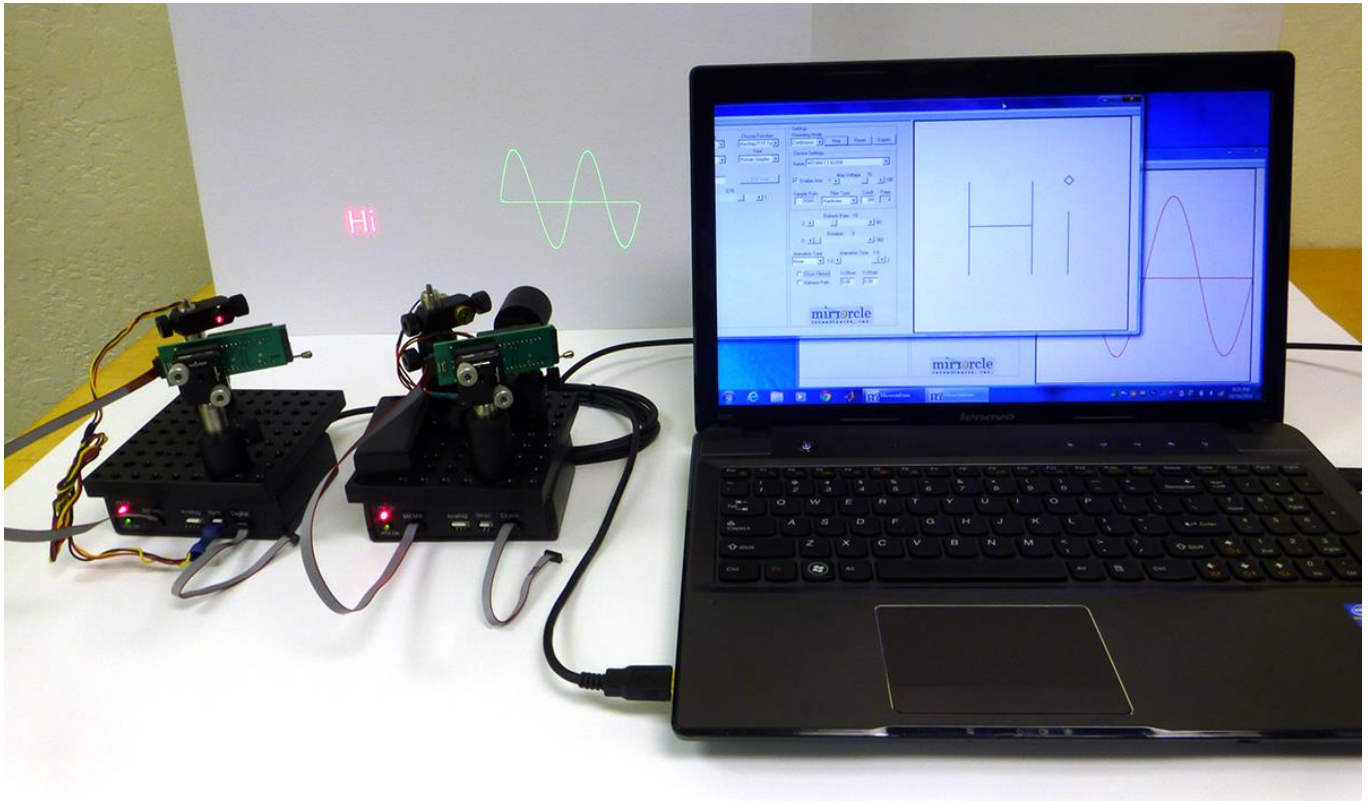
The products discussed in this guide are intended for development and prototyping purposes as **OEM** subsystems for incorporation into customer's prototypes and end products. Therefore, they do not comply with the appropriate requirements of FDA 21 CFR, section 1040.10 and 1040.11 for complete laser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



MIRRORCLE SOFTWARE SUITE APPLICATIONS

mirrorcle TECHNOLOGIES, INC.

Last Revised: Sep 2024

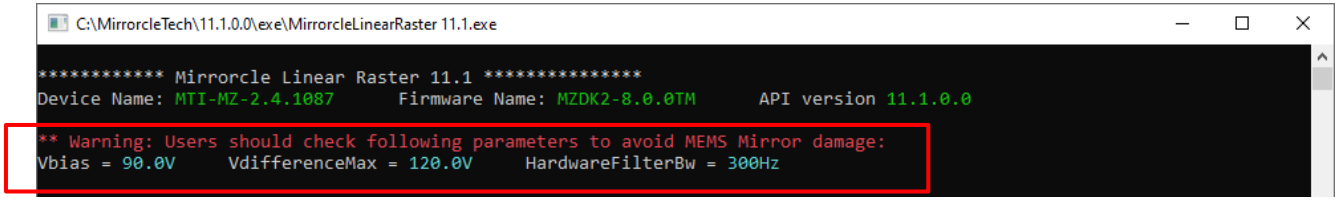
USER GUIDE

Mirrorcle Technologies, Inc.

Table of Contents

Software & Hardware Considerations

- The MEMS mirror actuators with their own driver stages are a highly complex, non-linear system. Our API functions provide easy to use, linear output behavior.
- Warning:
  - Wrong settings can damage the device!
  - Maximum voltage difference (“VdifferenceMax”) value and voltage bias value (“Vbias”) should never exceed the maximum value specified in the datasheet of the device in use.
  - The filter cut-off frequency should not exceed the value in specific device’s datasheet.
  - Never remove the cable from HV amplifier to MEMS Package/Mount during operation. Please refer to our separate handling instructions.
  - For setting up the system as well as for exchanging micro mirrors, please refer to the additional documents.
  - Please assure the correct device parameters and maximum limits according to the Datasheets are in the *mirrorcledraw.ini* and *mtidevice.ini* before starting any application.



The console applications displays the device parameters imported from the ini file on top

Included Windows Software

- mirrorcleDraw
  - Powerful Windows application to fully control the MEMS Mirror. (E.g. Freehand and polyline sketches, parameterized mathematical curves, import of data files, text or clock output, raster patterns with various settings and a function generator with various settings)
- **MirrorcleLinearRaster (Console Application)**
  - Create uniform velocity linear raster scans and control the number of lines, points per line, line scan times, rotation etc. Possible to export raster scan data files (.kpt and .smp).
- **MTIDevice-Demo (Console Application)**
  - Use the arrow keys on the keyboard or enter coordinates to direct the MEMS to a desired location. Import Keypoint or Sample files to be scanned.
  - Executable made from C++ SDK example code by the use of MTIDevice and MTIDatagenerator function calls.
- **MirrorcleListDevices (Console Application)**
  - Scans the COM ports of the computer and provides a table of connected MTI devices with their properties.

mtidevice.ini – Setting Parameters with File

- **Mirrorcle Software Suite (MSS) Applications** govern output voltages and frequencies which are ultimately applied to MEMS Mirror devices and thus have a number of important device driving parameters which should have correct values to obtain best results for a given device design, and to avoid device damage. Some of the key parameters are set in *mtidevice.ini* file in the applications' folder to allow users to modify Application defaults.
- **MirrorcleDraw** and other executable Applications of the Mirrorcle Software Suite (MSS) is coded to import settings/parameters from the *mtidevice.ini* file. Any parameters which are listed in the file will then over-ride parameters that are default inside each respective Application. Thus, the file does not need to be present in the folder, in which case the Application uses its pre-coded default.
- MSS's SDK example sources demonstrate to users how to set device parameters programmatically (via calls to various methods of the MTIDevice class) and how to set some device parameters with the *mtidevice.ini* file. Any of the available methods for setting the parameters may be used as preferred by the user.
- Mirrorcle Development Kits typically ship with *mtidevice.ini* files to assist new users with defining and governing some device parameters which are critical to avoiding potential device damage. However, such individualized files are not necessary and not provided beyond development kit orders. Typically, advanced users will enter their own settings into the file for a given design category, or not use this file at all and pre-code known parameters into their own Applications using the SDKs.

Critical MEMS Controller Parameters

- Following three parameters are most critical to achieve **good performance** and **reduce the chances of device damage** due to improper driving. These differ from one design (device type) to another and should be set according to manufacturer's recommendation for that design. Thus, they are always in the manufacturer's default *mtidevice.ini* file to over-ride any Mirrorcle application's pre-coded values and they are set to fairly conservative values for safe startup for new users.

- **Vbias = 90** – Defines the **default bias** voltage (specific datasheet value has to be used)
- **VdifferenceMax = 120** - Defines the **maximum** allowed voltage (specific datasheet value has to be used) Do not exceed 2x Vbias (e.g. 160 if Vbias is 80).
- **HardwareFilterBw = 300** – Defines the **default** (typical) **Cutoff** frequency (specific datasheet value has to be used)

mirrorcle TECHNOLOGIES, INC.

Additional MEMS Controller Parameters

- Following parameters are not critical but they are provided in the manufacturer's default *mtidevice.ini* file to demonstrate the ability to set device parameters both in the ini file or programmatically (see SDK). The specific parameters chosen to be set in the file are the ones that facilitate more convenient changes of some settings that a user could need in basic experimentation. For example, user tilts their device setup 90 degrees and needs to alter axes definition and simply updates the file to get a new orientation of axes.
- **DataMode = Sample_Output**
- **SyncMode = Output_DOut0** – Defines the relation of the **Sync** port to the **Digital** outputs.

Options are:		
	Default digital output copied from DOut0	Output_Inverted_DOut0
	Inverted digital output copied from DOut0	Output_Inverted_DOut0
	Outputs a clock signal at the sync connector	Output_Sample_Clock
	Outputs a trigger signal at the sync connector	Output_Start_Trigger
	Inputs an external clock signal at the sync connector	External_Sample_Clock
	Inputs a start trigger signal at the sync connector	External_Start_Trigger

- **DeviceAxes = Normal** – Defines the devices axes orientation.

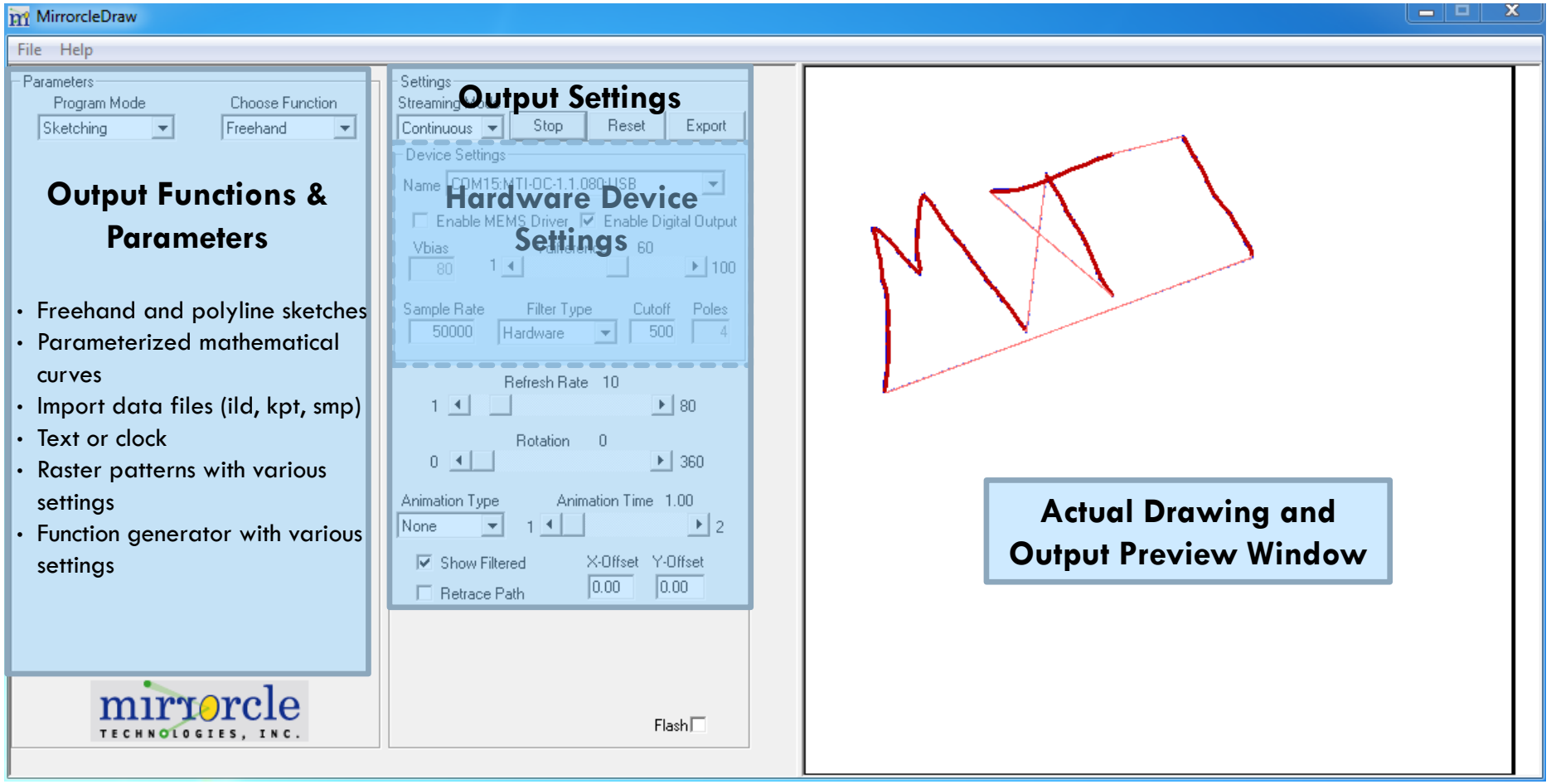
  Options are: Normal, FlipXY, MirrorY, MirrorY_FlipXY, MirrorX, MirrorX_FlipXY, MirrorX_MirrorY, MirrorX_MirrorY_FlipXY
- **DigitalOutputEnable = 1** – Enables/Disables the Digital Outputs

Additional Parameters and Definitions

- **SampleRate:** Defines the number of samples per second (sps) at which the MEMS controller updates MEMS driver output voltages, updates the sync port, and updates the 8-bit correlated digital output port. (In non-default Data Modes, it also takes analog input at the same rate). The applications and SDK examples all have default sps settings, but the user can define the sample rate between 200 and 100000 sps. Typical values used in most applications range from 20000 to 100000 sps.
- **VdifferenceMax:** The maximum Vdifference voltage for a MEMS device. This value is typically provided in quotations, as well as in MEMS mirror datasheets. Exceeding the recommended VdifferenceMax can cause the MEMS mirror to scan beyond its mechanical limits and physically damage the device.
- **HardwareFilterBw** (Filter Cut-off)**:** Most Mirrorcle MEMS controllers and drivers have hardware 5^{th} order Bessel low-pass filters in series with the driver output. This filter must be set with a cut-off value to ensure the driver is not passing higher frequencies than recommended for a device, to prevent the excitation of resonance. If the filters need to be bypassed, they can be set to their maximum cut-off frequency of 50kHz.

MirrorcleDraw – Application GUI

mirrorcleDraw

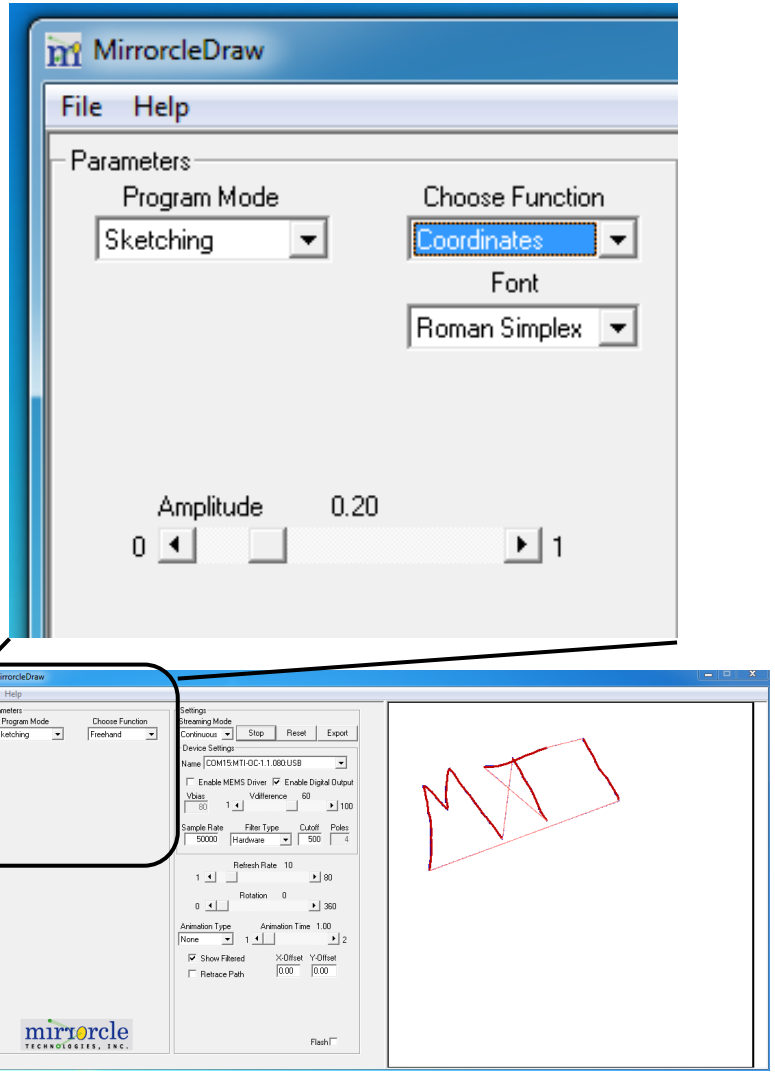


mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – GUI Menu & Mode

mirrorcleDraw

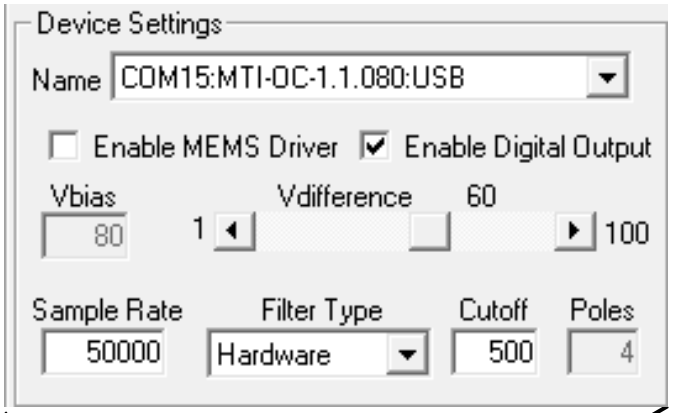
- **File** menu item allows you to **Exit** the Application
- **Help** provides information **About MirrorcleDraw** and **Get Device Firmware** as well as **Help** weblinks.
- In the **Parameters** Section choose a **Program Mode**:
  - Sketching, Vector Graphics or Waveform Generator
- **Choose Function** for designated feature.
- Additional function options/ settings will show-up below. For example: here **Font** Type and Size.
- The output will immediately be drawn in the preview window.



