医疗应用指南

Medical

TEXAS INSTRUMENTS

TEXAS INSTRUMENTS

消费类医疗

诊断、患者监测及治疗

医疗成像

医疗仪器

连通性解决方案

资源

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DIAGNOSTIC,
PATIENT MONITORING
AND THERAPY

MEDICAL
INSTRUMENTS

→ **目录**
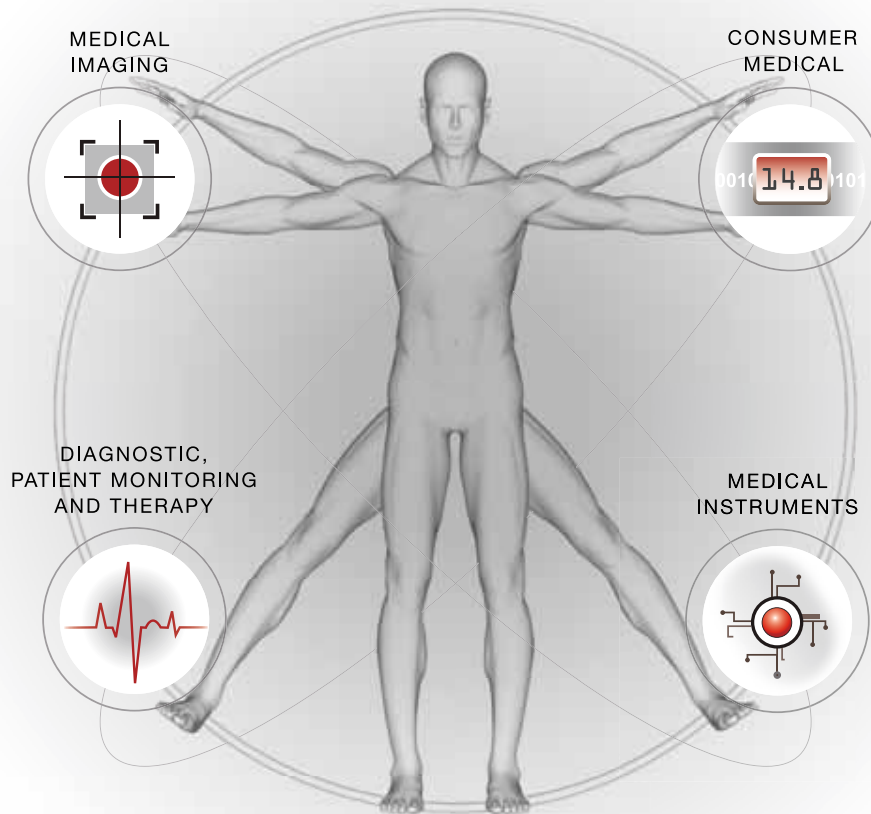
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可供单独下载的 TI 医疗应用指南：
- **消费类医疗**
- **诊断、患者监测和治疗**
- **医疗成像**
- **医疗仪器**

敬请访问：

www.ti.com/ medicalguides

医疗应用指南

➔ 引言

TI具有全范围的模拟及DSP产品——从构建模块直到完整的半导体解决方案，并结合系统层面的视角、全球性的支持基础架构、高级的处理工艺以及医疗行业参与，有助于成就更灵活、廉价且易于上手的革新性医疗电子产品。

TI具有多元化的市场经验，包括无线通信、消费电子产品、车载及宇航产品等，可满足工程师持续增长的需求，以实现更高的速度、更高的精度、较低的功耗及更小型的设备，同时保持医疗市场所苛求的高标准品质和可靠性。

为什么选择TI?

革新性的半导体解决方案

- 使高级医疗设备更为灵活、廉价且易于上手
- 满足不断增长的需求——便携性、无线连通性、能耗效率、性能及精度
- 最尖端的处理工艺

完备的产品组合

- 放大器、数据转换器、接口、电源管理、逻辑器件、DSP、超低功耗微控制器（MCU）、基于ARM的微处理器(MPU)、有线和无线连通设备、音频及视频IC
- 分类化且特定应用的增强型及定制型IC，具有芯片销售选项

品质及可靠性

- 长产品寿命及合理的产品废止政策(obsolescence policy)，确保了持续性的供货
- 有能力为所有产品尺寸且具有不同产品需求的客户提供服务
- 可提供增强型鉴定和筛选方式以及增强型封装
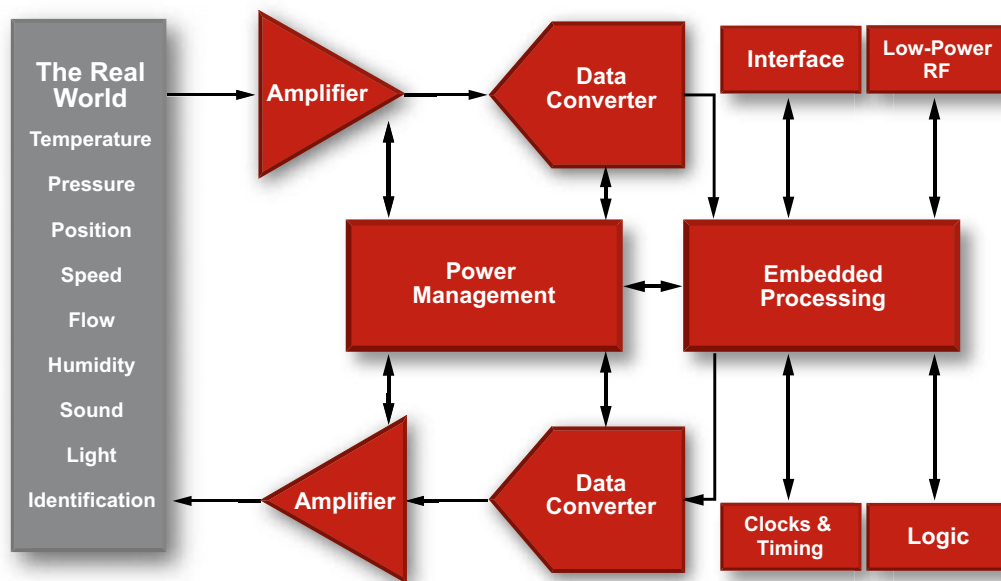- 行业标准组织和联盟（例如：Continua健康联盟）的成员
- 可靠的工艺变更控制通知 (PCN) 及业界领先的产品可追溯性

承诺

- 在供应针对众多医疗应用的器件方面拥有丰富的经验
- 全球性的支持架构
- 本地技术支持和分销
- 对于系统及应用的深入了解
- 工具和培训

本册最新的医疗应用指南为您提供了比以往更便捷的途径，以涉足TI针对医疗应用的IC解决方案。我们提供了诸多特点鲜明且全面的系统方框图、产品选择表和主要的设计工具，旨在帮助您加快创新的速度。

本册指南为您的医疗应用设计提供了下列区段的解决方案和支持，您也可以登录www.ti.com/medicalguides网站单独下载所需的章节：

- 消费类医疗
- 诊断、患者监测和治疗
- 医疗成像
- 医疗仪器

数字信号与实际参量的模拟连接。

➔ 概述

在进行从血糖仪、数字血压计、血脂 (cholesterol) 计到诸如数字脉搏/心率监测仪和数字体温计等健康和保健监测仪相关的一切设计时，都将涉及到5个常用的系统模块。这些模块是：

- 电源/电池管理
- 控制及数据处理
- 传感器接口、放大及模数转换
- 用户界面及显示
- 无线连通性（请参见有关连通性解决方案的章节）

所有的电池驱动、微控制器控制型手持设备均采用不同的生物传感器进行测量。由于仪表类型及功能设定对传感、处理及信息显示的要求不同，因此这些模块的实际实现的拓扑结构也会有很大差异。

使用者急切地希望获悉其健康状况，因此设计所指向的目标是延长电池寿命、提高精度及快速响应时间。额外的需求有可能驱动更高的要求，例如采用更大的内存以支持历史波形 (historical profiling) 的记录、缆线连接或无线接口以用于数据上传或访问传感器。音频反馈可用于简单的良好/非良好状态指示，或是用于所需的、更为复杂的逐步使用说明。添加这些特性而不增加功耗是此类应用面临的重大挑战。

TI可帮助您创造新的解决方案。我们可提供宽范围的处理器产品组合，包括了基于OMAP™平台的高性能应用处理器、数字信号处理器 (DSP)、基于ARM的Sitara™ 微处理器 (MPU) 以及超低功耗MSP430™微控制器 (MCU)，同时还提供了全范围的高性能模拟解决方案，包括了仪表放大器、运算放大器、缓冲器放大器、数据转换器、电源及电池管理组件、音频放大器以及有线和无线接口元件。

如今，由于消费者和护理人员需要把数据从医疗设备传递至诸如计算机和移动电话等数据集线器 (data hub)，因此便携式医疗应用的连通性变得至关重要。TI是〝康体佳〞健康联盟 (Continua Health Alliance) 的创立成员之一，目前为Agent Devices公司提供了首款经Continua认证的USB平台。*更多信息请参见第142页。*

如需了解更多有关Continua健康联盟的信息，敬请访问：

http://www.continuaalliance.org

如需获悉更多有关TI消费类医疗产品的信息，敬请访问：
www.ti.com/consumermedical
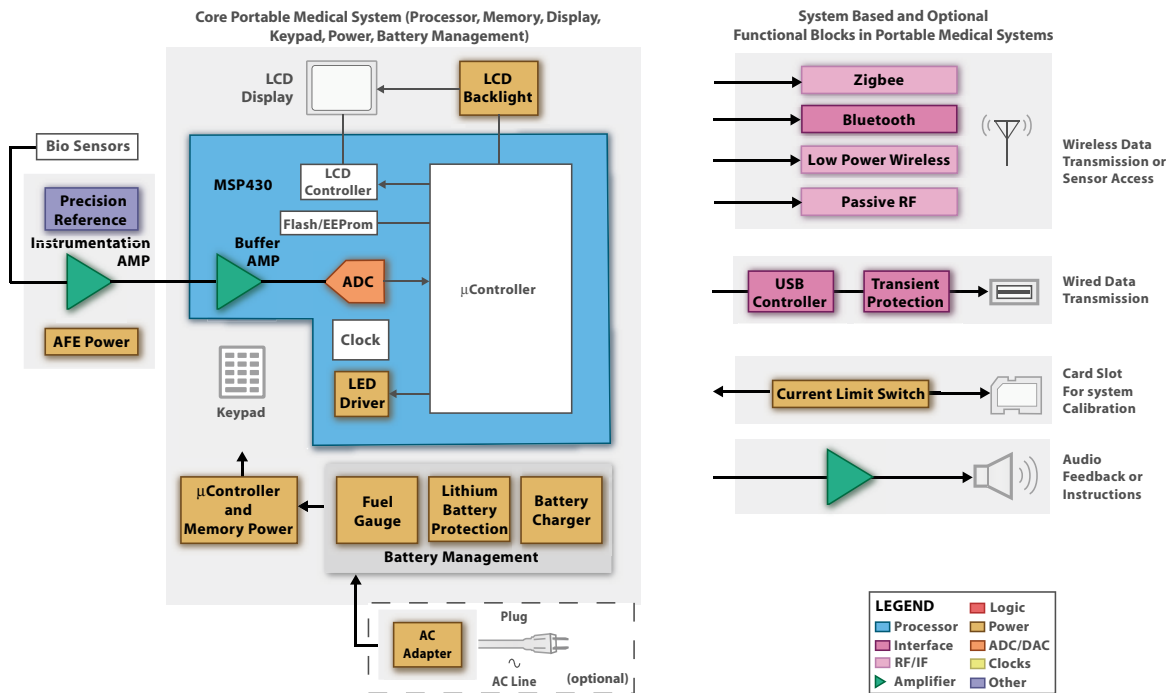
便携式医疗仪器系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

➜ 血压及心率/健身监测系统

血压监测仪

此 类 监 测 系 统 可 采 用 科 罗 特 科 夫 (Korotkoff) 法、示波测量法 (Oscillometry) 或 脉 冲 转 变 时 间 法 来 测 量 血 压。系 统 组 成 包 括 了 压 力 橡 皮 箍 袖 带 (cuff)、压 力 泵 (pump) 以 及 附 加 的 传 感 器，用 于 以 三 阶 段 (3 phases) 的 方 法 测 量 血 压 及 心 率：充 气 (inflation)、测 量、放 气 (deflation)。该 系 统 还 包 括 了 L C D、选 择 按 钮、内 存 再 调 用 (memory recall)、电 源 管 理 以 及 USB接口。

核心子系统包括：

处理器/内存——数字血压测量及 心率测量通过微控制器实现。测 量结果以数据日志的形式暂存在 闪存中，并可通过USB或无线连 接上传至计算机。

用户界面——允许使用者通过LCD 显示屏控制血压测量流程并读取结果。

传感器接口——允许处理器控制橡皮箍袖 带的充气/放气并感应血压信号，该信号将 被仪表放大器放大并通过ADC进行数字化 处理。

电源管理——转换源自碱性电池或可再充 电电池的输入功率，以用于驱动不同的功 能模块。

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

示例应用方框图——血压监测仪

心率/健身监测仪

健身监测仪同时测量个人的训练量和速率 （例如里程及步频）以及体力支出（例如 通过监测心率）。典型的情况多采用腕表 或腕戴式 (wrist-worn) 显示器进行控制及 提供反馈。所存储的数据可通过USB或无 线USB软件狗下载至计算机。系统的所有 部件均需通过超低功耗的嵌入式控制器及 低功耗射频器件实现通信。心率监测及运 动输出监测（例如：跑步步态传感器或功 率传感器）还需要额外的信号调节。

心率监测仪
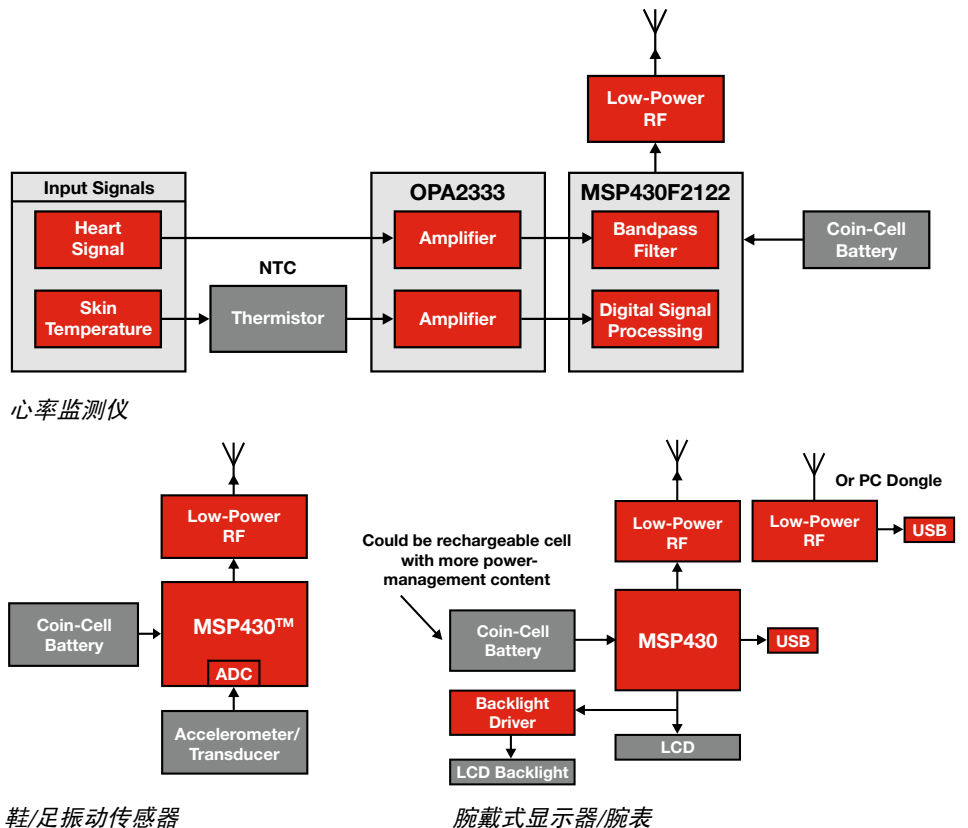
注释："采用MSP430FG439实现心率及 EKG监测"(slaa280) www-s.ti.com/sc/techlit/slaa280

鞋/足振动传感器

腕戴式显示器/腕表

→ 血糖仪及其他诊断仪表

革新性的新型诊断设备使得一系列必须极端仔细的血液化验变得比以往更为轻松、快捷，此类化验包括了血气含量 (blood gases)、血糖(glucose)、电解质(electrolyte)、血凝度 (coagulation)、化学性质、血液学及心脏标记 (cardiac markers，cTnI)。同时，随着新型数字技术的涌现，侵入式 (invasive) 血液分析仪已变得便携，并可用于进行血液系统中两类主要的代谢紊乱化验：血糖及血脂（cholesterol，胆固醇）。

用于血液分析测量的两大方法是色彩反射法 (color reflectance) 以及安培计法 （电化学传感器技术）。

反射法的模拟前端采用光学传感器（LED、光电晶体管）及跨阻抗放大器。使用色彩反射法的测量是基于测试带的反射层所反射色彩的强度，通过测定反射系数实现。仪表对色彩的改变进行量化，并生成相应数字值以表征血液中血脂/血糖的浓度。

采用安培计法时，生物传感器（测试带）直接连接至跨阻放抗大器。血液中包含的血脂/血糖与测试带发生化学反应并产生电荷，该过程将通过安培计法进行测量。在此，环境温度也是必需测量的数据，用于实现测试带特性补偿。

测量的次序通常由微控制器 (MCU) 进行控制。MCU还对转换结果进行处理，存储测量结果（至EEPROM或闪存）并控制其他功能，例如键区控制、实时时钟、声音/语音压缩以及连接至计算机的串行通信。

音频输出通过PWM电路或DAC提供。当得到测量结果时，这两种方法都可用于产生"吡吡"声的指示信号。音频输出还可采用ADPCM压缩算法，通过所采用的语音合成器软件产生话音指令。测量结果将与测量时间及日期一起以数据日志的形式存储至EEPROM或闪存中，该数据日志还可通过无线接口上传至计算机。

请参见第4页上的示例方框图。

因成功应用于Home Diagnostics公司的True2go便携式血糖监测仪而获奖。
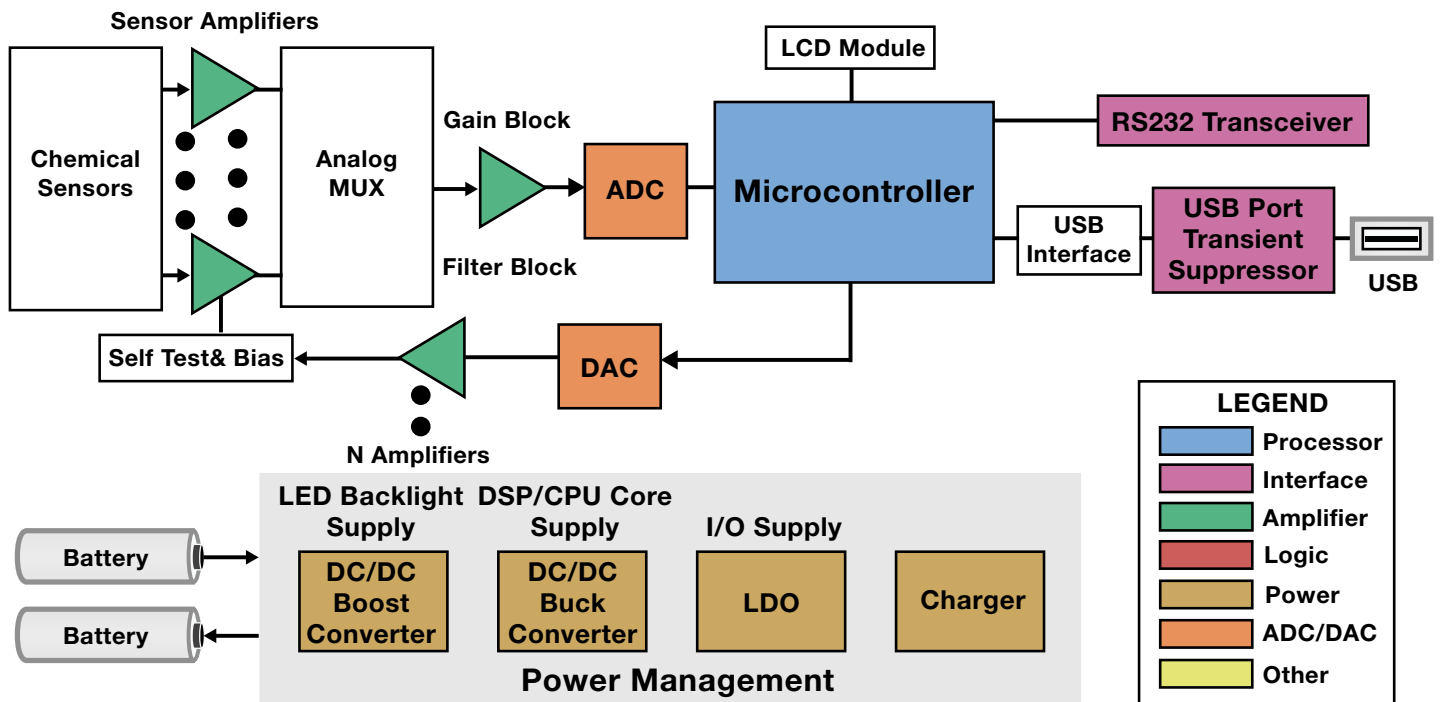
便携式血气分析仪方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

消费类医疗

 数字温度计

数字温度计

数字温度计正快速地取代传统的水银温度计，因为数字温度计更快捷、精确、更高效且不具有环境危险。数字温度计采用了最新近的技术，不同类型的数字温度计依照其应用部位（例如：口腔、直肠、腋下、耳部等）的不同进行分类。耳部温度计测量鼓膜的红外散热，该散热表征了视丘下部（hypothalamus，大脑的温度控制系统）的温度。耳部温度计可采用红外传感器进行测量，而其他类型的温度计则可采用热电堆或热敏电阻。

高端的温度计具有多个热电堆或热敏电阻，其电阻随温度而改变。电阻的变化通过测量电压的变化得到。该模拟电压通过模数转换器 (ADC) 进行数字化转换。ADC的速度及分辨率取决于所需信息的精度及时间。

当ADC模块不可用时，可采用比较器及定时器，以斜率 (slope) 模数转换实现模拟信号的数字化。该方法常见于低成本的数字温度计。单调的斜率转换是对温度的度量。电容、电源电压以及频率因老化或温度漂移而发生的改变都可通过比例制测量原理 (ratiometric measurement principle) 进行补偿。

方框图展示了低端多用途型及高端数字温度计。多用途数字温度计的典型ADC分辨率为12位或更高，取决于所需要的精度级别。良好的ADC基准是实现更高精度的必备条件。微控制器可用于实现控制。低

注释："采用斜率模数转换实现超低功耗温度计" (slaa129B)
www-s.ti.com/sc/techlit/slaa129b

成本的解决方案使用廉价的低功耗微控制器，例如集成了所需的比较器及定时器的MSP430，可采用斜率模数转换技术实现模拟信号的数字化。

诸如高温告警、测量结束声音提示、自动关断以及先前温度数据日志储存都是备选的特性。绝大多数的温度计具有易于读取

的显示器，通常为LCD显示屏及低电池电量 (low-battery) 指示器。其他外设还包括数字I/O端口及LCD驱动器。
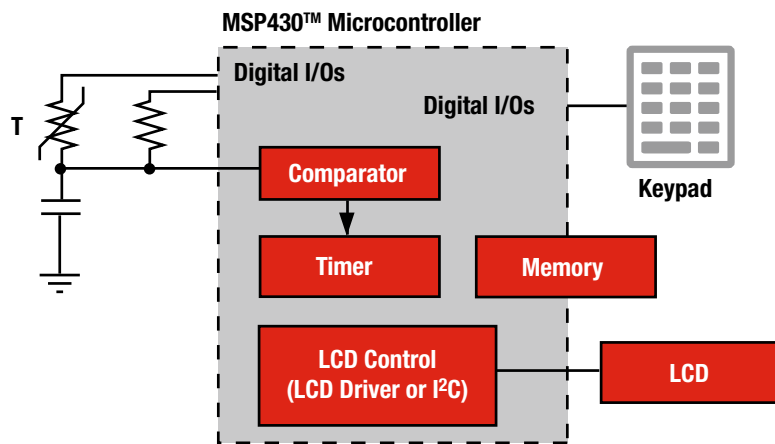
低成本数字温度计通用方框图

高精度数字温度计通用方框图

消费类医疗

超低功耗PaLFI（无源低频接口）
TMS37157

敬请访问**www.ti.com/sc/device/TMS37157**，以获取样片及数据表。

PaLFI将一个具SPI接口的低频转发器及电源管理电路组合至一个相连的MSP430™微控制器。它是适合任意数据记录器、传感器或远程控制应用的理想器件，可在无需电池的情况下运作。

主要特点

- 宽电源电压范围：2V至3.6V
- 超低功耗
  - 运行模式：150μA（最大值）
  - 断电模式：60nA
- 电池检查和电池充电功能
- 谐振频率：134.2kHz
- 具集成谐振频率修整功能电路

应用

- 便携式医疗设备
- 可移植设备
- 测量仪器
- 能量收集

PaLFI原理框图
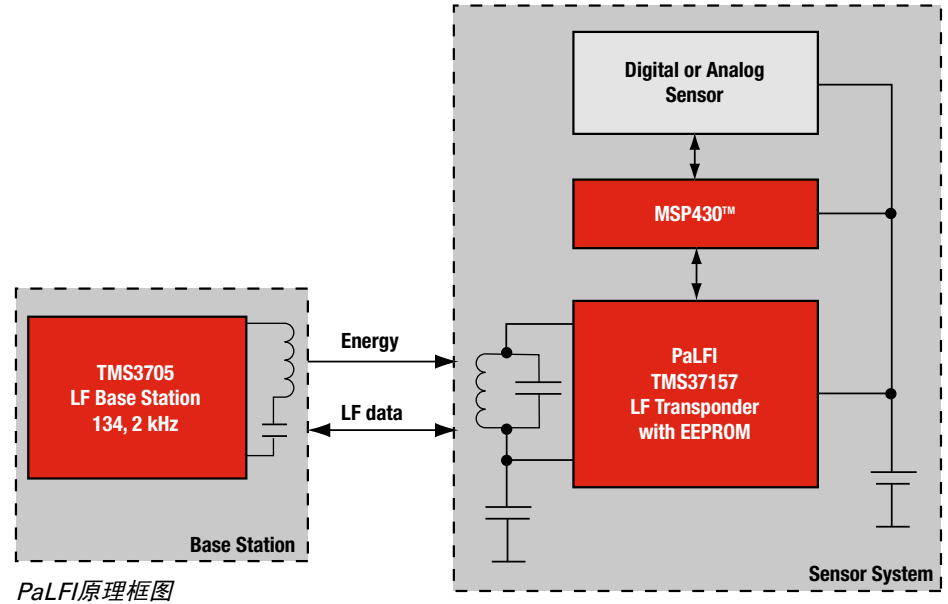
TMS37157

PaLFI——无源低频接口	
Communication Interfaces	SPI, RFID, direct microcontroller access via RFID
Operating Frequency	134.2kHz
Wired Communication Interface	3-wire SPI
Operating Voltage	2V to 3.6Vdc
Current Consumption	Active mode max: 150µA Power down mode: 60nA
Battery Charge Current	Max: 2mA
Memory	32-bit unique serial number 968-bit EEPROM user memory 8-bit selective address
Operating Temperature	–40°C to 85°C
Storage Temperature	–40°C to 125°C
Package	16-Pin VQFN (4mm × 4mm)
Packing/Delivery	Tape-on reel, 3000 per reel

➡ **一般消费类医疗**

16位、超低功耗微控制器
MSP430FG477、MSP430FG478、MSP430FG479

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片和数据表。
（**PARTnumber**请使用**MSP430FG477**、**MSP430FG478**或**MSP430FG479**替换）
敬请访问**www.ti.com/430medical**，查看我们的"用于便携式医疗设备的MSP430™ 16位超低功耗MCU"视频播客。

主要特点

- 低电源电压范围：1.8V至3.6V
- 超低功耗：
  - 工作模式：280μA（在1MHz、2.2V）
  - 待机模式：1.1μA
  - 关断模式（RAM保持）：0.1μA
- 五种功耗节省模式
- 待机模式唤醒时间小于6μs
- 16位RISC架构
- 125ns指令周期

应用

- 便携式医疗仪器，比如：血糖仪、脉搏血氧测定仪
- 胰岛素注射器
- 数字温度计
- 心率监测仪

TI的MSP430™系列超低功耗微控制器包括多款具有面向各种应用的不同外设集的器件。其架构整合了5种低功耗模式，专为在便携式测量应用中延长电池使用寿命而优化。该器件包括一个功能强大的16位RISC CPU、16位寄存器和有助于实现代码效率最大化的恒定代码生成器 (constant generator)。数控振荡器 (DCO) 可在不到6μs 的时间里将器件从低功耗模式唤醒至工作模式。

MSP430FG47x为微控制器配置，具有两个16位定时器、一个具有实时时钟的基本定时器、一个高性能的16位Σ-ΔA/D转换器、双通道12位D/A转换器、两个可配置的运算放大器、两个通用串行通信接口、48个I/O引脚及一个具对比度控制功能的液晶显示 (LCD) 驱动器。

MSP430FG47x隶属于MSP430产品库中的SoC（片上系统）系列之一。由于该器件系列实现了整个信号链路的片上集成，因而极大地简化了医疗设备的设计。除了可造就更加紧凑的产品之外，此器件系列还因为所需分立元件较少的缘故而降低了BOM（材料清单）成本。
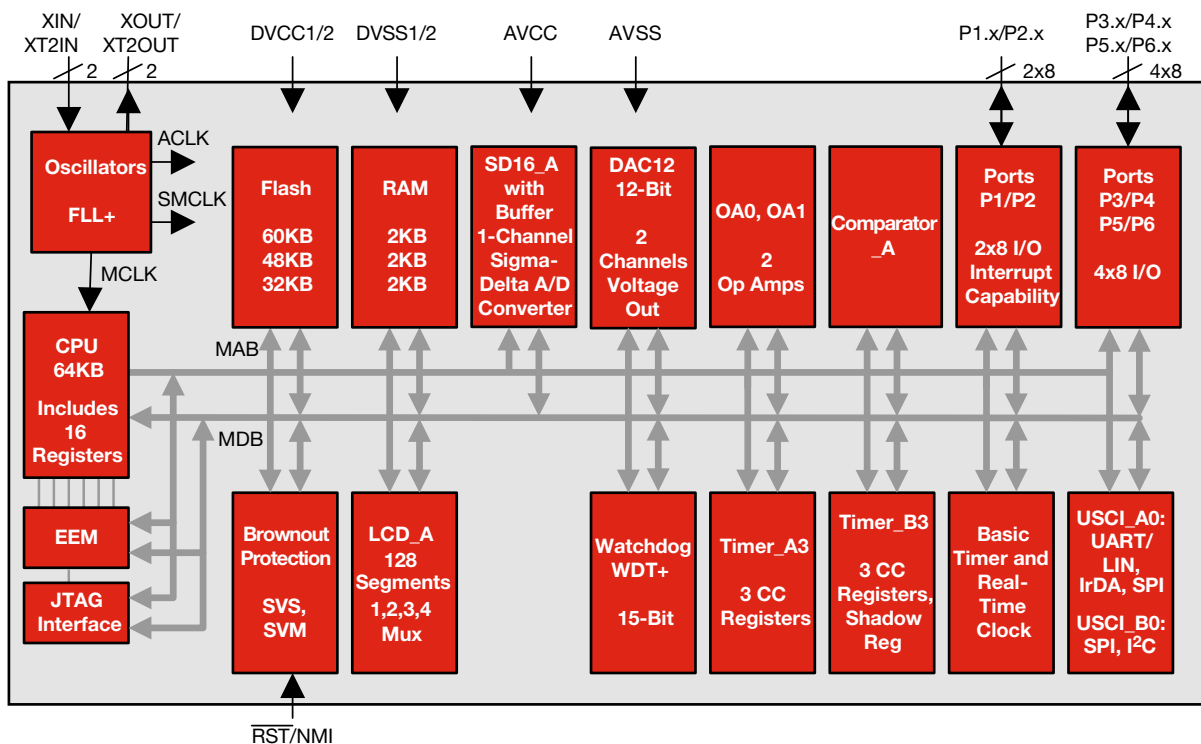
MSP430FG47x原理框图

