

ADI医疗生命科学仪器 解决方案 ——为健康护航

HUGH YU 俞毅刚

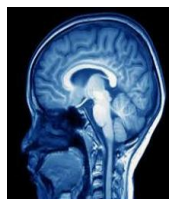
医疗业务亚太区系统应用经理



为所有人提供更好的健康管理和更
实惠的护理



远程医疗健康应用的专业知识



医疗影像



远程健康监护



医疗仪器与生命科学

通过科技提高生活质量

预防与健康

可穿戴设备、远程健康监护

诊断

医学成像、医疗点诊断、仪器仪表

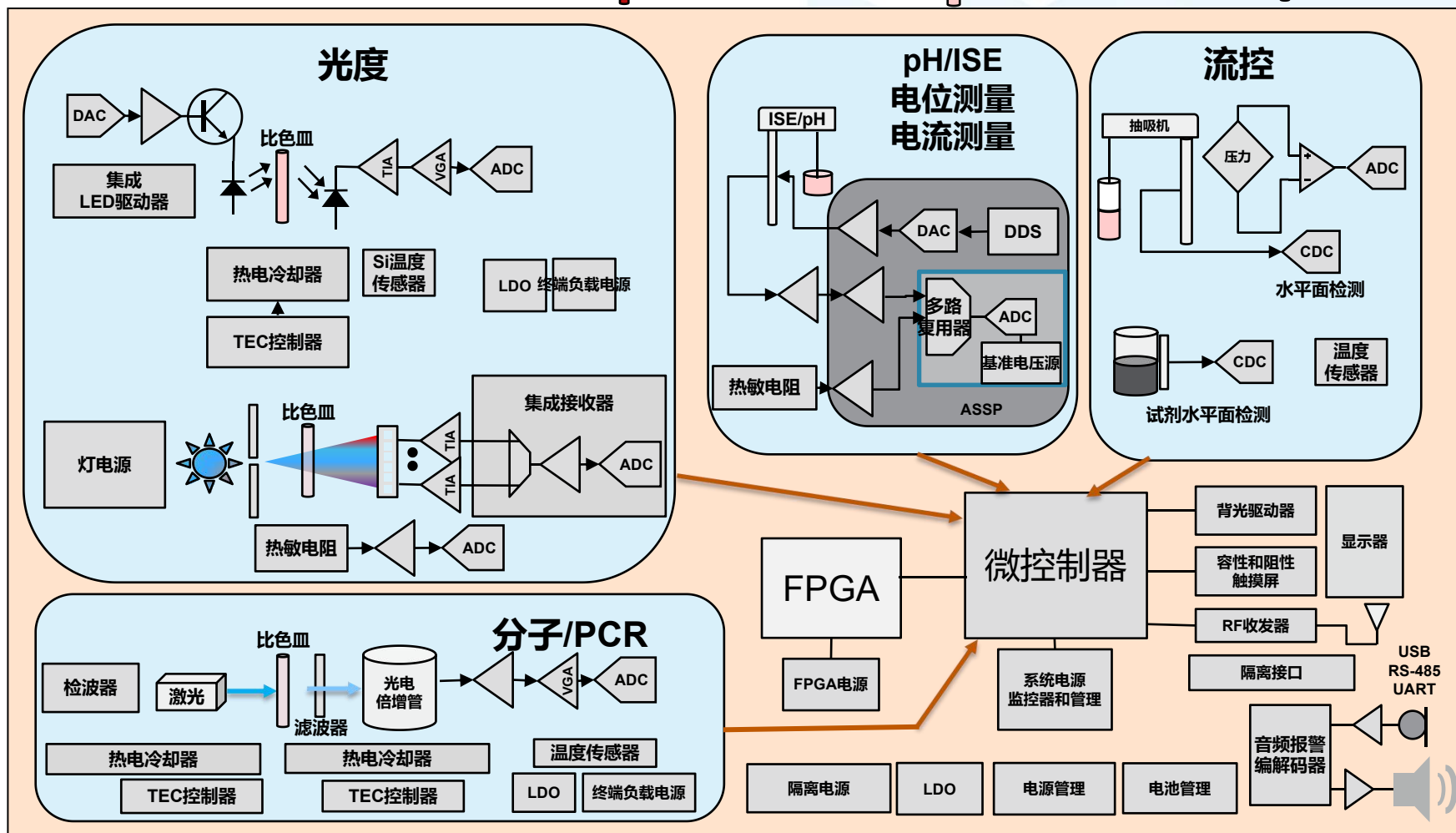
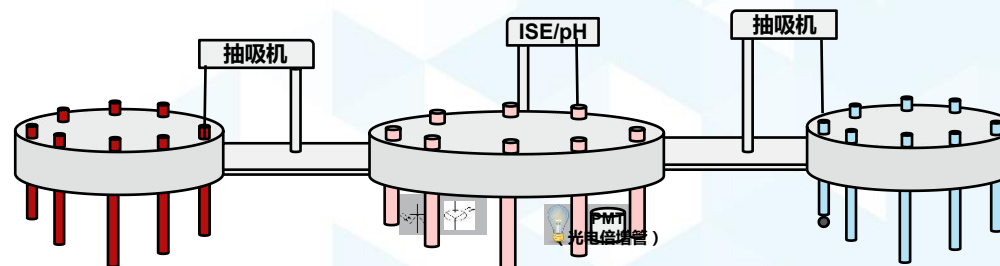
治疗

导管、外科手术机器人、可植入式设备、基因组

疾病管理

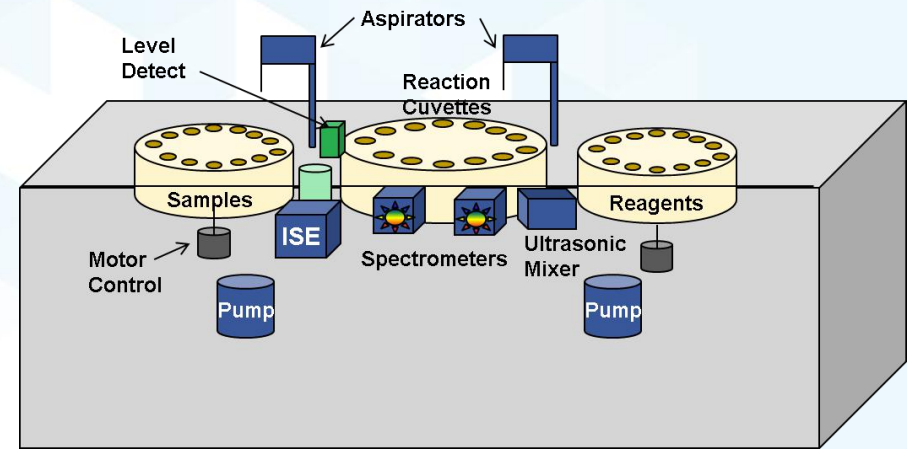
药物依从性、给药

生化分析仪、体外化学分析仪



化学分析仪：功能与实现

- ▶ 光度
 - 光电倍增管或光电二极管 (FET放大器、ADC、DAC)
 - 光源 (灯、激光、LED) - ADPxxx
 - 滤波器、光栅、镜和孔径 (DAC、放大器)
- ▶ ISE (电位测量与极谱)
 - 电位计 (DAC、放大器 (FET和CMOS)、ADC、REF、uC (ADuC350))
 - 电导率 (放大器、DAC、ADC)
- ▶ 样本移动/流控
 - 电平 (电容(CDC)、压力 (仪表放大器、ADC)、超声 (放大器、DAC、uC))
 - 温度 (传感器、放大器和ADC)
 - 运动 (电机控制、电源管理、近距离、放大器、DAC、ADC)
 - 混频 (超声 (放大器、DAC))
- ▶ 自动化
 - 电机控制、电源管理、条形码读取(DSP)、电平检测 (CDC或超声)、近距离(CDC)



◆ 控制和处理

- Blackfin、ADuCxxxx

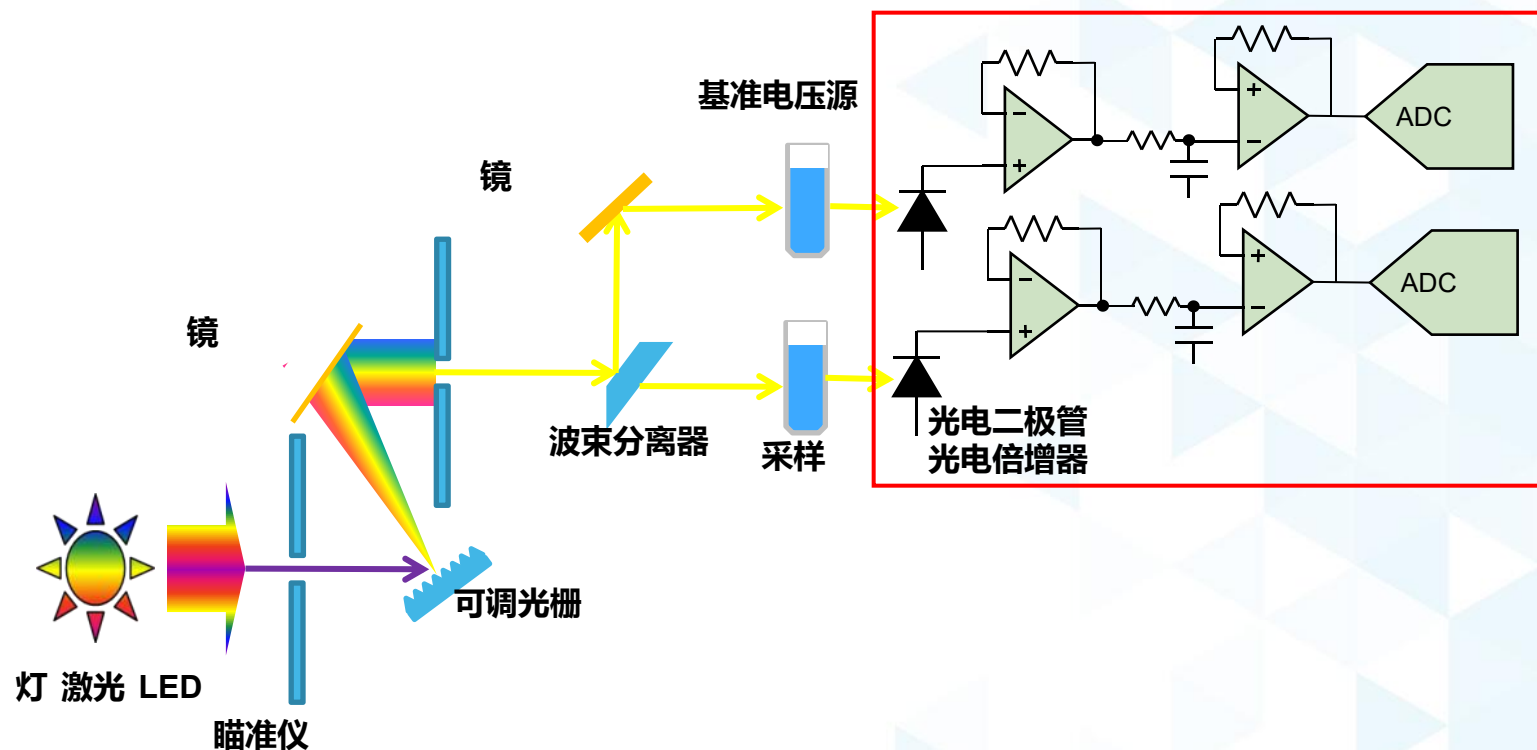
◆ 电源

- 电源管理
- 时序控制器、系统电源监控器

◆ 接口

- 隔离、USB、RS232、无线
- GUI – CAPTouch

光谱分析法



- ▶ 光谱学使用许多配置
- ▶ 光源取决于频谱和强度
 - 灯（氙灯、氙灯、卤素灯、钨灯）、LED、激光
- ▶ 检波器取决于强度、频谱和速度
 - 光电倍增管、APD、光电二极管、混合
- ▶ 极化器、滤波器、斩波器、增益

