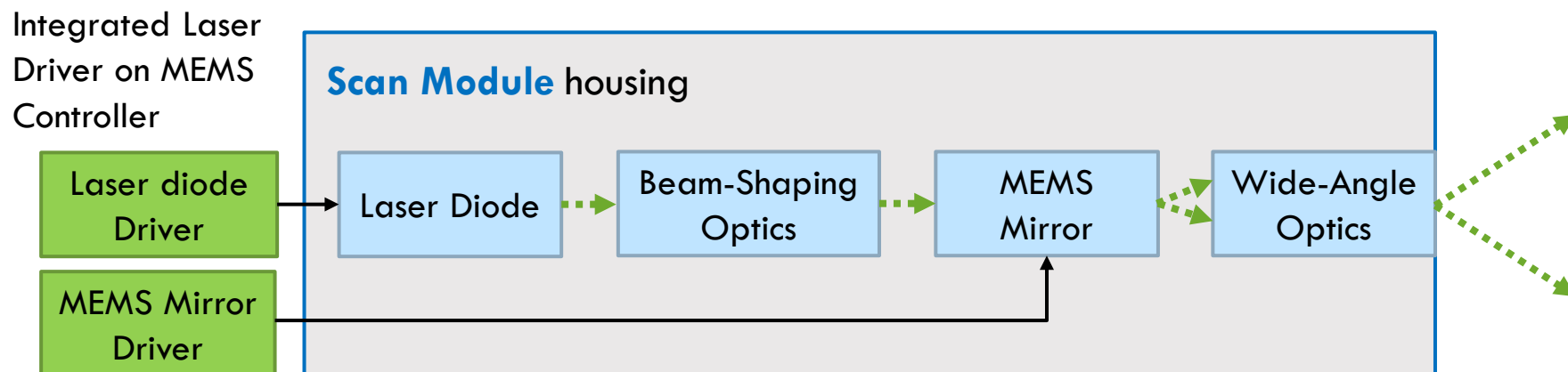
# Development Kit with Scan Module - Contents

- **EaZy4.0G Scan Module**
  - Optomechanical cell with MEMS mirror, laser and optics
  - Green Laser module (520nm), set by Controller to ~4.5mW max.
- **USB MEMS Controller**
  - Includes all necessary cables and connectors
- **Mirrorcle Software Suite**, with comprehensive documentation & support hours
- **Optical Breadboarding**
  - 2.5" x 2.5" optical plate and a 1.5" post holder
  - 2" long (0.5" diameter) post with threading adapter for the Scan Module mounting screw
    - Scan Module is shipped pre-mounted on the post
- **10-Pin Header Breakout PCBA** allowing simple break out of the 10-pin connectors
- **OPTIONAL Add-ons listed on Development Kit Optional Add-Ons section**



# Scan Module Overview

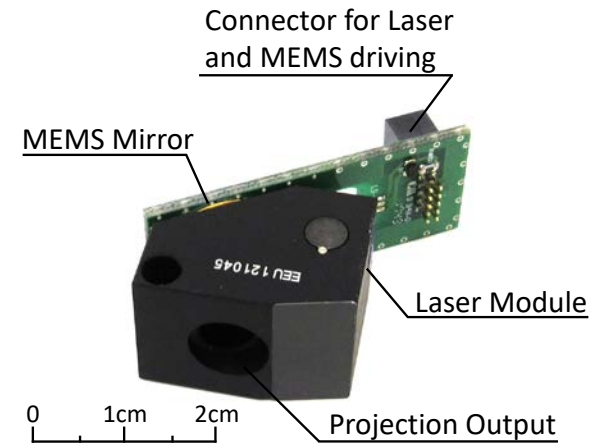
- The Scan Module is an easy to use opto-mechanical assembly of a laser source, beam shaping optics, Mirrorcle MEMS mirror and projection lens to achieve a large optical Field-of-View beam-steering capability.
- The modules have the laser diode pins available to be directly driven with an external laser diode driver.