16位、超低功耗微控制器
MSP430F5418A、MSP430F5419A、MSP430F5435A、MSP430F5436A、MSP430F5437A、MSP430F5438A

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片和数据表。
（**PARTnumber**请使用**MSP430F5418A、MSP430F5419A、MSP430F5435A、MSP430F5436A、MSP430F5437A**或**MSP430F5438A**替换）

主要特点

- 低电源电压范围：1.8V至3.6V
  - 超低功耗：
  - 工作模式：230μA/MHz
  - 待机模式（LPM3 RTC模式）：2.6μA
  - 关断模式（LPM4 RAM保持）：1.6μA
- 停机模式 (LPM5)：0.1μA
- 待机模式唤醒时间小于5μs
- 16位RISC架构：
  - 扩展内存
  - 高达25MHz的系统时钟

应用

- 便携式医疗仪器
- 血压监测仪
- 患者传感器系统

MSP430F541x和MSP430F543x系列微控制器配置包括：三个16位定时器、一个高性能12位ADC、多达4个通用串行通信接口、一个硬件乘法器、DMA、一个具告警功能的实时时钟模块及多达87个I/O引脚。其架构整合了5种低功耗模式，专为在便携式测量应用中延长电池使用寿命而优化。

这些器件系列是便携式医疗及健身应用的理想选择。凭借高达256kB闪存和16kB RAM，它们能够处理具有无线通信能力的医疗设备的应用程序及无线协议。例如：由MSP430F5438试验板 (MSP-EXP430F5438) 和BL6450 *Bluetooth*®连通性板卡组成的BlueMSPTM平台就能够采用MSP430F5438来处理*Bluetooth*®协议栈的健康设备配置 (Health Device Profile)。

*MSP430F54xx*原理框图

消费类医疗

低功耗精密型仪表放大器
INA333

敬请访问**www.ti.com/sc/device/INA333**，以获取样片和数据表。

主要特点

- 低失调电压：20μV（最大值）
- 低漂移：50nV/℃
- 低输入偏置电流：200pA（最大值）
- 低噪声：50nV/√Hz
- 电源电压：+1.8V至+5.5V
- 静态电流：50μA（最大值）
- EMI输入滤波
- 封装：MSOP-8、DFN-10

应用

- 桥接放大器
- 衡器
- 热电偶放大器
- RTD传感器放大器
- 医疗仪表
- 数据采集

INA333是低功耗精密仪表放大器，具有卓越的精确度。可采用单个外部电阻器实现从1至1000的增益设定，并可提供行业标准的增益公式：$G = 1 + (100k\Omega / R_G)$。INA333具有三个运算放大器和低静态电流特性，并可采用低至+0.9V的电源电压供电运转，因而是众多便携式应用的理想选择。

$$G = 1 + \frac{100k\Omega}{R_G}$$
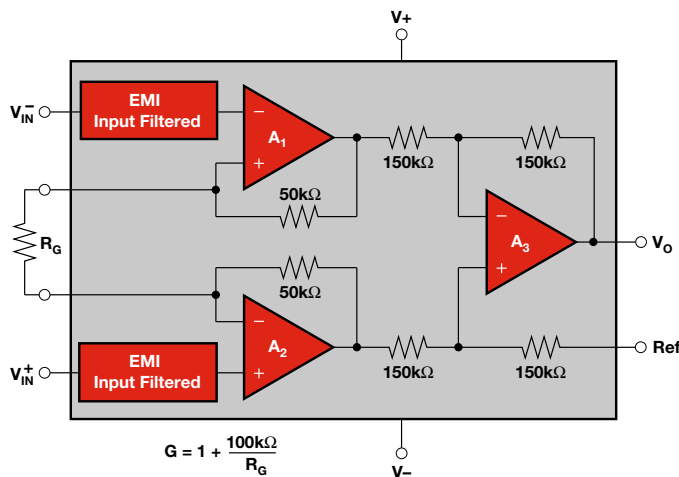
INA333原理框图

3.9μA、SC70-3封装、30ppm/℃漂移电压基准
REF3312、REF3318、REF3320、REF3325、REF3330、REF3333

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片、数据表、评估板及相关应用报告。
（**PARTnumber**请使用**REF3312、REF3318、REF3320、REF3325、REF3330**或**REF3333**替换）

主要特点

- 低功耗：Iq = 3.9μA（典型值）
- 高初始准确度：0.15%（最大值）
- 低压降（在25℃和1mA I_{OUT}条件下为25mV）
- 强大的输出电流驱动：±5mA
- ±30ppm/℃温度漂移（最大值）
- 扩展的工业温度范围：−40℃至125℃

应用

- 血糖仪
- 数字听诊器
- 便携式心电图 (ECG) / 脑电图 (EEG)

REF33xx是一个低功耗、精密、低压降电压基准系列，采用纤巧型SC70-3和SOT23-3封装。小外形尺寸及低功耗（5μA最大值）使REF33xx成为诸多便携式应用的理想选择。

Product	Voltage (V)
REF3312	1.25
REF3318	1.8
REF3320	2.048
REF3325	2.5
REF3330	3.0
REF3333	3.3
REF3340	4.096

基本的数据采集系统

消费类医疗
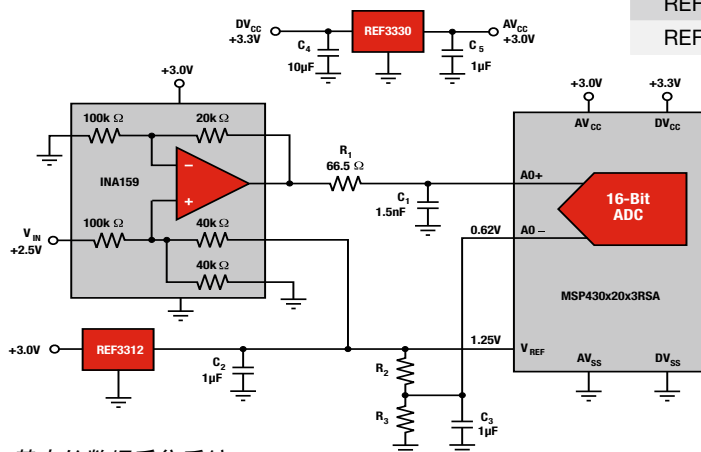
零漂移系列1.8V、微功率CMOS运算放大器
OPA333、OPA2333

敬请访问**www.ti.com/sc/device/OPA333** 或 **www.ti.com/sc/device/OPA2333**，以获取样片、数据表、评估板及相关应用报告。

主要特点

- 低失调电压：10μV（最大值）
- 零漂移：0.05μV/℃（最大值）
- 0.01Hz至10Hz噪声：1.1μVPP
- 静态电流：17μA
- 电源电压：1.8V至5.5V
- 轨至轨输入/输出
- 封装：SC70、SOT23
- EMI输入滤波

应用

- 医疗仪器
- 温度测量
- 电池供电型医疗仪器
- 电子秤 (electronic weigh scale)
- 患者监测

OPA333系列CMOS运算放大器采用了专利的自动校准 (auto-calibration) 技术，同时提供了随时间和温度变化很小的失调电压 (最大值10μV) 以及近乎为零的漂移。这些小型化、高精度、低静态电流的运算放大器提供了高阻抗的输入端，支持共模范围高于电源轨100mV，轨至轨输出摆幅在电源轨的50mV之内。可采用单端或双路供电，最低电压+1.8V（±0.9V），最高电压+5.5V（±2.75V）。OPA333系列提供了卓越的共模抑制比 (CMRR)，不会产生像传统补偿输入级一样的交越误差。该设计为驱动模数转换器 (ADC) 提供了卓越的性能且无需降低差分线性度性能。
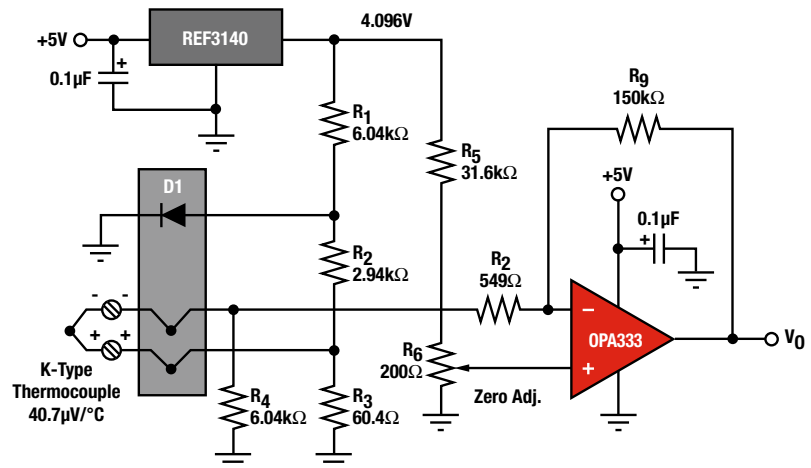
OPA333用于温度测量电路

电压电平转换

应用

- LCD接口
- 具有不同电源电压的接口器件

随着微处理器工作电压的不断降低，有可能导致外设器件与处理器间的电平差，从而中断器件间的连接。TI的转换器可通过1.2V、1.5V、1.8V、2.5V以及3V节点间的电平转换，实现原本非兼容I/O端口之间的通信。MSP430™微控制器具有3.6V（最大值）的I/O容限，因而允许使用转换器保护输入端并连接至更高电压的外设。

推荐器件

Component	Description	V$_{CC}$ Range (V)	Power Max I$_{CC}$ (µA)	Smallest Footprint Pins/Packages
SN74AVC1T45*	Single-bit Dual-Supply Bus Transceiver	1.2 to 3.6	10	6/WCSP (NanoStar™)
SN74LVC1T45	Single-bit Dual-Supply Bus Transceiver	1.65 to 5.5	4	6/WCSP (NanoStar)
SN74AVC2T45*	Dual-bit Dual-Supply Transceiver	1.2 to 3.6	10	8/WCSP (NanoStar)
SN74LVC2T45	Dual-bit Dual-Supply Transceiver	1.65 to 5.5	10	8/WCSP (NanoStar)
SN74AUP1T57	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
SN74AUP1T58	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
SN74AUP1T97	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
SN74AUP1T98	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
PCA9306	Dual Bidirectional I²C-bus and SMBus Voltage-Level Translator	—	—	8/US

示例应用方框图

* *支持总线保持 (Bus-hold) 选项*
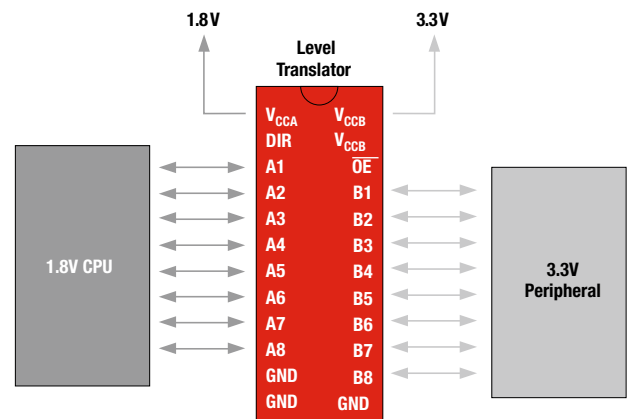
音频信号路由

应用

- 解多路复用 (DeMUX) 内部/外部扬声器
- 多路复用 (MUX) 音频功率放大器
- 低功耗路由 (＜100mA)
- 放大器增益调节

模拟开关最常见的应用之一就是信号路由。路由可能从单个信号源至多个目标，或从多个信号源至单个目标。单刀双掷的开关可用于任意一种情形。例如：使用开关将音频功率放大器的输出重路由 (reroute) 至两个不同的扬声器。模拟开关另一个常见的应用是将源自移动电话音频放大器的基带信号转换至音频功率放大器以获得更高功率的输出。

推荐器件

Component	Configuration	V+ (V)	r$_{on}$ (Ω)	Smallest Footprint Pins/Packages
TS5A3159A	1 x SPDT	1.65 to 5.5	0.9	6/WCSP
TS5A3166	1 x SPST	1.65 to 5.5	0.9	6/WCSP
TS5A23166	2 x SPST	1.65 to 5.5	0.9	6/WCSP
TS5A3153	1 x SPDT	1.65 to 5.5	0.9	8/WCSP
TS5A6542	1 x SPDT	1.65 to 5.5	0.75	8/WCSP
TS5A23159	2 x SPDT	1.65 to 5.5	0.9	10/Micro QFN
TS5A26542	2 x SPDT	1.65 to 5.5	0.75	12/WCSP
TS5A3359	1 x SP3T	1.65 to 5.5	0.9	8/WCSP

示例应用方框图

消费类医疗
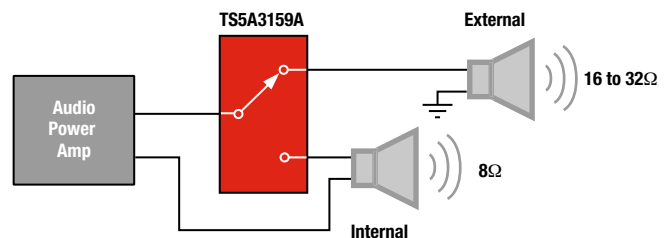
I²C总线I/O扩展及LED驱动器

优点

- 节省处理器引脚
- 改善板载路由
- 缩减板级空间

应用

- 键区控制
- LED控制
- 温度感应

I²C I/O扩展器及LED驱动器可作为应用功能性的补充。可从次重要的功能中解放处理器并服务于成就更高效的设计。微控制器经常缺乏足够可用的GPIO端口来控制全部所需的外设，例如键区的接口连接。I²C总线扩展器可增加应用中的GPIO端口数量，同时只占用极小的板级空间。I²C LED驱动器则通过实现LED闪烁 (blink) 运作而解放了处理器。
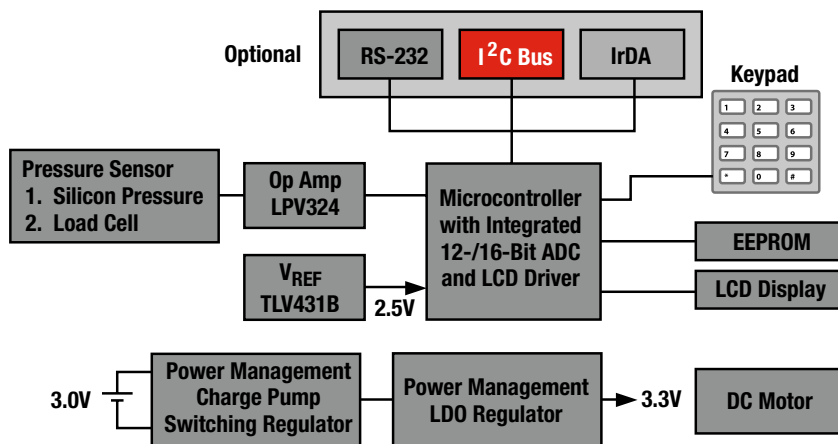
示例应用方框图

推荐器件

Device	Max freq. (kHz)	No. of I/Os	I²C address	V$_{CC}$ range (V)
Low–Voltage I/O Expanders				
TCA6408A	400	8	0100 00x	1.65 to 5.5
TCA6416A	400	16	0100 00x	1.65 to 5.5
TCA6424	400	24	0100 00x	1.65 to 5.5
TCA9535	400	16	0100 xxx	1.65 to 5.5
TCA9539	400	16	1110 1xx	1.65 to 5.5
TCA9555	400	16	0100 xxx	1.65 to 5.5
I/O Expanders				
PCA6107	400	8	0011 xxx	2.3 to 5.5
PCA9534	400	8	0100 xxx	2.3 to 5.5
PCA9534A	400	8	0111 xxx	2.3 to 5.5
PCA9535	400	16	0100 xxx	2.3 to 5.5
PCA9536	400	4	1000 001	2.3 to 5.5
PCA9538	400	8	1110 0xx	2.3 to 5.5
PCA9539	400	16	1110 1xx	2.3 to 5.5
PCA9554	400	8	0100 xxx	2.3 to 5.5
PCA9554A	400	8	0111 xxx	2.3 to 5.5
PCA9555	400	16	0100 xxx	2.3 to 5.5
PCA9557	400	8	0011 xxx	2.3 to 5.5
PCF8574	100	8	0100 xxx	2.5 to 6.0
PCF8574A	100	8	0111 xxx	2.5 to 6.0
PCF8575	400	16	0100 xxx	2.5 to 5.5
PCF8575C	400	16	0100 xxx	4.5 to 5.5
LED Driver				
TCA6507	400	7	1000 101	1.65 to 3.6
Keypad / Keyboard Controller				
TCA8418	1000	18	110100	1.65 to 3.6

消费类医疗

→ 系统支持产品

针对高速应用的系统级静电放电 (ESD) / 电磁干扰 (EMI) 保护

优点

- 针对高速互连的系统级ESD保护
- 采用空间节省型封装及流畅型布线，针对高速便携式应用实现了无干扰(glitch-free) 的布线
- 超低的1nA漏电流，可支持精密的模拟测量，例如多类血糖仪
- 可任选的V_{CC}引脚，允许器件用作瞬变抑制器

应用

- USB、HDMI、DisplayPort、eSATA、GigEthernet、1394、接口
- 模拟精密接口

对于任意外部接口的接线端而言，ESD冲击始终是对系统可靠性的威胁。许多低电压的核心芯片或系统ASIC仅提供器件级的人体模型 (HBM) ESD保护，均不能满足系统级的ESD要求。独立的ESD解决方案是具有空间效益及成本效益的解决方案，可保护系统互连免受外部ESD冲击的损害。

TI的TPDxE系列ESD器件提供了满足IEC-61000-4-2 (LEVEL 4) 标准的系统级ESD解决方案，同时可保持高速接口的信号完整性。TPDxF系列EMI滤波器则提供了传导EMI噪声抑制能力，同时还提供了系统级的ESD保护。
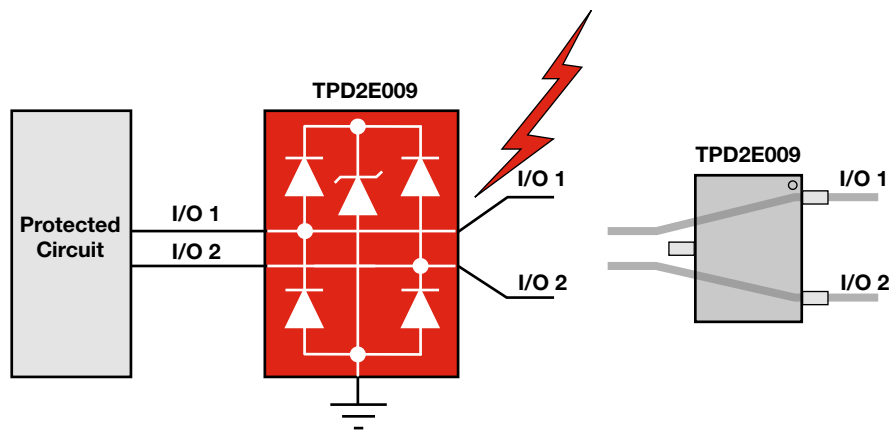
TPD2E009 ESD电路及板载布线

ESD/EMI解决方案

Device	Number of Channels	V_{DD} (V)	I/O Level (V)	Cap, Resistor	V_{BR} (min) (V)	Package(s)
ESD Solutions						
TPD2E009	2-Channel ESD	0.9 to 5.5/No V_{DD} pin	0 to V_{DD}	0.7pF	6	DRY, DRT, DBZ
TPD4S009	4-Channel ESD	0.9 to 5.5	0 to 5.5	0.8pF	9	DRY, DCK, DBV
TPD4S010	4-Channel ESD	No V_{DD} pin	0 to 5.5	0.8pF	9	QFN
TPD8S009	8-Channel ESD	0.9 to 5.5	0 to 5.5	0.8pF	9	DSM
TPD12S520	12-Channel, HDMI Receiver	0.9 to 5.5	0 to 5.5	0.9pF	9	DBT
TPD12S521	12-Channel, HDMI Driver	0.9 to 5.5	0 to 5.5	0.9pF	9	DBT
TPD4S012	4-Channel ESD with V_{BUS} Clamp	No V_{DD} pin	0 to 5.5	1.0pF, 9pF	7, 20	DRY
TPD2E001	2-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	DRL, DRY, DRS
TPD3E001	3-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	DRL, DRY, DRS
TPD4E001	4-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	DRL, DRS
TPD6E001	6-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	RSE, RSF
TPD6E004	6-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.6pF	6	RSE
TPD4E004	4-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.6pF	6	DRY
TPD4E002	4-Channel ESD	No V_{DD} pin	0 to 6	11pF	6	DRL
EMI Filters						
TPD6F002	6-Channel EMI	0.9 to 5.5	0 to 5.5	17pF, 100Ω, 17pF	6	DSV
TPD6F003	6-Channel EMI	0.9 to 5.5	0 to 5.5	8.5pF, 100Ω, 8.5pF	6	DSV

* 更多产品信息请参见指定页码。
如欲查阅更多系统方框图兼容的产品，敬请访问www.ti.com/medical

消费类医疗

→ **针对消费类医疗设备的电源管理**

带双电平输出的低静态电流 (I_Q) 低压降稳压器 (LDO)
TPS78001

敬请访问**www.ti.com/sc/device/TPS78001**，以获取样片、数据表及评估板。

主要特点

- 额定输出电流：150mA
- 超低静态电流 (I_Q)：500nA（典型值，TPS780xx）
- 输入电压范围：2.2V至5.5V
- 输出电压：定值（1.5V至4.2V）及可调节（1.22V至5.25V）
- V_{SET}引脚允许将V_{OUT}值设定为出厂前写入EEPROM的两个预设值
- 可采用1μF陶瓷输出电容器实现稳定运转
- 封装：TSOT23-5、2 x 2 mm SON

应用

- TI MSP430™配套应用
- 无线手持设备
- 便携式媒体播放器

TPS780xx系列低压降 (LDO) 稳压器提供了超低功率 (I_Q = 500nA)、小型化封装 (2 x 2 mm SON-6)，以及可选择的双电平输出电压的优点。可调节版本现也已上市，但它不具备电压电平移位能力。

V_{SET}引脚允许终端用户通过微处理器兼容的输入非常快速地在两个电平之间切换。该LDO器件针对需要双电平电压的电池供电型应用进行了特别设计，具有超低的静态电流I_Q (500nA)，是诸如微处理器、内存卡及烟雾探测器等应用的理想选择。
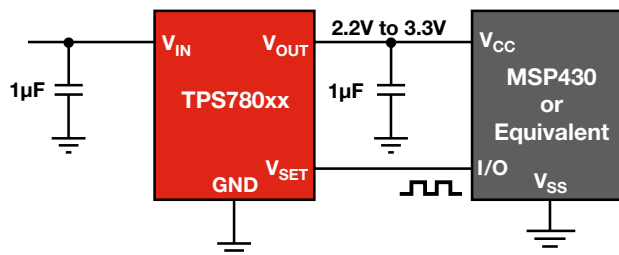
TPS780xx具有集成的动态电压调节功能电路

5μA静态电流 (I_Q)、0.7V_{IN}升压型转换器
TPS61220

敬请访问**www.ti.com/sc/device/TPS61220**，以获取样片和数据表。

主要特点

- 凭借极低的静态电流 (<5μA) 延长了电池的工作时间
- 具有低开关电流限值，是低电流应用的理想选择
- 与低功耗微控制器（比如TI的MSP430™系列）协同运转良好
- 开关频率：2MHz
- 封装：SC-70

应用

- 微控制器电源
- 任意便携式应用

TI的TPS6122x升压型转换器可用于功率转换管理，适用于由1~3块碱性电池、镍镉(NiCd)、镍氢 (NiMH)、单元锂离子电池或锂聚合物电池供电的应用。这些器件可采用单块锂离子电池或锂聚合物电池，以5V的输出提供高达50mA的输出电流，使电池放电至2.5V。TPS6122x系列基于迟滞型 (hysteretic) 固定截止时间控制器，采用同步整流以尽可能低的静态电流水平实现效率的最大化。其最大输入电流被限制为250mA，输出电压可通过外部电阻分压器编程设定，或设为芯片内置的固定值。TPS6122x转换器采用6引脚2 x 2 mm SC-70封装。
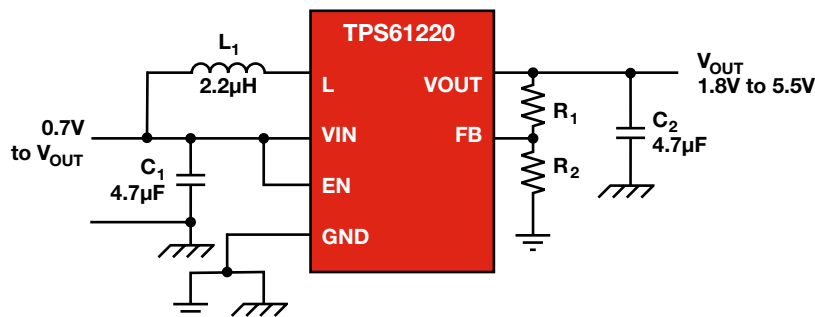
具有低静态电流I_Q的TPS61220升压型转换器

消费类医疗

→ **针对消费类医疗设备的电源管理**

具有数字及脉宽调制 (PWM) 亮度控制能力的单白光LED驱动器
TPS61160、TPS61161

敬请访问**www.ti.com/sc/device/TPS61160**或**www.ti.com/sc/device/TPS61161**，以获取样片、数据表、评估板和应用报告。

主要特点

- 输入电压范围：2.7V至18V
- 针对6 LED的26V开路LED保护 (TPS61160)
- 针对10 LED的38V开路LED保护 (TPS61161)
- 0.7A开关限流保护
- 600kHz开关频率
- 200mV基准电压，精度误差为2%
- EasyScale™单线亮度调节接口
- PWM亮度控制（5至100kHz）
- 内置软起动
- 封装：2 x 2 x 0.8 mm QFN-6

应用

- 2.5至4.0″显示器
- PDA、蜂窝电话、手持电脑
- GPS接收器
- 适合中等外形尺寸显示器的多用途单白光LED背光照明

TPS61160及TPS61161升压型转换器具有40V额定的集成开关FET，可驱动多达10个串联的LED。该升压型转换器工作于600kHz的固定开关频率，以降低输出纹波、改善转换效率并支持小型外部元件的使用。

典型应用

符合USB规范的 2mm x 2mm QFN 封装锂离子电池充电器
bq24040

敬请访问**www.ti.com/sc/device/bq24040**，以获取样片及数据表。

主要特点

- 30V额定输入和6.6V过压保护
- 集成型800mA FET和电流传感器
- 符合USB规范：USB电流限制和输入电压动态电源管理
- 符合JEITA标准：减小充电电流（在低温时）和降低充电电压（在高温时）
- 封装：小外形10引脚2mm x 2mm QFN

应用

- 由单块锂离子电池或锂聚合物电池供电的便携式设备

bq24040可采用USB端口或AC适配器来运作。USB模式中的100mA / 500mA电流限值完全符合USB标准。当输入电压下降至内部门限时，输入动态电源管理功能电路将减小充电电流以避免电源遭受过载的损坏。此外，bq24040还拥有另外的安全特性：符合JEITA标准、过压保护、安全定时器和ISET短路保护等。
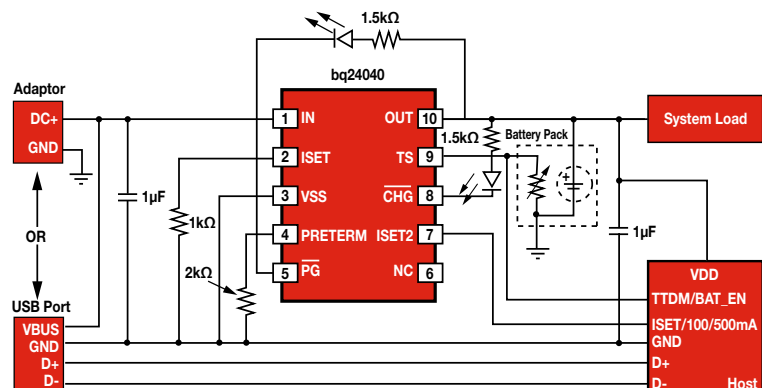
原理框图

→ **针对消费类医疗设备的电源管理**

电池包侧 (Pack-Side) 阻抗追踪 (Impedance Tracking™) 电量计
bq27541

敬请访问**www.ti.com/sc/device/bq27541**，以获取样片及应用报告。

主要特点

- 针对单块串联锂离子电池应用的电池电量计
- 微控制器外设提供了：
  - 精确的电池电量计量
  - 内部温度传感器，用于系统温度上报
  - SHA-1/HMAC认证
  - 96字节的非易失性高速暂存闪存
- 基于阻抗追踪 (Impedance Tracking™) 技术专利的电池电量计量
  - 采用电池放电曲线模型实现精确的剩余时间 (time-to-empty) 预测
  - 自动调节电池消耗进程、电池自放电及电池温度/速率相关的效率损耗
  - 低阻值感应电阻器（10mΩ或更低）
- SDQ、HDQ和I²C接口格式，用于与主控系统通信
- 封装：小外形12引脚、2.5 x 4 mm SON

应用

- 智能手机
- PDA
- 数码相机和数字摄像机
- 手持式终端
- MP3或多媒体播放器

TI的bq27541锂离子电池电量计量计是一类微控制器外设，可为单块锂离子电池包提供电量计量。该器件只需开发极少的系统微控制器固件即可实现精确的电池电量计量。bq27540安置于电池包内或置于具有嵌入式电池（非可拆卸）的系统主板上。

bq27541采用了专利的阻抗追踪 (Impedance Tracking™) 算法实现电量计量，并提供诸如残余电池容量 (mAh)、充电状态（百分比）、剩余运行时间（分钟）、电池电压 (mV) 及温度 (℃) 等信息。

bq27541还具有集成的电池包安全认证支持特性（采用SHA-1/HMAC认证算法）。

典型应用

→ 推荐器件

Amplifiers

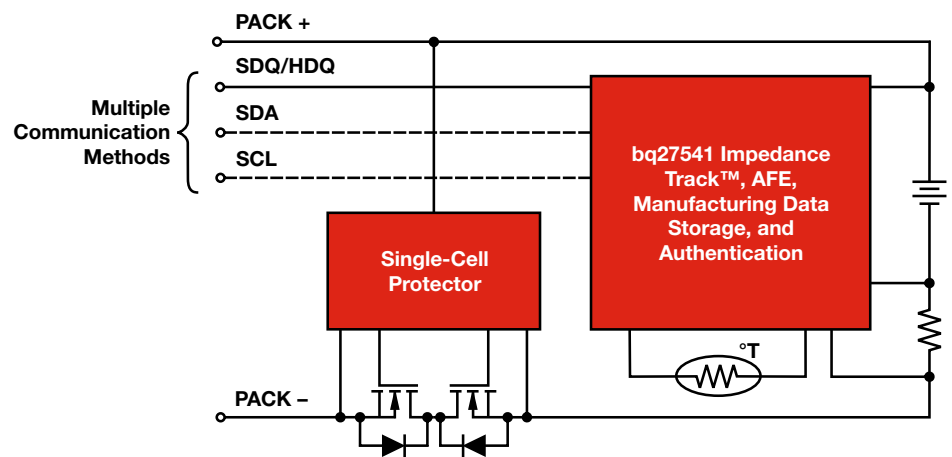| Component	Description	Key Features	Benefits	Other TI Solutions
INA118	Instrumentation Amp	55µV offset, 0.7µV/°C drift, 10nV/√(Hz) noise	Low drift, low noise, wide supply	INA128, INA326, INA333
INA122	Instrumentation Amp	±50µV (max) input offset, 83dB CMRR, 0.06mA (typ) I_Q	Low power, wide supply, CM to Gnd	INA122: INA121, INA126, INA128
INA333 *Page 11*	Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50µA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA326, INA118
OPA141	Precision Op Amp	10MHz, 6.5nV/√Hz, ±4.5V to ±18V, 1.8mA typical, FET input: I_B = 20pA max	Common mode voltage range includes GND	OPA827
OPA333/2333 *Page 12*	Precision Op Amp	1.8V min supply, 0.017mA/ch (max), 10µV offset (max), 0.05 µV/°C drift (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, **OPA330**
OPA364	CMOS Amplifier	1.8V, 7MHz, 90dB CMRR, 5V/µs slew rate, 750µA/ch I_Q	Sensor amplification in battery-powered systems	OPA363, OPA2363, OPA2364, OPA4364
OPA369	Nanopower Zero-Crossover Op Amp	1.8V to 5.5V, 700nA I_Q, CMRR 114dB RRIO, 0.4µV/°C, V_{OS} drift	Zero-crossover input offers excellent CMRR over entire input range	OPA379, OPA349
OPA378	Low Noise Precision Op Amp	0.1µV/°C Vos drift, 125µA, 900kHz, 0.4µV_{PP} (0.1Hz to 10Hz) 0.4µ V_{pp} (0.1Hz to 10Hz), 0.9MHz	Lowest noise, power, price, precision zero-drift option	**OPA330**, OPA333
OPA2889	Low-Power High-Speed Amp	Typical quiescent current of 460µA/channel	Supports portable and power-sensitive applications	OPAx890, OPAx684, OPAx683, THS4281
THS4524	Very Low-Power Differential Amp	SAR and ΔΣ drivers, 145MHZ, 490V/µs slew rate	Accurate output common-mode	
TLV276x	microPower Op Amp	1.8V, RRIO, 500µV input offset voltage, 500kHz BW	Available in S, D, Q, 20µA/ch IQ	
TPA2011D1	Analog-Input Class-D Amp	Variable gain, 3.2W mono Class-D with integrated DAC noise filter in 0.4mm pitch WCSP	The TPA2011D1 Class-D speaker amplifier is smaller, has fewer external components, consumes less power and has no pop	TPA2010D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA2026D2	Analog-Input Class-D Amp with AGC/DRC	3.2-W/channel, stereo Class-D audio amplifier with fast gain ramp, SmartGain™ AGC and DRC	Provides louder and clearer audio while protecting speakers using DRC and AGC compared to competitive products using just the AGC limiter option	TPA2016D2, TPA2017D2
TPA2028D1	Analog-Input Class-D Amp with AGC/DRC	3.0-W mono Class-D audio amplifier with fast gain ramp, SmartGain™ AGC and DRC	Provides louder and clearer audio while protecting speakers using DRC and AGC compared to competitive products using just the AGC limiter option	
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA751
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	

