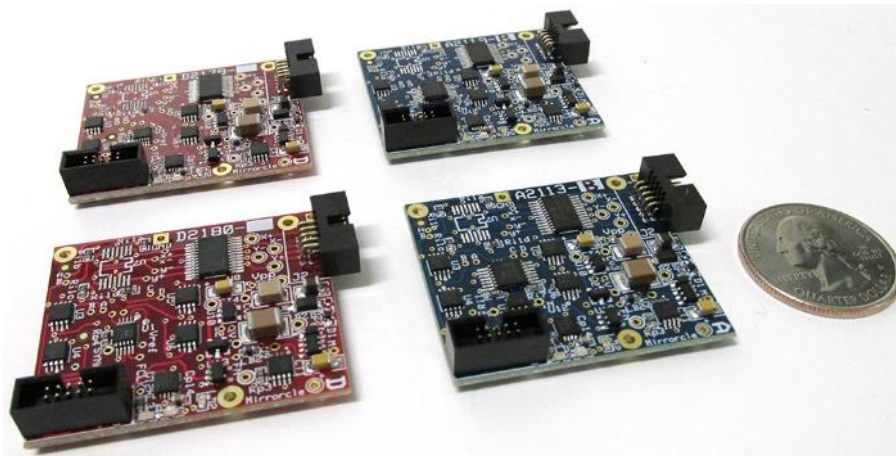


# Mirrorcle Products List



**mirrorcle**  
TECHNOLOGIES, INC.

**Mirrorcle Technologies, Inc.**

Richmond, CA

Last Revised: Jan. 2023

# Mirrorcle Products

## □ Development Kits (and Add-Ons)

- DK-015: Standard Development Kit
- DK-016: Semi-Custom Development Kit
- DK-030: Development Kit with Scan Module
- DK-026: LiDAR/Imaging MEMS Dev Kit I
- DK-027: LiDAR/Imaging MEMS Dev Kit II

## □ Playzer Development Kits

- PZDK-04(R/G/B/V) OEM: Monochrome Playzer Dev Kit
- PZDK-03RGB OEM: RGB Playzer Dev Kit

## □ Demonstrator Kits

- DEMO-01: Laser Tracking and Scan Module
- DEMO-02: Laser Scan and Camera Sense
- DEMO-04: Video Rate Projection and Imaging
- DEMO-06: 3D Scanning
- DEMO-07: SyMPL 3D MEMS Mirror LiDAR

## □ MEMS Mirrors

- Single Axis mirrors
- Dual Axis mirrors

## □ Scan Modules

## □ Electronics

- MEMS Controllers
- MEMS Drivers

## □ Software

- Mirrorcle Software Suite
- Software Development Kits

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 MEMS Mirror Development Kits

## MEMS Mirror Development Kits

- Standard Development Kit (P/N: DK-015)
- Semi-Custom Development Kit (P/N: DK-016)
- Development Kit with a Scan Module (P/N: DK-030)
- LiDAR/Imaging MEMS Dev Kit I (P/N: DK-026)
- LiDAR/Imaging MEMS Dev Kit II (P/N: DK-027)

## Add-Ons

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

For a most detailed overview including Add-On details, please see:

[https://www.mirrorclotech.com/pdf/Mirrorcle MEMS Mirror Development Kit - Overview.pdf](https://www.mirrorclotech.com/pdf/Mirrorcle_MEMS_Mirror_Development_Kit_-_Overview.pdf)

# 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](#).

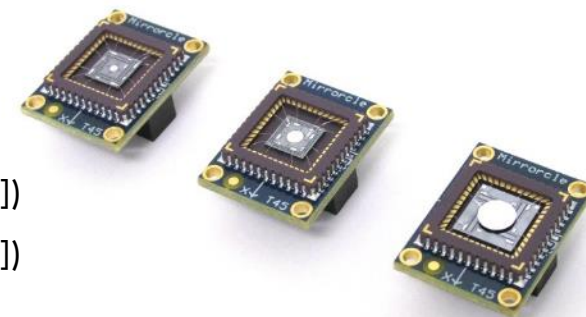
**Note on Kit Pricing:** as bundled, the LiDAR/Imaging Kits offer a nearly **\$1400 discount** from the list pricing of equivalent items (in a Semi-Custom kit with identical selections). This is offered along with **shorter lead times** however contents **cannot be modified**.

# 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**

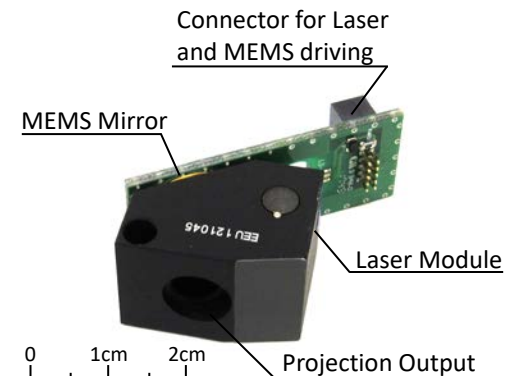


# Development Kit with Scan Module



# 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**



# 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

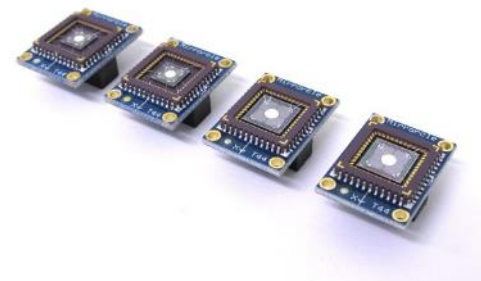
## Mirrorcle Software Suite, with comprehensive documentation & support hours

## 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)

# Playzer 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.

# Playzer Development Kits

## Development Kits

- Monochrome Playzer Development Kit [P/N: PZDK-04(**R**/**G**/**B**/**V**) OEM ]
  - Customers can order with one of the available colors (wavelengths), **Red**, **Green**, **Blue**, **Violet**, e.g. PZDK-04G OEM
- RGB Playzer Development Kit [P/N: PZDK-03RGB OEM ]

## Additional Playzer Modules

- For advanced users using Mirrorcle's software and hardware
- PZ-04(R/G/B/V) OEM – Available after purchase of any PZDK
- PZ-03RGB OEM – Available after purchase of any PZDK

## PlayzerX Modules (PlayzerX)

- For advanced users with own control software and hardware
- PX1-(R/G/B/V)

# Monochrome Player Development Kit (PZDK-04 OEM) - Overview

- **PZDK-04x OEM Monochrome Player Development Kit** is a demonstration and development bundle using Mirrorcle's Vector Graphics Laser Projection (**VGLP**) technology consisting of a **Player Module**, Windows **Software Applications**, and **Software Development Kits** in C++, Matlab, and LabView. **Player Module PZ-04 OEM** has a **fast MEMS mirror**, giving **several kHz of graphics bandwidth**. The Kit allows a plug-and-play, simple and playful environment for testing of displaying and other programmable monochrome laser applications.
- This development kit is intended for development and prototyping purposes as an **OEM** subsystem for incorporation into customer's prototypes and end products. Therefore, it does not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser products.



*All photographs are of actual displaying examples using previous version of monochrome Player, PZ-02*

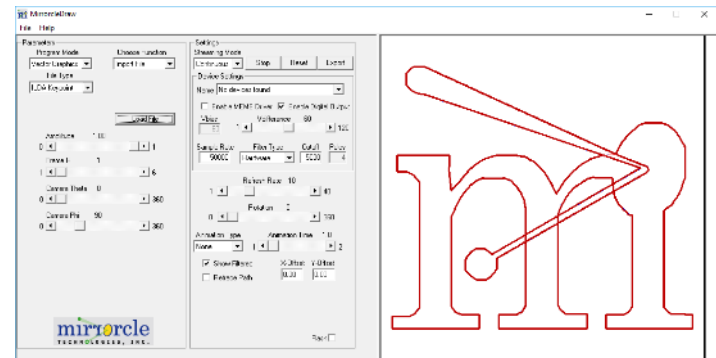
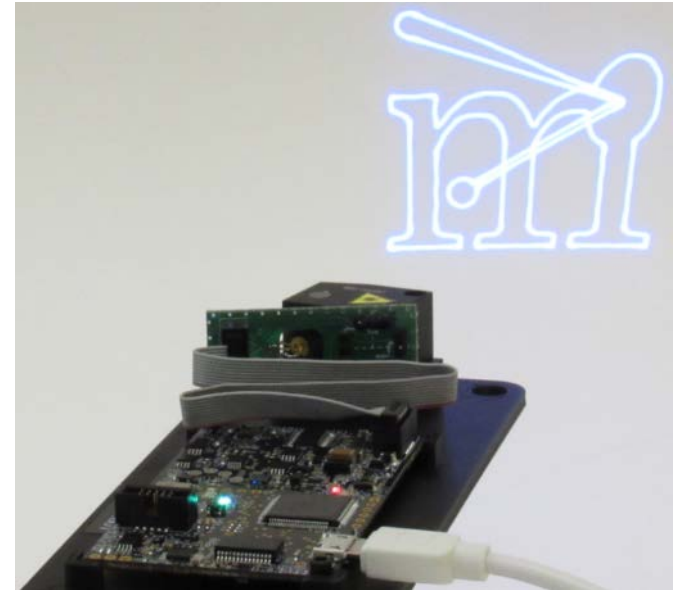
# Monochrome Player Development Kit (PZDK-04 OEM) - Features

