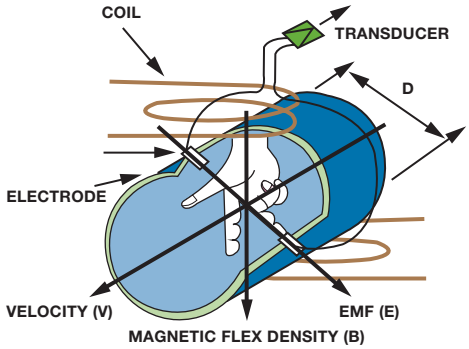
ADI Electromagnetic Flow Meter Solutions

System Theory and Typical Architecture of Industrial Electromagnetic Flow Meters

The operating principle of the electromagnetic flow meter is based on Faraday's law of electromagnetic induction. When the magnetic field direction perpendicular to the conductor cutting magnetic line is speed V, both ends of the conductor will be induced by a certain force E, and the liquid flow rate change can be calculated by detecting the value of the force.

The features of electromagnetic flow meters are no pressure loss and no impact from viscosity, fluid density, temperature, pressure, or conductivity, making it suitable for measuring pulp, slurry, and sewage with high accuracy.

An electromagnetic flow meter system consists of power supplies, magnetic excitation, signal conditioning, analog-to-digital conversion, processor, display, keyboards, logic I/Os, and multiple communications like 4 mA to 20 mA, HART, Profibus, RS-485/RS-422/RS-232, Modbus, and Foundation.



$E = K \times B \times V \times D$
K is instrument constant
B is magnetic flex density
V is average fluid velocity across the pipe
D is diameter of measurement pipe

System Design Considerations and Major Challenges of Industrial Electromagnetic Flow Meters

To appropriately design an electromagnetic flow meter system, designers must consider many different system requirements, including accuracy, bandwidth, and magnetic excitation frequency.

- Electromagnetic flow meter sensor output ranges can be as small as several tens of μV with a certain common voltage. The output impedance is often higher than the MΩ range. The front-end precision operational amplifier or instrumentation amplifier requires ultrahigh input impedance, very low leakage current, and excellent CMRR.
- Electromagnetic flow meter product maximum measurement range can be as wide as 1500:1, and the range for corresponding flow rate is 0.01 m/s to 15 m/s.
- Measurement accuracy can be as high as 0.2% of reading, which often requires a 16-bit to 24-bit analog-to-digital converter.
- Connectivity to different fieldbus protocols, such as HART, Profibus, Modbus, Foundation, RS-485/RS-422/RS-232, and wireless HART.
- Isolation needed between system power supply, central logic unit, communication, and I/Os. Isolation grade varies from 1 kV to 2.5 kV.
- Portable electromagnetic flow meters require ultralow power MCU, amp, and ADC components.
- Higher frequency square wave excitation improves the flow of mud and noise immunity, but needs to be balanced with zero stability.

Industrial site temperature environments are quite complex and sometimes even extremely adverse. Low temperature drift coefficient and low power consumption are very important for electromagnetic flow meters to withstand a wide working temperature range. ADI offers a complete portfolio such as precision amplifiers, precision references, precision analog-to-digital converters, and ARM core microprocessors.

Also, EMC interference immunity, such as for ESD, EFT and surge, is a big challenge for electromagnetic flow meters. The high level ESD immunity components offered by ADI greatly help to improve its reliability and robustness.

In addition, the limited space inside electromagnetic flow meters requires dense systems. Therefore, the form factor has to be reduced to accommodate this. Recently, advances in integration have allowed system designers to migrate to smaller, lower power, lower cost solutions, with performance approaching that of larger systems. The challenge moving forward is to continue to drive the integration of these solutions while increasing their performance and diagnostic capabilities.

ADI offers market tailored solutions to aid in the design process. These solutions feature our industry-leading technologies and offer a range of design options: from implementation of discrete components to fully integrated solutions and everything in between.

Total Solutions from ADI

Leverage ADI amplifier, data conversion, signal processing, communications, and power technology and expertise to design high resolution, low noise industrial electromagnetic flow meter systems.