



# USB-SL MZ USB MEMS CONTROLLER USER GUIDE



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Dr. Veljko Milanovic  
Abhishek Kasturi

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# MEMS Controller USB-SL MZ – Overview

- Mirrorcle-designed MEMS Controller with a fast Microchip PIC32MZ MCU
- Its main function is to interface with user software, store prepared waveforms in a buffer, and run/output those waveforms in open loop to drive the MEMS mirror and peripherals
- Compatible with latest Software Suite 10.2 or newer
- Powered and controlled by USB
- Available as OEM Controller (provided as PCBs with no boxes or cables and require minimum order quantities)

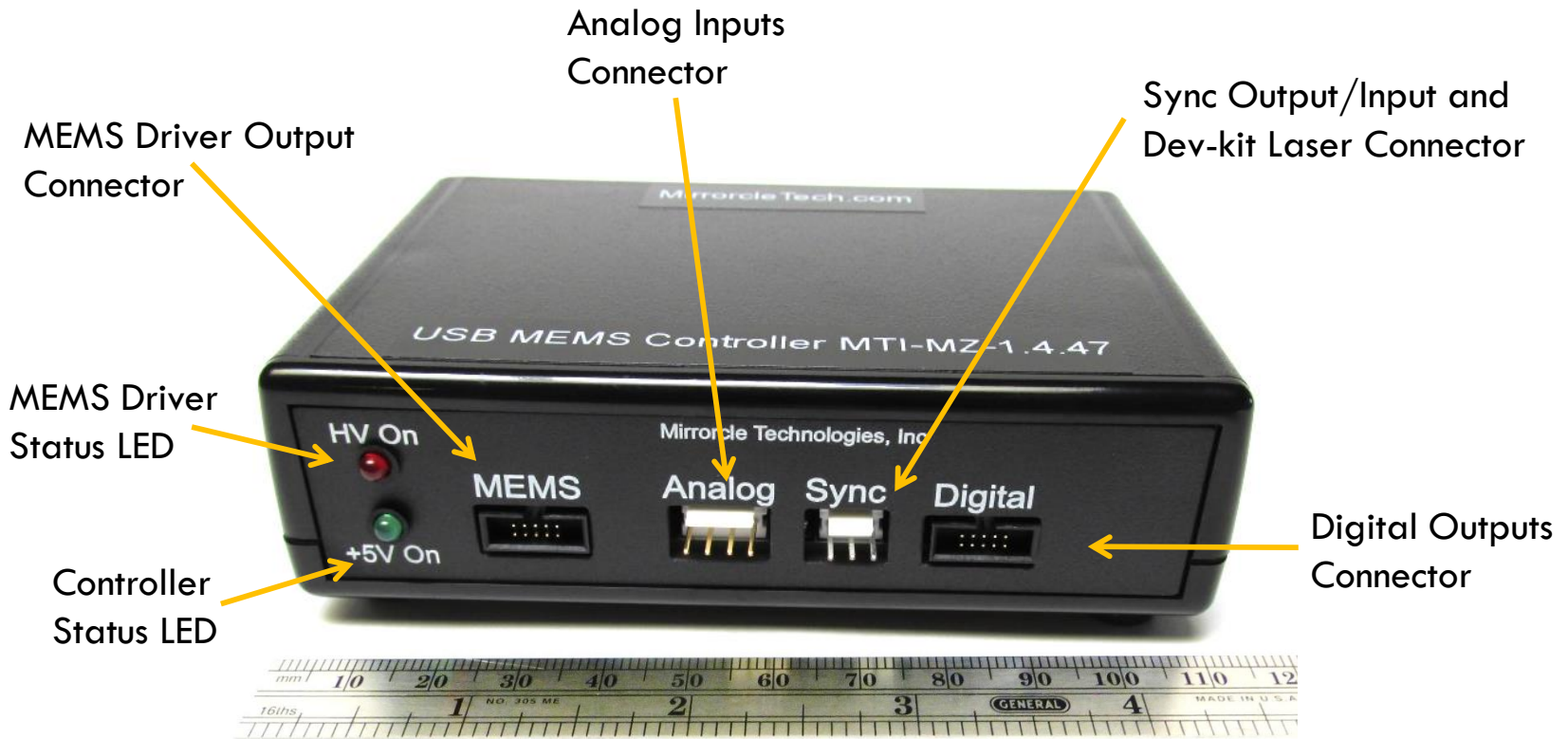


Dimensions: Approx. 80mm x 115mm x 30mm  
Weight: Approx. 140g

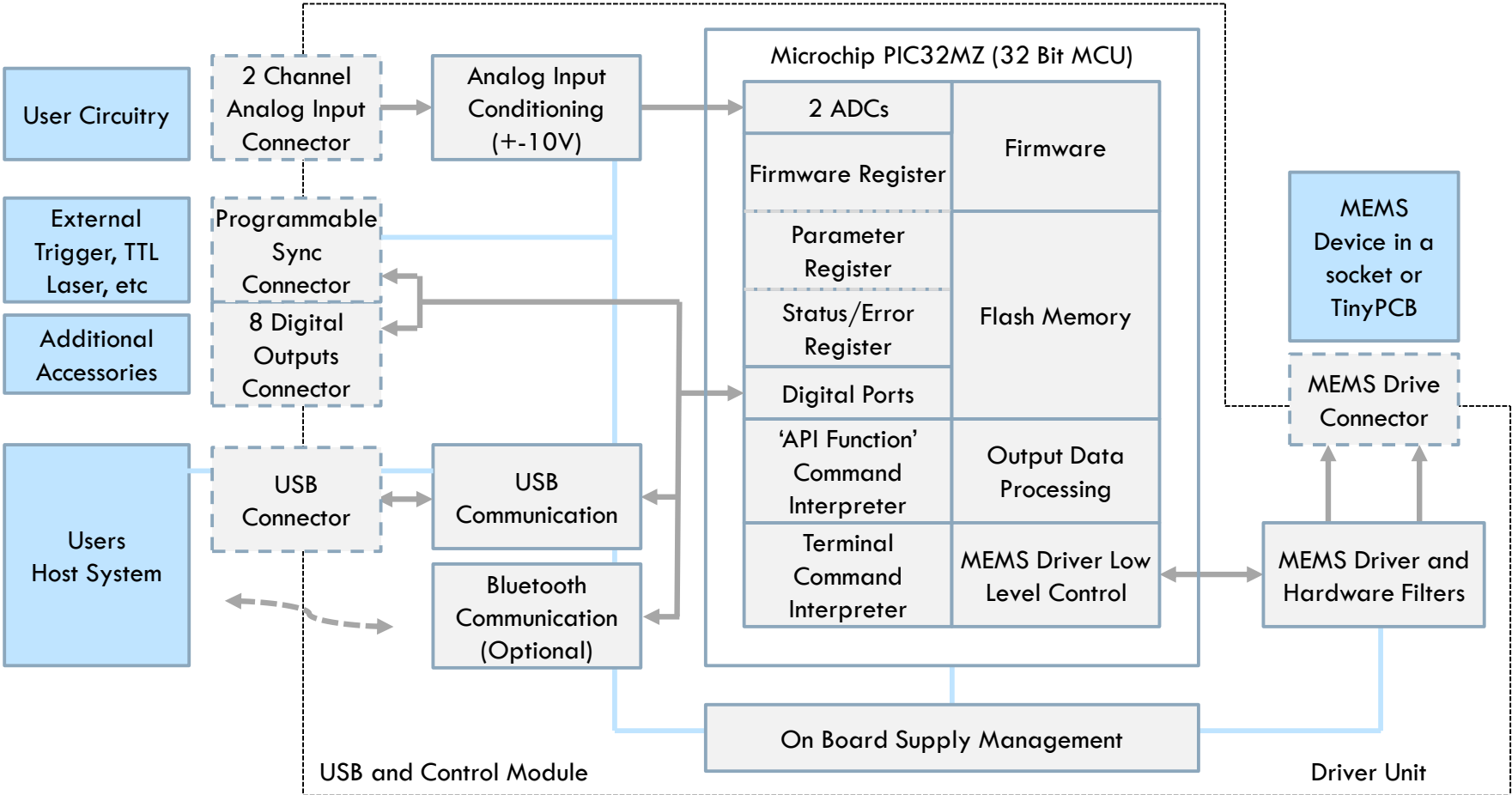
# Features

- ❑ 4x (16-bit) Analog Outputs for X and Y axis control of MEMS mirrors
- ❑ Programmable hardware-based low-pass filters and protection circuitry to reduce the chances of device damage