光源

▶ LED

- 白光
- 彩色
- 闪光

▶ 灯

- Deuterium 氘 [dāo] 灯
- Xenon 氙 [xiān] 灯
- Xenon Flash
- Tungsten-Halogen 钨卤素灯

▶ 激光

- CWLD
- PLD



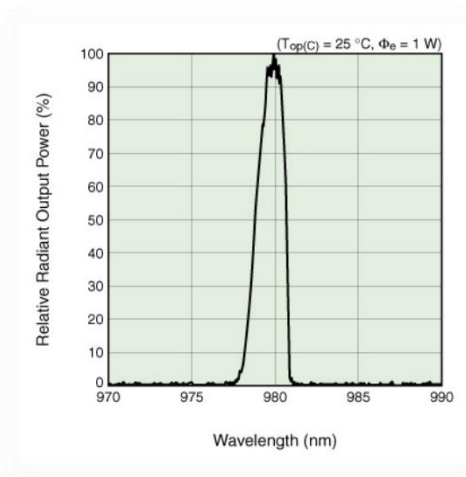
氘灯



氙闪光灯



氙灯



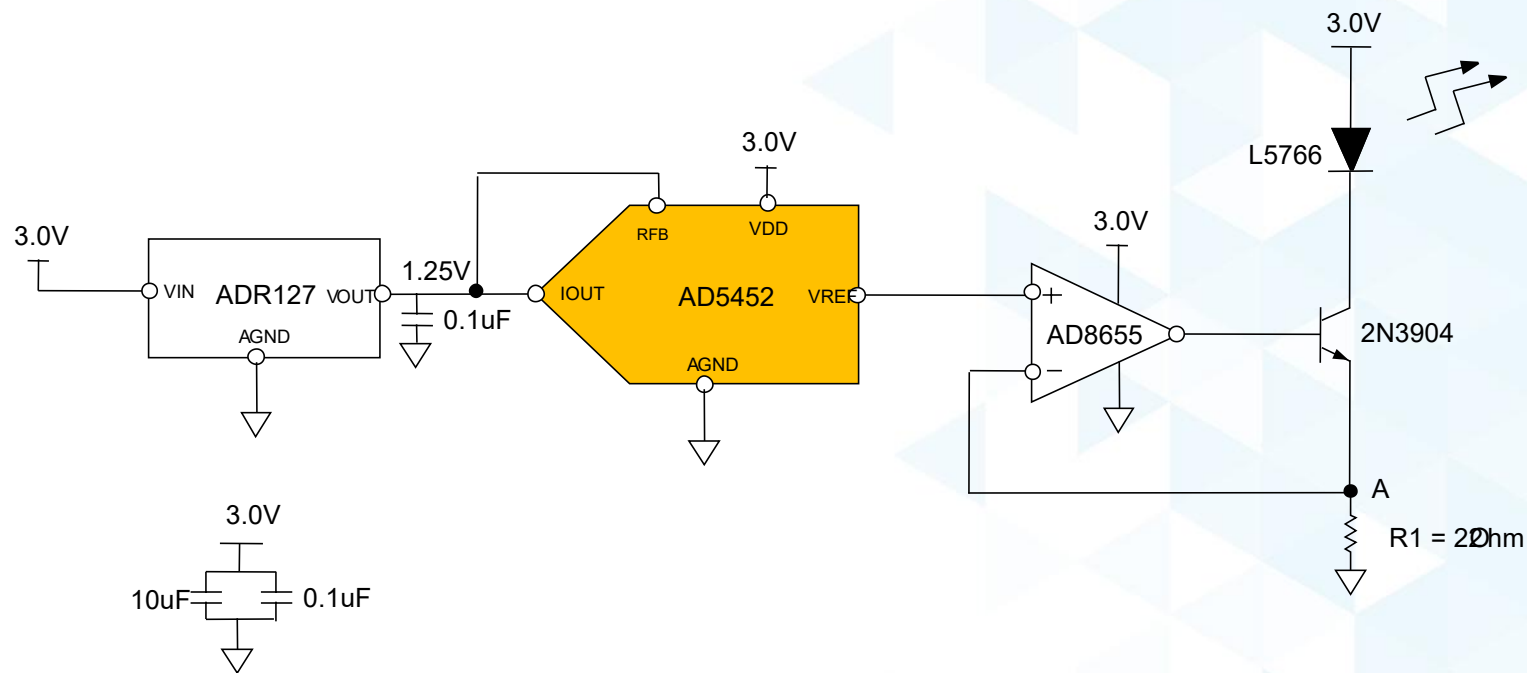
CWLD



PLD

* 所有图片均来自Hamamatsu(滨松)网站

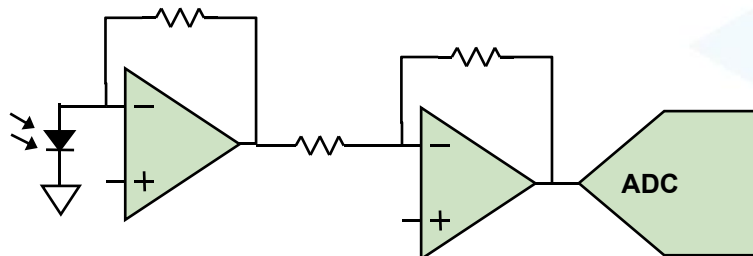
低噪声LED控制信号链



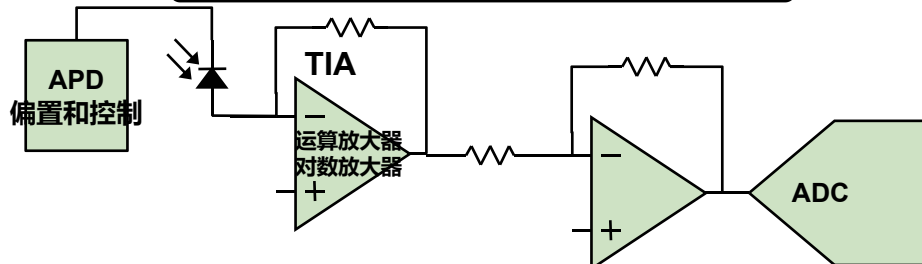
- 利用AD5452的低噪声R-2R架构控制电压。
 - 电流输出DAC处于反向模式以支持单电源功能。
 - 仅限低输入电压(<1.5V)，因为源漏驱动电压处于反向模式。
- 低噪声AD8655运算放大器通过R1检测电压。
- 使用低噪声精密ADR127 LDO生成1.25V基准电压。

光电检测器选项

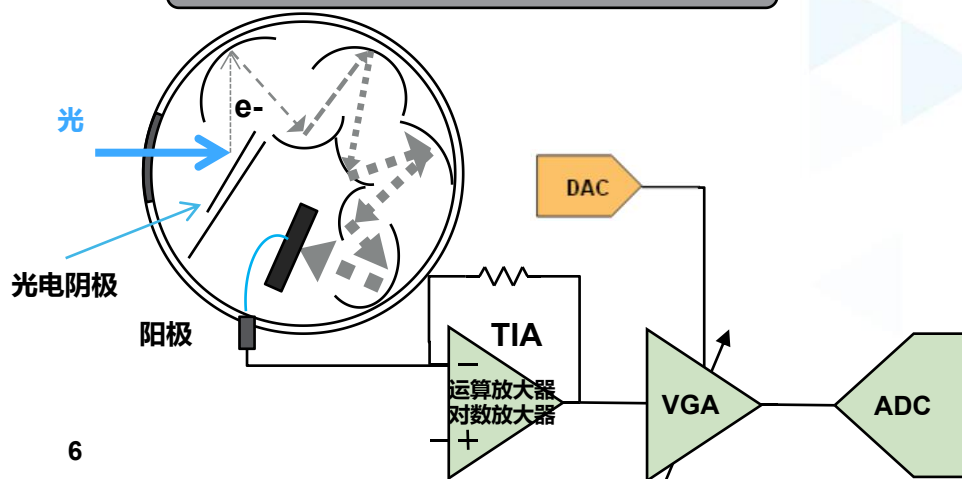
光电二极管(PD)



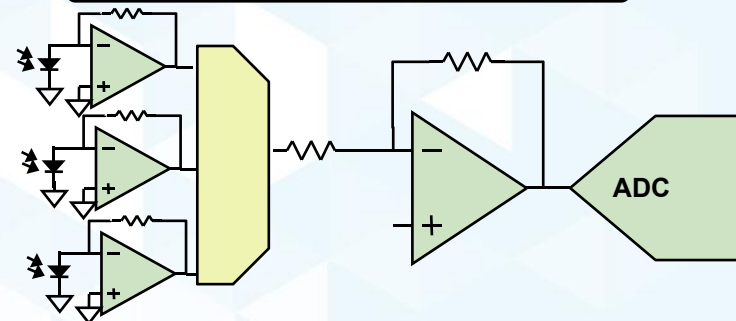
雪崩光电二极管(APD)



