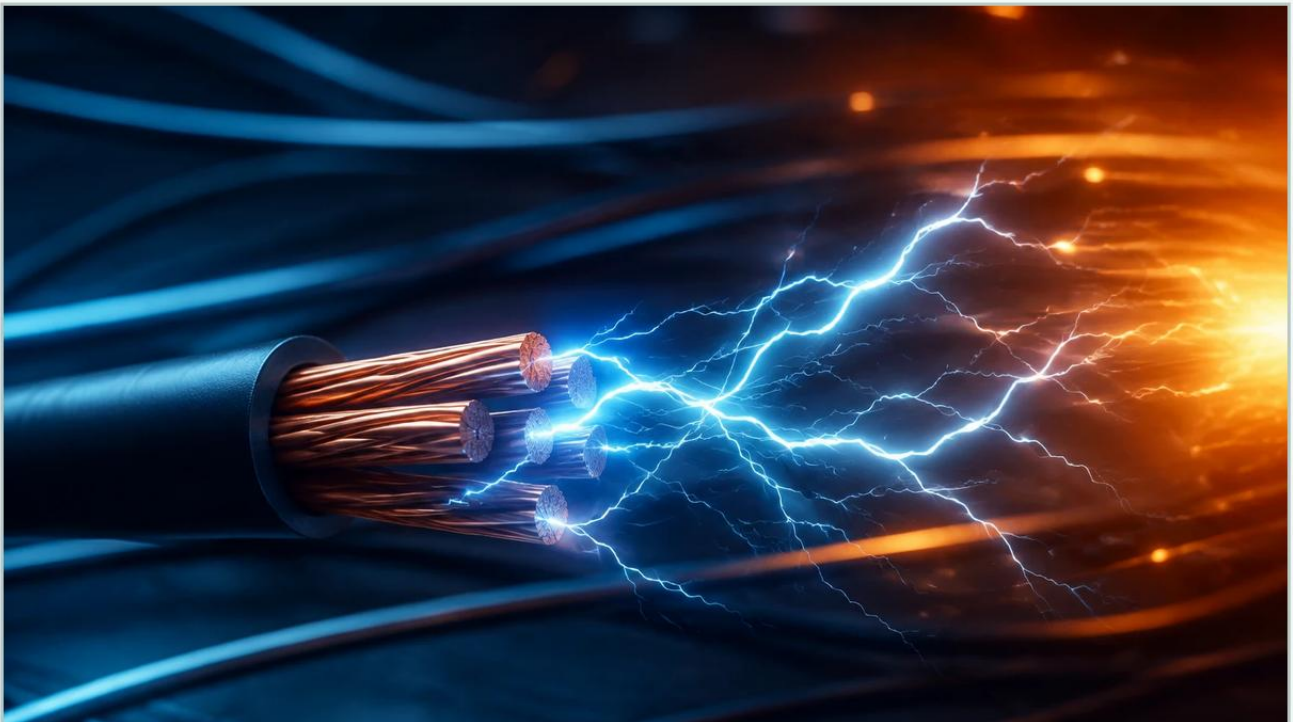


# What Is the Unit of Measure of Electric Current Flow

A practical guide to what is the unit of measure of electric current flow, covering the reader intent, the relationship to what is the unit of measure of electric current flow, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In the field of industrial automation and process control, understanding the fundamental principles of electricity is essential for the accurate implementation of measurement technologies. When engineers and technicians discuss the movement of electrical charge through a conductor, the primary question often arises: what is the unit of measure of electric current flow?

In the International System of Units (SI), the unit of measure for electric current flow is the Ampere, often shortened to "amp" and symbolized by the letter A. This unit is foundational to the operation of almost every industrial sensor, including the radar level meters and ultrasonic sensors used to monitor tank levels in chemical plants and water treatment facilities. This article provides a comprehensive technical overview of electric current measurement, its application in industrial level instrumentation, and the practical considerations for maintaining signal integrity in 4-20mA loops.

## **| Understanding the Physics of Electric Current**

To answer "what is the unit of measure of electric current flow" in a technical context, one must look at the rate of charge displacement. Electric current is defined as the rate at which electric charge flows past a specific point in a circuit.

