A New Distribution Automation Solution Based on the ADSP-CM40x Processor

Power Distribution Systems

In the modern smart grid system, distribution automation systems will update to increasingly more intelligent electronic devices, which are used to monitor power quality and quickly isolate any fault from affecting the overall grid operation. Smart terminals, including DTU/FTU/TTU, are growing in use and changing grid architecture. Designing these devices requires processors, multichannel ADCs, signal condition circuits, a power supply, and communication interfaces. Robustness and cost became the main sources of pressure for equipment providers. Analog Devices, as the worldwide technical leader of mixed-signal processing, is the major electronic system solution supplier in power distribution systems and will give the solutions.

ADI Value Proposition

ADI offers best-in-class products to help designers building their systems.

- Expertise in integrated energy measurement—300 million ADI metrology-based meters deployed.
- Precision measurement of current and voltage through highly accurate converters and amplifiers.
- Enable robust and reliable power networks using high performance processing technology.
- 50% of all electrical grid equipment worldwide uses ADI converters.
- Mixed-signal conversion and processing enable ease of design, saving cost and reduced time to market.
- Compact design, smaller housing which leads to new system level architecture consideration.

System Design Considerations and Major Challenges

- High channel account in the DTU-type application increases processor loads when using traditional system architecture.
- Same current sensing channel for protection and measurement functionality, which requires higher dynamic signal range.
- The integration of harmonic measurement functionality into terminal units requires a higher analog sampling rate and corresponding higher post signal processing calculation density.
- Due to more communication requirements in power distribution networks, IEC61850 compatibility will be necessary in the future.
- Robustness requirements such as overvoltage protection, EMC/EMI, operation temperature range over the standard industry requirement, a long lifetime, and more.
- Cost/functionality balance will be a key point for power distribution automation devices.

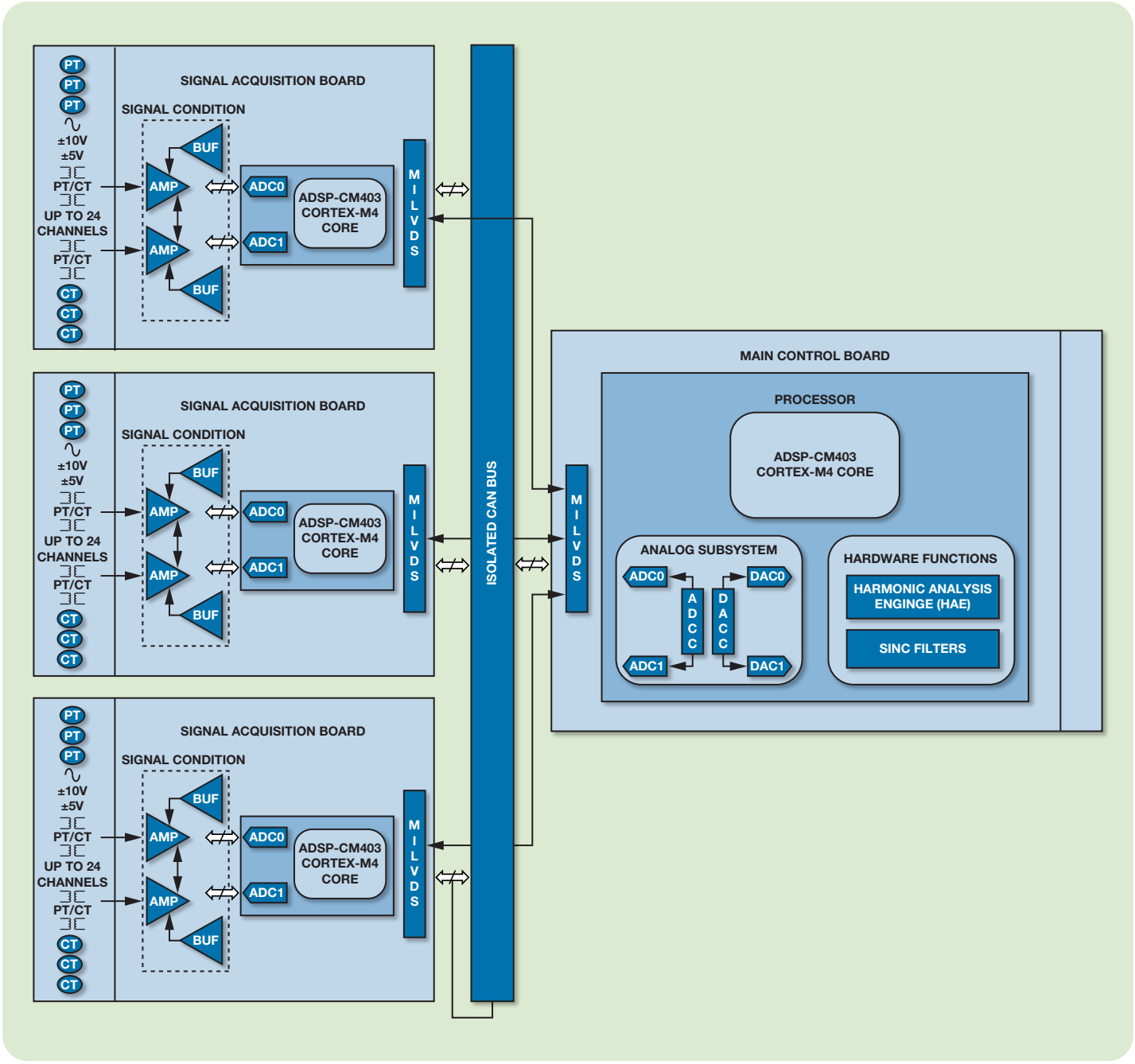
Why Use ADI Solutions?