  - ❑ Output bandwidth from 50Hz to 25kHz (governed by programmable filters)
- ❑ 8x Correlated Digital Outputs (3.3V) for controlling other components or systems
- ❑ Sample Rates up to 120,000 samples per second (120 kSPS)
- ❑ 500kB of Onboard RAM allows up to 100,000 samples to be stored
- ❑ 2x (12-bit) Analog Inputs with +/- 10V input range
- ❑ Flash Memory allows storage of settings and data for stand-alone operation (no PC)
- ❑ Sync Port for synchronization with additional Controllers or driving of laser peripherals
- ❑ USB Plug and Play support
- ❑ Separate analog input port for a laser tracking photosensor (with laser tracking bundle purchase)
- ❑ Wireless option (Add-On purchase) allows battery-run wireless operation over Bluetooth 16 bit outputs for X and Y axis control

# Status LEDs & Connections

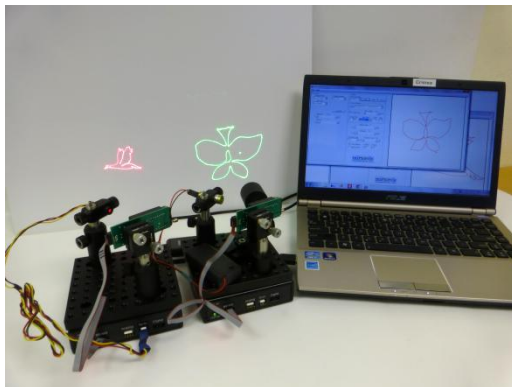