MirrorcleDraw – GUI Device Settings

mirrorcleDraw

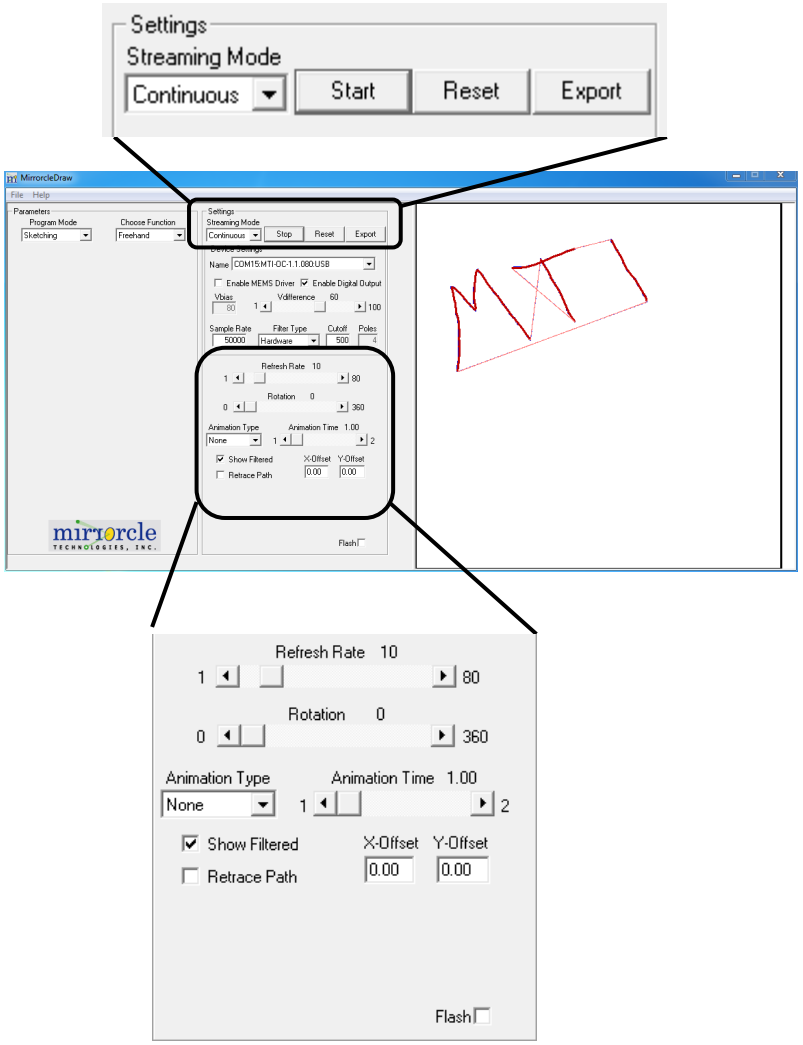
- In the **Device Settings** section all important device parameters can be set.
- Select from the **Name** drop-down menu the device.
- By **re-selecting** the device during operation, **changes** of the configuration "ini" files apply and **Vbias** voltage is read from the "ini" file.
- Set the **Vdifference** for the MEMS driver to the **datasheet specified maximum** value. Smaller values will scale down the output (resp. mirror angle).
- **Enable MEMS Driver** (or disable) for the MEMS driver stage via the checkbox.
- Set the **Sample Rate** for proper projection.
- Choose a hardware or software **Filter Type.** For a given filter, set the **Cutoff** frequency according to the **maximum** allowed **in the datasheet.** Various software filters allow the user to define the amount of **Poles.**



MirrorcleDraw – GUI Output Settings

mirrorcleDraw

- To perform a single scan or infinite loop, the **Streaming Mode** can be changed from Continuous to Single. Start and stop outputting by pressing the button on the right.
- Sliders are available to adjust the **Refresh Rate** (frame rate, see next page) and the **Rotation**.
- Select an **Animation Type** and **Animation Time** for its repetition.
- **Show Filtered** previews the filtered and/or animated output drawing.
- Checkbox **Retrace Path** lets the device go back to the starting point by following the same pattern backwards. If unchecked, it returns to the starting point via the shortest path.
- A change of the **X-, Y-Offset** values or a click into the preview window offsets the drawing.



mirrorcle TECHNOLOGIES, INC.

Setting and Understanding Refresh Rate

- **Refresh Rate:** the number of times the prescribed content is repeated (beam-scanned) over one second. It is equivalent to the Sample Rate divided by length of the waveform Data Stream.
- In the MirrorcleDraw GUI, the user has no knowledge of the length of the Data Stream, so the Refresh Rate slider and the Sample Rate edit box are used to determine the length of the Data Stream.
  - **Refresh Rate [Hz] = (Sample Rate [samples per second] / Length of Data Stream [samples])**
  - Example of the function refresh rate in MirrorcleDraw: given some prescribed content (a scan pattern), we may define the Sample Rate as 50,000 samples per second (sps) and set the Refresh Rate equal to 10 Hz. Using this and the rearranged equation above, Length of Data Stream = Sample Rate / Refresh Rate, we find that number of samples in the scan pattern sent to the controller is equal to 50,000 / 10 or 5,000 samples.
- Refresh rate directly affects the bandwidth of the content and therefore the bandwidth required to correctly execute (beam-scan) the content. For very complex content (or slower MEMS Mirrors) lower rates of few Hz to e.g. 10Hz are typically used, while for fastest MEMS Mirrors in e.g. vector graphics laser projection applications users may set refresh rates above 30Hz, etc.

mirrorcledraw.ini – GUI Settings

- **MirrorcleDraw settings are defined:**
- Vdifference = 60

Setting Section

- **Sample Rate** range:
  SpsMin = 2000
  SpsMax = 100000
- **Refresh Rate** range:
  RrMin = 2
  RrMax = 40
- **Animation Time** slider range
  AtimeMin = 1
  AtimeMax = 2

Parameter Section

- **Signal Generator** functions **frequency** range
  FreqMin = 10
  FreqMax = 5000
- **Vector** Graphics – **Scan Patterns** - Raster **Number of Lines** range
  RasterLinesMin = 10
  RasterLinesMax = 100
- **Vector** Graphics – **Scan Patterns – Image BW Cutoff** value:
  ImgBwCutoff = 200
- **Vector** Graphics – **Import file**
  InterpolateILDA = 1
- **Sketching – Projection Xfm**: Advanced Menu: Display checkbox, enable functionality and define default projection area
  AdvancedMenu = 0
  ProjXfm = 0
  ProjXfm XBR … YTL = 1

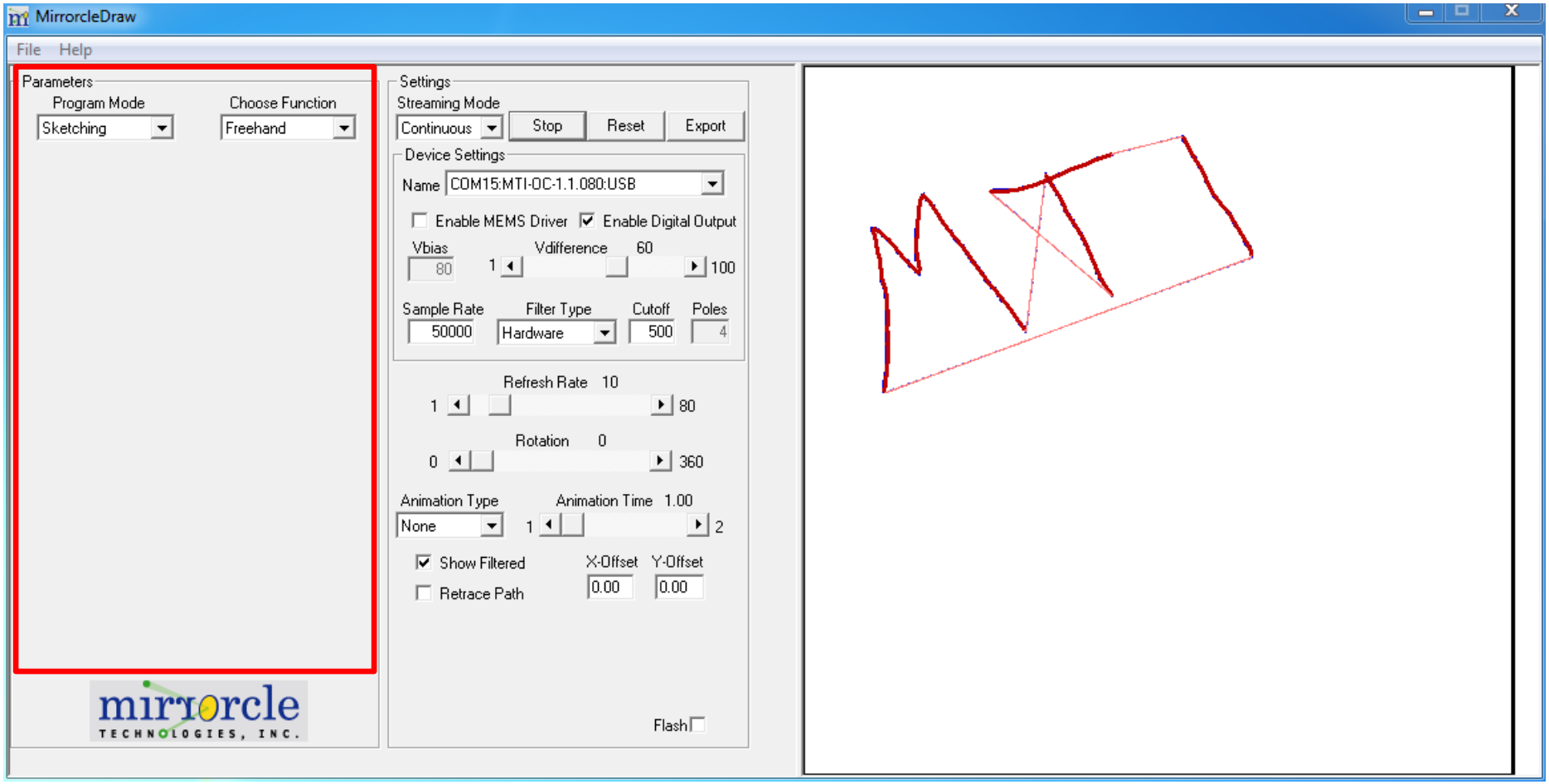
Window Frame

- **Adjust Applications Window Frame:**
  XPadPixels = 0
  YPadPixels = 0

mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Functions in Detail

mirrorcleDraw



mirrorcle TECHNOLOGIES, INC.

Functions in Detail

MirrorcleDraw – Complete Function Tree

mirrorcleDraw

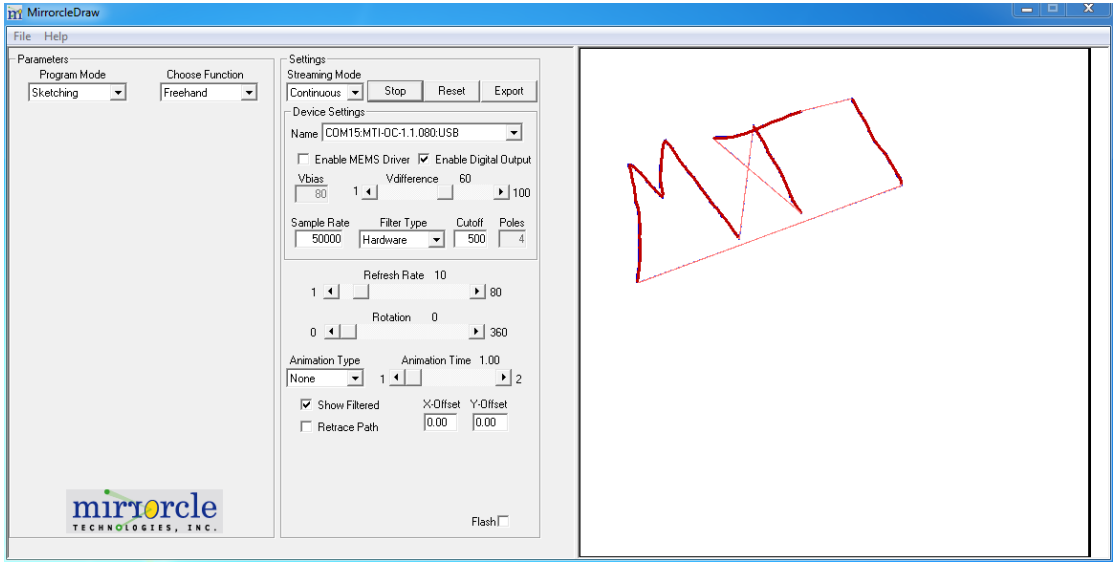
- **Sketching** with Functions:
  - Freehand, Polyline, Projection Xfm (via advanced menu) or Coordinates (Font Type, Amplitude)
- **Vector Graphics** with Functions:
  - **Waveforms** with Wave:
    - Sine (Amplitude, Frequency, Phase)
    - Sawtooth (Amplitude, Frequency, Width, Phase)
    - Square (Amplitude, Frequency, Duty Cycle, Phase)
  - **Spirograph** with Curve and Waveform:
    - Rose - Sine or Triangle (Amplitude, A, B)
    - Epicycloid - Sine or Triangle (Amplitude, A, B)
    - Epitrochoid - Sine or Triangle (Amplitude, A, B, C)
    - Hypocycloid - Sine or Triangle (Amplitude, A, B)
    - Hypotrochoid - Sine or Triangle (Amplitude, A, B, C)
  - **Lissajous** with Waveform and Modulation:
    - Sine – None, Amplitude or Frequency (Amplitude, X-, Y-Freq, XY-Phase, Mod: Ratio, Freq, Phase)
    - Triangle – None, Amplitude or Frequency (Amplitude, X-Freq, Y-Freq, XY-Phase, Mod: Ratio, Freq, Phase)
  - **Import File** with File Type:
    - ILDA Keypoint - Load: *.ild (Amplitude, Frame, Theta, Phi)
    - User Keypoint - Load: *.kpt (Amplitude, Frame)
    - ILDA Sample - Load: *.ild (Amplitude, Frame, Theta, Phi)
    - User Sample - Load: *.smp (Amplitude, Frame)
  - **Hershey/TTF Text** with Mode and Font:
    - Text – *Multiple to select* (Amplitude)
    - Characters – Kanji, Western, Math, Symbol (Ampl, CharID)
    - True Type – *System installed options* (Amplitude)
  - **Scan Patterns** with Patterns and Raster:
    - Raster – Point-Point or Continuous (Line time, Trigger Delay, X-, Y-Amplitude, Num Lines, Num Pixels)
    - Image – Grayscale or B/W (Image File: JPG or WMV, Line time, BW Cutoff, X-, Y-Ampl, Num: Lines, Pixels)
    - Spiral (X-Amplitude, Y-Amplitude, Num Loops)
  - **Clock** – Analog or Digital (Select Font, Ampl)
- **Signal Generator** with Function:
  - **Waveform** with X-, Y-Signal:
    - DC – DC, Sine, Triangle, Noise (X-, Y-Voltage, Y-Freq)
    - Sine – DC, Sine, Triangle, Noise (X-Amplitude, Y-Amplitude or Voltage, X-Frequency, Y-Frequency)
    - Triangle – DC, Sine, Triangle, Noise (X-Amplitude, Y-Amplitude or Voltage, X-Frequency, Y-Frequency)
    - Noise – DC, Sine, Triangle, Noise (X-Voltage, Y-Voltage or Amplitude, Y-Frequency)
  - **Lissajous** with Waveform and Modulation:
    - Sine – None, Amplitude or Frequency (Amplitude, X-, Y-Freq, XY-Phase, Mod: Ratio, Freq, Phase)
    - Triangle – None, Amplitude or Frequency (Amplitude, X-Freq, Y-Freq, XY-Phase, Mod: Ratio, Freq, Phase)

mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Sketching: Freehand

mirrorcleDraw

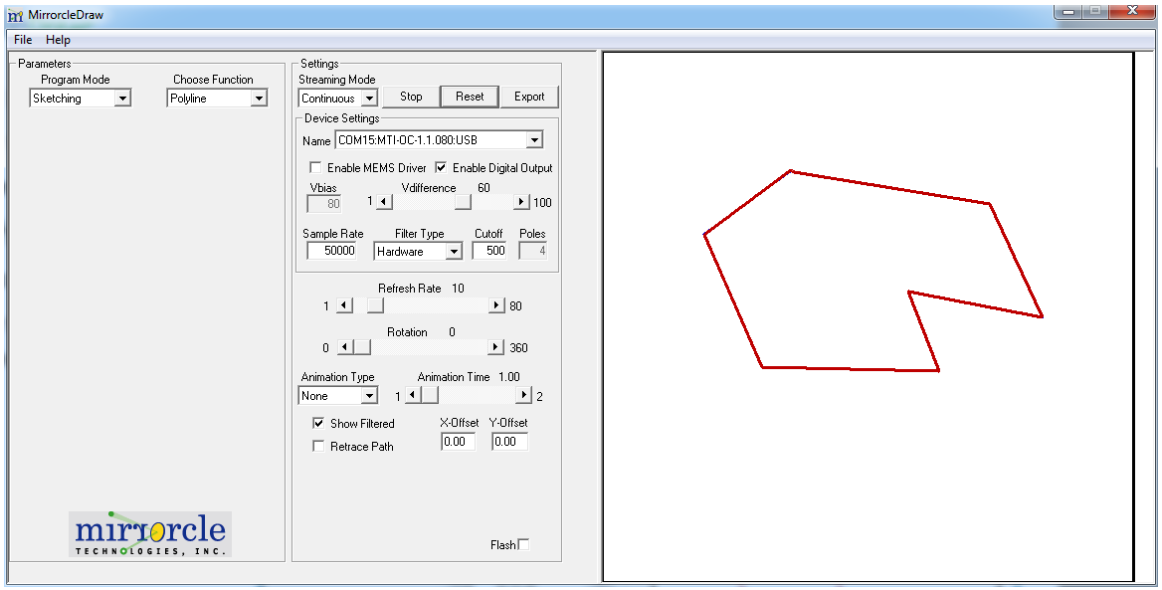
- **Draw** shapes by holding the left mouse button pressed while moving the mouse or place single points separate on the screen. The points will automatically be connected.
- **Close** sketch by connecting the first and last point with a right click.
- **Delete** points with a right click on it.
- **Start** or **Stop** the projection with the 'start/stop' button.
- **Erase** the complete sketch with the 'reset' button.



