

The R2D3 remote monitoring station measures absolute displacements in 3 directions (XYZ) as well as rotational movements in 2 horizontal directions. Millimeter-level displacement precision is achieved using streaming GNSS correction data and R2D3 software algorithms operating in a feedback loop. A two-axis high-performance tilt sensor measures rotational movements below 0.005 degrees.

Monitor displacement and rotation in 3 dimensions (XYZ) in real-time with the Geodaq R2D3 GNSS Position Module. Externally mounted Active Target Points (ATP) monitor horizontal displacements with 3mm precision and vertical displacements with 12mm precision. Each R2D3 module acquires high-accuracy position results for 1 to 8 ATP monitoring locations. Applications include landslides, earth retaining structures, cut slopes, embankments/levees, pipelines and existing structures.



R2D3 GNSS Position Module

Technical Features

- High-Precision GNSS Receiver
- Low-Cost
- Small Form Factor (2" x 2.8")
- 3D Movements at up to 8 Target Locations
- Millimeter-Level Precision (24-HR)
- Integrated 4G LTE Modem and Wi-Fi
- High-Resolution Rotational Movements
- Low Power Consumption
- 8 High-Speed Analog Sensor Inputs
- 16 Vibrating Wire Inputs (Optional)
- Compact and Battery Operated
- Rugged Waterproof Enclosure

Monitor Movements Remotely



GCM8 Controller Module

Up to 8 externally mounted ATP modules can be mounted at different monitoring locations to measure displacements in the latitudinal, longitudinal and vertical directions. In addition to displacement, the R2D3 includes a 3-Axis MEMS accelerometer to measure rotational movements to 0.005 degrees.

The R2D3 Position Module can be plugged into our new GCM8 Controller Module to create a remotely operated monitoring system. The GCM8 Controller Module includes a 4G LTE cellular communication module and multi-channel, high-speed data acquisition for externally connected sensors like piezometers, geophones, accelerometers and distance meters. The GCM8 and R2D3 modules are mounted inside a small waterproof polycarbonate enclosure (6" x 8" x 4") with internal LTE antennas.

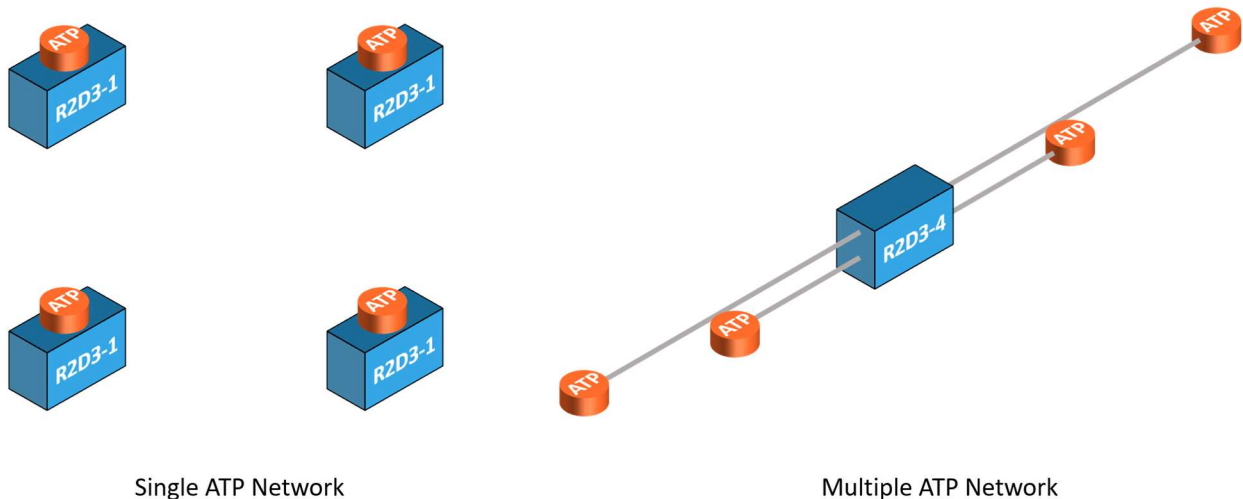


R2D3-1 Remote Monitoring Station

MODEL	DESCRIPTION
R2D3-1	Monitoring station with one externally mounted ATP module
R2D3-4	Monitoring station with 1 to 4 externally mounted ATP modules
R2D3-8	Monitoring station with 1 to 8 externally mounted ATP modules
R2D3-X-VW	Monitoring station with X ATP and 16 vibrating wire inputs