## Features and Specifications:

- VGLP, display vector content at  $\geq 40\text{Hz}$  rate
- R or G or B or V laser,  $\sim 10\text{mW}$  max. power
- 8-bit Modulation of Laser Power (1 channel)
- Approx.  $34^\circ \times 34^\circ$  Field of View
- $< 0.01^\circ$  Beam position repeatability
- MEMS Mirror: A7M10.2-1000AL
- USB Interfaced and Powered
- $< 1000\text{mW}$  Power Consumption

## Mirrorcle Software Suite

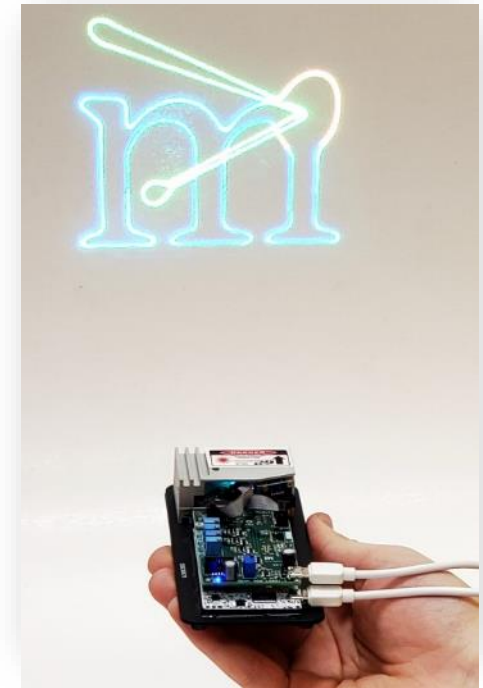
- MirrorcleDraw, MTIDevice-Demo
- MirrorcleLinearRaster, MirrorcleListDevices
- Comprehensive Documentation & Support Hours
- Full SDKs for C++, Matlab, LabView





# RGB Playzer Development Kit (PZDK-03RGB OEM) - Overview

- **PZDK-03RGB OEM** or **Playzer Development Kit** is a demonstration and development bundle using Mirrorcle's Vector Graphics Laser Projection (**VGLP**) technology consisting of an **RGB Playzer Module**, Windows **Software Applications**, and **Software Development Kits** in C++, Matlab, and LabView. **Playzer Module PZ-03RGB OEM** has a **fast MEMS mirror**, giving **several kHz of graphics bandwidth**. The Kit allows a plug-and-play, simple and playful environment for testing of displaying and other programmable laser applications. The module includes three laser sources(R | G | B), each with 8-bit digital modulation, that are combined in free-space.
- This development kit is intended for development and prototyping purposes as an **OEM** subsystem for incorporation into customer's prototypes and end products. Therefore, it does not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser products.



# RGB Playzer Development Kit (PZDK-03RGB OEM) - Features

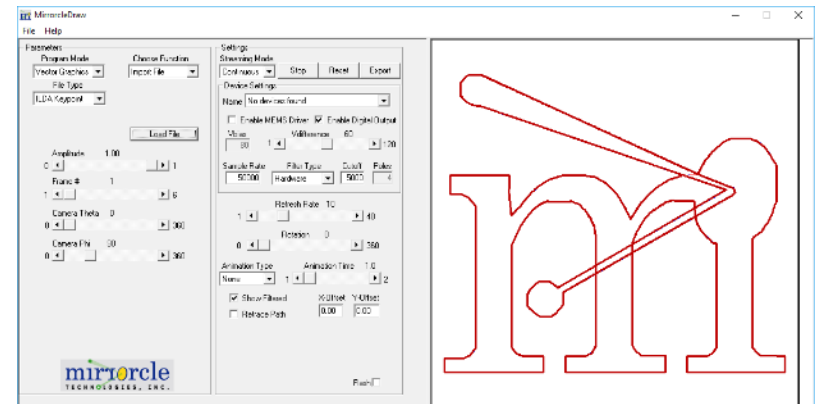
## Features and Specifications:

- VGLP, display vector content at  $\geq 40\text{Hz}$  rate
- R and G and B laser,  $\sim 10\text{mW}$  max. power
- 8-bit Modulation of Laser Power (3 channels)
- Approx.  $32^\circ \times 32^\circ$  Field of View
- $< 0.01^\circ$  Beam position repeatability
- MEMS Mirror: A7M10.2-1000AL
- USB Interfaced and Powered
- $< 1250\text{mW}$  Power Consumption



## Mirrorcle Software Suite

- MirrorcleDraw, MTIDevice-Demo
- MirrorcleLinearRaster, MirrorcleListDevices
- Comprehensive Documentation & Support Hours
- Full SDKs for C++, Matlab, LabView



# Demonstrator Kits

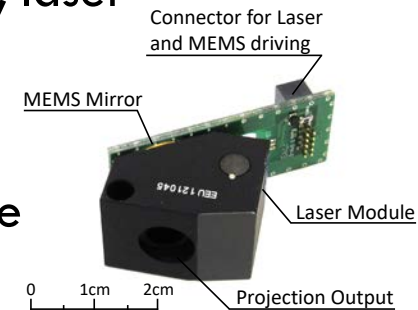
The listed products in this section are intended for development and prototyping purposes as an **OEM** subsystem for incorporation into customer's prototypes and end products. Therefore, they do not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser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

# Laser Tracking and Scan Module Demonstrator Kit (DEMO-01)



# Laser Tracking and Scan Module Demonstrator Kit (DEMO-01) - Contents

- EaZy4.0R **Scan Module** - optomechanical cell with MEMS mirror, laser and optics, designed to be driven by USB MEMS Controller
  - Red laser module (638nm), set by Controller to ~10mW max.
- **Photosensor** with optical filter and 60° FoV lens, pigtailed cable
- USB-SL MZ **USB MEMS Controller with Cables and Tracking Upgrade**
  - USB power and software interface, embedded MEMS and Laser driver
- **Mirrorcle Software Suite for DEMO-01**
  - Windows Applications, SDKs, software **Support Hours**
- **Retro-Reflective Tape Sample**
- **USB Thumbdrive with Software and Documentation**
- 3D Printed **Cradle Mount**

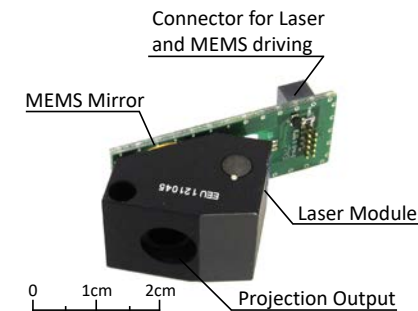


# Laser Scan and Camera Sense Demonstrator Kit (DEMO-02)



# Laser Scan and Camera Sense Demonstrator Kit (DEMO-02) - Contents

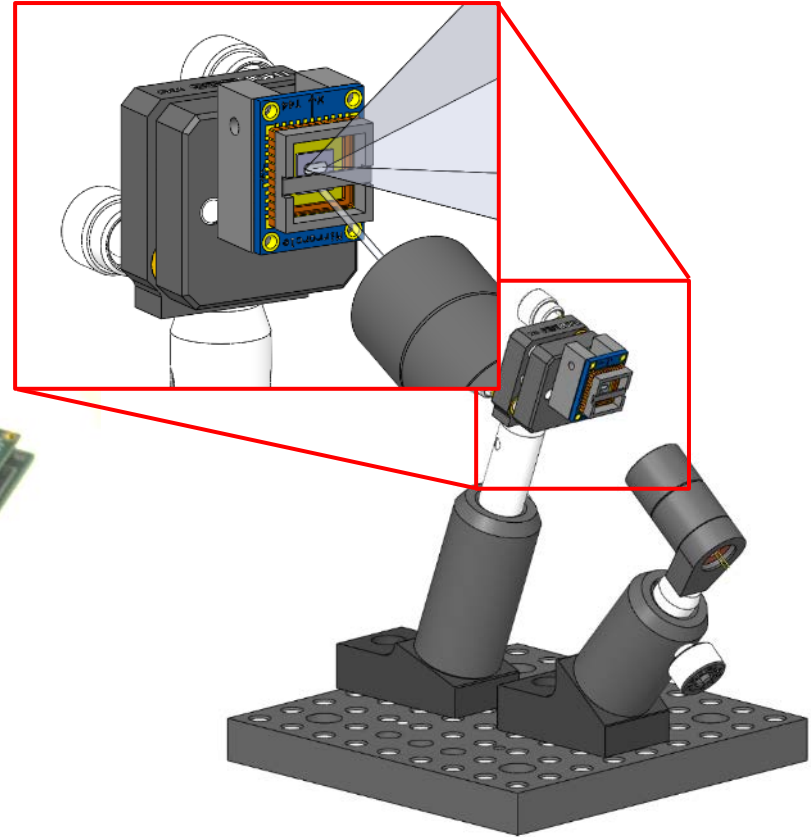
- EaZy4.0G **Scan Module** - optomechanical cell with mirror, laser and optics, designed to be driven by USB MEMS Controller
  - Green laser module (520nm), set by Controller to ~10mW max.
- **USB 3.0 Camera** with 6mm lens (~45° x 34.5° FoV)
  - 720x540 pixels, capable of up to 500 fps
- USB-SL MZ **USB MEMS Controller with Cables**
  - USB power and software interface, embedded MEMS and Laser driver
- **Mirrorcle Software Suite for DEMO-02**
  - Windows Applications, SDKs, software **Support Hours**
- **USB Thumbdrive with Software and Documentation**
- **Optical Breadboarding** for Camera and Scan Module