Data Converters				
ADS1115	Delta-Sigma ADC, I²C	16-bit, 860SPS, 4 SE, 2 diff input, PGA, MUX, comparator, V_{REF}	Smallest 16-bit ADC, 2.0 x 1.5 x .04 mm leadless WFN pkg; reduces system size/component count	**ADS1113/4, ADS1013/14/15**
ADS7866	SAR ADC, Serial	1.2V, 12-bit, 200kSPS (max), 85dB SFDR	Very small, low power	ADS7888
ADS7924	microPower SAR ADC	12-bit, 100kSPS, 4 channel, ≤1µA power down current, I²C interface, QFN package	Intelleigent system power management and self monitoring	
ADS8201	Low-Power SAR ADC	8 channel, 12-bit, 100kSPS, 1.32mW power consumption at 100kSPS	Full on-chip data acquisition system	ADS7870
ADS8317	SAR ADC, Serial	16-bit, 250kSPS, 2.7 to 5.5V, pseudo-bipolar, diff inputs	Excellent linearity, microPower, high speed	ADS8422
ADS8326	SAR ADC, Serial	16-bit, 250kSPS, 2.7 to 5.5V, pseudo-bipolar, diff inputs	Low noise, low power, high speed	ADS8325
ADS8331/32	SAR ADC	16-bit, 500kSPS, 4/8 channels, with serial interface	Mux out feature can be used to reduce system part count and overall cost	ADS8342
DAC7551	V_{OUT} DAC	12-bit, 500kSPS, ±0.5LSB DNL, ±1LSB INL, 0.27mW power	Ultra-low glitch	DAC7554
DAC8534	V_{OUT} DAC	16-bit, 0.093MSPS, ±1LSB DNL, ±64LSB INL, 2.7mW power	Quad	
DAC8554	Low-Power DAC	16-bit, 1-4 chs, ±3 LSB (typ) INL, 0.1 to 0.15nV-s glitch	Excellent AC/DC performance	DAC8564, DAC8534
DAC8551	V_{OUT} DAC	16-bit, 140µA at 2.7V operation, 0.1nV-s glitch energy	Very low power, ultra-low glitch	DAC8531
DAC8560	V_{OUT} DAC	16-bit, 2ppm/°C temp drift, 2.5V int reference	Tiny package, single channel	DAC8564, DAC8565
DACx311	Low-Power DAC	14-and 16-bit, 1.8V to 5.5V, 80mA, 14- and 16-bit, low-power, single-channel in SC70 package	Easy resolution upgrade and downgrade capability; decrease board space and power requirements	
TLV320DAC3120	Low-Power Audio DAC	Mono DAC with 2.5W mono Class-D speaker amplifier; miniDSP for audio processing	Longer battery life, better audio quality, lower cost	TLV320AIC3104, TLV320AIC3120

References				
REF29xx	Low-Power, Low-Cost Series Reference	50µA, 2% initial accuracy, 100ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF30xx, REF31xx, REF33xx
REF30xx	Low-Power, Low-Drift Series Reference	50µA, 0.2% initial accuracy, 50ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF31xx, REF33xx, REF29xx

* 更多产品信息请参见指定页码。
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新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

➜ **推荐器件**

Component	Description	Key Features	Benefits	Other TI Solutions
References (Continued)				
REF31xx	Voltage Reference	15ppm/°C (max) drift, 5mV low dropout, 115µA (max) I_Q, 0.2% (max) accuracy, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	No load capacitor required	REF32xx, REF33xx
REF32xx	Ultra-Low-Drift Series Reference	100µA, 0.2% initial accuracy, 7ppm/°C max drift, ±10mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Improves system accuracy	
REF33xx *Page 11*	Very-Low-Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF50xx	Precision Reference	0.05% accuracy, 3ppm/°C (max) drift, 3µV$_{PP}$/V low noise, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5V, 10V	Outstanding accuracy	REF02, REF102
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
MSP430F20xx	Ultra-Low-Power 16-Bit MCU	1KB/2KB Flash, 128B RAM, SPI+I²C	8 ch. 12-bit ADC or 4 ch. 16-bit SD ADC, 4 x 4mm package	
MSP430F22x4	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 512B/1KB RAM, SPI + I²C + UART/LIN + IrDA	12 ch. 10-bit ADC, 2 op.amps	
MSP430F23x0	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 1KB/2KB RAM, SPI + I²C + UART/LIN + IrDA	Analog comparator, HW multiplier	
MSP430F24xx	Ultra-Low-Power 16-Bit MCU	32 to 120KB Flash, 2 to 8KB RAM, SPI + I²C + UART, DMA, SVS	8 ch. 12-bit ADC, 2 ch.12-bit DAC, analog comp, HW multiplier	
MSP430F26xx	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I²C + UART, DMA, SVS	8 ch. 12-bit ADC, 2 ch.12-bit DAC, analog comp, HW multiplier	
MSP430F41x	Ultra-Low-Power 16-Bit MCU	4 to 32KB Flash, 256B to 1KB RAM, SVS, 96 segment LCD	Analog comparator	
MSP430F42x	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 256B to 1KB RAM, SPI + UART, SVS, 128 segment LCD	3 x 16-bit SD ADC	
MSP430F42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD, 2 op amps	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430FG42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD, 2 op amps	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430F43x	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 512B/1KB RAM, SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, analog comparator	
MSP430FG43x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, SPI + UART, SVS, 128 segment LCD, 3 op amps	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, DMA, 3 op amps	
MSP430F44x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 2x SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, HW multiplier	
MSP430FG461x	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I²C + UART/LIN + IrDA, 160 LCD, 3 op amps	12 ch.12-bit ADC, 2 ch.12-bit DAC, A-comp, 3 op amp, HW multiplier	
MSP430FG47x *Page 9*	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 2KB RAM, 16-bit ΔΣ A/D, 12-bit D/A, op amp, 128Seg LCD	Two 16-bit timers, a basic timer with a real-time clock, a high performance 16-bit ΔΣ ADC, dual 12-bit DACs, two configurable op amps	
MSP430F54xxA *Page 10*	Ultra-Low-Power 16-Bit MCU	128 to 256KB Flash, 16KB RAM, (4) USCI, PMM, DMA, temp. sensor	16 ch. 12-bit ADC, analog comparator, RTC, internal voltage regulator for power optimization	
MSP430F552x	Applications Processor	Up to 128KB Flash, 8+2KB RAM, USB, SPI + I²C	Integrated USB, 12-bit ADC	
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
TMS320C5000™	DSP	Power efficient, high performance	Fixed-point DSP with industry's best combination of standby and dynamic power consumption	
TMS320F2802x/3x Piccolo	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F283x Delfino	32-Bit Floating-point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320VC5506	DSP	200MHz, dual MAC, very low standby power of 0.12mW	Supported by eXpressDSP™ and many other software packages and tools	TMS320VC5509A, TMS320VC5502
Interface				
TPD3E001 *Page 15*	3-Bit/Single-Channel USB OTG ESD	1.5pF cap, 1nA leakage	Low capacitance, small package	TPD2E001, TPD4E001
TPD4S012 *Page 15*	4-Bit/Single-Channel ESD with V$_{BUS}$ Clamp	USB HS ESD with additional V$_{BUS}$ clamp	Replace one additional component for USB charger application	TPD4S014

* 更多产品信息请参见指定页码。如欲查阅更多系统方框图兼容的产品，敬请访问 **www.ti.com/medical**   新产品以**粗体红色标明**。

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Interface (Continued)				
TPD4E004 *Page 15*	4-Bit/2-Channel	1.6pF cap, low DC breakdown voltage	Low capacitance, small package	TPD6E004
TPD4E002 *Page 15*	4-Bit/2-Channel	USB FS	Very robust ESD (15kV contact)	
TUSB3410	USB 2.0 Full-Speed to Enhanced Serial Port Bridge	USB 2.0 compliance, enhanced UART port		
TUSB1106	USB 2.0 Full-Speed Trans.	USB 2.0 compliance, level shifting, system-level ESD	Smaller package, no external ESD needed	TUSB1105, TUSB2551A
Power Management				
bq77PL900	5-10 Series Li-ion Battery Protection & AFE	Integrated I^{2}C communications interface allows the bq77PL900 also to be as an analog front end (AFE) for a host controller	Provides full safety for overvoltage, under voltage, over current in discharge overvoltage and short circuit in discharge conditions	
bq2406x	Battery Charger	Linear 1-cell Li-Ion charger with thermal regulation, 6.5V OVP, temp sense	Good for space-limited designs with need for battery safety	bq2410x
bq24040 *Page 17*	USB-Compliant Li-Ion Charger	30-V input rating and 6.6V overvoltage protection; integrated 800mA FET and current sensor; USB and JEITA compliant	The bq24040 comes with more safety features: JEITA compliance, over-voltage protection, safety timers, and ISET short protection.	
bq24081	Battery Charger	One-cell Li-Ion charger with 1-A FET, timer enable and temperature sensing	Great for space-limited charger applications	
bq27010	Battery Fuel Gauge	Li-Ion and Li-Pol battery gas gauge	Reports accurate time-to-empty of battery	bq27200, bq27500
bq27541 *Page 18*	Battery Fuel Gauge	Li-Ion battery gas gauge with Impedance Track™ fuel-gauge technology	Reports accurate time-to-empty of battery	bq27510
TPS2041B	USB Power Switch	USB compliant power source, short circuit protection	USB switch with adjustable precision OC	TPS2550
TPS22902	Load Switch with Controller Turn-On	Low on resistance, controlled turn-on, ultra small 0.64mm^2 package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS22946	Current Limited Load Switch	Configurable current limit, ultra-small package, 1µA quiescent current at 1.8 V	Ultra-small, low quiescent current current limited switch	TPS22949, TPS22945
TPS2550	USB Power Switch	USB compliant power source, short circuit protection	USB switch with adjustable precision OC	TPS2551
TPS2551	Power Switch	Adjustable current limit, 100mA to 1100mA	Allows designer to precisely set current limit	TPS2051B, TPS2061
TPS61081	LED Boost Converter	Input to output isolation	Protection from short between any pins and between any pin to ground	TPS61161
TPS61093	OLED Boost Converter	Wide V$_{IN}$ range, input-output disconnect	Flexible, fail safe solution	TPS61080
TPS61097-33	Boost Converter with Bypass Switch	Highly efficient, operates down to 0.3V; bypass switch; 5nA shutdown current; SOT-23	Super efficient boost, works over entire battery range, low quiescent current, integrate the bypass switch, small package	
TPS61160/61 *Page 17*	Boost Converter	2.7V to 18V input voltage, up to 90% efficiency, built-in soft start	The boost converter runs at 600kHz fixed switching frequency to reduce output ripple, improve conversion efficiency, and allows for the use of small external components.	
TPS61200	Boost Converter	High efficient, operates down to 0.3V	Super efficient boost, works over entire battery range	TPS61010
TPS61220 *Page 16*	Boost Converter	Low Input Voltage, 0.7V boost converter with 5.5µA quiescent current	Can be switched off to minimize battery drain; small package solution	
TPS62230	Step-Down Converter	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm^2 solution size	TPS62260
TPS62300	Step-Down Converter	500mA, 3MHz synchronous step-down converter	Very small inductor and high efficiency	TPS62040
TPS63030	Buck-Boost Converter	1-A switch, automatic transition between step down and boost mode	Extending application run time, small solution	TPS61020
TPS717xx	Low-Noise Single-Channel LDO	High bandwidth, very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS799xx
TPS718xx-yy	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719xx-yy
TPS780xx	LDO with DVS	Dynamic voltage scaling (DVS) with low I$_Q$ 500nA	DVS voltage designed to operate with MSP430™ to increase power savings	TPS781xx
TPS78001 *Page 16*	Single-Channel LDO	Dual-level, fixed output voltages, ultra-low I$_Q$	Adjustable V$_{OUT}$ for optimal performance, longer battery life	TPS717xx, TPS739xx
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530

* 更多产品信息请参见指定页码。
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Component	Description	Key Features	Benefits	Other TI Solutions
RF ICs (Continued)				
RF Transceivers (Continued)				
TMS37157 *Page 8*	Passive Low Frequency Interface Device (PaLFI) With EEPROM and 134.2 kHz Transponder Interface	Ultra-low-power consumption, 2V to 3.6V supply voltage, low frequency HDX interface	It is the ideal device for any data logger, sensor or remote control application enabling operation without the need of a battery.	
RF Systems-on-Chip				
CC2560	2.4GHz *Bluetooth*® 2.1 chipset	Single-chip *Bluetooth*® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/1111	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/RF4CE/ ZigBee®	Excellent RX sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market. Provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4 GHz *Bluetooth*® low energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	Fast-to-market *Bluetooth*® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth*® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and *Bluetooth*® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with *Bluetooth*® technology and Wi-Fi.	

* 更多产品信息请参见指定页码。
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新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

→ 概述

医疗诊断、患者监测和治疗设备的发展趋势包括便携性、连通性、灵活性和系统智能。

凭借电池和电池管理技术的改进以及诸如Bluetooth®和ZigBee®等无线通信技术的迅速应用普及，像数字听诊器、患者监测、ECG、EEG和脉搏血氧测定仪这样的医疗设备其便携性均有所提高。诸如触摸屏控制和声音反馈等附加功能取消了旋钮和标度盘的复杂组合，而代之以菜单驱动型显示器和用户语音提示。除此之外，这些仪器不仅能够从信号的常态之中察觉出极其微小的扰动，还可对照大型数据库来收集和处理呈现未来走势的动态信息、甚至就应当采取的行动步骤提出建议，而为此铺平道路的则是传感器信号链路的高精度与当今嵌入式处理器之强大处理能力的完美结合。

另外，可靠性、电池存储容量及可用性方面的上述改进还扩大了自动外部去纤颤器(AED)的使用范围，使之不再是专属于医疗机构和救护车的医用设备，而是成为了部署于许多学校、企业和其他公共场所的医疗仪器。低功耗处理使得AED能够在很长的时间里处于睡眠模式，只在进行诊断时才被唤醒，并在需要的情况下迅速进入全面运转状态。比如，这些设备具有指导用户在其使用过程中保持安全的智能，并能够在患者身上的护垫 (pad) 放置不正确时及时检测出来，从而为其迅猛普及真正起到了助推的作用。

通过把监测能力的进步与电机控制、电源管理和控制系统的发展相结合，诸如通氧/CPAP、透析和输液泵等应用变得更小、更安全和更廉价。这一发展趋势已使CPAP系统和输液泵进入家庭变得切实可行，而透析治疗也不再是医院的"专利"，在医生的诊所也可进行。

如今，由于消费者和护理人员需要把数据从医疗设备传递至诸如计算机和移动电话等数据集线器 (data hub)，因此便携式医疗应用的连通性变得至关重要。TI是"康体佳"健康联盟 (Continua Health Alliance) 的创立成员之一，目前为Agent Devices公司提供了首款经Continua认证的USB平台。*更多信息请参见第142页。*

如需了解更多有关TI之诊断、患者监测及治疗产品的信息，敬请访问：
www.ti.com/patientmonitoring

→ 数字听诊器

数字听诊器（见第24页）的主要构成元素包括传感器单元（用于探测心脏及肺部的声响，也称作"听诊"[auscultation]）以及听诊信息的数字化和数字处理（用于实现噪声抑制、滤波及放大）。此外，针对心率检测及心脏缺陷检测的算法也可以包括在内。

对于此类极为便携的诊断工具而言，电源及电池管理是极重要的。设计考虑因素包括了超低功耗及高效率，两者均源于对延长电池寿命的需求。设计还必须结合高精密度及快速响应时间，以实现对患者健康状态的快速检测。

如欲记录听诊信息，则需要有线或无线接口，以传输听诊数据。为实现设备的简单易用性，诸如触摸屏控制及显示器背光照明等特性是非常必要的。如何添加此类特性、同时又不明显地增加功耗是一项极大的挑战。

TI的处理器、仪表放大器及缓冲器放大器、电源及电池管理、音频编解码器 (codec) 及有线和无线接口器件的组合为数字听诊器应用提供了理想的工具箱。

数字听诊器常见的核心子系统为模拟前端/传感器接口和编解码器、低功耗处理器、数据存储及传输模块。

诊断、患者监测及治疗

➜ **数字听诊器**

模拟前端/传感器接口及编解码器

听诊器信号输入通过音频编解码器实现放大及数字化。在经过数字化之后，听诊信号将进行信号处理。随后该信号重新转换为模拟信号并输送至听诊器听筒。

低功耗处理器

那些能够执行数字听诊器的信号处理功能（例如：噪声抑制、针对心率检测及心脏缺陷检测的算法等）、同时仍能保持非常低的恒定电流消耗（从电池汲取）的处理器是较为可取的。

处理器控制内存接口及外设器件的能力也是极为有用的。具有数字显示及键入管理功能的处理器则可支持听诊波形的显示及处理，无需附加元件。
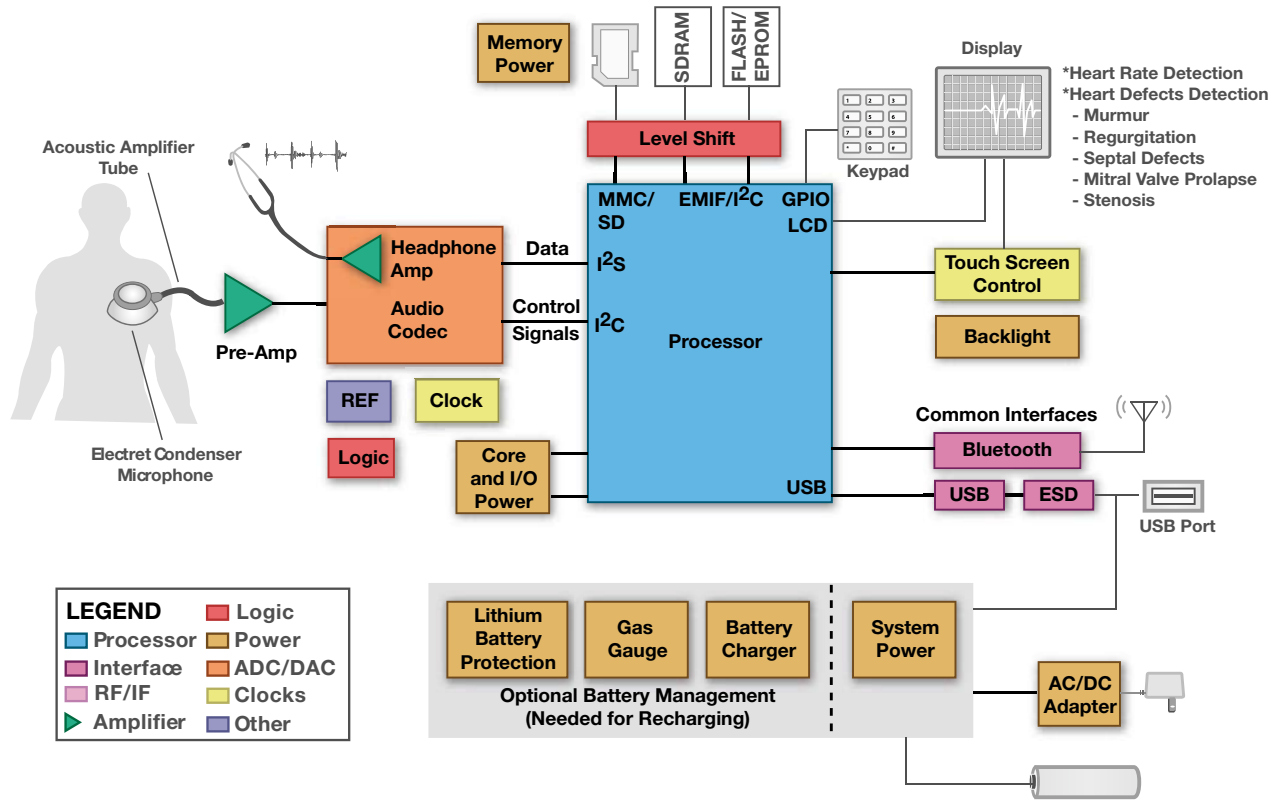
数字听诊器系统方框图

诊断、患者监测及治疗

→ **数字听诊器**

高效、定点型DSP
TMS320C5515

敬请访问**www.ti.com/sc/device/TMS320C5515**，以获取样片、数据表、工具及应用报告。

主要特点

- 高性能/低功耗、C55x™定点型DSP
  - 16.67/13.33/10/8.33ns指令周期时间
  - 60、75、100、120MHz时钟频率
- 320k字节片上RAM
- 16位/8位外部存储器接口 (EMIF)
- 两个多媒体卡/安全数字卡接口 (I/F)
- 具4种片选的串行端口I/F (SPI)
- 4路IC之间音频传输 (I²S bus™)
- USB 2.0全速和高速器件
- 具有异步接口的LCD桥接器
- 紧密耦合的FFT硬件加速器
- 10位4路输入SAR ADC

应用

- 便携式超声波设备
- 自动外部去纤颤器 (AED)
- 心电图 (ECG)
- 数字听诊器
- 耳蜗植入 (cochlear implants)

TMS320C5515隶属于TI的TMS320C5000™定点型数字信号处理器 (DSP) 产品系列，并专为低功耗应用而设计。TMS320C5515定点型DSP基于TMS320C55x™ DSP系列CPU处理器内核。C55x™ DSP的架构通过提升并行能力并从整体层面注重于节能而实现了高性能及低功耗。该CPU支持内置总线架构，其组成包括了一条程序总线、一条32位数据读总线和两条16位数据读总线、两条16位数据写总线以及额外的外设及DMA传输专用总线。这些总线提供了在单周期内读取4个16位数据并写入2个16位数据的能力。
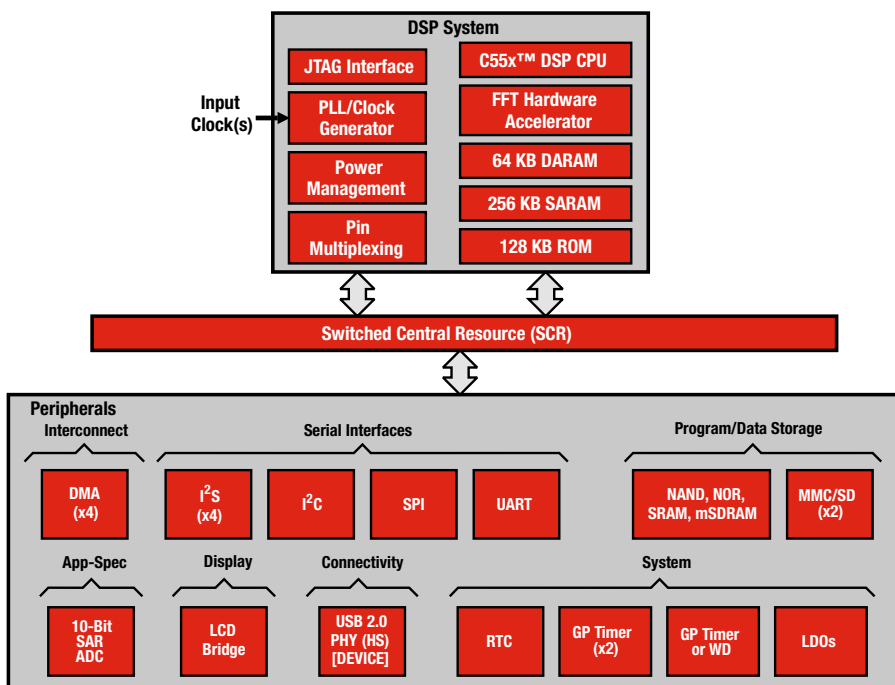
TMS320C5515 DSP方框图

→ **数字听诊器**

用于 C5515 DS 医疗开发套件的数字听诊器 (DS) 模拟前端模块
TMDXMDKDS3254

敬请访问**www.ti.com/tmdxmdkds3254**，以获取样片、数据表及评估板。

主要特点

- DS AFE模块的主要组件
  - TLV320AIC3254：具有可编程输入和输出的灵活、低功耗、低电压立体声音频编解码器
  - OPA335：0.5μV/°C、CMOS零漂移运算放大器
- DS MDK系统特性
  - 基于业界最低功耗的DSP处理器——TMS320C5515
  - 三种可选模式的音频输出：
    - 响铃模式（20Hz至220Hz）
    - 隔膜模式（50Hz至600Hz）
    - 扩展范围（20Hz至2000Hz）
  - 3种输入通道选择、2个电容器和1个接触式传声器
  - 音量控制和静音
  - 在板载LCD和PC上实时显示心跳信号
  - 在PC侧提供了存储和重放选项

应用

- 数字听诊器设备
- 患者监测

为了缩短医疗设备公司的产品面市时间，TI推出了一套医疗应用开发工具，并配有针对心电图、数字听诊器和脉搏血氧测定仪产品的完整信号链路设计方案及软件。这三款医疗开发套件 (MDK) 的构成方法均为：采购一款运用了专为每种终端产品而优化的特殊电路设计的模拟前端 (AFE) 模块，和一块基于业界最低功耗DSP——TMS320C5515的TMS320C5515 DSP评估板 (EVM)。这些MDK提供了一种绝佳的评估平台，意在帮助医疗设备制造商专注于实现产品的差异化（比如算法开发和功能强化）。

TMDXMDKDS3254数字听诊器 (DS) 模拟前端 (AFE) 模块包括DS AFE模块、一块处理器板（C5515 DSP评估板）、一组附属品和基于 C5515 的应用示例代码，用于实现DS应用。DS MDK提供了一款完整的信号链路解决方案，旨在使开发人员能够迅速设计出整体DS系统进行评估，并更快地投产。

TMDXMDKDS3254 EVM

→ **数字听诊器**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
TMS320C5505	Low-Power DSP	16-/8-bit EMIF, 320K bytes on-chip RAM, USB 2.0 full- and high-speed device	High-performance, low-power	
TMS320C5515 *Page 25*	Power-Efficient DSP	16-/8-bit external memory interface, 320K bytes on-chip RAM, USB 2.0 full- and high-speed device	Designed for low-power applications; low-power, high-performance	
TMS320VC5503	Low-Power DSP	Up to 200MHz, dual MAC, 16-bit HPI, 3 McBSP	Power efficient, low-cost DSP, C55x™ code compatibility	C550x DSP
TMS320VC5507	Low-Power DSP	Up to 200MHz, dual MAC, 128KB RAM/64KB ROM, USB 2.0 full speed, 10-bit ADC	Power efficient, C55x code compatibility	C550x DSP
TMS320VC5509A	Low-Power DSP	Up to 200MHz, dual MAC, 256KB RAM/64KB ROM, USB 2.0 full speed, MMC/SD, 10-bit ADC	Power efficient, large on-chip memory, rich peripheral set allows for various portable connectivity; C55x code compatibility	C550x DSP
Data Converters				
TLV320DAC32	Low-Power Audio DAC	Low-power stereo DAC, 4 outputs, HP/speaker amplifier, 3D effects		
TLV320AIC3104	Low-Power Audio Codec	Low-power stereo codec, 6 inputs, 6 outputs, headphone amp, enhanced digital effects		
TLV320AIC3106	Low-Power Audio Codec	Low-power stereo codec, 6 inputs, 6 outputs, headphone amp, enhanced digital effects		
TLV320AIC3254	Low-Power Audio Codec	Very-low power, single supply, miniDSP for audio processing	Longer battery life, better audio quality, lower system cost	TLV320AIC3204 (pin to pin without miniDSP)
Amplifiers				
DRV134/5	Line Driver/ Receiver	0.0005% at f = 1kHz distortion, 17V_{rms} into 600Ω output swing, ±5.2mA I_Q, ±4.5V to ±18V supply	Balanced output pair, low distortion	INA134, INA137
INA134/2134	Line Driver/ Receiver	0.0005% at f = 1kHz distortion, 90dB CMRR, 0dB (1V/V) fixed gain, ±2.9mA I_Q, ±4V to ±18V supply	Excellent AC specifications, low distortion	INA137, OPA1632
INA137/2137	Line Driver/ Receiver	0.0005% at f = 1kHz distortion, 90dB CMRR, 6dB fixed gain, ±2.9mA I_Q, ±4V to ±18V supply	Differential line receiver, low distortion	INA134, DRV134
OPA134/2134	Audio Amp	0.00008% ultra-low distortion, 8nV/√Hz noise, 8MHz BW, 120dB open-loop gain, ±2.5V to ±18V supply	True FET-input stage, low distortion, low noise	OPA211, OPA604
OPA141	Precision Op Amp	10MHz, 6.5nV/√Hz, ±4.5V to ±18V, 1.8mA typical, FET input: I_B = 20pA max	Common mode voltage range includes GND	OPA827, OPA132
OPA209	Precision Op Amp	2.2nV/√Hz at 1kHz, ±4.5V to 18V supply, 18MHz, 2.5mA quiescent current (typ)	Unity gain stable, RRO, wide supply range, low power	
OPA211	Precision Op Amp	1.1nV/√Hz noise at 1kHz, ±2.25V to ±18V supply, 80MHz BW	Unity gain stable, RRO, wide supply range	OPA227
OPA378	Low Noise Precision Op Amp	0.1μV/°C Vos drift, 125μA, 900kHz, 0.4μV_{PP} (0.1Hz to 10Hz) 0.4μ V_{pp} (0.1Hz to 10Hz), 0.9MHz	Lowest noise, power, price, precision zero-drift option	**OPA330**, OPA333
OPA827	Precision JFET Op Amp	4nV/√Hz noise at 1kHz, ±4V to ±18V supply, 15pA (typ) input bias current, 22MHz BW	High precision, low noise, low input bias, wide supply range	OPA177, OPA627,
THS4521	Low Power FDA	1.14mA quiescent current (typ), 4.6nV/√Hz voltage noise	Very low power, low noise enables high accuracy	
Interface				
TPD2E001	ESD Solution	Low capacitance, 2 channels, ±15kV ESD-protection array for high-speed data interfaces	IEC 61000-4-2 system level (level 4) ESD protection; low input capacitance in space-saving packages	SN65220

