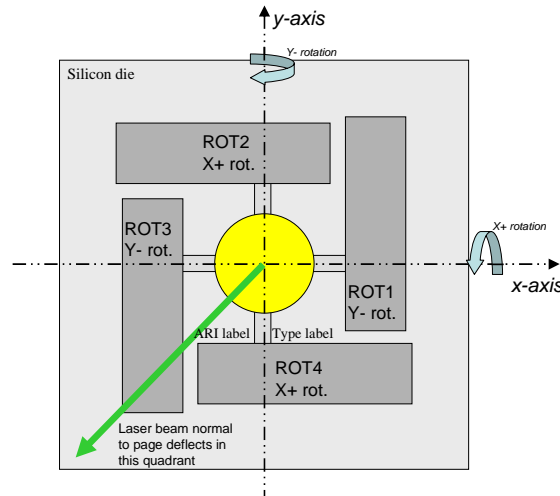


## MirrorcleTech Micromirrors - Pinouts and Typical Connections

### 1-QUADRANT TWO-AXIS ACTUATORS

Actuators rotate mirror in the **positive direction** about the **x-axis** and in the **negative direction** about the **y-axis**



### TERMINAL FUNCTIONS

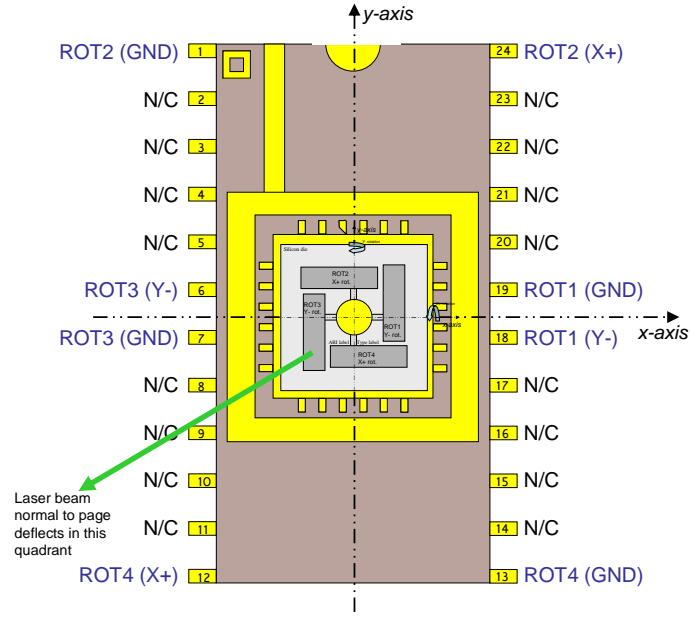
| Terminal Type    | Rotator | Rotation direction | Pin No. 24-pin DIP (old) | Pin No. 24-pin DIP (new) | Pin No. 8-pin DIP | Terminal Function   |
|------------------|---------|--------------------|--------------------------|--------------------------|-------------------|---|
| GND              | ROT2    |                    | 1                        | 4                        | 8                 | Ground connection for the ROT2 rotator.   |
| V <sub>ACT</sub> | ROT3    | Y-                 | 6                        | 7                        | 1                 | Actuation voltage for y axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the y axis in the negative Theta <sub>Y</sub> direction. |
| GND              | ROT3    |                    | 7                        | 10                       | 2                 | Ground connection for the ROT3 rotator  |
| V <sub>ACT</sub> | ROT4    | X+                 | 12                       | 13                       | 3                 | Actuation voltage for x axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the x axis in the positive Theta <sub>X</sub> direction. |
| GND              | ROT4    |                    | 13                       | 16                       | 4                 | Ground connection for the ROT4 rotator  |
| V <sub>ACT</sub> | ROT1    | Y-                 | 18                       | 19                       | 5                 | Actuation voltage for y axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the y axis in the negative Theta <sub>Y</sub> direction. |
| GND              | ROT1    |                    | 19                       | 22                       | 6                 | Ground connection for the ROT1 rotator  |
| V <sub>ACT</sub> | ROT2    | X+                 | 24                       | 1                        | 7                 | Actuation voltage for x axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the x axis in the positive Theta <sub>X</sub> direction. |

In standard operation, ROT1 and ROT3 drive voltages are connected together, and ROT2 and ROT4 drive voltages are connected together.

