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.
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 and actuators 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 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 solution**.
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 $1000 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

- **Three Gimbal-less Dual-Axis MEMS Mirrors**
  - 1.2mm, 2mm, 3.6mm diameter, Aluminum coated
    - Window coating 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 ½”-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 ½”-diameter post. Includes screws and L-key.

- **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 ~10mW 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

- **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**: ≈2400Hz in LPF-based driving
- **FoR**: Approx. 30° x 30° Field of Regard
- **Wavelength**: Single laser diode source in:
  - Green (~520nm), up to 30mW CW power
- **Divergence (half angle)**: <2.25mrad
- **Repeatability**: <0.005° each axis
- **MEMS Interface**:
  - 10-pin 0.05” Samtec connector, mates with all Mirrorcle MEMS Controllers and Drivers outputs
- **Laser Interface**:
  - Shares 10-pin MEMS Interface connector (see above)
  - Direct access to Laser Diode terminals by header pins
  - Requires separate laser driver to control
- **Recommended Driving Parameters**:
  - $V_{bias} = 90\text{V}$
  - $V_{\text{differenceMax}} = 140\text{V}$
  - $\text{HardwareFilterBw} = 2400\text{Hz}$

The products discussed in this Document 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**
  - 4.6mm, 4.6mm, 5.0mm – All three Gold coated
    - Window coating and 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 ½”-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 ½”-diameter post. Includes screws and L-key.

- **OPTIONAL Add-ons listed on Development Kit Optional Add-Ons section**
LiDAR/Imaging MEMS Dev Kit II (DK-027)

- **Four Gimbal-less Dual-Axis MEMS Mirrors**
  - 2.0mm, 2.0mm, 2.4mm, 2.4mm diameter – All Aluminum coated
    - Window coating and 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 ½”-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 ½”-diameter post. Includes screws and L-key.

- **OPTIONAL Add-ons listed on Development Kit Optional Add-Ons section**
Getting Started
Important Operating Guidelines

- Never exceed the maximum voltage level and angles specified for each mirror on the individual datasheet enclosed with your development kit.
- Always perform tests that include any new settings such as new drawings, new refresh rates, new filter settings etc., at low voltage settings until you can verify that those settings are working properly and not exciting the device beyond its mechanical limits.
- The devices are sensitive to electrostatic discharge. Always insure adequate grounding when handling the packages. A wrist grounding strap with a 10MΩ series resistance is recommended.
- MEMS mirrors come with anti-reflection (AR) coated windows that should not be directly handled. Any handling of the MEMS mirror should be done with care to maintain cleanliness of the AR-coated window.
- In some cases customers may remove the AR-coated windows to improve optical performance. This modification voids a device’s warranty, but is feasible when done properly. Open cavity mirrors should be handled with extra care because they are most vulnerable due to the exposed MEMS structures. They should never be directly touched in the device and package-cavity area by any object, including blowing air or similar disturbances, and dust/debris should be avoided.
- Optical radiation: Laser class 3R. It may pose a danger to eyes and skin in the event of incorrect use. Do not open the housing. Opening the housing may increase the level of risk. Current national regulations regarding laser protection Must be observed.
WARNING AND CAUTION

Danger due to improper use
Any improper use can result in dangerous situations. Therefore, observe the following information:

- Device should be used only in accordance with its intended use.
- All information in these operating instructions must be strictly observed.

Optical radiation: Laser class 3R
The accessible beam may pose a danger when viewed directly. It may pose a danger to eyes and skin in the event of incorrect use.

- Do not open the housing. Opening the housing may increase the level of risk.
- Current national regulations regarding laser protection must be observed.

Hazardous radiation
If any operating or adjusting other than those specified here are used or other methods are employed, this can lead to dangerous exposure to radiation. Damage to the eyes is possible.

- If the product is operated in conjunction with external illumination systems, the risk described here may be exceeded. This must be taken into consideration by the users on a case-by-case basis.
- Do not look into the light source when it is switched on.
- Comply with the latest version of the applicable regulations on photobiological safety of lamps and lamp systems as well as on laser protection.

Electrical voltage
Electrical voltage can cause severe injury or death.

- Work on electrical systems must only be performed by qualified electricians.
- The power supply must be disconnected when attaching and detaching electrical connections.
- The product must only be connected to a voltage supply as set out in the requirements in the operating instructions.
- National and regional regulations must be complied with.
- Safety requirements relating to work on electrical systems must be complied with.

NOTICE
Modifications and conversions to the device may result in unforeseeable dangers.