# Video Rate Projection and Imaging Demonstrator Kit (DEMO-04)



FPGA based MEMS Controller  
and Software on USB



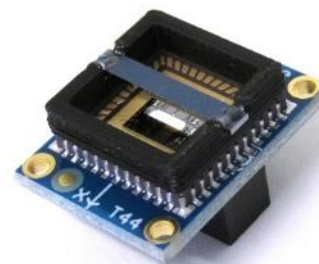
Optical Breadboarding with  
mounting for MPM and laser module



# Video Rate Projection and Imaging Demonstrator Kit (DEMO-04) - Contents

- 2x MPM – Two **MEMS Pair Modules**
  - MEMS1 – 0.9mm mirror
  - MEMS2 – 3.2mm x 1.3mm elongated mirror
- Cable for laser and MEMS mirror
- LM – Laser Module (Monochrome, Single Color)
  - Green ~520nm, ~20-40mW
  - Modulation capability >100MHz
  - Mounted with beam reducer to <0.9mm diameter, also low divergence for sharp projection
- Controller – FPGA-based controller with USB interface
  - Embedded MEMS driver
- Software
  - Matlab-based GUI application for parameter exploration
  - Windows-based console demo application

MPM, showing MEMS2

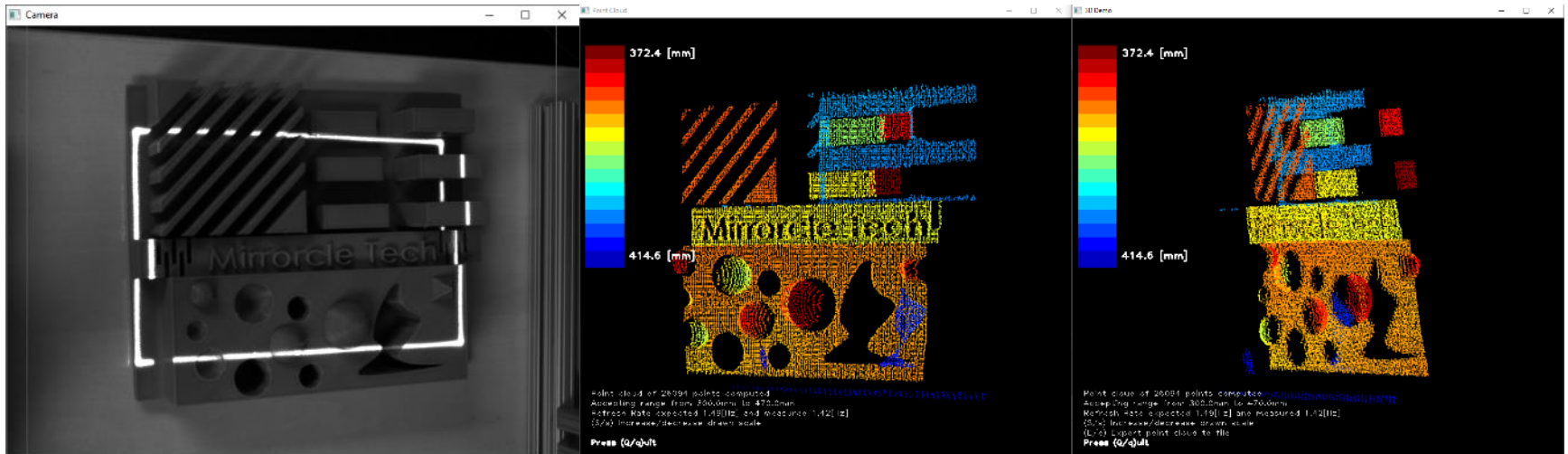


MPM, showing MEMS1



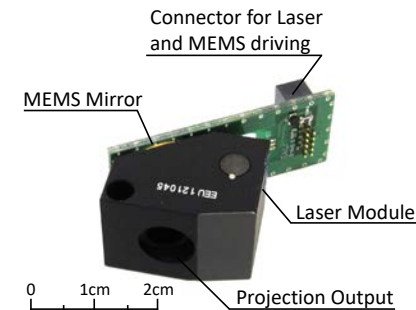
FPGA-based USB MEMS and Laser Controller

# 3D Scanning Demonstrator Kit (DEMO-06)



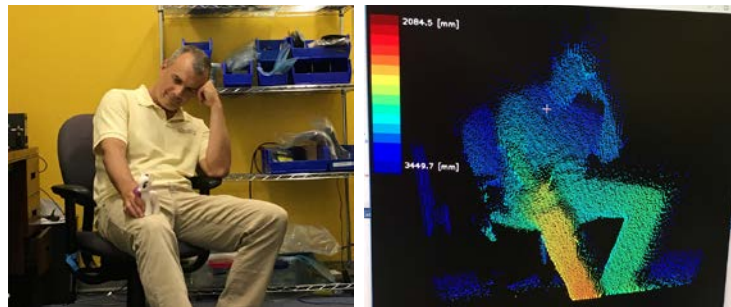
# 3D Scanning Demonstrator Kit (DEMO-06) - Contents

- **EaZy4.0V Scan Module** - optomechanical cell with mirror, laser and optics, designed to be driven by USB MEMS Controller
  - Violet laser module (405nm), set by Controller to ~10mW max.
- **USB 3.0 Camera** with 8mm lens (~34.5° x 26.2° FoV)
  - 720x540 pixels, capable of up to 500 fps
- **USB-SL MZ USB MEMS Controller with Cables**
  - USB power and software interface, embedded MEMS and Laser driver
- **Mirrorcle Software Suite for DEMO-06**
  - Windows Applications, SDKs, software **Support Hours**
- **USB Thumbdrive with Software and Documentation**
- **Optical Breadboarding** for Camera and Scan Module



# SyMPL MEMS Mirror 3D LiDAR Demonstrator Kit (DEMO-07)

- The **SyMPL MEMS Mirror 3D LiDAR** demonstrator kit includes a plug-and-play **3D LiDAR system** with **software applications** that demonstrate its capabilities.
  - Part Number: **DEMO-07**
- The kit is designed to demonstrate the capabilities of Mirrorcle's Synchronized MEMS Pair LiDAR ("SyMPL") architecture and to experience the aspect of **programmable scanning** for LiDAR applications.



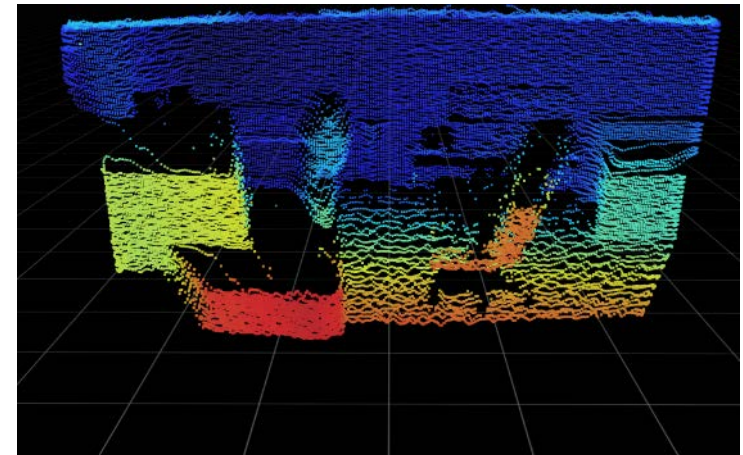
# SyMPL MEMS Mirror 3D LiDAR Demonstrator Kit (DEMO-07) - Contents

- **SyMPL 3D LiDAR system**
- Software Applications (Windows)
  - **MirrorcleLiDAR**
  - **MirrorcleCloud**
- Accessories
  - 1x **USB Micro Cable** for power and data