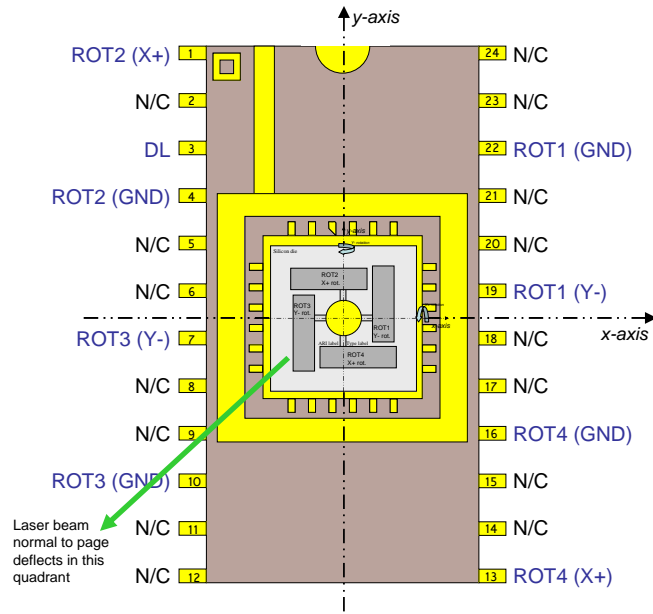
All four GND pins connect to the same silicon proof mass but at different points within the device so there is measurable resistance between those points. In standard operation all GND pins are connected together. Applying a voltage difference across these pins can result in device damage and failure.

## PIN ASSIGNMENTS (1-QUADRANT TWO-AXIS)

### 24-PIN DIP FOR 1-QUADRANT TWO-AXIS DEVICES FOR SERIAL NUMBERS FROM S0001 TO S0299

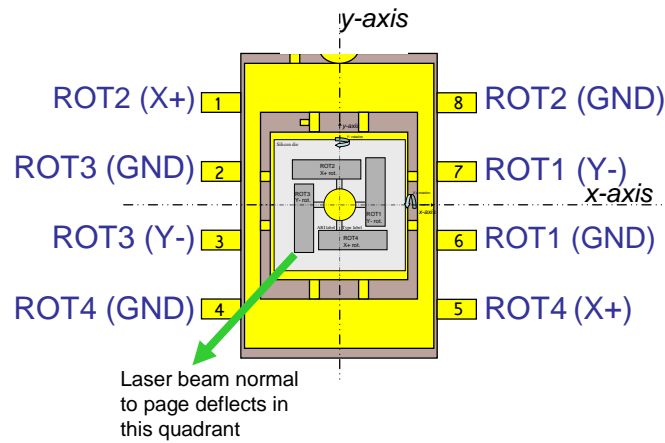


### 24-PIN DIP FOR 1-QUADRANT TWO-AXIS DEVICES FOR SERIAL NUMBERS S0300 AND HIGHER

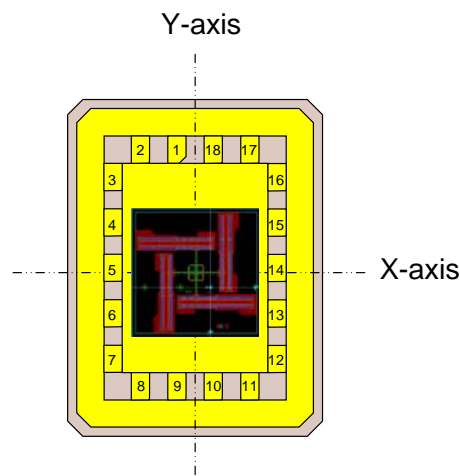


## PIN ASSIGNMENTS (1-QUADRANT TWO-AXIS) CONT.

### 8-PIN DIP FOR 1-QUADRANT TWO-AXIS DEVICES



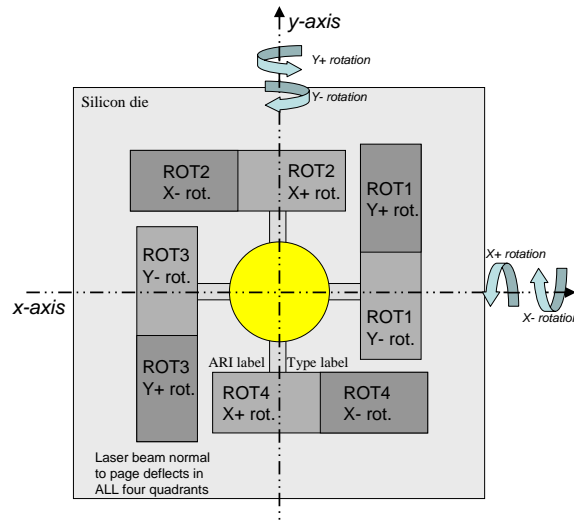
### 18-PIN LCC FOR 1-QUADRANT TWO-AXIS DEVICES