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→ **数字听诊器**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management				
bq29312A	Li-Ion Battery Protection IC	Provides under- and overvoltage, overcurrent, short-circuit and overtemperature protection	Provides primary safety protection for cells	
bq29330	Battery Safety	Battery pack full-protection analog front end	Provides individual cell voltages and battery voltage to battery-management host	
bq29410/1/2	Li-Ion Battery Protection IC	Provides overvoltage protection for Li-Ion and poly cells	Prevents false triggers during dynamic operating conditions	
bq2000	Battery Management	Multi-chemistry charger	One charge for both Li-Ion and NiCad/NiMH cells	
bq24100	Battery Charge Management	Switch mode, 1100kHz switching frequency, >2A charge current	d/dt, min current primary charge termination method	
TPS5130	DC/DC Converters	Triple synchronous buck controller with LDO	Provides 4 output voltages in 1 package	
TPS61070	DC/DC Converters	600mA switch low voltage in boost	Can generate 5V rail from 1-, 2- or 3-cell alkaline or 1-cell Li-Ion	
TPS61097-33	Boost Converter with Bypass Switch	Highly efficient, operates down to 0.3V; bypass switch; 5nA shutdown current; SOT-23	Super efficient boost, works over entire battery range, low quiescent current, integrate the bypass switch, small package	
TPS61120	DC/DC Converters	Dual switcher boost and LDO	Compact 2-voltage solution	
TPS62202	DC/DC Converters	300mA synchronous	Ultra-small battery-powered solutions	
TPS22902	Load Switch with Controller Turn-On	Low on resistance, controlled turn-on, ultra small $0.64mm^2$ package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS65020	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I^2C interface and dynamic voltage scaling	Provides complete solution in one package	
TPS65023	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I^2C interface and DVS, optimized for DaVinci™ DSPs	Provides complete DaVinci solution in one package	
TPS65800	Linear Charge Management	6-channel power management IC with 2 DC/DCs, 7 LDOs, I^2C interface and dynamic voltage scaling	Complete power management solution in one package	
TPS74401	LDO	Single-output LDO, 3.0A, adjustable (0.8V to 3.3V), fast transient response, programmable soft start	Adjust the voltage ramp rate for your processor requirements	
TPS79601	LDO	1A low-dropout regulator with high PSRR	Low-noise LDO stable with 1µF ceramic capacitor	TPS796xx
TPS79630	LDO	1A low-dropout regulator with high PSRR	Low-noise LDO stable with 1µF ceramic capacitor	TPS796xx
Toolkits				
TMDXMDKDS3254 *Page 26*	Digital Stethoscope (DS) Analog Front End Module for the C5515 DS Medical Development Kit	Audio output in three selectable modes; 3 channel input options; volume control and mute; real time display of heart signal on onboard LCD and PC; store and playback option on PC side	Based on industry's lowest power DSP processor – TMS320C5515	

* 更多产品信息请参见指定页码。

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→ 患者监测

近几年，一系列的便携式单一参数和多参数检测仪正逐渐兴起，可测量血压、血糖浓度、脉搏、二氧化碳含量涨落以及其他生物参量值。患者监测仪是便携、灵活的设备，支持多种有线及无线接口，可适用于众多的临床应用。

主要特点

现今的患者监测仪最为重要的特性为灵活机动性、简单易用性及患者数据传输的轻松便捷性。灵活机动性包括了便携特性以及连接至其他医疗设备（例如麻醉机 [anesthesia machines]及去纤颤器）的能力。简单易用性可通过触摸屏显示及多级菜单驱动配置实现，具体配置可针对环境及患者的生理统计参数进行设定。

数据传输必须通过从无线至RS-232的各种接口实现。医院有可能使用某一种特定的基础架构，并用于所有的院区、救护车、居家及其他环境，这通常需要支持不同的协议。

尽可能降低健康维护费用的需求日渐高涨，从而导致患者治疗及监测逐步转移至医院外进行。此项转变的重点在于远程患者监测及远程就医的解决方案，使得医疗提供方能够同时为处于高密度居民区、乡村及边远地区的患者提供医疗服务，具有显而易见的经济优势。
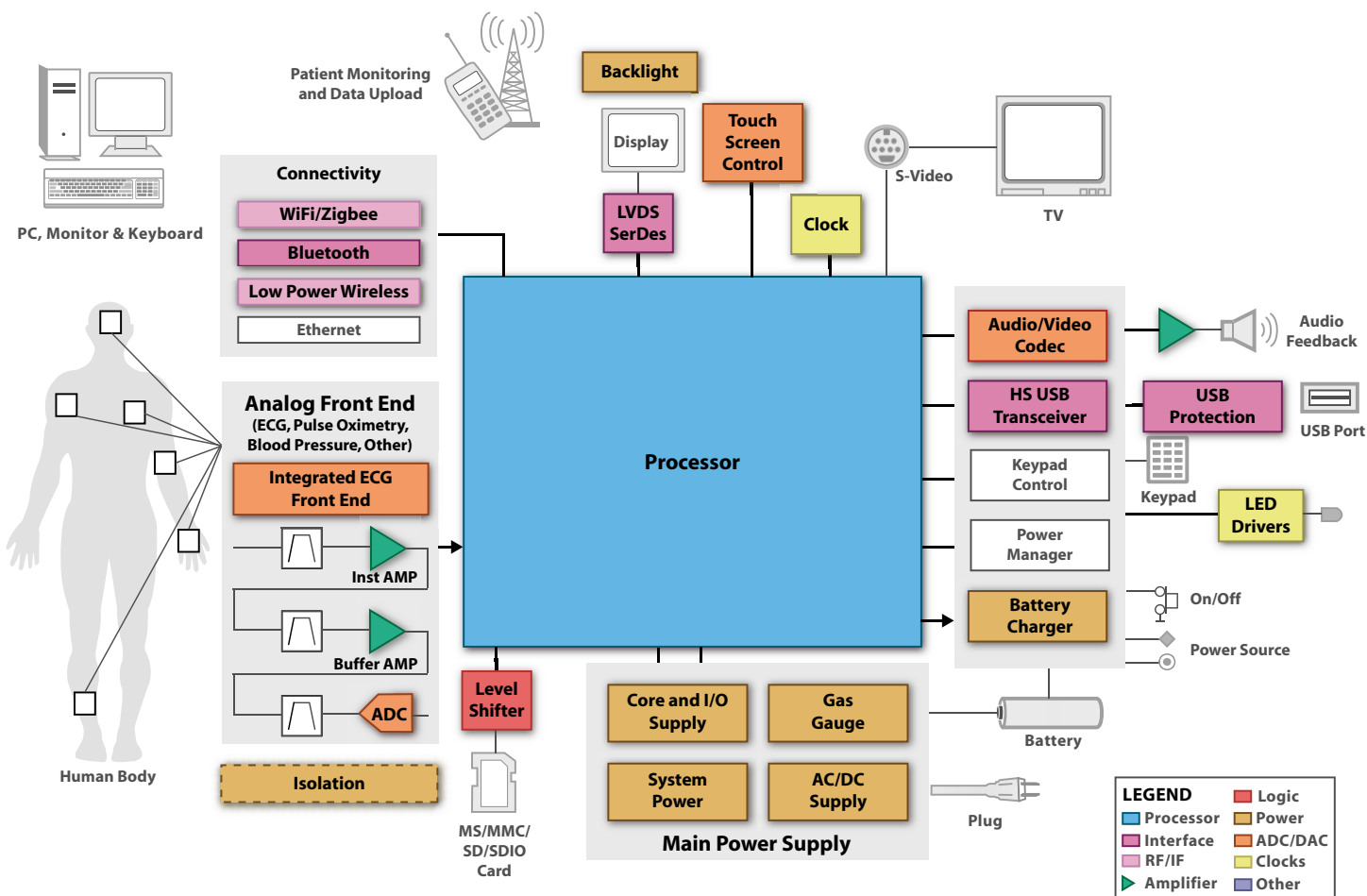
多参数患者监测系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

诊断、患者监测及治疗

→ 患者监测

TI的OMAP™ / Davinci™技术解决方案

患者治疗及监测设备的实现相关的挑战正类似于手机行业所面临的系统实现的挑战。TI的OMAP™技术具有嵌入式ARM及DSP处理器核心，可直接解决此类难题。TI具有宽范围的模拟前端解决方案产品组合，适用于重要信号的调节。OMAP 3处理器可满足患者状况监测领域的数字信号处理、测量及分析需求。

TI强大的ARM处理器可运行高级操作系统 (HLOS)，使得添加多模式监测更为简易，并可提供大量的用户接口及系统控制。异常状况的检测以及与中心服务器的通信是不可或缺的，可提供适时且急需的健康护理。OMAP 3具有革新性的外设集，可支持不同的连通性选项，例如蓝牙 (Bluetooth®) 技术、WiFi®、ZigBee® 及其他新兴的标准。

应用处理器
OMAP35x

敬请访问**www.ti.com/omap35x**，以获取样片、数据表、评估板及相关应用报告。

主要特点

- ARM® CORTEX–A8核心
- TI的DaVinci™ C64x+™ DSP核心
- 2D / 3D图形加速器
- OpenGL® ES 2.0兼容图形引擎
- NeonTM协处理器
- 可扩展的平台：
  - OMAP3503（仅限ARM版本）
  - OMAP3515（ARM及2D/3D图形加速器）
  - OMAP3525（ARM及DSP）
  - OMAP3530（ARM、DSP及2D/3D图形加速器）
- 以手持设备功耗级别的单芯片实现了与笔记本电脑 (laptop) 相近的性能优化
- TI的SmartReflex™电源及性能管理
- 65nm CMOS工艺

应用

- 多参数患者监护仪
- 便携式超声波设备
- 自动外部去纤颤器 (AED)
- 心电图 (ECG)

OMAP35x系列处理器包括了四款差异显著的单芯片处理器，由ARM® CORTEX –A8核心、多媒体丰富型外设、OpenGL® ES 2.0兼容图形引擎、视频加速器及高性能TMS320C64x+™ DSP核心的不同组合构成。OMAP35x系列以手持设备功耗级别实现了与笔记本电脑 (laptop) 相近的性能，为用户提供了高度灵活的平台，可提供强大的用户界面体验，并具有额外的信号处理能力以用于应用实现。此外，TI的SmartReflex™电源及性能管理技术降低了总体功耗并优化了性能，允许用户开发出革新性的低功耗应用。处理器提供了一系列的接口，可用于模拟前端、电源及电池监测、显示器、键区及触摸屏解决方案。另外，OMAP35x还可支持不同的连通性选项，诸如USB、Wi-Fi®、ZigBee®、以太网及其他逐渐兴起的标准均被集成至处理器中。

OMAP35x处理器

诊断、患者监测及治疗
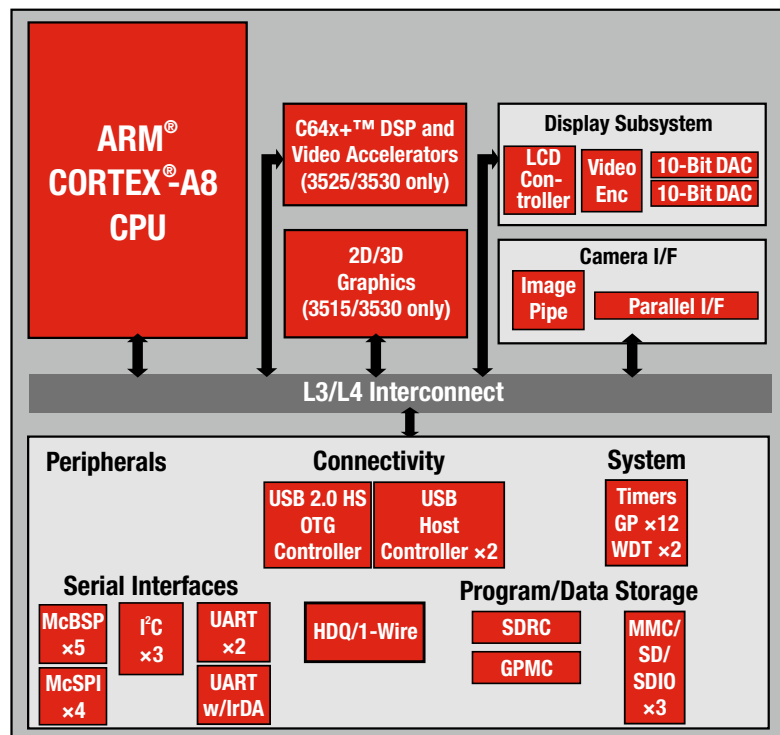
→ **患者监测**

Stellaris®
LM3S3xxx

敬请访问**www.ti.com/stellaris**，获取样片、数据表及评估板。

主要特点

- 高达256kB的集成闪存和96kB SRAM
- 集成型以太网MAC + PHY
- USB主机/设备/OTG (on-the-go)
- 为完整而丰富的软件库 (StellarisWare®) 提供了免费使用许可

应用

- 患者监测
- 家庭健康集线器 (Home health hubs)

Stellaris系列专为高端微控制器应用而设计，凭借介于1美元至1GHz的编码兼容性为进入该行业最强大的生态系统提供了途径。

- 出色的集成节省了高达3.28美元的系统成本
- 超过160款Stellaris系列成员可供用户选择
- 真正的MCU GPIO——均能生成中断信号，可容许5V电压，并拥有可编程驱动能力和转换速率控制功能
- 具高级通信能力，包括10/100以太网MAC/PHY、USB和USB OTG、CAN控制器和扩展的外设接口
- 利用硬件和软件提供了精细的运动控制支持
- 模拟比较器和ADC功能均提供了片上系统选项以平衡硬件和软件性能
- 可利用免版税的StellarisWare软件轻松完成开发工作
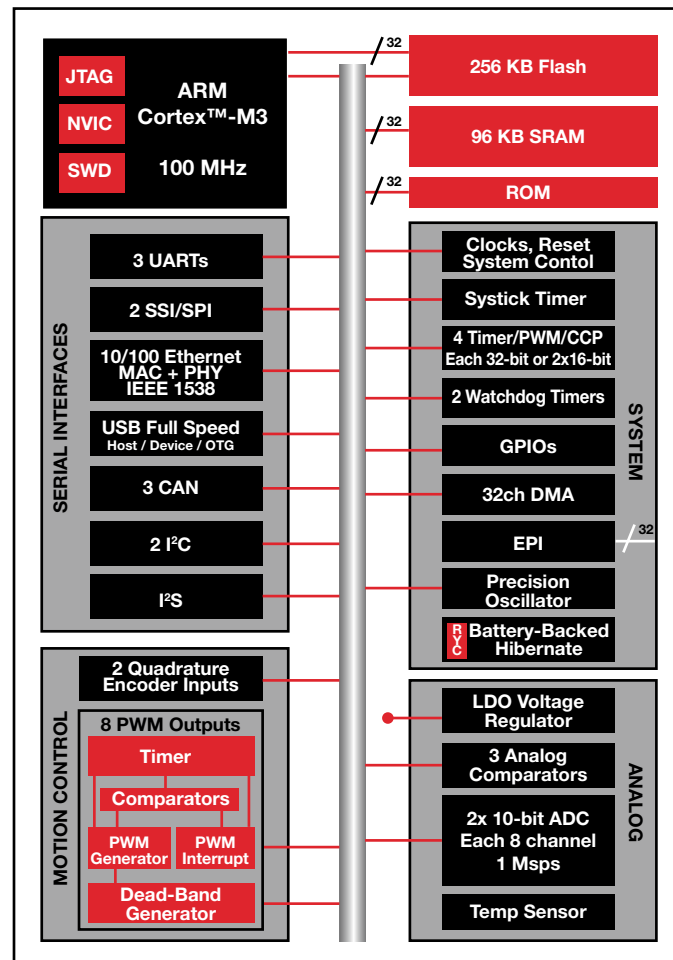
Stellaris系列方框图

患者监测

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics acelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
OMAP3530 *Page 30*	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
Stellaris® LM3S3xxx *Page 31*	Microcontroller	ARM® Cortex-M3, up to 256KB flash, up to 64kB RAM, USB host/device	USB, 10-bit ADC, temperature sensor	
Data Converters				
ADS1115	Delta-Sigma ADC	16-bit, 860SPS, 4 SE, 2 diff input, PGA, MUX, comparator, V_{REF}	Smallest 16-bit ADC, 2.0 x 1.5 x .04 mm leadless WFN pkg; reduces system size and componenent count	**ADS1113/4, ADS1013/14/15**
ADS1298	ECG/EEG AFE	24-bit, 8 PGA, 8 ADC, plus RLD and RESP	Complete front end, reduction in power and size, increase reliability	**ADS1294, ADS1296, ADS1198**, ADS1258
ADS7866	SAR ADC	12-bit, 200kSPS, 71dB SNR, ±1.5 LSB (max) INL, 1.6V to 3.6V supply	Small size, low power, serial interface	ADS7886
ADS7924	Low-Power SAR ADC	12-bit, 100kSPS, 4 channel, ≤1µA power down current, I²C interface, QFN package	Intelleigent system power management and self monitoring	ADS7828, ADS7823
ADS7953	SAR ADC	12-bit, 16-channel, 1MSPS, SPI interface with threshold alarms, QFN package	Low power, small package, and excellent performance	**ADS7952, ADS7956, ADS7957/60/61**
ADS8201	Micropower SAR ADC	8 channel, 12-bit, 100kSPS, 1.32mW power consumption at 100kSPS	Full on-chip data acquisition system	ADS7870
ADS8326	SAR ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL, SE input	Low power, small package, and wide supply range	**ADS8317**
TLV320AIC3104	Audio Codec	Low-power stereo codec, 6 inputs, 6 outputs, headphone amp, enhanced digital effects		
TLV320DAC3120	Low-Power Audio DAC	Mono DAC with 2.5W mono Class-D speaker amplifier; miniDSP for audio processing	Longer battery life, better audio quality, lower cost	TLV320DAC3101
TLV320AIC3254	Low-Power Audio Codec	Very-low power, single supply, miniDSP for audio processing	Longer battery life, better audio quality, lower system cost	TLV320AIC3204 (pin2pin without miniDSP)
TLV320DAC32	Audio DAC	Low-power stereo DAC, 4 outputs, HP/speaker amplifier, 3D effects		
Amplifiers				
INA126	Instrumentation Amp	±250µV (max) input offset, 83dB CMRR, 0.175mA (typ) I_Q	Precision low power, ±1.35V to ±8V supply	INA2126, INA122
INA128	Instrumentation Amp	60µV offset, 0.7 µV/°C drift, 8nV/√(Hz) noise	Low noise, low drift, wide supply, wide BW	INA118, INA129
INA333	Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50µA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA326
OPA2822	High-Speed Amp	Dual, 2nV/√Hz noise, 240MHz GBWP, 90mA output, 4.8mA/ch I_Q, +5V to +12V supply	High speed, wide input and output voltage swing, excellent DC accuracy	OPA2690, OPA842
OPA333	Precision Op Amp	1.8V min supply, 0.017mA/ch (max), 10µV offset (max), 0.05 µV/°C drift (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, **OPA330**
OPA376	Precision Op Amp	7.5nV/√Hz noise, 760µA(typ)/ch Iq, 5µV (typ) offset, input EMI filter, RRO	Low noise, low power, low input bias	OPA340, OPA337, OPA364
OPA378	Low Noise Precision Op Amp	0.1µV/°C Vos drift, 125µA, 900kHz, 0.4µVPP (0.1Hz to 10Hz) 0.4µ V_{pp} (0.1Hz to 10Hz), 0.9MHz	Lowest noise, power, price, precision zero-drift option	**OPA330**, OPA333
OPA695	High-Speed Amp	1.4GHz BW (G = +2), 4300V/µs slew rate, 129mW power, ±4.2V output voltage swing	Wide bandwidth, current feedback, low power, fast signal conditioning	OPA847, OPA691
TPA2006D1	Analog-Input Class-D Amp	1.45W mono, filter-free Class D, 1.8V shutdown		
TPA2010D1	Analog-Input Class-D Amp	2.5W mono, fully differential, filter-free Class D, in WCSP	Loud audio, long battery life, small package size	TPA2031D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA3007D1	Analog-Input Class-D Amp	Mono, medium power, filter-free Class D		
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA6204A1
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2 to 500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency hopping systems	CC2500
CC1150	Sub-1GHz Transmitter	Programmable data rate from 1.2 to 500 kBaud, fast startup time (0.3µs), low current consumption	Fast development time and low system cost, flexible optimization of range vs. power, small solution size	

如欲查阅更多系统方框图兼容的产品，敬请访问 **www.ti.com/medical**

新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

诊断、患者监测及治疗

→ 患者监测

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
RF ICs (Continued)				
RF Transceivers (Continued)				
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz Bluetooth® 2.1 chipset	Single-chip Bluetooth® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	Second Gen. System-on-Chip Solution for 2.4GHz IEEE 802.15.4/ RF4CE/ZigBee®	Excellent RX sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market. Provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4 GHz Bluetooth® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	RF design System-on-Chip for quick time to market. Provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
WL1271	2.4GHz 802.11b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Fast-to-market Bluetooth® low energy compliant solution	
WL1273	2.4/5GHz 802.11a/b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with Bluetooth® technology and Wi-Fi.	
Power Management				
bq2000/T	Battery Management	Multi-chemistry charger	One charge for both Li-Ion and NiCad/NiMH cells	
bq24100	Battery Charge Management	Switch mode, 1100kHz switching frequency, >2A charge current	d/dt, min current primary charge termination method	
TPS43000	DC/DC Controller	2MHz operation	Allows smaller-value inductor and input cap	
TPS5130	DC/DC Controller	Triple synchronous buck controller and LDO	Four outputs in one package allows smaller power solution	TPS65xxx
TPS61070	DC/DC Converter	Input voltage range of 0.9V to 5.5V	Allows 1-, 2- or 3-cell alkaline or 1-cell Li-Ion operation	
TPS61097-33	Boost Converter with Bypass Switch	Highly efficient, operates down to 0.3 V; bypass switch; 5nA shutdown current; SOT-23	Super efficient boost, works over entire battery range, low quiescent current, integrates the bypass switch, small package	
TPS61120	DC/DC Converter	Dual switch boost and 200mA LDO outputs	Highly efficient dual-output operation for 1-cell Li-Ion operation	
TPS22902	Load Switch with Controller Turn-On	Low on resistance, controlled turn-on, ultra small 0.64mm² package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS22946	Current Limited Load Switch	Configurable current limit, ultra-small package, 1µA quiescent current at 1.8 V	Ultra-small, low quiescent current current limited switch	TPS22949, TPS22945
TPS62420	DC/DC Converter	Dual step-down buck converter with 1-pin easy scale	Offers dynamic voltage scaling for power savings	
TPS62202	DC/DC Converter	300mA synchronous buck in a SOT-23 package	Ultra-small implementation	
TPS65020	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I²C interface and dynamic voltage scaling	Provides complete solution in one package	
TPS65023	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I²C interface and DVS, optimized for DaVinci™ DSPs	Provides complete DaVinci solution in one package	
TPS65800	Linear Charge Management	6-channel power management IC with 2 DC/DCs, 7 LDOs, I²C interface and dynamic voltage scaling	Complete power management solution in one package	
TPS74401	LDO	Single-output LDO, 3.0A, adjustable (0.8V to 3.3V), fast transient response, programmable soft start	Adjust the voltage ramp rate for your processor requirements	
TPS79601	LDO	1A low-dropout regulator with high PSRR	Low-noise LDO stable with 1µF ceramic capacitor	TPS796xx
TPS79630	LDO	1A low-dropout regulator with high PSRR	Low-noise LDO stable with 1µF ceramic capacitor	TPS796xx

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医疗应用指南   33   德州仪器 2010

→ 心电图 (ECG)/便携式心电图及脑电图 (EEG)

生物医学 (Biophysical) 监测概述

人类的医疗数据采集系统，特别是患者监测系统，一直是对设计人员的挑战——设计人员必须从非常大的共模电压及噪声中提取出非常微弱的电信号。前端放大器起到了必不可少的调节作用，以补偿后续的数字处理，从而改进了测量以及与其他系统的通信。生物医学的测量包括了电气及机械信号，可用于一般的监测、诊断以及临床和非临床环境下的科研用途。为了成功地应对信号采集需求方面的挑战，系统设计人员须具备信号源的相关知识，还需要拥有良好的设计实践以及特性、特点和性能均适合的IC。

信号采集的挑战

心脏壁 (heart wall) 收缩所引起的动作电势 (action potential) 将电流由心脏传播至整个人体。所传播的电流在人体的不同部位产生不同的电势，可使用由金属或盐类制成生物传感器，通过电极在皮肤表层感应得出。该电势属于交流 (AC) 信号，带宽为0.05Hz至100Hz，有时还能高达1kHz。该电势的峰峰值通常为1mV，存在于较大幅值的外部高频噪声中，并夹杂着50/60Hz的固有振荡模式干扰（与电极信号混频）以及共模电压（共模至所有电极信号）。

共模电压由两部分组成：50Hz或60Hz干扰以及直流电极偏置电势。处于生物医学带宽之内的其他噪声或高频成分源于人为的运动（改变了皮肤与电极的接触）、肌肉的收缩或肌动电流的脉冲尖峰 (spike)、呼吸运动（可能是有节奏的或随机的）、电磁干扰 (EMI) 以及来自其他电子设备并耦合至输入的噪声。部分噪声可通过高输入阻抗仪表放大器 (INA) 消除，例如INA326或INA118，可消除共模至双端输入的AC线路噪声并放大输入端上所残余的非直流信号；更高的仪表放大器共模抑制 (CMR) 能力将导致更强的抑制消除作用。由于源自人体的不同端点，左臂和右臂的心电图信号处于不同的电压电平，并通过仪表放大器放大。为了进一步地抑制50Hz及60Hz噪声，共模信号将通过一个运算放大器反相并得到共模电压，随后采用A2放大器将该共模电压通过患者的右腿驱送回患者体内。在此仅需几微安（甚至更小）的电流即可实现显著的共模抑制改善，且不会超出UL544标准的限制。
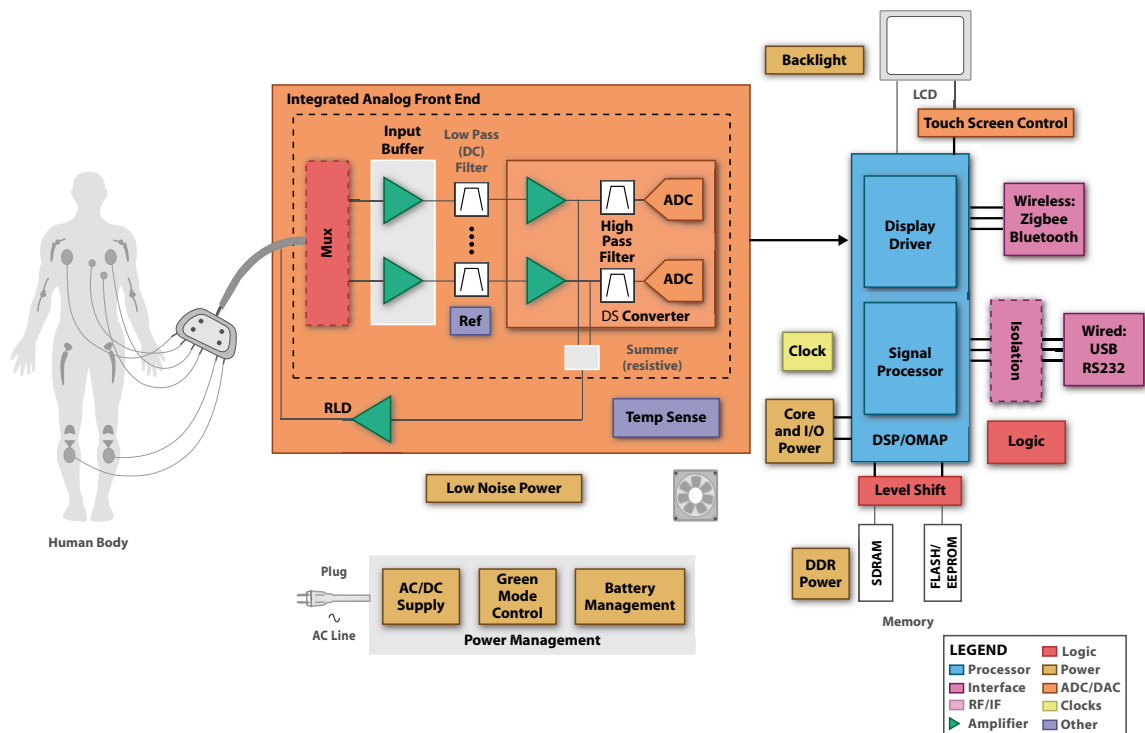
三个心电图电极通过5V单电源的CMOS元件连接至患者。此电路还可采用3.3V电源供电运转。

诊断、患者监测及治疗

→ 心电图 (ECG)/便携式心电图及脑电图 (EEG)

电源电压

与大多数其他应用一样，生物医学监测领域的系统电源电压也一直趋向于更低的单电源电平。目前双极型电源仍被采用，5V是现今常见的系统电平，但趋向于采用3.3V单电源供电。该趋势对设计人员提出了重大挑战，设计人员必须面对至少300mV的直流电极电势并注重于精密信号调节解决方案的需求。

频率响应

对于患者监测而言，标准的-3dB频率带宽是从0.05Hz至30Hz，而诊断层次的监测则要求0.05Hz至100Hz，乃至更高。模拟前端必须支持交流耦合以消除源自电极偏置电势的人为干扰。

仪表放大器要求

- 低增益稳定性（增益为1至10）
- 高共模抑制
- 低输入偏置电流 (I_B)
- 良好的至输出轨摆幅 (swing)
- 超低失调及漂移

运算放大器要求

- 高增益时的低噪声（增益为10至1000）
- 轨至轨输出
- 超低失调及漂移

随着护理机构要求将数据从医疗终端设备传递至诸如医院/诊所IT基础设施、计算机甚至移动电话等数据集线器 (data hubs)，ECG/EEG设备的连通性开始受到人们的关注。

低功耗应用处理器
OMAP-L137

敬请访问**www.ti.com/sc/device/omap-l137**，以获取数据表、样片及技术文件。

主要特点

- 双核SoC
  - 300MHz ARM926EJ-S™ RISC MPU
  - 300MHz C674x VLIW DSP
- TMS320C674x定点/浮点型VLIW DSP内核
- 增强型直接存储器存取控制器 3 (EDMA3)
- 128k字节RAM共享内存
- 两个外部存储器接口
- 三个可配置16550型UART模块
- LCD控制器
- 两个串行外设接口 (SPI)
- 多媒体卡 (MMC)/安全数字卡 (SD)
- 两个主控/受控内置集成电路
- 一个主机端口接口 (HPI)
- 具有集成PHY (USB1) 的USB 1.1 OHCI（主机）

应用

- 医疗测量
- 工业诊断

OMAP-L137是一款低功耗应用处理器，基于ARM926EJ-S™和C674x DSP内核。该处理器的功耗明显低于TMS320C6000™ DSP平台的其他成员。凭借一种完全集成的混合处理器解决方案的极大灵活性，OMAP-L137使得OEM和ODM能够将拥有稳健操作系统支持、丰富用户接口和高处理性能寿命的设备快速投放市场。OMAP-L137的双核架构兼具DSP和精简指令集计算机 (RISC) 技术的优势，采用了一个高性能TMS320C674x DSP内核及一个ARM926EJ-S内核。ARM926EJ-S是32位RISC处理器内核，可执行32位或16位指令及处理32位、16位或8位数据。

OMAP-L137方框图

→ *心电图 (ECG)/便携式心电图及脑电图 (EEG)*
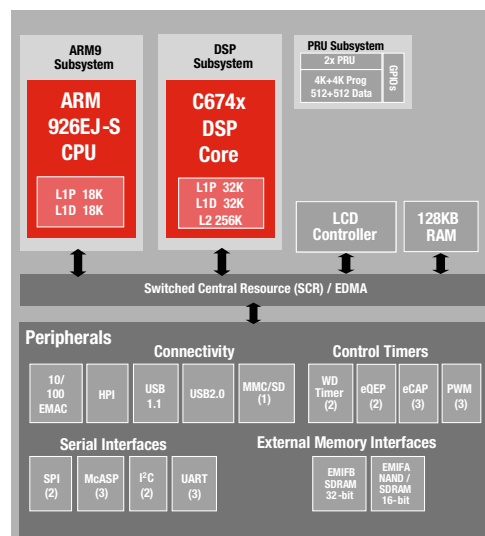
适合ECG/EEG应用的完整模拟前端
ADS1298

敬请访问**www.ti.com/sc/device/ADS1298**，以获取数据表、样片及评估板。
敬请访问**http://e2e.ti.com/videos/m/analog/134732.aspx**，以观看ADS1298的视频播客。

