# Dual-Axis Analog MEMS Pointing Mirror

Check for Samples: TALP1000B

## FEATURES

- **Two Axis, Gimbaled Mirror**
- **±5 Degrees Mechanical Rotation**
- **One Mirror, 9 mm$^2$ in Area**
- **Electromagnetic Actuation**
- **Low Voltage Operation**
- **Low Optical Insertion Loss (>95% Reflectivity, >5 m Radius of Curvature)**
- **High Precision Position Feedback (13-Bit Resolution)**
- **High Performance (<5 ms Switch Time)**
- **High Reliability**
- **Cost Effective Solution**
- **Simple Drive Requirements – Tilt Angle Linear with Applied Current**
- **Windowless Package – Allows Use in Multiple Light Steering Applications**

## APPLICATIONS

- **Optical Networking**
  - **ROADM (Reconfigurable Optical Add/Drop Multiplexer)**
  - **Channel Monitors**
- **Free Space Optical Communication**
  - **Outdoor Links**
  - **Indoor Links (Readily Reconfigurable)**
    - **At Trade Shows**
    - **On Production Floors**
    - **In an Office Area From Cubicle to Hubs**
    - **In Home Theater From Entertainment Center to Wall-Mounted HDTV**
- **Optical Alignment**
  - **Precise Light Steering and Control**
- **General Laser Steering that Requires a Large (3 mm) Mirror**
  - **LADAR (Laser Detection and Ranging) Object Detection**

## DESCRIPTION

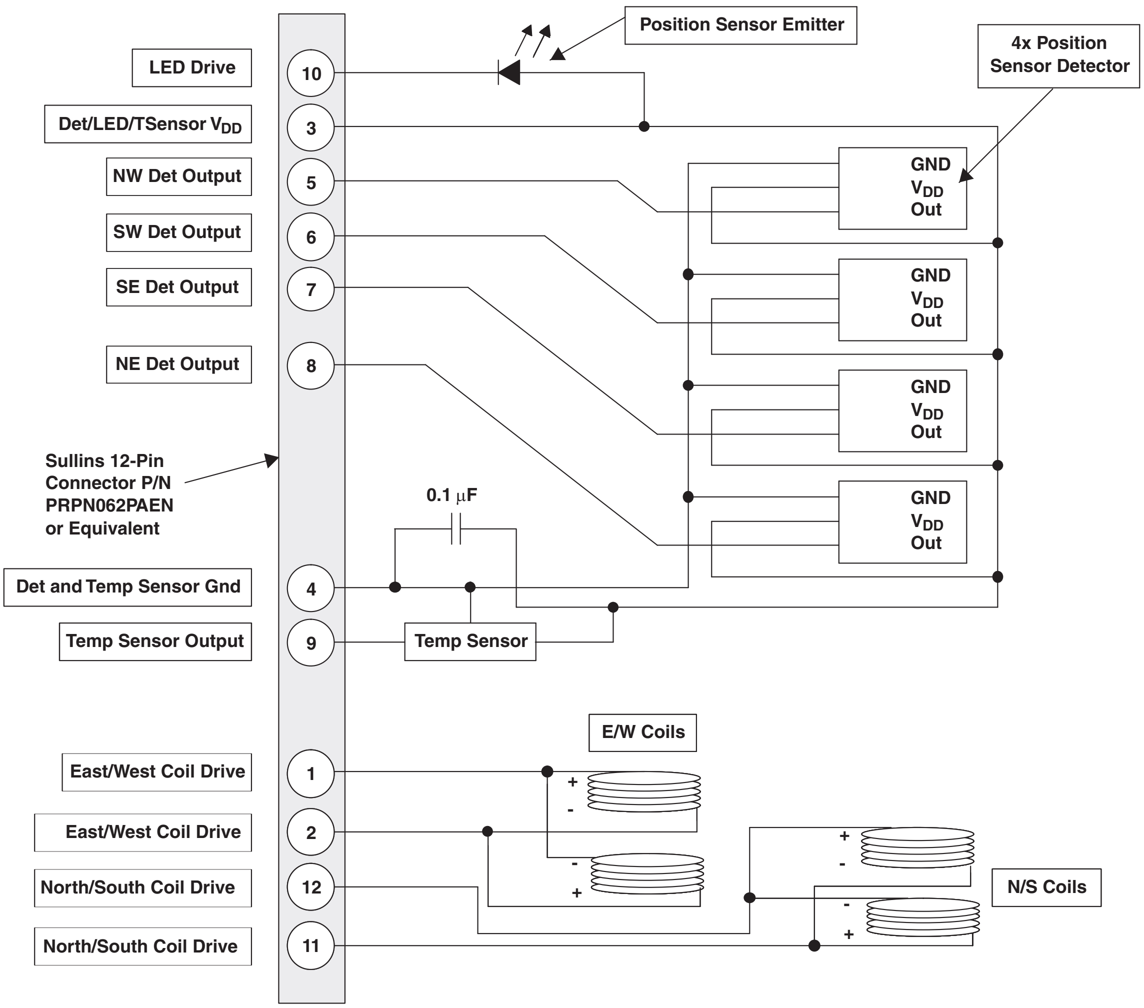
The TALP1000B is a high-performance micromirror designed for use in multiple light steering applications. The large 2-axis micromirror is constructed of single crystal silicon, which has no grain boundaries and is virtually defect free. This produces a hinge with no work hardening and gives the TALP1000B superior reliability characteristics. The gold coated optically active surface of the TALP1000B provides excellent reflectivity in the 700 nm –10 um wavelength range. The mirror’s large size, large radius of curvature and high reflectivity make it easy to incorporate into many optical designs.

