# ADI's Solution for Ultrasonic Non-Destructive Testing

## Application Introduction

Non-destructive testing (NDT) is a wide group of analysis techniques used in science and industry to evaluate the properties of a material, component, or system without causing damage or permanent alteration. Because it is a valuable technique that can save both money and time, it is widely used in product evaluation, troubleshooting, and research in many fields, such as mechanical engineering, electrical engineering, and civil engineering. Common NDT methods include ultrasonic testing, magnetic particle inspection, liquid penetrant testing, radiographic imaging, remote visual inspection, and eddy-current testing. This article will focus on ultrasonic test equipment, which is the most popular instrument in NDT and can also be used to measure thickness.

## System Design Considerations and Major Challenges

Historically, the large number of high performance transmitters and receivers required to implement these imaging systems resulted in large and expensive implementations. Recently, advances in integration have allowed system designers to migrate to smaller, lower cost, and more portable imaging solutions to be used in the field much easier. The challenges moving forward are to continue to drive the integration of these solutions, while increasing their performance and diagnostic capabilities, as shown below.

- Higher integration to reduce the size and power consumption for portable instruments—extends the battery life and makes it easier to use in the field.
- Heat dissipation is an important issue for miniaturized devices, particularly when improved image quality is the goal.
- Higher transmit voltages are needed to improve signal single word and for harmonic imaging. The acoustic power grows as the transmit voltage is increased.

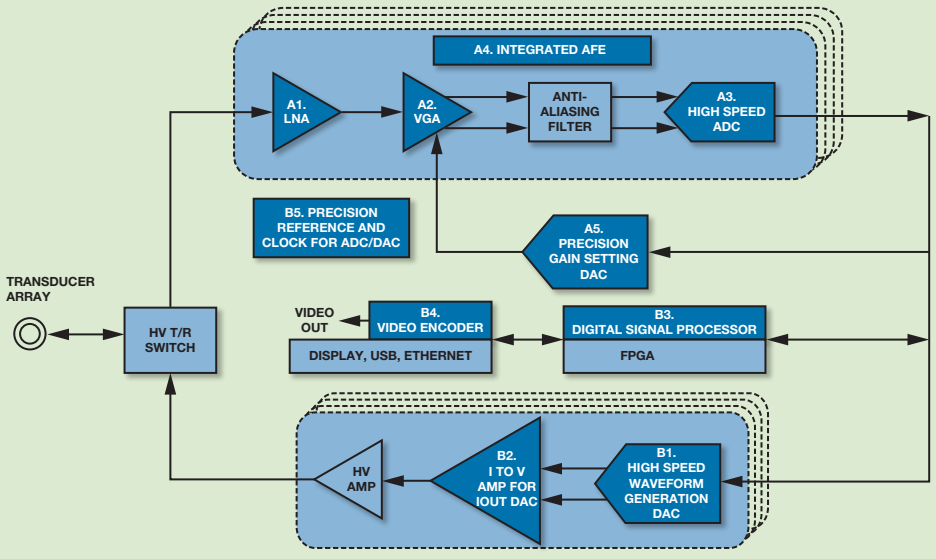
## Solutions from ADI

### ADI Solution Value Proposition

- One stop shopping to provide the broadest product portfolio for both signal processing and power conversion, including amplifiers, converters, regulators, and digital signal processors.
- Extensive design resources, like easy-to-use simulation tools (ADIsimPower,™ ADIsimADC,™ DiffAmpCalc,™ ADIsimCLK™), Circuits from the Lab,® forums in ADI's EngineerZone® website, technical articles, and fully populated evaluation boards.
- ADI's product compatibility supports design migration across multiple platforms, such as pin-compatible high speed ADCs and DACs for different sample rates and resolutions.