主要优点

- 将组件数量和电路板尺寸缩减了95%
- 1mW/通道将解决方案功耗降低了95%
- 单芯片解决方案可提高系统可靠性和患者移动能力

主要特点

- 8个低噪声PGA
- 8个高分辨率、同时采样ADC
- 适用于右腿驱动的集成放大器
- 适用于Wilson Central Terminal (威尔逊中央终端，简称WCT) 和Goldberger Central Terminal (哥德柏格中央终端，简称GCT) 的集成放大器
- 数字步速检测功能
- 连续导联断线 (lead-off) 检测
- 用于更小尺寸和低功耗应用的板载振荡器和基准

应用

- ECG和EEG应用

8通道、24位ADS1298是用于患者监测、便携式和高端心电图 (ECG) 及脑电图 (EEG) 的全集成化模拟前端 (AFE) 系列的首款器件。即将推出的4通道和6通道版本以及16位版本使设计人员能够迁移至适用于低噪声医疗设备的不同分辨率和通道组合。示例包括病患监测、静息和运动ECG、胎儿监测、医院和公共访问AED以及运动和健身监测器。
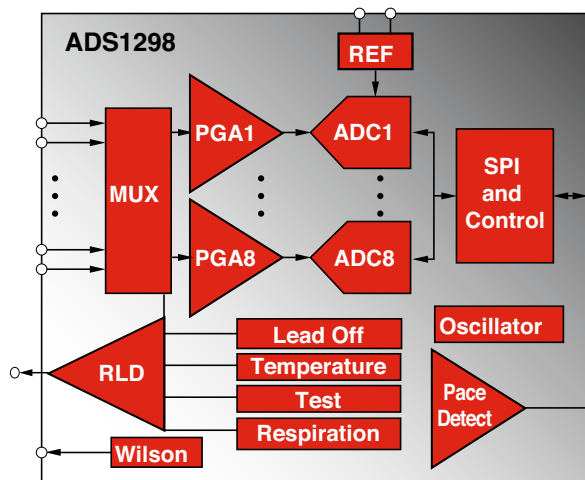
ADS1298方框图

→ *心电图 (ECG)/便携式心电图及脑电图 (EEG)*

低噪声、900kHz、50μV、轨至轨输入/输出 (RRIO) 精密运算放大器
OPA378、OPA2378

敬请访问**www.ti.com/sc/device/OPA378**或**www.ti.com/sc/device/OPA2378**，以获取样片及数据表。

主要特点

- 低噪声（0.1Hz至10Hz）：0.4μVPP
- 低失调电压：15μV（典型值）
- 静态电流：125μA（典型值）
- 失调漂移：0.1μV/℃（典型值）
- 单电源运转
- 电源电压：2.2V至5.5V
- EMI输入滤波器和RRIO
- 封装：SC70-5、SOT23-5

应用

- 电池供电型仪器
- 医疗仪表
- 温度测量
- 手持式测试设备

OPA378（单通道）及OPA2378（双通道）代表了新一代的微功耗运算放大器，它们整合了轨至轨输入/输出、低输入失调电压（50μV最大值）、低静态电流及90kHz带宽特性。该器件具有卓越的电源抑制比 (PSRR)，是采用非稳压电池直接供电型应用的理想选择。
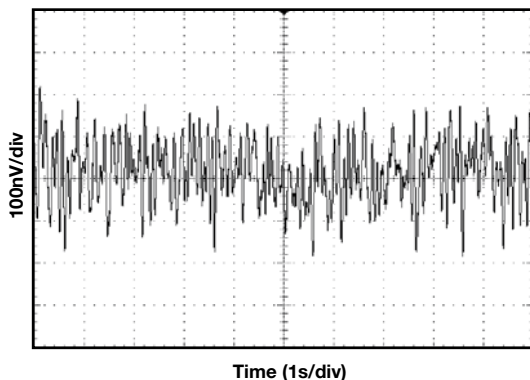
OPA378：0.1Hz至10Hz噪声
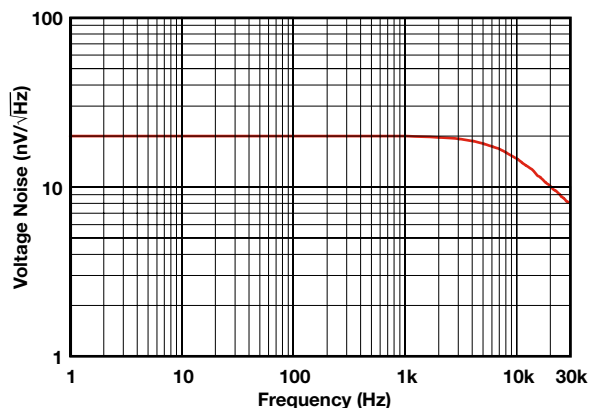
OPA378：电压噪声谱密度随频率的改变

零漂移、低失调、单电源运算放大器
OPA334、OPA335

敬请访问**www.ti.com/sc/device/OPA334**或**www.ti.com/sc/device/OPA335**，以获取样片、数据表、评估板及应用报告。

主要特点

- •增益带宽 (GBW)：2MHz
- •低失调电压：5μV（最大值）
- •零漂移：0.05μV/℃（最大值）
- •静态电流：285μA
- •EMI输入滤波
- •OPA344提供了停机功能
- •封装：SOT23-5、SOT23-6、SO-8、MSOP-10（双通道器件）

应用

- 传感器应用，例如压力检测
- 电子衡器
- 温度测量

OPA334和OPA335 CMOS运算放大器采用了自动调零技术，以同时提供非常低的失调电压以及近乎为零的漂移（随时间和温度的变化极小）。此类高精密运算放大器具有高输入阻抗以及轨至轨输出摆幅性能。
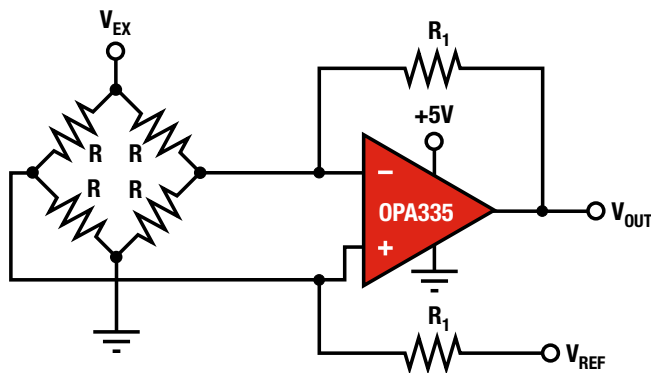
OPA335——针对高CMRR的5V供电桥式放大器

诊断、患者监测及治疗

➜ *心电图 (ECG)/便携式心电图及脑电图 (EEG)*

精密型轨至轨输入/输出仪表放大器
INA326

敬请访问**www.ti.com/sc/device/INA326**，以获取样片、数据表、评估板及应用报告。

主要特点

- 低失调：100μV（最大值）
- 低失调漂移：0.4μV/°C（最大值）
- 卓越的长期稳定性
- 超低频率 (1/f) 噪声
- 输入共模范围：低于负相电源轨200mV 至高于正相电源轨100mV
- 宽输出摆幅：电源轨的10mV以内
- 单电源：+2.7V至+5.5V
- 封装：MSOP-8、MSOP-10

INA326是带轨至轨输入输出的精密仪表放大器，支持真正的单电源操作。该器件具有超低的直流误差以及超越正、负相电源轨的输入共模范围。其出色的长期稳定性以及超低的频率 (1/f) 噪声特性确保了在产品寿命周期内极低的失调电压及漂移。

应用

- 医疗仪器
- 多通道数据采集系统
- 针对电桥、负载单元及热电偶的低电平传感器放大器
- 宽动态范围传感器测量
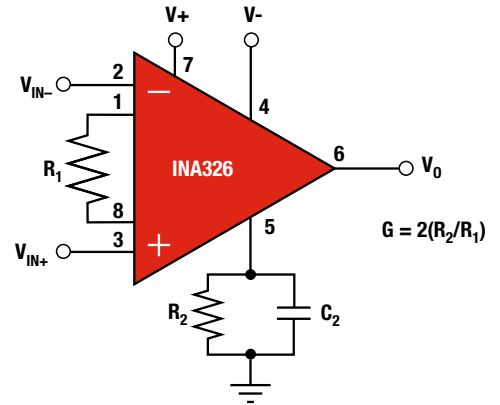
INA326原理框图

针对便携式应用的4通道/8通道、16位、串行输出ADC
ADS8331、ADS8332、ADS8341、ADS8342、ADS8343、ADS8344、ADS8345

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片、数据表、评估板及相关应用报告。
（**PARTnumber**请使用**ADS8331、ADS8332、ADS8341、ADS8342、ADS8343、ADS8344**或**ADS8345**替换）

主要特点

- 转换速率：高达100kHz
- 4通道/8通道单端或2通道差分输入
- 信号噪声失真比 (SINAD)：86dB
- 串行接口
- 单电源：2.7V至5V
- 封装：SSOP-16

ADS8341是带同步串行接口的4通道、16位ADC，于100kHz吞吐速率及+5V电源供电时典型功耗为8mW。基准电压的变化范围介于500mV与V_{CC}之间，可支持相应的输入电压范围为0V至V_{REF}。该器件经测试的最低工作电压为2.7V。另外，串行接口还提供了低成本的隔离以用于远程数据采集。

应用

- 便携式医疗设备
- 测试及测量
- 数据采集
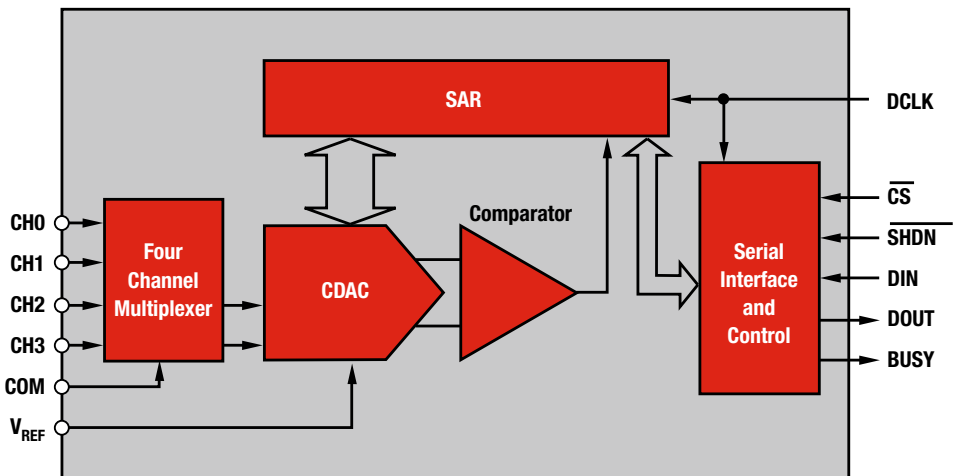
ADS8341原理框图

多通道、24位、ΔΣ ADC
ADS1271、ADS1274、ADS1278

敬请访问 **www.ti.com/sc/device/PARTnumber**，以获取样片、数据表、评估板及相关应用报告。
（**PARTnumber** 请使用 **ADS1271、ADS1274** 或 **ADS1278** 替换）

主要特点

- 单通道或同时测量4/8个通道
- 数据速率高达128kSPS
- 交流性能：
  - 带宽：62kHz
  - 信噪比 (SNR)：111dB（高分辨率模式）
  - 总谐波失真 (THD)：－108dB THD
- 直流准确度：
  - 失调漂移：0.8μV/℃
  - 增益漂移：1.3ppm/℃
- 线性相位数字滤波器
- SPI或帧同步串行接口
- 模拟电源：5V
- 封装：HTQFT-64 PowerPAD™

应用

- 压力传感器
- 患者监测
- 振动/模型分析
- 多通道数据采集
- 声学/动态应变仪

ADS1271、ADS1274及ADS1278分别为单通道、四通道和八通道ADC。此类24位的ΔΣ ADC具有高达128kSPS的数据速率，允许同步采样所有的通道，并以同样的封装提供了插入式 (drop-in) 的扩展能力。此类器件针对高精度测量应用提供了卓越的交流及直流性能规范。所提供的可用信号带宽高达90%的奈奎斯特速率 (Nyquist rate)，纹波低于0.005dB，并具有四种工作模式以实现速度、分辨率及功耗的优化。

ADS1271/4/8原理框图

单通道、双通道及四通道全差分放大器
THS4521、THS4522、THS4524

敬请访问 **www.ti.com/sc/device/PARTnumber**，以获取样片、数据表、评估板及相关应用报告。
（**PARTnumber** 请使用 **THS4521、THS4522** 或 **THS4524** 替换）

主要特点

- 低静态电流：1.14mA（典型值）
- 断电能力：20μA（典型值）
- 输入电压噪声：4.6nV/√Hz
- 转换速率：490V/μs
- 负相电源轨输入和轨至轨输出
- 电源电压：+2.5V（±1.25V）至+5.5V（±2.75V）
- 封装：SO-8和MSOP-8 (THS4521)、TSSOP-16 (THS4522) 和TSSOP-38 (THS4524)

应用

- 便携式医疗设备
- 低功耗SAR和ΔΣ ADC驱动器
- 低功耗差分驱动器
- 低功耗差分信号调节

THS4521（单通道）、THS4522（双通道）及THS4524（四通道）是负相电源轨输入、轨至轨输出全差分放大器，采用+2.5V至+5.5V的单工作电源。此类器件具有每通道1.14mA的低静态电流以及至20μA的断电能力，因而使其成为低功耗应用的上佳选择。输出共模控制以及低失调和漂移在高准确度数据采集系统中可支持直流去耦。
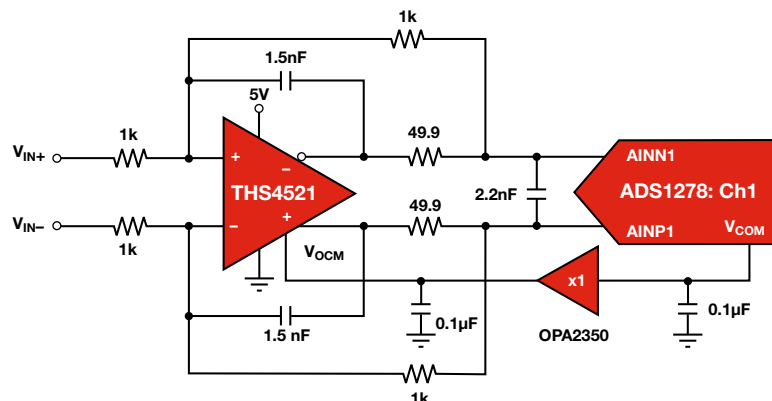
THS4521驱动ADS1278的一个通道

→ *心电图 (ECG)/便携式心电图及脑电图 (EEG)*

用于 C5515 ECG 医疗开发套件的心电图 (ECG) 模拟前端模块
TMDXMDKEK1258

敬请访问**www.ti.com/tmdxmdkek1258**，以获取样片、数据表及评估板。

主要特点

- ECG AFE模块的主要组件
  - ADS1258：16通道、24位ΔΣ模数转换器 (ADC)
  - INA128：精密型低功耗仪表放大器
  - PCA9535：远程16位I²C和SMBus低功耗I/O扩展器
  - TLV3404：毫微功率开漏输出比较器
  - REF5025：低噪声、非常低漂移、精密型电压基准
- ECG MDK系统特性
  - 基于业界最低功耗的DSP处理器——TMS320C5515
  - 采用10个电极输入的12引脚ECG输出
  - 0.05Hz至150Hz带宽
  - 断线检测
  - 在EVM LCD上实时显示12个引脚的ECG波形，每次一个引脚
  - 在PC上实时显示12个引脚的ECG波形，每次三个引脚
  - 心跳速率显示
  - ECG数据的记录，以及记录ECG数据的脱机显示选项

应用

- 便携式ECG设备
- 患者监测

为了缩短医疗设备公司的产品面市时间，TI推出了一套医疗应用开发工具，并配有针对心电图、数字听诊器和脉搏血氧测定仪产品的完整信号链路设计方案及软件。这三款医疗开发套件 (MDK) 的构成方法均为：采购一款运用了专为每种终端产品而优化的特殊电路设计的模拟前端 (AFE) 模块，和一块基于业界最低功耗DSP——TMS320C5515的TMS320C5515 DSP评估板 (EVM)。这些MDK提供了一种绝佳的评估平台，意在帮助医疗设备制造商专注于实现产品的差异化（比如算法开发和功能强化）。

TMDXMDKEK1258心电图 (ECG) 模拟前端 (AFE) 模块是ECG医疗开发套件(MDK) 的一部分，包括ECG AFE模块、一块处理器板（C5515 DSP评估板）、一组附属品和基于 C5515的应用示例代码，用于实现ECG应用。ECG MDK提供了一款完整的信号链路解决方案，旨在使开发人员能够迅速设计出完整的ECG系统进行评估，并更快地投产。
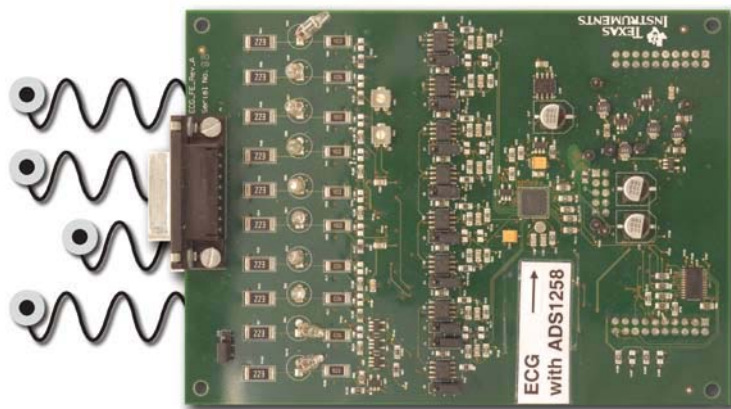
目前，采用最新款ECG ADC——ADS1298的新型ECG模拟前端模块也已上市。它的产品型号为ADS1298ECGFE-PDK，并能够与C5515 EVM (TMDXEVM5515) 无缝协调使用。

敬请访问下面的网址，以免费获取MDK ECG SW：

http://code.google.com/p/c5505-ezdsp/

➡ **心电图 (ECG)/便携式心电图及脑电图 (EEG)**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
INA118	Instrumentation Amp	110dB CMRR, 5nA (max) bias current, 50µV (max) offset	Wide BW at high gain, ±1.35V to ±18V supply	INA128, INA121
INA121	Instrumentation Amp	106dB CMRR, 4pA (max) bias current, 200µV (max) offset	Low input bias current	INA126
INA126	Instrumentation Amp	175µA/ch supply, 3µV/°C (max) drift, 250µV (max) offset	Precision low power, ±1.35V to ±18V supply	INA2126
INA128	Instrumentation Amp	120dB CMRR, 5nA (max) bias current, 50µV (max) offset	High CMRR, wide BW at high gain, ±2.25V to ±18V supply	INA129
OPA277	Op Amp	10µV offset, ±0.1µV/°C drift, 134dB open-loop gain	High precision, low drift, low power	OPA2277 (dual) OPA4277 (quad)
INA326 *Page 38*	Instrumentation Amp	120dB CMRR (G = 100), 100µV (max) offset, 0.4µV/°C (max) drift	High CMRR, low cost, +2.7V to +5.5V	INA321, INA333
INA333	Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50µA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA326, INA321
OPA130	FET-Input Amplifier	20pA (max) bias current, 90dB (min) CMRR, 1MHz BW	Precision, low input bias, low power	OPA131, OPA137
OPA333	Precision Op Amp	1.8V min supply, 0.017mA/ch (max), 10µV offset (max), 0.05µV/°C drift (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, **OPA330**
OPA334/5 *Page 37*	Op Amp	2MHz, 5µV (max) offset, 0.05µV/°C (max) drift, 285µA	Provides very low offset voltage and near-zero drift over time and temperature; SOT23	OPA735, OPA333, OPA334
OPA336	Op Amp	125µV (max) offset, 1.5µV/°C drift, 20µA supply	micoPower, SOT23 package	OPA379
OPA378 *Page 37*	Low Noise Precision Op Amp	0.1µV/°C Vos drift, 125µA, 900kHz, 0.4µV$_{PP}$ (0.1Hz to 10Hz) 0.4µ V$_{pp}$ (0.1Hz to 10Hz), 0.9MHz	Lowest noise, power, price, precision zero-drift option	**OPA330**, OPA333
OPA2378 *Page 37*	Precision Op Amp	2.2V to 5.5V supply, 20µV voltage, 0.1µV/°C drift, 125µA quiescent current	Has excellent PSRR which makes it an ideal choice for applications that run direct from batteries without regulation	
THS4521/22/24 *Page 39*	Low Power FDA	1.14mA quiescent current (typ), 4.6nV/√Hz voltage noise, 2.5V to 5.5V supply	Low power, low noise enables high accuracy	
Data Converters				
ADS1258	Delta-Sigma ADC	16-channel, 24-bit, 125kSPS, 23.7kSPS/channel	Fastest multi-channel, delta-sigma ADC, measures all 16 inputs in <675µs	ADS1256, ADS1255, ADS8344
ADS1271/74/78 *Page 39*	Delta-Sigma ADC	24-bit, 128kSPS, 8-channel, 111dB SNR	Simultaneous measurement, onboard decimation filter	
ADS1298 *Page 36*	ECG/EEG AFE	24-bit, 8 PGA, 8 ADC, plus RLD and RESP	Complete front end, reduction in power and size, increase reliability	**ADS1294, ADS1296, ADS1198,** ADS1258
ADS8317	SAR ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL, differential input	Low power, small package, and wide supply range	ADS8326
ADS8326	Low-Power ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL	Small package, wide supply range	
ADS8331/32 *Page 38*	SAR ADC	16-bit, 500kSPS, 4/8 channels, with serial interface	Mux out feature can be used to reduce system part count and overall cost	ADS8342
ADS8341/2/3/4/5 *Page 38*	Serial Output ADC	16-bit, 4-/8-channel single-ended or 2-channel differential input, 2.7V to 5V single supply ADC	Easy to use	
ADS8519	High Volt. SAR ADC	16-bit, 250kSPS, 1.5LSB (max) INL, 92dB SNR	Single supply, high voltage inputs	ADS8515
DDC112	Charge-Digitizing ADC	Dual current input, 20-bit ADC, ±0.005% INL reading ±0.5ppm FSR	High precision, true integrating function	DDC114, DDC118, DDC232
References				
REF02	Precision V$_{REF}$	0.2% (max) initial accuracy, 10ppm/°C (max) drift, 1.4mA (max)	Excellent line/load regulation, low noise	REF5050
REF102	10V, Ultra Precision	0.05% (max) initial accuracy, 2.5ppm/°C (max) drift, 1.4mA (max)	Excellent stability and line/load regulation	REF5010
REF30xx	Low-Power, Low-Drift Ref.	50µA, 0.2% initial accuracy, 50ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF31xx, REF33xx, REF29xx
REF32xx	Ultra-Low-Drift Series Reference	100µA, 0.2% initial accuracy, 7ppm/°C max drift, ±10mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Improves system accuracy	
REF33xx	Very Low-Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF5010	10V, High-Precision, Very Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 10V	Improves system accuracy	REF102
REF50xx	High-Precision, Very Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V	Improves system accuracy	REF02

* 更多产品信息请参见指定页码。
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*新产品以***粗体红色**标明。*

→ **心电图 (ECG)/便携式心电图及脑电图 (EEG)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
MSP430F20xx	Ultra-Low-Power 16-bit MCU	1KB/2KB Flash, 128B RAM, SPI+I^{2}C 16-bit MCU	8 ch. 12-bit ADC or 4 ch. 16-bit SD ADC, 4 x 4mm package	
MSP430F22x4	Ultra-Low-Power 16-bit MCU	8 to 32KB Flash, 512B/1KB RAM, SPI + I^{2}C + UART/LIN + IrDA	12 ch. 10-bit ADC, 2 operational amplifiers	
MSP430F23x0	Ultra-Low-Power 16-bit MCU	8 to 32KB Flash, 1KB/2KB RAM, SPI + I^{2}C + UART/LIN + IrDA	Analog comparator, HW multiplier	
MSP430F41x	Ultra-Low-Power 16-bit MCU	4 to 32KB Flash, 256B to 1KB RAM, SVS, 96 segment LCD	Analog comparator	
MSP430F42x	Ultra-Low-Power 16-bit MCU	8 to 32KB Flash, 256B to 1KB RAM, SPI + UART, SVS, 128 segment LCD	3 x 16-bit SD ADC	
MSP430F42x0	Ultra-Low-Power 16-bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430F43x	Ultra-Low-Power 16-bit MCU	16 to 32KB Flash, 512B/1KB RAM, SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, analog comparator	
MSP430F44x	Ultra-Low-Power 16-bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 2x SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, HW multiplier	
MSP430F47xx	Ultra-Low-Power 16-bit MCU	60KB Flash, 256B RAM, (4) USCI, 160 segment LCD	(4) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F241x	Ultra-Low-Power 16-bit MCU	120KB Flash, 8KB RAM, (4) USCI, SVS, temp. sensor	8 ch. 12-bit ADC, analog comparator, HW multiplier	
MSP430F261x	Ultra-Low-Power 16-bit MCU	120KB Flash, 8KB RAM, (4) USCI, SVS, DMA, temp. sensor	Analog comparator, 2 ch. 12-bit DAC, 8 ch. 12-bit ADC, HW multiplier	
MSP430F471xx	Ultra-Low-Power 16-bit MCU	120KB Flash, 8KB RAM, (4) USCI, DMA 160 segment LCD	(7) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F54xxA	Ultra-Low-Power 16-bit MCU	128 to 256KB Flash, 16KB RAM, (4) USCI, PMM, DMA, temp. sensor	16 ch. 12-bit ADC, analog comparator, RTC, internal voltage regulator for power optimization	
MSP430FG42x0	Ultra-Low-Power 16-bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC, 2 integrated op amps	
MSP430FG43x	Ultra-Low-Power 16-bit MCU	32 to 60KB Flash, 1KB/2KB RAM, SPI + UART, SVS, 128 segment LCD	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, DMA, 3 op amps	
MSP430FG461x	Ultra-Low-Power 16-bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I^{2}C + UART/LIN + IrDA, 160 LCD	12 ch. 12-bit ADC, 2 ch.12-bit DAC, A-comp, 3 op amp, HW multiplier	
MSP430FG47x	Ultra-Low-Power 16-bit MCU	32 to 60KB Flash, 2KB RAM, SPI + I^{2}C + UART/LIN + IrDA, 128 LCD controller	5 ch. 16-bit SD ADC, 2 ch. 12-bit DAC, comparator_A, 2 op amps	
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137 *Page 35	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
TMS320C5000™	DSP	Power efficient, high performance		
TMS320F28x™	32-Bit MCU	32-bit architecture, fixed- or floating-point code, up to 225MIPS operation	Microcontroller integration, real-time control performance	TMS320F2823x, TMS320F2833x
TMS320F2802x/3x Piccolo™	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F283x Delfino™	32-Bit Floating-point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320VC5506	DSP	200MHz, dual MAC, very low stand-by power of 0.12mW	Supported by eXpressDSP™ and many other software packages and tools	TMS320VC5509A, TMS320VC5502
Power Management				
bq20z90-V110	Battery Fuel Gauge	Instant accuracy better than 1% error over lifetime of the battery	Automatically adjusts for battery aging, battery self discharge and temperature inefficiencies	bq20z70, bq20z80
bq24703	Battery Charger	0V operation, ±0.4% charge voltage accuracy, integrated PWM	Dynamic power management, multichemistry	bq24702, bq24705
bq24721C	Battery Charge Management	Multi-chemistry and multi-cell sync switch-mode charger	High efficiency, pack and system protection functions	

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→ **心电图 (ECG)/便携式心电图及脑电图 (EEG)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
bq29330	Battery Safety	Battery pack full-protection analog front end	Provides individual cell voltages and battery voltage to battery management host	
DCH010505D	Galvanic Isolated, DC/DC Conv.	1W, 3kV isolation, minimal external components	Safety isolation, removal of ground loops	DCH010512/15 DCR021205
TPS22902	Load Switch with Controller Turn-On	Low on resistance, controlled turn-on, ultra small 0.64mm^2 package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS22946	Current Limited Load Switch	Configurable current limit, ultra-small package, 1µA quiescent current at 1.8V	Ultra-small, low quiescent current current limited switch	TPS22949, TPS22945
TPS3808Gxx	Voltage Supervisor	Low quiescent current, programmable-delay	Circuit initialization and timing supervision	TPS310x
TPS54350	DC/DC Converter	4.5 to 20V$_{IN}$ 3A DC/DC w/integrated switch FET, sync pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS61097-33	Boost Converter with Bypass Switch	Highly efficient, operates down to 0.3V; bypass switch; 5nA shutdown current; SOT-23	Supper efficient boost, works over entire battery range, low quiescent current, integrate the bypass switch, small package	
TPS62110	Step-Down Converter	3.1V to 17V V$_{IN}$, 1.5A conversion, synchronization pin, low battery indicator, power save mode	Very low noise/high efficiency	TPS62050
TPS62230	Step-Down Conv.	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm^2 solution size	TPS62260
TPS62400	Dual Output Step-Down Conv.	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62410
TPS63030	Buck-Boost Converter	1A switch, automatic transition between step down and boost mode	Extending application run time, small solution	TPS61020
TPS65130	Boost Converter	800mA switch, adjustable, dual output, positive/negative boost	Two supplies from one switcher	
TPS717xx	Single-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS795xx, TPS799xx
TPS718xx-yy	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719xx-yy
TPS780xx	LDO with DVS	Dynamic voltage scaling (DVS) with low I$_Q$ 500nA	DVS voltage designed to operate with MSP430 to increase power savings	TPS78101
TPS79901	Single Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS79501, TPS74301
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2 to 500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz Bluetooth® 2.1 chipset	Single-chip Bluetooth® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication	CC2510, CC2511
CC2530/CC2531	Second Gen. System-on-Chip 2.4GHz IEEE 802.15.4/RF4CE/ ZigBee	Excellent RX sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market. Provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz Bluetooth® Low Energy Compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	Fast-to-market Bluetooth® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with Bluetooth® technology and Wi-Fi.	
Toolkits				
TMDXMDKEK1258 *Page 40*	ECG Analog Front End Module for the C5515 ECG Medical Dev. Kit	12-lead ECG output using 10 electrode input; 0.05Hz to 150Hz bandwidth; leads off detection; heart beat rate display	Based on industry's lowest power DSP processor – TMS320C5515	

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*新产品以***粗体红色***标明。前瞻性产品以***粗体蓝色***标明。*

脉搏血氧测定仪 (Pulse Oximetry)

概述

脉搏血氧计通过感应去氧 (deoxigenated) 及氧化 (oxigenated) 血红蛋白对红外线及红光的吸收比例来测定血氧含量。脉搏血氧计包含了感应探针及显示器，前者附于患者的耳垂、脚尖或指尖并连接至数据采集系统以实现计算，后者则用于显示血氧饱和度、心率及血流量。

光源（通常为发光二极管 [LED]）将放射出红色可见光及红外光。去氧血红蛋白允许更多的红外光线通过并吸收大量的红色可见光。高度含氧的血红蛋白则允许大量的红色光通过并吸收更多的红外光线。

血氧计感应并计算上述与波长与血红蛋白的氧饱和度（或欠饱和度）成比例的光波的总量。由于使用了光波进行吸收测量，设计人员需要实现真正的"光－电压"转换（使用电流作为输入信号）。

放大器及处理器

传统的电阻反馈式跨阻抗放大器以及电容反馈式开关积分器均适用于脉搏血氧计应用。在任一放大器配置中，所产生的输出电压都将通过模数转换器读取并实现串行化 (serialized)，以便于MSP430™微控制器或TMS320™ DSP进行处理。

处理器的选择应基于信号处理的需求。TI具有多种不同的MSP430产品，可以提供高达25MIPS的性能及宽范围的混合信号集成。中端至高端的系统则要求高得多的数字信号性能，以实现增强的信号调节及处理能力，可采用诸如C55x™等低功耗的DSP处理器。此类处理器以非常低的功耗提供了超过100MIPS的性能。