The electromagnetic drive of the TALP1000B allows low voltage and low-power actuation. The mirror can be driven using an analog drive resulting in precise pointing resolution over the entire range of motion. Each rotation axis of the device is individually and independently actuated.

Integrated position feedback on the TALP1000B is optical based and provides greater than 13 bit pointing precision. Additionally, the position feedback can be used in conjunction with a servo loop to achieve <5 millisecond point-to-point switch times.

The ceramic circuit board base provides a mechanically rigid design, and the three point mounting interface allows precise and repeatable assembly into system hardware. The compact size of the TALP1000B is ideal for systems with small footprint requirements.

## Circuit Schematic




A. When a positive voltage is applied to pin #1 (a lower voltage is returned from pin #2), a beam reflected off the mirror rotates in the westerly direction. When a positive voltage is applied to pin #12 (a lower voltage is returned from pin #11), a beam reflected off the mirror rotates in the northerly direction. North and west arrows are on both sides of the package.

## RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

| | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|
| Operating temperature range | –10 | | 70 | °C |
| Storage temperature, $T_{stg}$ | –50 | | 85 | °C |

## ELECTRO/MECHANICAL CHARACTERISTICS

over operating supply voltage and operating temperature ranges (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | Typical power supply rejection of position sensor detectors is >50 dB, 20 kHz to 50 kHz. | 4.8 | | 5.2 | V |
| | Power dissipation | At maximum angle for both axes, includes position feedback and coil drive. 0.65 to 10 micron wavelength range | | | 700 | mW |
| | Mechanical rotation | Applies to both axes, each axis independent, angle relative to plane determined by mirror-side mounting positions, over the entire temperature range. | 0 | | ±5 | deg |
| | Mirror resonance frequency | Measured at 25°C and 0 degree rotation | 112 | | 152 | Hz |
| | Gimbals resonance frequency | Measured at 25°C and 0 degree rotation | 100 | | 140 | Hz |
| | Resonance frequency variation over operating temperature range | | | | 10 | Hz |
| | Resonance frequency variation over rotation range–each axis | | | | 8 | Hz |
| | Mirror mechanical Q | Measured by fitting exponential decay after removing 2-mA current pulse. Quiescent angle, 25°C | 100 | | | |
| | Coil current at maximum rotation | Over the entire temperature range | 20 | | 65 | mA |
| | Mirror drift at constant coil current | Mirror position is stable to within 5% of full angular range (0.5°) over time and operating temperature range. | | | 5% | |
| | Coil drive linearity | Difference between a mirror angle at a given current, and the angle predicted by a linear fit to angle versus current over the range of ±5 degrees at 25°C | | | 0.4 | deg |
| | Coil resistance: each axis | Measured at 25°C, coils use copper wire with variation over temperature given by $R = R_0[1 + a(T – T_0)]$, where, a = 3.9 × 10–3/°C | 61 | | 71 | Ω |
| | Quiescent angle: mirror side | Angle relative to plane determined by mirror-side mounting positions, over the entire temperature range | | | ±0.3 | deg |
| | Quiescent angle: coil side | Angle relative to plane determined by coil-side mounting positions, over the entire temperature range | | | ±0.5 | deg |
| | Mirror crosstalk | Off-axis rotation induced by on-axis actuation relative to axes determined by mirror mounting positions | | | 5% | |
| | Mirror curvature radius | Over the entire temperature range | 5 | | | m |
| | Mirror reflectivity | Over the entire temperature range | 95% | | | |
| | Displacement of optical surface from axis of rotation | | | | 65 | µm |
| | Mirror surface roughness | Measured over a 0.5 mm square window. $rms = \left(\frac{y_1^2 + y_2^2 + \ldots + y_N^2}{N}\right)^{½}$ Where $y_x$ are the height elements along the profile and N is the number of discrete elements. | | | 200 | nm |
| | Particulates | 3 dig surface quality. The diameter of the maximum sized particle on the mirror must not exceed 30 µmm (corresponding to 3 dig surface quality). The sum of the diameters of all particles on the mirror must not exceed twice this size. Two particles must not be closer than 200 µm. Particles less than 5 µm are ignored.(1) | | | | |

