

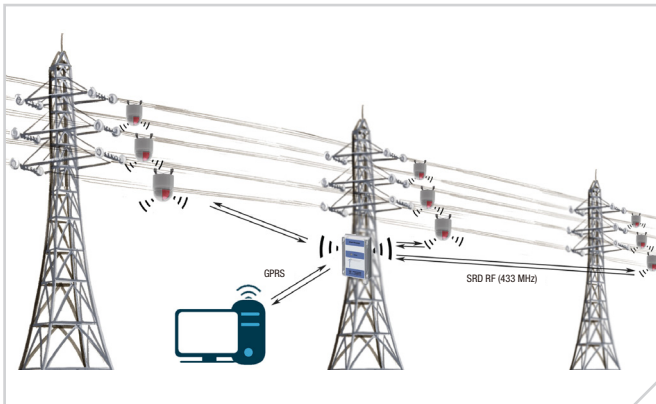
SMART ENERGY HARVESTING AND LOW POWER FCI DESIGN

FCI System And New Application Requirement

Power transmission and distribution (T&D) systems have evolved into a vast, interconnected power delivery network between the power generating station and different end user loads. These systems are best used to monitor the branches of a distribution grid as closely as possible, especially for the overhead power lines in urban and rural areas. Quickly locating and responding to any fault and bringing operation back to steady state condition, within the least amount of time possible, is of the utmost importance in the field.

Fault circuit indicators (FCIs) are growing devices for fault detection in these types of applications, due to their easy implementation, low cost solutions, and the lack of maintenance they require.

Designing such devices is mostly composed of energy harvesting, power management, processor, AFE circuit, and communication interfaces. Smart energy harvesting/management and ultra low power consumption became critical requirements in customers' design. As the worldwide, technical leader of mixed-signal processing products, Analog Devices is a major electronic system solution supplier.



ADI Value Proposition

- ▶ ADI is an expert in energy measurement—50% of all electrical grid equipment worldwide uses ADI converters.
- ▶ Complete, ultra low power signal chain covers everything from ADC conversion to processor processing and wireless communication.
- ▶ Industry-leading technology on energy harvesting.
- ▶ High integration with excellent system performance to enable ease of design, cost saving, and a robust and reliable system for a long-term period.
- ▶ High performance power/battery management from ADI (includes LTC legacy).
- ▶ Precision signal measurement through highly accurate converters and amplifiers.

System Design Considerations and Major Challenges

- ▶ Lower to μ A-level system power consumption.
- ▶ High efficiency for energy harvesting and power conversion.
- ▶ Multipower supply management and seamless switching to provide a stable power source for system loads.
- ▶ Battery charging and management on collection units to maximize the battery life.
- ▶ High voltage solar panel and amp level GPRS consumption design on a collection unit.
- ▶ Current measurement performance impact by CT as power supply.
- ▶ Performance/power consumption balance will be a key point for AFE circuit design.
- ▶ Power saving wireless communication and networking with synchronization consideration.
- ▶ Fast and accurate issue detection algorithm design.
- ▶ Long term robustness/reliability over system life cycle and protection, such as over current, surge, etc.

Why Use ADI Solution (ADI Solution Value Proposition)

Highly integrated solutions are a significant help to compact layout and reducing design complexity with industry-leading, ultra low power performance, in order to reach historically low power consumption over a full system signal chain.

- ▶ Customers can benefit from using a single ASIC to implement highly efficient energy harvesting and multipower source management; meanwhile, integrated regulator output can reduce BOM cost and simplify PCB design.
- ▶ Optimized maximum power point tracking (MPPT) has over 90% efficiency in power conversion under a small CT primary current.
- ▶ Dedicated battery ICs can support charging a multichemistry of battery (Li-ion/polymer, LiFePO₄, SLA) from solar panel with constant-current/constant-voltage, charging characteristics and providing complete battery management and protection.
- ▶ Low power op amp with wide dynamic range and high slew rate is easy to implement current measurement with a rogowski coil, which minimizes the magnetic field impact to the current measurement accuracy.
- ▶ High performance, ultra low power ARM® Cortex®-M3 processor provides rich digital peripherals and analog subsystem, security, and crypto features to enhance system safety and reliability.
- ▶ Lower to nA-level supervisory and comparator is available for extended design.
- ▶ Standard ISM band transceiver with sensor network protocol (6LoWPAN) integrated for smart RF communication.