Software on USB

SyMPL system +  
USB Micro Cable



# MEMS Mirrors

Single-Axis MEMS Mirrors selection

Dual-Axis MEMS Mirrors selection

MEMS Mirror optical coatings

MEMS Mirror packages and mounts

# Mirrorcle MEMS Mirrors

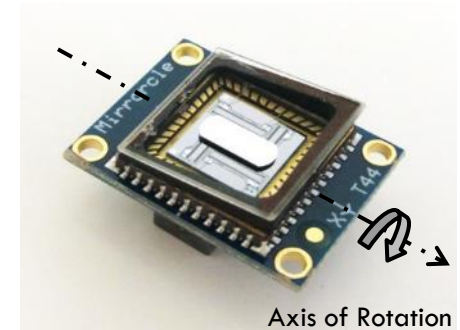
## □ Single-Axis (Quasi-static and Resonant)

- Integrated Mirrors (smaller sizes)
- Bonded Mirrors (larger sizes)

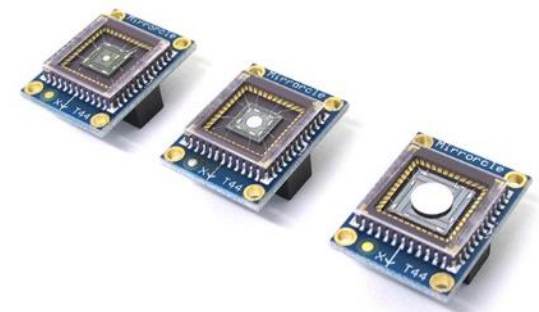
In addition to a number of single-axis specific products, most Quasi-static dual-axis designs can be assembled/tested/shipped in single-axis configuration.

## □ Dual-Axis (Quasi-static)

- Integrated Mirrors (smaller sizes)
- Bonded Mirrors (larger sizes)

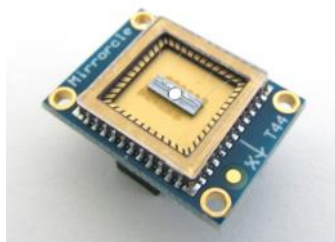


A8L2.2S-6000x2400AL-TINY48.4-B/W/TP  
Example

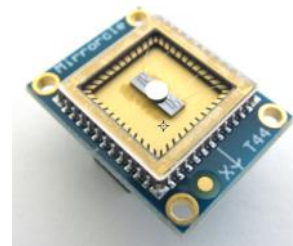


MEMS Mirrors in Standard Dev Kit (DK-015)  
(TINY48.4 connectorized packages)

# Single Axis MEMS Mirrors



A9R12.1-1200DAL-TINY48.4-A/F/TP  
Example



A9RB.1-2000AL-TINY48.4-A/F/TP  
Example

## Single Axis, Point-to-Point (Quasi-static)

Actuator Size	Actuator Name	Mech. Angle	Package	Resonant Freq.	Mirror Sizes
5.2 x 5.2mm	A9Q40.1	$\pm 4.5^\circ$	TINY48.4	$\sim 1.8$ kHz	Integrated 4mm x 1.3mm
5.2 x 5.2mm	A9S1.1	$\pm 6^\circ$	TINY48.4	varies	Bonded up to $\varnothing 3.6$ mm
5.2 x 5.2mm	A9S2.1	$\pm 5^\circ$	TINY48.4	varies	Bonded up to $\varnothing 3.6$ mm
7.25 x 7.25mm	A8L2.2S	$\pm 5^\circ$	TINY48.4	varies	Bonded up to $\varnothing 5$ mm
7.25 x 7.25mm	A5L2.2S	$\pm 1.15^\circ$	TINY48.4	varies	Bonded up to $\varnothing 7.5$ mm

## Single Axis, Resonant

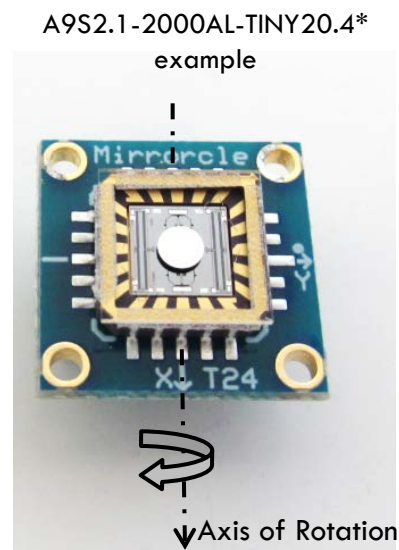
Actuator Size	Actuator Name	Mech. Angle	Package	Resonant Freq.	Mirror Sizes
5.20 x 1.73mm	A9R8.1	$\pm 8.5^\circ$	TINY48.4	$\sim 24$ kHz	Integrated $\varnothing 0.8$ mm
5.20 x 1.73mm	A9R12.1	$\pm 8.5^\circ$	TINY48.4	$\sim 12.5$ kHz	Integrated $\varnothing 1.2$ mm
5.20 x 1.73mm	A9RB.1	$\pm 8.5^\circ$	TINY48.4	$\sim 4.7$ kHz	Bonded $\varnothing 1.6$ mm
5.20 x 1.73mm	A9RB.1	$\pm 8.5^\circ$	TINY48.4	$\sim 3.4$ kHz	Bonded $\varnothing 2.0$ mm
5.20 x 1.73mm	A9RB.1	$\pm 8.5^\circ$	TINY48.4	$\sim 2.7$ kHz	Bonded $\varnothing 2.4$ mm



# Quasi-static Single Axis MEMS Mirrors Examples

## Quasi-static Round Mirrors (point to point):

- **A9S1.1**, mech. angle  $\pm 5.5^\circ$ , for various bonded mirrors
  - With bonded  $\varnothing 3\text{mm}$  mirror has  $\sim 650\text{Hz}$  resonance
- **A9S2.1**, mech. angle  $\pm 5.0^\circ$ , for various bonded mirrors
  - With bonded  $\varnothing 2.4\text{mm}$  mirror has  $\sim 1050\text{Hz}$  resonance
- For smaller mirrors (2.0mm diameter and smaller), recommend using integrated dual-axis devices (with one axis frozen for single-axis operation).



\* Shown in legacy TINY20.4 package, not recommended for new designs.

# Single Axis Quasi-static MEMS Mirrors Examples

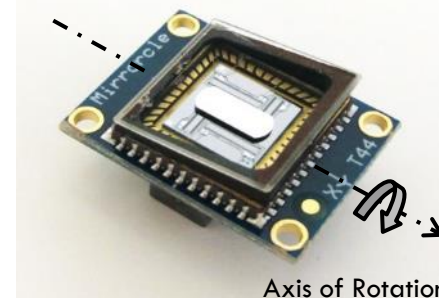
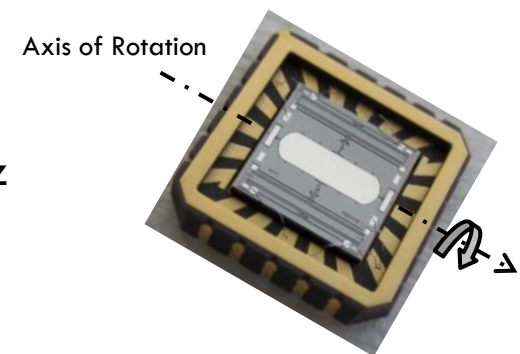
Quasi-static LINE mirrors are for example used in **LiDAR applications**, such as with scanning an emitter array in one axis, or as a second axis mirror with a two-single-axis (2SA) mirror setup, rastering on the fast axis, and Quasi-static scan on the slow axis.

## □ **A9Q40.1-4000x1300AL-TINY20.4**

- Rotates about the long axis,  $\pm 4.5^\circ$ , first resonance  $\sim 2000\text{Hz}$
- Typically used as the 2<sup>nd</sup> mirror in with 2SA scanned LiDARs, picoprojectors, 3D sensing

## □ **A8L2.2-6000x2400AL-TINY48.4**

- Rotates about the long axis,  $\pm 5^\circ$ , first resonance  $\sim 500\text{Hz}$
- Typically used with emitter array based LIDARs



# Single Axis Resonant MEMS Mirrors (1 DR)

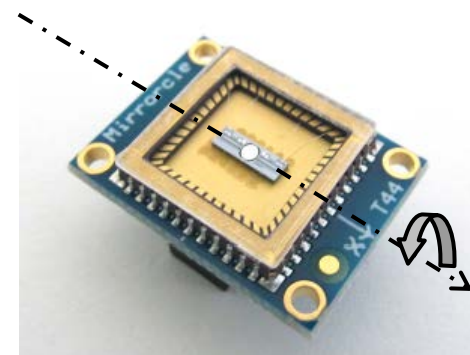
## Integrated Mirror Designs:

- **A9R12.1-1200DAL-TINY48.4**
  - $\pm 8.5^\circ$  max mechanical angle, around 12.5kHz resonance
- **A9R8.1-800DAL-TINY48.4**
  - $\pm 8.5^\circ$  max mechanical angle, around 24kHz resonance

