Project Code: APM_SPECTRO_PHOTOMETER_2015

ADI DUAL BEAM SPECTROPHOTOMETER DEMO SYSTEM AND SOLUTION

Application Introduction

This is the second article for spectrophotometer applications. In the first article, "ADI Dual Beam Spectrophotometer Solution," we discuss the applications, theory of operation, circuit architecture, and design considerations for spectrophotometers. This article introduces related, new ADI demo systems and products.

System Design Considerations

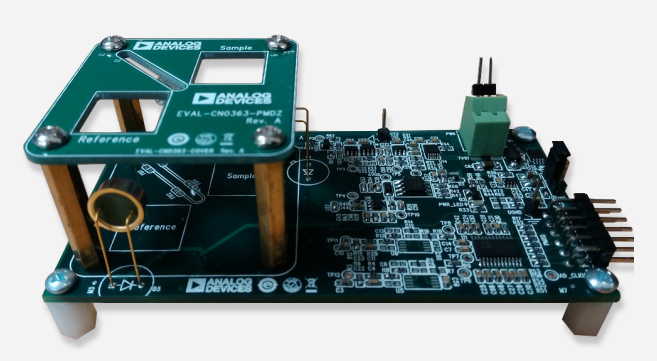
Stability

Drift with time and temperature are very important factors during spectrophotometer design. To achieve this objective, low drift and an accurate signal chain are required, and ADI excels in these two areas. Additionally, including dual beam architecture is also a key part of spectrophotometer design.

New Demo System from ADI

CN-0363: Dual-Channel Colorimeter with Programmable Gain Transimpedance Amplifiers and Digital Synchronous Detection

The circuit shown in the following figure is a dual-channel colorimeter featuring a modulated light source transmitter, programmable gain transimpedance amplifiers on each channel, and a very low noise, 24-bit, Σ-Δ analog-to-digital converter (ADC). The output of the ADC connects to a standard FPGA mezzanine card. The FPGA takes the sampled data from the ADC and implements a synchronous detection algorithm. By using modulated light and digital synchronous detection rather than a constant (dc) source, the system strongly rejects any noise sources at frequencies other than the modulation frequency, providing excellent accuracy.

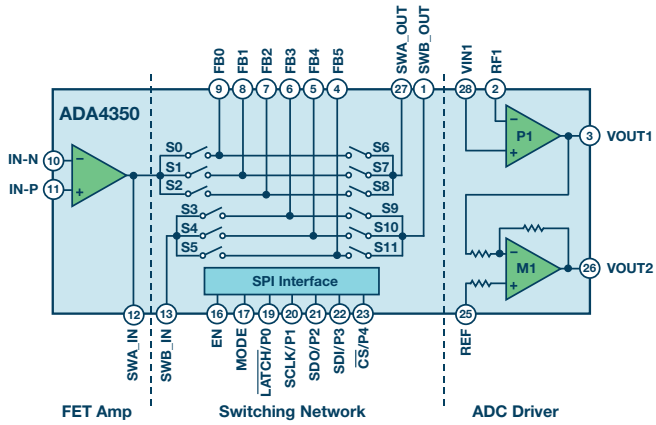


New Product from ADI

ADA4350: FET Input Analog Front End with ADC Driver for Current Detection, Photodiode Applications

The ADA4350 is an analog front end for photodetectors or other sensors whose output produces a current proportional to the sensed parameter or voltage input applications where the system requires the user to select between very precise gain levels to maximize the dynamic range.