Interrupting or modifying the device or Mirrorcle software will invalidate any warranty claims against Mirrorcle Technologies, Inc. This applies in particular to opening the housing, even as part of mounting and electrical installation.
Protecting your new MEMS mirrors

MEMS Driver Excitation

- When using your new mirror with Mirrorcle’s software, always use the device-specific `mtidevice.ini` file, to apply recommended `VdifferenceMax`, `Vbias`, and `HardwareFilterBw` settings.
- Never exceed the maximum voltage levels and maximum angles specified for each mirror on its individual datasheet or as stated in the quotation.

Shock, Vibration, Direct Contact

- Be careful when handling the devices and do not allow excessive shock or induce vibrations, especially around natural resonant frequency – they can cause the devices to break!
- Do not touch the MEMS Mirror structure/package cavity with any object or forced air.

Electrostatic Discharge

- The devices are sensitive to electrostatic discharge. Always insure adequate grounding when handling the packages. A wrist grounding strap with a 10MΩ series resistance is recommended.
Handling the Scan Module

- The MEMS output header on the MEMS controller will drive the scan module MEMS mirror and integrated laser module.
- For EaZy4.0 Scan Modules, connect 10-pin ribbon cable from scan module connector to MEMS header on MEMS controller.
Step-By-Step Guide

- **STEP 1:** After receiving MirrorcleTech’s MEMS Mirror Development Kit please check that all the items are included for the Development Kit (see previous slides).

- **STEP 2:** Assemble the optical breadboarding with MEMS Mount according to recommendations on the next two pages. DO NOT INSERT A MEMS MIRROR INTO THE MEMS MOUNT YET, UNTIL STEP 4.
Recommended Optical Breadboard Setup

Note: Metal-coated mirrors work at all angles, however setups with large incidence angles such as e.g. 45° AOI less efficiently use the available mirror area (aperture), and result in more optical distortion in scan field. Window AR coatings are optimized for 22.5° AOI, however also work well in a fairly wide range of angles.
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 - 3X, resulting in overall development kit scan capability of over 45°.

- Lens has 1/2" and 1" diameter elements and comes mounted on a 1/2 " optical post with 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.
Recommended Optical Breadboard Setup with Wide Angle Lens

Distance between MEMS and Lens: 10mm-12mm

Recommended Angle of Incidence (AOI) ~22.5°

Note: laser beam incident onto the MEMS mirror passes narrowly next to the Wide Angle Lens assembly but should not be clipped by the assembly.
STEP 3: Connect the MEMS Mirror drive ribbon cable (included 10-pin ribbon cable of 300mm length) to the Controller’s MEMS Connector. Connect the red laser module into the Sync Connector which provides power and modulation control. Note that the Digital Output ribbon cable is not necessary for basic startup. Connect USB cable’s “mini” side to the Controller’s backside USB port.

For additional information on the USB-SL MEMS Controller, refer to its User Guide.
Unpacking and Handling MEMS Mirrors

- Open in cleanroom.
- Handle only with gloves.
- Use convenience holes to grip device by the PCB.
- Handle only by PCB and/or connector. (not by window/wedge raised structure)
- Keep away from window or MEMS structure.

Note: When handling devices, disable the MEMS driver or Controller, or unplug the MEMS output cable from the MEMS driver or Controller.
Mounting MEMS Mirrors in TINY Packages

- **STEP 4:** Mounting of the MEMS Mirror package into the MOUNT-TINY.4-KMS MEMS mount (already in post holder on the breadboard). Note the Mount has 2 matching mounting holes for TINY20.4 MEMS package or TINY48.4 MEMS package.

- The MEMS Package should be plugged into the 10-pin ribbon cable, and then placed into the mount. The two screws are placed diagonally (shown below).

- The aluminum holder is screwed onto a kinematic mount for easy adjustment of the MEMS mirror.
Installing Drivers and Software

- **STEP 5:** Plug the USB cable into both your PC's USB port. Your PC will automatically detect and install the device. (If the drivers are not automatically installed, install them manually at C:\MirrorcleTech\Drivers)

- **STEP 6:** Mirrorcle Software Installation: Insert the installation USB Thumb Drive from Mirrorcle Technologies, and follow the instructions provided in the “Install Files/README.txt” file.

- **STEP 7:** For the MEMS mirror mounted in step 4, Mirrorcle’s software and MEMS Controller should be provided with device-specific parameters to get the best results and reduce chances of device damage. Each delivered MEMS mirror device has a datasheet, Sxxxxx.pdf and a corresponding mtidevice-Sxxxxx.ini file, contained in “Device Files” folder. The .ini file contains important device settings such as VdifferenceMax, VBias and the recommended hardware filter cut-off HardwareFilterBw.