## Bonded Mirror Designs:

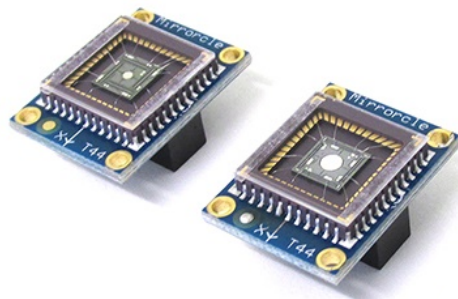
- **A9RB.1-2400AL-TINY48.4**
  - $\pm 8.5^\circ$  max mechanical angle, around 2.6kHz resonance
- **A9RB.1-2000AL-TINY48.4**
  - $\pm 8.5^\circ$  max mechanical angle, around 3.4kHz resonance
- **A9RB.1-1600AL-TINY48.4**
  - $\pm 8.5^\circ$  max mechanical angle, around 4.7kHz resonance

A9R12.1-1200DAL-TINY48.4-A/F/TP  
Example



Axis of Rotation

# Dual Axis MEMS Mirrors - Integrated



(left) A7M10.2-1000AL-TINY48.4-A/F/TP  
 (right) A7M20.2-2000AL-TINY48.4-A/F/TP  
 Examples

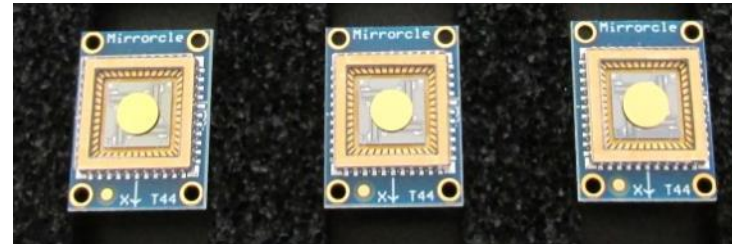
Dual Axis, Integrated Quasi-static					
Actuator Size	Actuator Name	Mech. Angle	Package	Resonant Freq.*	Mirror Diameters
4.25 x 4.25mm	A3I8.2	$\pm 6^\circ$	TINY48.4	$\sim 3.6$ kHz	0.8mm
5.2 x 5.2mm	A7M8.1	$\pm 4.75^\circ$	TINY48.4	$\sim 6$ kHz	0.8mm
5.2 x 5.2mm	A7M10.2	$\pm 4.75^\circ$	TINY48.4	$\sim 4.5$ kHz	1.0mm
4.25 x 4.25mm	A3I12.2	$\pm 5.0^\circ$	TINY48.4	$\sim 2.6$ kHz	1.2mm
5.2 x 5.2mm	F1M16.2	$\pm 4.5^\circ$	TINY48.4	$\sim 2.3$ kHz	1.6mm
5.2 x 5.2mm	A7M20.2	$\pm 5^\circ$	TINY48.4	$\sim 1.25$ kHz	2.0mm
7.25 x 7.25mm	A5M24.4	$\pm 6^\circ$	TINY48.4	$\sim 800$ Hz	2.4mm

\*Note: All above designs are point-to-point or Quasi-static and the natural resonant frequency is listed only as a reference for comparison of their respective available bandwidths. Bandwidth for driving with arbitrary waveforms depends on the driving and control method and is up to about 1.4X resonant frequency.

# Dual Axis MEMS Mirrors - Bonded



A5L3.3(C1)-6400AL-TINY48.4-B/W/TP  
Example



A8L2.2-4600AU-TINY48.4-B/W/TP (left and middle) and  
A8L2.2-5000AU-TINY48.4-B/W/TP (right) Examples

## Dual Axis, Bonded Quasi-static

Actuator Size	Actuator Name	Mech. Angle	Package	Resonant Freq.	Bonded Mirror Diameters
5.2 x 5.2mm	A7B1.1	$\pm 7^\circ$	TINY48.4	Varies w/ size	2.0, 2.4, 3.0, 3.6mm
5.2 x 5.2mm	A7B2.3	$\pm 6^\circ$	TINY48.4	Varies w/ size	2.4, 3.0, 3.6mm
7.25 x 7.25mm	A5L2.2	$\pm 1.15^\circ$	TINY48.4	Varies w/ size	2.0, 2.4, 3.0, 3.6, 4.2, 4.6, 5.0, 6.4, 7.5mm
7.25 x 7.25mm	A5L3.3 (C1)	$\pm 2.5^\circ$	TINY48.4	Varies w/ size	2.0, 2.4, 3.0, 3.6, 4.2, 4.6, 5.0, 6.4mm
7.25 x 7.25mm	A5L3.3 (C2)	$\pm 4.25^\circ$	TINY48.4	Varies w/ size	2.0, 2.4, 3.0, 3.6, 4.2, 4.6, 5.0mm
7.25 x 7.25mm	A8L2.2	$\pm 5^\circ$	TINY48.4	Varies w/ size	3.0, 3.6, 4.2, 4.6, 5.0mm

Note: Bonded mirror mech. angle. may be limited by mirror size

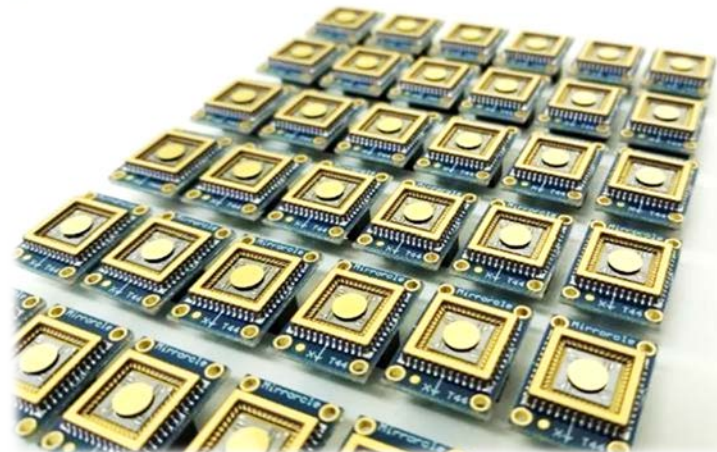
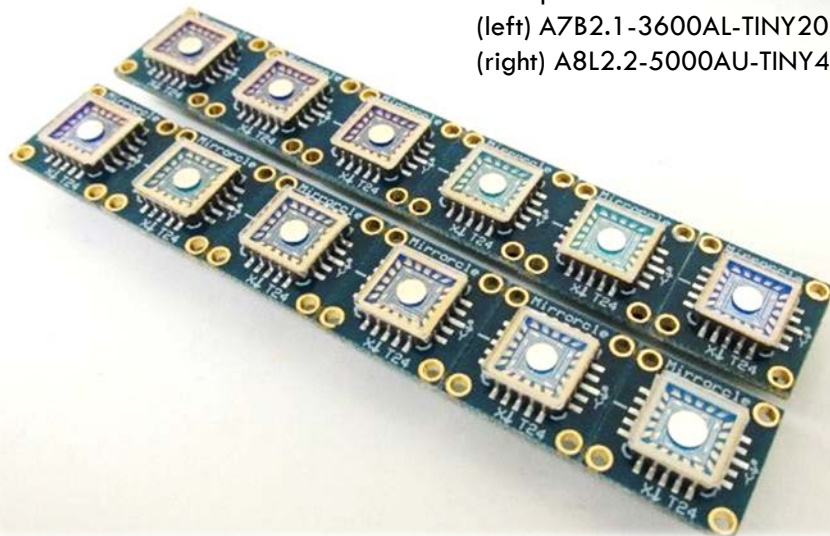
# MEMS Mirror Coatings

- **Bonded MEMS Mirrors** are offered with pure **Aluminum (AL)** or pure **Gold (AU)** coating. The thin-film coatings have very high optical quality.
- All **integrated MEMS mirrors** are available in **Al coatings**
- There are **no other coatings available with this technology**, however in special cases customers may purchase uncoated mirrors. (polished silicon surface)

Examples:

(left) A7B2.1-3600AL-TINY20.4-A/TP – non standard package

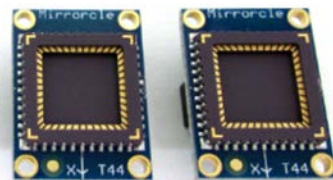
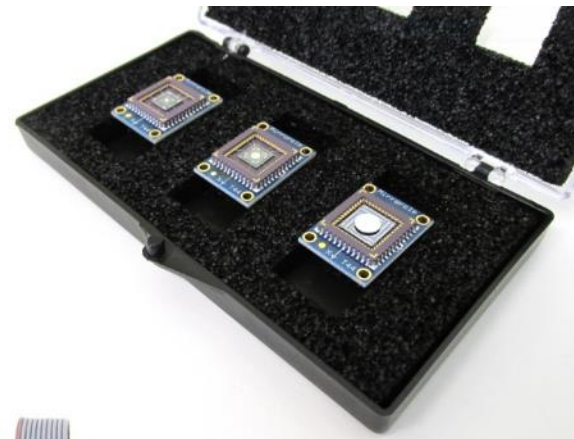
(right) A8L2.2-5000AU-TINY48.4-NW – standard package



