Anadigm® FPAA Solutions Training

Class I
Take Control of Your Analog Destiny

- Simplify Your Analog Design
- Gain the Flexibility to Adapt Your Design
- Add New Features and Capabilities to your Systems
- Improve the Manufacturability of Your Design
Anadigm Technology Enables You

- To shorten time to market by reducing analog design complexity
  - Work at a higher level functional level instead of low level components
  - You can be testing analog hardware in a few days

- To differentiate your products with dynamic re-configurability
  - Design products that adapt to their environment (auto-ranging, auto-calibration, automatic gain control, etc)
  - Design products that change functionality sequentially over time (multiple operating modes)
  - Connect to multiple analog sensors and provide signal chains appropriate for each with one circuit.
Anadigm Technology Enables You (cont)

- To future-proof designs
  - Allows updates of analog functions in the field or on the production line

- To attain cost savings in inventory control and field service
  - Consolidation and standardization of board designs that can be utilized across multiple products
  - Reduce the cost and complexity of system calibration in production and in the field

- To protect your IP of circuit designs.
  - The configuration data cannot be reverse engineered back to the original circuit
Anadigm Technology Enables You (cont)

- To implement high accuracy analog circuits in your products
  - Achieves 0.1% functional accuracy
  - Chip to chip accuracy ± 0.1%
  - Drift free performance immune to process, temperature and aging
Software Control of Your Analog Design

- Anadigm offers an advance in technology that is distinctive and valuable...

- The capability for pure analog signal processing under real-time software control
  - In-circuit programmability with no interruption in system operation
  - Software control over Analog circuit parameters
  - Software control over Analog circuit configurations
How We’re Making It Happen

- Anadigm® combines three powerful design trends from the digital world into the analog domain
  - EDA tools and design modules for complete analog design automation remove the complexity from analog design
  - Specialized architecture for external processor control to allow for in-circuit programmability and software control over analog circuit parameters
  - Reconfigurable CMOS silicon which allows instant creation of complex, high performance analog circuits
Development Tools
Anadigm Designer Overview

- AnadigmDesigner® 2
  - Easy-to-Use
  - Intuitive “drag-and-drop” user interface
  - Built-in signal generator, oscilloscope
  - Built-in, accurate discrete-time behavioral simulator
  - Extensive help documentation
  - Full version available free from Anadigm website (www.anadigm.com)
  - Supports the selection, configuration and interconnect of Configurable Analog Modules (CAM)
Configurable Analog Modules (CAM)

- Circuit building blocks abstracted to a functional level
- Supports true design abstraction
- A complex circuit can be implemented simply by selecting, configuring, and wiring CAMs
- Each CAM has a user interface to set options and limits
- Each CAM has an accurate model for use in time-based simulator
Typical CAM Options

- Half Cycle Inverting Gain Stage (optional hold)
- Half Cycle Inverting Rectifier (optional hold)
- Half Cycle Rectifier
- Gain Stage with Polarity control
- Integrator
- Inverting Gain Stage
- Inverting Sum Stage
- Multiplier
- Rectifier with Low Pass Filter
- Sample and Hold
- Sinewave Oscillator
- Transimpedance Amplifier
- User-defined Voltage Transfer Function
- Arbitrary Periodic Waveform Generator
- Sum/Difference Stage with Low Pass filter
- Analog to Digital Converter (SAR)
- Voltage-controlled Variable Gain Stage
- Low Corner Frequency Bilinear Low-Pass Filter
- Sum/Difference Integrator
- Square Root

All CAM parameters are user definable and may be changed under software control with 0.1% functional accuracy.
Customer CAMs

- Another library of CAMs
- Further level of customization for your products
- Integrate your special requirements
- Customer CAMs can be built to your needs.