- |    |          |     |          |
|----|----------|-----|----------|
| 1. | ROT2 X+  | 10. | ROT4 X+  |
| 2. | n/c      | 11. | n/c      |
| 3. | ROT2 GND | 12. | ROT4 GND |
| 4. | n/c      | 13. | n/c      |
| 5. | n/c      | 14. | n/c      |
| 6. | ROT3 Y-  | 15. | ROT1 Y-  |
| 7. | n/c      | 16. | n/c      |
| 8. | ROT3 GND | 17. | ROT1 GND |
| 9. | n/c      | 18. | n/c      |

## 4-QUADRANT TWO-AXIS ACTUATORS

Actuators rotate mirror in the **positive and negative direction** about the **x-axis** and in the **positive and negative direction** about the **y-axis**



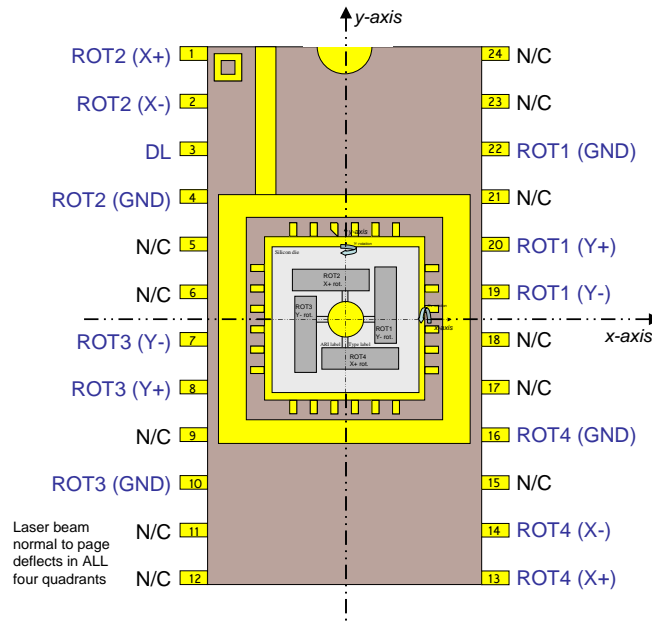
| Terminal Type    | Rotator | Rotation direction | Pin No. 24-pin DIP (new) | Pin No. 28-pin PGA | Terminal Function  |
|------------------|---------|--------------------|--------------------------|--------------------|--|
| V <sub>ACT</sub> | ROT2    | X+                 | 1                        | 28                 | Actuation voltage for x axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the x axis in the positive Theta_X direction. |
| V <sub>ACT</sub> | ROT2    | X-                 | 2                        | 3                  | Actuation voltage for negative Theta_X direction.  |
| GND              | ROT2    |                    | 4                        | 6                  | Ground connection for the ROT2 rotator   |
| V <sub>ACT</sub> | ROT3    | Y-                 | 7                        | 7                  | Actuation voltage for y axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the y axis in the negative Theta_Y direction. |
| V <sub>ACT</sub> | ROT3    | Y+                 | 8                        | 9                  | Actuation voltage for positive Theta_Y direction.  |
| GND              | ROT3    |                    | 10                       | 12                 | Ground connection for the ROT3 rotator   |
| V <sub>ACT</sub> | ROT4    | X+                 | 13                       | 14                 | Actuation voltage for x axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the x axis in the positive Theta_X direction. |
| V <sub>ACT</sub> | ROT4    | X-                 | 14                       | 17                 | Actuation voltage for negative Theta_X direction.  |
| GND              | ROT4    |                    | 16                       | 20                 | Ground connection for the ROT4 rotator   |
| V <sub>ACT</sub> | ROT1    | Y-                 | 19                       | 21                 | Actuation voltage for y axis rotation of the micromirror. Voltage difference between V <sub>ACT</sub> and GND is converted to torque and rotation of the micromirror about the y axis in the negative Theta_Y direction. |
| V <sub>ACT</sub> | ROT1    | Y+                 | 20                       | 23                 | Actuation voltage for positive Theta_Y direction.  |
| GND              | ROT1    |                    | 22                       | 26                 | Ground connection for the ROT1 rotator   |

In standard operation, ROT1 Y+ and ROT3 Y+ are connected together, ROT1 Y- and ROT3 Y- are connected together, ROT2 X+ and ROT2 X- are connected together, and ROT2 X- and ROT4 X- are connected together.

