

# Signal Processing Perspectives: Automotive System Designs

Analog Devices | Everywhere in automotive

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Analog Devices offers a wide range of performance-driven ICs for automotive designs, from bumper to bumper. We have provided automotive grade electronics and application support to the world's leading auto manufacturers. From powertrain to body electronics, safety to chassis electronics, driver assistance to audio/infotainment—analog is everywhere.

Our extensive list of automotive signal processing electronics includes amplifiers, ADCs, DACs, sensors, signal conditioners, RF transceivers, SHARC® and Blackfin® processors, iMEMS® accelerometers and gyroscopes, LED driver monitors, switches, voltage regulators, multiplexers, touch screen controllers, and more. You'll find all our automotive ICs, signal chains, and technical solutions online at [www.analog.com](http://www.analog.com).

Analog Devices has a longstanding commitment to automotive customers to enhance performance, safety, and comfort. For example, we have shipped more than 250 million airbag sensors, which have been designed into 160+ platforms. For more than a decade, we have proven that we can provide sole source products with 99.5% on-time delivery. In addition, we offer dedicated automotive account managers and FAEs, thorough ISO and QS certifications, JIT warehousing programs, zero defects on delivery, high reliability, long-term life cycles and supplies, and stable ASPs.

For 21<sup>st</sup> century signal processing performance, value, and reliability, Analog Devices is a signal processing problem solver you can trust, from bumper to bumper.

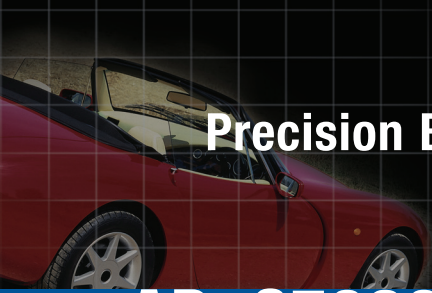
### FOR MORE INFORMATION ...

and to access everything from signal chains, technical articles, and application notes to design tools, data sheets, and in-depth design assistance—please visit our online automotive solutions resource center at [www.analog.com/autosolutions](http://www.analog.com/autosolutions).

All prices are in USD in quantities greater than 1000 (unless otherwise noted), recommended for lowest grade resale, FOB U.S.A.

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# Precision Battery Monitors Prolong Battery Life and Ensure Critical Function Success

## ADuC7030

### APPLICATIONS

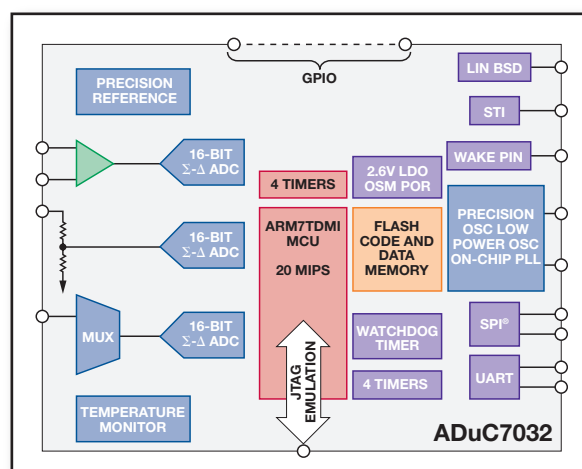
- Battery sensing/management for automotive systems

### FEATURES

- ARM7TDMI® MCU core
- Operates from 12 V battery supply
- LIN transceivers
- 96 kB Flash/EE, 6 kB SRAM
- Up to  $3 \times 16$ -bit,  $\Sigma$ - $\Delta$  ADC
- 5 ppm/°C  $V_{REF}$
- 2°C temperature sensor
- Digital comparator and integrator
- On-chip attenuation on  $V_{BAT}$  channel
- PLL
- Programmable gain amplifier (PGA)
- Precision oscillator (1%)
- Temperature range: -40°C to +125°C
- 7 mm  $\times$  7 mm, 48-lead LFCSP

#### FOR MORE INFORMATION...

[www.analog.com/ADuC7030](http://www.analog.com/ADuC7030)



### problem

With the profusion of safety, entertainment, navigation, and powertrain systems in today's cars, more sophisticated electronic subsystems to improve automotive performance are needed. System designers are requiring better battery management capabilities to monitor and distribute power and provide priority to critical functions, such as engine startup while increasing reliability and battery life.