(1) The diameter of an irregularly shaped particle is the average of its length and width.

## ELECTRO/MECHANICAL CHARACTERISTICS (continued)

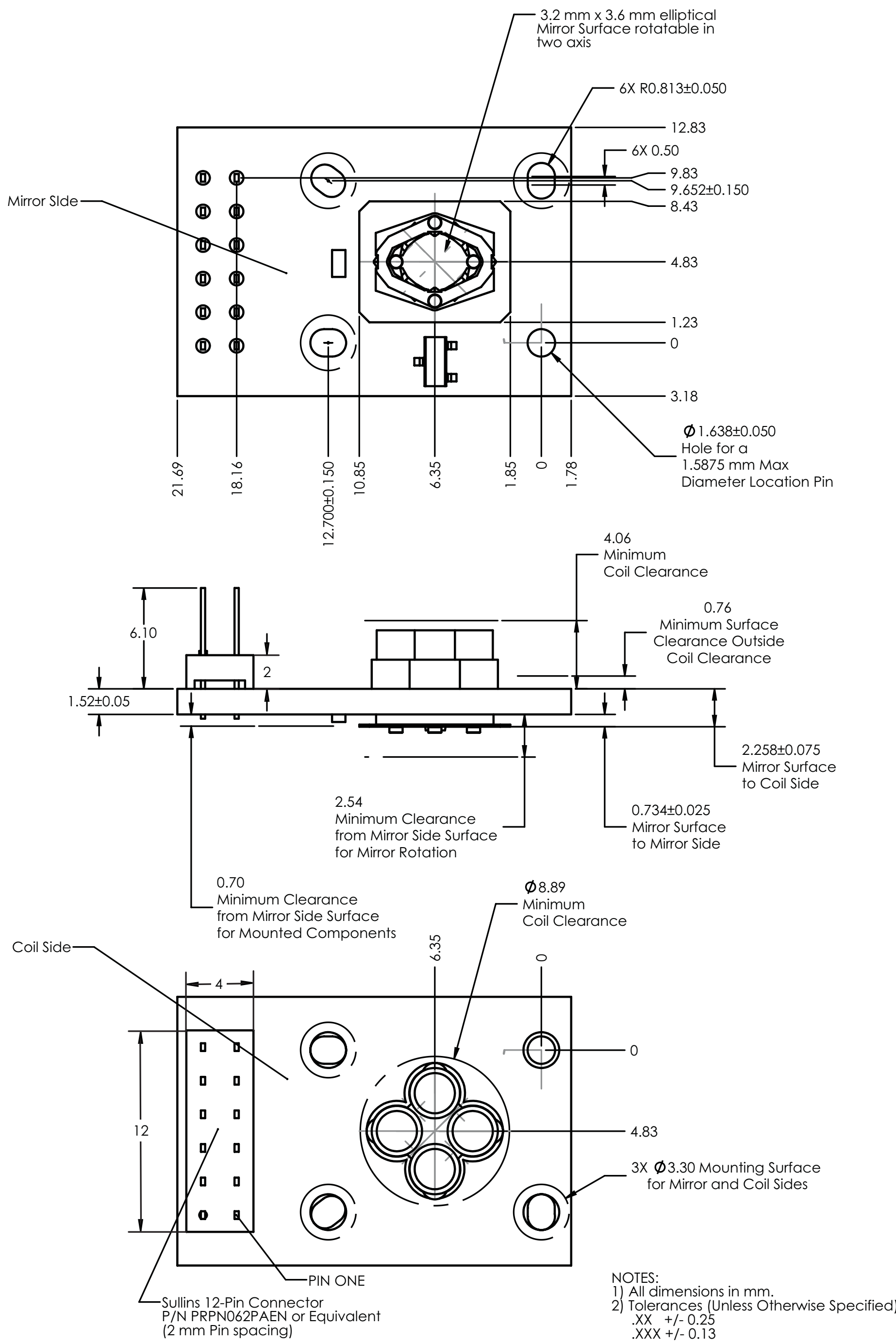
over operating supply voltage and operating temperature ranges (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| LED current for 3-V sensor output | At quiescent angle over the entire temperature range. | | | 22 | mA |
| Number of position sensor detectors | Axes of position sensor detectors rotated 45 degrees relative to rotation axes | 4 | | 4 | |
| Detector output nonuniformity | (Maximum minus minimum of the four detectors) / (minimum of the four detectors). Measured with quiescent mirror at 25°C. | | | 0.6% | |
| Position sensor power dissipation | Includes single LED and four detectors and temperature sensor over entire temperature range. | | | 100 | mW |
| Position sensor drift | 0°C to 70°C, relative to mirror position at 35°C. | | | ±5% | |
| Position sensor SNR(2) | For each axis, at 25°C.(2) | 4000:1 | | | |
| SNR per degree | Signal is the change in position sensor output with a 1 degree tilt in angle, and the noise is the standard deviation of the position sensor output with no coil current. Measure between integer angles (–5 to –4 degrees, –4 to –3 degrees, ..., 4 to 5 degrees) | 300:1 | | | |
| Position sensor detector rise and fall times | 10%–90% signal rise and fall, over the entire temperature range | | | 70 | μs |
| Position sensor detector output voltage | At 25°C | 0 | | 4.5 | V |
| Output voltage swing for each detector over rotation range | At 25°C | 1 | | | V |