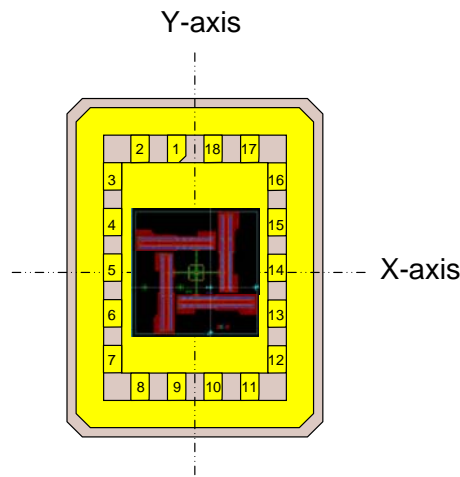
All four GND pins connect to the same silicon proof mass but at different points within the device so there is measurable resistance between those points. In standard operation all GND pins are connected together.

## PIN ASSIGNMENTS (4-QUADRANT TWO-AXIS)

### 24-PIN DIP FOR 4-QUADRANT TWO-AXIS DEVICES FOR SERIAL NUMBERS S0200 AND HIGHER

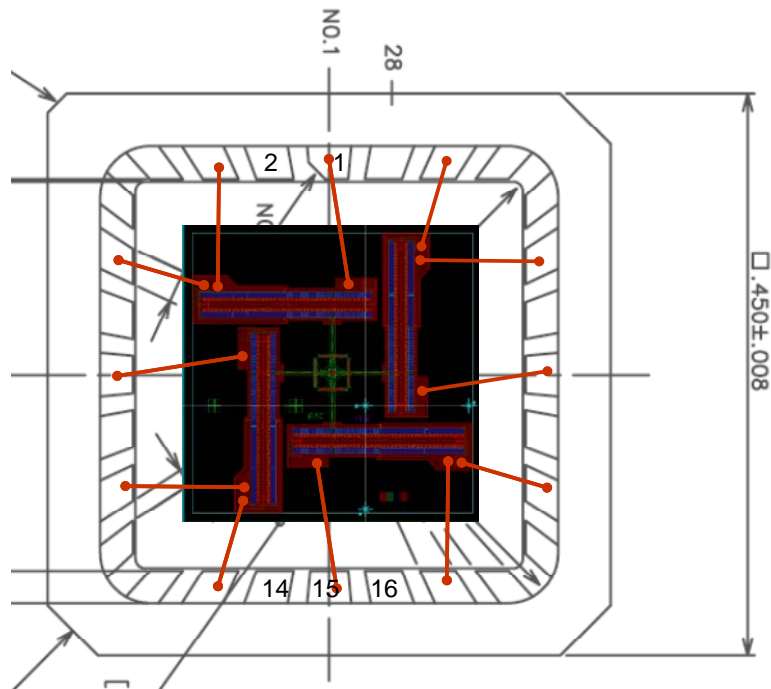


### 18-PIN LCC FOR 4-QUADRANT TWO-AXIS DEVICES



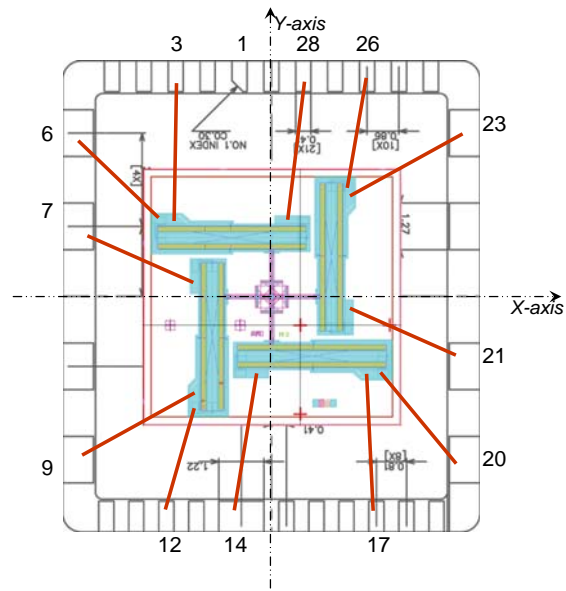
- |    |          |     |          |
|----|----------|-----|----------|
| 1. | ROT2 X+  | 10. | ROT4 X+  |
| 2. | ROT2 X-  | 11. | ROT4 X-  |
| 3. | ROT2 GND | 12. | ROT4 GND |
| 4. | n/c      | 13. | n/c      |
| 5. | n/c      | 14. | n/c      |
| 6. | ROT3 Y-  | 15. | ROT1 Y-  |
| 7. | ROT3 Y+  | 16. | ROT1 Y+  |
| 8. | ROT3 GND | 17. | ROT1 GND |
| 9. | n/c      | 18. | n/c      |