# Block Diagram



# Multi-Platform Compatibility

- Several ways of communicating with the USB-SL MZ Controller are available, whether by USB interface or by Bluetooth interface with a PC or an Android or Linux device.



# USB-SL MZ - Various Ways to Control

## APIs in several languages



- Comprehensive APIs for generation of content (MEMS positions and correlated digital outputs), for control and streaming of the content, reading of analog inputs, synchronization with additional Controllers or peripherals, tracking, etc.
  - C++ SDK (Windows and Linux)
  - LabVIEW and Matlab SDKs
  - Python SDK (with Add-On purchase)
  - Java (Android) SDK (with Add-On purchase)
- Easy-to-use GUI and Console Applications such as MirrorcleDraw, MirrorcleLinearRaster, MirrorcleTrack, for various platforms (previous slide)

## Serial Terminal Commands

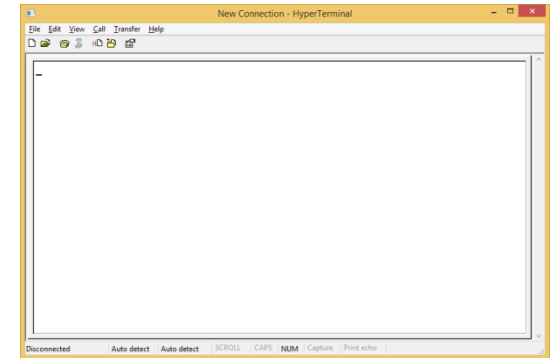
- Serial port terminal commands are available for more basic MEMS mirror control without the use of the Windows, Android, Linux APIs.