MirrorcleDraw – Sketching: Polyline

mirrorcleDraw

- **Draw** polygons by clicking with the left mouse button to add points to the existing polygon.
- **Close** sketch by connecting the first and last point with a right click.
- **Delete** points with a right click on it. Deleting the first/last point of a closed polygon opens it.
- **Modify** the existing polygon by moving points with holding & releasing the left mouse button.
- **Start** or **Stop** the projection with the 'start/stop' button.
- **Erase** the complete sketch with the 'reset' button.



MirrorcleDraw – Sketching: Projection Xfm

mirrorcleDraw

- **Projection Xfm** allows to **transform** the output projection to the polygon drawn, to match it onto a surface and compensate the angle. It allows to **Mirror the X-axis** and **correct Tan Theta** as well as **Barrel** distortions.

- Projection Xfm is **not available in** the **standard menu mode.**
- To enable **Projection Xfm** as an **Advanced Menu** feature in MirrorcleDraw, please **modify** *mirrorcledraw.ini* with the following change:
  - **AdvancedMenu = 1**. This option provides a checkbox for enabling Projection Xfm.
  - **ProjXfm = 1**. This option sets the checkbox of Projection Xfm.

- **MirrorcleDraw** application **settings** are stored in the *mirrorcledraw.ini* file in the same folder as the executable. It contains all settings that are required by the programs to run properly.

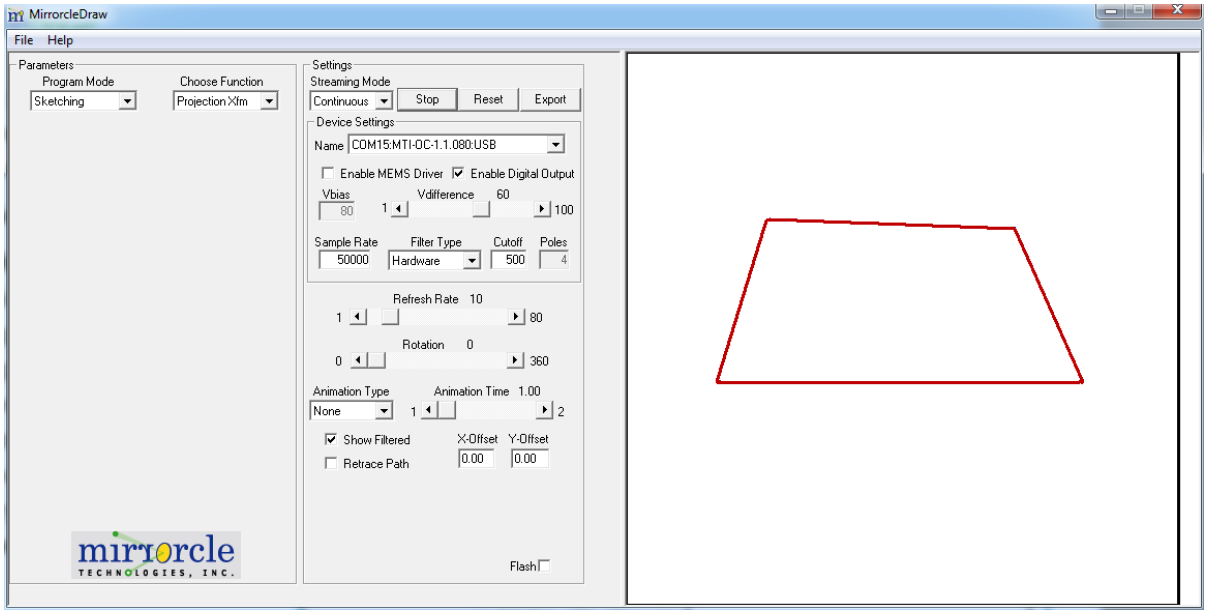
mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Sketching: Projection Xfm

mirrorcleDraw

- **Draw** polygon with adding points by the left mouse button **counterclockwise.**
  - **Modify** the existing polygon by moving points with hold & release the left mouse button.
  - The transformation will be **applied** when the Projection Xfm **box** is **checked.**
- Or **Mirror** the **X-axis** by checking the box.
- **Tan Theta and Barrel** distortion **correction:**
  - This setting is used to correct the keystone distortion. Angle of ½ the field of view

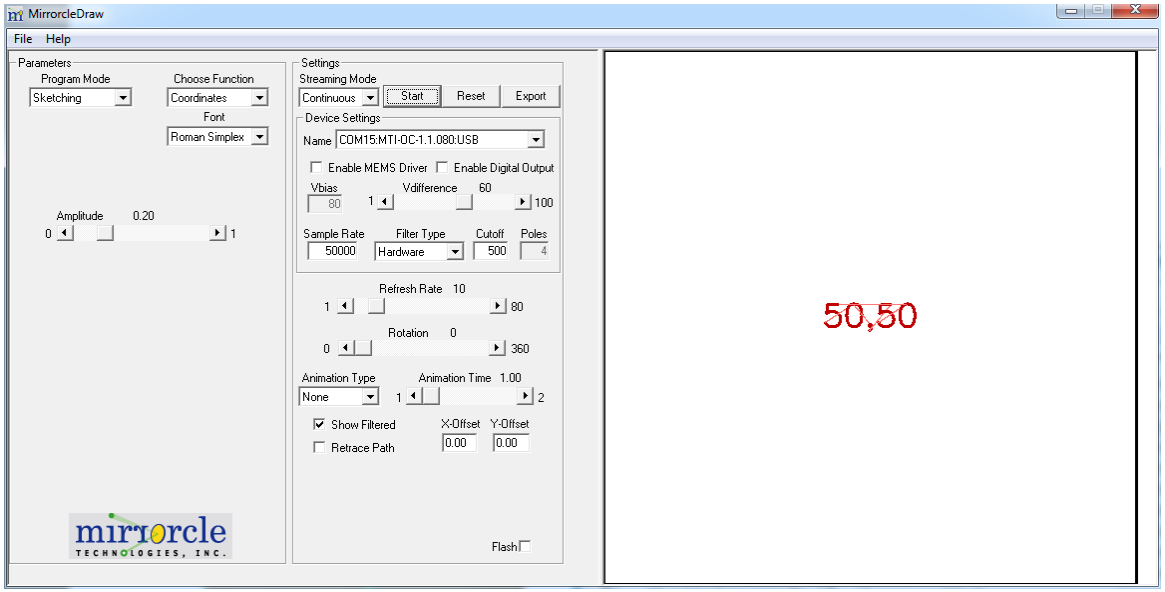
(approx. 20 deg) typically provides correction by applying barrel distortion to counter the tangential keystoning in corners of the field of view.



MirrorcleDraw – Sketching: Coordinates

mirrorcleDraw

- **Displays** the MEMS mirror **coordinates** (X,Y). It starts at 50, 50 center position.
- The coordinate system starts at the lower left corner with 0,0 and ends in the top right 100,100 position.
- Find a **new location** by clicking with the left mouse button in the drawing area. Keeping the left mouse button pressed while moving the mouse, dynamically updates the coordinates.

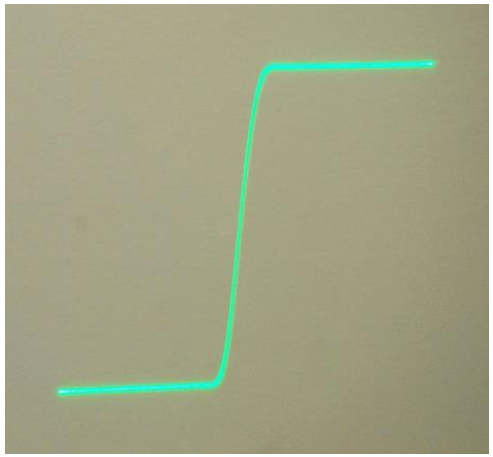


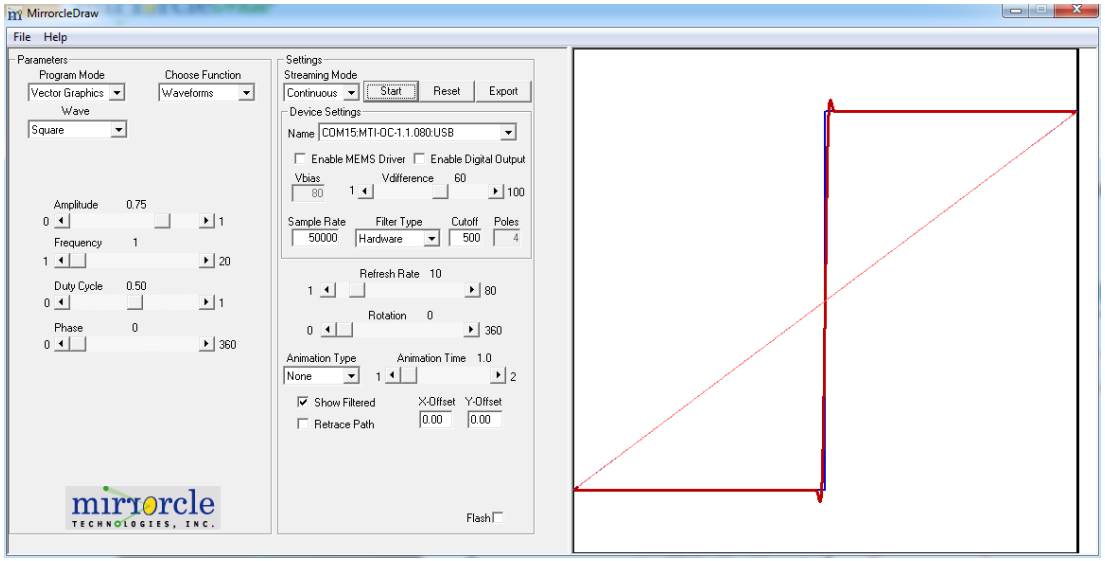
MirrorcleDraw – Vector: Waveforms

mirrorcleDraw

- **Generate** sine, sawtooth or square waveforms.
- **Adjust** the amplitude, the number of cycles displayed and the phase shift of the waveform. For the sawtooth and square waveforms the duty cycle can also be set.
- **Use of Filters**: Test the step response of the device and the effect of various filter parameters.
  - **Select** the square waveform with a single cycle for the step response.
  - **Choose** between different available filters to find out smoothing, overshot, ringing.

Output Example:



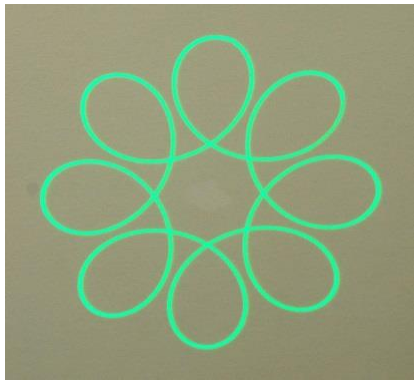


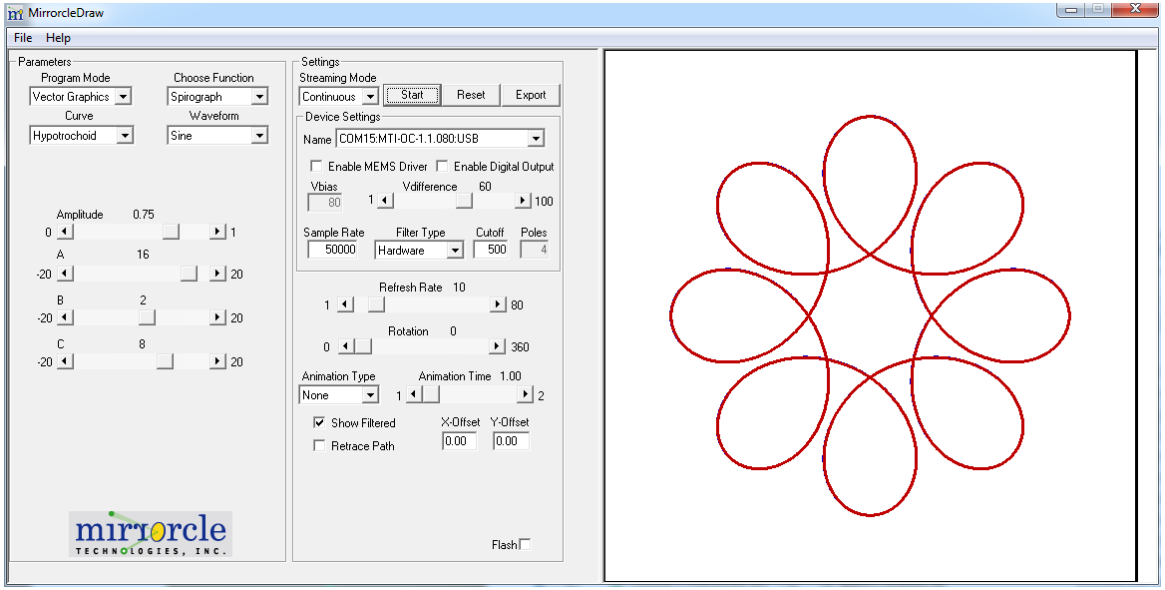
MirrorcleDraw – Vector: Spirographs (1/2)

mirrorcleDraw

- **Spirographs** patterns are formed by tracing points on a circle as it revolves around another circle. Depending on the circles' radii and position of the point, different curves are created.
- **Choose** between the different curves and specify the parameters A, B, C that determine the shape of the curves and the appearance of the resulting drawing.
- **Use of Animations**: Modify the curves with two main types of animations.
  - **Rotate** the entire curve at the rate specified by the animation time slider.
  - **Cycle** through different values of A, B, or C giving rise to a sequence of curves.

Output Example:

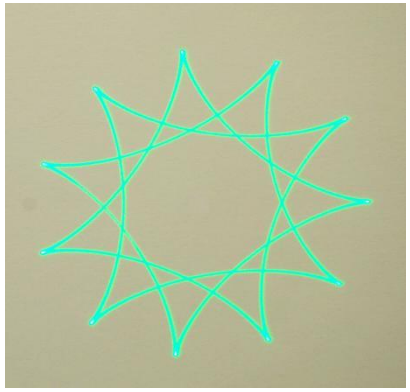


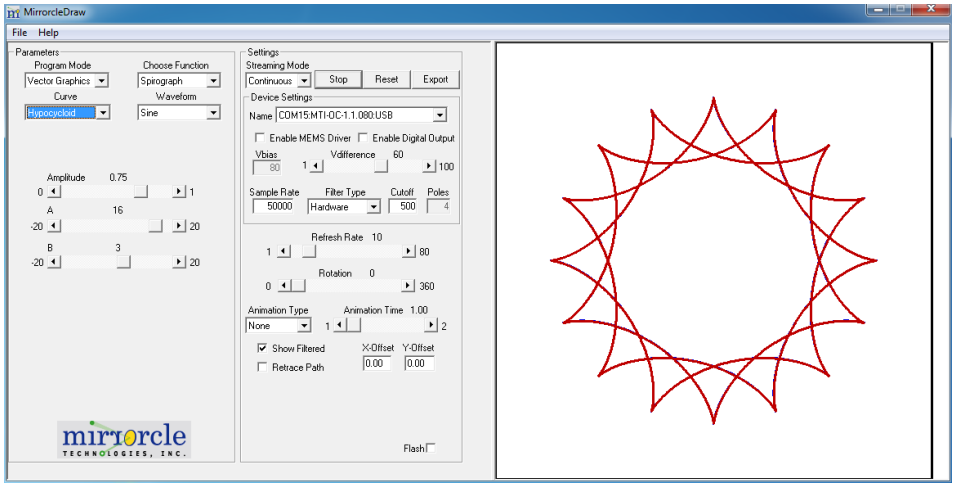


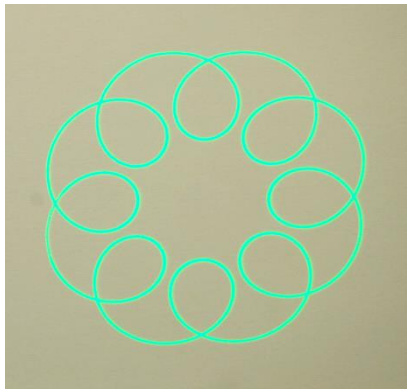
MirrorcleDraw – Vector: Spirographs (2/2)