## 28-PIN LCC FOR 4-QUADRANT TWO-AXIS DEVICES



|    |           |    |           |
|----|-----------|----|-----------|
| 1  | ROT2 (X+) | 15 | ROT4 (X+) |
| 2  | n/c       | 16 | n/c       |
| 3  | ROT2 (X-) | 17 | ROT4 (X-) |
| 4  | n/c       | 18 | n/c       |
| 5  | n/c       | 19 | n/c       |
| 6  | ROT2 GND  | 20 | ROT4 GND  |
| 7  | n/c       | 21 | n/c       |
| 8  | ROT3 (Y-) | 22 | ROT1 (Y-) |
| 9  | n/c       | 23 | n/c       |
| 10 | ROT3 (Y+) | 24 | ROT1 (Y+) |
| 11 | n/c       | 25 | n/c       |
| 12 | n/c       | 26 | n/c       |
| 13 | ROT3 GND  | 27 | ROT1 GND  |
| 14 | n/c       | 28 | n/c       |

## 28-PIN PGA FOR 4-QUADRANT TWO-AXIS DEVICES FOR SERIAL NUMBERS S0200 AND HIGHER

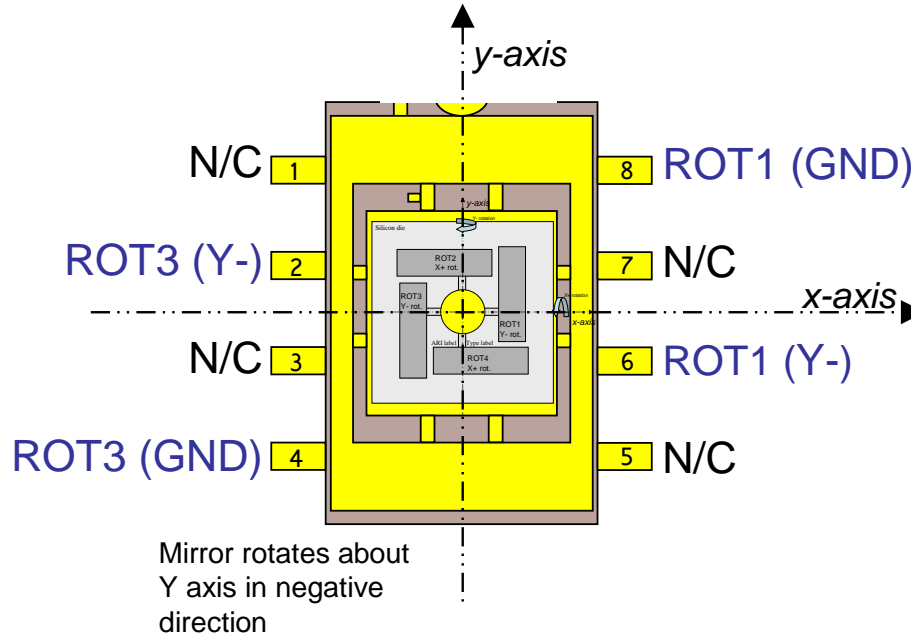


|    |           |    |           |
|----|-----------|----|-----------|
| 1  | n/c       | 15 | n/c       |
| 2  | n/c       | 16 | n/c       |
| 3  | ROT2 (X-) | 17 | ROT4 (X-) |
| 4  | n/c       | 18 | n/c       |
| 5  | n/c       | 19 | n/c       |
| 6  | ROT2 GND  | 20 | ROT4 GND  |
| 7  | ROT3 (Y-) | 21 | ROT1 (Y-) |
| 8  | n/c       | 22 | n/c       |
| 9  | ROT3 (Y+) | 23 | ROT1 (Y+) |
| 10 | n/c       | 24 | n/c       |
| 11 | n/c       | 25 | n/c       |
| 12 | ROT3 GND  | 26 | ROT1 GND  |
| 13 | n/c       | 27 | n/c       |
| 14 | ROT4 (X+) | 28 | ROT2 (X+) |

