

# Multiparameter Water Quality Monitor

## Application Introduction

For water quality monitor, Analog Devices offers a highly integrated multiparameter measurement solution based on a powerful on-chip system that controls and measures electrochemical sensors and biosensors. With an integrated, ultra low power ARM® Cortex®-M3 processor and multichannel analog front end, the on-chip product can simultaneously connect multiple electrodes and cyclically measure multiple parameters via a programming state machine. It can realize the measurements of five routine parameters integrated into a single platform, including temperature (TEM), dissolved oxygen (DO), electrical conductivity (EC), pH, and turbidity.

## System Design Considerations

### Compatibility

With multiple probes immersed in the tested liquids, the excitation signal and the measured signal will interfere with each other through the liquid. The independent measurement loop and noise reduction methods are the key to ensure the compatibility between multiple measurement modes.

### Range

Some indicators of different tested liquids vary greatly. Adaptive parameter adjustment is the main way to extend the measurement range while ensuring resolution.

### Accuracy

As the life of probes are usually short, effective calibration of probe parameters, and storage of calibration results can help judge electrode quality and ensure measurement accuracy.

### Reliability

Long-term stability is an important factor. To achieve this, a low drift signal chain and power-on system calibration are needed for a reliable water quality monitor.

## Diagnostic

When it comes to sensor safety, ADI has advanced sensor diagnostic capabilities, such as high speed waveform generators and impedance spectroscopy engine.

## ADI Solution Value Proposition

Compared to the traditional discrete device solution, this solution based on a powerful, one-chip platform can minimize the number of chips required. It can effectively reduce costs, power consumption, and volume, while providing good noise performance and high precision measurement results. This application is suitable for the development of multiparameter monitors, the digitization of probes, and the research of pH probe life diagnosis in the field of water quality monitoring.

## Highlight Features

- ▶ Single platform, multiparameter monitoring integrated with multiple independent measurement loops
- ▶ System calibration capability and adaptive parameter adjustment
- ▶ Probe diagnostic capability (pH probe impedance measurement) and probe digitalization reference design
- ▶ Low power, small size, and high accuracy
- ▶ Especially suitable for portable application with power supply measurement by [ADuCM355](#)
- ▶ Isolation of both power and digital interface

## System Block Diagram and Signal Chain

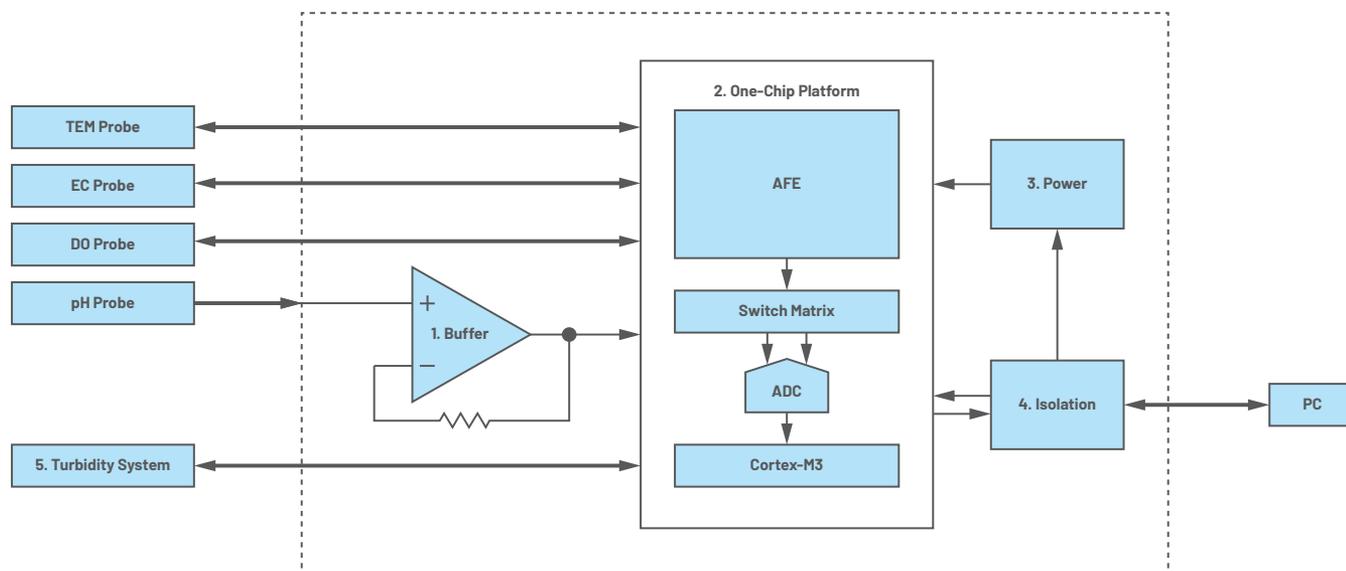


Figure 1. Multiparameter water quality monitor system block diagram.

Note: The signal chains above are representative of the system block diagram of multiparameter water quality monitor design. The technical requirements of the

blocks vary, but the products listed in the table below are representative of ADI's solutions that meet some of those requirements.