# Development Kit with Scan Module - EaZy4.0G

## Scan Module

- **MEMS Mirror:** A7M10.2-1000AL
- **Bandwidth:** ~2200Hz in LPF-based driving
- **FoR:** Approx. 34° x 34° Field of Regard
- **Wavelength:** Single laser diode source in:
  - Green (~520nm), <30mW CW power
- **Divergence (half angle, average):** <2.5mrad
- **Repeatability:** <0.005° each axis
- **MEMS Interface:**
  - 10-pin 0.05" Samtec connector, mates with all Mirrorcle MEMS Controllers
- **Laser Interface:**
  - Shares 10-pin MEMS Interface connector (see above)
  - Requires Mirrorcle MEMS Controller which is paired with the Scan Module to match the laser diode (LD) characteristics
- **Recommended Driving Parameters:**
  - Vbias = 90V
  - VdifferenceMax = 160V
  - HardwareFilterBw = 2200Hz



*Example application of EaZy4.0V (405nm) in 3D Scanning Demonstrator Kit (DEMO-06)*



The products discussed in this User Guide are intended for development and prototyping purposes as an **OEM** subsystem for incorporation into customer's prototypes and end products. Therefore, they do not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser products.

# LiDAR/Imaging MEMS Dev Kit I (DK-026)

- **Three Gimbal-less Dual-Axis MEMS Mirrors**
  - 4.2mm diameter, AL-coated (P/N: A8L2.2-4200AL-TINY48.4-[cover])
  - 4.2mm diameter, AL-coated (P/N: A8L2.2-4200AL-TINY48.4-[cover])
  - 5.0mm diameter, AL-coated (P/N: A8L2.2-5000AL-TINY48.4-[cover])
    - For cover options (window coating, mounting) options (see [Packages and Mounts](#) guide)
- **USB MEMS Controller**
  - Includes all necessary cables and connectors
- **Mirrorcle Software Suite**, with comprehensive documentation & support hours
- **Laser and Optical Breadboarding**
  - Red Laser module – with TTL modulation input
  - 90° optical mount for the laser module on a 1/2"-diameter post
  - 4.5" x 4.5" optical plate and two post holders
  - MEMS Mount "Horseshoe" (anodized aluminum) mounted on a kinematic mount (2-axis) and a 1/2"-diameter post. Includes screws and L-key.
- **10-Pin Header Breakout PCBA** allowing simple break out of the 10-pin connectors
- **OPTIONAL Add-ons listed on Development Kit Optional Add-Ons section**



MEMS Mirrors in DK-026  
(TINY48.4 connectorized packages)

# LiDAR/Imaging MEMS Dev Kit II (DK-027)

## Four Gimbal-less Dual-Axis MEMS Mirrors

- 2.0mm diameter, AL-coated (P/N: A7M20.2-2000AL-TINY48.4-[cover])
- 2.0mm diameter, AL-coated (P/N: A7M20.2-2000AL-TINY48.4-[cover])
- 2.4mm diameter, AL-coated (P/N: A5M24.3-2400AL-TINY48.4-[cover])
- 2.4mm diameter, AL-coated (P/N: A5M24.3-2400AL-TINY48.4-[cover])
  - For cover options (window coating, mounting) options (see [Packages and Mounts](#) guide)

## USB MEMS Controller

- Includes all necessary cables and connectors

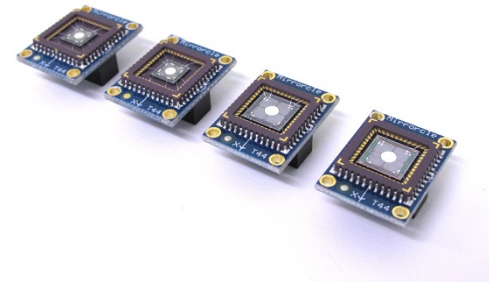
## Mirrorcle Software Suite, with comprehensive documentation & support hours

## Laser and Optical Breadboarding

- Red Laser module – with TTL modulation input
- 90° optical mount for the laser module on a 1/2"-diameter post
- 4.5" x 4.5" optical plate and two post holders
- MEMS Mount "Horseshoe" (anodized aluminum) mounted on a kinematic mount (2-axis) and a 1/2"-diameter post. Includes screws and L-key.

