

## Space Telescope Positioning



- **Objectives:** Accurately position telescopes
- **Solution:** Jewell Instruments Electrolytic [700 Series](#)
- **Benefits:** High-precision and exceptional repeatability
- **Results:** Reliable and precise telescope positioning

### Overview

Accurately positioning large and small telescopes has always been difficult. Jewell Instruments precision tiltmeters provide a simple and effective solution. Tiltmeters are not like conventional systems, which measure telescope position using rotary encoders coupled to the telescope axes. The electrolytic sensor always orients itself perpendicular to the vertical gravity vector. The electrolytic sensor in the tiltmeter behaves like a level, changing its internal resistance as the sensor rotates. The tiltmeter electronics convert this change to a high-level analog or digital signal proportional to the tilt angle.

By using tiltmeters, one can avoid many sources of non-repeatable error, such as hysteresis in the telescope structure, random slippage in the couplings between the position encoders and the telescope axes, and rotational wobble. And unlike

optical encoders, tiltmeters do not need to be reinitialized on power up. Jewell Instruments' [700 Series](#) tiltmeters are used on large radio and optical telescopes for zenith finding, to monitor small variations in axis alignment, and to measure deformation of the telescope structure.

Jewell Instruments [700 Series](#) tiltmeters are designed for extreme precision and repeatability in comparison to other technologies. A variety of designs offer solutions for a wide range of operating conditions. For applications with size or weight constraints, our Miniature Tilt Sensors provide the same performance as our self-contained tiltmeters they are operated using a remote signal conditioner.

These Jewell Model [A701](#) and [A711](#) platform tiltmeters are the most popular design. Using their built-in invar leveling legs, our [A701](#) can be set up and operated on any hard, horizontal surface. The two orthogonal tilt sensors parallel the right-angle sides of the base plate. Each tiltmeter includes a temperature sensor. Model [A701](#) has switchable gain and low-pass filter settings that provides a range of measurement options. Sensors and electronics are mounted in a rugged housing that also provides electrical shielding. Models [A711\(4X\)](#) and [A701\(4X\)](#) are water resistant for extra environmental protection. Using an absolute



Jewell Instruments 700 series tiltmeter



**Phone :**  
+1 (603) 669-6400



**Email :**  
info@jewellinstruments.com



**Web :**  
[jewellinstruments.com](http://jewellinstruments.com)



gravity-referenced electrolytic sensor, our [700 series](#) tiltmeters deliver ultra-high sensitivity to  $<0.1 \mu\text{rad}$  with virtually zero long-term drift. Jewell's [A711](#) (floor mount) and [A716](#) (wall mount) come with mounting screws that can be bolted to any surface for long-term measurements.

The Digital [D711](#) series offers RS232 and RS422 interfaces available. Its internal electronics drive signals over cable lengths greater than 1000m. The digital version comes with on-board memory – with storage capacity for up to 22,000 samples – programmable firmware controls that includes sample data averaging and wide-range option up to  $\pm 70^\circ$ .

Therefore, the [700 series](#) can provide ultimate performance in static applications where high-precision is the highest priority. For customers that have high-

end accuracy concerns, [because environmental temperature can affect the performance of these tiltmeters](#), Jewell also offers temperature characterization across temperature. This process will begin with the customer's determination of the temperature range of interest, as well as how many temperatures they want to perform testing at. Jewell will then thermally pre-stress the sensors, and characterize them across several angular positions at each temperature. This data is then published along with  $K_s$  and  $K_z$  calculations so that you can perform bilinear interpolations,  $K_s$  &  $K_z$  compensation, or any compensation scheme that customer deems appropriate. The scientific research community has contracted Jewell in the past for seven temperatures, though most clients choose three or five temperatures to characterize.

**“Jewell electrolytic tiltmeters are designed for extreme precision and repeatability.”**



## Facilities Using Jewell Tiltmeters

- James Clerk Maxwell Telescope, Mauna Kea
- National Radio Astronomy Observatory
- Owens Valley Radio Observatory, Caltech
- Submillimeter Array, Smithsonian Astrophysical Observatory, Mauna Kea
- Hubble Space Telescope (ground-based simulations), Jet Propulsion Laboratory
- Kitt Peak National Observatory, Arizona
- Lick Observatory, California
- Monterey Institute for Research in Astronomy
- Nordic Optical Telescope, La Palma
- Gran Telescopio Milimetrico, INAOE, Mexico
- McDonald Observatory, University of Texas

## About Jewell Instruments

Jewell Instruments is a world leader in the design, manufacture, and distribution of high-precision products. Our expertise includes acceleration and tilt sensors, electronic compasses, avionics components, solenoids, and panel meters. The extensive application knowledge we have obtained through decades of experience allows us to provide custom solutions for a diverse group of industries. In fact, customers from all over the globe contact us for solutions to aerospace, medical, industrial, and telecommunications applications - to name a few.

To find out more, visit our website!



**Phone :**  
+1 (603) 669-6400



**Email :**  
[info@jewellinstruments.com](mailto:info@jewellinstruments.com)



**Web :**  
[jewellinstruments.com](http://jewellinstruments.com)



CSTM1 Rev. A