Analog Devices Wireless Sensor Network (WSN) Solutions

Industry WSN System Theory and Typical Architecture

Wireless sensor networks (WSNs) consist of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion, or pollutants. These sensors cooperatively pass their data through the network to a main location, the base station. Modern WSNs are bidirectional, enabling users to control the activity of the sensors.

WSNs are built of “nodes,” from as little as a few to potentially thousands, with each node connected to one or more sensors. Each such sensor network node typically has several parts: a radiotransceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors, and an energy source, usually a battery or an embedded form of energy harvesting.

Communication Standards and Specifications

Several standards are currently either ratified or under development for wireless sensor networks. There are a number of standardization bodies in the field of WSNs. The IEEE focuses on the physical and MAC layers; the internet engineering task force works on layers 3 and above. Standards are used far less in WSNs than in other computing systems. However predominant standards commonly used in WSN communications include:

- ZigBee/802.15.4
- IEEE 802.11
- ISA100
- WirelessHART

Industry WSN System Design Considerations and Major Challenges

To have appropriate WSN system design, designers must consider many different system requirements including

- Power consumption constraints for nodes using batteries or energy harvesting
- Interoperability
- Ease of use
- Ability to cope with node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity nodes
- Scalability to large scale deployment
- Ability to withstand harsh environmental conditions
- Unattended operation
The main challenge in a WSN is to produce low cost, low power, and tiny sensor nodes. Energy is the scarcest resource of WSN nodes, and it determines the lifetime of WSNs. Another challenge is improving network system reliability in light of packet loss, which can occur through factors such as low power radio communication, variable transmission power, multihop transmission, noise, radio interference, and node mobility. With these characteristics, the quality of service (QoS) of the network is associated with parameters such as adjacent channel rejection, sensitivity, blocking, antenna efficiency, etc.

Resolution is not important, as 1% accuracy is often good enough. Full solution delivery includes RF software stacks, network protocol, and hardware, getting government approvals is important as end customer would like to buy an off the shelf solution.

ADI offers market tailored solutions to aid in the design process. These solutions feature our industry-leading technologies.

**Total Solutions from ADI**
Leverage ADI’s sensor, signal processing, RF and power technology and expertise to high performance WSN system.

**Main Signal Chain of WSN Node**

Notes: The signal chains above are representative of a wireless sensor network application system. The technical requirements of the blocks vary, but the products listed in the table are representative of ADI solutions that meet some of those requirements.
Typical Applications

Street Lighting:
vehicle and passenger detection; lighting control

Infrastructure Monitoring:
vehicle and collision detection; lighting and video surveillance control

Smart Building:
temperature, humidity, PIR, CO₂, and vibration detection; lighting, ventilation, and alarm control

Asset Tracking:
barcode, temperature, humidity, and vibration detection; barcode tracking

Product Table List

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<th>Sensor</th>
<th>ISM Band Transceiver</th>
<th>Processor</th>
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<td>ADT7420/ADXL362/AD7151/ADT75/AD7745/ADM0441/SHT21/ADPD220/ AD7798/AD7799/AD7792/ADA4528-1</td>
<td>ADuCRF101/ADF7020/ADF7021/ADF7241/ADF7242/ADF760xx</td>
<td>ADuCRF101/ADuCM3xx/ADuC7026</td>
<td>ADP125/ADP160/ADP3330/ADP5054</td>
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<td>AD7781</td>
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# Main Products Introduction