System Block Diagram
ADI Solution to Cover Whole FCI Signal Chain (Acquisition Unit and PMU of Collection Unit)

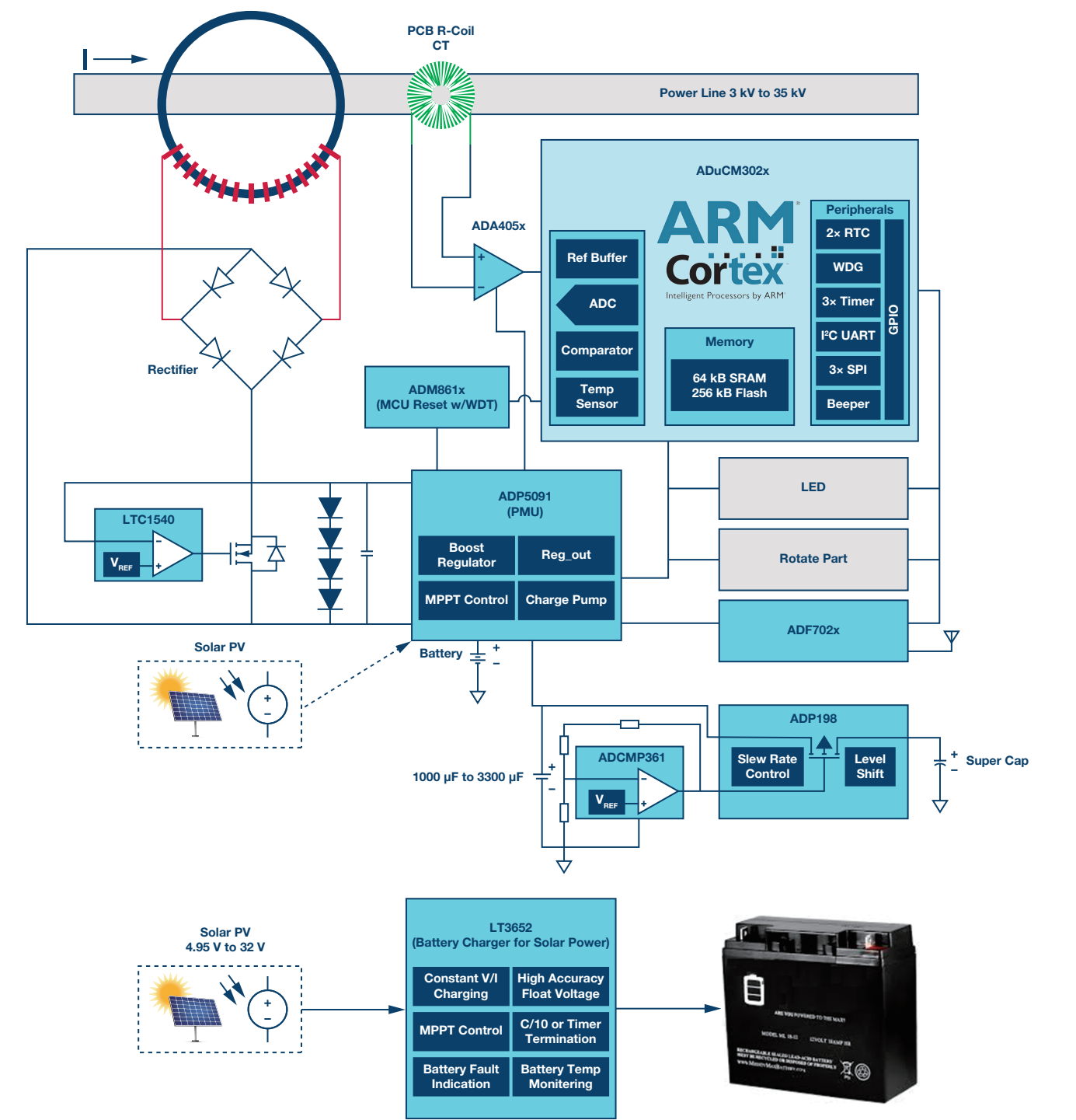


Figure 1. This signal chain is representative of a typical FCI application design. The technical requirements of the blocks vary, but the products listed in the following tables are representative of ADI's solutions that meet some of those requirements.

	ADI Recommended
Power management (acquisition unit)	ADP5091/LTC3330
Power management (collection unit)	LT3652
Signal condition	Amplifier: ADA4051-x/AD850x
Processor	ADuCM302x
Power supervisor	ADM861x
RF transceiver	ADF702x
Voltage comparator	LTC1540/ADCMP361
Voltage reference	AD1582/ADR525

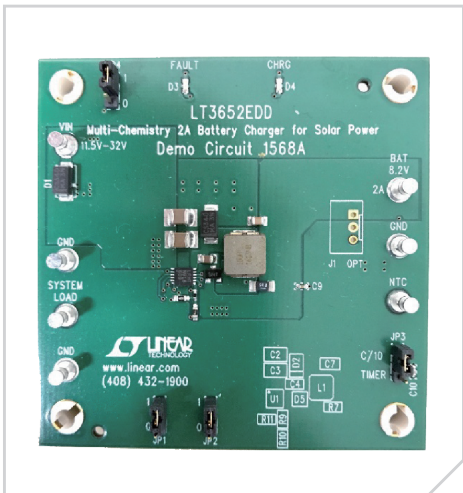
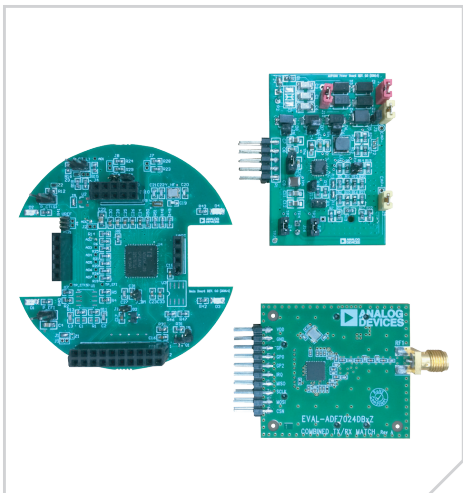
Main Products Introduction