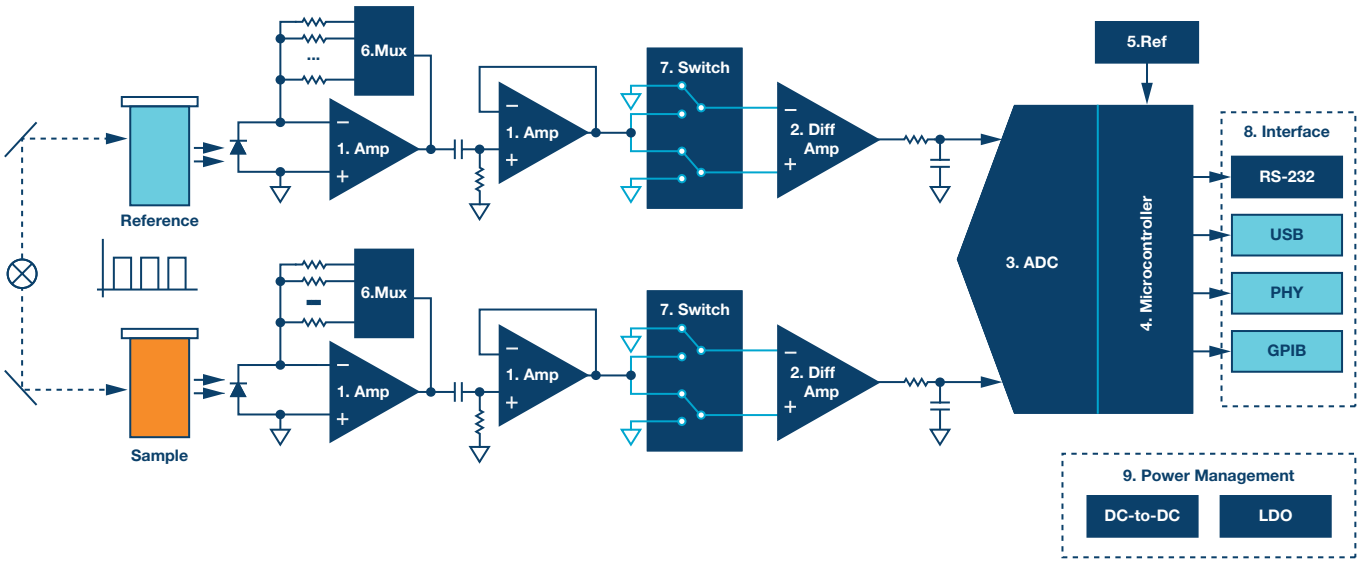
The ADA4350 integrates a FET input amplifier, a switching network, and an ADC driver with all functions controllable via a serial peripheral interface (SPI) or parallel control logic into a single IC. The FET input amplifier has very low voltage noise and current noise, making it an excellent choice to work with a wide range of photodetectors, sensors, or precision data acquisition systems.



Solutions from ADI

System Block Diagram

1. Below is the system block diagram of a general spectrophotometer including a simplified optical system, sample and reference cells, dual-channel signal conditioning circuit, microcontroller (ADC integrated), communication interface, and power management.



1. Amplifiers	2. Difference Amplifiers	3. ADCs	4. MCUs
ADA4350/AD8615/AD8605/AD8626	AD8271/AD8278	AD7175-2/AD7798/AD7799	ADuCM361/ADuC7061

5. References	6. Muxes	7. Switches	8. Interface	9. Power Management
ADR4525/ADR3425/ADR291	ADG704/ADG708/ADG1609	ADG733/ADG1636	ADM3251E	ADP2441/ADP2370/ADP160/ ADP7102/ADP7182

Main Products

Part Number	Description	Benefit
Amplifiers		
ADA4350	Analog front end with integrated ADC driver and integrated gain switching SPI or parallel switch control of all functions; input bias current: ±0.25 pA typ at 25°C; GBP: 175 MHz; up to 12 V power supply	Analog front end for spectrophotometer applications, featuring high integration and precision
AD8615	1 pA max @ 25°C, low offset voltage: 80 µV typ, 24 MHz bandwidth, 12 V/µs slew rate, low noise 8 nV/√Hz, 5 V power supply, rail-to-rail input/output	Low bias current at room temperature, high speed, low noise, low offset op amp
AD8605	1 pA max @ 25°C, low offset voltage: 65 µV max, 10 MHz bandwidth, low noise 8 nV/√Hz, rail-to-rail input/output	Low bias current at room temperature, high speed, low noise, low offset op amp
AD8626	0.25 pA bias current @ typ room temperature, less than 2 pA bias current @ typ 50°C, low offset drift 2 µV/C, up to ±13 V power supply, high bandwidth 5 MHz, rail-to-rail output	Wider power supply range, low bias current @ 0°C to 50°C, low offset drift
Difference Amplifiers		
AD8271	Gain = ½, 1, 2, gain drift 10 ppm/°C, 15 MHz and 30 V/µS slew rate	Low gain drift and high speed, suitable for ADC drivers
AD8278	Low power consumption 100 µA, G = ½ or 2, bandwidth 1MHz	Low power consumption, enough bandwidth
ADCs		
AD7175-2	Fast output rate: up to 250 kSPS; 24 noise free bits @ 20 SPS; 17.2 noise free bits @ 250 kSPS; INL: ±1 ppm of FSR	Fastest and most accurate Σ-Δ ADC in the world
AD7798	380 µA quiescent current, 3-channel, 16-bit peak-to-peak resolution, up to 470 Hz output update rate	Low power consumption and highly integrated Σ-Δ ADC, high resolution, and high accuracy
AD7799	380 µA quiescent current, 3-channel, 24-bit Σ-Δ ADC, up to 470 Hz output update rate	Low power consumption and high integrated Σ-Δ ADC, high resolution, and high accuracy

