Sensor Digitization Guide

Analog to Modbus TCP Specifications: Physical layer engineering standards. No fluff.

1. 2-Wire vs 3-Wire Schematic Wiring

2-Wire Sensors (Loop-Powered)

These transmitters do not have a dedicated power supply. They draw power directly from the 4-20mA loop itself.

- **Wiring Path:** External 24VDC (+) → Sensor (+) → Sensor (-) → I/O Analog Input (AI) Terminal → I/O GND → 24VDC (-)
- **Engineering Rule:** You MUST wire an external industrial power supply in series. Standard Edge I/O AI terminals are passive and do not provide excitation voltage to the loop.

3-Wire & 4-Wire Sensors (Self-Powered)

These transmitters have their own dedicated power terminals (L/N or 24VDC) entirely separate from the signal lines.

- **Wiring Path:** Sensor Signal Out (+) → I/O Analog Input (AI) Terminal.
- **Crucial Step:** You MUST tie the sensor's power ground and the I/O module's ground together to establish a common voltage reference, otherwise the signal will float and output garbage data.

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2. Modbus Float Scaling Formulas

A standard 12-bit Analog-to-Digital Converter (ADC) outputs a raw integer (0-4095). To convert this raw Modbus integer into a readable engineering unit (e.g., PSI, Gallons, Celsius), apply the linear scaling formula: `y = mx + b`.

Parameter	Description
Raw_ADC	The integer value read from the Modbus register.
Min_ADC / Max_ADC	The hardware ADC limits at 4mA and 20mA (e.g., 819 and 4095 for a typical 0-20mA 12-bit chip).
Min_Eng / Max_Eng	The physical measurement range of your field sensor (e.g., 0 to 100 PSI).

The Scaling Equation:

```
Engineering_Value = [ (Raw_ADC - Min_ADC) / (Max_ADC - Min_ADC) ] × (Max_Eng - Min_Eng) + Min_Eng
```

** Note: Advanced Valtoris Edge I/O modules handle this math internally via the VirCOM utility, outputting IEEE 754 Floating Point values directly to the 4xxxx holding registers, bypassing SCADA-side scripting.*

3. EMI Shielding Standards (Preventing Ground Loops)

When running 4-20mA lines near Variable Frequency Drives (VFDs) or large motors, electromagnetic interference (EMI) can induce voltages on the line, causing SCADA readings to fluctuate wildly.

> **The Golden Rule of Analog Shielding:**
>
> According to ISA standards, twisted-pair cable shields must be grounded at **ONE END ONLY** (typically at the receiving Edge I/O module's earth ground block inside the control panel).
>
> **Why?** If you ground the shield at both the sensor chassis in the field and the control panel, you create a "Ground Loop." Because the earth potentials are slightly different at both locations, current will flow through the shield itself, acting as an antenna and destroying your 4-20mA signal accuracy.

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