

Procurement Ledger: Pivot Tracking Module (PMT)

Role: Kinematic/Flow Auditor | Quantity: 1,280 Units

The Pivot Tracking Module (PMT) is the primary "Hydraulic Auditor" of the FarmSense network. Positioned on the main span of the center-pivot irrigation system, it provides the kinematic and flow data necessary to verify exactly where, when, and how much water is applied to the field. This document details the high-precision procurement requirements and the logistical framework for deploying these units across Subdistrict 1.

1. Granular Hardware & Component Costs

Category	Component Description	Supplier	Part # / Type	Cost (Unit)
Housing	IP67 UV-Polycarbonate Puck	Polycase	WP-21F	\$45.00
Mounting	304-SS Band-It Straps (x2)	McMaster	5530K34	\$12.50
Mounting	Neoprene Friction Pad (Anti-Slip)	McMaster	8637K32	\$5.50
Computing	Cortex-M4 Processing Sled	Digi-Key	ATSAMD51	\$65.00
Position	u-blox ZED-F9P RTK GNSS	SparkFun	GPS-15136	\$140.00
Position	9-Axis IMU (Vibration/Tilt)	Bosch	BNO055	\$32.00
Hydraulic	Ultrasonic Transit-Time Pair	Badger Meter	Dynasonics	\$648.00
Power	10W Solar Lid + LiFePO4 Buffer	Renogy	10W-Mono	\$95.00
Power	LiSOC12 5yr Hibernation Pack	Saft	LS14500	\$25.00
Fasteners	SS M4 Security Screws (x4)	McMaster	91316A200	\$2.00
Radio	High-Gain BLE Whip Antenna	Linx	ANT-2.4-CW-HWR	\$30.00
TOTAL	Per Unit Hardware Cost			\$1,100.00

2. Engineering & Procurement Justification

- **The Ultrasonic Audit (\$648):** The single most expensive sub-component is the Badger Meter Dynasonics transducer pair. Unlike mechanical paddle-wheel meters, these transit-time ultrasonic sensors are non-invasive. They clamp to the *outside* of the 8" galvanized pivot pipe, using high-frequency sound waves to measure flow velocity through the pipe wall. This eliminates the need for pipe cutting (saving \$400/unit in welding costs) and ensures zero pressure drop in the system, which would otherwise increase the farmer's seasonal pumping electricity bill.
- **Kinematic "Crabbing" Detection:** The Bosch BNO055 IMU is fused with the u-blox ZED-F9P GNSS data to monitor the structural health of the pivot. By tracking the vibration harmonics and the "tilt" of the first span, the PMT can detect "crabbing"—a condition where a drive tower slips on muddy ground, causing alignment stress. Detecting this early prevents catastrophic pivot collapse, a failure that typically costs the grower over \$80,000 in structural repairs and crop loss.
- **Dual-Power Redundancy:** The PMT is exposed to the most extreme environmental conditions in the San Luis Valley. We utilize a Renogy 10W solar lid for primary power, but include a Saft LS14500 *LiSOCl₂* "Hibernation Pack." During the 120-day winter dormancy, the solar panel may be obscured by snow; the Saft cell ensures the PMT keeps its GNSS clock and "Home" position in memory, allowing for an instant, error-free startup in the spring.
- **Mechanical Security:** Given the high value of the u-blox and Badger components, the housing is secured with SS M4 Security Screws and clamped via 304-Stainless "Band-It" straps. The Neoprene friction pad is a critical addition; it prevents the module from "walking" or sliding down the pipe during the heavy vibrations of the pivot's drive motors.

3. Deployment Totals & Calibration Logistics (Subdistrict 1)

Deploying 1,280 PMTs requires more than just physical installation; it requires a state-certified calibration for every well source to ensure the "Digital Ledger" is legally defensible.

- **Hardware Subtotal: \$1,408,000**
 - *Reflects a 15% volume discount negotiated with Badger Meter for the bulk purchase of transducers.*
- **Calibration & Field Audit: \$57,440**
 - **Audit Process:** Every PMT must be cross-verified against a "Master Meter" during the first 48 hours of operation. This cost covers the specialized "Audit Crew" that travels from pivot to pivot with a portable high-accuracy flow rig to verify the PMT's $\pm 1.0\%$ accuracy rating.
- **Labor (Installation): \$100,000**

- **The "Band-It" Blitz:** Installation is calculated at 2 hours per unit. This involves precision cleaning of the galvanized pipe (to ensure ultrasonic coupling), mounting the stainless brackets, and performing the initial RF handshake with the field's VFA anchor. The labor rate factors in the use of specialized "Boom Trucks" required to reach the pivot spans safely.

PMT TOTAL PROJECT COST: \$1,565,440

Note: The PMT is the only component that requires an annual "Field Check" to re-apply ultrasonic couplant (grease) between the sensors and the pipe. This O&M cost is factored into