# USB Supply, Status LEDs & Wireless Option

- Please Note that the power supply (+5VDC) and fast communication is handled via the USB interface. To ensure proper operation, use the provided USB cable directly plugged into the PC instead of a USB hub (too long or not conforming cables could cause malfunction).
- Ensure proper USB or battery power supply. The USB voltage level has to be in spec (at least 4.7 V). If a USB port or a battery does not provide adequate supply, the Mirrorcle MEMS Controller card may respond to software commands but may not fully enable the MEMS Driver.
- The green status LED will light up after approx. 4 seconds when the device is ready. It will flash during communication. The red LED indicates the switched on MEMS Controller.
- With the optional Wireless Add-On, Bluetooth is used to communicate with the Mirrorcle MEMS Controller with almost all Android devices by using the powerful Android SDK. When used in wireless mode, power should be supplied to the USB input port from either a computer's USB port or a 5VDC battery.
- For communicating with SoCs e.g. Arduino or Raspberry Pi, its possible to change the USRAT/Bluetooth interface baudrate of the processor between 115200 and 460800 Baud.

# How to use Terminal Mode

- Please consider this mode is dedicated for experienced users only.
- Install Terminal Application (e.g. HyperTerminal, PuTTY)
- Connect the terminal application to the proper COM port.
- Enable/unlock the UART/terminal mode by entering '\$MTI\$'.
- Switch on displaying your commands (ECHO) by 'MTI+EO\n\r'.
- Ensure proper hardware settings from their representative datasheets with 'MTI+SetVbias 70\n\r', 'MTI+SetVdifferenceMax 100\n\r', and 'MTI+SetHardwareFilterBw 300\n\r'.
- Enable the MEMS Mirror driver with 'MTI+EnableDevice\n\r'.
- Manipulate the output by steering the mirror: 'MTI+GotoDevicePosition 0.45 -1.00 255\n\r'.
- Before quitting the terminal application, disable the MEMS driver by 'MTI+DisableDevice\n\r' and exit/lock the terminal/UART mode by the 'MTI+Exit\n\r' command.
- Please note that there are also short commands available.
- Type MTI+? For a complete list of available terminal commands.



# Terminal Communication Table

Prefix	Command	Suffix (Return)	Short Command	Description	Reply	Reply Suffix	Example Terminal Input
	\$MTI\$	\n or \r		Enter Terminal Command Mode	MTI-Device [name] Ready in command mode	\n	\$MTI\$\n
MTI+	Exit	\n or \r	EX	Exit Terminal Command Mode	MTI-Device Exit command mode	\n	MTI+EX\n
MTI+	EnableDevice	\n or \r	EN	Enable MEMS Driver	MTI-OK	\n	MTI+EN\n
MTI+	DisableDevice	\n or \r	DI	Disable MEMS Driver	MTI-OK	\n	MTI+DI\n
MTI+	EnableDigitalOutput	\n or \r	ED	Enable Digital Output	MTI-OK	\n	MTI+ED\n
MTI+	DisableDigitalOutput	\n or \r	DD	Disable Digital Output	MTI-OK	\n	MTI+DD\n
MTI+	EnableModulation	\n or \r	EM	Enable Modulation for PD measurement	MTI-OK	\n	MTI+EM\n
MTI+	DisableModulation	\n or \r	DM	Disable Modulation for PD measurement	MTI-OK	\n	MTI+DM\n
MTI+	GoToDevicePosition	\n or \r	GT	Mirror XY Position and Digital output M, Send 3 values: float float byte	MTI-OK	\n	MTI+GT 0.5 -.22 13\n
MTI+	GetAnalogInputValue	\n or \r	GA	Replies with AI0 and AI1 values as floats, samples of both analog input channels	MTI-AI0:float AI1:float	\n	MTI+GA\n
MTI+	GetPhotoDetectorValue	\n or \r	PD	Replies with AI0 value - AI0 value halfway through sample (laser is on half of sample and off half of sample) - Must be in SyncMode 2	MTI-AI0:float	\n	MTI+PD\n
MTI+	EchoOn	\n or \r	EO	Echo mode on (displays keyboard input)	MTI-OK	\n	MTI+EO\n
MTI+	EchoOff	\n or \r	EF	Echo mode off	MTI-OK	\n	MTI+EF\n
MTI+	DisableConfirm	\n or \r	DC	Disable confirm reply after commands (only MTI-OK)	MTI-OK	\n	MTI+DC\n
MTI+	EnableConfirm	\n or \r	EC	Enable confirm reply after commands	MTI-OK	\n	MTI+EC\n
MTI+	SetVdifferenceMax	\n or \r	VD	Sets Maximum Voltage Difference, number between 0-200	MTI-OK	\n	MTI+VD 80\n
MTI+	SetHardwareFilterBw	\n or \r	BW	Set Hardware Filter, number between 50-15000	MTI-OK	\n	MTI+BW 200\n
MTI+	SetVbias	\n or \r	VB	Set Bias Voltage, number between 0-100	MTI-OK	\n	MTI+VB 70\n
MTI+	SetSyncMode	\n or \r	SM	Set SyncMode, number between 0-6	MTI-OK	\n	MTI+SM 2\n
MTI+	GetDeviceParams	\n or \r	GP	Get device parameters	MTI-[list of device parameters]	\n	MTI+GP\n
MTI+	Help	\n or \r	?	Lists all terminal commands	MTI-[list of all commands]	\n	MTI+?\n