Multiple Monitoring Points

One R2D3 station can network up to 8 externally mounted low-cost ATP nodes (Active Target Points) adding multiple precision measurement points to each station which greatly expands the coverage area. This allows one R2D3 station to track movements with millimeter-level accuracy at up to 8 ATP locations, significantly lowering cost per monitoring point. The R2D3-1 station connects to one externally mounted ATP and can be installed in locations where running cable is cost prohibitive. The R2D3-4 and R2D3-8 stations multiplex several ATP locations and work well for locations where running cable is feasible like along the top of a retaining wall or an existing structure.



Whether you are monitoring existing structures, earth retention systems, pipelines, landslides, embankments, dams, levees or cut slopes, the R2D3-4 or -8 can cover up to 8 monitoring points spread out over long linear features or star-type configurations. Installation of each ATP above the ground surface is recommended whenever possible because it improves signal reception, but it is not required.

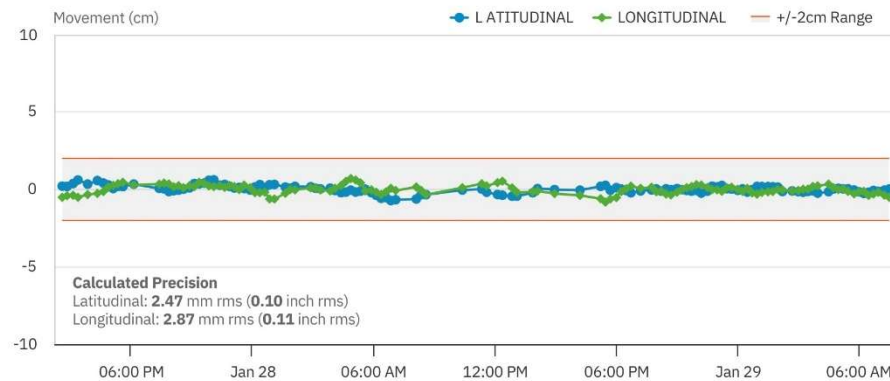


ATP – Active Target Point

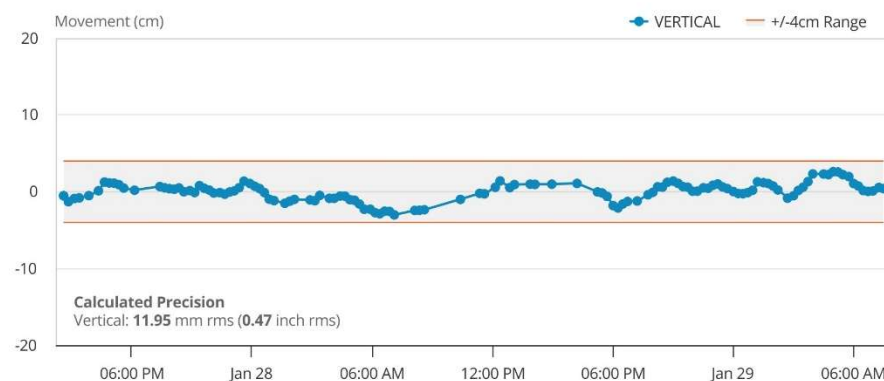
Performance Results

Horizontal and Vertical Movement

R2D3 field performance results show movement precision in both horizontal directions of 3mm rms, and vertical movement performance of 12mm rms. Performance testing was conducted with the ATP maintained in a fixed position to evaluate relative movement accuracy and precision, and the results are shown below for horizontal and vertical directions. These plots were obtained using the Geodag Web Application which provides fully reduced, real-time results.