The ADSP-CM40x system in one package, with a rich set of industry-leading system peripherals and memory, is helpful for a compact layout and reducing design time.

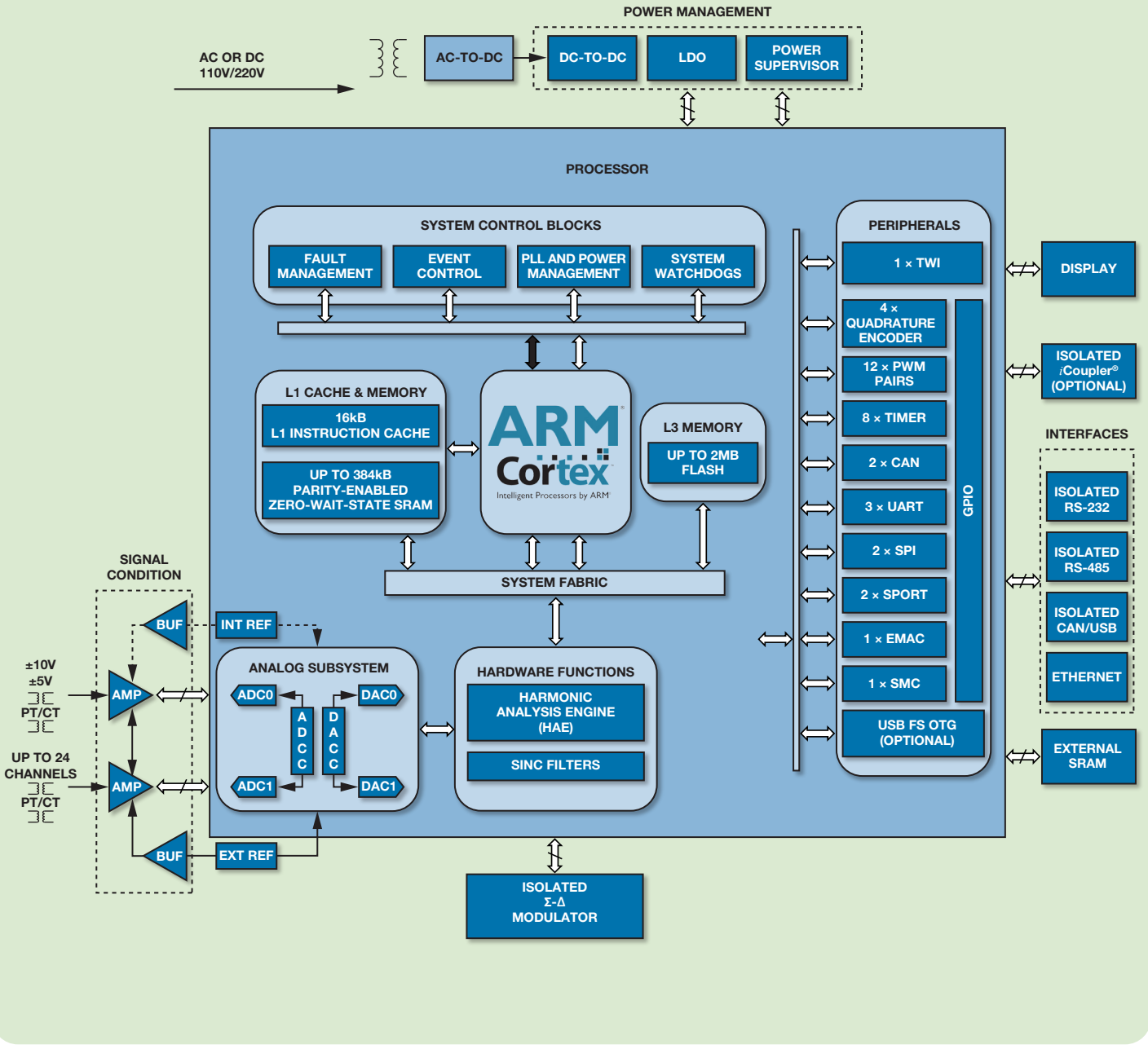
- Decrease the overall system cost by using 16-bit, high precisions ADCs with low cost but high performance op amps.
- Offers an additional on-chip assistant hardware module—HAE (harmonic analysis engine)—to reduce the load of the MCU for post signal processing algorithms (for example, energy metrology and FFT). Provide an easy approach for the customer to realize a metering and protection automation device.
- Support two CAN buses for enhanced back plane communication, which increases communication bandwidth or provides system-level redundancy
- Enhanced back plane-based, system-level robustness by using a differential type communication interface.
- Integrated Ethernet MAC with IEEE1588 supported.