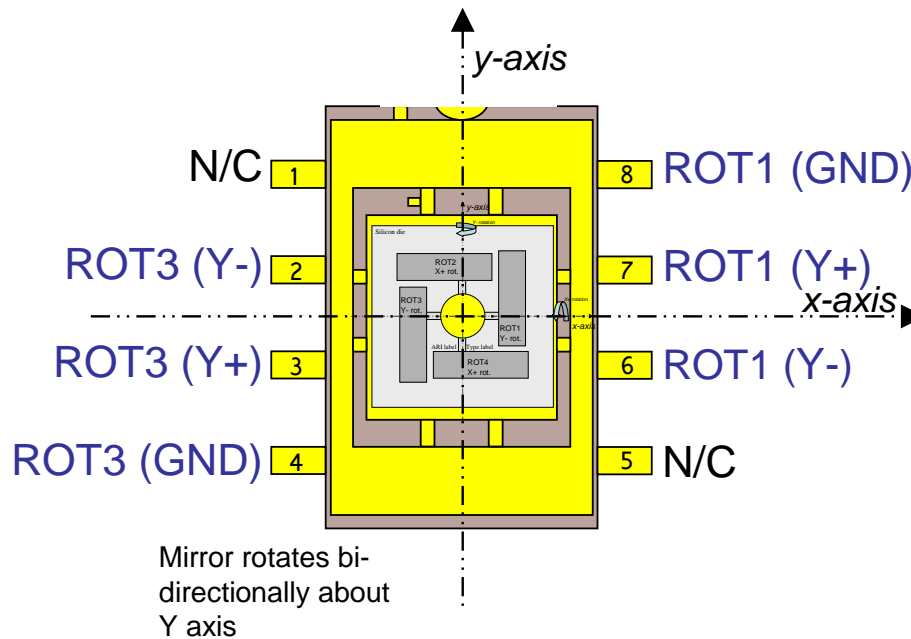
## ONE-AXIS DEVICES

### PIN ASSIGNMENTS (ONE-AXIS)

#### 8-PIN DIP FOR UNI-DIRECTIONAL ONE-AXIS DEVICES

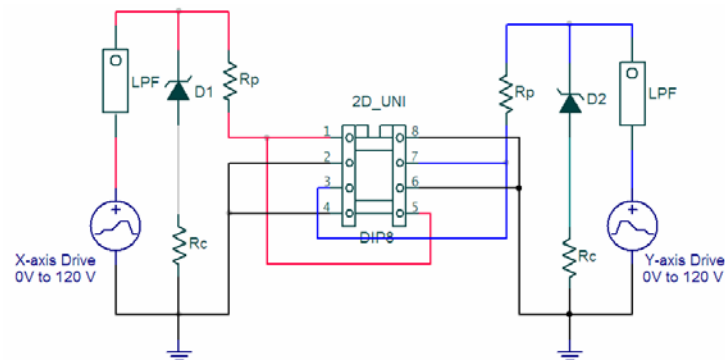


#### 8-PIN DIP FOR BI-DIRECTIONAL ONE-AXIS DEVICES

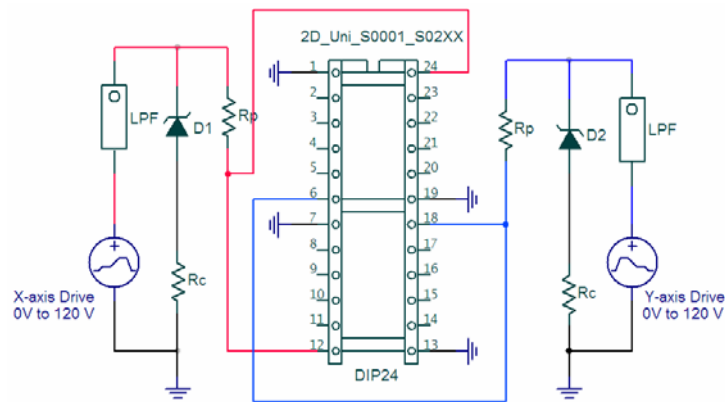


## TYPICAL CONNECTIONS – TWO-AXIS 1-QUADRANT DEVICES

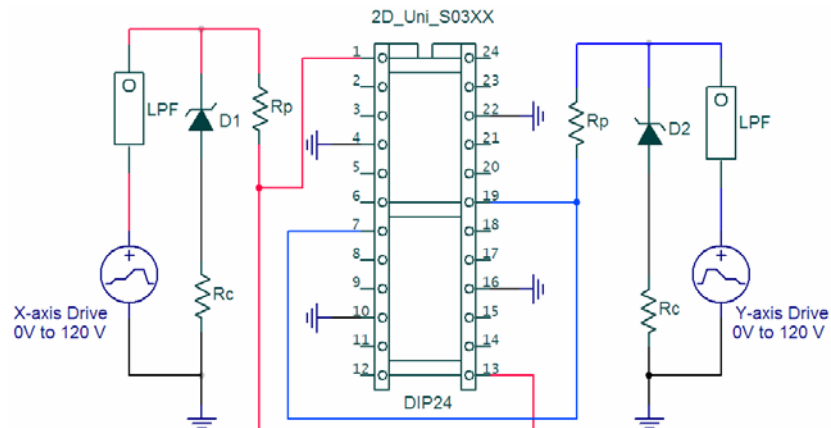
8-pin DIP based devices



24-pin DIP based devices – devices S0001 to S0299



24-pin DIP based devices – devices S0300 and up

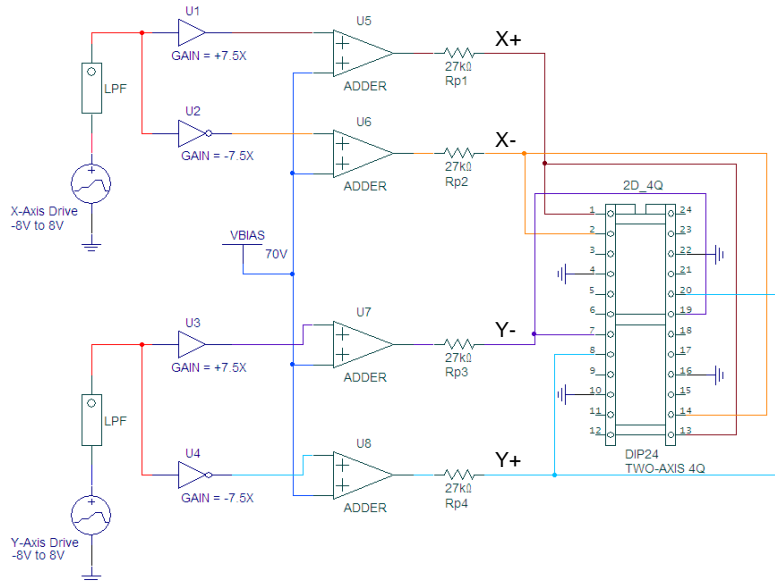


$R_p$  resistors protect the MEMS device against current flow in case of shorting. Typical value is 20k $\Omega$ -100k $\Omega$ .  $D_1$  and  $D_2$  are zener diodes of 120V, in series with  $R_c$  which is typically 51k $\Omega$  to limit voltages to the MEMS device to <120V with a relatively slow time constant to prevent resonant ringing response of the device during clipping. X axis driver and Y axis driver provides voltages from 0 to 120V corresponding to desired positions according to device's voltage to angle charts (see ramp responses.) Low pass filters (LPF) are typically Bessel type analog or digital approximation filters of 6<sup>th</sup> order and cutoff frequency at  $\sim 1/3$  of the device's first resonant frequency.

## TYPICAL CONNECTIONS – TWO-AXIS 4-QUADRANT DEVICES

### RECOMMENDED METHOD – HARDWARE SOLUTION

#### 4-channel Bias Differential Quad-channel method



A bias circuit is constructed that applies 70V to all 4 channels. Another circuit takes user input to control the X-axis and