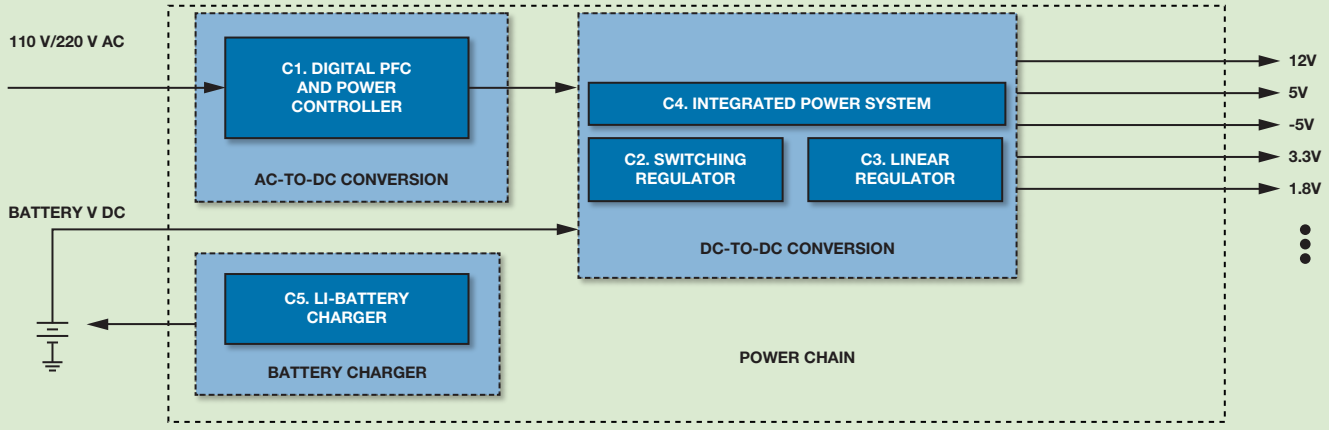
### System Block Diagram

The diagram below is the main signal processing chain of an ultrasonic NDT device.



| A1. LNA (Low Noise Amplifier) | A2. VGA (Variable Gain Amplifier) | A3. High Speed ADC | A4. Integrated AFE | A5. Precision Gain Setting DAC |
|---|---|---|---|---|
| ADA4897-1/ADA4897-2/ ADA4898-1/ADA4898-2/ ADA4895-2/ADA4896-2/ ADA4899-1 | AD8334/ AD8332/ AD8331 | AD9257/ AD9637/ AD9222 | AD9272/AD9273/AD9276/ AD9277/AD9278/AD9279/ AD9670/AD9671 | AD5684R/ AD5685R/ AD5694R/ AD5695R |
| **B1. High Speed Waveform Generation DAC** | **B2. I-to-V Amplifier for Current Output DAC** | **B3. Digital Signal Processor** | **B4. Video Encoder** | **B5. Precision Reference and Clock for ADC/DAC** |
| AD9704/AD9705/ AD9706/AD9707/ AD9106 | ADA4898-1/ADA4898-2/ ADA4927-1/ADA4927-2/ ADA4937-1/ADA4937-2 | ADSP-BF522/ADSP-BF524/ ADSP-BF526/ADSP-BF606/ ADSP-BF607 | ADV7390/ADV7391/ ADV7392/ADV7393 | ADR3420/ ADR4525/ AD9515 |

The diagram below is the typical power chain of an ultrasonic NDT device, which can be both battery powered and ac powered.




| C1. Digital PFC and Power Controller | C2. Switching Regulator | C3. Linear Regulator | C4. Integrated Power System | C5. Li-Battery Charger |
|---|---|---|---|---|
| ADP1046/ ADP1047/ ADP1851 | ADP2384/ ADP2386/ ADP2441 | ADP7104/ ADP7102 | ADP5040/ ADP5041 | ADP5061/ ADP5065 |

Note: The signal chains above are representative of ultrasonic NDT device 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.

## Major Product Introductions

| Part Number | Description | Benefits |
|---|---|---|
| ADA4896-2/ ADA4897-1/ ADA4897-2 | Dual/single/dual low wideband noise 1 nV/√Hz and 2.8 pA/√Hz ; low 1/f noise 2.4 nV/√Hz @ 10 Hz, 80 mA output current, rail-to-rail output (ADA4897-1 and ADA4897-2 have extra disable pins) | Suitable for ultrasound CW path I/V, summing, and ADC driver application |
| AD8331/ AD8332/ AD8334 | Single/dual/quad ultralow noise 48 dB VGAs with preamplifier and programmable RIN; $V_N$ RTI = 0.74 nV/√Hz; $I_N$ RTI = 2.5 pA/√Hz, bandwidth = 100 MHz | Precise linear-in-dB, excellent gain matching and bandwidth uniformity suitable for ultrasound applications |
| AD9257 | Eight channels of 14-bit, 65 MSPS serial LVDS ADC pin-to-pin compatible with 12-bit version, AD9637 pin similar to AD9252/AD9222 octal family | Small package, pin-to-pin compatible series can be flexibly selected |
| AD9106 | Quad, 12-bit, 175 MSPS DAC integrating 4096 × 12 on-chip pattern memory for complex waveform generation with one output direct digital synthesizer (DDS) and SPI interface to configure and load waveform data | Suitable for ultrasound linear transmit signal waveform generation and also transmit beamformer. Small size and low power consumption |
| AD9706 | 12-bit current output DAC, update rate: 175 MSPS. Pin-to-pin compatible with 8-bit/10-bit/14-bit versions, AD9704/AD9705/AD9707 | Small package, pin-to-pin compatible series can be flexibly selected |
| ADP2384/ ADP2386 | 20 V $V_{IN}$ range, 4 A/6 A, ultrahigh efficiency, fully integrated switching synchronous regulator | Low power consumption and high integration |