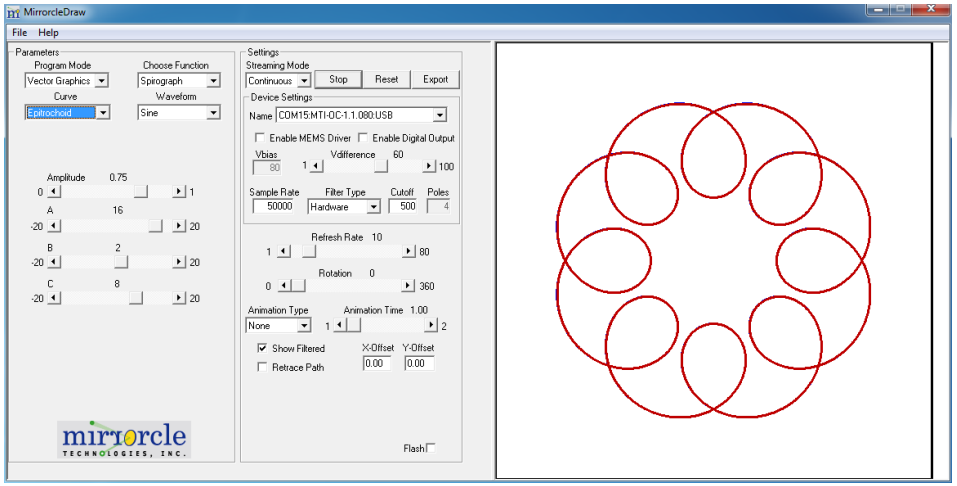
mirrorcleDraw

- **Additional Spirographs:**







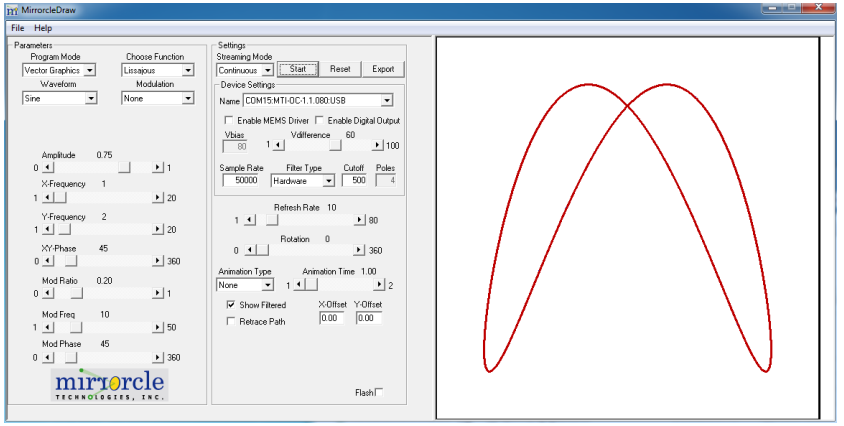


mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Vector: Lissajous

mirrorcleDraw

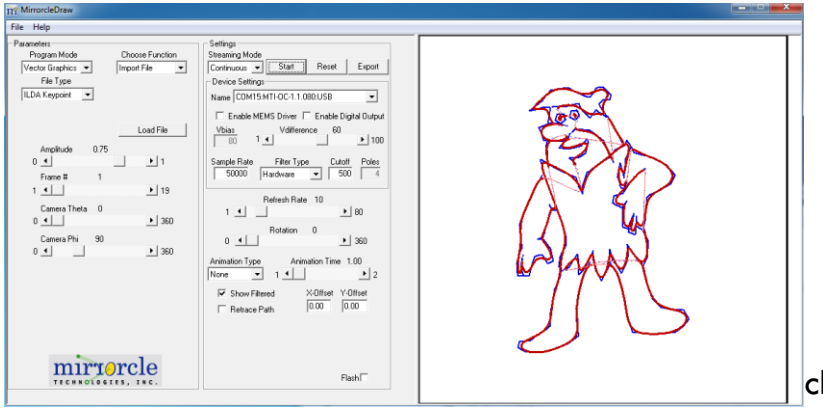
- **Generate** Lissajous patterns by using a set of basis **sinusoidal** and **triangle** waveforms applied on the X and Y axes as commonly seen on oscilloscopes.
- **Change** the **amplitude** and **phase** to modify size and appearance of the pattern. A modification of the relative **frequencies** on either axis will create a whole array of patterns. The **frequency** parameters correspond to the periods of the waveform per T where T is the reciprocal of the Refresh Rate.
- Even more complex patterns are generated by allowing **modulation** of a waveform. Define **amplitude** or **frequency** modulation for each axis. By increasing **modulation ratio, frequency** and **phase,** the modulation index, it highly deviates from its non modulated origin.
- **Use of animations:** The entire curve can be **rotated** or modified with **frequency**. The **phase** lag animation sweeps the phase by 360°. The result appears to be rotated about its long axis.
- Sweep with the **modulation ratio** or **modulation frequency** in order to visualize the effect of increasing modulation strengths on the base signal. (It is useful always to modify and test different values.)

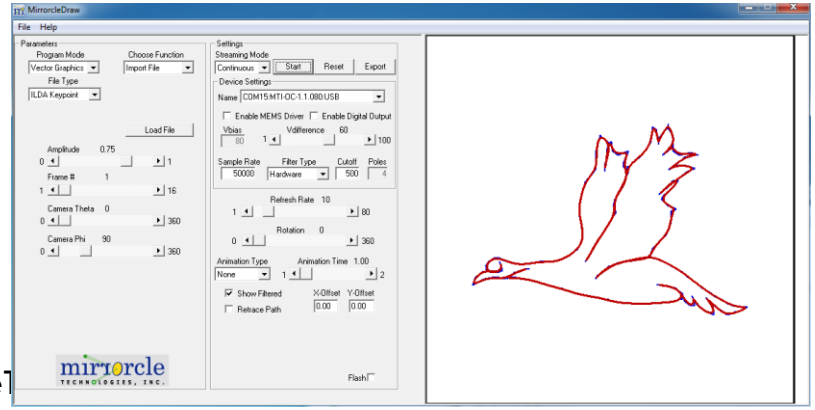


MirrorcleDraw – Vector: Import ILDA Files

mirrorcleDraw

- **Import ILDA** (International Laser Display Association) files (*.ild) for laser graphics. The binary file format and can contain multiple frames that are part of an animation sequence.
- Choose the proper **File Type** either **ILDA Keypoint** or **ILDA Sample** of the source. A number of sample ILDA files are included in the software suit (C:\MirrorcleTech\Media\ILDA\).
- Display a single static frame by using the **frame** number slider or play all frames by setting the **Animation Type** to **Slideshow**.
- For Slideshows it is recommended to match the **sample rate** and **refresh rate** with a ratio of at least 1000:1.

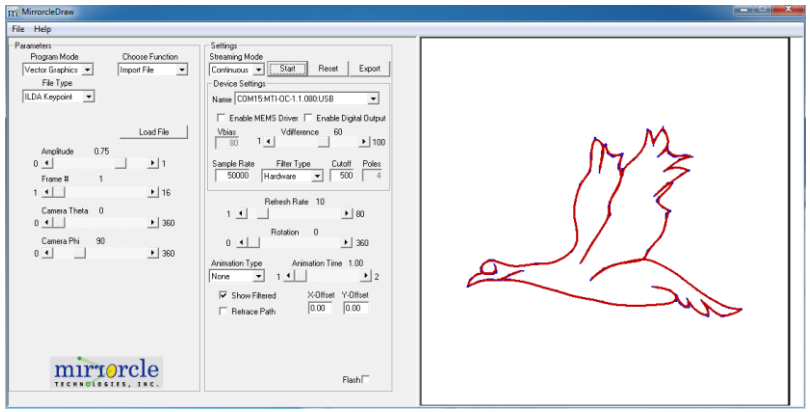




MirrorcleDraw – Vector: Animation

mirrorcleDraw

- In **Vector Graphics** mode choose function **Import File** and select **ILDA Keypoints**. Load file 'CanGoose.ild' from the C:\MirrorcleTech\Media\ILDA\ folder.
- As **1st** exercise select **Slideshow** in **Animation Type** and set **Animation Time** to 2 sec. The **Animation Time** determines the time to display all the frames. To make the bird fly faster, decrease animation time to 1sec in 0.25 sec in steps.
- As **2nd** exercise create a rotation animation of a single frame by choosing the **Rotate** mode as the **Animation Type**. Modify the **Animation Time** again.
- As **3rd** exercise rotate in 3D by adjusting **Camera Theta** (angle with +X axis) and **Camera Phi** (angle from XY plane). This leads to great effects in viewing frames containing 3D objects!
- Please consider for displaying animations, if the total **Animation Time** is too short, each frame will only have few points resulting in loss of detail or smoothing. As well as too high **Refresh Rates** decrease the number of points available per frame leading in a loss of details.
- Find a tradeoff between a sufficiently large **Animation Time** and low enough **Refresh Rate** for best results!

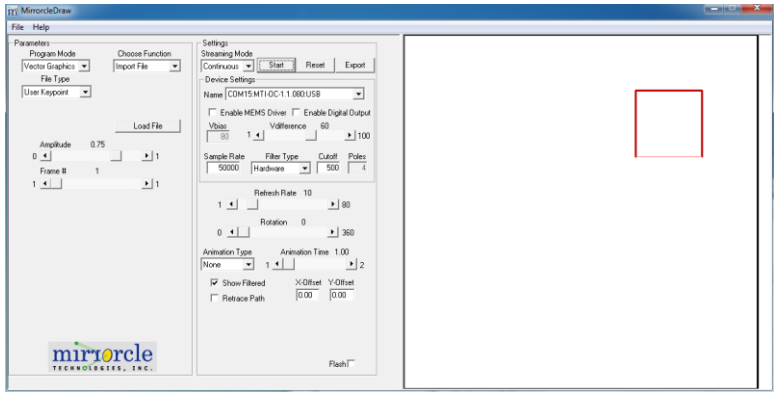


MirrorcleDraw – Vector: Import Files (1/2)

mirrorcleDraw

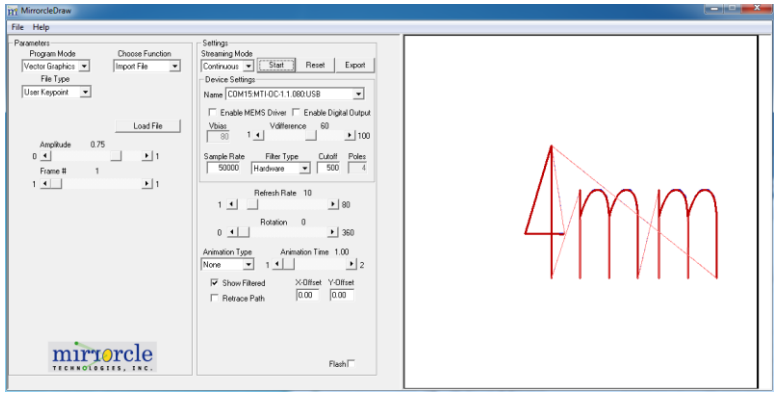
- **Choose** the proper **File Type** either **Keypoint** (.kpt) or **Sample** (.smp) as source. A number of sample files are included in the software suit folder C:\MirrorcleTech\Media\.
- Both file types are **text files**. Each line contains normalized XY coordinates and output on/off value separated by 'blank spaces'. The **Sample Rate** can be defined in the first line ('SPS *number*'). If not, the existing value will be used.
- Example **Keypoint** files OpenBox.kpt:
  - Normalized X Y coordinates and output state

    0.250000 0.250000 255
    0.250000 0.750000 255
    0.750000 0.750000 255
    0.750000 0.250000 255



- Example **Keypoint** file Text.kpt:
  - Normalized X Y coordinates and output state

    -0.296875 0.500000 255
    -0.494792 -0.166667 255
    {…}
    0.950000 -0.500000 255



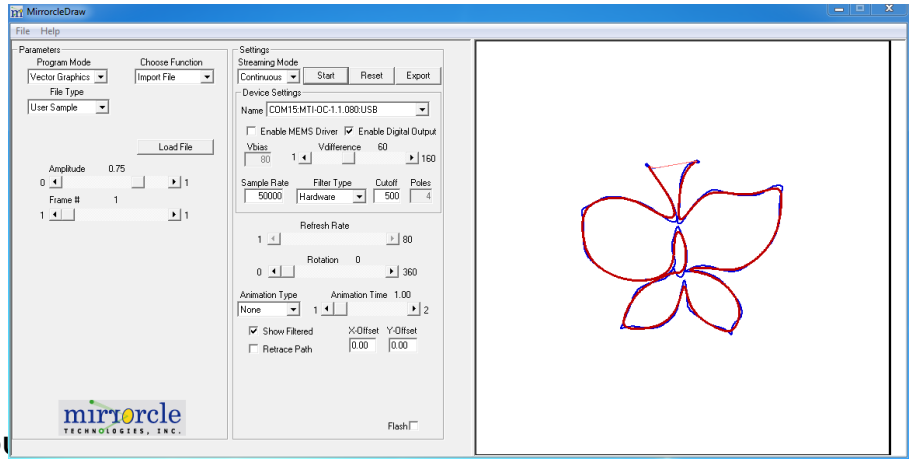
mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Vector: Import Files (2/2)

mirrorcleDraw

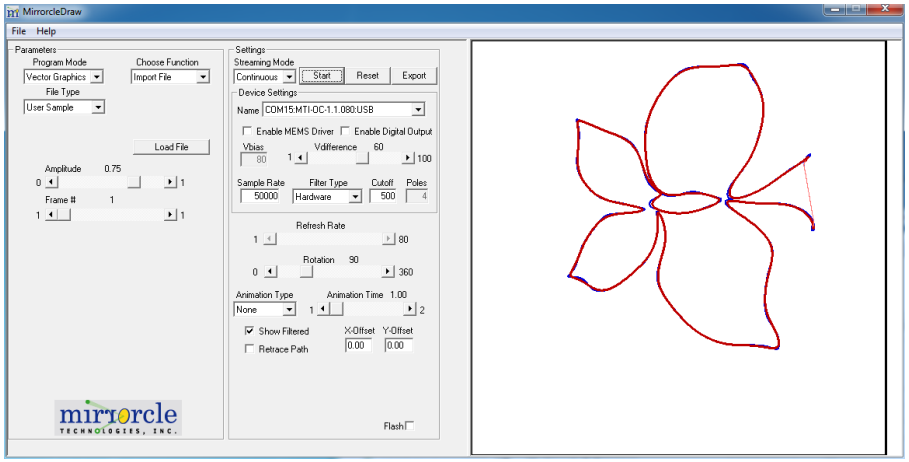
- Example **Sample** file Butterfly.smp:
  - X Y coordinates and output state:

    -0.207420 0.514200 255
    -0.210580 0.515460 255
    {…}
    -0.200640 0.512000 0
    -0.203160 0.512720 0



- Example **Sample** file Vertical_Raster.smp
  - **Sample Rate,** X Y coordinates and outpu

    sps 50000
    -0.000012 -0.000117 0
    {…}
    -0.900000 -0.832948 255
    -0.901283 -0.832948 255
    -0.901283 -0.833081 255
    {…}
    0.000012 -0.000117 0

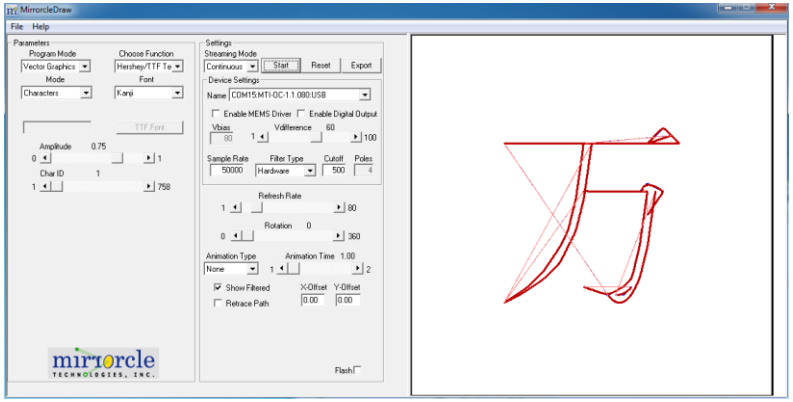


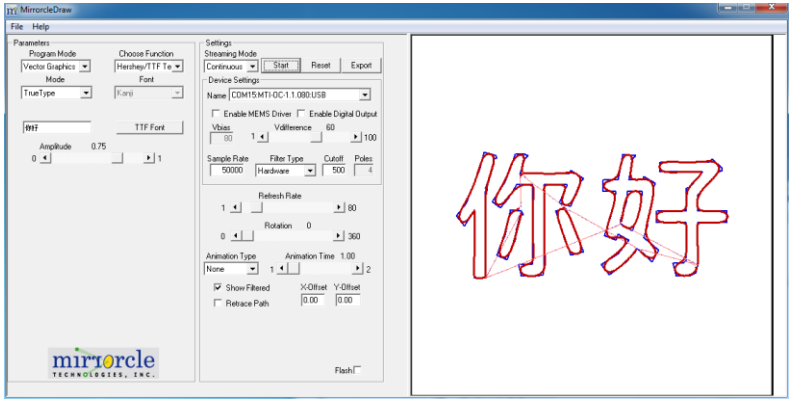
mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Vector: Hershey/TTF Text

mirrorcleDraw

- Enter a **text string** or a **special character**. The program translates it into vector graphics.
- For a text string the font style can be selected out of the **Hershey** font set, which contains 6 fonts including Cyrillic and Greek or any other, on your computer, installed **TrueType** font.
- In the character mode **Kanji, ASCII, mathematical** and other **symbols** can be selected. For more special characters, select the font type and access non-ASCII symbols by using 'Alt-XXXX' in the text box. Find the code for particular characters by the Windows Character Map utility.
- Please note, if the text string is too long, scroll the text across by selecting **Scroll** under **Animation Type.** Note that it can take a long time to compute the scrolling waveform.



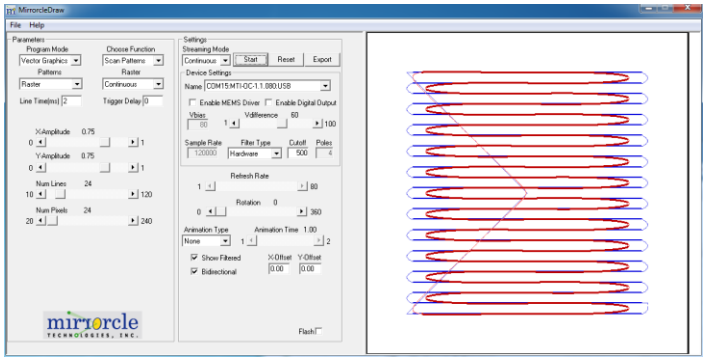


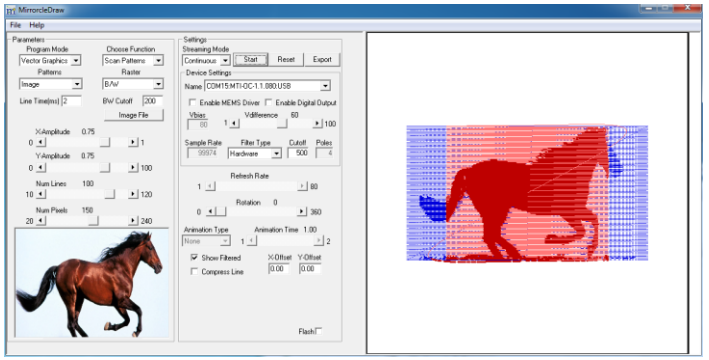
mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Vector: Scan Patterns

mirrorcleDraw

- **Generate** different **scan patterns**: Raster, Image or Spiral.
- Control the XY-Amplitudes, the Number of Lines and Pixels as well as the Rotation. With the animation time slider the total time for one cycle can be set. Typically, animation time of 1-2 sec gives visually pleasing results. Increasing the time slows the rotation. Once all frames of the animation are computed, the program loops it infinitely.
- The **Raster** scan creates lines along the horizontal axis and repeats it on the vertical axis.
- Import .jpg files for the **Image** scan and choose black and white or grayscale for import. The displayed resolution of the image is adjusted by the number of lines used to create the image.
- The **Spiral** scan traces out a right-angled spiral starting at the center and returns back by retracing its path. It is useful for checking the fidelity of the filters in tracing sharp corners.