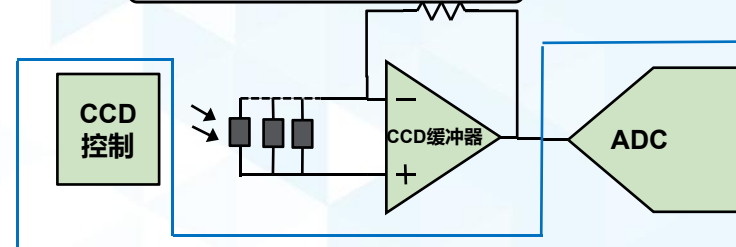
光电倍增管(PMT)



光电二极管阵列(PDA)



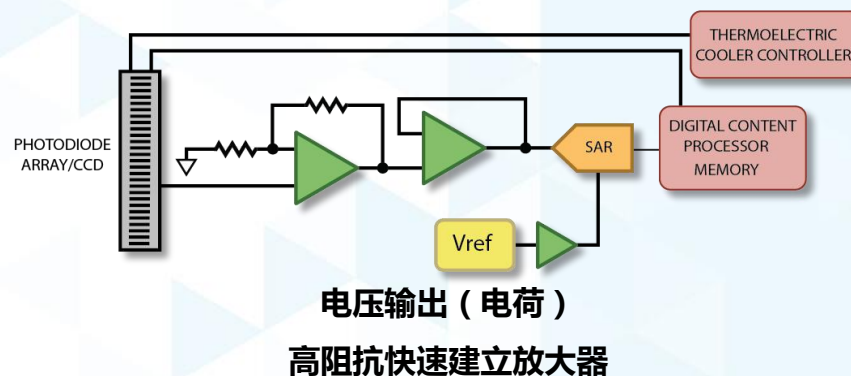
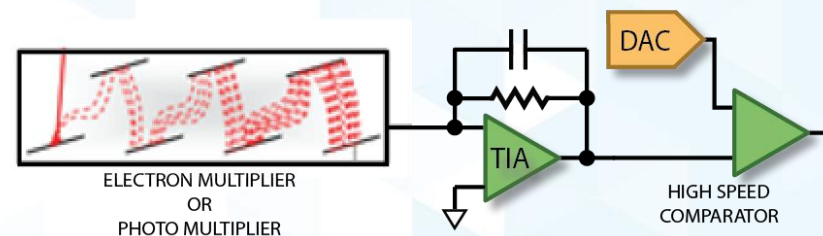
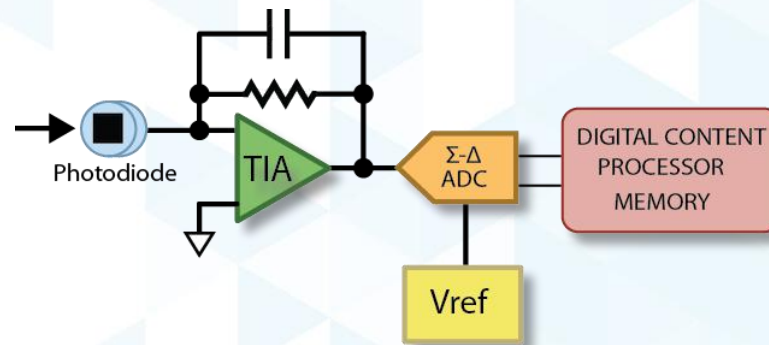
CCD阵列(CCD)



- 多种方法
- ADI解决方案：
 - 光学传感器
 - 放大器、对数放大器和缓冲器
 - ADC
 - 偏置和控制
 - 温度控制
 - 还有低噪声电源

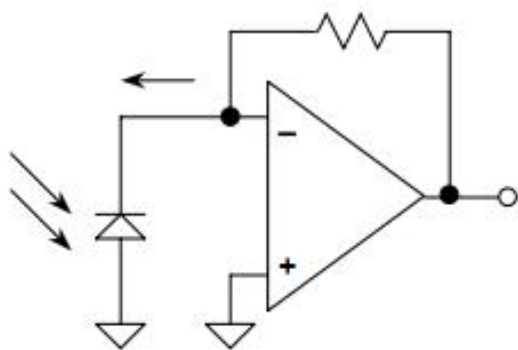
光谱分析接收链路：光学传感器

- ▶ 光电二极管
 - 恒定功率或脉冲/调制光源
(电流输出)
- ▶ 光电倍增管
(电流输出)
- ▶ CCD阵列
(电荷输出)



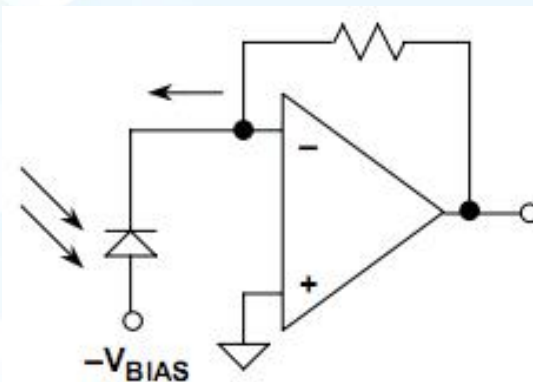
光电二极管工作模式

◆ 光伏



- 零偏置
- 无暗电流
- 线性
- 低噪声 (约翰逊)
- 精密应用

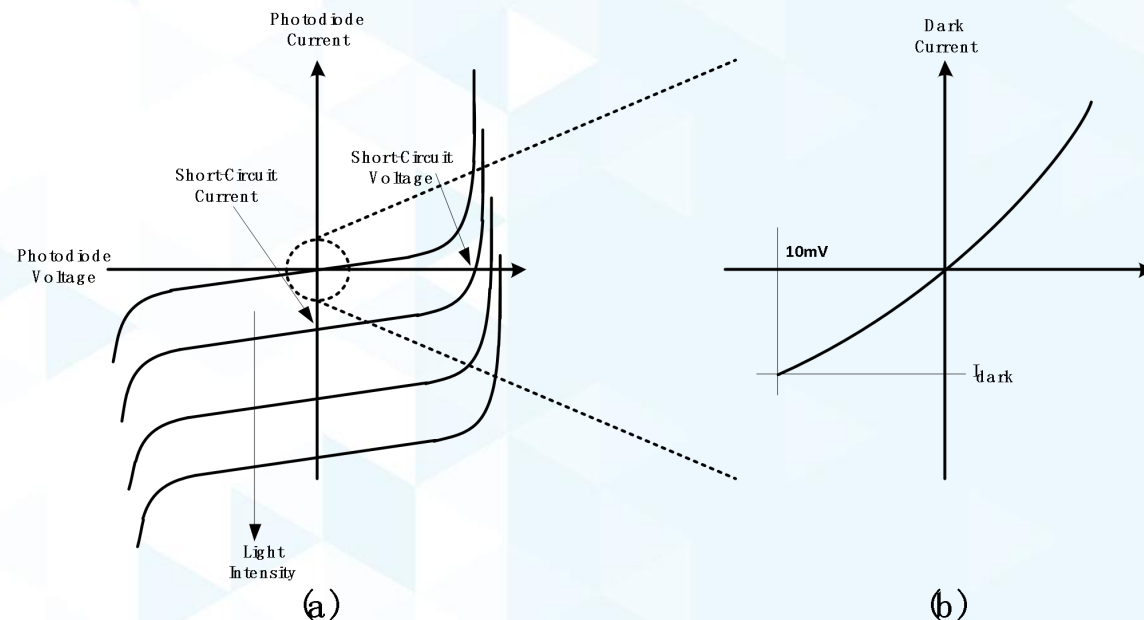
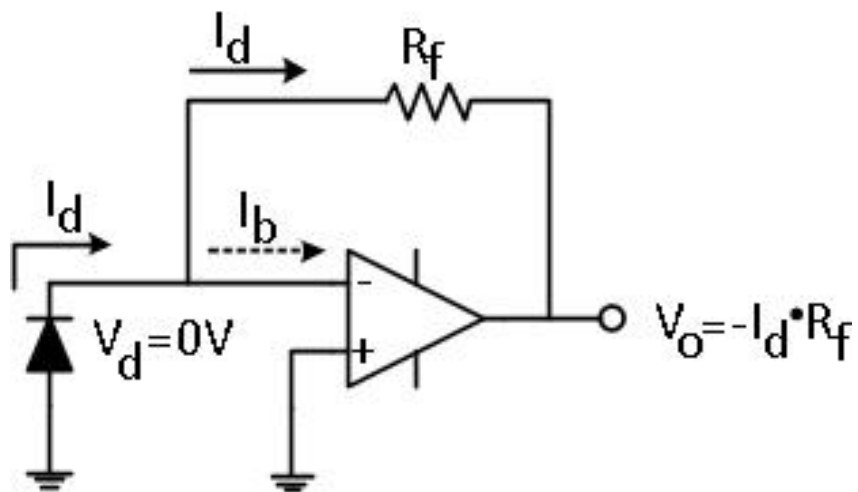
◆ 光导



- 反向偏置
- 有暗电流
- 非线性

测量光电二极管输出

- ▶ 有光输入时，光电二极管电压的非线性特征十分明显
- ▶ 有光输入时，光电二极管电流呈线性特征
 - 需要将光电二极管电流转换成输出电压
- ▶ 跨阻放大器
 - 电流电压转换器



PD & PMT跨阻放大器

► TIA目标

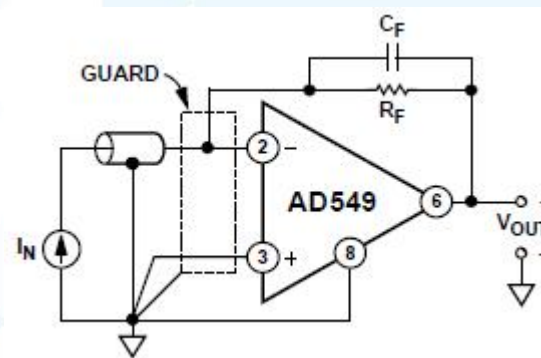
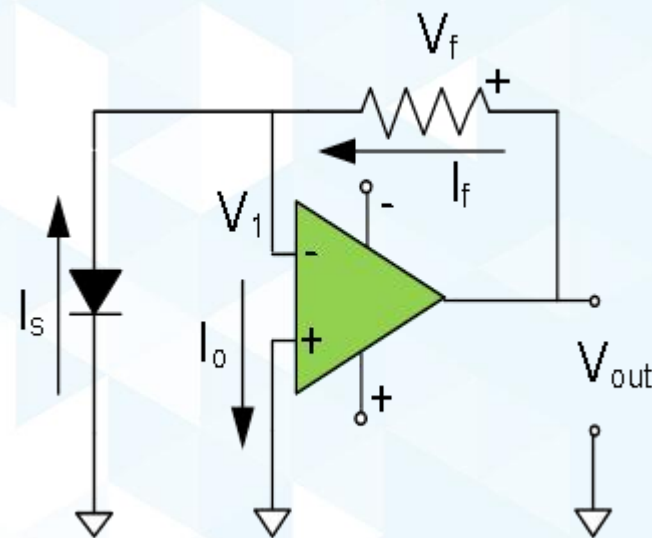
- 完整的电流到电压转换
- 无噪声，不会增加信号
- 不会对PD/PMT过载
- 保持稳定性