## **| The Ampere Defined**

One Ampere represents a flow of one Coulomb of electrical charge per second. Quantitatively, this can be expressed by the formula:

$$I = Q / t$$

Where:

I is the current in Amperes (A).

Q is the electric charge in Coulombs (C).

t is the time in seconds (s).



In practical industrial terms, current is the "flow rate" of electricity, analogous to the liters per minute (L/min) flowing through a pipe. Just as a flow meter measures the volume of liquid passing through a cross-section, an ammeter or a process controller measures the quantity of electrons passing through the copper wiring of an instrument loop.

## **| Direct Current (DC) vs. Alternating Current (AC)**

In industrial level measurement, two types of current flow are prevalent:

1. Direct Current (DC): The flow of electrons is in a single, constant direction. Most industrial sensors, such as hydrostatic level transmitters, operate on DC power (typically 24V DC) and provide a DC signal output.
2. Alternating Current (AC): The direction of the flow reverses periodically. AC is primarily used for the main power supply of heavy machinery and plant infrastructure but is rarely used as a signal carrier for sensitive level measurement instruments due to potential interference.

## **| The Role of Current in Industrial Level Measurement**

While the Ampere is the standard unit, industrial instrumentation most frequently utilizes a subset of this unit: the milliampere (mA), where 1,000 mA equals 1 Ampere. The 4-20mA current loop is the global standard for transmitting analog signals from field sensors to a control room.

## **| Why Use Current Instead of Voltage?**

When selecting equipment from a Main Page of industrial instrumentation, you will notice that 4-20mA is preferred over 0-10V signals for several technical reasons:

**Immunity to Voltage Drop:** Current remains constant throughout a series circuit. Unlike voltage signals, which drop over long cable runs due to the internal resistance of the wire, a 4-20mA signal maintains its accuracy over hundreds of meters.

**Noise Resistance:** Current loops are inherently more resistant to electromagnetic interference (EMI) from motors and heavy equipment, which is common in industrial environments.

**Live Zero (Fault Detection):** By using 4mA to represent the "zero" or minimum level (instead of 0mA), the system can distinguish between a low measurement and a broken wire. If the current drops to 0mA, the controller immediately identifies a loop failure.

## **| Measurement Principles in Level Instruments**

Industrial level meters, such as those manufactured by Welk, convert physical properties into an electrical current signal. The process varies depending on the technology used:

### **| 1. Radar and Ultrasonic Level Meters**

These non-contact sensors measure the time-of-flight of a signal (microwave or sound) reflecting off a material surface. The internal microprocessor calculates the distance and scales it to a 4-20mA output. For instance, in a 10-meter tank, 4mA would represent 0 meters (empty) and 20mA would represent 10 meters (full).

### **| 2. Hydrostatic Level Transmitters**

These sensors measure the pressure exerted by a liquid column. A pressure-sensitive diaphragm converts the mechanical force into a proportional electrical signal, which is then regulated into a current flow within the standard 4-20mA range.

### **| 3. Magnetic Level Gauges with Transmitters**

In these systems, a float containing a magnet moves with the liquid level. A reed chain or magnetostrictive sensor mounted outside the chamber detects the float's position and converts that position into a current signal for remote monitoring.



## Technical Selection Criteria for Current-Loop Sensors

When designing a system that utilizes electric current flow for data transmission, engineers must evaluate several criteria to ensure accuracy and reliability.

| Feature               | 4-20mA Analog Loop        | RS485 / Modbus (Digital) | 0-10V Analog                |
|-----------------------|---------------------------|--------------------------|-----------------------------|
| Transmission Distance | Excellent (up to 1000m+)  | Excellent (up to 1200m)  | Poor (Short distances only) |
| Noise Immunity        | High                      | High                     | Low                         |
| Wiring Complexity     | Low (2-wire)              | Moderate (Shielded pair) | Low (3-wire)                |
| Power Requirement     | Loop-powered possible     | Requires separate power  | Requires separate power     |
| Fault Diagnostics     | Basic (Low/High burn-out) | Advanced (Error codes)   | None                        |

## Loop Resistance and Power Supply

To maintain a consistent current flow, the power supply must provide enough voltage to overcome the total resistance (load) of the loop. This includes the resistance of the sensor itself, the wires, and the input resistance of the PLC (Programmable Logic Controller).