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<tr>
<th>Part Number</th>
<th>Description</th>
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<tr>
<td><strong>Sensors</strong></td>
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<tr>
<td>ADT7420</td>
<td>Temperature sensor</td>
<td>±0.5°C over range of –40°C to +125°C</td>
<td>High stability and reliability vs. thermistors. No additional components and calibration required.</td>
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<tr>
<td>ADXL362</td>
<td>3-axis MEMS accelerometer</td>
<td>±2 g/±4 g/±8 g with digital output; high resolution: 1 mg/LSB</td>
<td>Ultralow power.</td>
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<tr>
<td>AD7745</td>
<td>CDC (capacitance-to-digital converter) for humidity sensing</td>
<td>Interfaces to single or differential floating sensors; resolution down to 4 fF (that is, up to 21 ENOB).</td>
<td>High accuracy; 4 fF; high linearity: 0.01% temperature sensor on chip.</td>
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<tr>
<td>AD7798/AD7799</td>
<td>Complete analog front ends for smoke detection</td>
<td>RMS noise: AD7799: 27 nV at 4.17 Hz; 65 nV at 16.7 Hz; AD7798: 40 nV at 4.17 Hz; 85 nV at 16.7 Hz</td>
<td>Built in low noise, programmable gain, instrumentation amp, and flash/EE memory on a single chip.</td>
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<tr>
<td>AD7151</td>
<td>CDC for proximity sensing</td>
<td>Two independent capacitance input channels sensor capacitance (CSENS) 0 pF up to 13 pF sensitivity to 1 fF</td>
<td>Ultralow power; 2.7 V to 3.6 V, 100 μA.</td>
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<tr>
<td><strong>Processor</strong></td>
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<tr>
<td>ADuC36x</td>
<td>Analog microcontroller with ARM® Cortex™-M3 core</td>
<td>32-bit ARM Cortex-M3 processor core; 128 k bytes of flash memory, 16 k bytes SRAM; single/dual single 24-bit ADC; offers up to 20 MIPS peak performance</td>
<td>High integration, low power consumption, precision ADC performance.</td>
</tr>
<tr>
<td>ADuCRF101</td>
<td>Analog microcontroller + RF transceiver</td>
<td>32-bit ARM Cortex-M3 processor core; 128 k bytes of flash memory, 8 k bytes SRAM; 862 MHz to 928 MHz and 431 MHz to 464 MHz</td>
<td>A fully integrated data acquisition system incorporating high performance, multichannel ADCs, DACs, ARM7TDMI® core, and flash/EE memory on a single chip.</td>
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<tr>
<td><strong>RF</strong></td>
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<td>ADF7242</td>
<td>ISM band transceiver</td>
<td>Frequency range (global ISM band) 2400 MHz to 2483.5 MHz; programmable data rates and modulation IEEE 802.15.4 compatible (250 kbps)</td>
<td>Low power consumption 19 mA (typical) in receive mode; high sensitivity (IEEE 802.15.4-2006) −95 dBm at 250 Kbps.</td>
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<tr>
<td>ADF7023</td>
<td>ISM band transceiver</td>
<td>Frequency bands 862 MHz to 928 MHz; 431 MHz to 464 MHz low IF receiver with programmable IF bandwidths 100 kHz, 150 kHz, 200 kHz, 300 kHz</td>
<td>High receiver sensitivity (BER) −116 dBm at 1.0 kbps, 2 FSK, GFSK −107.5 dBm at 38.4 kbps, 2 FSK, GFSK very low power consumption.</td>
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<tr>
<td><strong>Power</strong></td>
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<td>ADP160/ADP161/ADP162/ADP163</td>
<td>LDO</td>
<td>Ultralow quiescent current, low dropout, linear regulators that operate from 2.2 V to 5.5 V and provide up to 150 mA of output current</td>
<td>Ultralow quiescent current Iq = 560 nA with 0 μA load; Iq = 860 nA with 1 μA load; initial accuracy: ±1% over line, load, and temperature: ±3.5%.</td>
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<td>ADP5054</td>
<td>Quad high current buck regulators</td>
<td>CH1/CH2: programmable 2 A/4 A/6 A sync buck regulator with low-side FET driver; CH3/CH4: 2.5 A buck regulator wide input range: 4.5 V to 15 V; 250 kHz to 2 MHz adjustable switching frequency</td>
<td>Small package, frequency synchronization input or output.</td>
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<td>ADP5090</td>
<td>Energy harvesting</td>
<td>Maximum power point tracking with harvester OCV sensing to extract the most energy from harvester best-in-class ultra light load (10 μA to 100 μA) efficiency reach &lt;250 nA Iq under deep sleep mode with programmable automatic switcher shutdown start at 380 mV input voltage with integrated charge pump</td>
<td>Support different energy storage with flexible programmability intelligently manage additional power path for optional primary cell backup battery.</td>
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<td><strong>Mux</strong></td>
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<td>ADG1408</td>
<td>4-channel/8-channel, ±15 V multiplexers</td>
<td>4.7 Ω maximum on resistance, up to 190 mA continuous current, rail-to-rail operation</td>
<td>Fully specified at ±15 V/±12 V/±5 V.</td>
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<td><strong>Amp</strong></td>
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<td>AD8236</td>
<td>In-amp</td>
<td>40 μA micropower (40 μA) INA with zero crossover distortion; 1 pA input bias current; high CMRR: 110 dB CMRR, G = 100; rail-to-rail input and output</td>
<td>Can operate on voltages as low as 1.8 V; excellent choice in battery-powered applications.</td>
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</table>
A wireless sensor node capable of sensing environmental variables or other types of inputs and wirelessly transmitting the pertinent information to other nodes or to a base station.

**ADI WSN Platform**

- Available
  - ADT75 Temp Sensor
  - ADXL362 Accelerometer
  - ADMP441 Microphone
  - SHT21 Sensirion Humidity Sensor
  - ADPD220 Photodiode, Ambient Light Sensor
  - Panasonic PIR Sensor
  - Connector for GSS CO2 Sensor
- CR2032 Coin cell battery (on back of board)
- 45 mm × 33 mm (1.78” × 1.3”)
- Out-of-the-box compatibility with ADI WSN platform

**What ADI Can Provide to Customers**

- **WSN** Demo board
- **RF EVB** ADIsimRF, ADIsimSRD™
- **Power** EVB ADIsimPower
- **Processor** EVB emulation tools and software

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For more WSN applications and products information, please visit:
www.analog.com/building-control-automation

For a complete WSN demo system, please visit:
www.analog.com/building-control-automation_Demo

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- **Free Samples** www.analog.com/sample