the Y-axis as a bi-polar input voltage (e.g. -8V to 8V represent maximum negative and positive angles.) Circuit applies this voltage differentially to opposing channels (“X+” channel gets  $V_{bias} + 7.5 \cdot V_{SX}$  and “X-” channel gets  $V_{bias} - 7.5 \cdot V_{SX}$ ; “Y-” channel gets  $V_{bias} + 7.5 \cdot V_{SY}$  and “Y+” channel gets  $V_{bias} - 7.5 \cdot V_{SY}$ )

This method of driving 4-quadrant (bi-directional) devices utilizes two bi-polar drive channels for the x- and y-axis, which are converted to four appropriate uni-polar high voltage channels.

$R_p$  resistors protect the MEMS device against current flow in case of shorting, recommended value is  $20 \text{ k}\Omega < R_p < 100 \text{ k}\Omega$ . Low pass filters (LPF) are typically Bessel type analog or digital approximation filters (in software) of 6<sup>th</sup> order and cutoff frequency at  $\sim 1/3$  of the device’s first resonant frequency.

### RECOMMENDED METHOD – SOFTWARE SOLUTION

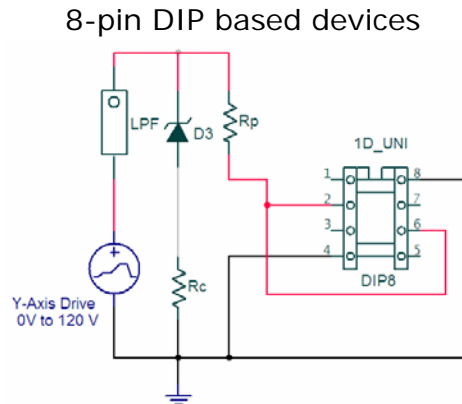
#### 4-channel Bias Differential Quad-channel method

The above hardware method assumes that user has a two-channel analog output from a PC and therefore creates the four appropriate channels in hardware. In the case where a four-channel analog output is directly available and driveable from software, the method can be implemented in software. External to the computer we still require high voltage amplification for each analog output, but the biasing and inverting of every other channel can be software-implemented. (see hardware solution above.)