► 要求

- 高输入阻抗(Z_{in})
- 低输入偏置电流(I_b)
- 低失调电压(V_{os})
- 低噪声(V_n & I_n)
- 低失调电流(I_{os})
- 适当选择带宽
- 超高速，可能需要电流反馈放大器

► FET输入放大器

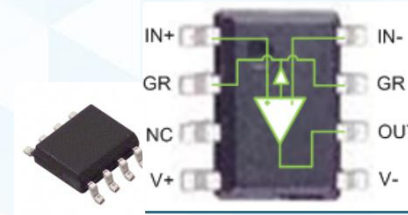
- CMOS放大器可用在控制温度的地方



超低偏置电流运算放大器路线图



生命科学和化学分析应用
需要超低偏置电流放大器和保护环驱动器



ADA4530

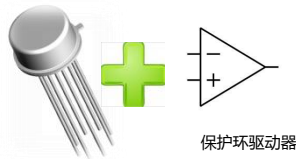
IBIAS 20 fA (最大值), 18V集成保护
环驱动器



AD8661

IBIAS 300 fA (典型值)
1pA (最大值), 16V

保护环驱动器



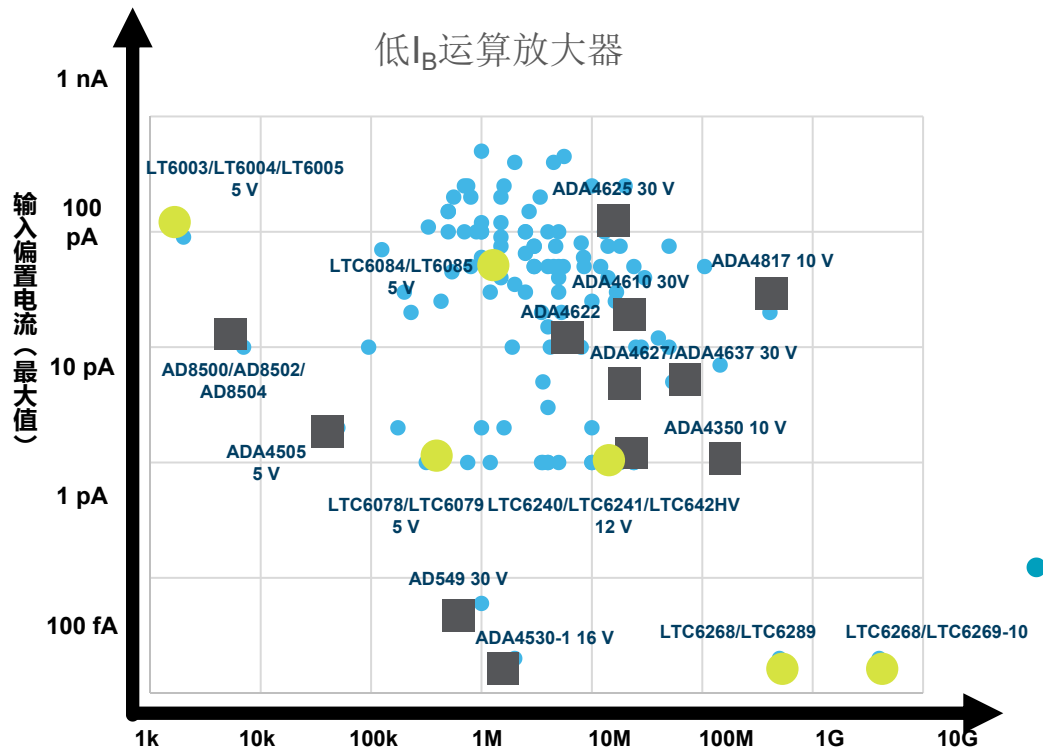
保护环驱动器

AD549

IBIAS 60fA (最大值), 36V



低IB运算放大器产品系列（JFET和CMOS）

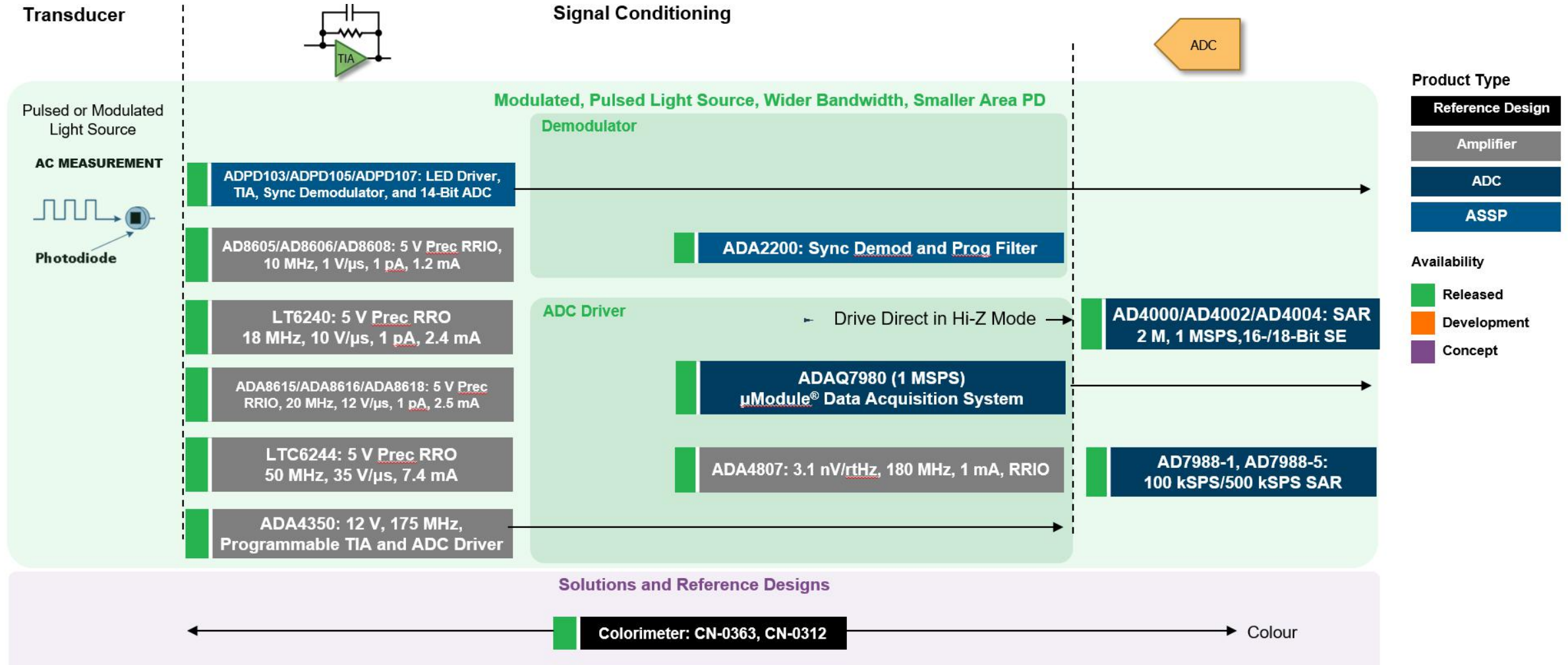


主要应用优势：

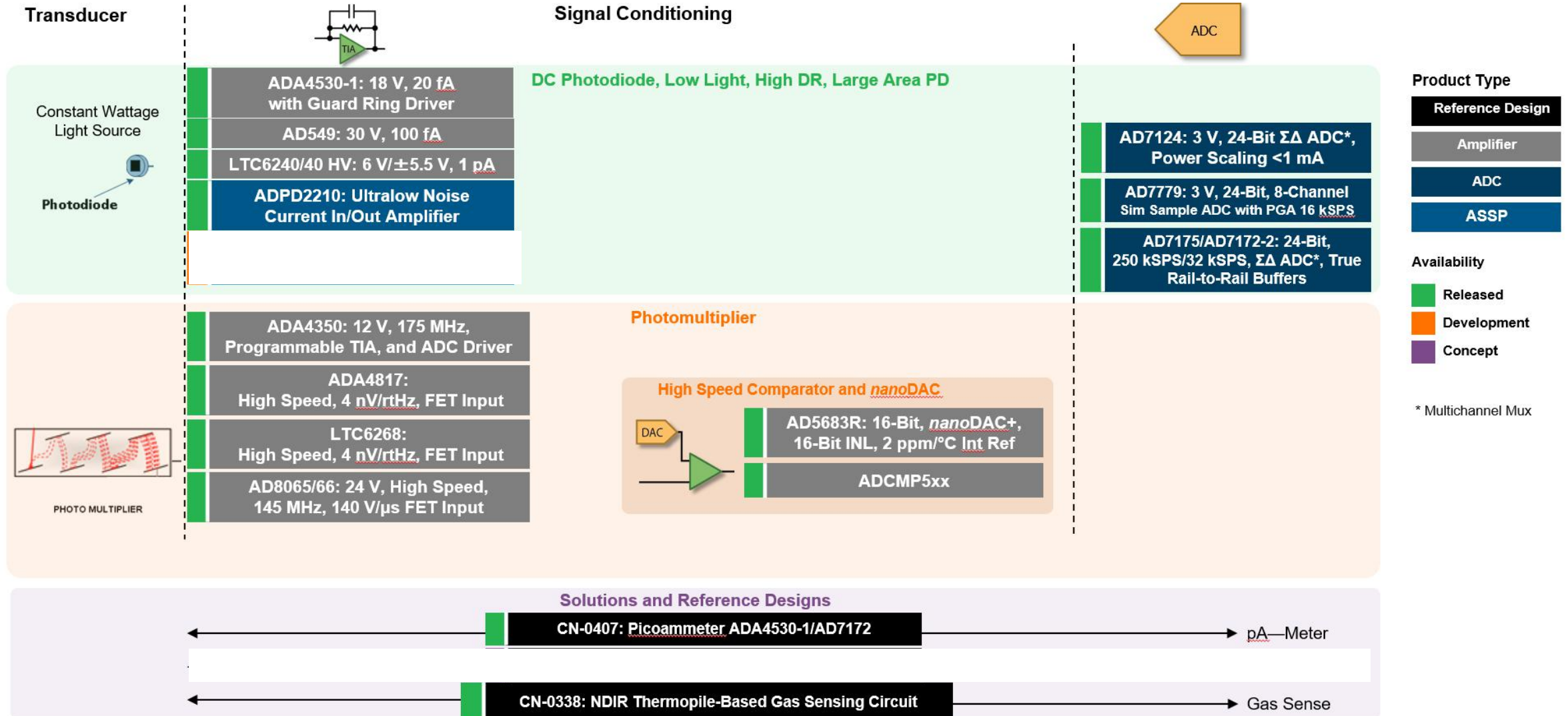
- 高输入阻抗以及直流精度与交流性能的组合，支持缓冲高阻抗传感器而不会破坏信号或产生伪像。
- 与精密双极性放大器相比，FET放大器的TCVos通常要高得多。这方面在持续进步。
- 当1/f噪声至关重要时，JFET仍会是首选