Table 1. Sub-Block of System

1. Buffer	2. One-Chip Platform	3. Power	4. Isolation	5. Turbidity System
LTC6078	ADuCM355	ADP122	ADuM5211	ADP7105/ADPD105/LTC4313

Table 2. Main Products

Part Number	Description	Benefits
LTC6078	Dual/quad, low offset, low noise operational amplifiers with low power consumption and rail-to-rail input/output swing	Maximum offset voltage of 25 $\mu\text{V}$ (25 $^{\circ}\text{C}$ ); maximum offset drift of 0.7 $\mu\text{V}/^{\circ}\text{C}$ ; maximum input bias of 1 pA (25 $^{\circ}\text{C}$ ), 50 pA ( $\leq 85$ $^{\circ}\text{C}$ )
ADuCM355	On-chip system that controls and measures electrochemical sensors and biosensors; an integrated ultralow power ARM Cortex-M3 processor and multichannel analog front end; features include current, voltage, and impedance measurement capability	26 MHz features; current, voltage, and 128 kB Flash/64 kByte SRAM and advanced security features; current, voltage, and impedance measurement, two ultra low noise, always-on potentiostat loops, up to 200 kHz precision impedance spectroscopy loop, switch matrix/flexible 16-bit receive channel
ADP122	Low quiescent current, low dropout linear regulators	Very low dropout voltage: 85 mV at 300 mA load; Low quiescent current: 45 $\mu\text{A}$ at no load
ADuM5211	Dual-channel digital isolators with <i>isoPower</i> <sup>®</sup> , an integrated, isolated dc-to-dc converter	High common-mode transient immunity: >25 kV/ $\mu\text{s}$
ADP7105	CMOS, low dropout (LDO) linear regulator that operates from 3.3 V to 20 V and provides up to 500 mA of output current	Low dropout voltage: 350 mV at 500 mA; low quiescent current: 900 $\mu\text{A}$ at $V_{\text{IN}} = 10$ V, $I_{\text{OUT}} = 500$ mA
ADPD105	Highly efficient, photometric front ends, each with an integrated 14-bit analog-to-digital converter (ADC) and a 20-bit burst accumulator that works with flexible light emitting diode (LED) drivers	Flexible sampling frequency ranging from 0.122 Hz to 3820 Hz; three 370 mA LED drivers, multifunction photometric front end
LTC4313	Hot swappable 2-wire bus buffer that provides bidirectional buffering while maintaining a low offset voltage and high noise margin up to 0.3 $V_{\text{CC}}$	Bidirectional buffer increases fanout; level shift 1.5 V, 1.8 V, 2.5 V, 3.3 V, and 5 V buses compatible with noncompliant I <sup>2</sup> C devices that drive a high $V_{\text{OL}}$

## Design Resources

### Key Products

- ▶ Precision Analog Microcontroller with Chemical Sensor Interface ADuCM355 [analog.com/aducm355](http://analog.com/aducm355)
- ▶ High Precision, Impedance, and Electrochemical Front End AD594x [analog.com/AD5940](http://analog.com/AD5940)

### Eval Tools

- ▶ Multiparameter water quality monitoring boards [analog.com/cn0428](http://analog.com/cn0428)



Figure 2. Water quality measurement system with AD594x (CN-0428).

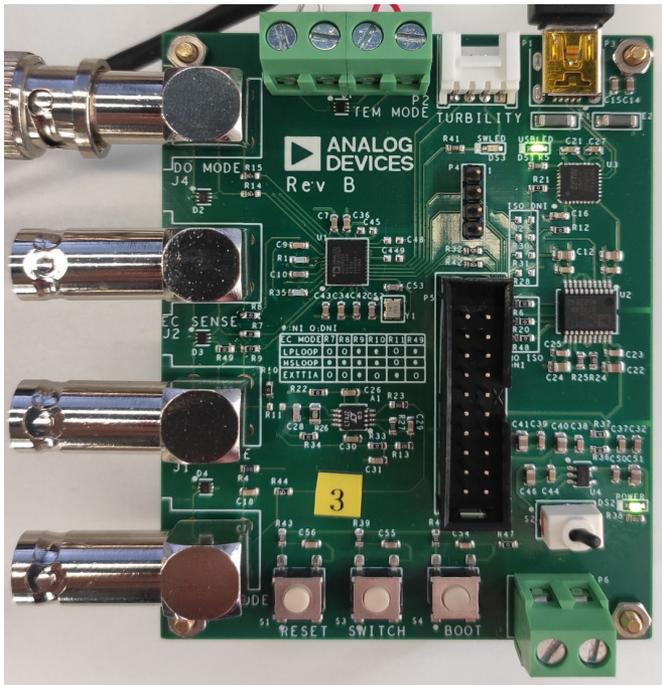


Figure 3. Multiparameter water quality monitor system with ADuCM355.

### Reference Design

- ▶ Water Quality Measurement System (CN-0428) [analog.com/CN0428](http://analog.com/CN0428)
- ▶ Low to High Level Water Turbidity Measurement System (CN-0409) [analog.com/CN0409](http://analog.com/CN0409)

### Application Article

- ▶ Wireless Water Quality Monitoring System [analog.com/en/analog-dialogue/articles/wireless-water-quality-monitoring-system.html](http://analog.com/en/analog-dialogue/articles/wireless-water-quality-monitoring-system.html)

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