#### Description

Previous command was invalid  
Previous send data was invalid

#### Error Replies

MTI-ERR InvalidCommand  
MTI-ERR InvalidCommandData

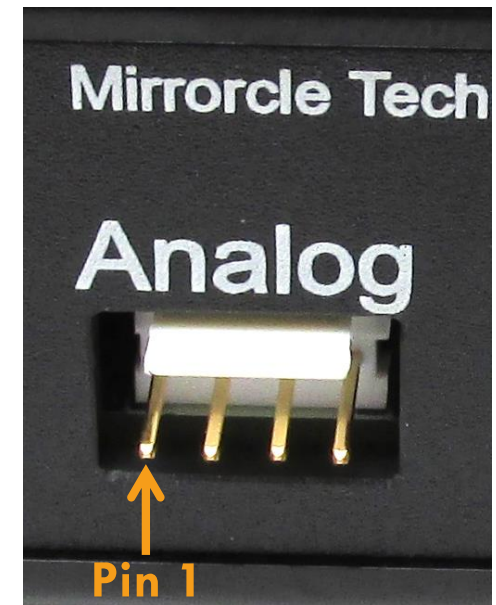
\*Please note: MTI-OK reply can be disabled by DisableConfirm command

# Analog Inputs Connector Pinout



- 2x Analog Input Channels
  - Voltage Range: -10 V to +10 V
  - ADC Resolution: 12-Bit
  - Sample Rate: up to 120ksps (API sample rate setting)
  - +3.3V supply is for any external circuits related to Analog Inputs. Pin can be left open / floating when not in use

Analog Connector: 4 - Pin Header		
J7-Pin	Name	Description
1	+3.3V	+3.3V Output, limited to 25mA (Do not input 3.3V. Output Pin for Optional Customer Use)
2	AIO	Analog Input Channel 0
3	AI1	Analog Input Channel 1
4	Gnd	Ground



Header Digikey Part #: A106219-ND

# Synchronization Connector Pinout



- The Synchronization port controls accessories e.g. Laser, Camera, etc.
- The port's middle Sync-pin can be set via software as an output to send start trigger, sample clocks.
- This port's middle Sync-pin can be set via software as an input to receive external sample clock or start triggers.
- The default setting for this pin is a direct copy of DOut0.

Sync Connector: 3 - Pin Header		
J6-Pin	Name	Description
1	+3.3V	+3.3VDC Output, 60mA (Do not input 3.3V. Output Pin for Optional Customer Use)
2	SNYC	Pin Function set with MTISync Parameter
3	Gnd	Ground

- **The SYNC pin is limited to sourcing / sinking 3mA of current – depending on it's operating mode of output or input.**

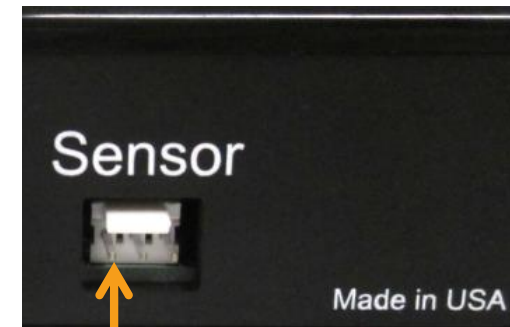


Header Digikey Part #: A19451-ND

# Sensor Connector Pinout



- This port is only enabled with the purchase of the Laser Tracking Bundle.
- The Sensor port powers the tracking bundle photosensor.
- The middle pin receives the analog voltage from the photosensor which is amplified in the Controller before being processed by the MCU.
- This port's middle pin should receive AC-coupled signals, and has a bandwidth of 1kHz up to 100kHz, to filter out ambient light in a room.