## Major Product Introductions (Continued)

| Part Number | Description | Benefits |
|---|---|---|
| ADP7102/ ADP7104 | 20 V $V_{IN}$ range, ultralow noise, 300 mA and 500 mA LDO low noise performance 15 μV rms for fixed voltage output, high PSRR 60 dB at 10 kHz, reverse current protection, wide range voltage input 3.3 V to 20 V | Improves performance of noise sensitive loads |
| ADP5041 | Power management unit (PMU), one 1.2 A buck, two 300 mA LDOs, supervisory, watchdog, manual reset | Integration makes design easier and BOM cost lower |
| ADSP-BF522/ ADSP-BF524/ ADSP-BF526 | Digital signal processor (Blackfin®), 400 MHz fixed point DSP, flexible peripheral options of USB 2.0 OTG and 10/100 Ethernet MAC | Ultralow standby power, cost-performance-ratio (MIPS/$) leadership |
| ADSP-BF606/ ADSP-BF607 | Dual core digital signal processor (Blackfin), 800 MHz/1 GHz DSP performance, flexible peripheral options of USB 2.0 OTG and 10/100 Ethernet MAC | High performance, big internal memory, low power, and high integration |
| ADV7390/ ADV7391/ ADV7392/ ADV7393 | ADV7390/ADV7391/ADV7392/ADV7393 are a family of high speed video encoders on single monolithic chips. Three 2.7 V/3.3 V 10-bit video DACs provide support for composite (CVBS), S-Video (Y/C), or component (YPrPb/RGB) analog outputs in either standard-definition (SD) or high-definition (HD) video formats | Low power consumption, suitable for ultrasound image display |
| AD9272/ AD9273/ AD9276/ AD9277/ AD9278/ AD9279 | Eight channels of LNA with 42 dB VGA, AAF with LPF 8 MHz to 18 MHz and HPF, and 12-bit, 10 MSPS to 80 MSPS ADC | Integrated small size and ease of use analog front-end chip with options of cost, noise, and power |
| AD9670/ AD9671 | Eight channels of LNA with 45 dB VGA, AAF with LPF 8 MHz to 18 MHz or 13.5 MHz to 30 MHz and HPF, 14-bit, 10 MSPS to 125 MSPS ADC. 130 mW/ch @ 40 MSPS | AD9670: low cost, low noise, high resolution, small size, reduces FPGA. I/O and computational rate for beam former and processors. AD9671: Four configurable 5 Gbps serial JESD204B CML data lanes provide an interface for further data processing. Reduces the number of FPGA I/O and components |

## Design Resources

### Circuits from the Lab

- Powering the AD9272 Octal Ultrasound ADC/LNA/VGA/AAF with the ADP5020 Switching Regulator PMU for Increased Efficiency (CN0135)
  *www.analog.com/CN0135*
- Powering the AD9268, Dual Channel, 16-Bit, 125 MSPS Analog-to-Digital Converter with the ADP2114 Synchronous Step-Down DC-to-DC Regulator for Increased Efficiency (CN0137)
  *www.analog.com/CN0137*
- High Frequency Variable Gain Amplifier Extends the Dynamic Range of a 10-Bit, 65 MSPS ADC to Greater than 100 dB (CN0096)
  *www.analog.com/CN0234*

### Application Notes/Articles

- Designing an Inverting Buck Using the ADP2300 and ADP2301 Switching Regulators (AN-1083)
  *www.analog.com/an1083*
- A Practical Guide to High-Speed Printed-Circuit-Board Layout, *Analog Dialogue*, Volume 39
  *www.analog.com/library/analogDialogue/archives/39-09/layout*
- "Rules of the Road" for High Speed Differential ADC Drivers, *Analog Dialogue*, Volume 43
  *www.analog.com/library/analogdialogue/archives/43-05/adc_drivers*
- How Ultrasound System Considerations Influence Front-End Component Choice, *Analog Dialogue*, Volume 36
  *www.analog.com/library/analogDialogue/archives/36-03/ultrasound*

**Design Tools/Forums**

- ADIsimADC™: ADI's high speed ADC evaluation tool. There are three ways to use ADIsimADC. For simple product selection, a Web-based application allows users to analyze ADC performance online. ADC Analyzer™ is a downloaded tool that runs behavioral models and configures evaluation boards. VisualAnalog™ takes this concept further by allowing designers to customize their input signal and data analysis
  *www.analog.com/ADIsimADC*
- DiffAmpCalc™: ADI's differential amplifier calculator
  *www.analog.com/diffampcalc*
- ADIsimCLK™: ADI's tool for predicting phase noise and jitter for ADI clock products
  *www.analog.com/ADIsimCLK*
- ADIsimPower™: ADI's collection of downloadable Excel spreadsheets that produce complete power designs optimized to your design goals
  *www.analog.com/ADIsimPower*
- EngineerZone: ADI's online technical support community
  *ez.analog.com*

**To View Additional Signal Generator Resources, Tools, and Product Information, Please Visit *instrumentation.analog.com***

## Customer Interaction Center

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