# Packages and Mounts

- Connectorized standard package: TINY48.4
- Multiple window (AR-coating) options and window mounting methods.
- See detailed MEMS Packages and Mounts Guide:

[http://www.mirrorcletech.com/pdf/Mirrorcle MEMS Packages and Mounts - User Guide.pdf](http://www.mirrorcletech.com/pdf/Mirrorcle_MEMS_Packages_and_Mounts_-_User_Guide.pdf)



# Scan Modules

Also see:

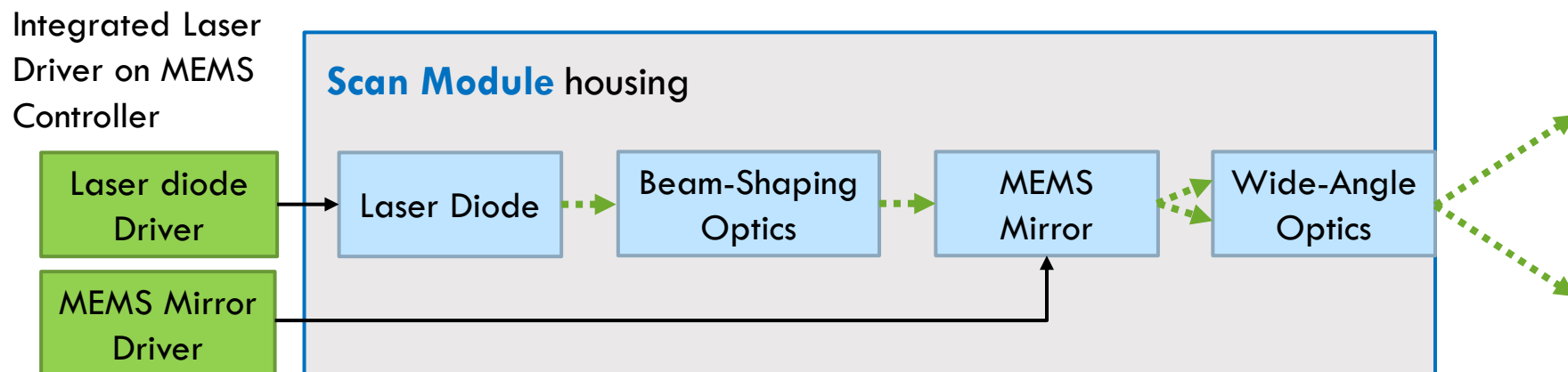
[Development Kit with Scan Module](#)

[Monochrome Playzer Development Kit](#)



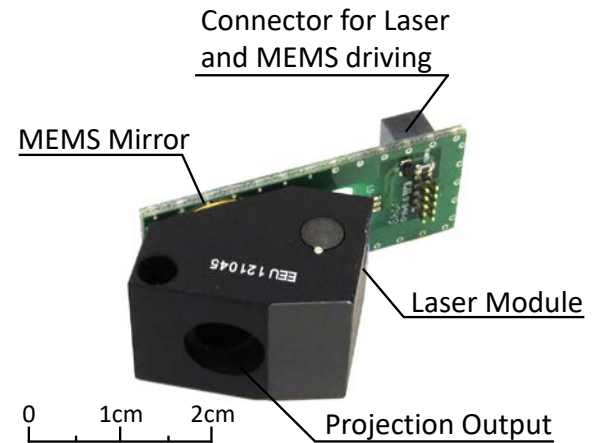
# Scan Module - Overview

- 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 Scan Module connector includes pins for MEMS Mirror driving and for Laser Diode (LD) driving. A Scan Module should be connected to and driven by a Mirrorcle MEMS Controller which is paired with the Scan Module to match the laser diode (LD) characteristics.

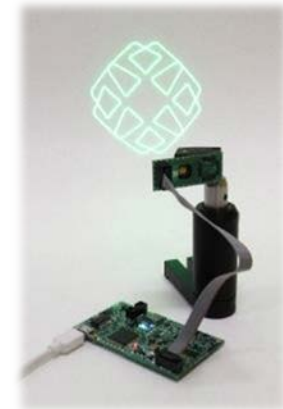


# EaZy4.0 Scan Module - Specifications

- ❑ **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:
  - ❑ Red (~638nm), <30mW CW power
  - ❑ Green (~520nm), <30mW CW power
  - ❑ Blue (~450nm), <30mW CW power
  - ❑ Violet (~405nm), <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 in Vector Graphics Laser Projection (VGLP)*



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.



# Electronics

# Mirrorcle Electronics

- MEMS Controllers
  - **USB MEMS Controller “USB-SL MZ”**
    - Standard, boxed version for all initial development cases
    - OEM Version for production cases
  - **Compact USB MEMS Controller “MiniMZ”**
    - OEM Version with **Minimum Order Quantity (MOQ)**
    - **For production cases only, with minimal peripherals**
- MEMS Drivers
  - Digital Input – **“PicoAmp”**
  - Analog Input – **“BDQ PicoAmp”**
  - MEMS Driver Connections Breakout – **“BRK-DRIVER 5.x”**

# MEMS Controller vs. MEMS Driver

- A Controller converts user-provided software input commands to 8 high voltage outputs to command X,Y positions as well as to 8 low voltage digital outputs (trigger pins or M output). Mirrorcle's MEMS Controllers are designed for plug-and-play simplicity and are paired with an expansive, open application programming interface (API) for users to interact with the Controllers and develop their own applications.
- A MEMS Driver converts user-provided low voltage input commands (e.g. analog -10V to +10V from 2 inputs X,Y or digital SPI) to 4 high voltage outputs to command X,Y positions. Use of a MEMS Driver (as a general Mirrorcle product for OEM customers) instead of a Controller requires bench-top lab equipment such as function generators or a data acquisition (DAQ) card.

# MEMS Controllers Selection

- The USB-SL MZ controller is a complete development solution that works with all of Mirrorcle MEMS mirror products like MEMS Mirrors, Scan Modules, etc., and includes dedicated connectors for analog inputs, correlated digital outputs, synchronization port. It is available without housing as well for OEM with all of the same connectors, however without panel LEDs.
- The MiniMZ controller is a highly compact OEM-only solution designed for volume MEMS mirror applications, designed primarily for MEMS Mirror or Scan Module driving only.

	<b>USB-SL MZ</b>	<b>MiniMZ</b>
<b>Availability</b>	Always in Stock No MOQ	Lead Time MOQ
<b>Power</b>	USB port	USB port or Host Connector (J5)
<b>USB Connector</b>	USB Mini (J1)	USB Micro (J1)
<b>MEMS Driver</b>	Yes (J9)	Yes (J2)
<b>Laser Driver</b>	Yes (J9)	Yes (J2)
<b>Sync Port</b>	Yes (J6)	No
<b>Analog Inputs</b>	Dedicated Port (J7)	Not standard
<b>Digital Outputs</b>	Dedicated Port (J8)	Not standard
<b>Tracking Support</b>	Yes and Dedicated Port (J4)	No
<b>Enclosure</b>	Yes	No
<b>Dimensions</b>	80mm x 115mm x 30mm	70mm x 40mm x 15mm

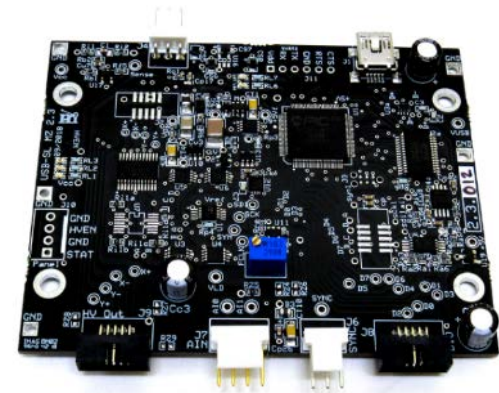


# USB MEMS Controller – “USB-SL MZ”

- ❑ 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

# USB-SL MZ Features and Specifications

- The USB-SL MZ controller interfaces with Windows Applications for Scan Control and software command that results in MEMS mirror scans and repeatable patterns.
- USB Powered MEMS Controller: USB-SL MZ MEMS Controller
  - <1000mW Power Consumption
  - Analog Input connector with 2x Analog Inputs
  - Digital Output connector with 8 Digital Outputs
  - Synchronization Port to trigger lasers, cameras, etc.
  - Sense Port for tracking and imaging applications
  - Single PCB Design
- OEM Version provided without box and cables in production quantities (>5 units)



# Compact USB MEMS Controller – “MiniMZ”

- Contact [Mirrorcle sales](#) regarding pricing and **Minimum Order Quantity (MOQ)**
- The **MiniMZ** controller interfaces with Windows Applications for Scan Control and software command that results in MEMS mirror scans and repeatable patterns.
- **Features and Specifications:**
  - USB Powered MEMS Controller: MiniMZ 1.x
  - <750mW Power Consumption (board consumption with MEMS mirror, not including any peripherals like laser sources, LEDs, etc.)
- Provided without housing and cables
- Production-line ready, available in volumes with a 3 month lead time.