## 10-Pin Header Breakout PCBA allowing simple break out of the 10-pin connectors

## OPTIONAL Add-ons listed on Development Kit Optional Add-Ons section



MEMS Mirrors in DK-027  
(TINY48.4 connectorized packages)



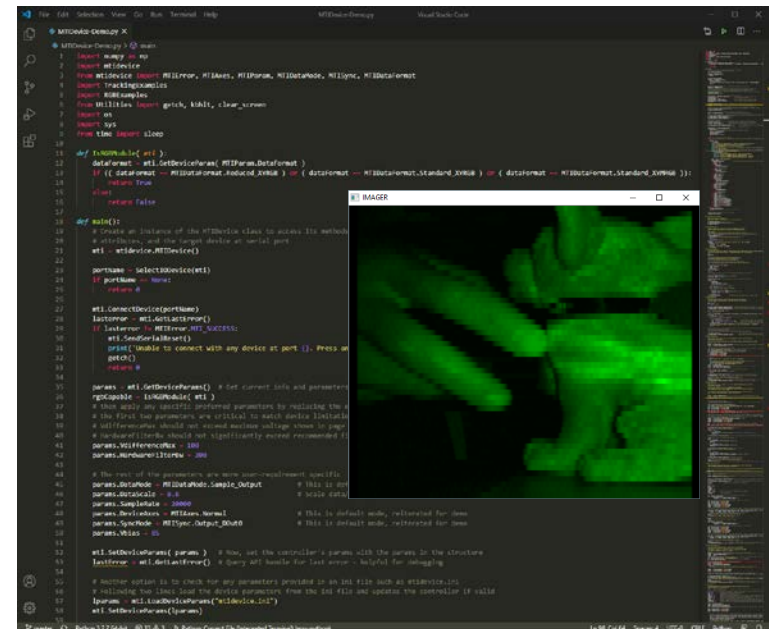
# Development Kit Add-Ons

# Mirrorcle Development Kit Optional Add-Ons

- ❑ Python Software Development Kit
- ❑ Wide Angle Lens
- ❑ Linux Development Kit
- ❑ Laser Tracking Bundle
- ❑ Wireless Option
- ❑ Android Development Kit (Includes Wireless Option)
- ❑ PSD Bundle

# Python Software Development Kit Add-On

- Additional SDK for development using Python language with the same functionality and capability of the Windows-based C++ SDK. Includes a library of functions and multiple example scripts.
- For users of Mirrorcle's Linux Development Kit Add-On, a Linux (Ubuntu 18.04 for x86\_64) compatible version of the Python SDK is also provided.
- Python Software Development Kit includes:
  - MTIDevice-Demo.py
  - RGBExamples.py
  - TrackingExamples.py
  - Demo-Template.py
  - GenerateTextData-Demo.py



Python SDK in Windows example: Development Kit with Tracking Bundle Add-On used in Laser Imaging Mode



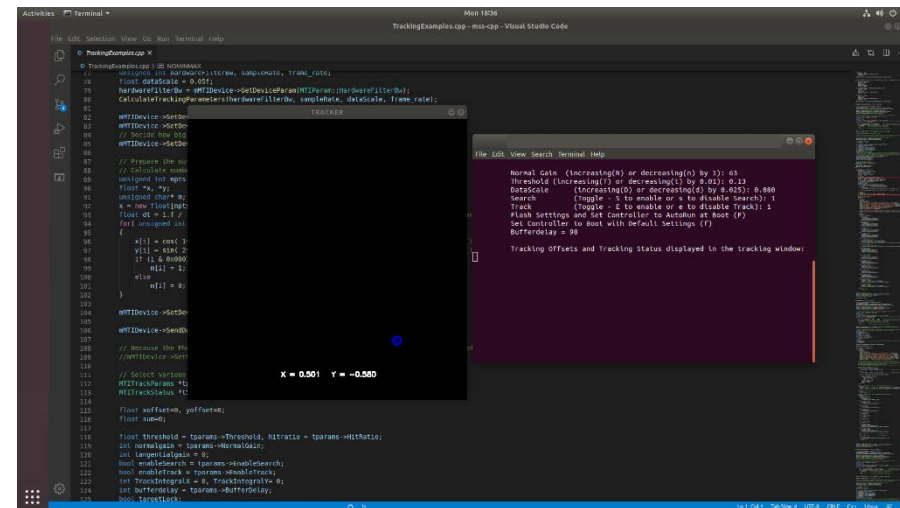
# Wide Angle Lens Add-On



- Custom designed and built with 3 lens elements that will magnify the optical scan-angles of the system by approximately 2.5X. For example, if used with MEMS Mirrors with  $\pm 5^\circ$  tip-tilt mech. Angle, scanned field of regard (FoR) of over  $45^\circ$  is achieved.
- Lens has 1/2" and 1" diameter elements and comes mounted on a 1/2" optical post with a post holder and a swivel element for position adjustment within the experimental breadboard. Lens elements are broadband anti-reflection coated.
- The part number includes the AR coating of the lens, e.g. WAL-A includes A-coating (visible wavelengths), also available with B, and C (Thorlabs AR coatings).
- Design information is available upon request after purchase of the Add-On.