低端便携式脉搏血氧测定仪

对低端的设计而言，TI的高集成度MSP430FG437减少了外部元件的数目。该非侵入性光学脉搏血氧测定仪的设计采用了MSP430FG437微控制器 (MCU)，由单个外设探针并结合氧饱和度及脉搏速率
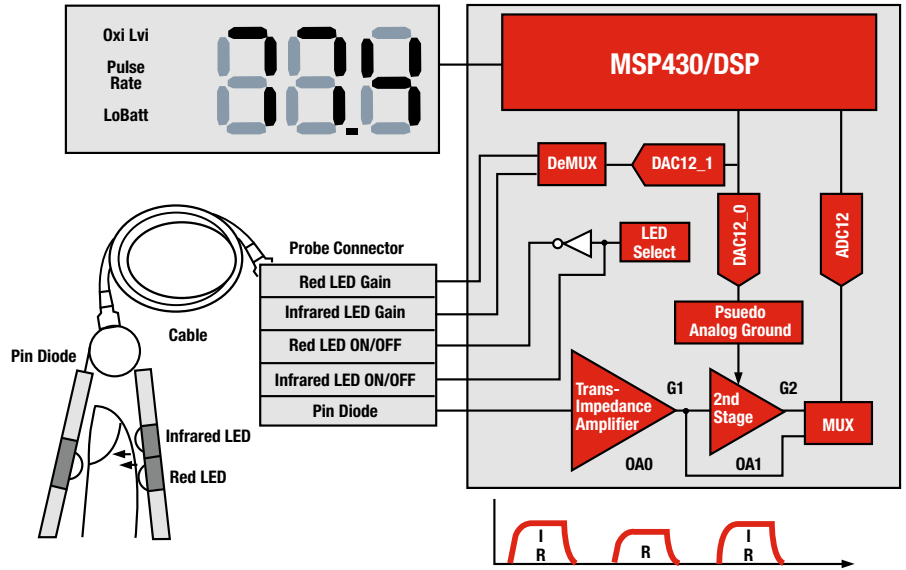
除MCU及4个晶体管之外，该设计的实现仅需无源元件。

显示LCD屏组成。在该应用中，心率检测及脉搏血氧计量采用了同一个传感器。

探针被置于人体表面外设端点，例如指尖、耳垂或鼻头。探针包括了两个LED——一个处于可见红光光谱 (660nm)，另一个则处于红外光谱 (940nm)。人体的含氧量百分比通过测量每种频率的光通过人体后的光强度而确定。随后，这两种光强度的比例将计算得出。

下方的示意图展示了采用超低功耗MSP430 MCU的单芯片便携式脉搏血氧测定仪的实现。

LED驱动电路

诊断、患者监测及治疗
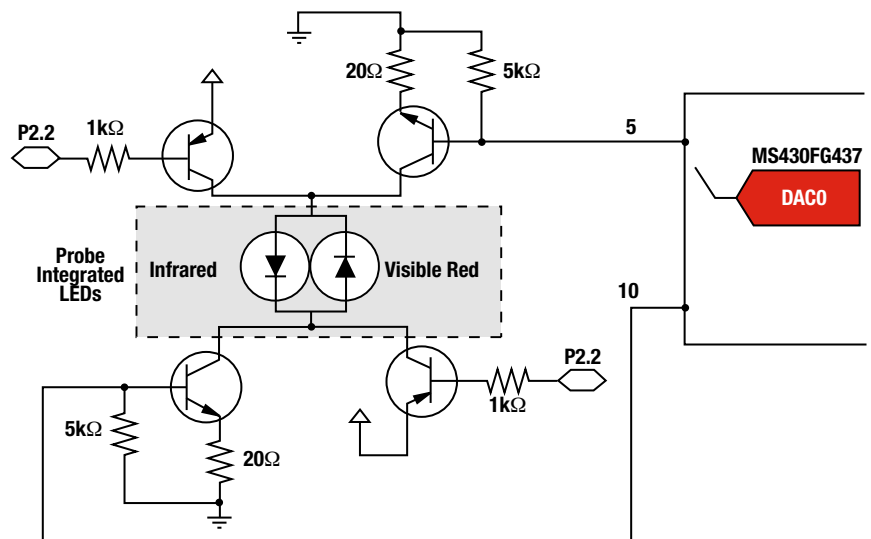
→ 脉搏血氧测定仪 (Pulse Oximetry)

由于实现了很高的模拟集成度，因而确保了外部元件数目的最小化。尽可能地缩短导通 (ON) 时间及两个光源的周期循环供电也将起到降低功耗的作用。

中端及高端的应用

对于中端及高端应用而言，更高的性能及测量精度是必备的，因此需要可实现更低系统功耗、更高性能的处理器及高精度模拟元件。

例如。多种信号源的干扰（比如：霓虹[neon]灯、紫外[UV]灯以及其他发光体）都有可能影响LED与成像接收器之间的光学通路，进而影响测量精度。信号读取期间的运动所导致的失真也可能存在。精细的DSP技术可用于消除或抑制此类影响，并提取出所关注的重要信号。通常情况下，此类DSP技术需要以高采样速率信号处理的方式运作，例如解调、数字滤波、抽取 (decimation)

以及频域分析，而这些都可以通过C55x™低功耗数字信号处理器有效地完成。

脉搏血氧测定仪系统方框图

→ **脉搏血氧测定仪 (Pulse Oximetry)**

信号采集的挑战

电阻反馈放大器电路是最常见的生物电跨阻抗电路。放大器采用反相配置，光波照射在光电二极管上并产生微弱的电流，该电流经由反馈电阻流至放大器的累加结点 (summing junction)。由于给定的反馈电阻阻值非常大，因此该电路对于光密度的变化极为敏感。例如：仅 0.001 μW 的输入光信号强度即可产生满摆幅 (full-swing) 的输出。
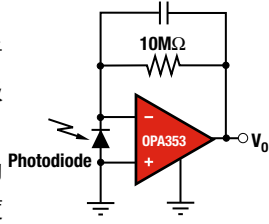
视设计需要的不同，使输出摆幅降至乃至低于参考地 (ground) 可能会非常有用。自动归零跨阻抗放大器配置如右侧的图A所示，可允许摆幅降至参考地；图B中的配置则允许摆幅非常接近于参考地。图B中连接至−5V的下拉电阻器将允许摆幅略低于参考地，从而最大限度地降低了当输出非常接近于0V之时的误差。

TI的OPA380是整合了高速OPA355及自动归零OPA335放大器的单片式集成电路。该器件可提供90MHz的增益带宽乘积，性能可媲美1MHz跨阻抗放大器，具有极高的精度（最大失调为25μV，最大漂移为0.1μV/°C）。

取决于设计的需要，开关积分器将会是非常有效的解决方案。TI的IVC102不存在反馈电阻器的热噪声，也不会碰到采用大反馈电阻的跨阻抗放大器所常见的稳定性问题。

采用单个光电二极管及两片IVC102可消除暗流（dark current，无光时产生的电流）及环境光照的误差，因为两个器件的共模误差可通过相减而消去。此外，IVC203还允许以整数倍交流线路的频率进行同步采样，从而赋予了极高的噪声抑制能力。跨阻抗增益则可通过延长或缩短S2开关的积分时间轻松地改变。

跨阻抗放大器的要求

- 在所关注的温度范围内具有较低的输入偏置电流
- 相对于光电二极管电容更低的输入电容
- 高增益带宽乘积
- 低电压噪声
- 为了实现精度的最大化，应在整个温度范围内实现低失调漂移
- 对于单电源系统：
  ○ 如果光电二极管工作于光伏模式（photovoltaic mode，零偏置），则要求轨至轨输入（包括0V）及输出
  ○ 如果光电二极管工作于光导模式（photoconductive mode，带偏置），则仅要求轨至轨输出
  ○ 如果系统采用电池供电，则要求可关断及/或低供电电流

A. 双电源

B. 单电源

Optional pull-down resistor to allow below ground output swing.

诊断、患者监测及治疗
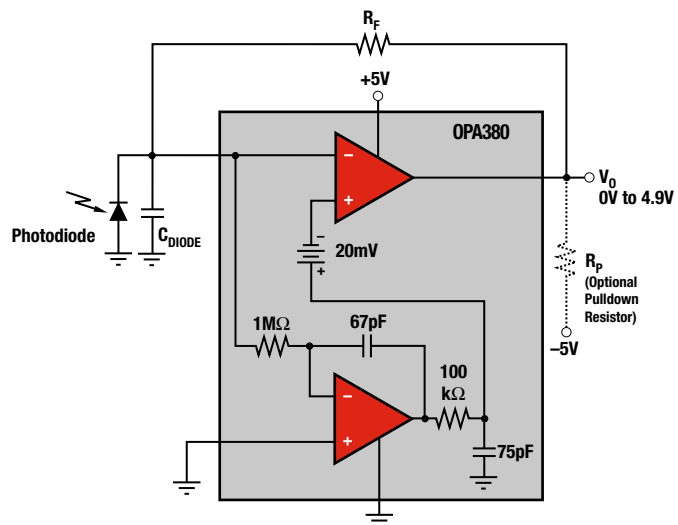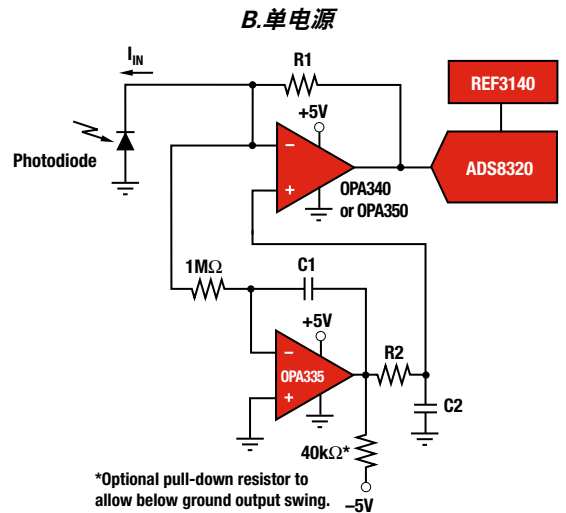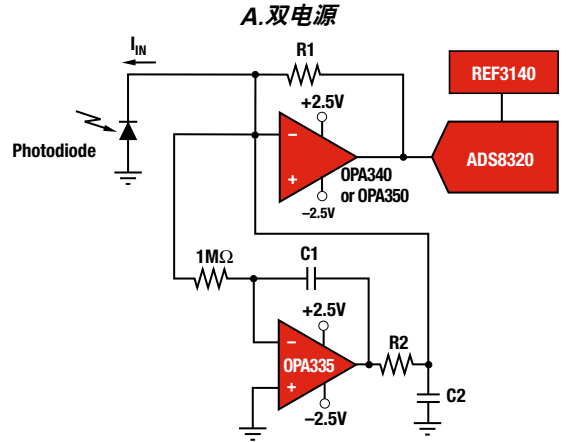
→ **脉搏血氧测定仪 (Pulse Oximetry)**

设计提示

反馈环路内的小（＜1pF）电容 (C_F) 用于控制因二极管电容而导致的增益剧增。噪声（电压输出的波动）则源于电阻噪声、放大器及电流噪声以及环境噪声的拾取（例如：50Hz或60Hz的线路噪声）。为实现电路噪声的最小化，设计人员应选用低噪声的放大器，选择尽可能大的实际反馈电阻器、对放大器输入端实施射频屏蔽、采取低通滤波并运用上佳的PCB布线方法。

如果光电二极管的并联电阻远远大于反馈电阻，则失调电压不是很重要。如果极为注重偏置电压的稳定性，采用包含OPA335的自动归零解决方案是最佳选择。

为了实现最佳精度，系统设计人员应选择OPA380。该器件专为满足苛刻的跨阻抗应用要求而设计，可提供无可比拟的速度（在1MHz跨阻抗带宽之内，增益带宽[GBW]为85MHz）与精度（最大失调电压为25μV，漂移为0.1μV/℃，并具有低频率1/f噪声）组合。分立型替代方案采用OPA365、OPA350或OPA355，对于要求低失调及低漂移的电路，可将OPA335添加至积分器稳定 (integrators-stabilized) 的跨阻抗配置中。在基本的跨阻抗放大器中添加OPA335积分器还将进一步降低其原本就很低的频率噪声。

中端解决方案的优势

- 单芯片解决方案
- 高分辨率
- 低噪声
- 通过调节积分时间实现宽输入范围
- 无需二极管电流的直流校正

$$V_O = \frac{-1}{C_{INT}} \int I_{IN}(t)\, dt$$
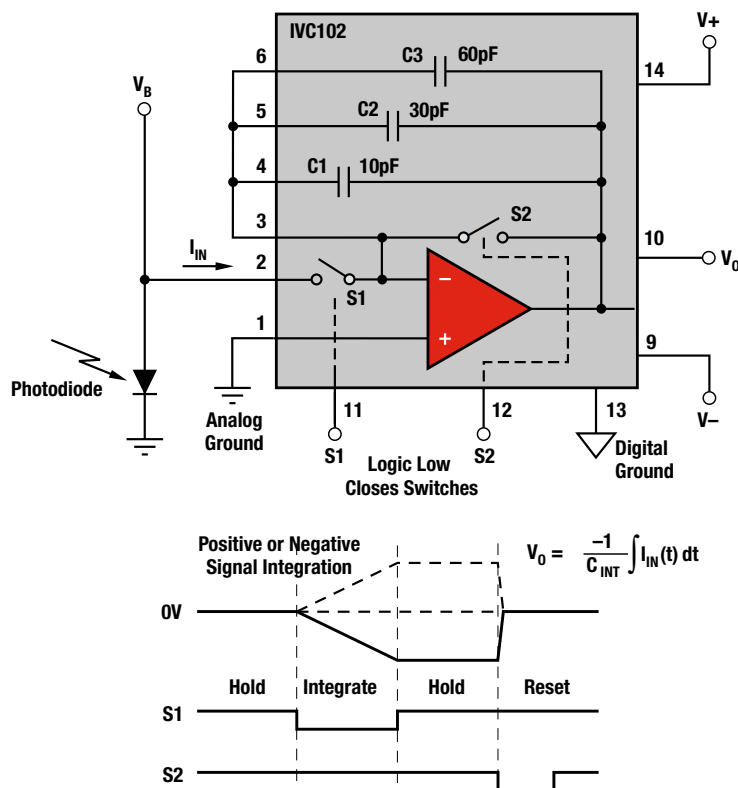
高端解决方案的优势

- 超高分辨率
- 差分输入，具有较强的噪声免疫力
- 由于可在AC电源上实现同步，因而拥有较强的噪声免疫力
- 软件控制，无积分及复位的开关接触，实现了较强的噪声免疫力
- 无需二极管电流的直流校正
- 自由设定可编程积分时间，因而可覆盖极大的输入范围（＞24位）

高端解决方案方框图

诊断、患者监测及治疗
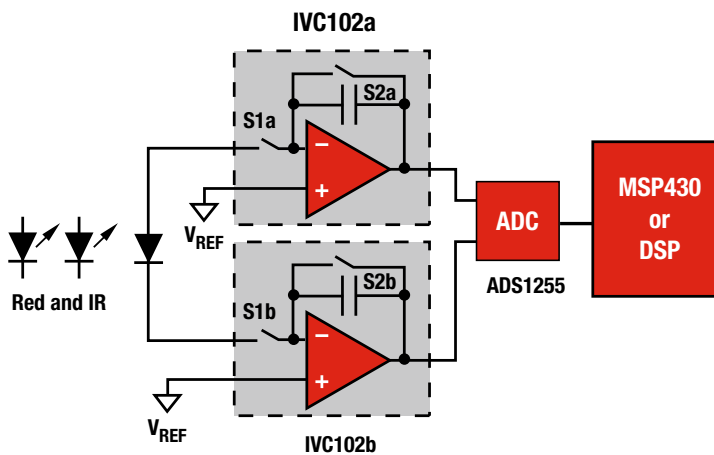
→ **脉搏血氧测定仪 (Pulse Oximetry)**

双路、电流输入、20位电荷数字化ADC
DDC112

敬请访问**www.ti.com/sc/device/DDC112**，以获取样片、数据表、评估板及应用报告。

主要特点

- 单芯片解决方案，可用于测量光电二极管
- 高精度，具有真正的积分功能
- 低噪声：3.2ppm，rms
- 出众的线性度性能：±0.005%积分非线性，读取±0.5ppm FSR
- 可编程满量程范围：50pC至1000pC
- 单电源：+5V电源
- 封装：SO-28、TQFP-32

应用

- 血液分析
- 液相/气相色谱法
- 直接光传感器数字化
- 红外测温

DC112是双路输入、宽动态范围、电荷数字化ADC，允许将低电平电流输出IC直接连接至其输入端。由于每个输入端可使用两个积分器，使得电荷积分实现了连续化；当一个积分器处于数字化转换期间，另一个积分器可用于积分。除了内置的可编程满量程范围之外，用户还可通过附加外部积分电容自设定满量程范围，最高可达1000pC。用于保持最终转换结果的高速串行移位寄存器可配置为允许堆叠多个DDC112，从而实现了器件互连的最少化。
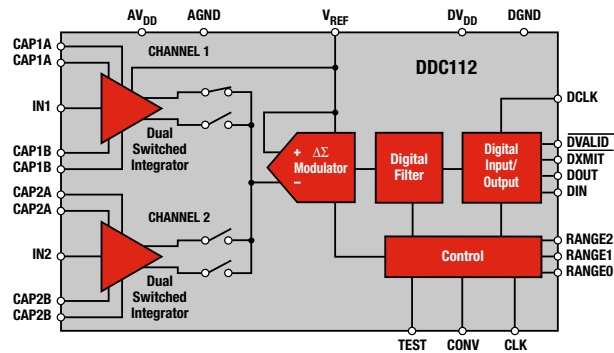
DDC112原理框图

1.1nV/$\sqrt{Hz}$低噪声、低功耗、精密运算放大器
OPA211、OPA2211

敬请访问**www.ti.com/sc/device/OPA211**，以获取样片、数据表、评估板及应用报告。

主要特点

- 输入电压噪声：80nV$_{PP}$，0.1Hz至10Hz
- 低失调电压：50μV (最大值)
- 低失调电压漂移：0.15μV/℃ （典型值）
- 电源电流：每通道3.6mA
- 增益带宽乘积：80MHz (G = 100)
- 转换速率：27V/μs
- 电源电压范围：±2.25V至±18V，+4.5V至+36V
- 输出电流：30mA
- 单位增益稳定
- 封装：纤巧型DFN-8、MSOP/SO-8

应用

- 医疗仪器
- 便携式医疗设备
- 超声波放大器
- 低噪声、低功耗信号处理

OPA211系列以仅仅3.6mA的电源电流实现了非常低的1.1nV/$\sqrt{Hz}$噪声密度，并提供了轨至轨输出摆幅，实现了动态范围的最大化。在精密数据采集系统中，OPA211针对16位精度乃至10V的输出摆幅实现了小于1μs的稳定时间。OPA211的失调仅为50μV且偏置点随温度的漂移很小，综合此交流性能，OPA211能够驱动快速、高精度的ADC或缓冲高分辨率DAC的输出。
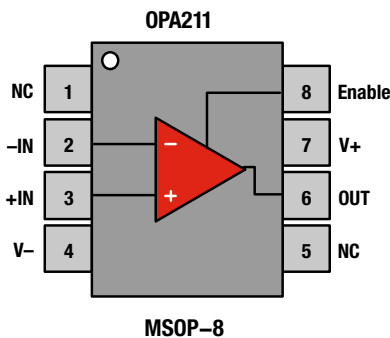
引脚配置
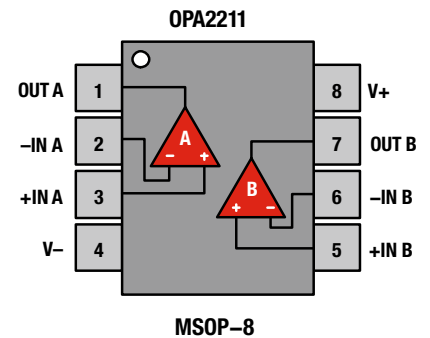
→ 脉搏血氧测定仪 (Pulse Oximetry)

用于C5515 PO或SpO2医疗开发套件的脉搏血氧测定仪 (PO或SpO2) 模拟前端模块
TMDXMDKPO8328

敬请访问**www.ti.com/sc/tdmxmdkpo8328**，以获取样片、数据表及评估板。

主要特点

- PO AFE模块的主要组件
  - ＡＤＳ８３２８：低功耗、16位、500ksps、模数转换器 (ADC)
  - DAC7573：四通道、12位、低功耗、电压输出数模转换器DAC
  - OPA381：精密、低功耗、跨阻抗放大器（电流至电压转换器）
  - REF5025：低噪声、非常低漂移、精密型电压基准
- DS MDK系统特性
  - 基于业界最低功耗的DSP处理器——TMS320C5515
  - 显示血液含氧百分比（0%至100%）
  - 显示脉搏跳动频率（20至300）
  - 在PC上实时显示体积描记图
  - 传感器关断检测
  - 为红光信号和红外信号提供了公用的信号调节通路

为了缩短医疗设备公司的产品面市时间，TI推出了一套医疗应用开发工具，并配有针对心电图、数字听诊器和脉搏血氧测定仪产品的完整信号链路设计方案及软件。这三款医疗开发套件 (MDK) 的构成方法均为：采购一款运用了专为每种终端产品而优化的特殊电路设计的模拟前端 (AFE) 模块，和一块基于业界最低功耗DSP——TMS320C5515的TMS320C5515 DSP评估板 (EVM)。这些MDK提供了一种绝佳的评估平台，意在帮助医疗设备制造商专注于实现产品的差异化（比如算法开发和功能强化）。

TMDXMDKPO8328脉搏血氧测定仪 (PO或SpO2) 模拟前端 (AFE) 模块包括PO AFE模块、一块处理器板（C5505 DSP评估板）、一组附属品和基于 C5505 的应用示例代码，用于实现PO应用。PO MDK提供了一款完整的信号链路解决方案，旨在使开发人员能够迅速设计出完整的PO系统进行评估，并更快地投产。

应用

- 脉搏血氧测定仪
- 患者监测

推荐器件

| Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
IVC102	Transimpedance Amp	Precision switched integrator	Reduces noise by averaging the input noise of the sensor, amplifier, and external sources	
OPA141	Precision Op Amp	10MHz, 6.5nV/√Hz, ±4.5V to ±18V, 1.8mA typical, FET input: I_B = 20pA max	Common mode voltage range includes GND	OPA827
OPA211/2211 *Page 48*	Precision Op Amp	1.1nV/√Hz noise at 1kHz, ±2.25V to ±18V supply, 80MHz BW	Unity gain stable, RRO, wide supply range	OPA227, OPA827
OPA334/5	Op Amp	2MHz, 5µV (max) offset, 0.05µV/°C (max) drift, 285µA	Provides very low offset voltage and near-zero drift over time and temperature; SOT23	OPA735, OPA333, OPA334
OPA336	Op Amp	125µV (max) offset, 1.5µV/°C drift, 20µA supply	micoPower, SOT23 package	OPA379
OPA350	Op Amp	500µV V_{OS}, 38MHz, 2.5V to 5V supply		
OPA353	MicroAmplifier™ Series	High speed, single supply, rail-to-rail		
OPA363	Op Amp	1.8V, high CMR, RRIO, shutdown		OPA364
OPA380	Transimpedance Amp	90MHz GBW, over 1MHz transimpedance BW, 25µV offset (max), 0.1µV/°C drift (max)	Precision, dynamic range 4 to 5 decades, excellent long term stability	OPA350, OPA335
OPA725	12V Op Amp	Very low noise, high speed, 12V CMOS		OPA727
OPA726	CMOS Op Amp	4V to 12V, 20MHz GBW, 30V/µs slew rate, 0.0003% (typ) at 1kHz THD+N	Outstanding ac performance, excellent CMRR, PSRR	
OPA735	Zero-Crossover Op Amp	2.7V to 12V, 0.75µA (max) I_Q/ch, 1.6MHz GBW, 115dB (min) CMRR, RRO	Zero-crossover input offers excellent CMRR over entire input range	
OPA365	Zero-Crossover Op Amp	1.8V to 5.5V, 50MHz BW, 25V/µs slew rate, 0.0004% (typ) THD+N, 4.5nV/√Hz at 100kHz, RRIO	Zero-crossover, high speed, low input bias, low noise, RRIO	

*更多产品信息请参见指定页码。
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→ 脉搏血氧测定仪 (Pulse Oximetry)

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Data Converters				
ADS8318	High-Speed SAR	16-bit, 500kSPS, 18mW at 500kSPS power, ±1 LSB INL	Precision, excellent AC/DC performance	**ADS8319**
ADS8317	SAR ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL, differential input	Low power, small package, and wide supply range	ADS8326
ADS8326	Low-Power ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL	Small package, wide supply range	
DDC112 *Page 48*	Dual Current Input ADC	Wide dynamic range, charge digitizing, 20-bit ADC	Single-chip solution	
References				
REF31xx	Low-Drift Series Reference	0.2% initial accuracy, 15ppm/°C max drift, ±10mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF30xx, REF33xx, REF29xx
REF32xx	Ultra-Low-Drift Series Reference	100µA, 0.2% initial accuracy, 7ppm/°C max drift, ±10mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Improves system accuracy	
REF33xx	Very-Low-Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF50xx	High-Precision, Very-Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V, 10V	Improves system accuracy	REF02
Processors				
MSP430F20xx	Ultra-Low-Power 16-Bit MCU	1KB/2KB Flash, 128B RAM, SPI+I²C	8 ch. 12-bit ADC or 4 ch. 16-bit SD ADC, 4 x 4mm package	
MSP430F22x4	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 512B/1KB RAM, SPI + I²C + UART/LIN + IrDA	12 ch. 10-bit ADC, 2 op amps	
MSP430F23x0	Ultra-Low-Power 16-bit MCU	8 to 32KB Flash, 1KB/2KB RAM, SPI + I²C + UART/LIN + IrDA	Analog comparator, HW multiplier	
MSP430F41x	Ultra-Low-Power 16-Bit MCU	4 to 32KB Flash, 256B to 1KB RAM, SVS, 96 segment LCD	Analog comparator	
MSP430F42x	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 256B to 1KB RAM, SPI + UART, SVS, 128 segment LCD	3 x 16-bit SD ADC	
MSP430F42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430F43x	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 512B/1KB RAM, SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, analog comparator	
MSP430F44x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 2x SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, HW multiplier	
MSP430F47xx	Ultra-Low-Power 16-Bit MCU	60KB Flash, 256B RAM, (4) USCI, 160 segment LCD	(4) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F241x	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, SVS, temp. sensor	8 ch. 12-bit ADC, analog comparator, HW multiplier	
MSP430F261x	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, SVS, DMA, temp. sensor	Analog comparator, 2 ch. 12-bit DAC, 8 ch. 12-bit ADC, HW multiplier	
MSP430F471xx	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, DMA, 160 segment LCD	(7) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F54xxA	Ultra-Low-Power 16-Bit MCU	128 to 256KB Flash, 16KB RAM, (4) USCI, PMM, DMA, temp. sensor	16 ch. 12-bit ADC, analog comparator, RTC, internal voltage regulator for power optimization	
MSP430FG42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC, 2 integrated op amps	
MSP430FG43x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, SPI + UART, SVS, 128 segment LCD	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, DMA, 3 op amps	
MSP430FG461x	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I²C + UART/LIN + IrDA, 160 LCD	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, A-comp, 3 op amp, HW multiplier	
MSP430FG47x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 2KB RAM, SPI + I²C + UART/LIN + IrDA, 128 LCD controller	5 ch. 16-bit SD ADC, 2 ch. 12-bit DAC, comparator_A, 2 op amps	
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138

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➡ **脉搏血氧测定仪 (Pulse Oximetry)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Processors (Continued)				
TMS320C5000™	DSP	Power efficient, high performance	Fixed-point DSP with industry's best combination of standby and dynamic power consumption	
TMS320C5505	Low-Power DSP	16-/8-bit EMIF, 320K bytes on-chip RAM, USB 2.0 full- and high-speed device	High-performance, low-power	
TMS320F28x™	32-Bit MCU	32-bit architecture, fixed- or floating-point code, up to 225MIPS operation	Microcontroller integration, real-time control performance	TMS320F2823x, TMS320F2833x
TMS320F2802x/3x Piccolo™	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F283x Delfino™	32-Bit Floating-point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320VC5506	DSP	200MHz, dual MAC, very low stand-by power of 0.12mW	Supported by eXpressDSP™ and many other software packages and tools	TMS320VC5509A, TMS320VC5502
TMS320VC5509A	Low-Power DSP	Up to 200MHz, dual MAC, 256KB RAM/64KB ROM, USB 2.0 full speed, MMC/SD, 10-bit ADC	Power efficient, large on-chip memory, rich peripheral set allows for various portable connectivity; C55x code compatibility	C550x DSP
Power Management				
bq2406x	Battery Charger	Linear 1-cell Li-Ion charger with thermal regulation, 6.5V OVP, temp sense	Good for space-limited designs with need for battery safety	bq2410x
bq27500	Fuel Gauge	System side Impedance Track™	Accurately know remaining battery capacity, state-of-charge, run-time to empty	
TPS61081	LED Boost Converter	Input to output isolation	Protection from short between any pins and between any pin to ground	TPS61042
TPS61093	OLED Boost Converter	Wide V_{IN} range, input-output disconnect	Flexible, fail safe solution	TPS61080
TPS62230	Step-Down Converter	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm² solution size	TPS62260
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62410
TPS63030	Buck-Boost Converter	1A switch, automatic transition between step down and boost mode	Extending application run time, small solution	TPS61020
TPS717xx	Single-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS795xx, TPS799xx
TPS71710	Low-Noise Single-Channel LDO	High bandwidth, very high rejection of power source noise	Low-noise power rails for sensitive analog components	TPS759xx, TPS739xx
TPS718xx-yy	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719xx-yy
TPS780xx	LDO with DVS	Dynamic voltage scaling (DVS) with low I_Q 500nA	DVS voltage designed to operate with MSP430™ to increase power savings	TPS78101
TPS78001	Single-Channel LDO	Dual-level, fixed output voltages, ultra-low I_Q	Adjustable V_{OUT} for optimal performance, longer battery life	TPS78101
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2 to 500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz *Bluetooth*® 2.1 Chipset	Single-chip *Bluetooth*® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511

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→ **脉搏血氧测定仪 (Pulse Oximetry)**

Component	Description	Key Features	Benefits	Other TI Solutions
RF ICs (Continued)				
RF Systems-on-Chip (Continued)				
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/RF4CE/ ZigBee	Excellent RX sensitivity, low power, easy-to-use development tools	RF design SOC for quick time to market; provides a robust and complte ZigBee USB dongle or firmware-upgradable network node.	CC2590/91, CC2530ZNP
CC2530ZNP	Second Generation Zstack Network Processor	ZigBee stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated, excellent selectivity and blocking performance systems; excellent coexistence with *Bluetooth* ® technology and Wi-Fi.	
CC2540	2.4GHz *Bluetooth*® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market *Bluetooth*® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth*® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and *Bluetooth*® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with *Bluetooth*® technology and Wi-Fi.	
Toolkits				
TMDXMDKPO8328 *Page 49*	Pulse Oximeter (PO or SpO2) Analog Front End Module for the C5515 PO or SpO2 Medical Development Kit	Display of oxygen level percentage ranging from zero to 100 percent; display of pulse rate, ranging from 20 to 300; real-time display of plethysmogram on PC; sensor off detection; common signal conditioning path for red and infrared signal	Based on industry's lowest power DSP processor – TMS320C5515	

* 更多产品信息请参见指定页码。
如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical**

新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

诊断、患者监测及治疗

➜ 通氧机 (Ventilator)

便携式呼吸设备

便携式呼吸设备可为患者提供适当剂量的供氧。位于气阀之前的压力传感器负责测量吸入空气的压力，另一个位于气阀之后的压力传感器则用于测量呼出的压力。微控制器将采用源自两个压力传感器以及一个流量传感器的数据计算出气阀的输出，并调整气流量。医疗工作者可通过触摸屏或键盘设定适合的气流量。便携式设备，例如应用于救护车的设备，具有尖端的电源管理电路以支持交流电源及电池供电运作。

TMS320C2000™ 32位控制器可用于便携式呼吸应用，例如便携式制氧机 (oxygen concentrators)，其实时控制能力即使在非常高速的条件下也能极其精密地控制无刷直流 (BLDC) 电机。此类优化的功耗及强化的续航能力和可靠性都是便携式呼吸设备所必需的。