OEM Dimensions: Approx.  
70mm x 40mm x 15mm



# OEM MEMS Drivers



Digital Input

Analog Input

OEM Dimensions: Approx.  
35mm x 40mm x 9.3mm

- **Digital Input MEMS Driver - PicoAmp 5.X**
  - 4 unipolar analog outputs  $\sim 0V-200V$  (“X200” Drive Mode)
  - 10 pin input for: SPI, MEMS Driver Enable, FCLK\_X, FCLK\_Y, VDD and GND
  - User controls 4 channels (X+, X-, Y-, Y+) via SPI commands to 16-bit DAC
    - Update rates of up to 250k samples per second are possible for all 4 channels
  - User provides a clock for setting hardware filter cut-off (required)
- **Analog Input MEMS Driver - BDQ PicoAmp 5.X**
  - 4 unipolar analog outputs  $\sim 0V-xxx$  (“B160”, “T180” and “X200” Drive Modes)
  - 10 pin input connector for: XIN and YIN Analog Inputs, MEMS Driver Enable, Low-pass Filter Control (FCLK), VDD and GND
  - User controls 4 channels (X+, X-, Y-, Y+) via 2 analog input signals for X and Y axis (with -10V to +10V input range)
  - User provides a clock for setting hardware filter cut-off (required)

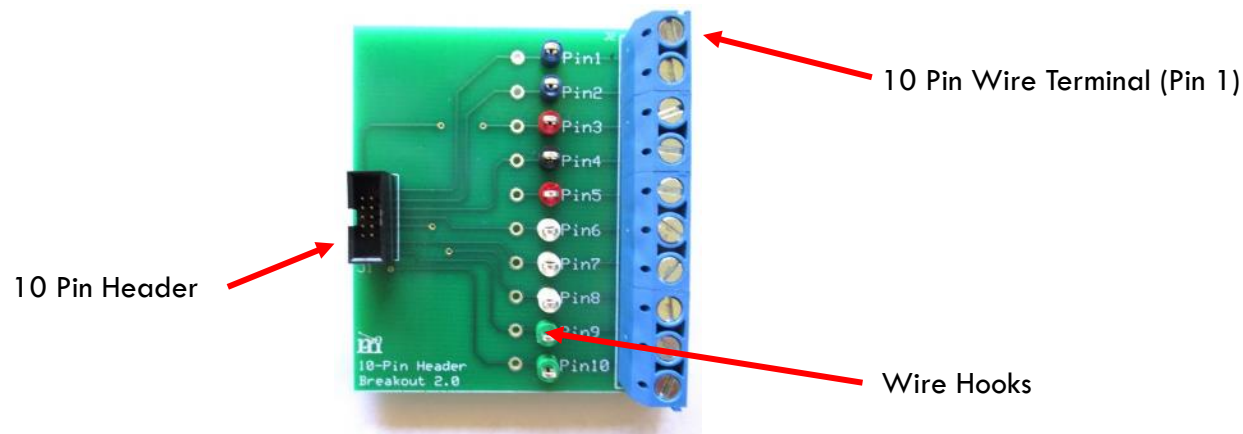
# OEMS MEMS Drivers – Part Name/Numbers

- To accommodate driving the different MirrorcleTech MEMS Mirrors products to achieve best performance, there are a few different options available:
  - **MEMS Driver – Analog Input** is a simpler interface, with three different voltage ranges, B160, T180 and X200 (**T180 being the most recommended**). These drivers require the user to provide a  $\pm 10V$  input for the X and Y axis, which corresponds to the  $V_{\text{difference}}$  of the output range of the specific driver. For example, a T180 driver would correspond  $\pm 10V$  with a 0-180V  $V_{\text{difference}}$ , about a  $V_{\text{bias}}$  of 90V. The maximum voltages should be checked with the specific device before operation, to prevent any damage to the device.
  - **MEMS Driver – Digital Input** are only recommended for advanced development kit users who have already used the Mirrorcle hardware, and understand the methodology of driving the device directly with all four channels. In this case, the user is required to generate the Biased-Differential-Quad channels correctly. The user is also responsible for setting the correct  $V_{\text{bias}}$  and  $V_{\text{difference}}$  limitations, to not damage the device.

Driver Name	Version	Interface	Output Range	Part Number
MEMS Driver - Digital Input	5.4 RevB	Digital SPI	0-200V (X200)	DR-10-056-00
MEMS Driver - Analog Input	5.4 RevB	$\pm 10V$ Analog Inputs	0-160V (B160)	DR-11-054-00
MEMS Driver - Analog Input	5.4 RevB	$\pm 10V$ Analog Inputs	0-180V (T180)	DR-11-055-00
MEMS Driver - Analog Input	5.4 RevB	$\pm 10V$ Analog Inputs	0-200V (X200)	DR-11-056-00

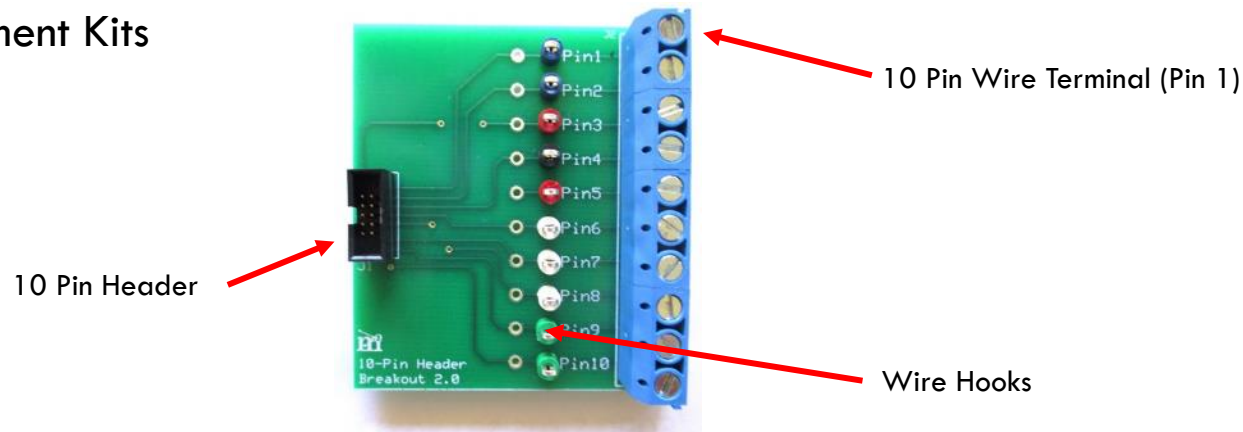
# Driver Connections Breakout: BRK-DRIVER 5.x

- PCBA which breaks out the input connection side of both digital and analog-input MEMS driver to easy to use terminals or test points / pins. Each pin of the 10-pin connector has its own screw terminal, hook, and hole connection and easy to read label. **Not necessary for production OEM quantities, but bundled with prototyping orders** of Mirrorcle's MEMS Drivers (Ver. 5.x).
- **INPUT:** Screw terminals, test points, connect pins - multiple options for easy connections.
- **OUTPUT:** 10-pin header connector (0.05", 2 rows, right angle) which can be directly connected to MEMS Drivers (Analog and Digital) of 5.x generations.
- This item is offered with prototyping purchases of Mirrorcle MEMS Drivers



# MEMS Controller Breakout: BRK-DRIVER 5.x

- PCBA which breaks out the output connection side of both Digital Outputs and MEMS driver outputs to easy to use terminals or test points / pins. Each pin of the 10-pin connector has its own screw terminal, hook, and hole connection and easy to read label. **Not necessary for production OEM quantities, but bundled with prototyping orders** of Mirrorcle's MEMS Controllers part of MEMS Mirror Development Kits
- **OUTPUT:** Screw terminals, test points, connect pins - multiple options for easy connections.
- **INPUT:** 10-pin header connector (0.05", 2 rows, right angle) which can be directly connected to MEMS Output and Digital Output headers of the MEMS controller ver. 2.x generations.
- This item is offered with prototyping purchases of Mirrorcle MEMS Mirror Development Kits





# Mirrorcle Software Suite

Software Applications and SDKs for  
Development with MEMS Mirrors, Scan Modules,  
and Playzer Modules