# Linux Development Kit Add-On

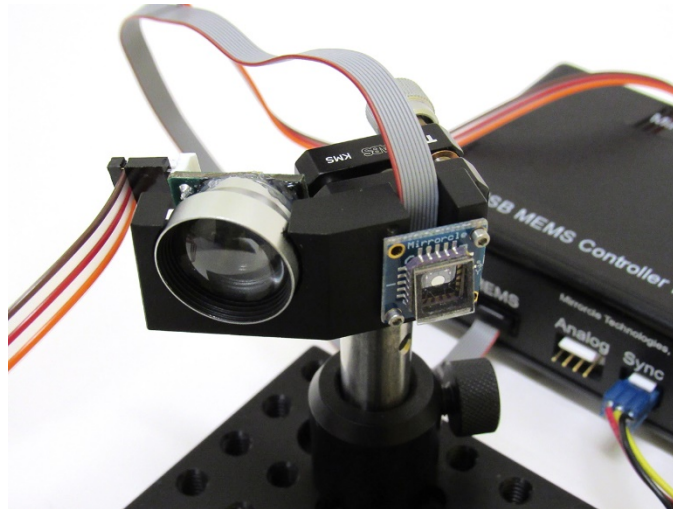
- ❑ Mirrorcle's Linux Development Kit is built on Ubuntu 18.04 for the x86\_64 architecture.
  - ❑ Builds for related architectures such as AMD x64 may be possible with customization fee.
- ❑ It includes the complete C++ SDK as well as open-source examples of MTIDevice-Demo and MirrorcleLinearRaster.
- ❑ Mirrorcle Software Suite for Linux includes:
  - ❑ Applications:
    - MTIDevice-Demo
    - MirrorcleLinearRaster
    - MirrorcleListDevices
  - ❑ SDK:
    - C++ SDK
    - MTIDevice-Demo source code (C++)
    - MirrorcleLinearRaster source code (C++)



Linux Development Kit example: Development Kit with Tracking Bundle Add-On used in Laser Tracking Mode on a 64-bit Ubuntu Linux system.

# Laser Tracking Bundle Add-On

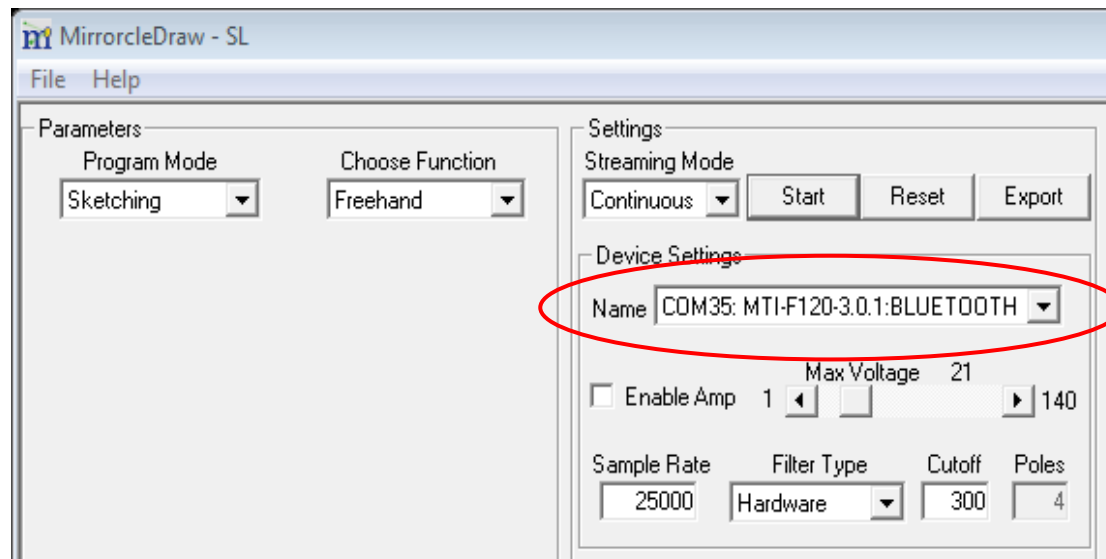
- Tracking PhotoSensor PCB with lens and red optical filter
- Red and silver retro-reflective tape for tracking targets
- Software API for tracking commands in C++ and Matlab SDKs
- Software example project using C++ SDK
- Software example project using Matlab SDK