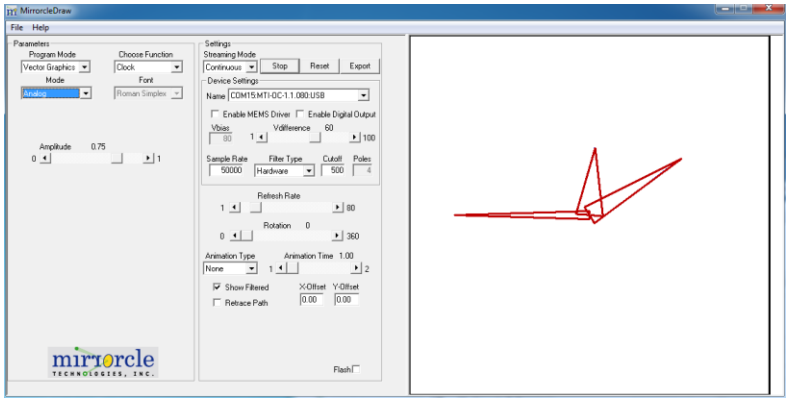


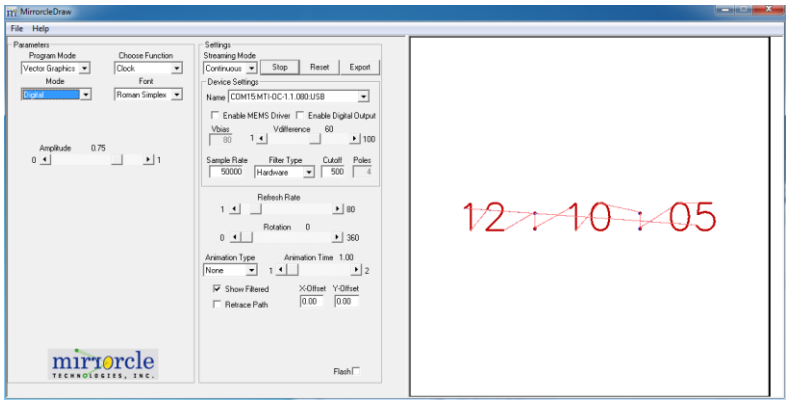
mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Vector: Clock

mirrorcleDraw

- This mode creates a vector graphic drawing of the **current time** as an analog clock with the hour, minute and seconds hand or in digital 24-hour format (HH:MM:SS). Updated every second.



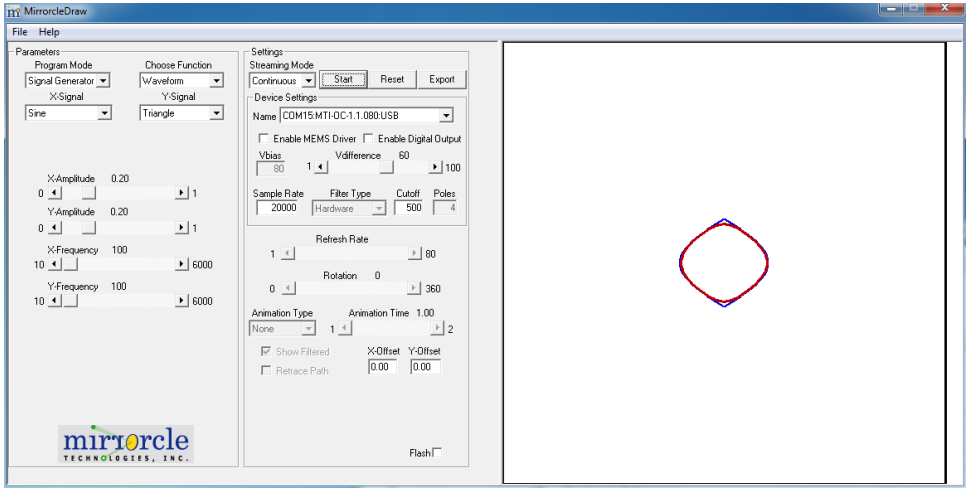


mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Signal Generator (1/3)

mirrorcleDraw

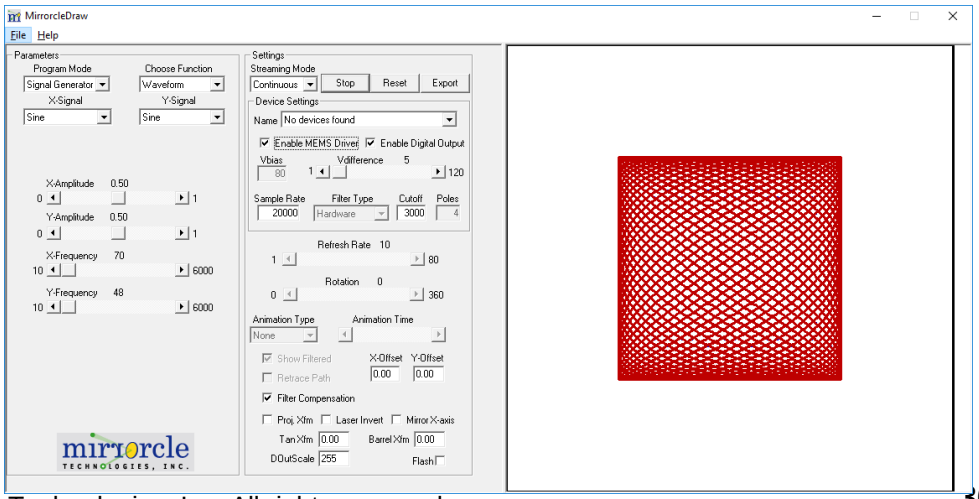
- **Waveforms** set the device into analog output mode that directly sends waveforms on one or both channels to the mirror.
- **In this mode, it is possible to excite the resonant frequencies of the device and damage it! The filter type is defaulted to Hardware for device safety.**
- **Select** separately between DC, sinusoid, triangle or noise waveforms on both channels.
- The **DC** mode allows to apply any voltage level to either axis. For the **Sinusoid** and **Triangle** waveforms choose the amplitude and frequency.
- The **Noise** waveform is useful for checking if the devices are functional and can also be used to revive devices that may be stuck or crashed.



MirrorcleDraw – Signal Generator (2/3)

mirrorcleDraw

- Example of detecting **resonant frequencies** of a MEMS Mirror in **Waveforms** mode:
- **Use only a very low Vdifference** since the MEMS Mirrors have a very high Q and can be damaged by exciting them at/near resonance (response may be 50-100X higher than at low frequency, so use e.g. 5V Vdifference and 0.5 Amplitudes in first sweep)
- Another reason for using small Vdifference is to avoid harmonic responses due to any device nonlinearity and obtaining a linear-approximation small-signal response instead.
- Choose **sine** waves and sweep through the **frequencies.** Find the mirror's deflection peak at the resonant frequency which should be visibly obvious. Axes will likely couple near/at resonance as most MEMS Mirrors have symmetric responses.
- The resonant frequency can then be used to model the device in cases where users want to optimize input waveforms, or can be used to obtain an estimate Cutoff parameter for the hardware low-pass filters based on the Fres/3 rule-of-thumb.

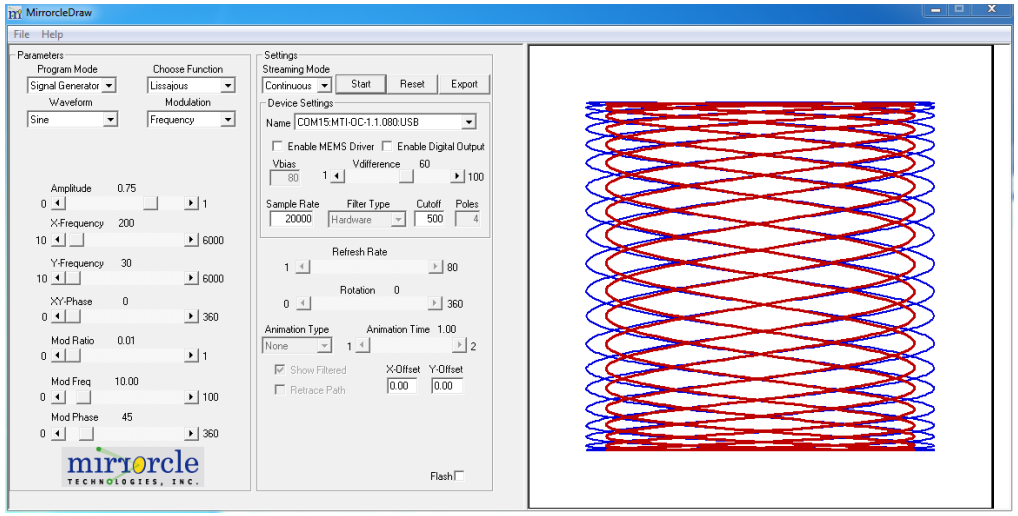


mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – Signal Generator (3/3)

mirrorcleDraw

- **Lissajous** is similar to the function in the curve plotter mode but without modulation.
- Directly **select** the base and modulation frequencies on both axes and the types of waveforms.
- **Animation Examples:**
  - **Create** animations by offsetting the X or Y frequency by 1-2 Hz (e.g. 201/200 Hz).
  - Near resonance another interesting animation can be observed: Set both X, Y base frequencies near resonance so that a large mirror amplitude is obtained. Reduce the MaxVoltage before. To a safe level. Now change the modulation frequencies to greater than 30-35 Hz so that persistence of vision gives rise to an intricate set of animations. Changing the modulation frequency to a non-integer number slows the animation and also gives more aesthetic patterns. It is possible to get a virtually limitless set of patterns using the four sets of frequency parameters.

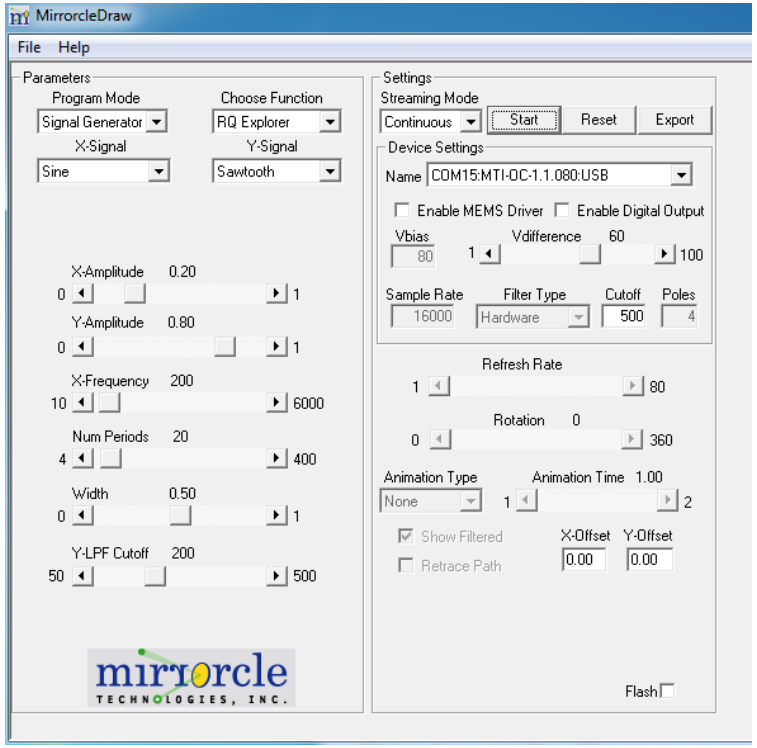


MirrorcleDraw – RQ Explorer

mirrorcleDraw

RQ (Resonant-Quasistatic) Explorer is a function in the Signal Generator mode to drive a MEMS device with sinusoid waveforms on the X-axis to achieve resonance, and quasi-static sinusoid or sawtooth waveforms on the Y-axis

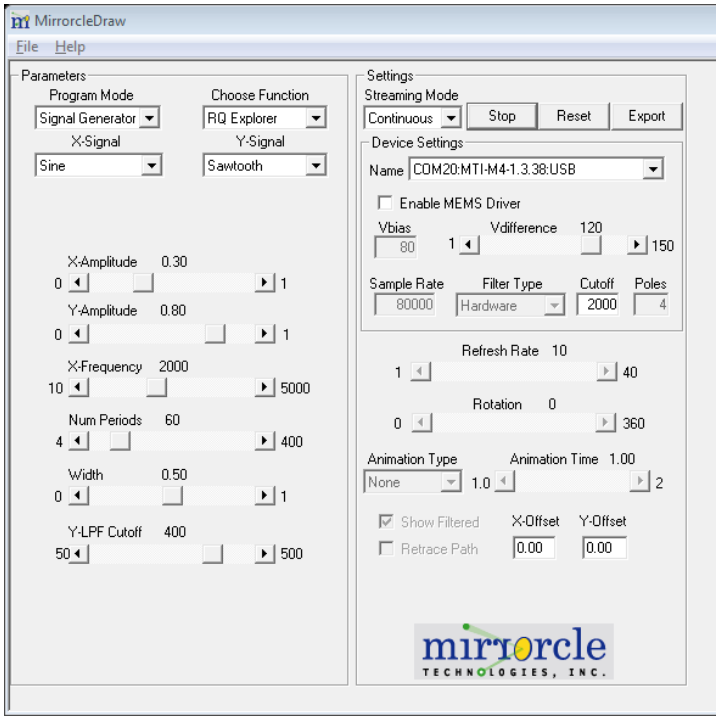
- The **Vdifference** is set to the values needed to reach the desired Y-axis angles.
- The **Cutoff frequency** in the settings panel should be set to control the X-Frequency, and should be set to at least **90% of the resonant frequency.**
- For the Y-axis, additional software LPF (**Y-LPF Cutoff**) is used to prevent any excitation of resonance on that axis, and should be set to the Recommended LPF Cutoff frequency
- The Y-axis is controlled by selecting the **Y-Signal** of sawtooth or sine, controlling the duty cycle on the **Width** slider, and the number of lines on the **Num Periods** slider.



MirrorcleDraw – RQ Explorer

mirrorcleDraw

- Begin with a **low X-Amplitude** (0.20)
- The **X-Frequency should be set to 10% below the resonant frequency** of the device under test.
- The **X-Frequency** should be **slowly & carefully increased** until the device begins to resonate. This should be clearly observed from a significant increase in scanning angle
- Some fine-tuning of the X-Amplitude can be made, but it is important not to over-drive and damage the device.
- **The device should never operate at exactly the resonant frequency. Instead, the user should stay at least 5% above or below it.**



mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – RQ Explorer

mirrorcleDraw

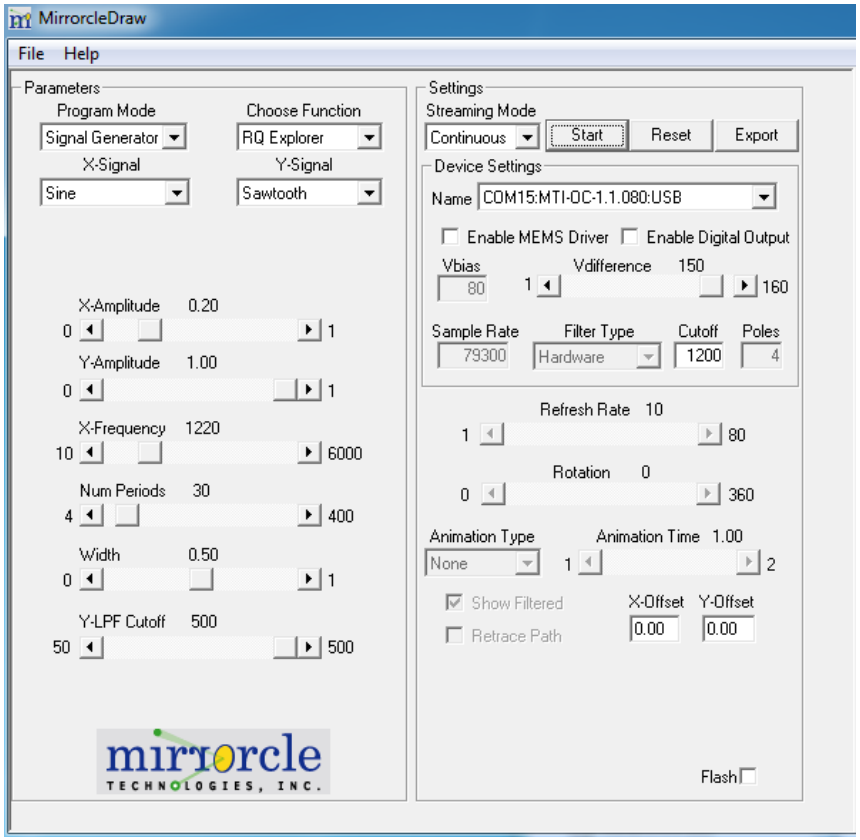
- The Digital Output connector has 8 digital outputs that are synchronous with the MEMS Driver sample output. **Dout0-5 are used to provide various trigger signals in RQ Explorer Mode.**
- Pin 1 can supply +3.3V, with a maximum current output of 25mA.
- Line Direction signals are high when slope is positive, and low when slope is negative.

DOut Connector: 10 - Pin Header		
J8-Pin	**Name**	**Description**
1	+3.3V	+3.3V Supply, limited to 25mA
2	GND	Ground
3	DOut0	1 - Always On for Laser
4	DOut1	½ Sample Rate
5	DOut2	Horizontal Sync (active going right)
6	DOut3	Vertical Sync (active going up)
7	DOut4	Start of Frame Trigger
8	DOut5	0 – Not Active
9	DOut6	0 – Not Active
10	DOut7	0 – Not Active

mirrorcle TECHNOLOGIES, INC.