System Block Diagram

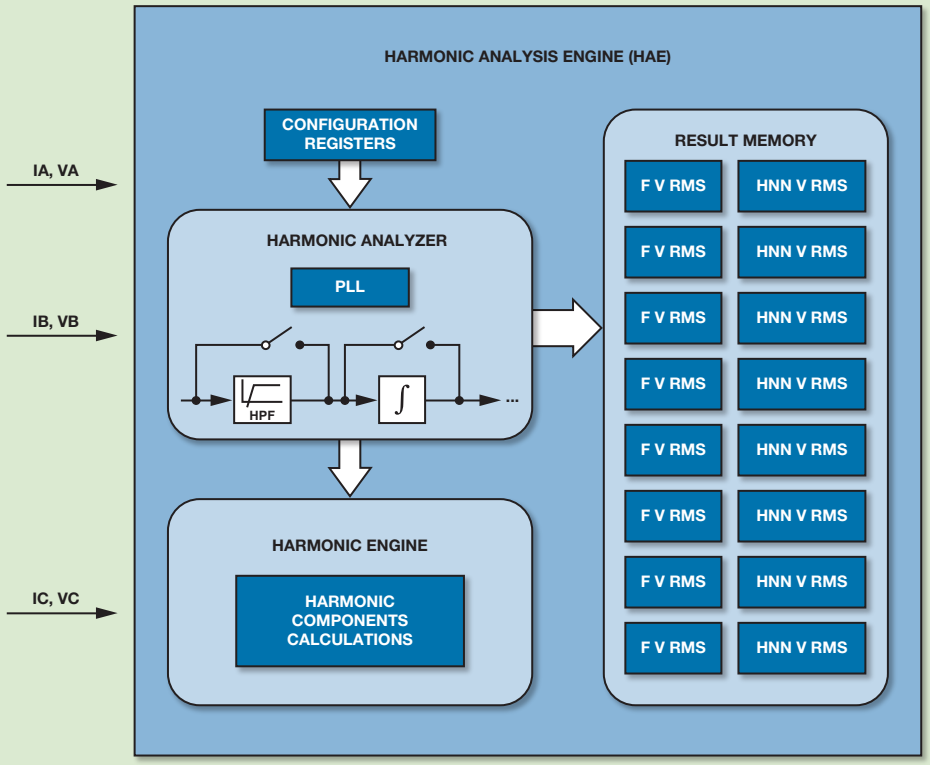
- **DTU System Architecture**



- **Signal Acquisition Subsystem**



- **HAE Function Block**



Notes: The signal chain above is representative of a typical DTU type application design. The technical requirements of the blocks vary, but the products listed in the table below are representative of solutions that meet some of those requirements