Part Number	Description	Benefit
Microcontrollers		
ADuCM361	Precision analog microcontrollers, ARM® Cortex®-M3 32-bit processor, six differential channels, single (24-bit) ADCs, single 12-bit DAC, power consumption 1.0 mA, 290 µA/MHz, 19-pin GPIO, 128 kB Flash/EE memory, 8 kB SRAM; small package, low drift internal reference 5 ppm typical, integrated programmable current source	Low power consumption, high precision 24-bits Σ-Δ ADC, 4 mA to 20 mA loop applications, small package
ADuC7061	A precision analog microcontroller based on a 10 MHz ARM7 and a highly precise dual Σ-Δ ADC front end, 24-bit of resolution and 16-bit ENOB and sub-100 Hz output rates; memory footprint includes a 32 kB flash and 4 kB SRAM; other key specs includes sub-3 mA operation (with MCU core at 1 MHz) making the part suitable for 4 mA to 20 mA loop applications, a 12-bit DAC and small packaging, 5 mm × 5 mm 32-lead LFCSP	Low power consumption, low cost 24-bits Σ-Δ ADC, 4 mA to 20 mA loop applications, small package
References		
ADR4525	2.5 V reference, very low drift: 2 ppm/°C (max), low noise: 1.25 µV pp @ 0.1 Hz to 10 Hz, long-term stability: 25 ppm/$\sqrt{1000hr}$, hysteresis: 50 ppm	Low drift, very good stability and low noise reference, low hysteresis, and many other choices for output voltage in ADR45xx family
ADR3425	2.5 V reference, low drift 8 ppm/°C (max), long-term stability 30 ppm/$\sqrt{1000hr}$, 100 µA max quiescent current, small size SOT-23, 6-lead package	Low drift, good stability, and many other choices for output voltage in ADR34xx family
ADR291	2.5 V reference, 12 µA quiescent current	Low power consumption, good drift and stability
Muxes		
ADG704	4-channel multiplexer, low on resistance 2.5 Ω @ typ, low leakage current 10 pA @ typ, low power consumption 1 µA	Low leakage and low on resistance help to build high accurate system
ADG708	8-channel multiplexer, low on resistance 3 Ω @ typ, low leakage current 10 pA @ typ, low power consumption 1 µA	Low leakage and low on resistance help to build high accurate system
ADG1609	4-channel multiplexer, ±8 V power supply, low on resistance 4.5 Ω @ typ, low leakage current 20 pA @ typ, low power consumption 1 µA	Wider power supply range, low leakage and low on resistance help to build high accurate system
Switches		
ADG733	Double SPDT switch, low on resistance 2.5 Ω @ typ, low leakage current 10 pA @ typ, low power consumption 1 µA	Low leakage and low on resistance help to build high accurate system
ADG1636	Double SPDT switch, ±8 V power supply low on resistance 2.5 Ω @ typ, low leakage current 10 pA @ typ, low power consumption 1 µA	Wider power supply range, ow leakage, and low on resistance help to build high accurate system
Interface		
ADM3251E	Isolated RS-232 transceiver, 460 kbps data rate, 5 V or 3.3 V operations, 15 kV ESD protection, 2.5 kV isolation	High integrated isolated RS-232 transceiver
Power Management		
ADP2441	4.5 V to 36 V input buck regulator, 1A output current, high efficiency larger than 90%, adjustable switching frequency: 300 kHz to 1 MHz, current limit protection, external soft-start, thermal shutdown	Small 3 mm × 3 mm LFCSP package, high efficiency
ADP2370	3.0 V to 15 V input buck regulator, 800 mA output current, 1.2 MHz or 600 kHz PWM frequency, low quiescent current 14 µA, high efficiency larger than 90%, current-mode control architecture	Small 3 mm × 3 mm LFCSP package, few peripheral components, and a small solution size
ADP160	2.2 V to 5.5 V input LDO, 150 mA maximum output current, ultralow quiescent current: 10 µA when output 10 mA, up to 15 fixed output voltage options available from 1.2 V to 4.2 V	Low power consumption, integrated output discharge resistor, small package with only two 1 µF external capacitor
ADP7102	20 V input LDO, 300 mA output current, low noise 15 µV rms, seven fixed output voltage versions and an adjustable version	High input voltage, low noise LDO
ADP7182	–28 V input LDO, 200 mA output current, low noise 18 µV rms	High input voltage, low noise negative LDO