MirrorcleDraw – RQ Explorer Example

The following is an examples of settings on the RQ Explorer for the **A7M20.1-2000AL** device, full datasheet available on the Mirrorcle Support webpage.



Device ID : S4342

Actuator Name : A7M20.1

Actuator Type : 4-Quadrant (Two-Axis, Bidirectional)

Mirror Type and Size : Integrated mirror of 2000um diameter

Mirror Coating : Aluminum

Maximum Angle - X Axis [degrees] : 5.1283

Maximum Angle - Y Axis [degrees] : 5.1064

Maximum Voltage - X Axis [V] : 158

Maximum Voltage - Y Axis [V] : 158

Bias Voltage [V] : 80

Maximum Angle - Coupled Axes [degrees] : 6.5301

Resonant Frequency - X Axis [Hz] : 1296

Resonant Frequency - Y Axis [Hz] : 1292

Quality Factor- X Axis : 49

Quality Factor - Y Axis : 45

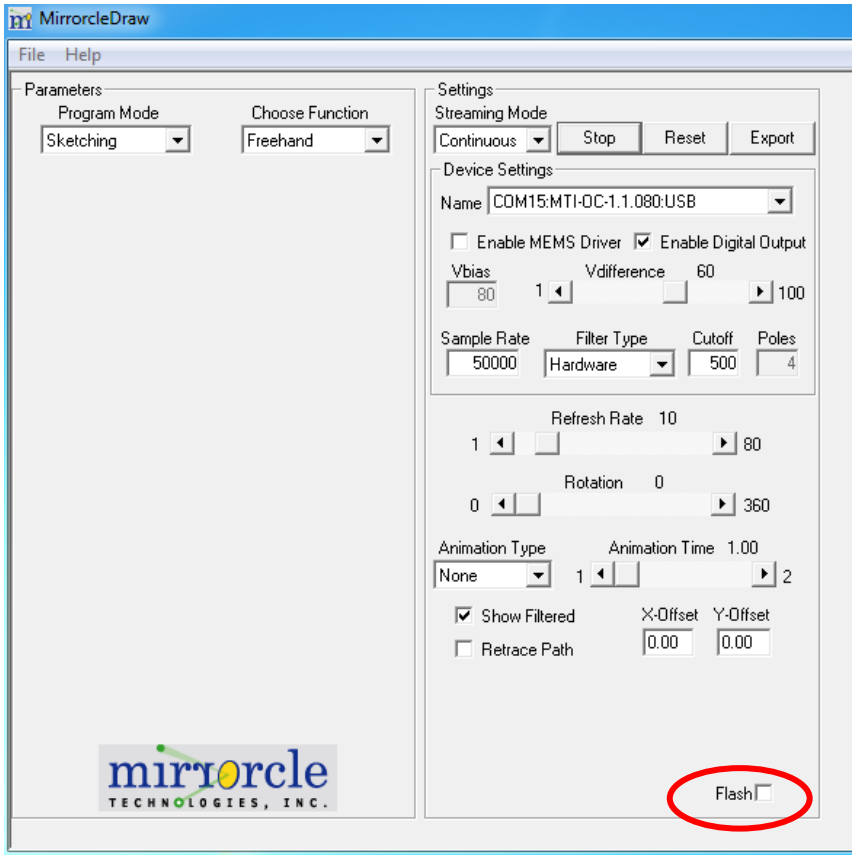
Recommended LPF Cutoff Frequency (6th Order Bessel) : 500

Date and Time Report was Created: 17-Feb-2015 at 19:12:27

MirrorcleDraw – Flashing Content

mirrorcleDraw

- The flash function allows the user to program the active scanning waveform into flash memory, along with all the active parameters.
- The controller is also set to boot up and run with the flashed parameters and scan waveform.
- The Flashing commands have additional features available in the API including just flashing the waveform without the settings or flashing the parameters without the waveform.

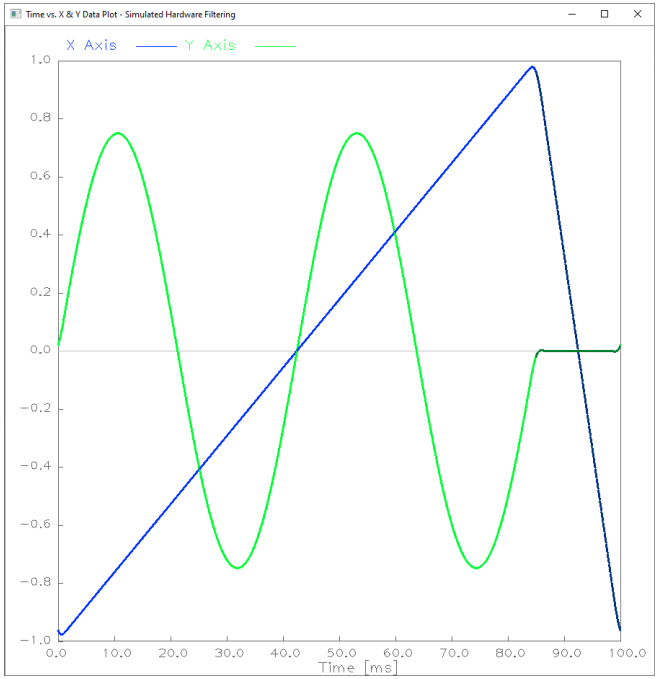


MirrorcleDraw – External Plot

- To enable external plots in MirrorcleDraw. user should set ExtPlotEnable = 1 in the *mirrorcledraw.ini* file
- User can customize external plot by adjusting the following parameters:

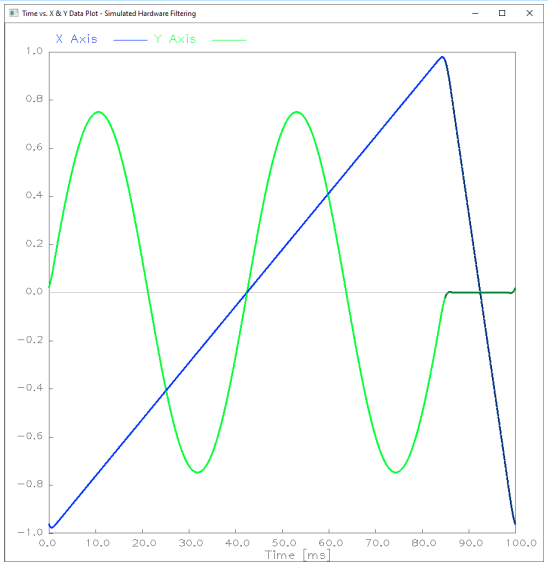
```
ExtPlotEnable = 1
ExtPlotHeight = 825
ExtPlotWidth = 900
ExtPlotType = 0
```

  - External Plot Types:
    - TimeVsXYData = 0
    - XDataVsYData = 1
    - TimeVsXData = 2
    - TimeVsYData = 3
    - TimeVsMData = 4
    - TimeVsXMData = 5
    - TimeVsYMData = 6
    - TimeVsXYMData = 7

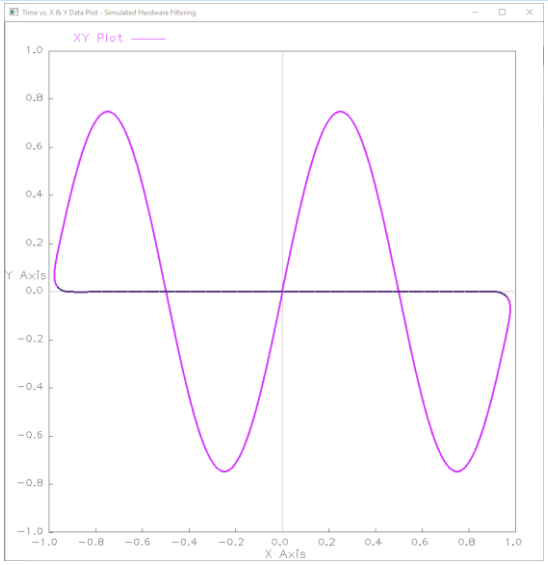


MirrorcleDraw – External Plot Types

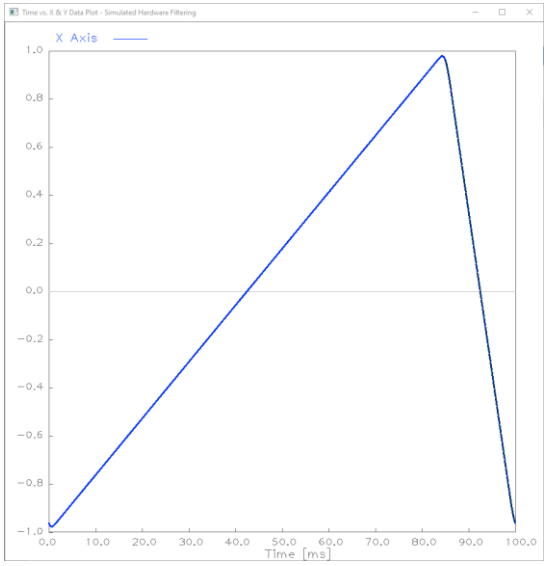
TimeVsXYData = 0



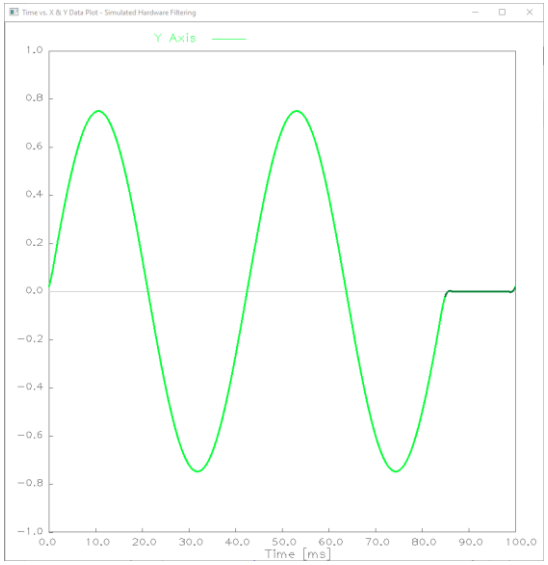
XDataVsYData = 1



TimeVsXData = 2

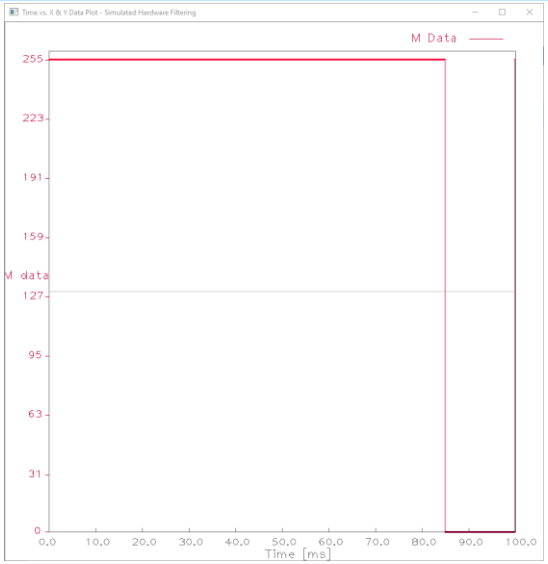


TimeVsYData = 3

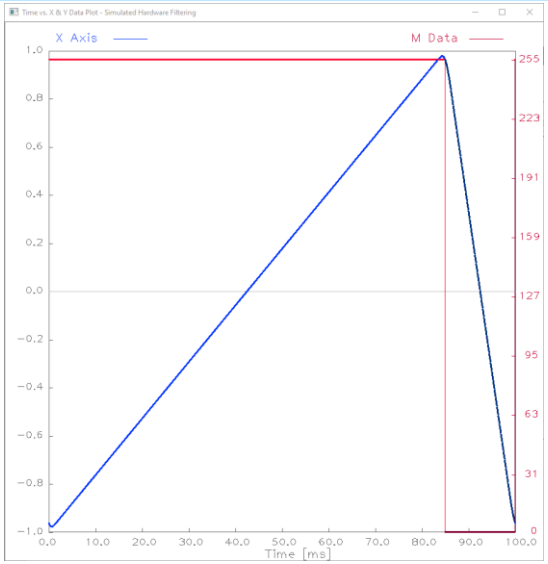


MirrorcleDraw – External Plot Types

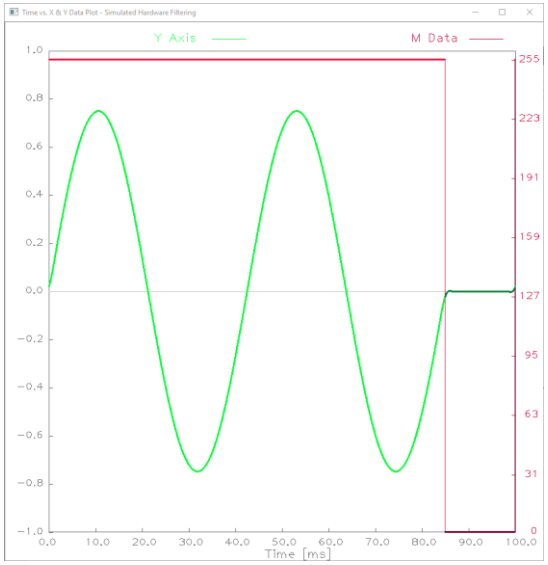
TimeVsMData = 4



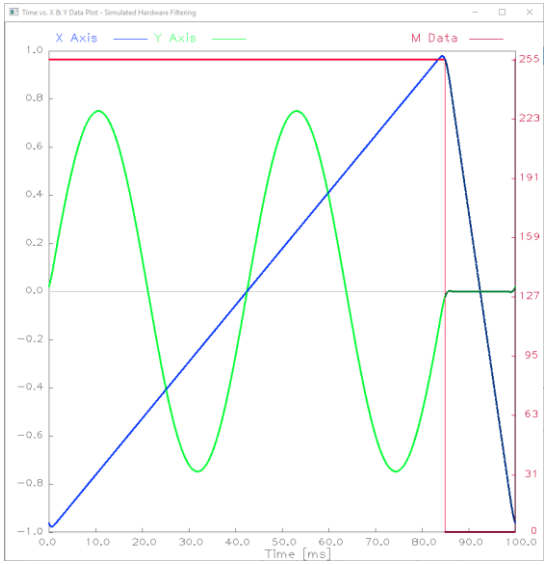
TimeVsXMData = 5



TimeVsYMData = 6



TimeVsXYMData = 7

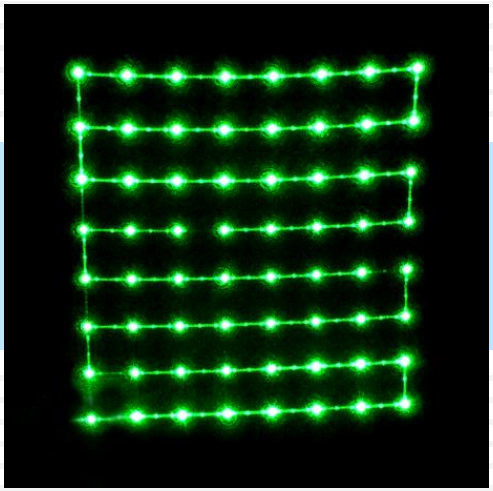


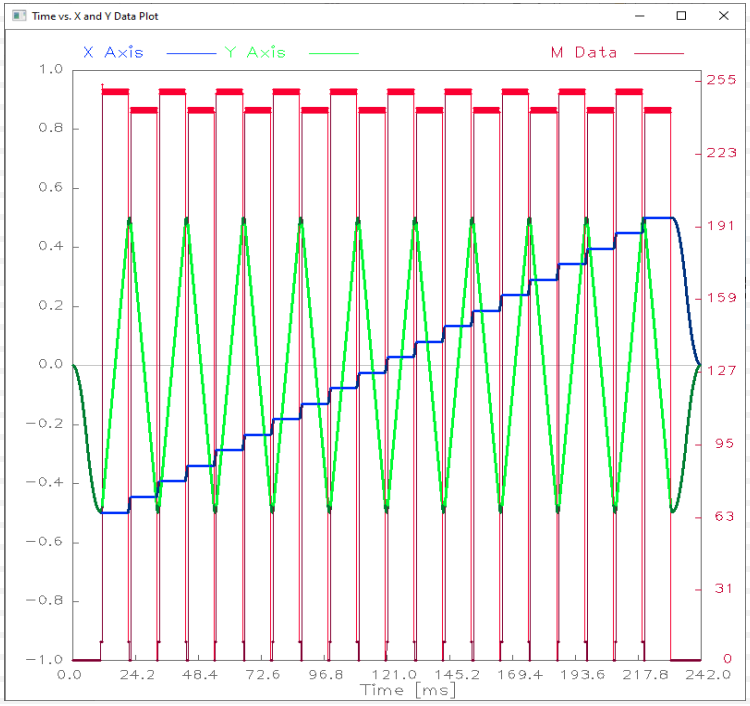
Additional Software

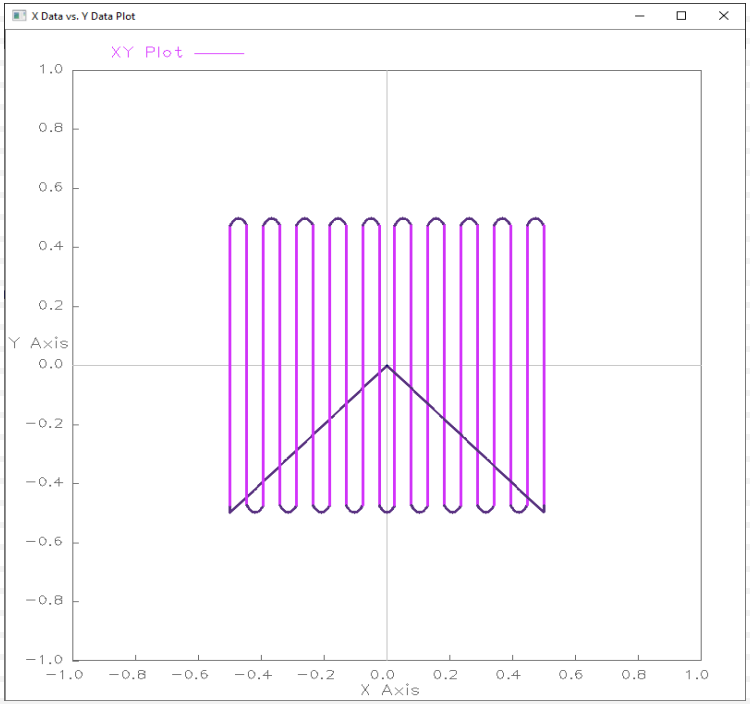
Additional Windows Software

- **MirrorcleLinearRaster**
  - Create uniform velocity linear raster scans
  - Control the number of lines, points per line, line scan times, etc.
  - Raster patterns can be rotated to any desired angle and changed in amplitude and offset.
- **MTIDevice-Demo**
  - Using the arrow keys on the keyboard or enter coordinates to direct the MEMS to a desired location. Import Keypoint or Sample files to be scanned.
  - Executable made from C++ SDK example code by the use of MTIDeviceDemo and MTIDataGenerator function calls.
- **MirrorcleListDevices**
  - Scan the com ports of the computer and provides a table of connected MTI devices with their properties