更多信息

压力传感器在呼吸设备中起着重要的作用。有关压力感应技术及考虑因素的简要指南请参见第53页【译者注：原文此处似有误，应为第54页】。

其他可考虑的TI元件

- F2802x/F2803x Piccolo™系列32位 MCU
- DRV103，作为气阀驱动器
- 功率放大器系列OPA54x、OPA56x，作为气阀驱动器
- bq系列电源管理IC，用于电池充电及电量计
- LED驱动器
- 低功耗无线器件，可用于未来的设计
- RS-485（SN65HVD3082）、CAN (SN65HVD251) 或其他接口IC，用于传感器与控制板之间的通信
- Stellaris® Cortex M3微控制器
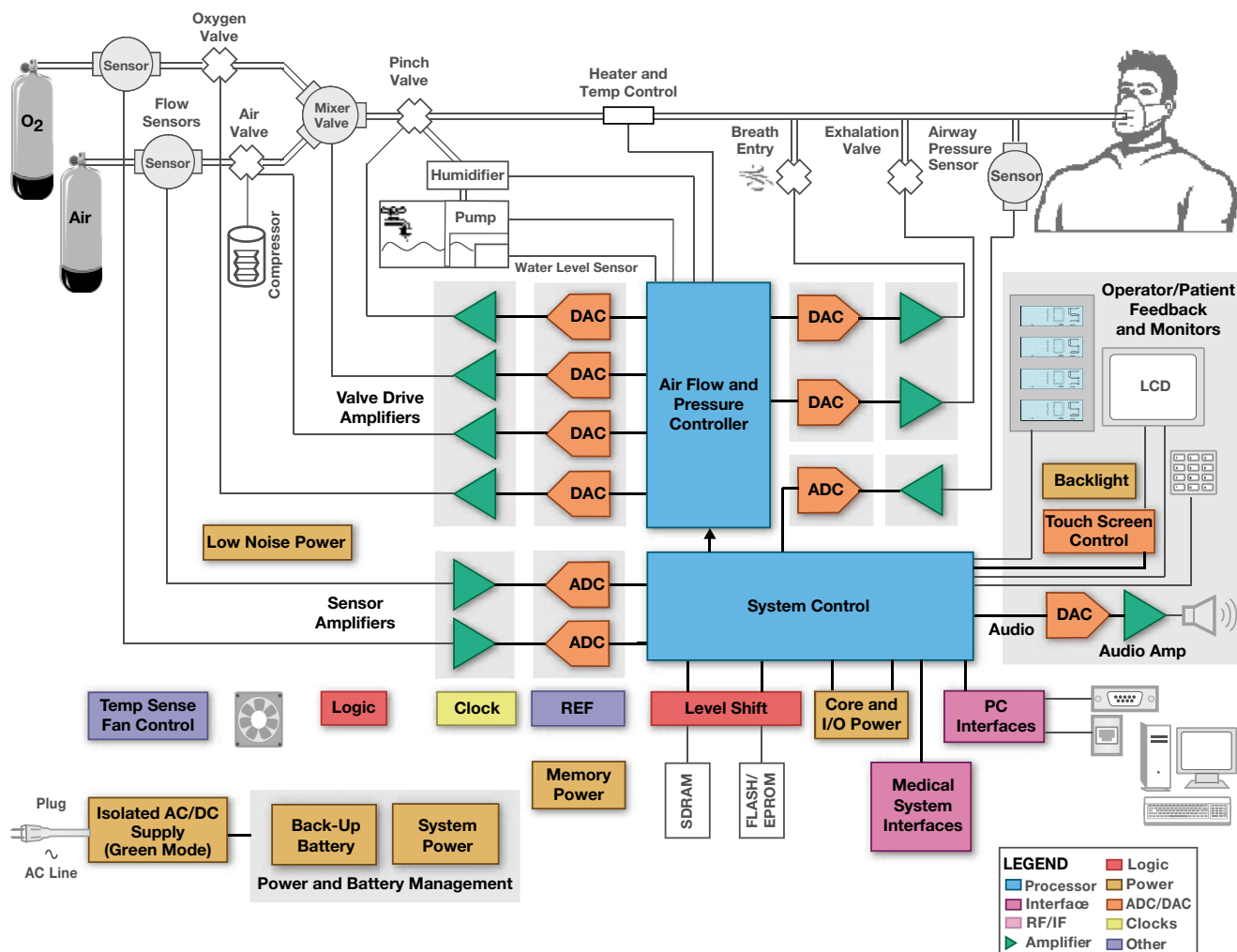
便携式呼吸设备系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

诊断、患者监测及治疗

➜ 通氧机 (Ventilator)

压力传感器可将一定的物理量（重量、水平、压力及流量）转换为mV/V范围的差分信号，涉及到金属厚膜、陶瓷或压阻等材料。绝大多数设计人员选用经济高效的压阻式传感器（25mbar至25bar）。然而，此类压阻式传感器具有非常大的非线性度、温度依赖性，并具有较大的失调及失调漂移。而且，这些传感器还需要特别注重电子校准 (electronic calibration) 及补偿。

下面的框图为某压力信号调节系统的原理框图。

PGA309桥接压力非线性校正

传感器信号调节——实现了所有必需的功能，以用于对传感器信号的校准、温度变化补偿、比例缩放及线性化。

模拟/数字处理——有两种方式可实现对传感器信号的转换及线性化。源于模拟技术的模拟解决方案可提供模拟输出。此项技术廉价且快速，但局限于最大11位至16位的分辨率。数字技术更为精确，分辨率高达24位，并以适中的速度提供数字输出。

电桥激励线性化电路针对桥接压力非线性（如上图所示的抛物线波形）修正进行了优化。线性化电路是数字可编程型的，但纯模拟信号调节仍然采用与TI有名的4-20mA发送器（例如XTR105、XTR108或XTR117）相同的处理流程进行处理。PGA309的核心是一个精密、低漂移的可编程增益仪表放大器，采用了自动归零技术并包括了可编程故障监视器及过/欠量程 (over/underscale) 限制器。PGA309还提供了一个数字温度补偿电路，其校准可任意通过单线式数字串行接口或业界标准的双线连接来实现。
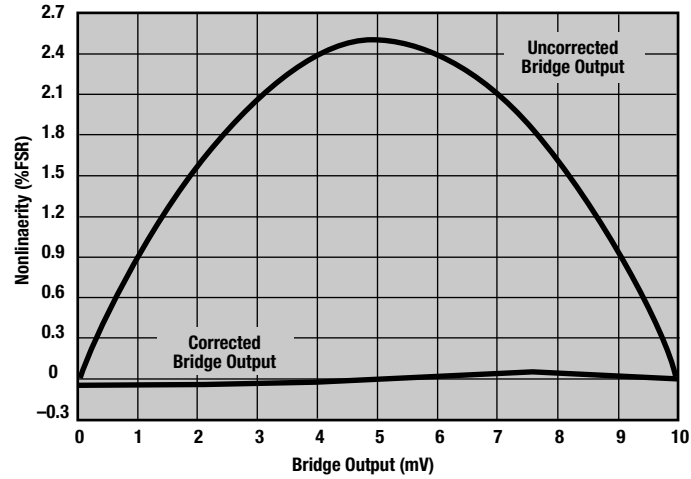
校准参数被存储于外部的非易失性存储器中，可免除手动的微调并实现长期稳定性。评估板PGA309EVM（见下文）包括了软件及校准表，可轻松地实现对您的传感器 + PGA309组合的评估。

高度集成的CMOS PGA309采用TSSOP-16封装，针对桥式压力传感器进行量身定做，隶属于TI高度灵活、超低噪声放大器及仪表放大器解决方案产品组合。这些解决方案还包括了OPAx227、OPAx132、OPA335、OPA735、INA326、INA333、INA118以及INA122。

PGA309EVM评估板方框图

诊断、患者监测及治疗
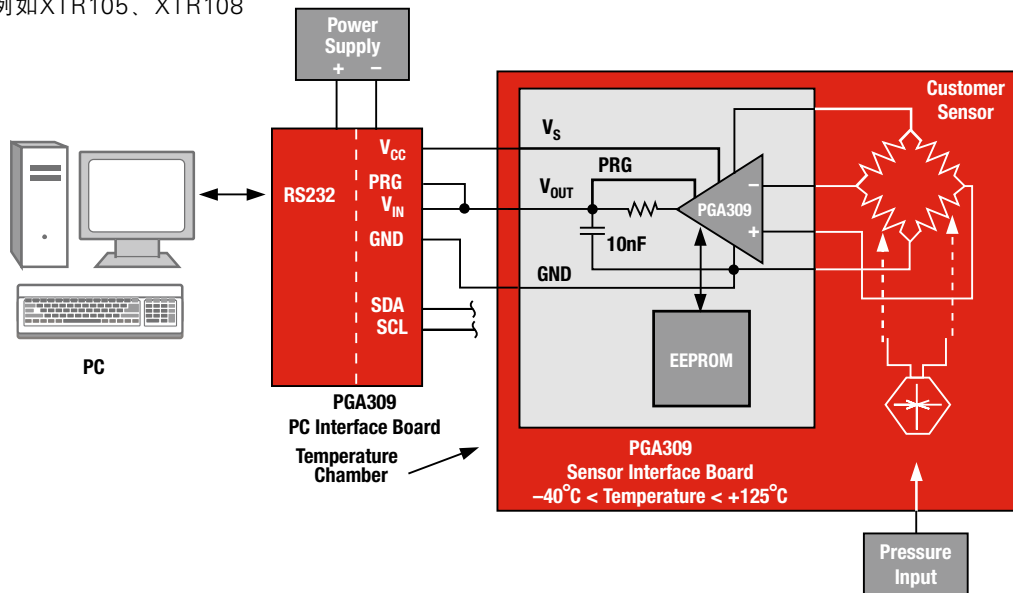
→ **通氧机 (Ventilator)**

32位微控制器
TMS320C28x™

敬请访问**www.ti.com/c2000**，以获取样片及数据表。

主要特点

- 浮点及定点型微控制器
- 性能高达150MIPS或300MFLOPS
- 16位及32位指令的混合架构
- 统一标准的内存架构
- 同类最佳的编译器效率
- 单周期32 x 32位乘加操作
- 容量高达512kB的片上闪存及68kB的片上SRAM
- 具有80ns转换时间及16个输入通道的12位ADC
- 六通道DMA
- 高分辨率脉宽调制 (PWM)，具有150ps的精度
- PWM微控制器具有可编程死区 (deadband)、相位或占空比控制能力以及多达6个跳变区，可生成任意需要的波形
- SCI、SPI、I²C、McBSP及CAN端口
- 工业温度范围（−40℃至85℃）或扩展温度范围（−40℃至125℃），完全符合车载要求

C2000™ MCU采用了改进的哈佛型 (harvard) 架构，实现了高性能32位核心与不同片上外设的统一。高级的中断管理系统确保了中断响应的快速性。C2000 MCU整合了集成的闪存及RAM内存模块，为诸多嵌入式应用提供了极为适用的强大单芯片解决方案。

C28x™系列微控制器进行了优化，旨在以尽可能快的产品上市时间交付最高性能的控制解决方案。
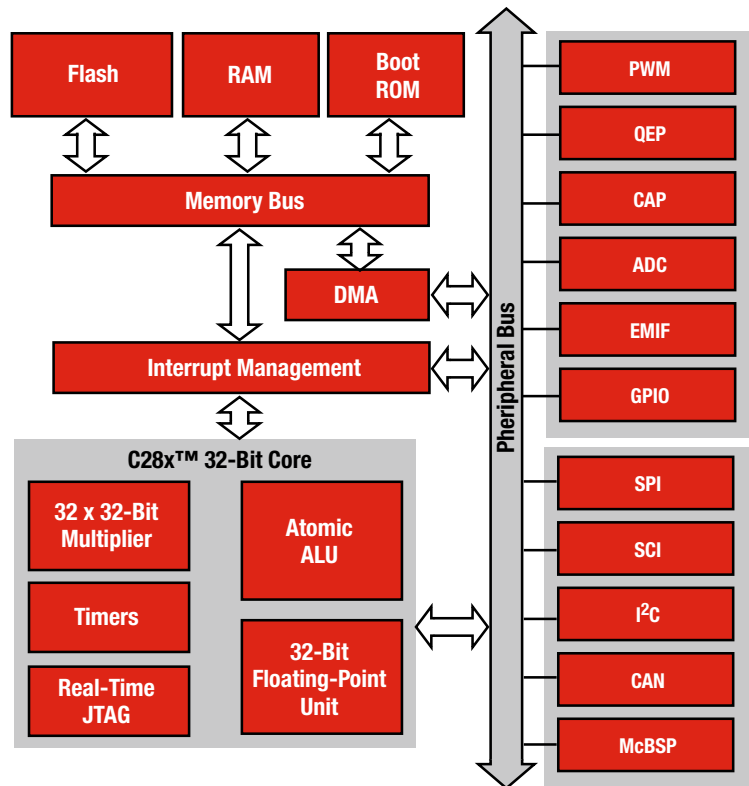
TMS320C28x™ 32位微控制器方框图

诊断、患者监测及治疗

→ **通氧机 (Ventilator)**

完整的电压输出、可编程桥接传感器信号调节器
PGA309

敬请访问**www.ti.com/sc/device/PGA309**，以获取样片、数据表、评估板及应用报告。

主要特点

- 比例制或绝对值电压输出
- 通过单线或双线接口实现数字校准
- 免除电位计及微调
- 总体调节误差较低，且时间稳定性 (time-stable) 较好
- +2.7V至+5.5V工作电压
- 封装：小外形TSSOP-16

应用

- 桥式传感器
- 远程4-20mA发送器
- 应变、负载、重量测量
- 车载传感器

* 请参见新款器件PGA308

PGA309是针对桥接电感器而设计的可编程模拟信号调节器。模拟信号通路对传感器信号进行放大，并可通过施加载荷（applied stress，例如压力、应变等）提供对零点 (zero)、幅度 (span)、零点漂移、幅度漂移以及传感器线性化误差的数字校准。校准可通过单线数字串行接口或通过业界标准的双线连接来实现。校准参数存储于外置非易失性存储器内（通常采用SOT23-5封装），以免除手动微调并实现长期稳定性。
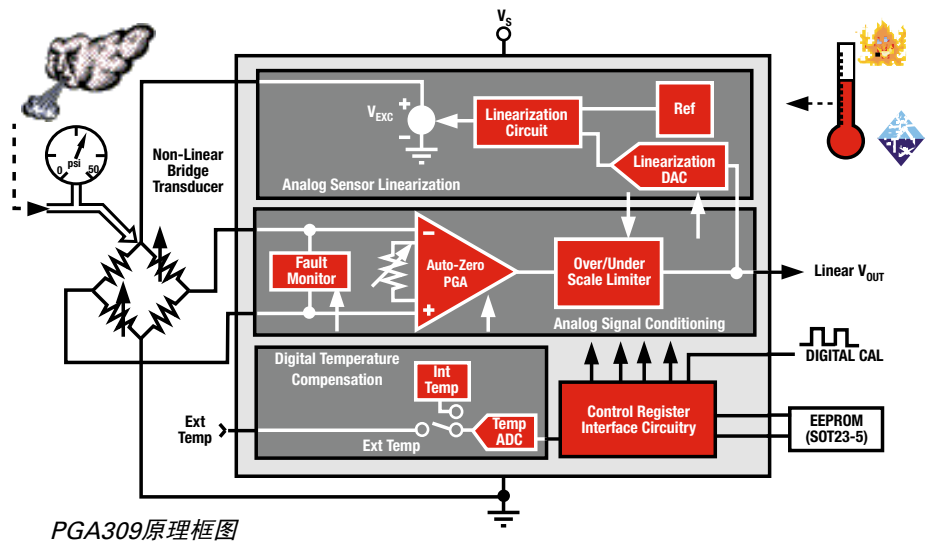
PGA309原理框图

高电压、大电流运算放大器
OPA549

敬请访问**www.ti.com/sc/device/OPA549**，以获取样片、数据表、评估板及应用报告。

主要特点

- 大输出电流：8A连续输出，10A峰值输出
- 宽电源范围：
  - 单电源：+8V至+60V
  - 双电源：±4V至±30V
- 宽输出电压摆幅
- 高转换速率：9V/μs
- 控制基准引脚
- 全面的保护：热停机、可调电流限值
- 输出停用控制
- 封装：11引脚功率封装

应用

- 气阀、致动器驱动器
- 同步、伺服驱动器
- 测试设备
- 传感器激励
- 电源

OPA549是高电压、大电流运算放大器，设计用于驱动宽范围的各种负载。该器件提供了稍低层次的信号精度以及大输出电压和电流，内置了过热状况及电流过载保护功能。此外，OPA549还提供了精确的、用户自设定的电流限值。与其他在输出电流通路上串联"功耗"电阻（"power" resistor) 的设计不同，OPA549并不直接感应负载，从而允许采用单个电阻器/电位计实现从0A至10A的电流限值调节范围，或通过电压输出或电流输出DAC实现数字控制。
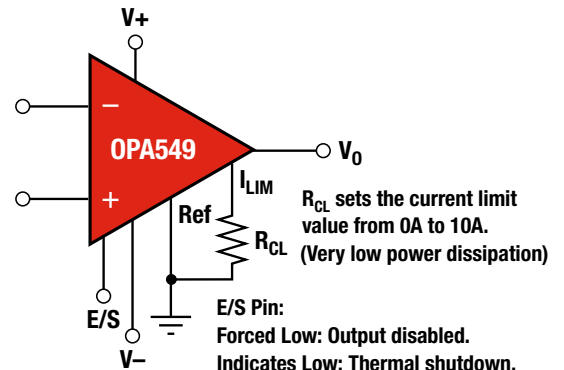
OPA549原理框图

➡ **通氧机 *(Ventilator)***

高侧测量、双向、零漂移电流并联监视器
INA210、INA211、INA212、INA213、INA214

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片及数据表。
（**PARTnumber**请使用**INA210、INA211、INA212、INA213**或**INA214**替换）

主要特点

- 宽共模范围：－0.3V至26V
- 偏置电压：±35μV（最大值）（支持10mV的满量程分流压降）
- 精度：
  ○ 增益：±1%（最大值）
  ○ 偏置点漂移：0.05μV/℃（最大值）
  ○ 增益漂移：25ppm/℃（最大值）
- 可选增益范围：50至1000V/V
- 电源电压：+2.7V至+18V
- 静态电流：100μA（最大值）
- 封装：SC70

应用

- 医疗设备
- 笔记本电脑
- 蜂窝电话
- 电池充电器

INA21x系列器件为电压输出电流并联监视器，可独立于电源电压，感应横跨并联端的电压降，共模电压范围为－0.3V至26V。可提供5种增益选项：50V/V、100V/V、200V/V、500V/V或1000V/V。该系列零漂移器件的架构具有低偏置的特点，可支持横跨并联端的最大电压降低至10mV满量程的电流感测。

Product	Gain	R$_3$ and R$_4$	R$_1$ and R$_2$
INA210	200	5kΩ	1MΩ
INA211	500	2kΩ	1MΩ
INA212	1000	1kΩ	1MΩ
INA213	50	20kΩ	1MΩ
INA214	100	10kΩ	1MΩ
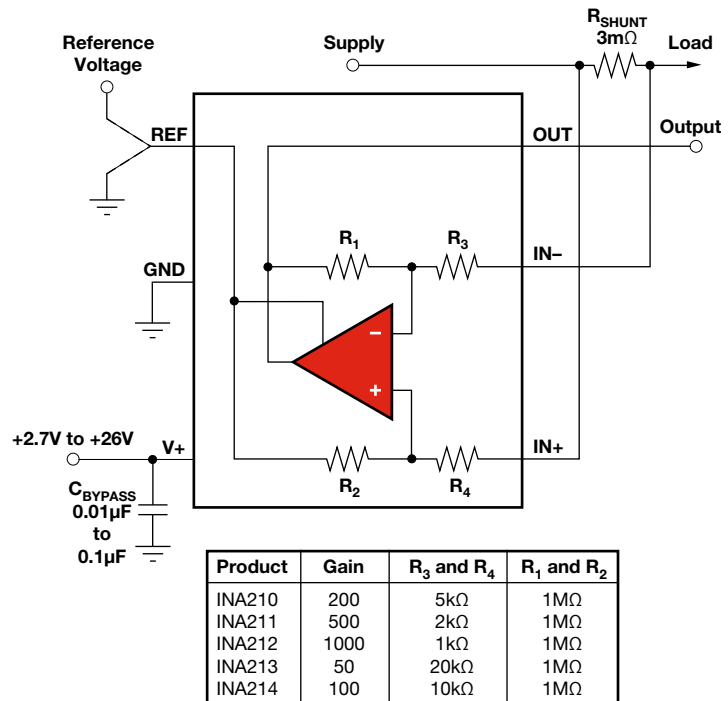
典型器件配置选项

➡ **通氧机 (Ventilator)**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
DRV8402	PWM Motor Driver	24A peak current, 52.5V supplies, 500kHz PWM input	Precision motor control in a complete integrated solution	
INA210/11/12/13/14 *Page 57*	Current Shunt Monitor	±35μV (max) offset, 0.05μV/°C (max) drift, 2.7 to 18V supply voltage	Enables current sensing with maximum drops across the shunt as low as 10mV full-scale	
OPA549 *Page 56*	Power Amplifier	8A continuous, 10A peak output current, 9μs slew rate	Wide supply range, thermal protection	OPA547, OPA548
OPA564	Power Amplifier	1.5A, 24V, 17MHz, power operational amplifier	Near rail output, current and thermal protection	
OPA567	Power Amplifier	2A output, 150mV of rails with I/O = 2A output swing	Thermal protection, adj. current limit	OPA569
PGA309 *Page 56*	Prog. Sensor Conditioner	Sensor error compensation: span, offset, temp drifts	Complete bridge sensor conditioner	**PGA308**
THS452X	Low Power FDA	1.14mA quiescent current (typ), +2.5V to 5.5V supply, 4.6nV/√Hz voltage noise	Low power enables high accuracy, low crosstalk in multichannel options	THS4522, THS4524
Data Converters				
ADS1258	Delta-Sigma ADC	16-channel, 24-bit, 125kSPS, 23.7kSPS/channel	Fastest multi-channel, delta-sigma ADC, measures all 16 inputs in <675μs	ADS1251, ADS1253,
ADS1271	Delta-Sigma ADC	24-bit, 105kSPS, serial interface, SPI w/FSYNC	Designed for multi-channel systems	**ADS1274, ADS1278**, ADS1284
ADS1278	Delta-Sigma ADC	24-bit, 128kSPS, 8 channels, 111dB SNR	Simultaneous measurement, onboard decimation filter	ADS1271, ADS1274
ADS1298	ECG/EEG AFE	24-bit, 8 PGA, 8 ADC, plus RLD and RESP	Complete front end, reduction in power and size, increase reliability	**ADS1294, ADS1296, ADS1198**, ADS1251/58
ADS8318/19	High-Speed SAR	16-bit, 500kSPS, 18mW at 500kSPS power, ±1 LSB INL	Precision, excellent AC/DC performance	
ADS8326	Low-Power ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL	Small package, wide supply range	
DAC7564	Quad DAC	Ultra-low glitch, voltage output DAC	Internal low drift reference	DAC8564
DAC7568	Octal DAC	Ultra-low glitch, voltage output DAC	Internal low drift reference	
DAC8411	High Resolution DAC	16-bit, low power DAC	Small size, wide supply range	DAC8311, DAC7311
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics acelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
MSP430F20xx	Ultra-Low-Power 16-Bit MCU	1KB/2KB Flash, 128B RAM, SPI+I²C	8 ch. 12-bit ADC or 4 ch. 16-bit SD ADC, 4 x 4mm package	
MSP430F22x4	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 512B/1KB RAM, SPI + I²C + UART/LIN + IrDA	12 ch. 10-bit ADC, 2 op amps	
MSP430F23x0	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 1KB/2KB RAM, SPI + I²C + UART/LIN + IrDA	Analog comparator, HW multiplier	
MSP430F41x	Ultra-Low-Power 16-Bit MCU	4 to 32KB Flash, 256B to 1KB RAM, SVS, 96 segment LCD	Analog comparator	
MSP430F43x	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 512B/1KB RAM, SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, analog comparator	
MSP430F44x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 2x SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, HW multiplier	
MSP430F471xx	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, DMA, 160 segment LCD	(7) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F54xxA	Ultra-Low-Power 16-Bit MCU	128 to 256KB Flash, 16KB RAM, (4) USCI, PMM, DMA, temp. sensor	16 ch. 12-bit ADC, analog comparator, RTC, internal voltage regulator for power optimization	
MSP430FG42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC, 2 integrated op amps	
MSP430FG43x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, SPI + UART, SVS, 128 segment LCD	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, DMA, 3 op amps	
MSP430FG461x	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I²C + UART/LIN + IrDA, 160 LCD	12 ch. 12-bit ADC, 2 ch.12-bit DAC, A-comp, 3 op amps, HW multiplier	
MSP430FG47x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 2KB RAM, SPI + I²C + UART/LIN + IrDA, 128 LCD controller	5 ch. 16-bit SD ADC, 2 ch. 12-bit DAC, A-comp, 2 op amps	
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
Stellaris® LM3S3xxx	Microcontroller	ARM® Cortex-M3, up to 256KB flash, up to 64kB RAM, USB host/device	USB, 10-bit ADC, temperature sensor	

* 更多产品信息请参见指定页码。
如欲查阅更多系统方框图兼容的产品，敬请访问 **www.ti.com/medical**

*新产品以***粗体红色***标明。前瞻性产品以***粗体蓝色***标明。*

→ **通氧机 (Ventilator)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Processors (Continued)				
TMS320C28x™ *Page 55*	32-Bit MCU	Up to 512KB on-chip flash and 68KB on-chip SRAM, up to 150MIPS or 300MFLOPS	Optimized for delivering the highest-performance control solution with the best time to market	
TMS320C5000™	DSP	Power efficient, high performance	Fixed-point DSP with industry's best combination of standby and dynamic power consumption	
TMS320F28x™	32-Bit MCU	32-bit architecture, fixed- or floating-point code, up to 225MIPS operation	32-bit microcontroller integration, real-time control performance	TMS320F2823x, TMS320F2833x
TMS320F2802x/3x Piccolo	32-Bit Microcontroller	Up to 60 MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F2808	32-Bit MCUs	100MIPS, 8KB ROM, 36KB RAM, 128KB Flash, 12-bit ADC	I²C, 4 SPI, 2 SCI, 2 CAN	
TMS320F283x Delfino	32-Bit Floating-point Microcontroller	Up to 300 MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320F28234	32-Bit MCUs	150MIPS, 8KB ROM, 68KB RAM, 256KB Flash, 12-bit ADC	McBSP, 1 SPI, 2 SCI, 2 CAN	
TMS320F28015	32-Bit MCUs	60MIPS, 8KB ROM, 12KB RAM, 32KB Flash, 12-bit ADC	I²C, 1 SPI, 1 SCI	
TMS320VC5506	DSP	200MHz, dual MAC, very low standby power of 0.12mW	Supported by eXpressDSP™ and many other software packages and tools	TMS320VC5509A, TMS320VC5502
Interface				
SN65HVD1050	CAN Transceiver	−27V to 40V bus-fault protection, meets or exceeds ISO11898-2	High EMI, low EME	HVD234 is 3.3V version
SN65HVD3082	RS-485 Transceiver	1/8 unit load — up to 256 nodes on a bus, 15kV ESD protection	Glitch-free power-up/down bus inputs and outputs	
Power Management				
bq2406x	Battery Charger	Linear 1-cell Li-Ion charger with thermal regulation, 6.5V OVP, temp sense	Good for space-limited designs with need for battery safety	bq2410x
bq27010	Battery Fuel Gauge	Li-Ion and Li-Pol battery gas gauge	Reports accurate time-to-empty of battery	bq27200
bq27540	Battery Fuel Gauge	Li-Ion battery gas gauge with Impedance Track™ fuel-gauge technology	Reports accurate time-to-empty of battery	bq27510
TPS2041B	USB Power Switches	USB compliant power source, short-circuit protection	Single-chip power-source solution for USB and memory cards	TPS2550, TPS2061
TPS22902	Load Switch w/ Controller Turn-On	Low on resistance, controlled turn-on, ultra small 0.64mm² package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS22946	Current Limited Load Switch	Configurable current limit, ultra-small package, 1µA quiescent current at 1.8 V	Ultra-small, low quiescent current current limited switch	TPS22949, TPS22945
TPS23750	Power-over-Ethernet	PoE interface and DC/DC controller in one IC	Transmit power and data to remote devices over Ethernet cable	TPS23753
TPS23753	Power-over-Ethernet	PoE with AC adaptor ORing function	Allows 12V adaptor ORing	
TPS61042	LED Boost Converter	Current source with over voltage protection	Simple backlight boost for improved visibility of LCD	TPS61140
TPS61097-33	Boost Converter with Bypass Switch	Highly efficient, operates down to 0.3 V; bypass switch; 5nA shutdown current; SOT-23	Super efficient boost, works over entire battery range, low quiescent current, integrate the bypass switch, small package	
TPS61240	Boost Converter	Input current limit, load disconnect during shutdown	Small, fail save solution	TPS61070
TPS62230	Step-Down Converter	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm² solution size	TPS62260
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62410
TPS62750	Step-Down Converter	Programmable input current limit, hot plug and reverse current protection	Supports USB powerde applications and large output caps	TPS62040

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➡ **通氧机 (Ventilator)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
TPS63000	Buck Boost Converter	Automatic transition between step down and boost mode	Produce mid-range voltage out over entire range of battery	TPS62113
TPS63030	Buck-Boost Converter	1-A switch, automatic transition between step down and boost mode	Extending application run time, small solution	TPS61020
TPS717xx	Low-Noise Single-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS793xx, TPS795xx, TPS799xx
TPS718	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719
TPS780xx	LDO with DVS	Dynamic voltage scaling (DVS) with low I_Q 500nA	DVS voltage designed to operate with MSP430™ to increase power savings	TPS78101
TPS79901	Low-Noise Single-Channel LDO	Very high rejection of power source noise	Low-noise power rails for sensitive analog components	TPS793xx, TPS795xx
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz Bluetooth® 2.1 chipset	Single-chip Bluetooth® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC2510/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/RF4CE/ ZigBee®	Excellent RX sensitivity, low power, easy-to-use development tools	RF design SOC for quick time to market; provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4 GHz Bluetooth® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	Fast-to-market Bluetooth® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations ; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with Bluetooth® technology and Wi-Fi.	