每个点代表ADI和LTC产品系列组合中的一款产品；精选重要产品以高亮显示

光谱分析接收链路

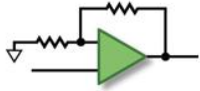


光谱分析接收链路



光谱分析接收链路

Transducer



CCD
(Charged Coupled Device)

- ADA4896/ADA4897: 230 MHz, Low Noise, RRO
- ADA4800: 400 MHz, Low Power CCD Buffer
- LTC6253: 720 MHz, Low Noise, RRIO
- ADA4807: 180 MHz, Low Noise, RRIO
- LTC6246: 180 MHz, IB 30 nA, RRIO

Signal Conditioning

Charged Coupled Display (CCD)

ADC Driver

- ADAQ7980: (1 MSPS) μModule Data Acquisition System
- ADA4940-1: 3.9 nV/rtHz, 1.25 mA, 260 MHz Diff Amp
- LTC6403: Diff Amp 200 MHz, 2.8 nV/rtHz
- LTC6363: Diff Amp 500 MHz, 2.9 nV/rtHz
- ADA4932: 3.6 nV/rtHz, 9.6 mA, 560 MHz Diff Amp



- AD4000: SAR 2 MSPS, 16-Bit Single Ended Input
- AD7677: SAR 2.5 MSPS, 16-Bit Differential Input
- AD7961: SAR 5 MSPS, 16-Bit Differential Input
- AD7988-1, AD7988-5: 100 kSPS/500 kSPS SAR
- AD7626: SAR 10 MSPS, 16-Bit Differential Input
- LT2387-16/LT2387-18: SAR 15 MSPS, 16-/18-Bit Differential Input

Product Type

- Reference Design
- Amplifier
- ADC
- ASSP

Availability

- Released
- Development
- Concept

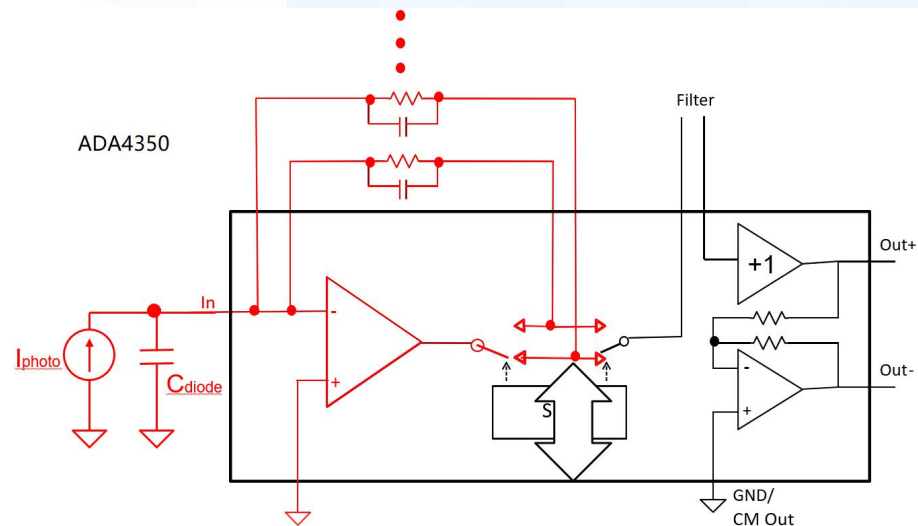
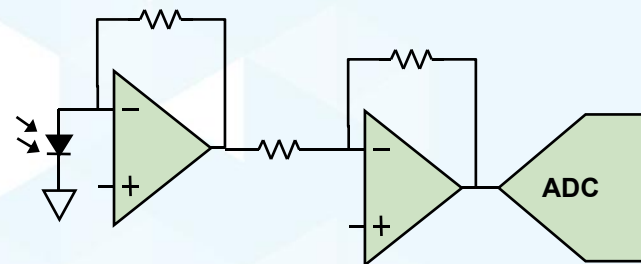
Solutions and Reference Designs

CN-0338: NDIR Thermopile-Based Gas Sensing Circuit

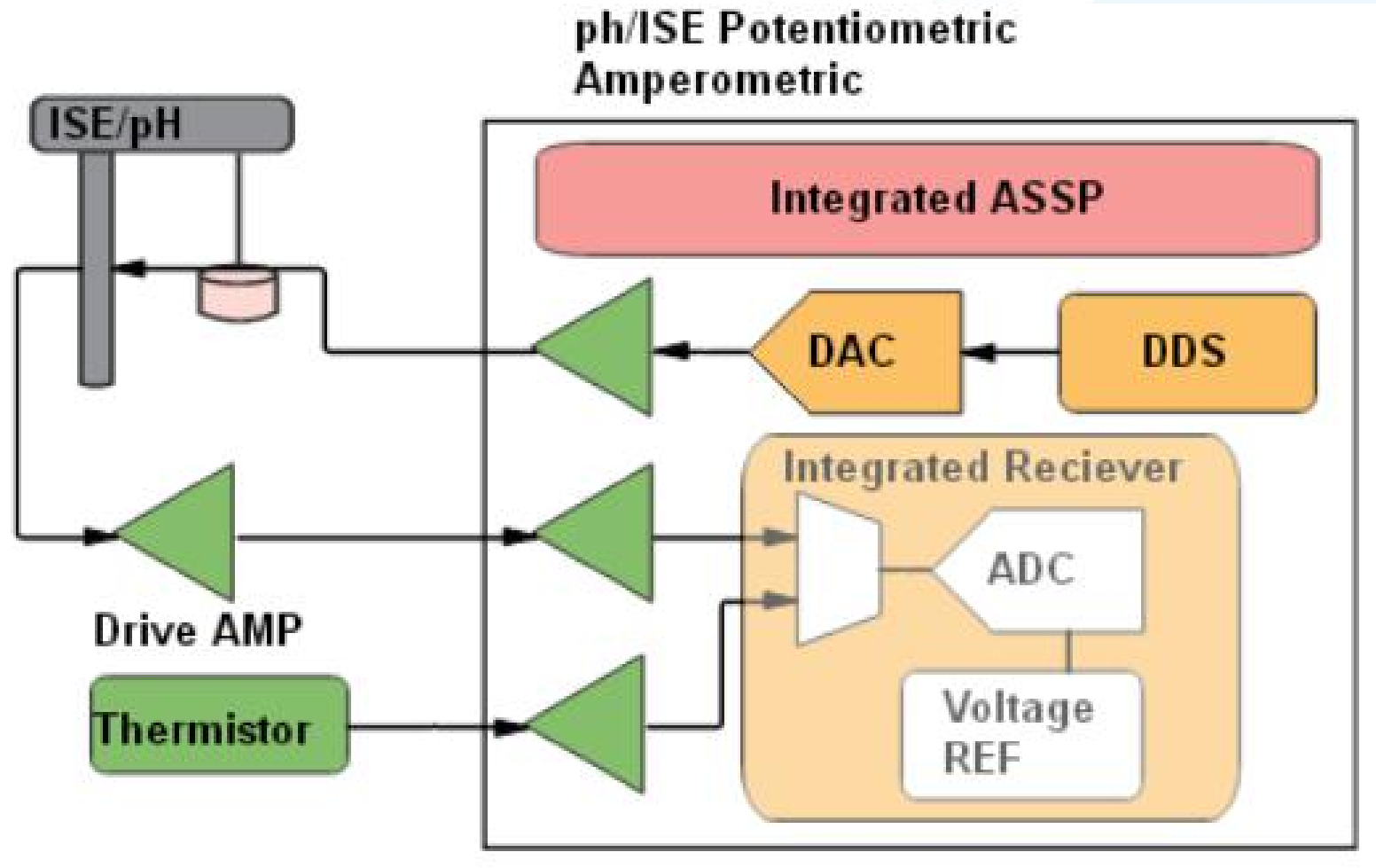
Gas Sense

光谱测定信号链

- ▶ 高检测率光电二极管和放大器
 - 低 I_b 、高 Z_{in} 、低噪声FET或CMOS运算放大器
 - 精密、低噪声运算放大器（信号调理、ADC驱动）
- ▶ ADC
 - 12至20+位 – SAR或 Σ - Δ ，单通道、多通道或同步采样
- ▶ 电流数字转换器
 - 集成16位多通道解决方案
- ▶ 支持器件
 - 热电冷却器控制器/驱动
 - 低噪声基准电压源
 - 低 C 、低 R_{on} 的开关/多路复用器
 - 低噪声、稳定的电源管理
 - 数字电位计

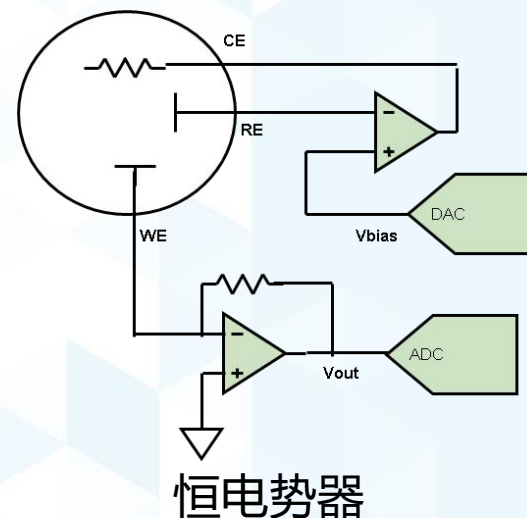
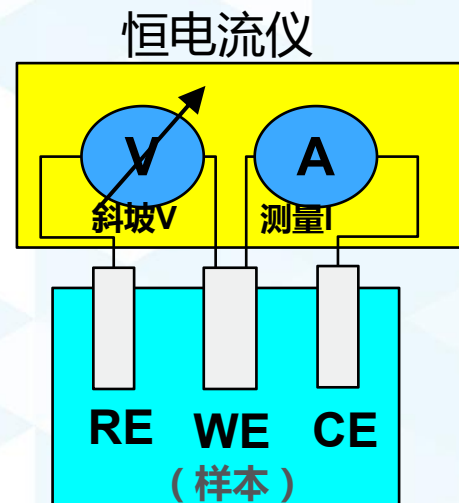