These parameters are included in the “mtidevice-Sxxxxx.ini” file delivered with each MEMS Mirror. Find the associated *.ini file for that mirror, rename the file to "mtidevice.ini", and copy it into the installed "exe" folder and the SDK folders:

- C:\MirrorcleTech\exe
- C:\MirrorcleTech\SDK-Cpp
- **Note:** user will find a default mtidevice.ini file which must be overwritten
Starting MirrorcleDraw

- **STEP 8**: Start the software “MirrorcleDraw” from the Mirrorcle folder of your computer’s Programs menu. In the software’s graphical user interface (GUI), check that the output device name is the proper USB MEMS Controller (e.g. if multiple Controllers are plugged into the PC, user should select the desired Controller). Set $V_{\text{difference}}$ to approximately 60V as a ‘safe’ value for initial evaluation. Note that the maximum value of the slider should match the $V_{\text{differenceMax}}$ entry in the device-specific *.ini file (STEP 7).

- **STEP 9**: With Enable Dout / Laser checkbox still off (no laser beam), enable the MEMS by clicking on Enable MEMS Driver. The red LED on the controller box should be ON now and the device is ready to scan. Select Vector Graphics as the Program Mode, and it defaults into Waveforms Function. Click on Enable Dout / Laser checkbox - this turns on the red laser beam which can now be more carefully aligned with the MEMS mirror.

- **STEP 10**: After better aligning the beam with the MEMS Mirror and verifying correct operation (see next slide), please enjoy trying different Wave options, or other Program Mode options, Functions, Refresh Rates, etc., within the appropriate limitations of the device design used in the setup.
Example Waveform in MirrorcleDraw

- **MirrorcleDraw preview:**

- **Output Laser Beam:**

Step 9
Turning Off the Kit Safely

- Do not plug-in or un-plug any cables of the USB MEMS Controller while the MEMS mirror is connected and MEMS driver is enabled (red LED).
- Lower Vdifference settings, and then uncheck Enable MEMS Driver box in the GUI.
- Close the application (before unplugging USB).
- Disconnect the USB MEMS Controller from USB.
Tracking Bundle
Tracking Bundle Add-ons

- Tracking PhotoSensor PCB with 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
Connecting the Photosensor

- The tracking photosensor connects to the back of the USB-SL MEMS Controller, under the Sensor label.
- A 3 pin header with the pinout:
  - Pin 1: VDD (+5VDC)
  - Pin 2: AIN (photosensor analog voltage)
  - Pin 3: GND (Ground)
- The provided 3 pin ribbon cable for the photosensor has pin 1 with orange, pin 2 red and pin 3 as brown
Connect Sensor to MiniPCB Mount

MEMS Mount with 3D Printed cradle for tracking sensor

10 Pin MEMS Ribbon Cable

3 pin sensor cable plugs into back of MiniPCB, or can be directly connected to the sensor.
Pin 1 Orange, Pin 2 Red, Pin 3 Brown
Software Check

- Open the Matlab or C++ SDK Tracking Example folder
- Compile and run the project to check the following:
  - The controller is able to connect to the host PC
  - The MEMS driver can be enabled. In C++ examples, it is enabled during initialization. In the Matlab example, the Enable MEMS Driver box needs to be checked. The controller’s front panel red light turns on.
  - The simplest tracking mode is DataMode8, or Autotrack mode.
  - Some threshold and gains may need to be adjusted for the system to start tracking the retro-reflective tape
Additional Resources

- Manuals for Software and hardware are in the USB Thumb Drive’s “Documentation” folder, and after software installation are also placed in the \Documentation folder

- **Mirrorcle Technologies MEMS Mirrors - Technical Overview** – Overview document about Mirrorcle’s MEMS Devices
- **Mirrorcle Products List**
- **Mirrorcle Online Documentation – Mirrorcle Docs** (online portal)

- SDK and other documentation is available online at:
  - [https://www.mirrorcletech.com/documentation/](https://www.mirrorcletech.com/documentation/)

- Supporting documents, publications and sample device datasheets are available online:
  - [https://www.mirrorcletech.com/wp/support/](https://www.mirrorcletech.com/wp/support/)

- If you have any further questions please contact support@mirrorcletech.com
Thank you for Choosing

That’s it! Thank you for reading through this guide.

If you have any further questions or suggestions please email us:

support@mirrorcletech.com