Calculation Example:

If a sensor requires a minimum of 12V to operate and the PLC has a 250-ohm input resistor, at 20mA (0.02A), the voltage drop across the resistor is:

$V = I \times R = 0.02A \times 250\Omega = 5V$

$\text{Total Voltage Required} = 12V \text{ (Sensor)} + 5V \text{ (PLC)} = 17V$

A standard 24V DC power supply is therefore sufficient for this application.

## | Installation and Maintenance Considerations

To ensure that the unit of measure of electric current flow remains accurate and free from distortion, proper installation is critical.

1. **Cable Selection:** Use twisted-pair shielded cables. The twisting cancels out electromagnetic induction from external sources, while the shield drains electrostatic noise to the ground.
2. **Grounding:** Ensure the shield is grounded at only one point (usually the control room side) to prevent ground loops, which can introduce stray currents into the measurement.
3. **Proper Termination:** Loose connections increase resistance, which can cause the current to fluctuate or the transmitter to lose power.
4. **Signal Isolation:** In environments with heavy electrical noise, use signal isolators to prevent high-voltage transients from damaging sensitive measurement electronics.

## | Troubleshooting Current Flow Issues

If a level meter provides erratic readings, the first step is to measure the actual current flow using a digital multimeter (DMM).

**Measuring in Series:** Break the loop and insert the DMM in series. This provides a direct reading in mA.

**Measuring via Test Points:** Many modern transmitters include test terminals that allow for measurement without breaking the circuit, preventing process downtime.

## | Limitations and Environmental Factors

While current-based transmission is robust, it is not without limitations:

**Temperature Effects:** Extreme temperatures can affect the resistance of copper wiring. While the current loop compensates for this, extreme heat can degrade the insulation over time.

**Intrinsic Safety:** In explosive environments (oil and gas), current flow must be strictly limited using Zener barriers or galvanic isolators to prevent sparks that could ignite flammable vapors.

**Bandwidth:** Standard 4-20mA loops can only transmit one primary variable. For multi-variable data (e.g., level plus temperature), digital protocols like HART (Highway Addressable Remote Transducer) must be superimposed on the current signal.

## **| Frequently Asked Questions (FAQ)**

**Q:** Can I use a regular voltmeter to check a 4-20mA signal?

**A:** Not directly. To check a current signal with a voltmeter, you must measure the voltage drop across a known resistor (usually 250 ohms) in the circuit. A 1-5V reading across a 250-ohm resistor corresponds to 4-20mA.

**Q:** What happens if the current flow exceeds 20mA?

**A:** Most transmitters are designed to "clamp" the signal at a slightly higher value (e.g., 20.5mA or 22mA) to indicate an over-range condition or a specific sensor error (NAMUR NE43 standard).

**Q:** Is the Ampere the same as the Coulomb?

**A:** No. The Coulomb is a unit of electric charge (quantity), while the Ampere is a unit of current (rate of flow). One Ampere is one Coulomb per second.

**Q:** Why is 4mA used as the bottom of the scale instead of 0mA?

**A:** 4mA provides a "live zero." If a wire breaks, the current drops to 0mA, which the controller recognizes as a fault. If 0mA were the valid signal for "empty," the system could not distinguish between an empty tank and a broken wire.



## **| Conclusion**

Identifying what is the unit of measure of electric current flow is the first step in mastering industrial instrumentation. The Ampere, and specifically its derivative the milliampere, serves as the backbone of process communication. Whether you are deploying radar level meters for corrosive chemicals or hydrostatic sensors for deep-well monitoring, the integrity of the current flow determines the reliability of your data. By adhering to proper loop calculations, shielding practices, and selection criteria, engineers can ensure that their level measurement systems operate with maximum precision and minimal downtime. For further technical specifications on current-loop compatible sensors, professionals are encouraged to review available documentation and application guides.