| Differential output voltage swing for two opposing detectors over rotation range | At 25°C | 2 | | | V |
| Position sensor linearity | Difference between the rotation angle at a given sensor output and the angle predicted by a linear fit to angle versus output over the range of ±5 degrees at 25°C | | | 0.5 | deg |
| Position sensor crosstalk | Off-axis sensor output induced by on-axis actuation relative to axes determined by mirror mounting positions, at 25°C | | | 10% | |
| Mechanical shock | Product has passed 1 ms shock at this level in accordance with Method 2002 and MIL-STD-883 | | | 500 | g |
| Temperature cycling | Product has passed testing of 100 cycles across this temperature range in accordance with EIA/TIA-445-3A | –40 | | 85 | °C |
| Vibration | Product has passed vibration testing at 20G across this frequency range in accordance with Method 2007 MIL-STD-883 | 20 | | 2000 | Hz |

(2) The position sensor SNR is specified for each axis to be the peak-to-peak sensor output divided by the standard deviation of the sensor output where: position sensor output east west = $PS_{EW}$ = (NE + SE – NW – SW)/(NE + SE + NW + SW), $PS_{NS}$ = (NE – SE + NW – SW)/(NE + SE + NW + SW). NE, SE, NW, and SW denote the voltage outputs of the northeast, southeast, northwest, and southwest detectors respectively. Peak-to-peak output is measured when the mirror is rotated through the full range of motion. Standard deviations are measured at the quiescent angle and all values are sampled simultaneously at 8 kHz for 1 second.

## DEVICE INFORMATION



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