### solution

ADI's new ADuC703x family of automotive battery monitor ICs provides a level of integration that addresses these needs in a single-chip IC and is easier to use, has higher performance, and is more cost effective than the existing patchwork solutions currently in use today. The ADuC703x family measures elementary physical variables such as battery voltage, current, and temperature to determine the battery's state-of-charge and state-of-health. The vehicle's energy management system then uses this data to reserve sufficient battery energy for a guaranteed engine start and to tailor the charging cycles to extend battery life.

The ADuC703x family integrates an on-chip programmable gain amplifier for a wide range of battery current measurements and attenuation for battery voltage measurement. Also on board are up to three 16-bit ADCs, an ARM7 microcontroller, a local interconnect network (LIN) transceiver, and embedded memory in a single package. The devices offer a cost-efficient and space-saving single chip alternative to discrete solutions. They include a standalone processor, LIN transceiver, low dropout regulator (LDO), and analog front end. As a result, the component can be located between the battery terminal and the connector on the main power cable, providing a great saving in space and cost, while simplifying overall system design.

Part Number	ADCs	Flash (kB)	SRAM (kB)	Timers	Package	Price (\$U.S.)
ADuC7030	2	32	4	5	48-lead LFCSP, 48-lead LQFP	6.73
ADuC7032	3	96	6	4	48-lead LQFP	7.55
ADuC7033	2	96	6	5	48-lead LFCSP, 48-lead LQFP	7.10

# New Capacitance Converter for Proximity Sensing Addresses Power and Sensitivity Requirements

## AD7150

### APPLICATIONS

- Keyless entry systems
- Remote detection
- Contactless switches

### FEATURES

- Ultralow power: 3.3 V, 90  $\mu$ A
- Response time: 10 ms
- Adaptive environmental compensation
- Two independent capacitance input channels
- Sensor capacitance ( $C_{\text{SENS}}$ ):  
0 pF up to 14 pF sensitivity to 0.8 fF
- EMC tested
- Two modes of operation:
  - Standalone with fixed settings
  - Interfaced to a  $\mu$ C for user-defined settings
- Two proximity detection output flags
- 2-wire serial interface (I<sup>2</sup>C<sup>®</sup>-compatible)
- Operating temperature:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- 10-lead MSOP

#### FOR MORE INFORMATION ...

[www.analog.com/AD7150](http://www.analog.com/AD7150)

### problem

Discrete sensors have a history of being expensive and difficult to implement. These constraints often prevent designers from adding sensing functions to their system designs due to cost and excessive power consumption.

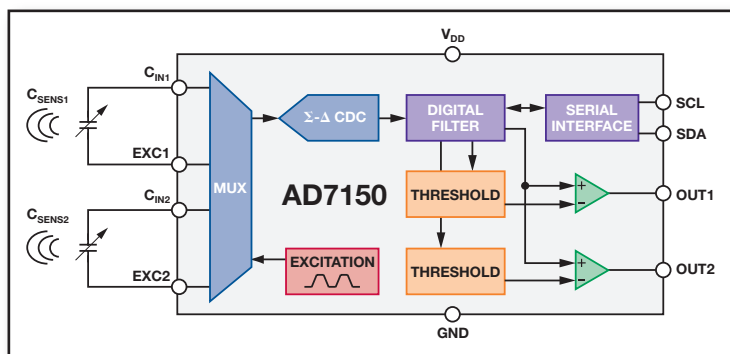
### solution

Leveraging ADI's established capacitance technology, the new AD7150 CDC for sensor systems delivers a complete signal processing solution for proximity sensors. The new CDC offers important features such as electromagnetic compatibility, adaptive environmental calibration, small package, low power consumption, and fast response time. Unlike existing solutions that use potentially unreliable and power hungry optical sensors, the AD7150 consumes just 90  $\mu$ A, resulting in a 70% power savings.

The AD7150 has undergone extensive EMC evaluation, making it particularly suitable for use in the harsh environments of today's demanding automotive applications. In addition, ADI's patented CDC front-end architecture makes the AD7150 tolerant of input parasitic ground capacitance, leakage currents, and power supply noise. This capability greatly enhances the implementation of robust and highly sensitive proximity sensor systems that provide consistent detection every time.

The proximity sensor system is further enhanced by the on-chip adaptive environmental calibration feature. This feature enables the device to automatically recalibrate and adapt to capacitance changes due to shifts in environmental conditions, such as temperature, humidity, and the gradual buildup of dust and dirt.

The AD7150 is specified over a  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range and communicates over an I<sup>2</sup>C serial interface. The AD7150 is sampling now, in 10-lead MSOP, and is priced at \$1.35 in 1000 unit quantities. Automotive-qualified models will be available.