*Laser Tracking Bundle Add-On in use with a Standard Devkit's 2mm MEMS Mirror A7M20.2-2000AL-TINY20.4. Mirror is co-mounted with a Tracking Photosensor addressing a common Field of View.*

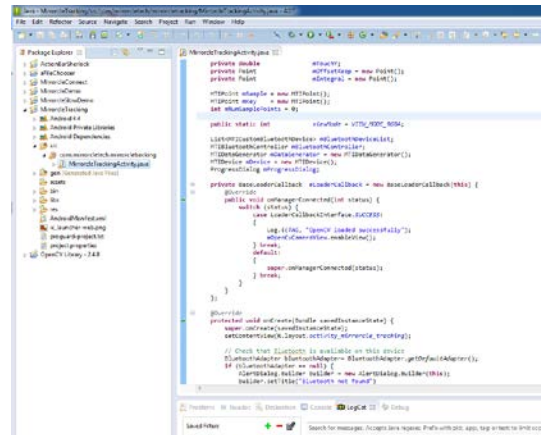
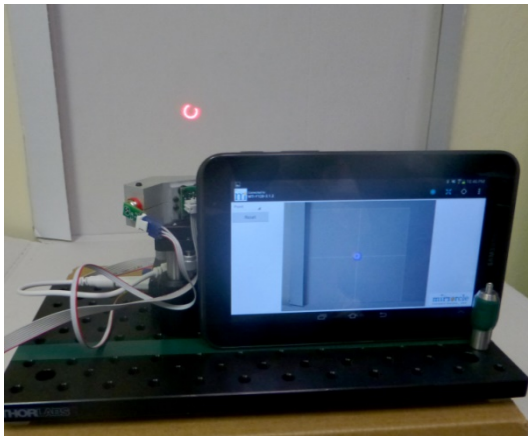
# Wireless Option Add-On

- USB-SL MZ Controller is upgraded with a Bluetooth transceiver
- The firmware on the Controller supports USB and Bluetooth operation
- In wireless mode, the communication remains as high as 921kBaud
- Windows executables like MirrorcleDraw can detect wireless controllers if the host PC has Bluetooth connectivity and has paired with the Controller

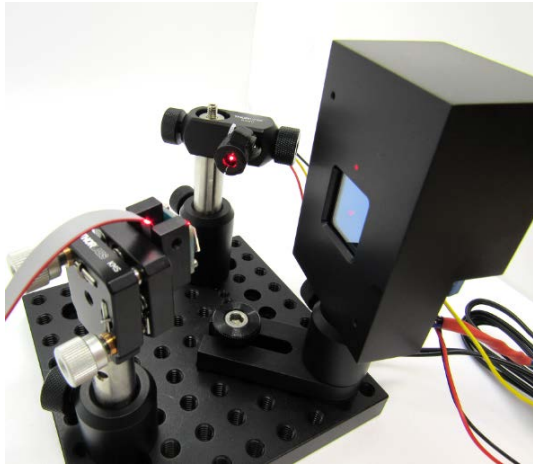


# Android Development Add-On

- ❑ Includes the 'Wireless Option' - Mirrorcle USB-SL MEMS Controller with Bluetooth
- ❑ Android SDK: Application example Project using Mirrorcle Android API 10.x
- ❑ Android SDK Guide
- ❑ Android Tablet or Smartphone device with preloaded application examples
- ❑ Controller powered by USB connection (possible by rechargeable USB battery)



# Optional Add-on – PSD Bundle



- The PSD Bundle consists of a PSD Module, optical breadboarding, and open-source C++ and Matlab examples for use with Mirrorcle Software Suite's C++ and Matlab SDKs.
- The PSD Module consists of a 20mm x 20mm dual-lateral PSD (Position Sensing Device) and conditioning circuits for powering the PSD and converting its output currents to X and Y positions, and a CW red laser module with focusing capability.
- The open-source examples provided are intended for use with the Mirrorcle Software Suite and demonstrate the creation of Look-Up-Tables, characterizing MEMS devices' Angle vs.  $V_{\text{difference}}$  responses, etc.



