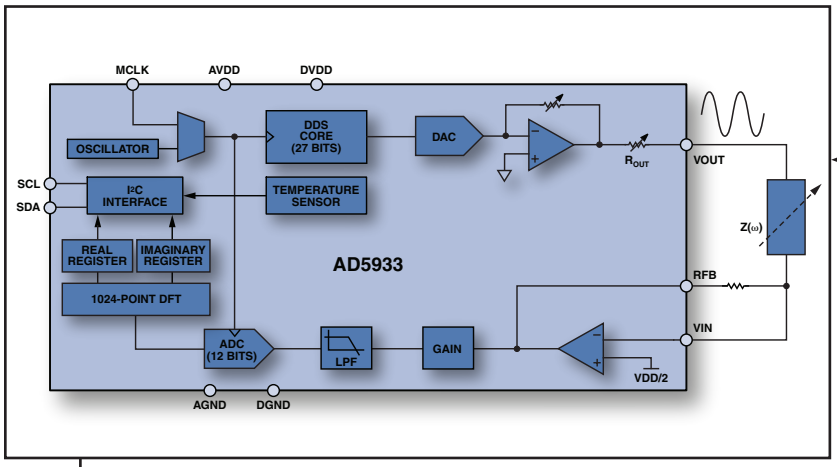
Impedance-to-Digital Converters—Compact and Easy to Use



Integrated Impedance Converter for Complex Measurements

Traditional solutions for impedance measurement involve the design of complex sampling systems, consisting of many discrete components. The AD5933 provides a single chip system level solution for impedance conversion. This integrated solution delivers unprecedented levels of precision and accuracy, available in a small package, requiring less design time, and at lower overall cost and power. This advanced level of integration is particularly important when processing small signals where excess noise, component tolerances, and temperature drift can adversely impact measurement accuracy. The AD5933 combines an on-board frequency generator and a 12-bit, 1 MSPS ADC for data collection, with integrated Fourier processing to measure the impedance, extracting real and imaginary components of the response signal at each frequency point. This compact and optimized converter is an ideal solution for industrial, instrumentation, automotive, and biomedical impedance sensing applications.

Key Features

- Single supply, 2.7 V to 5.5 V range
- Internal system clock option
- Impedance measurement range from 100 Ω to 10 MΩ[1]
- Excitation frequency up to 100 kHz, resolution <0.1 Hz[2]
- System accuracy of 0.5% typical
- Temperature range –40°C to +125°C
- Serial I²C® interface
- Selectable output peak-to-peak voltage
- Phase measurement capability
- DDS provides fine frequency excitation based on predefined frequency parameters
- Data output as real and imaginary components allowing phase and impedance magnitude to be calculated

Key Benefits

- Ease of use/integrated solution
- Eliminates need for discrete solution
- All on-chip IC functions designed to provide synchronized optimal system performance over temperature
- Compact 16-lead SSOP package

Applications

- Electrochemical impedance analysis
- Proximity/inductive transducers/metal detection
- Loudspeaker impedance measurement
- Biomedical impedance analysis
- Liquid/concentration analysis

[1]To use device to measure impedance outside this range, contact factory.

[2]To use this device at frequencies outside these ranges, contact factory.

Impedance-to-Digital Converters

Part Number	Impedance Range[1]	System Accuracy	Power Supply	Temperature Range	Sampling Speed	On-Chip Oscillator	Temp Sensor	Price @ 1k ($U.S.)
AD5933	100 Ω to 10 MΩ	0.5% typ	2.7 V to 5.5 V	–40°C to +125°C	1 MSPS	Yes	Yes	6.65
AD5934	100 Ω to 10 MΩ	0.5% typ	2.7 V to 5.5 V	–40°C to +125°C	250 kSPS	No	No	4.35

[1]Lower range can be reduced—see Application Note AN-848.