酸碱度/离子选择电极法



恒电势器、恒电流仪

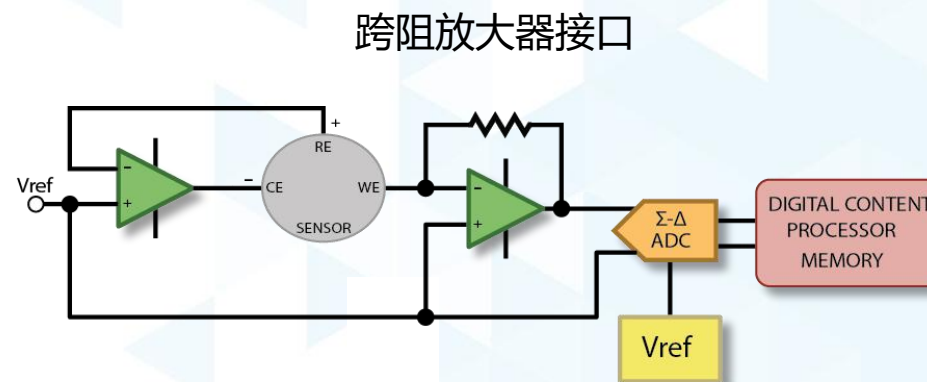
- ▶ 3电极单元
 - 用于研究分析物的半电池反应性
 - 由工作电极、参比电极和反电极组成
- ▶ 许多电压测量技术和配置
 - 扫描、溶出、吸附等
- ▶ 恒电势器
 - 保持恒定的WE到RE电位，通过驱动CE电流
- ▶ 恒电流仪
 - 根据电池电阻的变化调整RE和WE之间的电压，使WE和CE之间的电流保持恒定



电势/电流测量

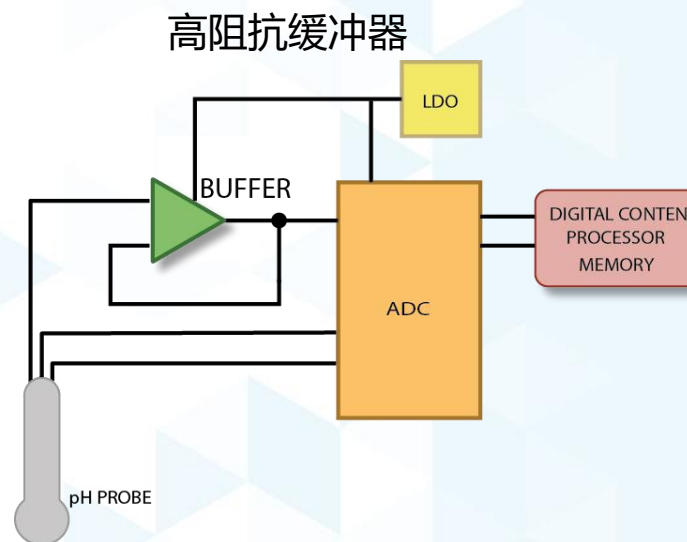
▶ 伏安法

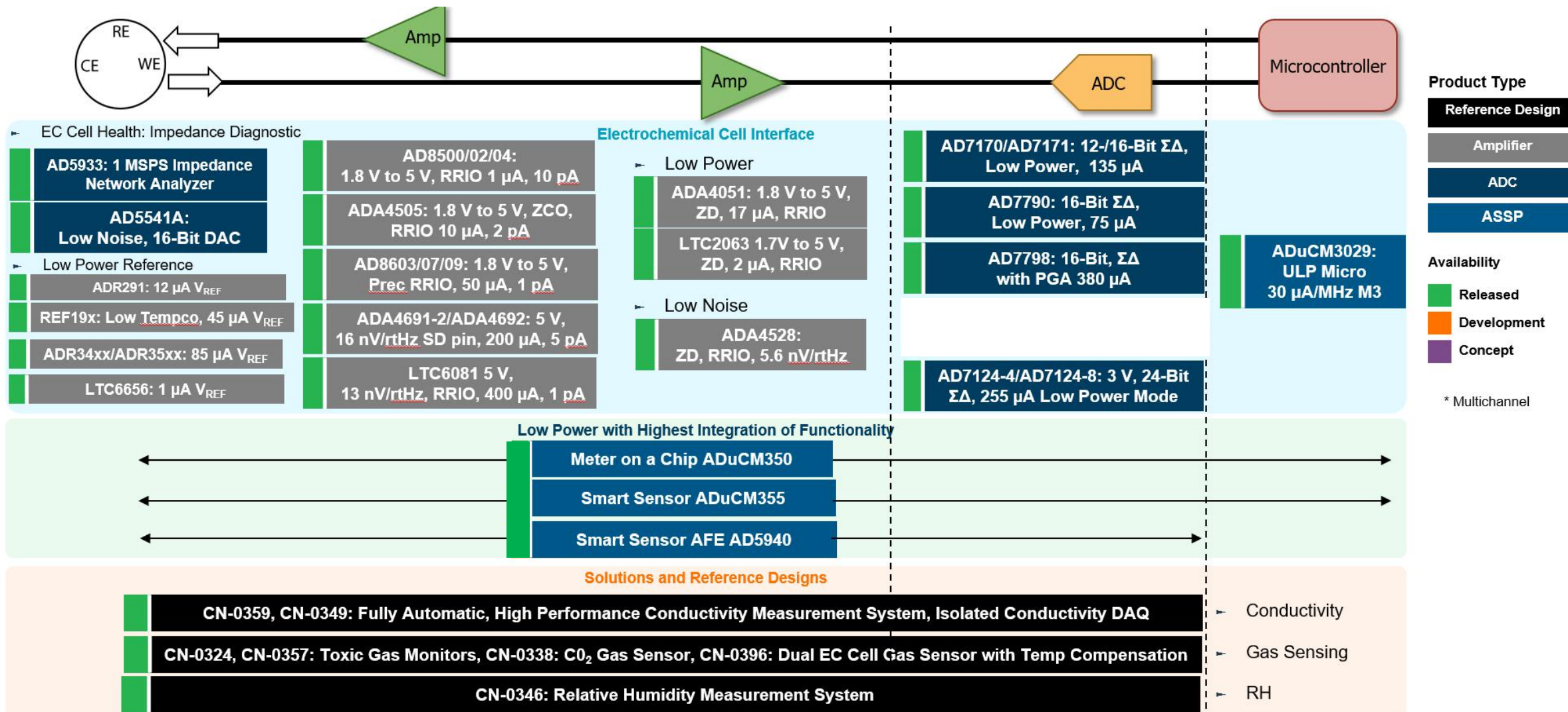
- 电压驱动
- 测量电流 (例如：气体传感器)



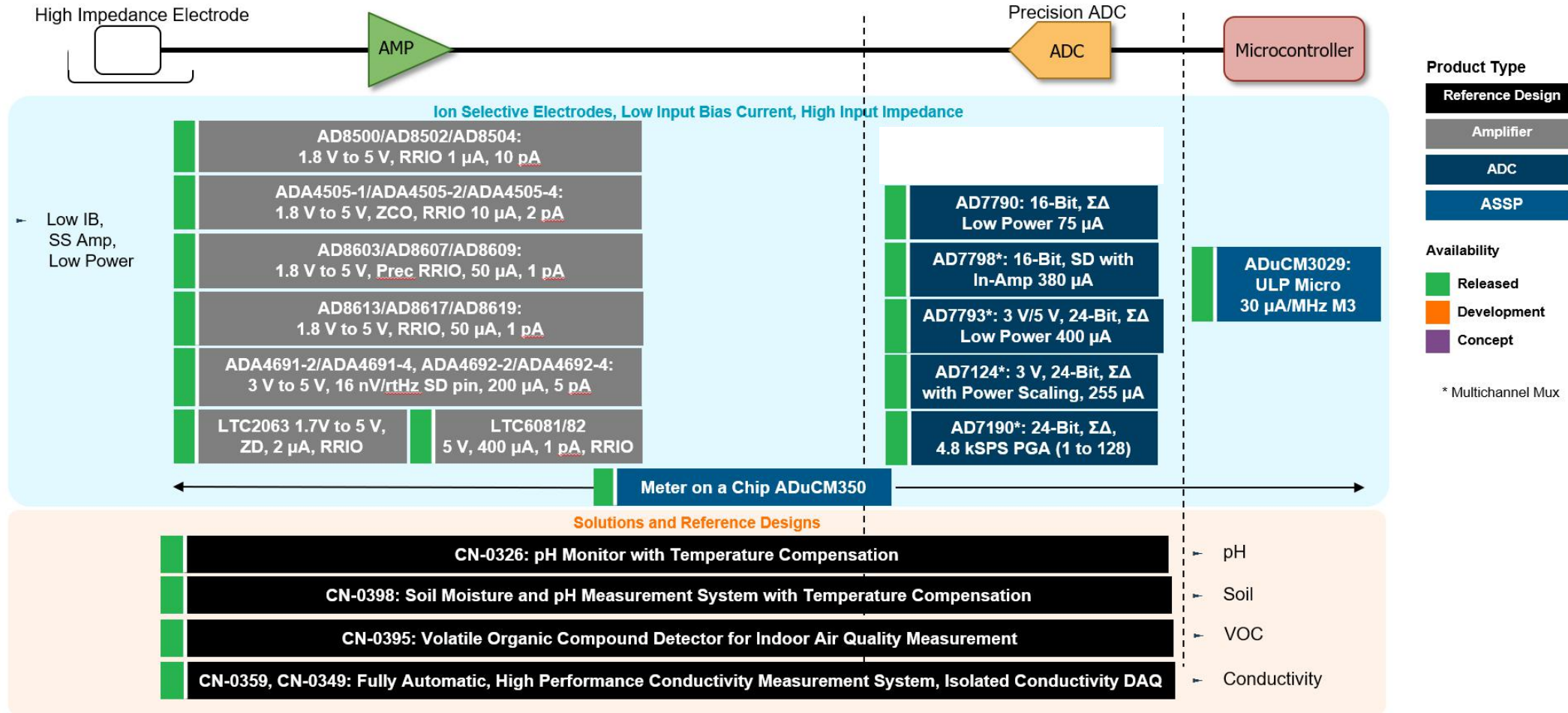
▶ 电压输出

(例如：pH探头)