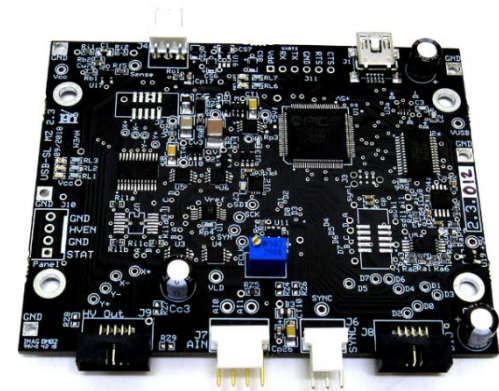
# Development Kit Controller

# USB MEMS Controller – “USB-SL MZ”

- ❑ Mirrorcle-designed MEMS Controller with a fast Microchip PIC32MZ MCU
- ❑ Its main function is to interface with Mirrorcle software applications or user software based on Mirrorcle software APIs, receive and store prepared waveforms in a buffer, and run/output those waveforms in open loop mode to drive a MEMS Mirror or a Scan Module, and to optionally trigger or sync with peripherals.
- ❑ Compatible with Mirrorcle Software Suite 11.0 and newer
- ❑ Powered and controlled by USB, <750mW power consumption
- ❑ Digital Output connector with 8 digital outputs correlated with MEMS output
- ❑ Available as OEM Controller (provided as a PCBA with no housing or cables)



Boxed Dimensions: Approx. 80mm x 115mm x 30mm  
Weight: Approx. 140g



OEM Dimensions: Approx.  
87mm x 69mm x 20mm





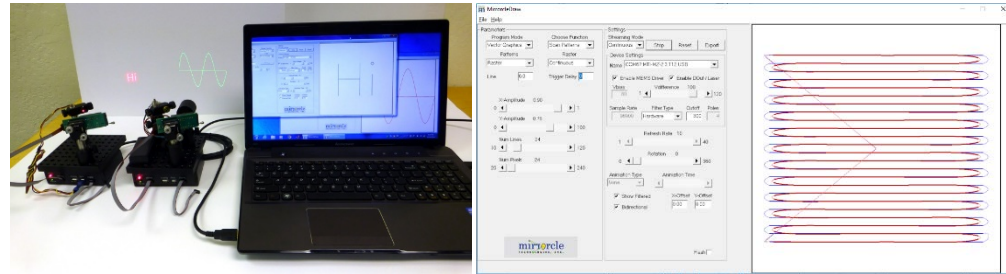
# Development Kit Software Suite

# Mirrorcle Software Suite - Platforms



## □ Mirrorcle Software Suite - Windows

- Windows Applications
- C++ SDK
- Matlab SDK
- LabView SDK
- Python SDK – see Add-Ons



## □ Mirrorcle Software Suite - Linux (Ubuntu) – see Add-Ons

- Shell Applications
- C++ SDK



## □ Mirrorcle Software Suite - Android – see Add-Ons

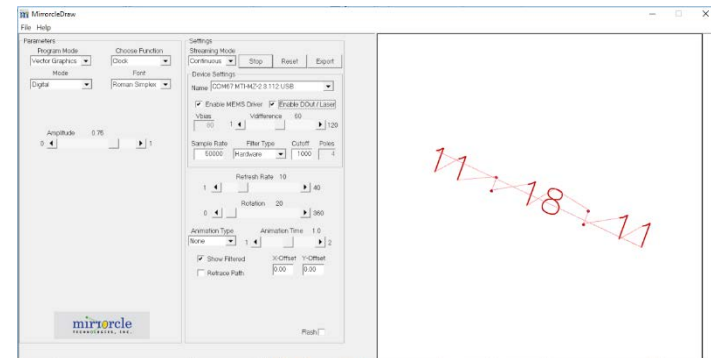
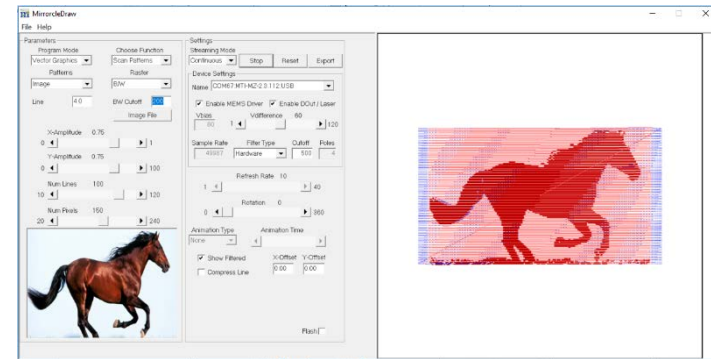
- Android Applications
- Java on Android SDK