	ADI Recommended
Processor	ADSP-CM403F/CM408F
Signal Condition	Amplifier: AD8604 Buffer: AD8601/AD8655
Reference	ADR3425/ADR421
Isolated Σ-Δ Modulator	AD7403
Power Management	ADP2164/ADP2311/ADP2118
Interface	Isolated RS-232: ADM3252E Isolated RS-485: ADM2587E Isolated CAN: ADM3053 M-LVDS Transceiver: ADN469xE
Power Supervisor	ADM13305/ADM708

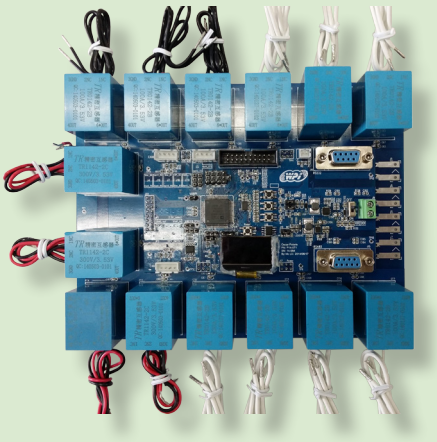
Main Products Introduction

Part Number	Description	Key Features	Benefits
Processor			
ADSP-CM403F/ ADSP-CM408F	Mixed-signal control processor with ARM® Cortex™-M4	Up to 240 MHz ARM Cortex-M4 with floating-point unit, 384 kB SRAM, 2 MB flash, two 16-bit SAR ADCs with up to 24 multiplexed inputs, two 12-bit r-string DACs, harmonic analysis engine, sinc filters, CAN, UART, Ethernet MAC, PWM	System in package, ADC simultaneous sampling (up to 2.63 MSPS), 3-phase harmonic analysis, low static power consumption
Amplifier			
AD8604	Precision CMOS single supply op amp	V_{os} = 500 μV (max), single V_{SUPPLY} = 2.7 V to 5.5 V, wide bandwidth: 8 MHz, slew rate: 5 V/μs	Low distortion, no phase reversal, RIO, low cost quad amplifier
Reference			
ADR3425	Voltage reference	Initial accuracy: ±0.1% (max), temperature coefficient (max): 8 ppm/°C, operating temperature range: −40°C to +125°C	Low cost, SOT-23 package, 10 mA source and 3 mA sink reference
Isolated Σ-Δ Modulator			
AD7403	Isolated Σ-Δ modulator	V_{SUPPLY}: single 5 V, input range: differential ±250 mV, SNR: 88 dB typical, ENOB: 14.2 bits typical,1.6 μV/°C maximum offset drift, on-board digital isolator	Avoid Hall sensors to reduce cost; 16-bit high resolution (±2 LSB INL typ)
Power Management			
ADP2164	Step-down (buck) switch regulator	Input voltage: 2.7 V to 6.5 V, 4 A output current, ±1.5% output accuracy, temperature range: −40°C to +125°C	Internal compensation and soft start, overvoltage/overcurrent protection, TSD
Interface			
ADM2587E	Isolated RS-485 transceiver	*iso*Power® integrated isolated dc-to-dc converter, data rate: 500 kbps, 2.5 kV rms for 1 minute, ±15 kV ESD protection on RS-485 input/output pins, 5 V or 3.3 V operation	Eliminates the need for an external dc-to-dc isolation block, connect up to 256 nodes on one bus
ADM3053	Isolated CAN transceiver	2.5 kV fully isolated (power and data), up to 1 Mbps data rate, slope control for reduced EMI	Connect 110 or more nodes on the bus, unpowered nodes do not disturb the bus
ADN4697E	Multipoint LVDS transceiver	Switching rate: 200 Mbps (100 MHz), supported bus loads: 30 Ω to 55 Ω, high-Z when disabled or powered off	Glitch-free power-up/power-down, enhanced ESD protection on bus pins
Supervisor			
ADM13305	Processor supervisors	Dual supervisory circuits, V_{SUPPLY}: single 2.7 V to 5.5 V, pretrimmed threshold options: 1.8 V, 2.5 V, 3.3 V, and 5 V, reset valid from V_{DD} ≥ 1.1 V	On-chip watchdog timer, 8-lead, narrow body SOIC package