Design Resources

APM Article

- APM: ADI Dual Beam Spectrophotometer Solution—*www.analog.com/en/apm/dbs.pdf*

Circuits from the Lab®

- CN-0363: Dual-Channel Colorimeter with Programmable Gain Transimpedance Amplifiers and Digital Synchronous Detectors—*www.analog.com/en/cn-0363*
- CN-0312: Dual-Channel Colorimeter with Programmable Gain Transimpedance Amplifiers and Synchronous Detectors—*www.analog.com/en/cn-0312*

Application Notes/Articles

- *Analog Dialogue*, "Programmable-Gain Transimpedance Amplifiers Maximize Dynamic Range in Spectroscopy Systems"—*www.analog.com/en/analogdialogue/47-05.pdf*
- Use Synchronous Detection to Make Precision, Low Level Measurements—*www.analog.com/en/ms-2698.pdf*
- Optimizing Precision Photodiode Sensor Circuit Design—*www.analog.com/en/ms-2624.pdf*
- Seven Steps to Successful Ultralow Light Signal Conversion—*www.analog.com/en/ms-2394.pdf*

Design Tools/Forums

- ADA4350 Video—*http://bcove.me/9a2kxy3m*
- ADuCM361 Design Tools—*http://ftp.analog.com/pub/MicroConverter*
- Analog Photodiode Wizard—*www.analog.com/designtools/en/photodiode/#/photoDiode*
- ADIsimPower™: ADI Voltage Regulator Design Tool—*www.analog.com/adisimpower*
- Engineer Zone®: Online Technical Support Community—*ez.analog.com*

Additional Gas Detector Resources, Tools, and Product Information:

instrumentation.analog.com/en/segment/im

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

cic.asia@analog.com

Free Samples

www.analog.com/sample

Technical Hotline

1-800-419-0108 (India)

1-800-225-5234 (Singapore)

0800-055-085 (Taiwan)

82-31-786-2500 (Korea)

Analog Devices, Inc.
Worldwide Headquarters

Analog Devices, Inc.
One Technology Way
P.O. Box 9106
Norwood, MA 02062-9106
U.S.A.
Tel: 781.329.4700
(800.262.5643, U.S.A. only)
Fax: 781.461.3113

Analog Devices, Inc.
Europe Headquarters

Analog Devices, Inc.
Wilhelm-Wagenfeld-Str. 6
80807 Munich
Germany
Tel: 49.89.76903.0
Fax: 49.89.76903.157

Analog Devices, Inc.
Japan Headquarters

Analog Devices, KK
New Pier Takeshiba
South Tower Building
1-16-1 Kaigan, Minato-ku,
Tokyo, 105-6891
Japan
Tel: 813.5402.8200
Fax: 813.5402.1064

Analog Devices, Inc.
Asia Pacific Headquarters

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

BR13927-0-11/15

analog.com

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™