# Mirrorcle Software Suite – Windows Applications

**MirrorcleDraw** is a powerful Windows-based application to control the two axes (tip and tilt) of a MEMS micromirror in a laser-beam steering system to deflect the laser beam in order to create vector images and animations.

- Create **freehand** and **polyline sketches**.
- Parameterized mathematical curves (**Lissajous**, **Spirographs**, **Waveforms**)
- Create **raster patterns** with various settings and rotate to any desired angle
- Display **text** in different fonts and multiple languages.
- Load **ILDA format vector animations** and create custom animations.
- Run the computer as a **two-channel function generator**.
- Select different types of **filters**, **signal-processing** schemes.
- Sample data files (.kpt and .smp) are provided
- Sample ILDA files are provided
- Sample image files are provided



# Mirrorcle Software Suite – Windows Applications

## □ MTIDevice-Demo –

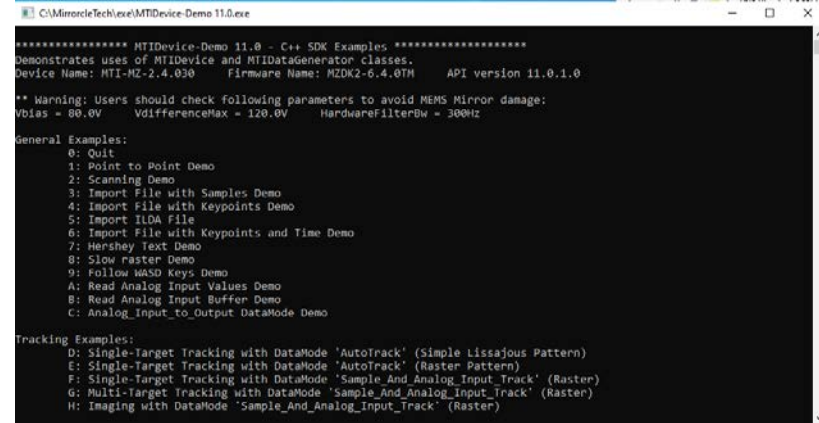
The compiled C++ SDK example project file which demonstrates a variety of ways to drive MEMS mirrors in point to point, scanning, rastering, and other modes.

## □ MirrorcleLinearRaster –

A command prompt based application that controls the two axes (tip and tilt) of a MEMS mirror in a laser beam steering system to deflect the laser beam in a line by line raster pattern optimal for laser marking, bio-medical imaging and similar applications.

## □ MirrorcleListDevices –

A small tool to scan the ports for Mirrorcle devices. It will report any Mirrorcle MEMS Controllers available for connection whether by USB connection or wireless (Bluetooth) and their respective COM ports.