Sync Connector: 3 - Pin Header		
J6-Pin	Name	Description
1	+5VDC	+5VDC (Do not input 5V. Output Pin for Optional Customer Use)
2	AI2	Tracking Sensor Input
3	Gnd	Ground

Header Digikey Part #: A19451-ND

# Digital Output Connector Pinout



- The Digital Output connector has 8 digital outputs that are synchronous with the MEMS Driver sample output. (It enables to trigger accessories like cameras, lasers, etc.)
- Pin 1 can supply +3.3V, with a maximum current output of 25mA.
- Pins DOut0 – DOut8 can source 3mA of current per channel.

DOut Connector: 10 - Pin Header		
J8-Pin	Name	Description
1	+3.3V	+3.3V Supply, limited to 25mA (Do not input 3.3V. Output Pin for Optional Customer Use)
2	GND	Ground
3	DOut0	Digital Output Pin DOut0
4	DOut1	Digital Output Pin DOut1
5	DOut2	Digital Output Pin DOut2
6	DOut3	Digital Output Pin DOut3
7	DOut4	Digital Output Pin DOut4
8	DOut5	Digital Output Pin DOut5
9	DOut6	Digital Output Pin DOut6
10	DOut7	Digital Output Pin DOut7



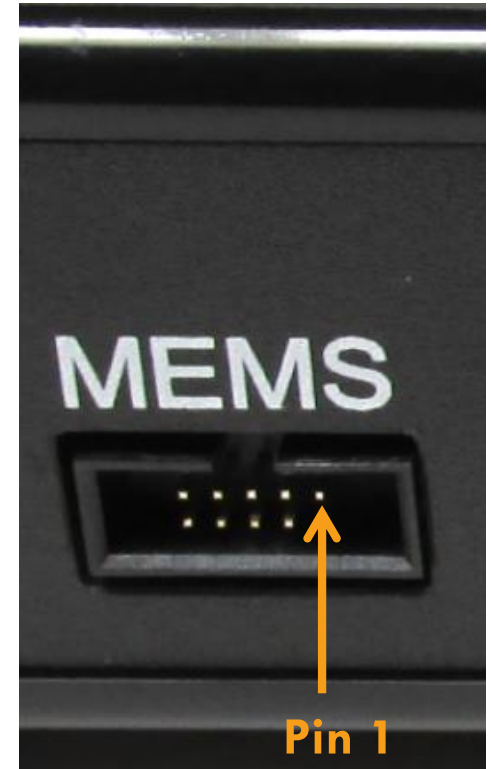
Header Digikey Part #: 1175-1628-ND

# MEMS Output Connector Pinout



- 4x High Voltage Analog Output Channels
  - Voltage Range: 0V to 200V\*
  - DAC Resolution: 16-Bit
  - Sample Rate: up to 120ksps+ (API sample rate setting)
  - Do not probe header for Driver Output voltages, it can cause shorts and damage the driver.