# System Management IC Features Programming Quad Voltage Monitoring and Supervisory Functions

## AD5100

### APPLICATIONS

- Infotainment system supply monitoring
- Car battery

### FEATURES

- Two high voltage monitoring inputs: 3 V to 30 V
- Two low voltage monitoring inputs: 1.7 V to approximately 8 V. The V4 Mon pin can withstand up to 30 V, allowing connectivity to the eMOST ring
- Two supervisory functions:
  - Watchdog reset controller with programmable timeout and selectable floating input
  - Manual reset control for external devices
- Operating range: supply voltage of 6.0 V to 30 V
- Temperature range:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- Low shutdown current: 10  $\mu\text{A}$
- High voltage input antimigration shielding pinouts

#### FOR MORE INFORMATION...

[www.analog.com/AD5100](http://www.analog.com/AD5100)

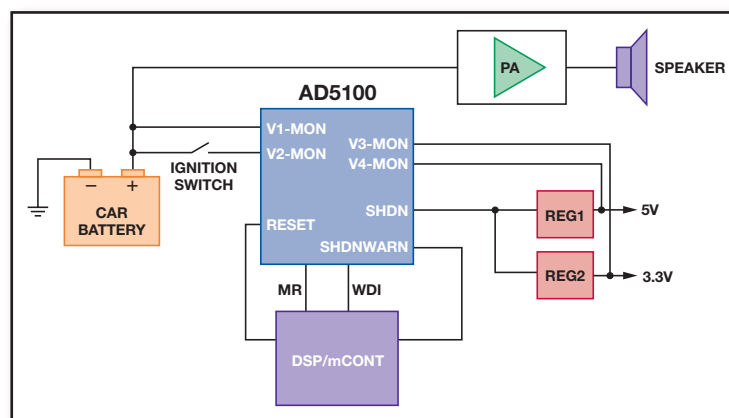
### problem

When an automobile's power system fails or shuts down unexpectedly, audio infotainment systems need to be shut down properly, and processors reset to avoid damage. Current solutions generally use discrete components to achieve this—increasing design complexity and component count. Additionally, current solutions limit the level of programmability available to the designer.

### solution

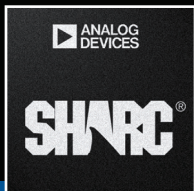
The AD5100 system management IC offers wider flexibility across different platforms and is a programmable system-management IC that combines four channels of voltage monitoring plus a watchdog supervision that can be used to shut down external supplies, reset processors, or disable any other system electronics when the system malfunctions. The AD5100 can monitor two 30 V, one 2.5 V to 5.0 V, and one 1.7 V to 8 V inputs with various shutdown and reset control capabilities. Parameters can be programmed permanently in the factory with OTP fuse array or dynamically in the field with OTP overwritten. The AD5100 is versatile for system monitoring applications where critical  $\mu\text{P}$ , DSP, and embedded systems must operate under harsh conditions such as automotive environments.

The AD5100 is available in a compact 16-lead QSOP and can operate in an extended automotive temperature range from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .



Call your local ADI representative for pricing.





# Third-Generation SHARC® Processors and Software Tools Simplify Automotive Audio System Design

## APPLICATIONS

- High quality surround-sound audio in the car

## FEATURES

- High performance SIMD SHARC core combined with efficient multichannel audio algorithm implementations ensure industry-leading system performance
- Large on-chip RAM and ROM arrays enable single chip system implementations—deleting the need for external memory
- High level of peripheral integration reduces IC count and overall BOM costs
- Family of pin-compatible products reduces development risks

### FOR MORE INFORMATION...

[www.analog.com/sharc](http://www.analog.com/sharc)

### Custom Audio Processing Design Simplified

The historical challenge faced by DSP users has been the development of software that makes optimum use of processor clock cycles and efficient use of memory. The laborious approach of hand-coding audio signal processing algorithms in assembly language has become less viable. This is particularly true when a large portion of the required effort goes into creating standard "checklist" and "me-too" features instead of focusing on differentiating the product with value-added features.

Analog Devices has developed an easier approach to develop audio product software with its VisualAudio® graphical environment. Used as an aid in designing and developing audio systems with the SHARC processor family, VisualAudio provides most of the software building blocks—together with an intuitive, graphical interface—for designing, developing, tuning, and testing auto audio systems.