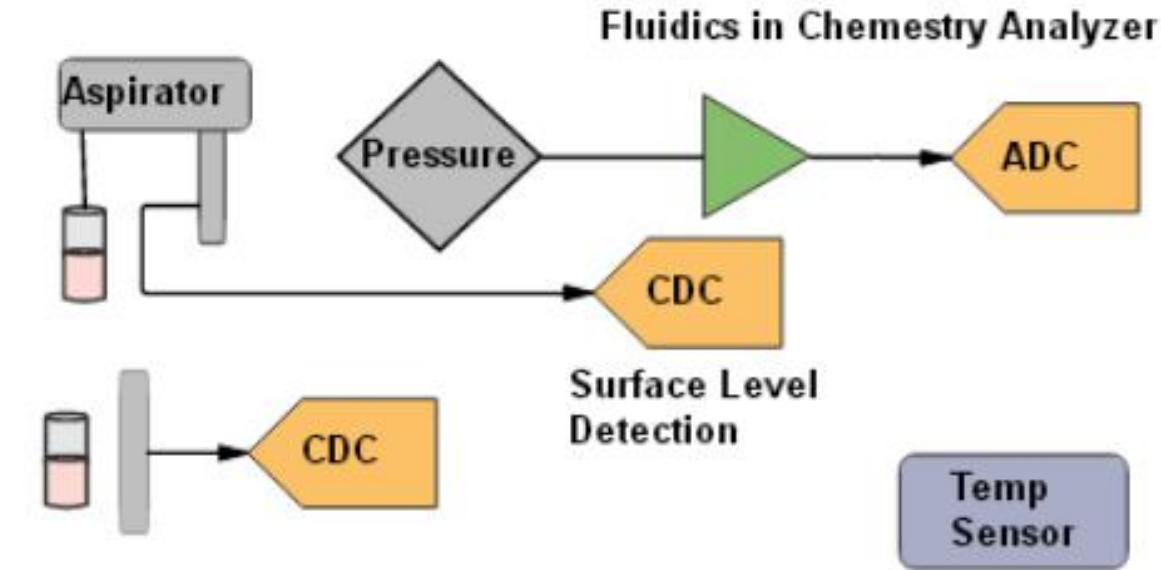




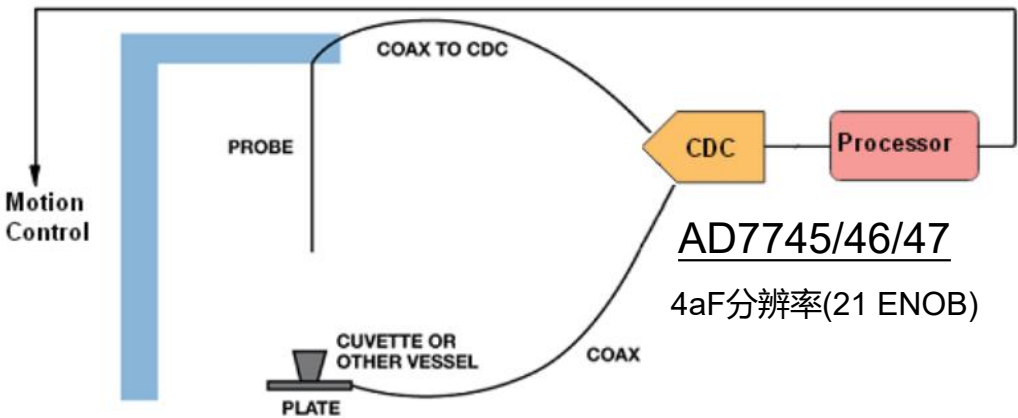
离子选择电极法



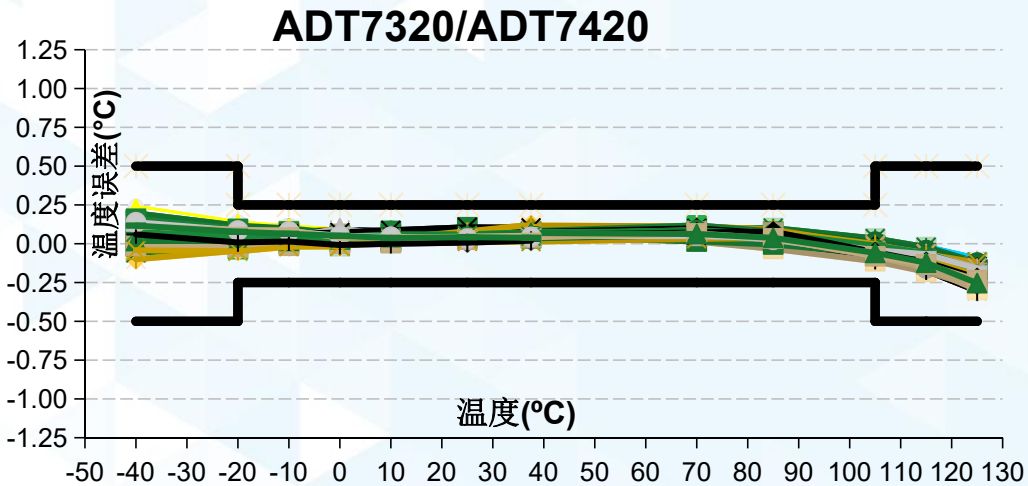
液位，压力，温度测量



Reagent Level Detection



AD7745/46/47
4aF分辨率(21 ENOB)



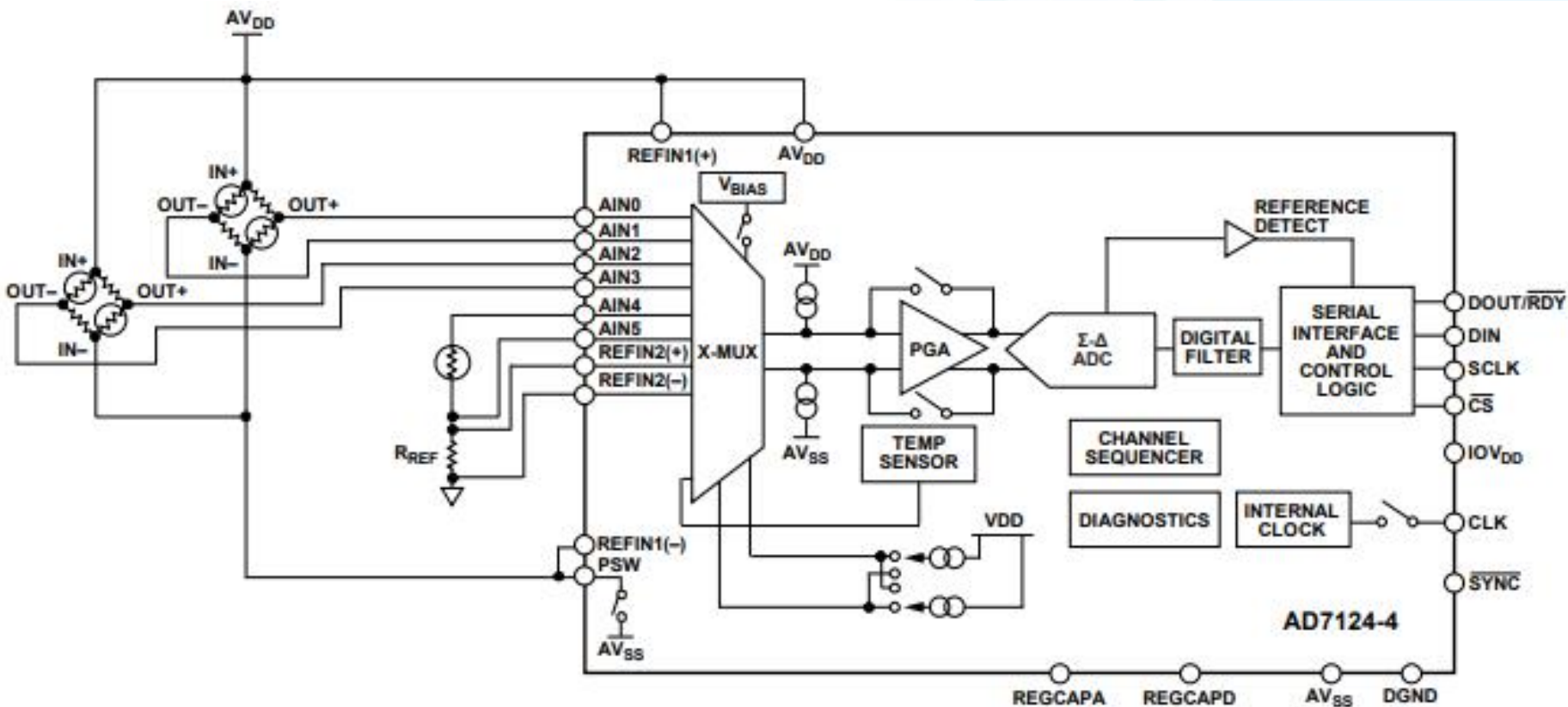
**Temperature Sensor
Achieves Highest
Accuracy of $\pm 0.25^{\circ}\text{C}$**



压力测量 AD7124-4

AD7124-4 非常适合差分压力测量

- 双桥+ 温度
- 23 nV rms Noise (In-Amp Gain = 128)
- 安全诊断
- 系统自校准



体外诊断设备中的电源管理

LDO

升压器

PSM/VR

uModule

ISO电源

LED驱动器

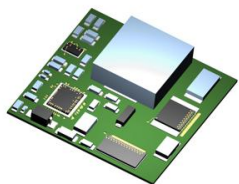
降压-升压

监控器

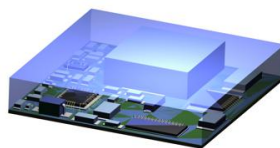
混合DC/DC

单片降压器

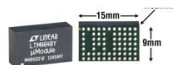
Components Attached on a
Substrate



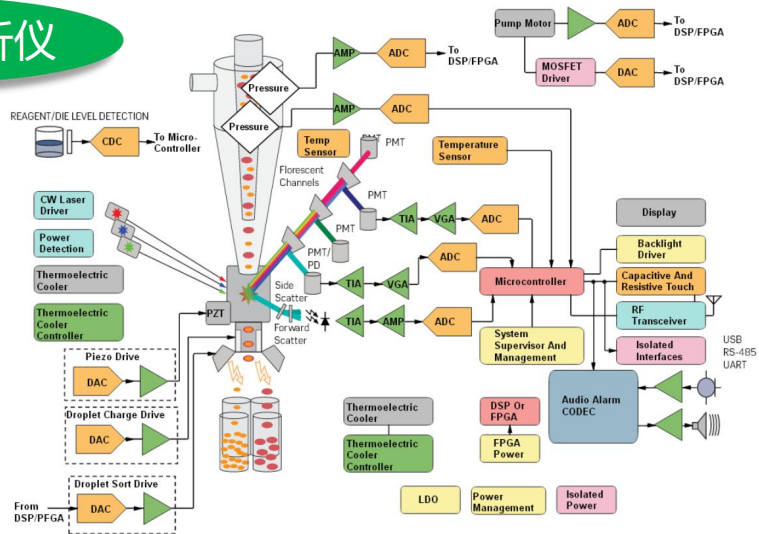
Molded and Tested Like a
Standard Semiconductor