MEMS Connector: 10-Pin Header		
J5-Pin	Name	Description
1	HV_A (X+)	MEMS Channel X+
2	GND	Ground
3	HV_B (X-)	MEMS Channel X-
4	GND	Ground
5	HV_C (Y-)	MEMS Channel Y-
6	GND	Ground
7	HV_D (Y+)	MEMS Channel Y+
8	GND	Ground
9	NC	No Connection
10	NC	No Connection



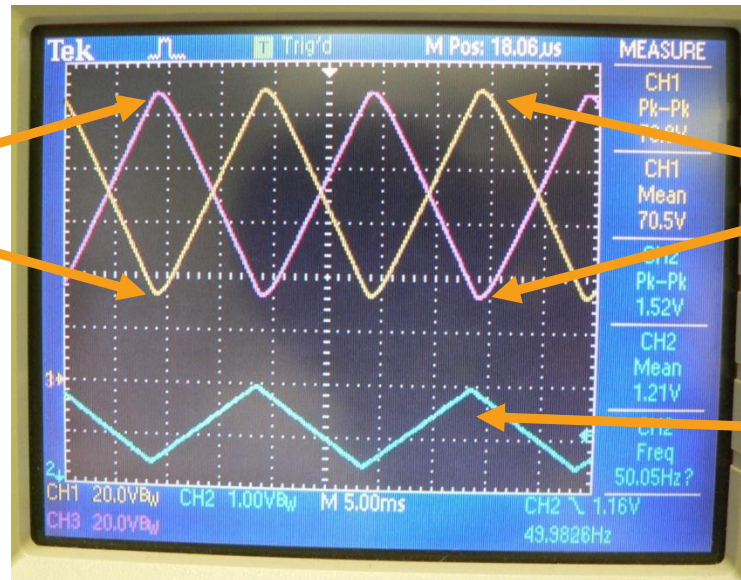
Header Digikey Part #: 1175-1628-ND

\*versions 1.4.x and earlier range up to 160V

# Embedded MEMS Driver

- Embedded, sophisticated MEMS driver generates biased differential quad (BDQ) channel high voltage control signals
- Driver Bandwidth is governed by hardware filters set in software – settings from 50Hz to 50kHz are accepted.
- Output Voltage Range (each channel): 0V - 160V
- BDQ driving provides linearization and smooth driving of MEMS mirrors over all four quadrants (bi-directional on both axes).

HV\_B is high  
HV\_A is low  
Mirror rotates in  
X- direction

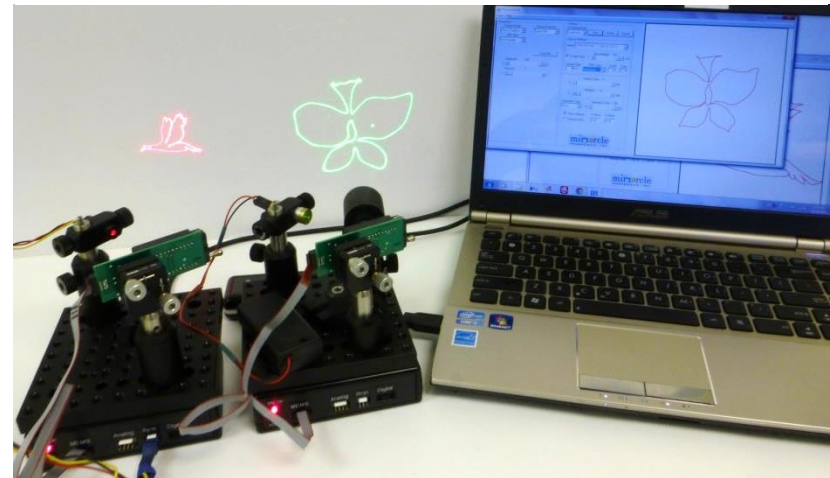


HV\_A is high  
HV\_B is low  
Mirror rotates in  
X+ direction

Resulting Mirror  
X-axis Tilt

# MTI's Development Kit Enables Fast Setups

- Mirrorcle Technologies MEMS Mirror Development Kit allows a user to quickly and efficiently gain familiarity with all aspects of these devices and their various possible uses.
- It enables safe operation of the devices with specifically developed software and MEMS driver solutions which include several levels of protection for the MEMS devices.
- Display a variety of vector graphics as well as animations at arbitrary refresh rates.
- Mirrors can be operated in point-to-point (quasi-static), resonant or hybrid modes.
- The system is highly adaptable to projection on various surfaces and in a variety of applications.



# Thank You for Choosing

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

[support@mirrorcletech.com](mailto:support@mirrorcletech.com)