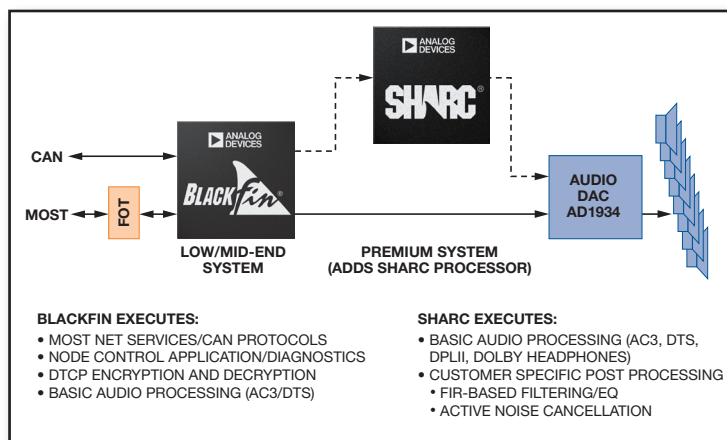
## problem

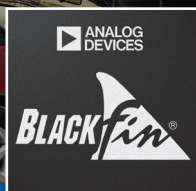
Audio enthusiasts have experienced high quality surround-sound audio in the home and are increasingly demanding comparable performance in their cars. The technical challenges in addressing this trend are significant—with high end system implementations requiring both high performance programmable DSPs as well as efficient audio decoder, virtualizer, and equalizer algorithms.

## solution

ADI offers hardware and software solutions designed for the broad spectrum of automotive audio amplifier systems. For high end systems, the SHARC 32-bit floating-point processors provide the highest quality audio. Designed for automotive DSP amplifier systems, the SHARC ADSP-21365 offers 333 MHz and 2 GFLOPs performance while integrating a variety of peripherals including a Digital Transmission Content Protection (DTCP) accelerator, an all-digital S/PDIF transmitter/receiver, and an 8-channel asynchronous sample rate converter. This peripheral set combined with industry-standard multichannel audio decoders embedded in on-chip ROM enable the ADSP-21365 to serve as a single chip solution for high end DSP amplifiers.

SHARC processors support all major, industry-standard stereo and multichannel audio decoders/post processors. Among the formats supported are multiple offerings from Dolby®, DTS, SRS®, THX®, Microsoft® (WMA-Windows Media® 9 Audio Professional), AAC (LC and MP), MP3, MPEG-2 Audio Layer 1, and 2. Also available are algorithms developed by Analog Devices including ADI surround, bass management, delay management, and automatic detection of the incoming audio bit stream, among others.





# Blackfin-Based Navigation Head Unit Reduces Telematics System Costs, Size, and Development Time

## APPLICATIONS

- Telematics/GPS systems

## FEATURES

- Navigation application and map database management
- Map drawing with speech guidance
- Bluetooth® handsfree
- Music ripping to local storage

### FOR MORE INFORMATION ...

[www.analog.com/blackfin](http://www.analog.com/blackfin)

## problem

Existing telematics/GPS systems remain in the high priced option category because discrete modules or subsystems are required to perform a host of specific functions—such as user interface, GPS, traffic data, routing and navigation systems, dead reckoning, and mobile communications. These functional subsystems are usually implemented as separate subunits, driven by devices like DSPs, microprocessors, microcontrollers, FPGAs, or ASICs. Such devices are typically sourced from separate vendors—with each requiring their own memory and I/O components, development tools, and operating systems. The market-limiting result is a telematics/GPS system that is physically large, expensive, and time-consuming to develop.

## solution

ADI's Navigation Head Unit capitalizes on the processing power of a single Blackfin processor to reduce telematics system costs, size, and development time by integrating multiple telematics tasks onto a single

processing platform. Our navigation technology provides accurate location information that can be supplied to drivers for navigation purposes, as well as to network operators to build local traffic and weather information delivery services. This capability significantly reduces system deployment costs compared with existing schemes that require separate hardware and software modules for each function. System functionality enabled includes GPS location management, route calculation, map rendering, voice guidance, handsfree operation with Bluetooth/telephone connectivity, and audio playback of prerecorded content.