MirrorcleLinearRaster

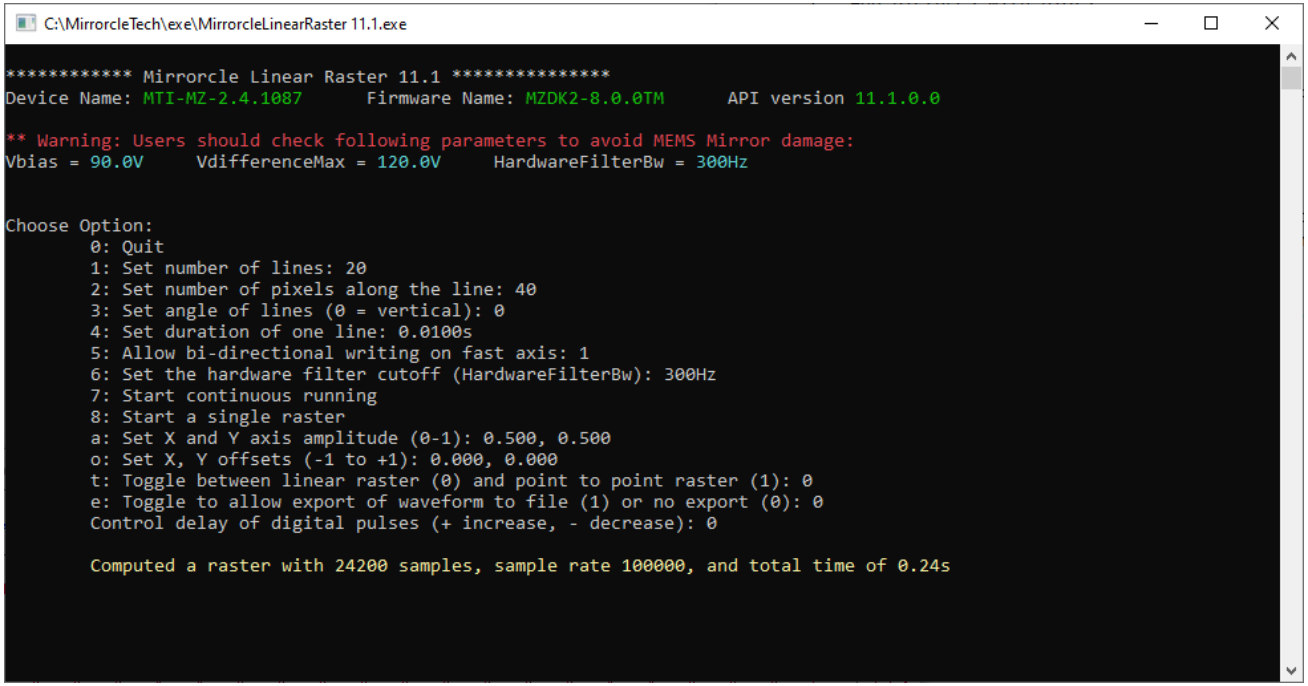






MirrorcleLinearRaster - Application

- **MirrorcleLinearRaster** is a console application. It provides a simple user interface for preparing and **running raster scans** with uniformly spaced lines and uniform scanning velocity.
- Lines can have any user-controlled angle, i.e. horizontal, vertical, or any in-between angles are possible. The program controls both the MEMS mirror X- and Y-axes, and also provides synchronized digital output to the laser driver or other used peripherals.



MirrorcleLinearRaster – Options (1/4)

- 1: **Set number of lines** (Values: 2 - 1000):

  Allows the user to set the total number of lines for the scan. Please note that if the number of lines multiplied by number of pixels exceeds a maximum possible number of points for the system, the system will notify and reject the settings.

- 2: **Set number of pixels along the line** (Values: 2 - 1000):

  Allows the user to set the number of pixels per line. Please note that if the number of lines multiplied by the number of pixels exceeds a maximum possible number of points for the system, the system will notify and reject the settings.

- 3: **Set angle of lines (0 = vertical)** (Values: 0 - 360):

  Allows the user to rotate the raster scan clockwise, at any desired angle. It is an integer input and therefore the angle can be rotated in increments of 1 degree.

MirrorcleLinearRaster – Options (2/4)

- 4: **Set duration of one line** (Floating point values: 0.002 to 1.000):

  Allows the user to set the time duration of one line during the raster scan. The time applies only to the active scan portion of the line, after the initial acceleration from the edge of the scan field, and before the deceleration at the other edge of the scan field. The input is in seconds, and the input accepts decimal point numbers.

  Please Note: The lower end limitation of 0.0025 second is dependent on the settings of number of lines and number of pixels along the line.

- 5: **Allow bi-directional writing on fast axis** (Values: 0 or 1):

  Toggles between bi-directional writing on (1) and off (0). The default value is on (1).

- 6: **Set the filter cut-off frequency** (Values: 50 to 50000 Hz):

  The USB MEMS Controller hardware includes on-board filters for each analog output channel. The minimum allowable value is 50 Hz and maximum value is 50000 Hz.

  Warning: The filter cut-off frequency should not exceed the recommended value published in specific device's datasheet. Values higher than the recommended filter value can cause ringing, larger angle overshoot and device damage.

MirrorcleLinearRaster – Options (3/4)

- 7: **Start continuous running:**

  Starts the raster scan with the settings from the GUI. After the scan has started, pressing any key will stop the operation and return to the main menu.

- 8: **Start a single raster:**

  Starts a single raster scan with the settings from the GUI.

  Note: The Linear Raster Scan also outputs synchronous digital outputs on the Digital port. For additional information on the Digital port pinout, refer to the Documentation Portal

- x: **Set the X axis amplitude** (Floating point values: 0.00 to 1.00):

  Scales the created X axis analog waveform.

  Warning: The maximum voltage value may not exceed the maximum voltage value published in the specific device's datasheet. Higher values can cause device damage.

- y: **Set the Y axis amplitude** (Floating point values: 0.00 to 1.00):

  Scales the created Y axis analog waveform.

  Warning: The maximum voltage value may not exceed the maximum voltage value published in the specific device's datasheet. Higher values can cause device damage.

MirrorcleLinearRaster – Options (4/4)

- t: **Toggle between linear raster (0) and point to point raster (1):**

  Switch between a linear raster scan and a point to point raster scan. The linear raster scans the individual lines with constant velocity, with acceleration and deceleration at the turn around portions. The point to point raster scan drives the MEMS mirror to each pixel in a line, decelerating to each pixel point, and accelerating after each pixel point in a line.

- e: **Toggle to allow export of waveform to file (1) or no export (0):**

  When enabled (1) the waveform including current settings is exported into a text file. The text file contains a list of X, Y sample points and the modulation data.

- +, -: **Control delay of pulses (+ Increase, - Decrease):**

  With +/- keys adjust the pulse delay. The software is already calibrated to adjust the hardware, low pass Bessel filters, delay. This feature allows to manually adjust the delay to synchronize pulses with other peripherals, such as lasers, cameras, etc

MirrorcleLinearRaster – Streaming

- The use of unlimited streaming in LinearRasterPattern is beneficial because this method allows for streaming data beyond the buffer size, enabling long and indefinite waveform streaming while avoiding discontinuities in the output.

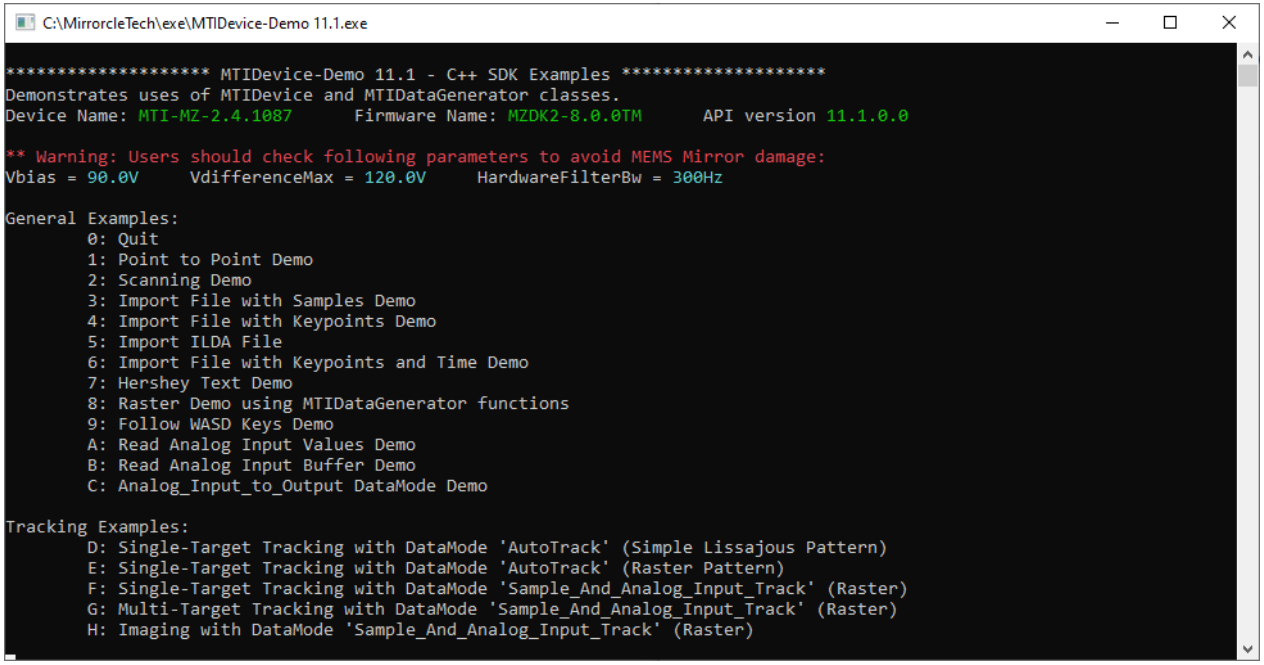
- **Sample_Output_FIFO Data Mode:**
  - The FIFO DataMode refers to the way data is managed within the controller. When data is sent to the controller, it is stored in a buffer in the order it was received. The controller then reads this data from the buffer in the same order it was received, ensuring that data is processed sequentially. This mode helps in managing the continuous flow of data, particularly when the waveform exceeds the buffer size.

- **Ping-pong algorithm:**
  - The Ping-Pong algorithm utilizes two buffers that alternate between being read and written to. As one buffer is being read (the "Ping" buffer), new data can be written to the other buffer (the "Pong" buffer). This process continues in a ping-pong fashion, allowing for uninterrupted data streaming and processing. By using this algorithm, data can be continuously sent to the controller without delays, ensuring smooth and efficient operation.

MTIDevice-Demo

MTIDevice-Demo - Application

- The application provides many different ways of actuating MirrorcleTech devices, and additional examples for the tracking development kit (Requires Tracking bundle upgrade).
- As an SDK example, the C++ source code comes with detailed comments to ease customers own software development.
- The program starts with a prompt for the user to select the USB MEMS Controller.
- After the controller is selected, the following GUI is presented:



MTIDevice-Demo - Point to Point

- **Point-to-point** demonstrates one way to simplify the open-loop control of devices in an application where the user will need to point the laser beam to different sequential points and would like to have a smooth and fast transition between those points.
- The user selects the step time of greater than 10ms for each point-to-point movement.
- The example will ask the user to input a set of normalized coordinates to send the device to. Values from 0 to 1 on each axis are valid unless you have a bi-directional device in which case values from -1 to 1 are valid inputs.
- When a new set of coordinates is entered, the program sends a step to the USB MEMS Controller which will send the device from Xold, Yold to Xnew, Ynew taking the user defined time to get to the Xnew, Ynew location.
- In the current version, the digital output channel is given zeros during the step such this channel will be turned off in the transition region between the new and old coordinates. The digital output is then turned on at the very last point of the transition.

MTIDevice-Demo - Scanning Mode

- This mode is designed to send a stream of co-ordinates to the micromirror device via USB MEMS Controller output ports. It demonstrates the use of functions such as SendDataStream() to communicate to the target controller to drive the MEMS device.
- Various scan patterns are generated using MTIDataGenerator functions.

MTIDevice-Demo - Import Samples (1/2)

- This mode **Imports** the 'butterfly.smp' file from the same directory.
- Each line in the text file must have three space-delimited columns (sample data-points in XYM format) and each line must terminate with an EOL ("\n") character. Optionally the sample rate can be specified in the first line of the file (e.g. 'sps 50000'). If not, then the function uses the default "Sample Rate (sps)" set in the .cpp file.
- This way each line represents a sample to be sent in seuence to the DAC. (Please note hardware filters are still applied after the DAC output and before the high voltage amplifier.)
- WARNING: A list of samples must be carefully designed in order to give desired MEMS mirror movement results and avoid device damage. Samples are read line by line and sent to the output DAC without interpolation and processing. If there are any significant steps (position changes) from sample to sample, they will result in large oscillations of the MEMS device and possibly damage. Therefore, smooth transitions (e.g. by spline function or software filtering) should be used. The end of the list should bring the device back to the same or very near the same coordinates as those at the beginning since will loop. The proper design of such sample files is demonstrated in various examples. Several steps ensure smooth transitions: Return the trajectory onto itself (ideally at device origin at each beginning and end) by trapezoidal interpolation between desired locations and finally smoothening by software filtering.

MTIDevice-Demo - Import Samples (2/2)

- All XY coordinates should be normalized to -1 to +1 and are imported as floating point numbers. The normalized data for X and Y is scaled by the VdifferenceMax voltage setting.
- The third column is a unsigned 8-bit value from 0 to 255 which appears on the systems digital output ports synchronously with the MEMS voltages (XY values) of the first two columns. It may be written as floating point but the system will interpret them as unsigned integers.
- The digital outputs (Pins D0-D7)are often used for triggering various accessories or instruments in sync with the MEMS mirror, e.g. lasers, timers, cameras, etc. For example if a camera which is connected to pin D3 should be triggered, the number has to be 8 (binary 00001000). If two devices should be triggered and connected to pins D5 and D0, DOUT has to be 33.
- An example list of a few sample points:

```
0.51231 0.85026 255.00000
0.51163 0.85054 200.00000
0.51035 0.85114 0.00000
0.50975 0.85144 0.00000
```

MTIDevice-Demo - Import KeyPoint Files

- This example imports the list of XYM Keypoints from the 'text.kpt' text file.
- Each line in this file represents a KeyPoint and is processed with the sps setting, interpolated, and filtered before being outputted to the DAC as in the 'Samples' mode.
- All XY coordinates should be normalized to -1 to +1 and are imported as floating point numbers. The normalized data for X and Y is scaled by the VdifferenceMax voltage setting.
- The third column is a unsigned 8-bit value from 0 to 255 which appears on the systems digital output ports synchronously with the MEMS voltages (XY values) of the first two columns. It may be written as floating point but the system will interpret them as unsigned integers.
- The user provides a refresh rate to display the content, and this function also shows the versatility of manipulating content on the fly with downloading a stream of new offsets, changing amplitudes and changing rotations.

- **Please note** that this import mode is for vector **Keypoints** and not for actual samples. The software API will appropriately interpolate from one keypoint to the next to optimize mirror movement and will copy the same DOUT number to all samples between two Keypoints.

MTIDevice-Demo - Import KeyPoint Time Files

- This example imports the list of XYM and Time Keypoints from the 'test.kpt' text file.
- Each line in this file represents a KeyPoint, and the time (ms) to stay at the given key point.
- The file is processed with the sps setting, interpolated, and filtered before being outputted to the DAC as in the 'Samples' mode.
- All XY coordinates should be normalized to -1 to +1 and are imported as floating point numbers. The normalized data for X and Y is scaled by the VdifferenceMax voltage setting.
- The third column is a unsigned 8-bit value from 0 to 255 which appears on the systems digital output ports synchronously with the MEMS voltages (XY values) of the first two columns. It may be written as floating point but the system will interpret them as unsigned integers.
- The fourth column is a floating point number, representing time in milli-seconds.

- **Please note** that this import mode is for vector **Keypoints** and not for actual samples. The software API will appropriately interpolate from one keypoint to the next to optimize mirror movement and will copy the same DOUT number to all samples between two Keypoints.