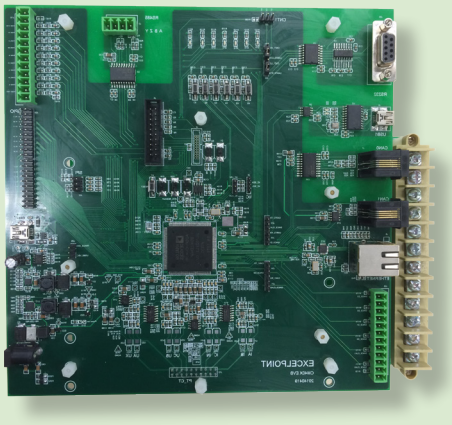
Design Resource

Reference Design/Demo Design

The data acquisition board designed by our distributor: WPI and Excelpoint, which is based on the ADSP-CM40x processor and other ADI products to cover the full signal chain. Meanwhile, integrated voltage and current sensors on the board for more compact layout.



Designed by WPI



Designed by Excelpoint

Application Notes/Technical Articles/Circuit Notes

- Maximizing ADC Sampling Rate on ADSP-CM40x Mixed-Signal Control Processors (EE365)—*www.analog.com/EE-365*
- ADSP-CM40x Power Supply Transistor Selection Guidelines (EE361)—*www.analog.com/EE-361*
- Utilizing the Trigger Routing Unit for System Level Synchronization (EE360)—*www.analog.com/EE-360*
- ADSP-CM40x Serial Flash Execute-in-Place Technology (EE363)—*www.analog.com/EE-363*
- ADSP-CM403HAE-Harmonics-Analysis in Solar Applications (MS-2543)—*www.analog.com/MS-2543*
- LVDS and M-LVDS Circuit Implementation Guide (AN-1177)—*www.analog.com/AN-1177*
- Robust Completely Isolated Current Sense Circuit with Isolated Power Supply for Solar Photovoltaic Converters (CN0280)—*www.analog.com/CN0280*

Design Tool

- www.analog.com/en/evaluation/cm40x-ez/eb.html

ADI Contact

If you need more ADI energy applications and products information, please visit: *energy.analog.com*

Customer Interaction Center

Technical Hotline	***1-800-419-0108 (India)***
	1-800-225-5234 (Singapore)
	0800-055-085 (Taiwan)
	82-31-786-2500 (Korea)
Email	***cic.asia@analog.com***
EngineerZone	***ez.analog.com***
Free Samples	***www.analog.com/sample***

Analog Devices China
Asia Pacific Headquarters
5F, Sandhill Plaza,
2290 Zuchongzhi Road
Zhangjiang Hi-Tech Park,
Pudong New District
Shanghai, 201203
China
Tel: 86.21.2320.8000
Fax: 86.21.2320.8222

Analog Devices, Inc.
Korea Headquarters
6F Hibrand Living Tower
215 Yangjae-Dong
Seocho-Gu
Seoul, 137-924
South Korea
Tel: 82.2.2155.4200
Fax: 82.2.2155.4290

Analog Devices, Inc.
Taiwan Headquarters
5F-1 No.408
Rui Guang Road, Neihou
Taipei, 11492
Taiwan
Tel: 886.2.2650.2888
Fax: 886.2.2650.2899

Analog Devices, Inc.
India Headquarters
Rmz - Infinity
#3, Old Madras Road
Tower D, Level 6
Bangalore, 560 016
India
Tel: 91.80.4300.2000
Fax: 91.80.4300.2333

Analog Devices, Inc.
Singapore Headquarters
1 Kim Seng Promenade
Great World City
East Tower, #11-01
Singapore, 237994
Tel: 65.6427.8430
Fax: 65.6427.8436

BR12501p-.5-7/14

ANALOG DEVICES