# Blackfin-Based Soft Radio Supports Emerging Digital Transmissions, Legacy FM, and Prerecorded Media

## APPLICATIONS

- Digital radio

## FEATURES

- Blackfin soft radio delivers programmable reception of digital radio formats:
  - Digital audio broadcast (DAB)
  - Digital radio mondiale (DRM)
- Digital reception of legacy AM/FM broadcasts
- Playback of WMA/MP3 prerecorded files

### FOR MORE INFORMATION ...

[www.analog.com/blackfin](http://www.analog.com/blackfin)

## problem

For digital radio applications, processor selection is heavily weighted toward finding the right architecture to support the convergence of complex data, media, and communication requirements. The challenge is to efficiently address these requirements and simultaneously enable a great user experience. Designs need to control the radio by helping people select stations and facilitate voice controlled volume settings—while decoding streaming signals for 250 stations without losing packets.

ADI's Blackfin processor-based audio system supports

## solution

legacy analog FM, emerging digital transmissions, and prerecorded media—greatly enhancing head unit functionality. This “software-defined radio” approach adapts signal processing on the Blackfin to incoming radio streams, extracting and decoding the appropriate audio. Additional playback of MP3/WMA files from portable media and standard audio processing functions complete the system—providing a total radio experience in a highly cost-efficient platform.



# Automotive Audio Post-Processing Is Simplified with SigmaDSP™ Audio Processors

## APPLICATIONS

- CDs and car radios
- Automotive amplifiers
- Infotainment systems

## FEATURES

- SigmaDSP Core—50 MHz
- 2 high performance audio ADCs
- 4 high performance audio DACs
- Battery monitoring ADC

### FOR MORE INFORMATION ...

[www.analog.com/sigmaDSP](http://www.analog.com/sigmaDSP)

Analog Devices' AD193x codec family offers designers the essential converter building blocks to complete the audio signal chain. These codecs are designed specifically to address automotive audio requirements while simplifying automotive audio system design. They offer complete compatibility with ADI's versatile family of DSPs including SigmaDSP, Blackfin, SHARC processors, or a combination of these processors.

- Supports 24-bit, 192 kHz sample rate
- No master clock needed; can derive MCLK from LR Clock
- TDM mode supports 16in/16out using a single DSP SPORT
- Codec family members include:
  - AD1938: 4-ADC/8-DAC codec
  - AD1934: 8 DACs
  - AD1974: 4 ADCs

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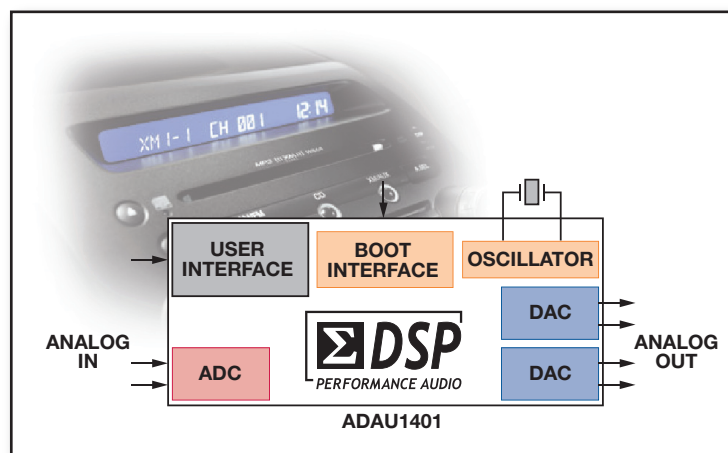
## problem

In today's evolving car audio environment, designers are challenged by the demands of audio enthusiasts for high quality surround-sound audio performance, the complexity of multifunctional infotainment systems, and the cost objectives of the OEMs. Designing audio systems that offer OEMs an upgrade path from the lowest end to the premium systems is also essential.

## solution

Audio system partitioning offers the greatest flexibility to automotive OEMs. Analog Devices' SigmaDSP processors are cost-effective, fully configurable, and scalable digital audio processors used for post-processing in many automotive amplifiers being supplied for today's automotive OEM platforms. Products such as the AD1940, a multichannel 28-/56-bit audio processor, are designed from the ground up to be audio specific digital processors for high volume amplifiers. ADI also offers the ADAU1401, the latest member of the SigmaDSP family, a 28-/56-bit audio processor with two ADCs and four DACs, for cost-effective post-processing in automotive head units.

Requiring no DSP programming knowledge, the SigmaStudio™ tool set features an easy to use graphical user interface (GUI) creating a seamless hardware and software tool environment. The drag-and-drop interface allows designers to build multichannel digital audio platforms by selecting from a library of audio function blocks, including volume controls, crossover and equalizer filters, and professional-grade dynamic processors. SigmaStudio tools also enable easy implementation of industry-standard licensed algorithms such as Dolby or SRS.



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