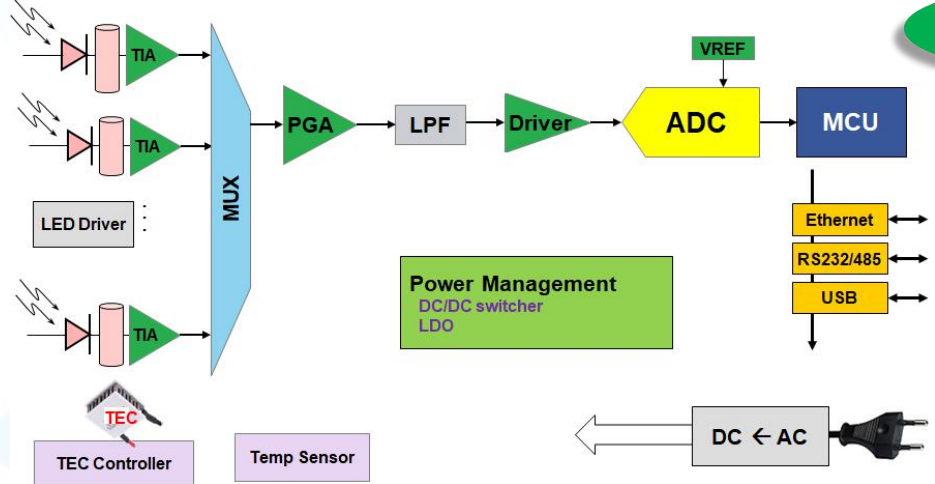
Both Die and Packaged Components



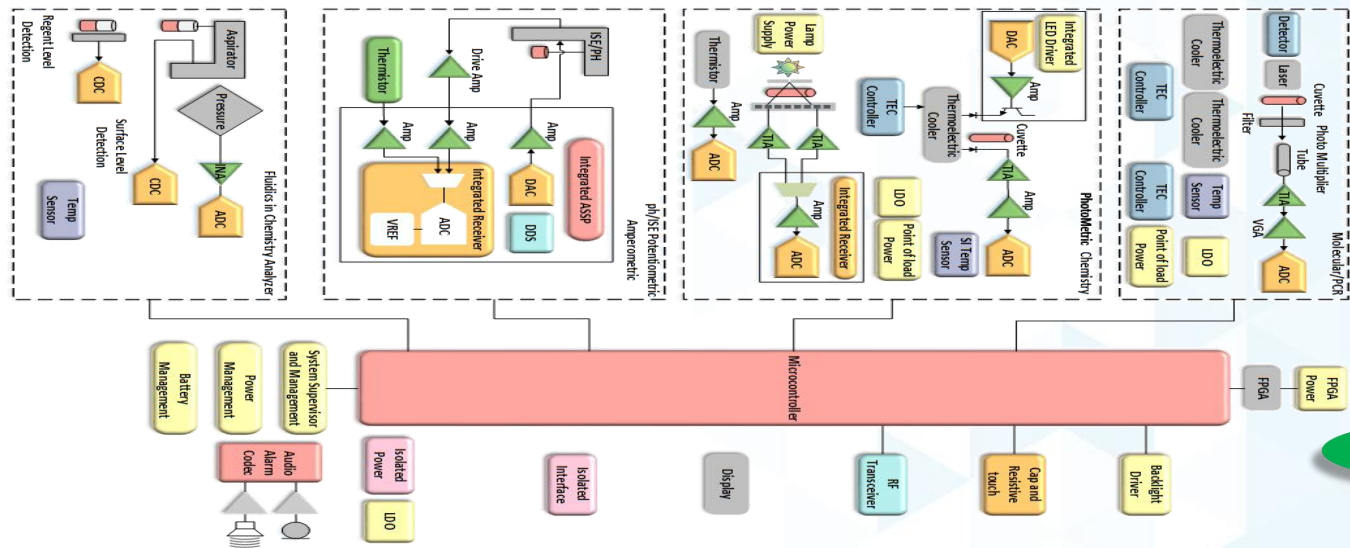
流式细胞分析仪



PCR



体外化学分析仪



**ANALOG
DEVICES**
AHEAD OF WHAT'S POSSIBLE™

The diagram illustrates the ADSP-CM40x Microcontroller and its various peripheral interfaces. The central component is the **Microcontroller**, which is connected to several input and output blocks.

Inputs (Left Side):

- Bubble Detection:** ADPD1080, ADPD188BI
- Bubble Detection:** AD7745, AD7746
- Pressure Sensing:** AD622x/AD855x, AD7124
- Level Control:** AD774x, ADPD108x
- Conductivity Sensing:** AD5940, ADUCM350, ADUCM355
- Gate Drivers:** ADUM1415, ADUM1412, LT116x

Processing (Center):

- Analog Front End** (connected to Bubble Detection)
- RTD** (connected to Bubble Detection)
- Pressure** (connected to Pressure Sensing)
- Level** (connected to Level Control)
- Conductivity** (connected to Conductivity Sensing)
- MOSFET Driver** (connected to Gate Drivers)

Outputs (Right Side):

- Audio Codec** (connected to Audio Codec)
- CAN Interface** (connected to CAN Isolator)
- USB Interface** (connected to USB Isolator)
- Capacitive Touch** (connected to Cap Touch)
- Backlight Control** (connected to Backlight Control)
- Temperature Sensor** (connected to Temp Sensor)
- ECG Monitor** (connected to ECG Front End)
- EAD/CSR BIA** (connected to Optical Front End)
- Body Temp** (connected to Optical Front End)
- Battery Mgmt** (connected to Power Management)
- Supervisor, Sequencer, and Power Management** (connected to Power Management)
- Switch Mode Power Supplies** (connected to Power Management)

Microcontroller: ADSP-CM40x

Power Management:

See following slide

The diagram illustrates the system architecture of a medical infusion pump. It is divided into several functional blocks:

- Input/Output and Patient Interface:** Includes an **Infusion Bag** connected to the pump line, an **LED Driver** for the bag, an **Optical Detector** for air detection, an **Air Detect** sensor, and a **Motor** for fluid delivery. The pump line is labeled **To Patient IV**.
- Control and Processing:** A central **Micro-controller** is connected to an **Integrated AFE** (Analog Front End) which contains a **Mux** (Multiplexer), **ADC** (Analog-to-Digital Converter), and **Voltage Reference**. The micro-controller also interfaces with a **Digipot** and a **Display**.
- Power and Peripheral Management:** Includes **Battery Management**, **System Supervisor and Management**, and a **Power Management** section containing **LDO** (Low Dropout Regulator), **Switching Converters**, and **Power Supervisors**.
- Communication and Control:** Features a **Backlight Driver**, **Cap and Resistive Touch** interface, **RF Transceiver** with an antenna, **USB RS-485 UART**, **ICoupler Isolated Interface**, **ICoupler Isolated Power**, and an **Audio CODEC** connected to speakers.
- Signal Processing:** Various **AMP** (Amplifier) and **DAC** (Digital-to-Analog Converter) blocks are used for signal conditioning and control.

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The diagram illustrates the architecture of an endoscopic system, centered around an FPGA (Field-Programmable Gate Array). The system is divided into several functional blocks and their interconnections:

- Input/Imaging Section:** Includes an **IMAGER POWER** block connected to a **CCD** sensor. A **CIS** (Complementary Image Sensor) is also shown. Both sensors feed into **ADC** (Analog-to-Digital Converter) blocks. These ADCs are connected to **ISOLATION AND ISOLATED POWER** blocks, which then interface with the **FPGA**.
- Control and Timing Section:** An **IMAGER POWER** block is connected to a **CCD TIMING GENERATOR**, which provides timing signals to the **ADC** blocks. The **FPGA** is connected to an **IMAGE PROCESSOR AND CONTROL** block, which in turn manages the **IMAGER POWER** and the **CCD TIMING GENERATOR**.
- Power and Isolation Section:** The **FPGA** is connected to multiple **ISOLATION AND ISOLATED POWER** blocks, which provide power to various components: **LED** (Light Emitting Diode), **LAMP**, **MOTOR CONTROL**, **SUPERVISORY FUNCTIONS**, **PROCESSOR POWER**, and **CLOCK GENERATOR AND DISTRIBUTION**.
- Output and Interface Section:** The **FPGA** outputs video data to a **VIDEO ENCODER**, which is connected to an **AMP FILTER** and then to a **DISPLAY BACKLIGHTING TOUCH SCREEN**. The **FPGA** also outputs to an **HDMI** port. The **IMAGE PROCESSOR AND CONTROL** block is connected to an **INTERFACE/ISOLATION** block, which manages **USB PORTS**, **FOOT PEDAL SWITCH**, and **CONTROL BUTTONS**.
- User Interface:** A **USER INTERFACE AUDIO/VOICE LIGHTING I/O AND CONTROL HAPTICS** block is connected to the **FPGA** and the **PROCESSOR POWER** block.

The system is powered by **SYSTEM POWER**, which is distributed to the **CLOCK GENERATOR AND DISTRIBUTION** block and the **USER INTERFACE** block. The **LED** and **LAMP** are connected to the **ISOLATION AND ISOLATED POWER** blocks, which are also connected to the **ULTRASONIC LENS DRIVER** block. The **ULTRASONIC LENS DRIVER** is connected to the **IMAGER POWER** block and the **CCD** sensor.

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Quiz ?

- ▶ 医疗仪器经常会用到哪些技术来进行测量？
- ▶ ADI有哪个器件特别适用于压力等低频信号测量？