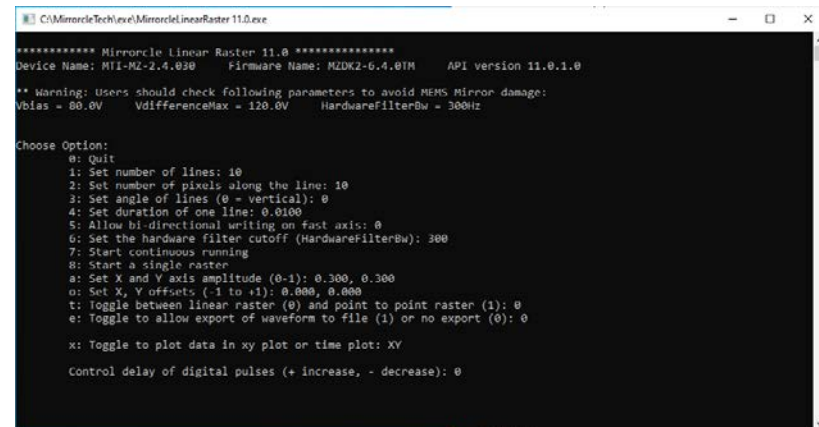
```
***** MTIDevice-Demo 11.0 - C++ SDK Examples *****
Demonstrates uses of MTIDevice and MTIDataGenerator classes.
Device Name: MTI-M2-2.4.030 Firmware Name: M2DK2-6.4.0TM API version 11.0.1.0

** Warning: Users should check following parameters to avoid MEMS Mirror damage:
Vbias = 80.0V VdifferenceMax = 120.0V HardwareFilterBw = 300Hz

General Examples:
0: Quit
1: Point to Point Demo
2: Scanning Demo
3: Import File with Samples Demo
4: Import File with Keypoints Demo
5: Import ILDA File
6: Import File with Keypoints and Time Demo
7: Hershey Text Demo
8: Slow Raster Demo
9: Follow WASD Keys Demo
A: Read Analog Input Values Demo
B: Read Analog Input Buffer Demo
C: Analog_input_to_output DataMode Demo

Tracking Examples:
D: Single-Target Tracking with DataMode 'AutoTrack' (Simple Lissajous Pattern)
E: Single-Target Tracking with DataMode 'AutoTrack' (Raster Pattern)
F: Single-Target Tracking with DataMode 'Sample_And_Analog_Input_Track' (Raster)
G: Multi-Target Tracking with DataMode 'Sample_And_Analog_Input_Track' (Raster)
H: Imaging with DataMode 'Sample_And_Analog_Input_Track' (Raster)
```

MTIDevice-Demo 11.0



```
***** Mirrorcle Linear Raster 11.0 *****
Device Name: MTI-M2-2.4.030 Firmware Name: M2DK2-6.4.0TM API version 11.0.1.0

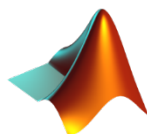
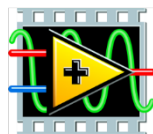
** Warning: Users should check following parameters to avoid MEMS Mirror damage:
Vbias = 80.0V VdifferenceMax = 120.0V HardwareFilterBw = 300Hz

Choose Option:
0: Quit
1: Set number of lines: 10
2: Set number of pixels along the line: 10
3: set angle of lines (0 = vertical): 0
4: Set duration of one line: 0.0100
5: Allow bi-directional writing on fast axis: 0
6: Set the hardware filter cutoff (HardwareFilterBw): 300
7: Start continuous running
8: Start a single raster
a: Set X and Y axis amplitude (0-1): 0.300, 0.300
o: Set X, Y offsets (-1 to 1): 0.000, 0.000
t: Toggle between linear raster (0) and point to point raster (1): 0
e: Toggle to allow export of waveform to file (1) or no export (0): 0
x: Toggle to plot data in xy plot or time plot: XY

Control delay of digital pulses (+ increase, - decrease): 0
```

MirrorcleLinearRaster 11.0

# Software Development Kits



Mirrorcle offers comprehensive Application Programming Interfaces (APIs) for generation of content (MEMS positions and correlated digital outputs), control and streaming of content, reading of analog inputs, synchronization with additional Controllers or peripherals, tracking, etc.

Mirrorcle APIs are available in multiple languages and on various platforms:

- ❑ **Included in the Suite: C++** (Windows and Linux)
- ❑ **Included in the Suite: LabVIEW** (Windows)
- ❑ **Included in the Suite: Matlab** (Windows)
- ❑ **Available Add-On: Python** (Windows and Linux)
- ❑ **Available Add-On: Java** (Android)

Extensive documentation and references are provided at <https://mirrorcletech.com/documentation/>



# Pricing and Availability

# Pricing and Availability

- Contact [sales@mirrorcletech.com](mailto:sales@mirrorcletech.com) for a formal quotation with most up to date pricing and lead time
- Typical lead times:
  - ▣ Standard Development Kit: 1 Week
  - ▣ Semi-Custom Development Kit: 3 Weeks
  - ▣ Development Kit with Scan Module: 2 Weeks
  - ▣ Lidar/Imaging MEMS Dev Kits: 2 Weeks

# Thank You for Choosing



## Additional Resources:

- [Mirrorcle MEMS Mirrors – Technical Overview](#)
- [Mirrorcle Software Suite Applications – User Guide](#)
- SDK and other documentation is available online at:  
<https://www.mirrorcletech.com/documentation/>
- Supporting documents, publications and sample device datasheets are available online:  
<https://www.mirrorcletech.com/wp/support/>