### ALTERNATE METHODS

Alternative to the recommended bias-differential driving method above is to drive one direction at a time. For example a software selector could apply drive voltage to “X-” channel whenever desired angle is negative, and apply 0 to the “X+” channel at the same time. For desired positive angles the situation would be reversed. In this manner a quadratic relationship of angle to voltage is obtained, similar to that in 1-quadrant devices, although in both directions. The recommended bias-differential methods shown above perform some device linearization and give smoother quadrant transitions.

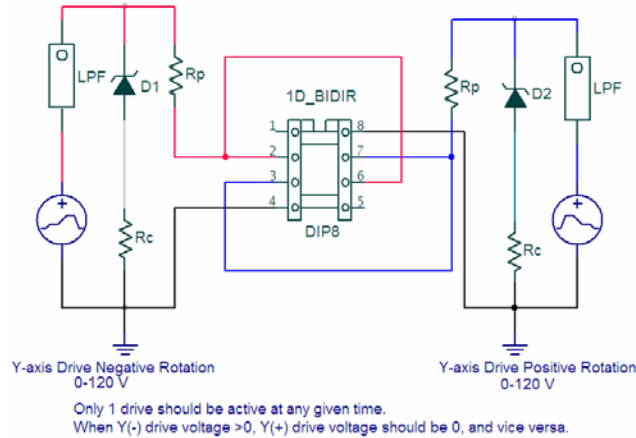
## TYPICAL CONNECTIONS – ONE-AXIS UNI-DIRECTIONAL DEVICES



$R_p$  resistors protect the MEMS device against current flow in case of shorting.  $D_3$  is a zener diode of 120V, in series with  $R_c$  which is typically  $51k\Omega$  to limit voltages to the MEMS device to  $<120V$  with a relatively slow time constant to prevent resonant ringing response of the device during clipping. Low pass filters (LPF) are typically Bessel type analog or digital approximation filters of 6<sup>th</sup> order and cutoff frequency at  $\sim 1/3$  of the device's first resonant frequency.

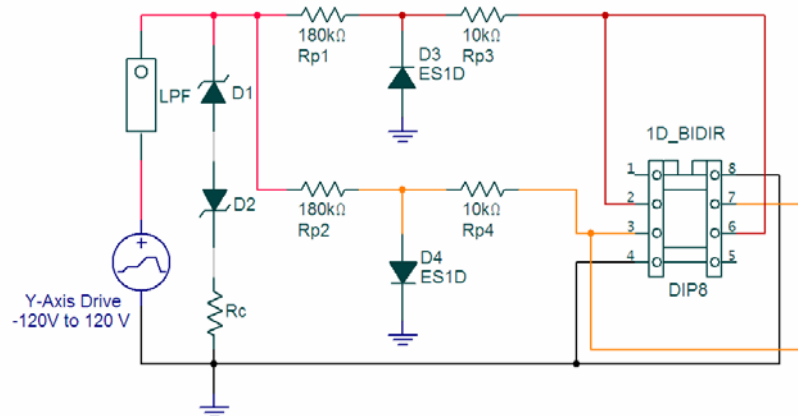
## TYPICAL CONNECTIONS – ONE-AXIS BI-DIRECTIONAL DEVICES

### 8-pin DIP based devices – 2-channel method with software splitter



This method of driving bi-directional devices utilizes two single-supply drivers (0V to 120V,) for the y-axis positive and y-axis negative direction rotation. It is necessary to implement software splitting in this method such that only one drive at a time is active (voltage > 0.) For Y+ angles, only the right-hand-side drive should be active.

### 8-pin DIP based devices – 1-channel dual-supply method with diode splitters



This method of driving bi-directional devices utilizes a dual-supply driver (-120V to 120V,) for the y-axis positive and y-axis negative direction rotation. Positive y-drive voltages are passed by a reverse-biased diode D3 to Y- rotators on pins 2 and 6. Negative y-drive voltages are blocked by D3, while on the other hand passed by D4 to Y+ rotators on pins 3 and 7.

$R_p$  resistors protect the MEMS device against current flow in case of shorting.  $D_3$  is a zener diode of 120V, in series with  $R_c$  which is typically  $51k\Omega$  to limit voltages to the MEMS device to <120V with a relatively slow time constant to prevent resonant ringing response of the device during clipping. Low pass filters (LPF) are typically Bessel type analog or digital approximation filters of 6<sup>th</sup> order and cutoff frequency at  $\sim 1/3$  of the device's first resonant frequency.