Measuring, Monitoring & Documentation Systems

The **Sensors Layer** defines all devices and measurement systems used by AOFS controllers to monitor irrigation, energy usage, water distribution, and environmental conditions. All AOFS-compliant deployments **must implement the sensors and documentation systems specified here**.

1. Sensor Categories

AOFS uses four main sensor categories:

1. **Soil Monitoring Sensors**
2. **Water Monitoring Sensors**
3. **Power / Energy Sensors**
4. **Optical / Camera Monitoring Systems**

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2. Soil Monitoring Sensors

Purpose: Measure soil conditions to optimize irrigation schedules.

Required Measurements:

- Soil moisture (volumetric water content) per zone
- Soil temperature (optional but recommended)
- Electrical conductivity (optional; for salinity monitoring)

Placement Guidelines:

- At least one sensor per irrigation zone; multiple sensors for large or heterogeneous fields
- Sensors should be placed at root depth appropriate to the crop type

Data Collection:

- Sample at a frequency suitable for crop needs (typically 15–60 min)
- Data logged locally in Field Controller and synced with Farm/HQ controllers

Calibration & Maintenance:

- Sensors must be calibrated according to manufacturer recommendations
- Regular inspection to prevent soil compaction or damage

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3. Water Monitoring Sensors

Purpose: Ensure safe and efficient water delivery.

Required Measurements:

- Tank levels: FULL and LOW float switches
- Flow meters on main and zoned pipelines
- Pressure sensors for distribution lines
- Optional: rain gauges (tipping bucket) for weather lockouts

Placement Guidelines:

- Tank sensors at critical fill/drain points
- Flow meters before distribution manifolds
- Pressure sensors after pumps and at main lines

Safety Requirements:

- Water sensors must enforce Field Controller fail-safes (pump cutoff, overflow prevention)
- Must function independently of network connection

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4. Power / Energy Sensors

Purpose: Monitor energy consumption and optimize PUE (productive use of electricity).

Required Measurements:

- DC battery voltage and current
- Pump energy consumption
- Valve power usage
- Optional: solar panel output monitoring

Placement Guidelines:

- Measure energy at the main DC bus and key loads
- Optional per-zone energy monitoring for detailed efficiency analysis

Integration:

- Data feeds into Field Controller for fail-safe shutdowns on low voltage
- Logged for auditing and analytics

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5. Optical / Camera Monitoring Systems

Purpose: Supplement sensor data with visual field observations.

Use Cases:

- Crop growth monitoring
- Pest or disease detection (optional, non-critical for irrigation)
- Soil surface moisture and coverage assessment

Requirements:

- Cameras must be oriented for optimal coverage of zones
- Images or video must be timestamped and logged
- Data should integrate with Field Controller for automated or semi-automated analysis

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6. Data Logging & Documentation

* All sensor readings **must be logged locally** on the Field Controller. * Logs include timestamp, sensor ID, measured value, and status/quality flags. * Data must be synced with Farm Controller for aggregation and with HQ Controller for analytics. * Field workers may document crop growth, harvest outcomes, and environmental observations via **Field Survey Interfaces**, complementing automated measurements.

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7. Calibration & Maintenance

* All sensors **must be regularly calibrated** according to manufacturer specifications. * Field inspections are required to prevent sensor drift, damage, or misplacement. * AOFS-compliant deployments **must maintain logs of calibration and maintenance events**.

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8. Compliance Notes

* All AOFS deployments **must implement at minimum**:

1. Soil moisture per irrigation zone
2. Tank LOW/FULL switches
3. Flow meters and pressure sensors on all irrigation manifolds
4. Power monitoring for pumps and valves

* Optional sensors (temperature, conductivity, cameras) are recommended for **advanced**

optimization, but not mandatory.

* All data must be **timestamped, logged locally, and synchronized** according to federation rules.

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9. References

* Field Controller Layer * Farm Controller Layer (Local / Federated) * Hydraulic & Water Systems * Electrical & Control Interfaces * Optical Monitoring (Cameras)

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