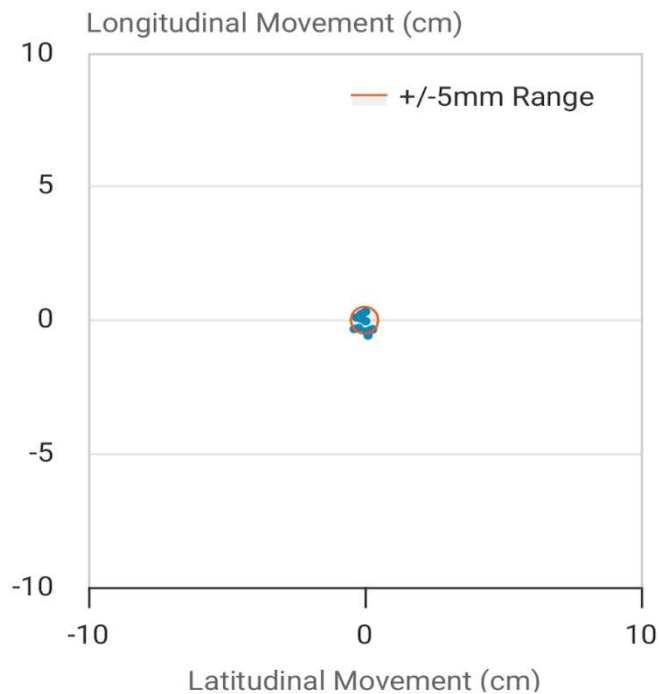
Horizontal Displacement at 15 Minute Sample Intervals



Vertical Displacement at 15 Minute Sample Intervals

Directional Movement

In addition to horizontal and vertical movement trends over time, the Geodac Web Application also presents directional movement. The directional movement shown below represents 24-hour sample interval readings over a period of 2 weeks with the ATP in a fixed position. Results indicate a horizontal precision of **2.5 mm rms**.



Directional Movement at 24-Hour Sample Interval

Monitor Additional Sensors

The GCM8 embedded in the R2D3 has significant additional monitoring capability derived from two JETDAQ modules providing 16 vibrating wire inputs and 8 static or dynamic analog voltage inputs. Each JETDAQ module has 8 analog input channels accommodating unipolar or bi-polar inputs, variable input ranges with a programmable gain amplifier (PGA), and sample rates up to 30,000 samples per second per channel on all 8 inputs. Add piezometers, displacement transducers, strain gauges, accelerometers, geophones or any other vibrating wire or voltage output sensor to compliment the GNSS absolute 3-dimensional translation and rotation movements.

Performance Specifications

Parameter	Specification
GNSS Constellations	GPS, Galileo, GLONASS, BeiDou plus SBAS and QZSS satellites
Frequencies	GPS L1/L2; GLONASS L1/L2; BEIDOU B1/B2; GALILEO E1/E5; QZSS L1/L2
Cellular	Global Cellular Coverage and Carrier Agnostic
ATP Capacity	8 external ATP inputs (1 to 8 differential GNSS measurement points)
Horizontal Precision¹	3 mm rms with differential gnss correction service
Vertical Precision¹	12 mm rms with differential gnss correction service
Rotation Direction	3-Axis XYZ directions
Rotation Resolution	+/- 0.005 degrees
Rotation Range	+/- 90 degrees each axis
Vibrating Wire Sensor Inputs (optional)	2 banks of 8 simultaneously sampled channels (total 16 vibrating wire sensors with thermistor)
Analog Sensor Inputs	8 bi-polar analog inputs, 16-bit resolution, programmable gain PGA, aggregate sample rate of 500k samples per second, input overvoltage protection +/- 20V
Internal Health Monitoring	Supply voltage, current draw, temperature and humidity
Sample Interval	5 minutes to 24 hours
Power	10V to 14V DC unregulated supply
Environmental	Polycarbonate NEMA 4X IP66
Operating Temperature	-40 to +85 degrees Celsius
R2D3 Dimensions	6 inches x 8 inches x 4 inches or 10 inches x 8 inches x 6 inches
ATP Dimensions	6 inch diameter and 2.7 inch height

(1) Accuracy and precision based on measurements with a partial clear sky view and low ionospheric index