Think outside the box
Mapping Functions to CAMs

High Pass Filter → Half-Wave Rectifier → Low Pass Filter → Inverting Gain → Comparator w/ Ref

High Pass Filter → Rectifier/Filter with Gain → Comparator w/ Ref
Simulator
Anadigm Developers Kits

- Perfect hardware platform to get started with FPAA's
- Evaluation board suitable for development and instant prototyping
- Three board sizes with 1, 2 or 4 FPAA mounted on the PCB
- Part Numbers: AN231K04-SING1
  - AN231K04-DUAL2
  - AN231K04-QUAD4
Static Configurability and Dynamic Re-configurability
Static and Dynamic Devices

- All FPAA parts need configuration information loaded when the device first powers up (static configuration)
- Some devices have an additional feature to allow you to change the active configuration while device is operational (dynamic re-configuration)
- Potential uses for dynamic re-
  - Reconfigure the device to match multiple system states
  - Auto calibrate the system at power-up
  - Automatically adjust system to incoming signal characteristics
- Apex devices that support dynamic re-configuration (AN231E04)
How Does Dynamic Reconfiguration Work?

**System Update via C-code**

- Circuit description available in C-code
- System software can change functionality by making a function call
- Allows the MCU to update the system functionality dynamically
FPAA Applications
Typical FPAA Applications

- **Complex analog filtering circuits**
  - Guaranteed and repeatable filter implementation
  - Implemented filter is drift-free and immune to aging or component variations
  - Make tunable (adaptable) filters within minutes

- **Sensor signal conditioning**
  - Gain, offset correction, linearization, etc.
  - Stable and adaptable sensor stimulus
  - Correct / adjust for aging, drift, manufacturing variability, etc.
  - Improve accuracy, performance and control by providing real time adjustments to range of operation
EDA Tools-AnadigmFilter - It builds the circuit for you!
**Sensor Signal Conditioning – Overview**

The FPAA helps meet the following system challenges:
- Sourcing stable references and stimulus
- Multiple sensors with differing signal conditioning needs
- Real time adjustments to range of operation
- Methods of calibration and maintenance
- Correct / adjust for aging, drift, manufacturing variability, etc.
- Manufacturing considerations for multiple boards

**Stimulus**
- DC Source
- Oscillator
- Waveform generator

**Signal Conditioning**
- Amplification/Attenuation
- Filtering
- Rectification
- Peak detection
- Phase detection
- Linearization
- Polarity

**Processing**
- Analog
- Digital
- Open loop
- Closed loop

**System/Plant**
Summary
Take Control of Your Analog Destiny

- Simplify Your Analog Design
  - Reduce design time
  - Save engineering costs
- Gain the Flexibility to Adapt Your Design
  - Easily address unknown/unforeseen design issues
  - Quickly modify circuits when specifications change
  - A board spin can be replaced with a software change
  - And this flexibility can extend all the way to your customer’s site
  - One PCB can serve many products
Take Control of Your Analog Destiny

- **Add New Features and Capabilities to your Systems**
  - Change your analog feature-set while your system runs
  - Add new capabilities you could only dream of in the past

- **Improve the Manufacturability of Your Design**
  - Automated system calibration and testing on production line
  - High integration – BOM reduction
  - Removes need for high tolerance components
Backup Materials
AnadigmApex (3.3volt) Architecture

- OpAmps contain an Input offset voltage “auto-nulling” feature. (I/O and core OpAmps)
- SPI configuration interface enables software control
- dualSRAM based configuration for real time state changes and seamless control over analog parameters
- Four type1 “featured” I/O cells, each can be independently powered down or configured as
  - single-ended or differential
  - an independent differential gain stage
  - differential input filter
  - input or output sample and hold
  - a bypass wire or digital output
- Three (type2) simple differential I/O cells.
  - One chopper stabilized gain stage (G <= 60dB), available to use with Type1 or type2 I/O cells
  - Two logic/control signal outputs
  - Clock management providing 6 non-overlapping internal clocks, two with variable phase delay
  - Look Up Table for arbitrary waveform generation
  - Rich pre-built (CAM) library

Four Configurable Analog Blocks (CABs) controlled by a switch capacitor architecture each containing:

- 2 differential 50MHz op-amps
- 1 differential comparator
- 1 SAR based ADC
- 8 programmable capacitors
Switched Capacitors
Precise Operation

- **Capacitor ratios** deliver accurate circuit parameters
  - Achieves 0.1% functional accuracy
  - Chip to chip accuracy ± 0.1%
- **Capacitor ratios** deliver drift-free operation
  - Immune to:
    - Process
    - Temperature
    - Aging

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\frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1} - \frac{1/f_c C_2}{1/f_c C_1} - \frac{-C_1}{C_2}
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