ADI Products

Part Number	Description	Key Features	Benefits
<i>Power Management</i>			
ADP5091	Ultra low power energy harvester PMU	Input voltage: 80 mV to 3.3 V; fast cold start from 380 mV; 150 mA regulated output from 1.5 V to 3.6 V; programmable voltage monitor for charging storage and backup cell battery	Boost regulator with maximum power point tracking; RF transmission friendly
LT3652	Power tracking 2 A battery charger for solar power	Voltage range: 4.95 V to 32 V; resistor programmable float voltage up to 14.4 V; accommodates li-ion/polymer, LiFePO4, and SLA chemistries; user selectable termination	Power tracking in solar applications; constant-current/constant-voltage charge characteristic
<i>Amplifier</i>			
ADA4051-x	Zero-drift, rail-to-rail op amps	Very low supply current: 13 μ A; low offset voltage: 15 μ V maximum; offset voltage drift: 20 nV/°C; V_{SUPPLY} : 1.8 V to 5.5 V	Rail-to-rail input/output; unity-gain stable; extended industrial temperature range: -40°C to +125°C
<i>Processor</i>			
ADUCM302x	Ultra low power ARM Cortex-M3 MCU	Up to 26 MHz ARM Cortex-M3 core with 64 kB, 256 kB flash, 4 kB cache; V_{SUPPLY} : 1.8 V to 3.6 V; active <38 μ A/MHz, hibernate <750 nA; 8-channel, 1.8 MSPS, 12-bit SAR ADC; digital comparator; hardware crypto accelerator/CRC	Power supply monitor; LDO+ buck converter for improved efficiency; user code protection; dynamic/sw clock and power gating
<i>Power Supervisor</i>			
ADM861x	Ultra low power supervisory	Ultra low power consumption ICC = 92 nA; voltage monitoring range: 0.5 V to 4.63 V, $\pm 1.3\%$ threshold accuracy; optional watchdog timer	Manual reset input; active low, open-drain reset output; power supply glitch immunity
<i>Power Supervisor</i>			
ADF7024	Sub-GHz, ISM/SRD, FSK/GFSK, transceiver	ISM bands: 431 MHz to 435 MHz/862 MHz to 928 MHz; data rates supported: 9.6 kbps to 300 kbps; V_{SUPPLY} : 2.2 V to 3.6 V; automatic frequency/gain control (AFC/AGC); 11.75 μ A autonomous receive sniff using smart wake mode (SWM)	Ultra low power sleep modes; digital received signal strength indication (RSSI); highly linear/blocking/sensitivity; on-chip, 8-bit ADC
<i>Voltage Comparator</i>			
LTC1540	Nano, low power voltage comparator	Ultra low quiescent current: 0.3 μ A; on-chip reference output sources up to 1 mA; 2 V to 11 V supply	Adjustable hysteresis; TLL-/CMOS-compatible outputs
ADCMP361	Dual, polarity output voltage comparator	Supply range: 1.7 V to 5.5 V; 400 mV $\pm 0.275\%$ threshold; low input bias current: ± 5 nA max; dual open-drain outputs	Comparator with on-chip reference; input glitch immunity
<i>Voltage Reference</i>			
AD1582	Micropower, precision series mode voltage reference	Low quiescent current: 70 μ A maximum; current output capability: ± 5 mA; wide supply range: $V_{IN} = V_{OUT} + 200$ mV to 12 V; wideband noise (10 Hz to 10 kHz): 50 μ V _{RMS}	Patented temperature drift curvature correction design; industrial temperature range of -40°C to +125°C

Design Resource

Reference Design/Demo Design (Acquisition Unit and PMU of Collection Unit)



Technical Support

Engage with the Analog Devices technology experts in our online support community. Ask your tough design questions, browse FAQs, or join a conversation.

ez.analog.com

Customer Interaction Center

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Free Samples

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Technical Hotline

1-800-419-0108 (India)

886-2-2650-2888 (Taiwan)

82-2-368-2500 (Korea)



AN/Article/CFTL

- ▶ EVAL-ADP5091/ADP5092 User Guide
- ▶ Demo Manual DC1568A for [LTC3652](#)
- ▶ EE388v01 Power Optimization Guide for [ADuCM302x](#) Processors
- ▶ EE381v01 Using the [ADuCM302x](#) Processor Boot Kernel
- ▶ [AN-1315](#) Autonomous IR Calibration on the [ADF7024](#)
- ▶ [AN-1317](#) Rolling Data Buffer on the [ADF7024](#)

Design Tool

- ▶ analog.com/en/eval-aducm3029-ezkit.html

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If You Need More ADI Energy Applications and Products Information, Please Visit: analog.com/en/energy.

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