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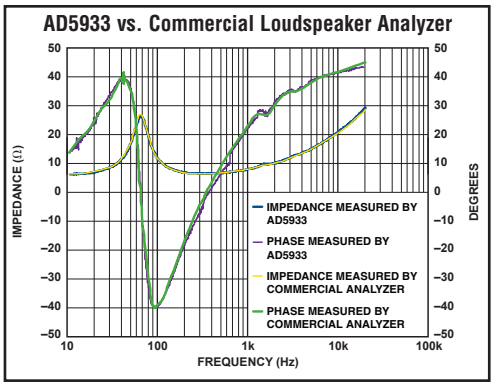
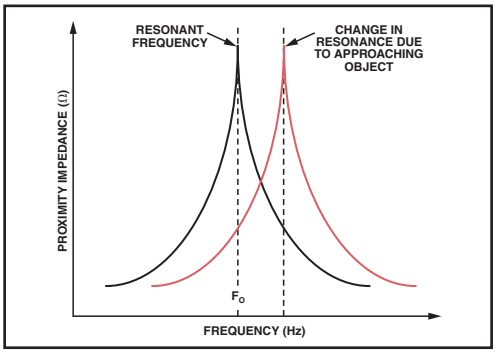
Loudspeaker Impedance Measurement

To date, various measurement tools are used in loudspeaker impedance measurement ranging from simple test equipment (e.g., oscilloscopes, voltmeters, signal generators, etc.) to PC sound cards and expensive audio network analyzers. A fundamental limitation exists. The impedance measurement apparatus remains separate from the audio system driving the loudspeaker. Now, by using the AD5933, these measurements can be incorporated in the audio chain. For example, at system power-up, the loudspeaker impedance and acoustics can be compared to a stored (calibrated) profile, changes measured, and diagnostic tests performed.

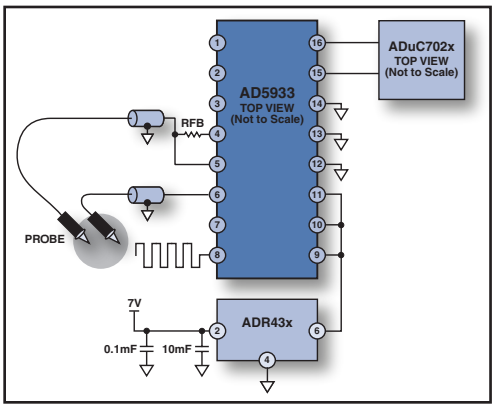




Proximity/Metal Detection Sensors

The AD5933 enables the user to examine impedance changes due to induced effects over a range of frequencies. This provides a more accurate result than a single point measurement and allows the optimal operating point to be determined. There are a number of useful applications:

- *Proximity or presence detection*—The magnetic field of an approaching or stationary object impacts resonant frequency of a detection coil.
- *Metal recognition*—The permeability of a material impacts the impedance of a detection coil.



Biomedical Applications for Impedance Sensing

Sample analysis—Accurate, fast, and affordable analysis of the constituent component of liquids and samples is of prime interest for medicine and research. The AD5933 is used to apply a user-selectable frequency stimulus signal through the sample and captures impedance changes based on changes induced in the sample.

Application Notes

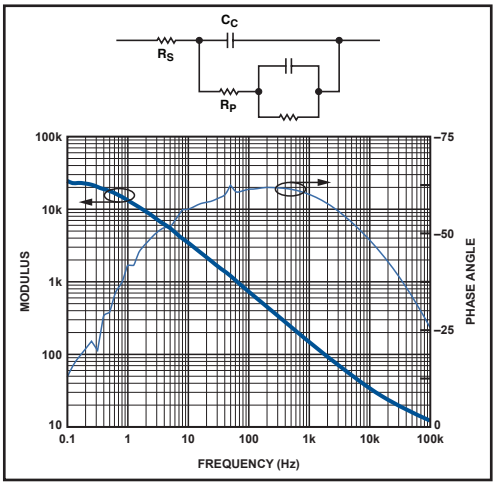
For applications notes on these subjects and more, visit *www.analog.com/IDC*.

Electrochemical Impedance Spectroscopy (EIS)

Corrosion monitoring—The AD5933 enables a compact in-situ or hand-held solution for corrosion monitoring systems. Pipelines and storage tanks are subject to corrosion and the environmental and cost implications of undetected deterioration are severe. The corrosion process can be modeled as an equivalent circuit and impedance spectroscopy allows the evaluation of the state of corrosion and the corrosion process.

AD5933/AD5934 Demonstration and Design Tool

This tool is both a demonstration and a design tool for the AD5933 and AD5934 impedance converter/network analyzer products. In the default (start-up) mode, it demonstrates the steps needed to configure and use the device. A design mode is also available which permits free control of the user interface and the calculation of values for programming the internal registers.



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