MTIDevice-Demo – Raster Scan

- RasterDemo utilizes MTIDataGenerator functions to create raster scans. It includes two examples:

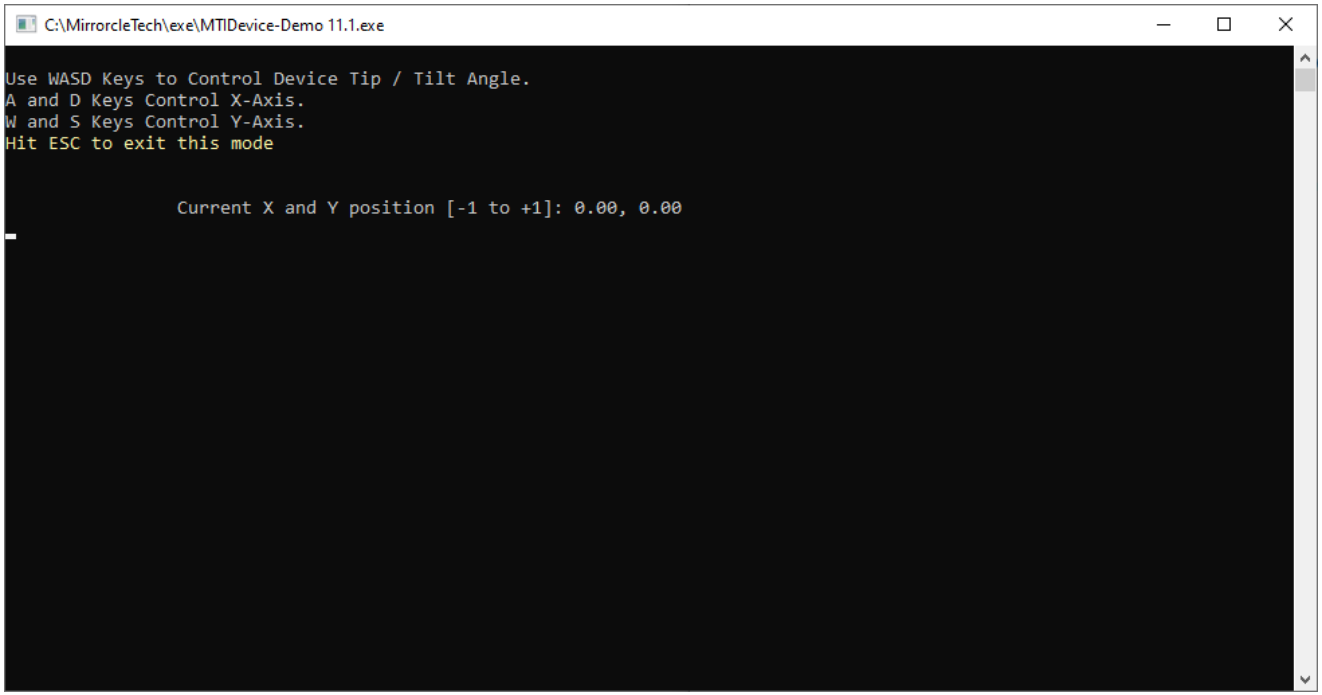
- **LinearRasterPattern:**
  - This demonstrates a slow raster scan with uniform velocity lines (linear position over time).
  - The MTIDataGenerator::LinearRasterPattern() generates line scans with uniform scan velocity or point-to-point scan movement. Typically this is used in slower scans in various imaging applications.
    - More information:
      AN018 - LinearRasterPattern Function (mirrorcletech.com)

- **RQWaveform:**
  - This showcases a fast 'Resonant–Quasi-static' (RQ) raster scan
  - The MTIDataGenerator::RQWaveform() generates a fast, sinusoidal scanning waveform for the x-axis and slower, sine or sawtooth waveform for the y-axis. Typically this is used in in various imaging applications with faster scans where fast, x-axis is near resonance, for so-called Resonant - Quasi-static (RQ) raster scanning.
    - More information:
      AN005 - MEMS Mirror Resonant Scanning (mirrorcletech.com)

mirrorcle TECHNOLOGIES, INC.

MTIDevice-Demo - Follow Arrow Keys

- The **Follow Arrow Keys** mode allows the user to manipulate a laser beam being reflected off the MEMS device by using the keyboard.
- Each 'arrow' key press adjusts the DC voltage on each axis of the mirror and with that directs the beam to the requested position. The commands send to the MEMS device are filtered to avoid overshoot and ringing. Because of the filtering, after each button press, the position is quickly and smoothly updated and displayed on the screen.



MTIDevice-Demo – Analog Input Modes

- There are two methods of reading Analog Inputs with the MTIDevice API: **Reading individual values** and **Reading a buffer**
- Reading individual values displays a single read of each analog input channel
- Reading a buffer is done by a synchronous analog input read for every digital sample output from the scan.
  - The process involves the user preparing a buffer of data, downloading it to the controller and issuing a start for a single scan. During the scan, the buffer stores the measured analog input value read after each digital output is sent to the DAC.
  - The buffer of analog inputs is returned and saved into a text file in the same directory as the application.

MTIDevice-Demo – Analog Input To Output

- Analog Input to Output Datamode demo demonstrates using the two analog input ports to receive analog position signals for X and Y position (±10V), and convert them to MEMS driver output signals.
- This requires the controller to enter into a different datamode, and parameters such as sample rate, DataScale, VdifferenceMax, Vbias and HardwareFilterBw to be set.
- There are no correlated digital outputs when in this datamode, therefore the Sync Port and Digital Output port will not be active, or providing any triggers.

Tracking Examples: DataModes

- There are two methods of tracking using the USB-SL MEMS controller:
  - DataMode7: Sample_And_Analog_Input_Track takes an analog input measurement at each sample output. The AIs are streamed back to the host PC to process the data and adjust the tracking offsets as needed
  - DataMode8: AutoTrack takes an analog input measurement at each sample output and processes the data onboard the controller to search, capture, maintain track and adjust the tracking offsets. The host can request the offset positions, and set various track parameters.

Requires Tracking bundle upgrade

mirrorcle TECHNOLOGIES, INC.

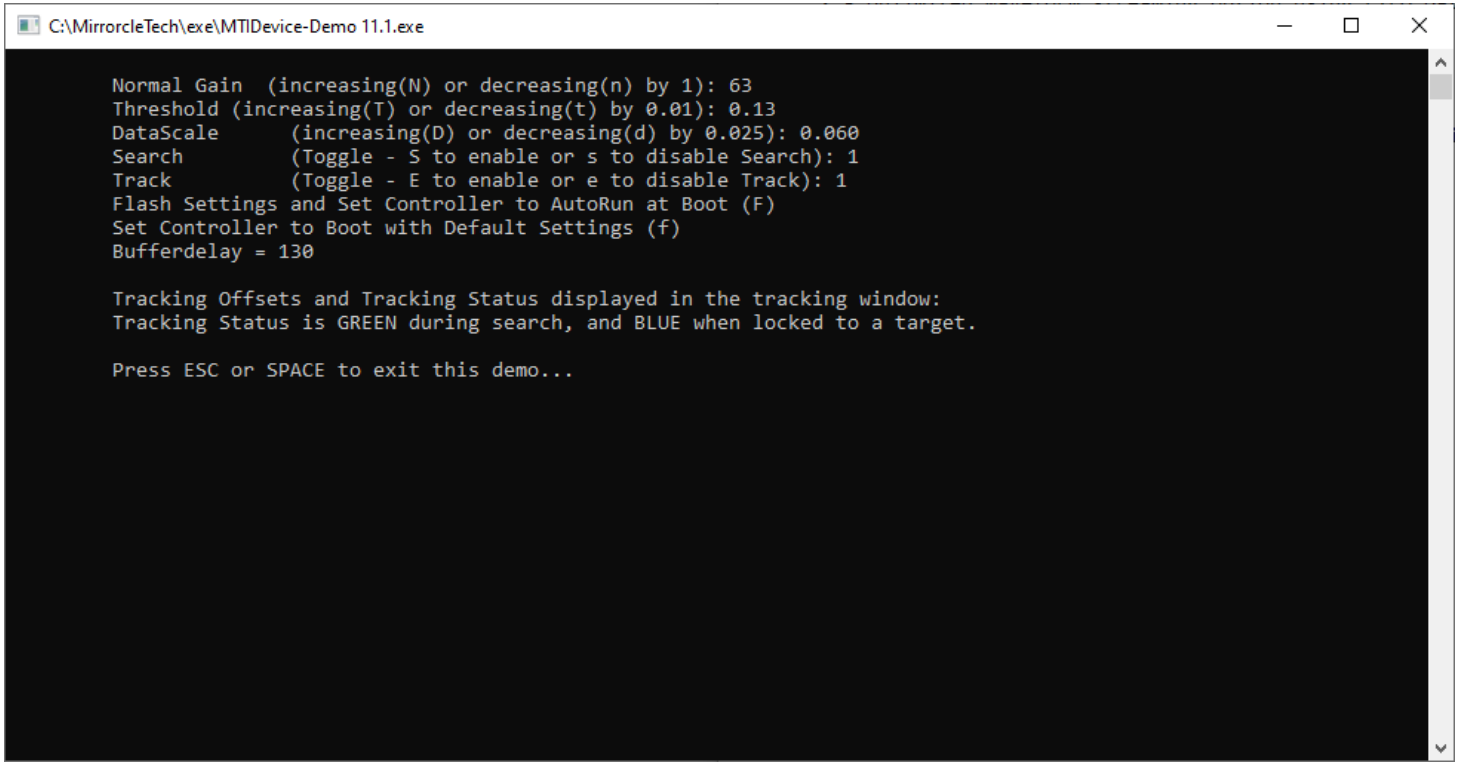
Tracking Examples – Scan Pattern

- There are two methods of scan patterns downloaded to the USB-SL MEMS controller for datamode7 or datamode8 tracking:
  - Lissajous Pattern: The Lissajous pattern based tracker searches for a single retro-reflective target, and tries to maintain the Lissajous at the center of the target. Best use for single point tracking.
  - Raster Pattern: The Raster pattern based tracker performs a raster scan and records brightness locations that are triggered above the threshold value, and maintain the raster pattern centered over the area of targets. Best use for multi-point tracking.

Requires Tracking bundle upgrade

Tracking Examples: Track Params - 1

- There are 9 track params that can be set by the host to control the tracker, or read by the host to get information from the tracker:



Requires Tracking bundle upgrade

Tracking Examples: Track Params - 2

- Normal Gain: Tracking gain to follow target – corrections toward the estimated center of the target. (Integer from 0-255)
- Tangential Gain: Tracking gain to move along the perimeter of target (Positive is clockwise and negative is counterclockwise) – corrections perpendicular to the estimated vector from current position to the center of the target. (-25 to +25)
- Threshold: Analog input voltage threshold to trigger tracking. (floating point value between 0.00 and 1.00)
- Hit Ratio: The ratio of the MEMS scan (nutation) that should hit/cover the target. (e.g. 1 to fully cover the target, 0.5 to cover half of the target).
- DataScale: Adjust the size of the scan pattern (0.000 to 0.200)
- Search Enable: Toggle on/off to enable searching for a target

Requires Tracking bundle upgrade

mirrorcle TECHNOLOGIES, INC.

Tracking Examples: Track Params - 3

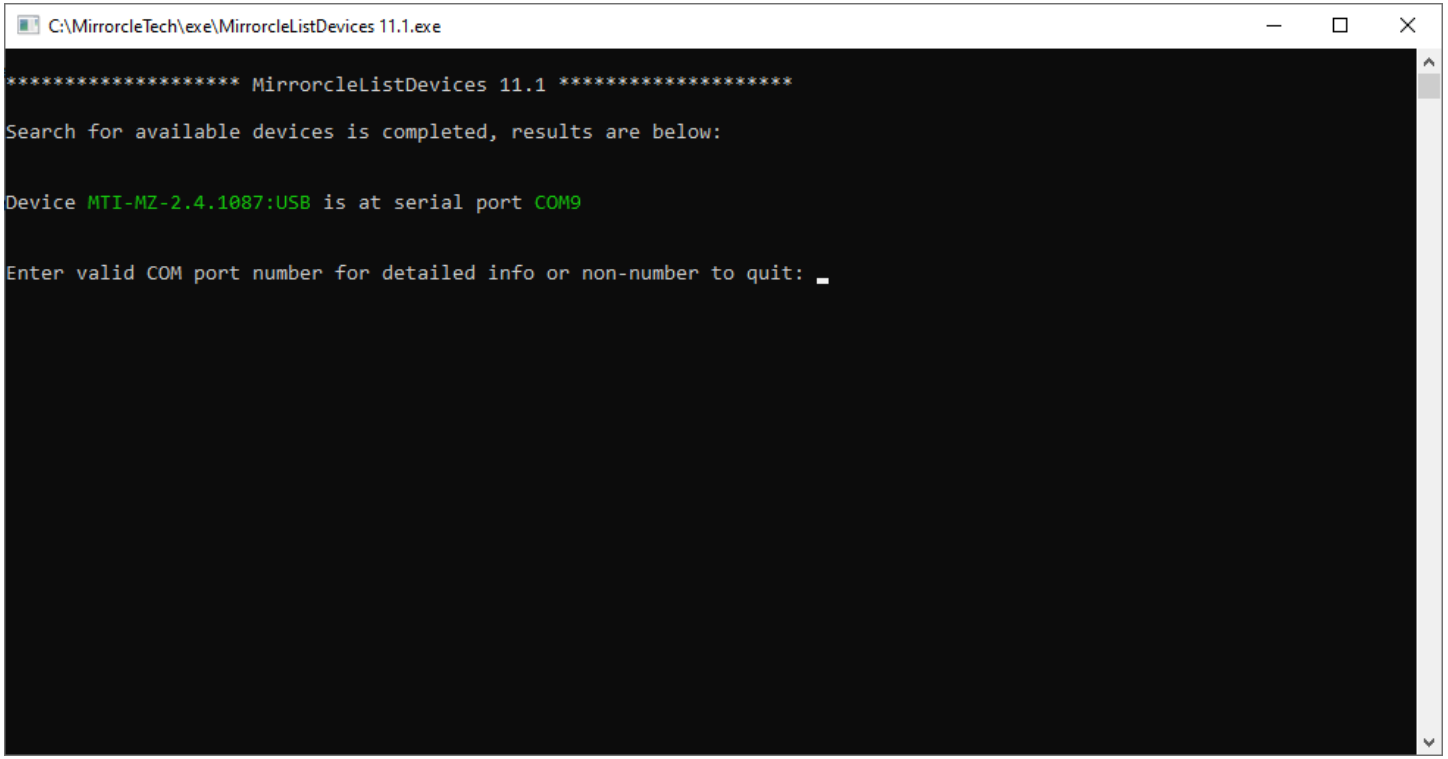
- Track Enable: Toggle on/off to enable tracking for a target
- Flash Settings: This feature allows the settings to be flashed onto the controller, and be ready to boot up and run with the settings after a power cycle – no need for a host PC
- Track Integrals: X and Y integrals of the light reflected back from the scan pattern. The sum of position times brightness, adjusted by buffer delay, over the entire buffer of the scan pattern. $\sum_{n=1}^{n=buffer}\left(X_{n-bufferdelay} * I_n\right)$
- X and Y Offsets: Location of a locked target normalized to +/-1
- Track Status: Shows if the target is locked on (1) or off (0)
- Buffer Delay: Number of position samples rotated to adjust for delay due to MEMS mirror bandwidth.

Requires Tracking bundle upgrade

MirrorcleListDevices

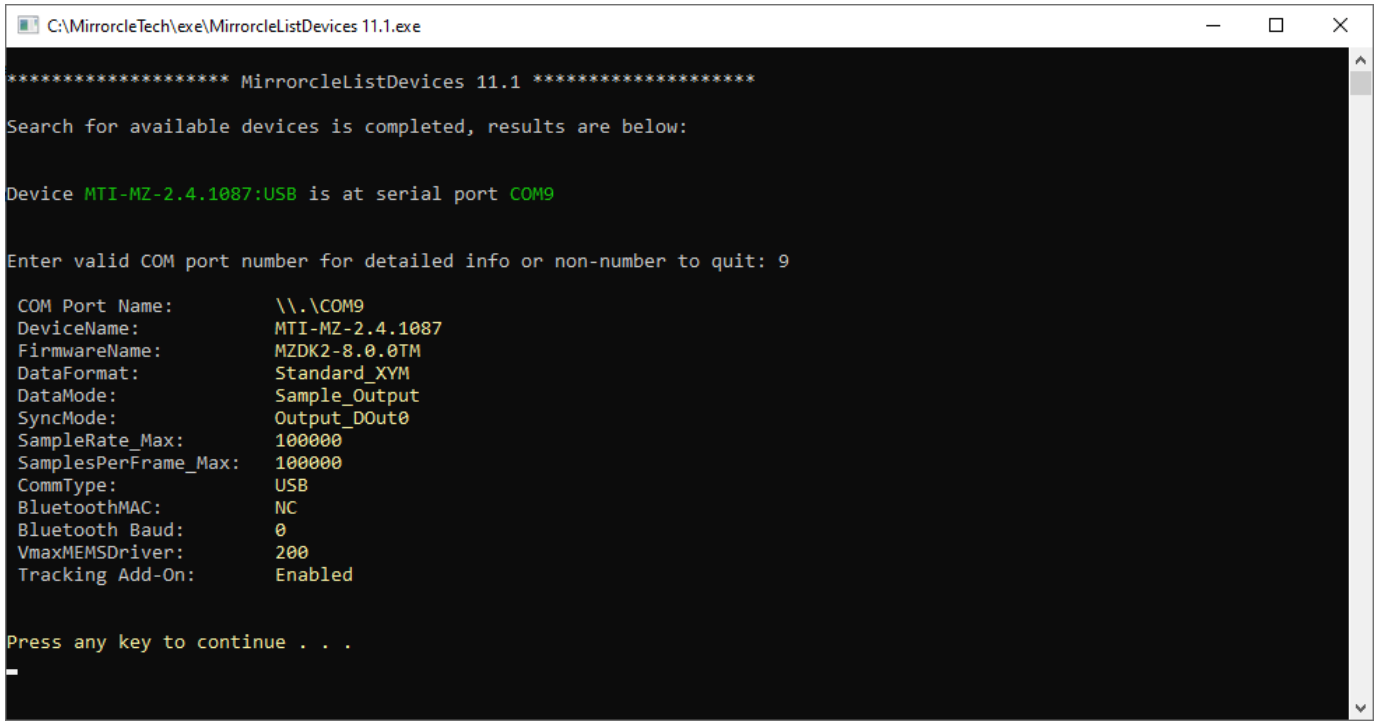
MirrorcleListDevices - Application

- A small tool which scans the COM ports of the host computer and provides a table of connected MTI devices. Any devices found on USB ports or via Bluetooth will be listed in the console window as in the following example. User then has the option of listing detailed info about a specific device by providing a port number.



MirrorcleListDevices - Application

- Device info as shown below is then provided, including BluetoothMAC address if the Controller includes the Wireless Option Add-On. This may be a useful tool for a user that wishes to connect to the Bluetooth module from e.g. Mirrorcle Android SDK but first needs to get the MAC address.



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 Software Suite - Application Guide** - Software Applications Manual
  - **Mirrorcle Technologies MEMS Mirrors - Technical Overview** – Overview document about Mirrorcle's MEMS Devices
  - **USB-SL MZ MEMS Controller - User Guide** – USB MEMS Controller Manual
  - **Mirrorcle Products List**
  - **Mirrorcle Online Documentation – Mirrorcle Docs** (online portal)

- 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/

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

mirrorcle TECHNOLOGIES, INC.

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