# Included with Mirrorcle Software Suite

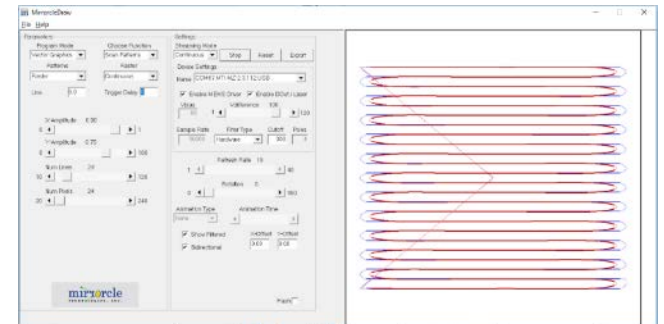
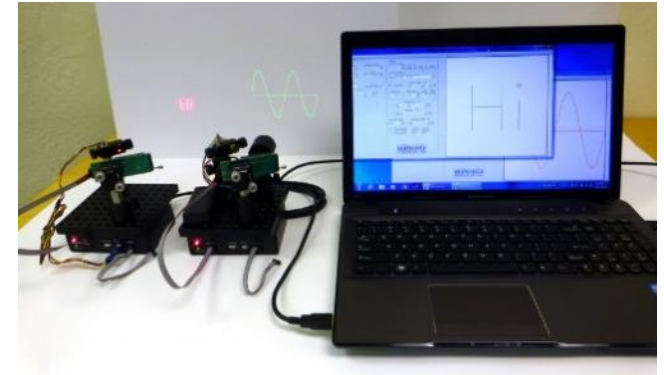
## □ Mirrorcle Software Suite - Windows



- Windows Applications
- C++ SDK
- Matlab SDK
- LabView SDK

## □ This standard Mirrorcle Software Suite (MSS) ships with

- All MEMS Mirror Development Kits
- Development Kit with Scan Module
- Playzer Development Kits



# Software Add-Ons

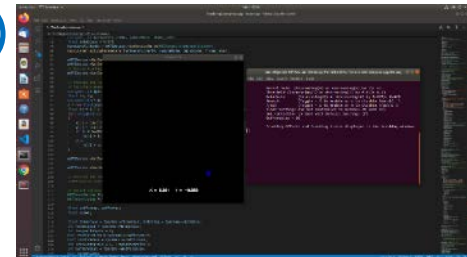


## □ Mirrorcle Software Suite – Python SDK



## □ Mirrorcle Software Suite - Linux (Ubuntu x64)

- Built Applications
- C++ SDK



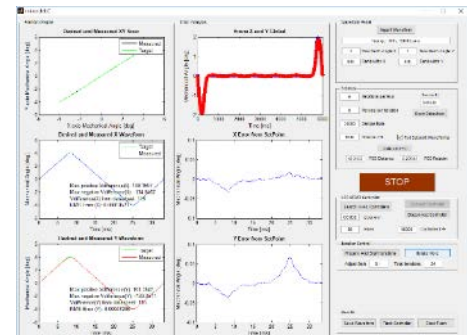
## □ Mirrorcle Software Suite - Android

- Android Applications
- Java on Android SDK



## □ MirrorcleLC

- Windows Application

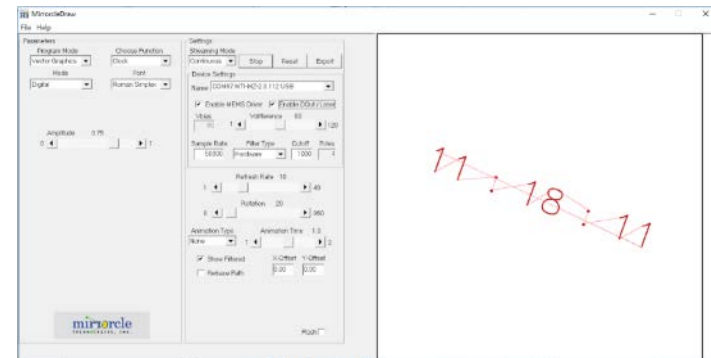
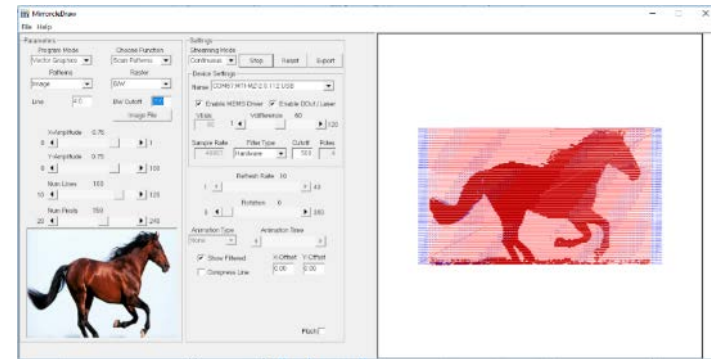




# Mirrorcle Software Suite – Windows Applications

**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 MTL 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 MTLDevice and MTLDataGenerator classes.
Device Name: MTL-HZ-TBD   Firmware Name: MZDK2-6.6.0TM   API version 11.0.2.0

** 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: Hertzley Test 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 DataDemo Demo

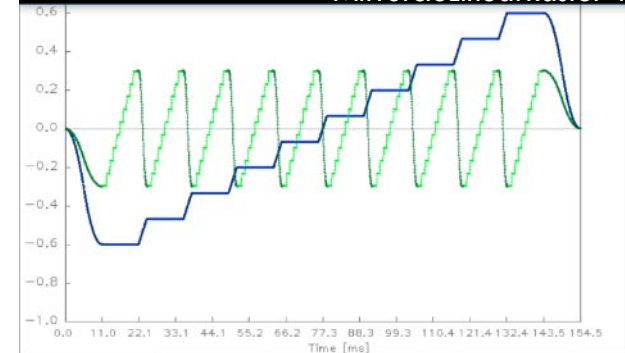
Tracking Examples:
D: Single-Target Tracking with DataMode 'AutoTrack' (Simple Lissajous Pattern)
E: Single-Target Tracking with DataMode 'AutoTrack' (Raster Pattern)
F: Single-Target Tracking with DataMode 'Sample_And_Analog_Input_Track' (Raster)
G: Multi-Target Tracking with DataMode 'Sample_And_Analog_Input_Track'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

```
***** Mirrorcle Linear Raster 11.0 *****
Device Name: MTL-HZ-TBD   Firmware Name: MZDK2-6.6.0TM   API version 11.0.2.0

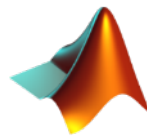
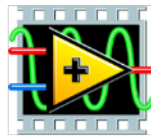
** Warning: Users should check following parameters to avoid MEMS Mirror damage:
vBias = 80.0V   VdifferenceMax = 120.0V   HardwareFilterBw = 300Hz

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): 0.600, 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): 1
e: Toggle to allow export of waveform to file (1) or no export (0): 1

X: Toggle to plot data in xy plot or time plot: TIME
Control delay of digital pulses (+ increase, - decrease): 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/>

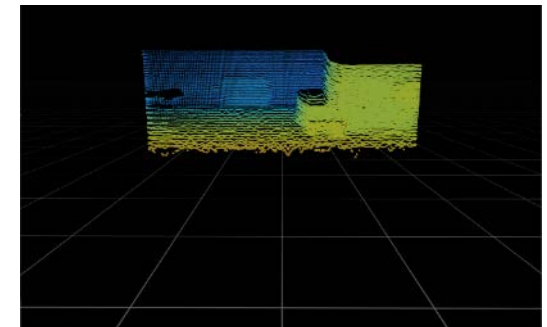
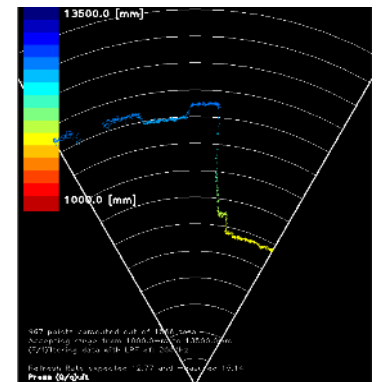


# Mirrorcle Lidar Software Suite

Software Applications and SDKs for  
Development with SyMPL 3D MEMS Mirror Lidar

# Mirrorcle Lidar Software Suite (MLSS) - Applications

- ❑ SyMPL 3D MEMS Mirror Demonstrator Kit (DEMO-07) Software package consists of two Windows applications and their supporting libraries and files
  - ❑ Application **MirrorcleLiDAR.exe** utilizes Mirrorcle Software Suite API to communicate with the MEMS Controller, set all the scanning parameters, and receive sensor data over the USB link. This data is then presented at a TCP/IP socket for client applications to receive and process.
  - ❑ Application **MirrorcleCloud.exe** is a Mirrorcle-developed example client for visualizing point cloud data provided by the SyMPL LiDAR. Users may develop their own client applications to receive and process the point cloud data.
- ❑ Linux (Ubuntu x64) Versions are available as an Add-On purchase



# Mirrorcle Lidar Software Suite (MLSS) – Software Development Kits

As Add-Ons for DEMO-07, Mirrorcle offers a comprehensive Application Programming Interface (APIs) for generation of content (rasters, point-to-point) and streaming of 3D data from the sensor.

Mirrorcle's LiDAR API is available in C++ and on various platforms:

- **Available Add-On: C++ SDK** (Windows, x86 and x64)



- **Available Add-On: C++ SDK** (Linux, Ubuntu x64)



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 time for most items is 2-3 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/>