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➡️ 持续正压通气 (CPAP)

持续正压通气 (CPAP) 是一类呼吸通气方法，主要用于居家环境内睡眠呼吸暂停症状的治疗。睡眠呼吸暂停出现于睡眠期间，因肌肉趋向于自然松弛而导致上呼吸道狭窄。这种收窄将降低血液的氧含量并导致从睡眠状态惊醒。

压力传感器是呼吸设备的重要组成部分。除了将物理参量（例如空气压力及流量）转换为差分信号之外，气压及流量传感器还用于产生信号以辅助微处理器调节电机，从而调整/维持患者吸气或呼气时所需的气压。

传感器非常经济有效，较大的偏置及偏置点漂移将导致信号超量程 (over-scale)、随温度变化以及信号的非线性。具有低偏置电压且偏置点随时间及温度漂移较小的放大器是信号调节的理想选择。

直流电机控制可通过监测至少两个电流相位（共三个电流相位）来完成，并同时将直流总线电压馈入电机驱动桥。对于相位电流，可以采用两类方法：高侧 (high-side) 或低侧 (low-side)。

直接相位测量（或称为高侧法，需要高速差分放大器或电流并联监视器）通常更为精确。低侧法在靠近半桥接地线路的地方进行测量，并使用相对廉价但精度也稍低的简易放大器。直流电机由分立的FET器件驱动。

TI的DRV系列器件提供了集成的驱动器及电桥，具有过热保护功能，而且更小、更精确、更具效率。（接下页）
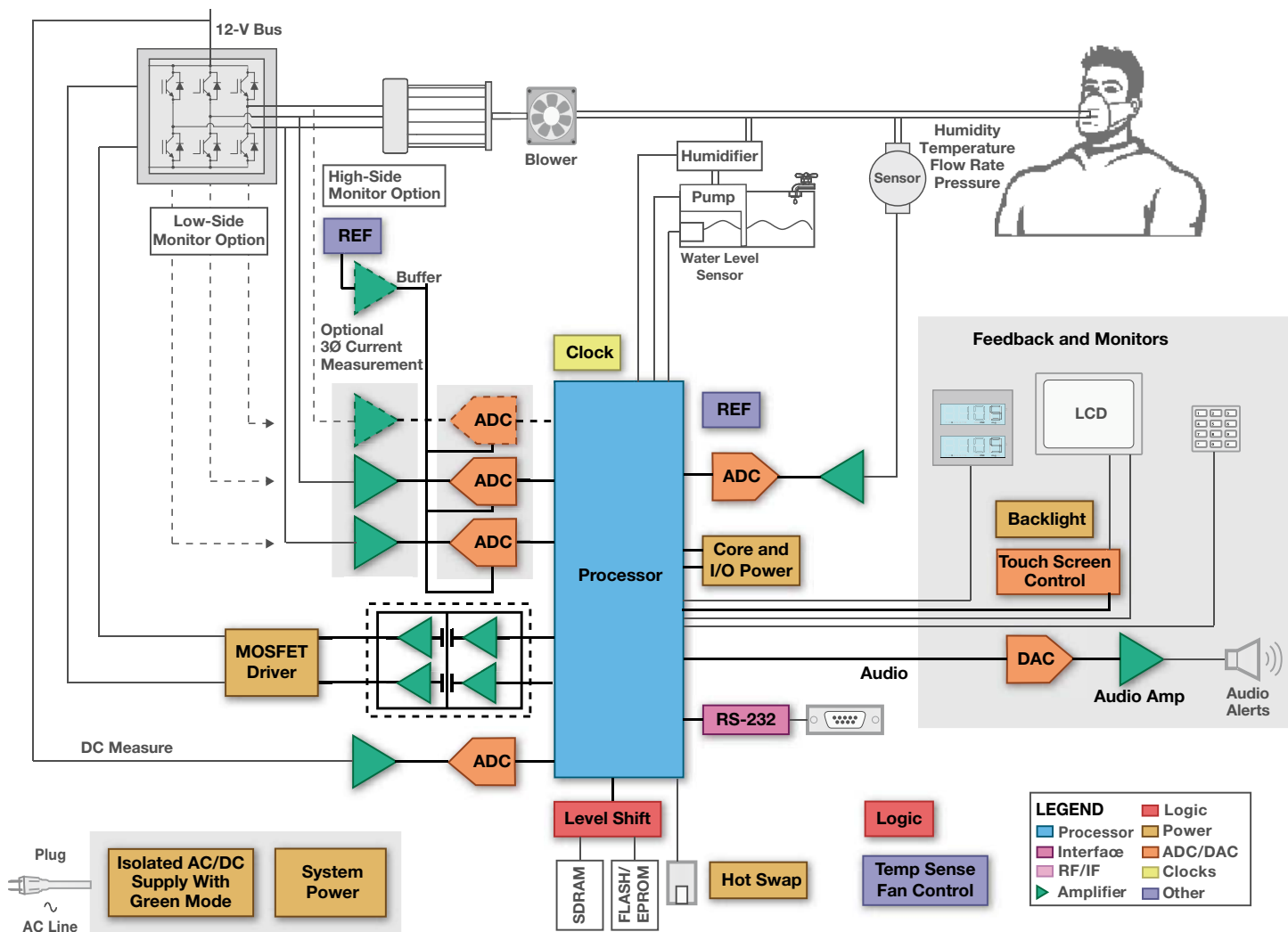
CPAP系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

➔ 持续正压通气 (CPAP)

（接上页）

微处理器执行多项运算。这些运算包括了采样压力信号并计算出所需的通气压力及流量，以传达至电机。为了高效、实时地完成此类运算，应采用高速、低功耗且高度集成的微处理器。高品质的DSP可用于此类应用，并将为患者提供极其安静的运转环境。

针对持续正压通气机 (CPAP) 的高性能32位微控制器
TMS320C2000TM

敬请访问**www.ti.com/c2000**，以获取样片、数据表、评估板及应用报告。

持续正压通气机 (CPAP) 是避免使用插管疗法 (intubation) 的有效途径，可降低伴有剧烈呼吸衰竭患者的死亡率，可为伴有睡眠呼吸暂停症的患者提供帮助并缓解慢性呼吸衰竭症。

CPAP机的设计人员注重于高效的运转电机以驱动持续的气流供给患者，并竭尽所能地减少系统板载元件数量以实现更低的成本、更轻松的开发以及更快的产品上市。CPAP机的系统设计人员极为看重TMS320C2000，源于其非同一般的能力，包括：

1. TMS320C2000 32位微控制器是高性能、低成本IC，可实时地控制电机的速度、位置及转矩。在需要的情况下，此类控制器甚至能够提供处理能力，可采用源自旋转变压器 (resolver)、编码器及霍尔效应传感器的数据，通过执行非常精细的位置及速度估计算法实现对电机的控制。

2. 此类高性能控制器不仅提供了精确的电机控制，同时还能提供额外的处理能力 (MIPS) 及外设集成，足以胜任主控MCU的角色。这些IC的性能可高达150MIPS，并拥有很高的外设集成度——具有片上闪存、12位16通道ADC（性能可高达12.5MSPS）和多个GPIO引脚，因而设计人员可通过使用单个控制器实现更低的成本。

3. C2000™平台具有免费且广泛的电机控制资料库 (*www.ti.com/c2000appsw*)，可帮助开发人员获得所需的软件框架，以控制单相或三相无刷直流 (BLDC) 电机。此外，C编译器的高效率还免除了对大多数汇编编码的需求。

主要特点

- 实时控制，降低了总体系统成本
- 可扩展的控制器，价格低至2美元以下，性能达150MIPS
- 全系列器件均具有软件及工具兼容性

TMS320C2000™ 32位MCU方框图
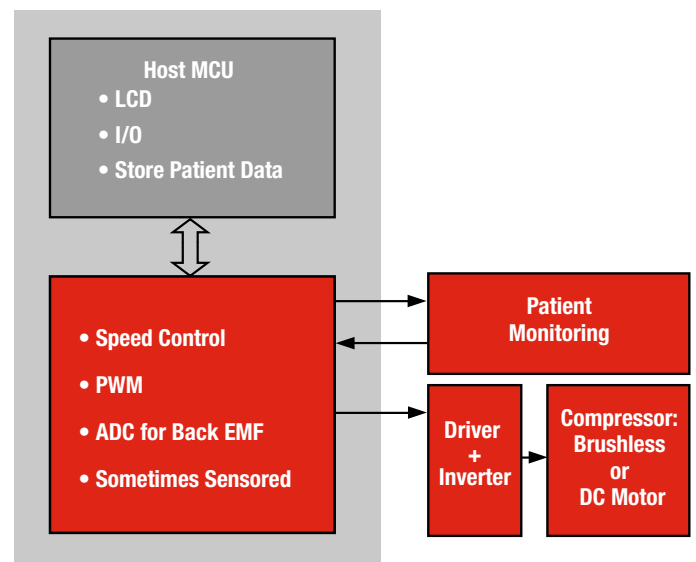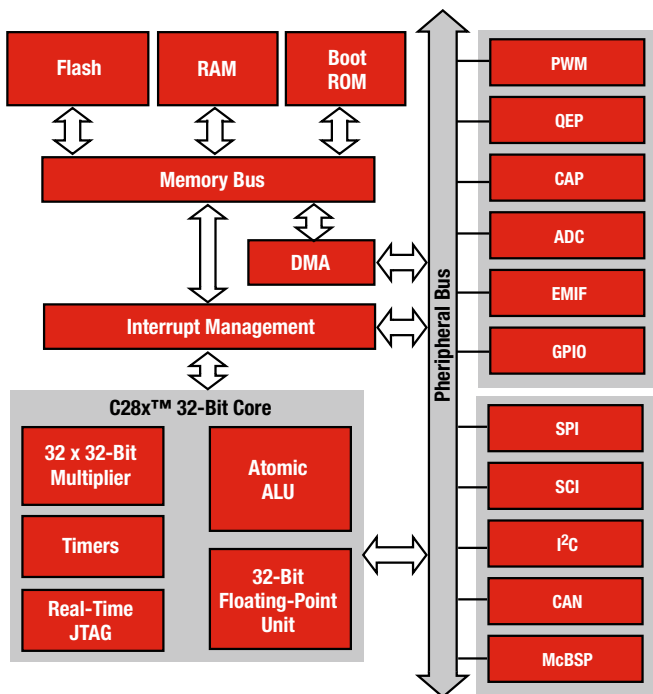
TMS320C2000™ 32位MCU用于简化的患者监测系统

→ **持续正压通气 (CPAP)**

主要特点（续）
- 片上可编程闪存
- C编译器的高效率免除了对大多数汇编编码的需求
- 10位或12位ADC，可支持最高16通道以及12.5MSPS的采样率

- 独立或互补型脉宽调制 (PWM)，带死区
- 独立的占空比或相位控制
- 150ps高分辨率PWM
- 编码器接口及事件捕获输入

- CAN 2.0B、SCI、SPI以及I^2C端口接口
- 长产品寿命周期，确保了供应的持续性

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
TMS320C2000™ *Page 62*	High-Performance Microcontroller	32-bit, up to 150MIPS, up to 12.5MSPS	High-performance, low cost	
TMS320F2802x/3x Piccolo™	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F28015	High-Speed Microcontroller	32-bit digital signal controller with flash		
TMS320F2812	High-Speed Microcontroller	32-bit digital signal controller with flash		
TMS320F28232	Digital Signal Controller	High-performance static CMOS technology. Highly integrated, high-performance solutions for demanding control applications		
TMS320F28234	Digital Signal Controller	High-performance static CMOS technology. Highly integrated, high-performance solutions for demanding control applications		
TMS320F28235	Digital Signal Controller	High-performance static CMOS technology. Highly integrated, high-performance solutions for demanding control applications		
TMS320F283x Delfino	32-Bit Floating-point Microcontroller	Up to 300 MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320F28335	Digital Signal Controller	High-performance static CMOS technology. Highly integrated, high-performance solutions for demanding control applications		
TMS320VC5509A	Low-Power DSP	Up to 200MHz, dual MAC, 256KB RAM/64KB ROM, USB 2.0 full speed, MMC/SD, 10-bit ADC	Power efficient; large on-chip memory, rich peripheral set allows for various portable connectivity; C55x™ code compatibility	C550x DSP
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
Stellaris® LM3S3xxx	Microcontroller	ARM® Cortex-M3, up to 256KB flash, up to 64kB RAM, USB host/device	USB, 10-bit ADC, temperature sensor	
Data Converters				
ADS1258	Delta-Sigma ADC	16-channel, 24-bit, 125kSPS, 23.7kSPS/channel	Fastest multi-channel, delta-sigma ADC, measures all 16 inputs in <675µs	ADS1158, ADS1248
ADS7952	SAR ADC	12-bit, 1MSPS, 70dB SNR, 11.5mW power	Zero latency, ideal for multi-channel systems	ADS7951, ADS7953
ADS8317	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Excellent linearity, micropower, high speed	ADS8422
ADS8318	SAR ADC	16-bit, 500kSPS, 18mW (typ) power, 95.5dB SNR, ±1 LSB (max) INL	Zero latency, serial interface, low power	ADS8519, ADS8321
ADS8326	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Low noise, low power, high speed	ADS8325
ADS8331/32	SAR ADC	16-bit, 500kSPS, 4/8 channels, with serial interface	Mux out feature can be used to reduce system part count and overall cost	ADS8342
ADS8201	Low-Power SAR ADC	8 channel, 12-bit, 100kSPS, 1.32mW power consumption at 100kSPS	Full on-chip data acquisition system	ADS7870

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→ **持续正压通气 (CPAP)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Data Converters (Continued)				
ADS8472	SAR ADC	16-bit, 1MSPS, ±0.4LSB (typ) INL	Zero latency, low power	
TLV320DAC3120	Low-Power Audio DAC	Mono DAC with 2.5W mono Class-D speaker amplifier; miniDSP for audio processing	Longer battery life, better audio quality, lower cost	TLV320DAC3101
TLV320DAC32	Audio DAC	Low-power stereo DAC, 4 outputs, HP/speaker amplifier, 3D effects		
TSC2000	Touch-Screen Controller	4-wire programmable touch-screen controller with 8-/10-/12-bit 125kHz ADC and SPI interface		
TSC2003	Touch-Screen Controller	4-wire touch-screen controller		
TSC2006	Touch-Screen Controller	Nano-power touch-screen controller with SPI serial interface		
TSC2007	Touch-Screen Controller	Nano-power touch-screen controller with I^2C serial interface		
TSC2046	Touch-Screen Controller	4-wire touch-screen controller with low-voltage digital I/O		
TSC2200	Touch-Screen Controller	Programmable 4-wire touch-screen controller with 12-bit 125kHz ADC and keypad interface		
References				
REF3030	Series Voltage	3.0V, 50ppm/°C, 50µA in SOT23-3	Low power, small size	REF2930
REF3130	Series Voltage	20ppm/°C max, 100µA, SOT23-3	Precision, low power, small size	REF3330
Clocking				
CDCE913	Programmable 1-PLL VCXO Clock Synthesizer with 2.5 or 3.3V LVCMOS Outputs	Input clock: X-tal (8 to 32MHz) or LVCMOS up to 150MHz; VCXO input with ±150ppm (typ) pulling range; output frequencies up to 230MHz; three low-jitter, low-skew, high-performance LVCMOS output fan-out buffers	Wide input/output frequency range supports wide frequency ratio for audio/video clocking; easy frequency synchronization; fractional PLL enables zero PPM clocking generation; integrated fan-out buffers reduce clock distribution cost	
CDCEL913	Programmable 1-PLL VCXO Clock Synthesizer with 1.8V LVCMOS Outputs	Input clock: X-tal (8 to 32MHz) or LVCMOS up to 150MHz; VCXO input with ±150ppm (typ) pulling range; output frequencies up to 230MHz; three low-jitter, low-skew, high-performance LVCMOS output fan-out buffers	Wide input/output frequency range supports wide frequency ratio for audio/video clocking; easy frequency synchronization; fractional PLL enables zero PPM clocking generation; integrated fan-out buffers reduce clock distribution cost	
Interface				
ISO721	Single-Channel, 100Mbps Digital Isolator	Silicon-integrated SiO_2 dielectric capacitor; 0 to 150Mbps and DC signal pass with fail-safe; 1ns skew, 1ns jitter, 1ns pulse distortion; input threshold; noise filter; high magnetic immunity (1E6 > inductive)	Proven reliability of SiO_2 dielectric, stable over temperature and moisture; lowest skew, jitter and pulse width distortion; filters noisy signals before entering system; high immunity for noisy environments	
ISO7221C	Dual-Channel, 1/1, 25Mbps Digital Isolator	Silicon-integrated SiO_2 dielectric capacitor; 0 to 150Mbps and DC signal pass with fail-safe; 1ns skew, 1ns jitter, 1ns pulse distortion; input threshold; noise filter; high magnetic immunity (1E6 > inductive)	Proven reliability of SiO_2 dielectric, stable over temperature and moisture; lowest skew, jitter and pulse width distortion; filters noisy signals before entering system; high immunity for noisy environments	
ISO7231C	Triple-Channel, 2/1, 25Mbps Digital Isolator	Silicon-integrated SiO_2 dielectric capacitor; 0 to 150Mbps and DC signal pass with fail-safe; 1ns skew, 1ns jitter, 1ns pulse distortion; input threshold; noise filter; high magnetic immunity (1E6 > inductive)	Proven reliability of SiO_2 dielectric, stable over temperature and moisture; lowest skew, jitter and pulse width distortion; filters noisy signals before entering system; high immunity for noisy environments	
ISO7241M	Quad-Channel, 3/1, 150Mbps Digital Isolator	Silicon-integrated SiO_2 dielectric capacitor; 0 to 150Mbps and DC signal pass with fail-safe; 1ns skew, 1ns jitter, 1ns pulse distortion; input threshold; noise filter; high magnetic immunity (1E6 > inductive)	Proven reliability of SiO_2 dielectric, stable over temperature and moisture; lowest skew, jitter and pulse width distortion; filters noisy signals before entering system; high immunity for noisy environments	
Amplifiers				
OPA4376	Precision Op Amp	Quad, 5.5MHz GBW, 2V/µs slew rate, 0.95mA/ch I_Q, 76dB CMRR, 7.5nV/√Hz noise	Precision, low power	OPA4727, OPA2376
INA169	Current-Shunt Monitor	2.7V to 60V, 60µA (typ) I_Q, unipolar, high-side current measurement	High speed, small size	INA168, INA139
INA170	Current-Shunt Monitor	2.7V to 40V supply, 2.7V to 60V common-mode voltage, 75µA (typ) I_Q, bidirectional	Low power, current output	INA193, INA138
INA210	Current-Shunt Monitor	−0.3V to 26V common-mode range, ±35µV offset, 100µA I_Q, 0.5µV/°C (max) offset drift	Voltage output, bidirectional, zero-drift series	INA138, INA193
INA332	Instrumentation Amp	0.07%, 2ppm/°C, G = 5 gain accuracy, 73dB CMRR, 0.5pA IB, 490µA (max/ch) I_Q	Single or bipolar operation, low noise	INA326, INA338
INA333	Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50 µA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA118

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→ **持续正压通气 (CPAP)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers (Continued)				
OPA333	Precision Op Amp	1.8V min supply, 0.017mA/ch (max), 10µV offset (max), 0.05 µV/°C drift (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, **OPA330**
OPA2365	Precision Op Amp	Dual, zero crossover, 0.0006% THD+N, 100dB CMRR, RRIO, 4.5nV/$\sqrt{Hz}$ noise, 50MHz GBW, 200µV input offset	Superior performance, excellent for driving single-supply ADCs	OPA2333
OPA376	Precision Op Amp	7.5nV/$\sqrt{Hz}$ noise, 760µA(typ)/ch Iq, 5µV (typ) offset, input EMI filter, RRO	Low noise, low power, low input bias	OPA340, OPA337
TLC2264	Op Amp	Quad, 12nV/$\sqrt{Hz}$ (typ) noise, 1pA bias current, 500µA (max) I_Q, RRO	Single or split supply, low noise	TLC2274
THS452X	Low power FDA	+2.5V to 5.5V supply, 1.14mA (typ) quiescent current, 4.6nV/$\sqrt{Hz}$ voltage noise	Low power, low noise enables high accuracy	THS4522, THS4524
TPA2006D1	Analog-Input Class-D Amp	1.45W mono, filter-free Class D, 1.8V shutdown		
TPA2010D1	Analog-Input Class-D Amp	2.5W mono, fully differential, filter-free Class D, in WCSP	Loud audio, long battery life, small package size	TPA2031D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA2016D2	Analog-Input Class-D Amp	1.7W stereo, Class D with dynamic range compression and automatic gain control		
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA6204A1
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	
Power Management				
TPS2550	USB Power Switch	Adjustable current-limited power-distribution switch	Allows custom current set limit for different designs	
TPS2811	MOSFET Driver	Inverting dual high-speed MOSFET drivers with internal regulator	Saves solution space	
TPS3103E12	Supervisory Circuit	Ultra-low-supply-current/supply-voltage supervisory circuit	Saves battery power	
TPS3813I50	Supervisory Circuit	Supervisor with programmable watchdog window	Allows custom time intervals	
TPS40077	DC/DC Controller	Wide-input (8V to 40V), up to 1MHz-frequency synchronous buck controller, source only	Higher frequency requires smaller inductor and input capacitor	
TPS40200	DC/DC Controller	4.5V to 52V input non-synchronous buck DC/DC controller	Very wide input allows wider range of solutions	
TPS5410	DC/DC Converter	5.5V to 36V input, 1A step-down converter	Wide input range provides for mulitple input solutions	
TPS54310	DC/DC Converter	Low-input-voltage, 3A synchronous buck converter with adjustable output voltage	Higher efficiency with synchronous solution	
TPS54350	DC/DC Converter	4.5 to 20V$_{IN}$, 3A DC/DC with integrated switch FET, sync pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS61050	White LED Driver	1.2A high-power white LED driver with I^{2}C-compatible interface	Provides I^{2}C control	TPS61058
TPS61093	OLED Boost Converter	Wide V$_{IN}$ range, input-output disconnect	Flexible, fail safe solution	TPS61080
TPS61140	White LED Driver	Dual, 2x 27V, 700mA switch, 1.2MHz boost converter with single-inductor white LED and OLED driver	High switching frequency requires smaller inductor and input capacitor	
TPS61160	White LED Driver	White LED driver with digital and PWM brightness control in 2mm x 2mm package	Will allow stepped brightness adjustment	TPS61061
TPS62110	Step-Down Converter	3.1V to 17V V$_{IN}$, 1.5-A conversion, synchronization pin, low battery indicator, power save mode	Very low noise/high efficiency	TPS62050
TPS62230	Step-Down Converter	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm2 solution size	TPS62260
TPS62750	Step-Down Converter	Programmable input current limit, hot plug and reverse current protection	Supports USB powerde applications and large output caps	TPS62040
TPS65120	DC/DC Converter	5V/20mA (I/O), 4-ch high-accuracy multi-converter w/3.3V LDO for LCD bias	Complete solution in one package	
TPS65123、	DC/DC Converter	5V/20mA (I/O), 4-ch high-accuracy multi-converter w/o LDO for LCD bias	Complete solution in one package	

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持续正压通气 (CPAP)

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
TPS65124	DC/DC Converter	5V/20mA (I/O), 4-ch high-accuracy multi-converter w/o LDO and w/programmable seq. for LCD bias	Complete solution in one package	
TPS65130	DC/DC Converter	800mA boost current w/positive and negative (dual) output for OLED and CCD sensor	Provides smaller solution size	
TPS73025	LDO	Single-output LDO, 200mA, fixed (2.5V), high PSRR, low noise	High PSRR requires less noise filtering in sensitive applications	
TPS73028	LDO	Single-output LDO, 200mA, fixed (2.8V), high PSRR, low noise	High PSRR requires less noise filtering in sensitive applications	
TPS75103	LDO	Low-dropout, two-bank LED driver with PWM brightness control	Will allow stepped brightness adjustment	
TPS75105	LDO	Low-dropout, two-bank LED driver with PWM brightness control	Will allow stepped brightness adjustment	
TPS767D301	LDO	Dual-output LDO voltage regulator	Core and I/O voltage rails in one LDO	
TPS79718	LDO	Single-output LDO, 50mA, fixed (1.8V), low quiescent current, power-good output	Better battery life with PG signal for the processor	
TPS79730	LDO	Single-output LDO, 50mA, fixed (3.0V), low quiescent current, power-good output	Better battery life with PG signal for the processor	

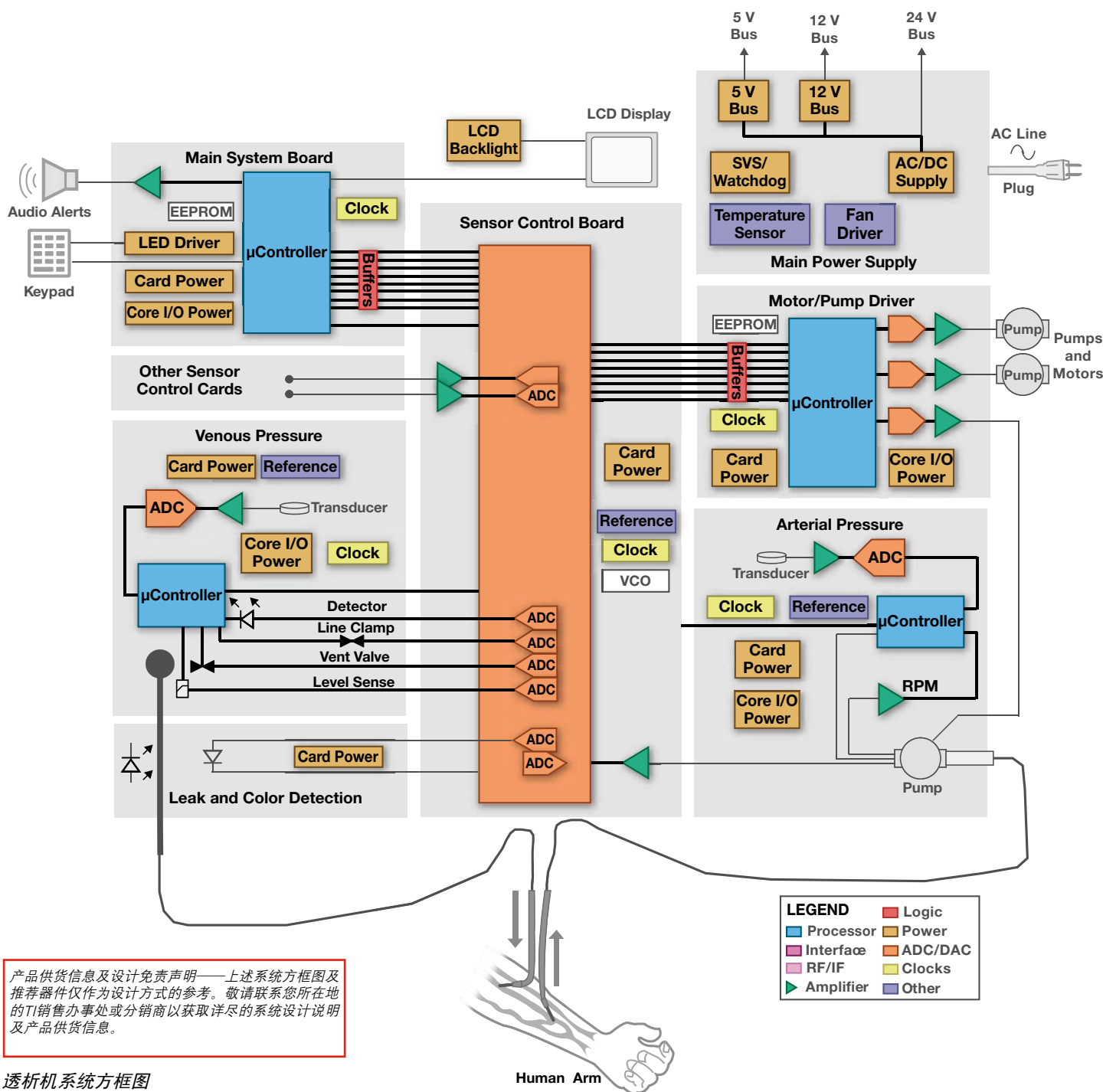*如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical***

➜ 透析机

透析机是一种人工肾，可为肾功能不全的患者提供血液治疗。透析机基于处理器，并结合了机电控制的体外血液循环通路，其循环通路借助泵及半透性的透析滤膜实现对人体血液的过滤。

令人放心的安全标准

从运作的角度来看，透析机必须满足特定的安全标准。单项故障容限 (single-fault tolerance) 是此类标准之一，意味着泵、电机、管道或电气部分均不存在危及患者安全的单点失效故障。为了实现单点容限，透析机必须具有若干富余的组件及电路，并具有"看门狗"(watchdog) 管理释放系统机制。

安全运作模式涉及到动脉血液泵的停用以及静脉线路的箝位 (Clamping)，以避免不安全的血液流向患者。（接下页）

透析机系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

诊断、患者监测及治疗

→ 透析机

（接上页）此类功能的实现需要有源及无源元件，例如控制器件、传感器、电机、加热器、泵及阀门驱动器。

透析机的典型电子线路包括了传感器控制载板、动脉及静脉控制卡、电机及泵驱动器。

传感器控制载板

传感器控制载板包含了模数转换器（ADC）、精密基准、时钟及压控振荡器（VCO），并包括了仪表或运算放大器。尽管此类电路需要有足够快的响应速度，但其调教却更倾向于精密而非高速，以满足对测量或告警信号进行校验的需求，并调整整个系统的响应而不是仅对随机性的激励有反应。所使用的ADC必须具有高可靠性、良好的噪声抑制能力（考虑到系统中存在电机及泵）以及优良的精度。

动脉及静脉控制卡

系统的此部分的功能模块可能包括动脉及静脉压力传感器、血液泵、线路夹钳、液面（level）传感器、血液检测传感器以及各类监测和控制特性。

TI的C2000™ 32位微控制器非常适用于电机控制及工业传感器应用。此类MCU提供了驱动及诊断能力，同时允许实行对转速（RPM）及电机线圈电流的感测。此类器件还提供了读取压力传感器的能力，并可以最低的成本实现对必需的系统备用部件的支持。

电机及泵驱动器

透析机内具有一定数量的电机、泵、阀门及加热器，其中每一类都可能需要特殊的驱动电路，而某些则可通过一个C2xxx控制器直接驱动。对于电机/泵控制及预期使用期限（life expectancy）而言，选择适当的数模转换器（DAC）及驱动放大器是很重要的。以包含过多干扰的信号过于猛烈地驱动任意阀门或电机将导致其运转过热及快速老化。这些因素均可能在连接至透析机期间对患者的舒适性产生负面的影响。

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
Stellaris® LM3S3xxx	Microcontroller	ARM® Cortex-M3, up to 256KB flash, up to 64kB RAM, USB host/device	USB, 10-bit ADC, temperature sensor	
TMS320F28022	Low-End 32-Bit MCU with Analog Integration	Small packages, integration, real-time control performance	System cost optimization	F2802x Piccolo™ Series
TMS320F28032	Mid-End 32-Bit MCU with Analog Integration	Integration, up to 128KB Flash, control-law accelerator, real-time control performance	System cost optimization, performance at lower power	F2803x Piccolo Series
TMS320F2808	Mid-End 32-Bit MCU	Integration, 12 derivatives pin-to-pin compatible from 60MHz to 100Hz, real-time control performance	System cost optimization, scalability in design	F280x derivatives series
TMS320F28234	High-End 32-Bit Fixed-Point MCU	Integration, performances, pin-to-pin compatibility with floating point	Room for performance and application evolution	F28232, F28235
TMS320F28334	High-End 32-Bit Floating-Point MCU	Integration, performances, unique pin-to-pin compatibility with fixed point, supports both fixed and floating	Ease of development, room for performance and software evolution	F28332, F28335
Data Converters				
ADS1115	Delta-Sigma ADC	16 bit, 860SPS, 4 SE, 2 Diff input, PGA, MUX, Comparator, V_{REF}	Smallest 16-bit ADC – 2.0 x 1.5 x .04 mm leadless QFN pkg – reduces system size and component count	ADS1013/14/15/ ADS1113/14/
ADS1251	Delta-Sigma ADC	24-bit, 20kSPS, 7.5mW power, 1.5ppm low noise	Precision, wide dynamic range	ADS1252/53/58
ADS7866	SAR ADC, Serial	1.2V, 12-bit, 200kSPS (max), 85dB SFDR	Very small, low power	
ADS7924	Micropower SAR ADC	12-bit, 100kSPS, 4 channel, ≤1µA power down current, I²C interface, QFN package	Intelleigent system power management and self monitoring	
ADS7951	SAR ADC	12-bit, 8-channel, 1MSPS, SPI interface w/threshold alarms, QFN package	Low power, small package, and excellent performance	ADS7955, ADS7959
ADS8201	Low-Power SAR ADC	8 channel, 12-bit, 100kSPS, 1.32mW power consumption at 100kSPS	Full on-chip data acquisition system	ADS7870

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推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Data Converters (Continued)				
ADS8326	SAR ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL, SE input	Low power, small package, and wide supply range	**ADS8317**
DAC8806	Multiplying DAC	14-bit, 0.5µs settling time, 2MSPS update rate, parallel interface, 2.7V to 5.5V supply	Low noise, low power	DAC7742
DAC8811	Multiplying DAC	16-bit, serial input, 0.5µs settling time, 2MSPS update rate, 0.025mW power	Low noise, low power	DAC7811, DAC8801
DAC8820	Multiplying DAC	16-bit, parallel input, 0.5µs settling time, 2MSPS update rate, 0.025mW power, current output	Parallel interface for high-speed communications	DAC7541, DAC8806
Amplifiers				
INA118	Instrumentation Amp	110dB CMRR, 5nA (max) bias current, 50µV (max) offset	Wide BW at high gains, ±1.35V to ±18V supply	INA128
INA126	Instrumentation Amp	175µA/ch supply, 3µV/°C (max) drift, 250µV (max) offset	Precision low power, ±1.35V to ±8V supply	INA2126 (dual)
INA333	Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50µA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA326
OPA141	Precision Op Amp	10MHz, 6.5nV/√Hz, ±4.5V to ±18V, 1.8mA typical, FET input: I_B = 20pA max	Common mode voltage range includes GND	OPA827
OPA211	Precision Op Amp	1.1nV/√Hz noise at 1kHz, ±2.25V to ±18V supply, 80MHz BW	Unity gain stable, RRO, wide supply range	OPA227
OPA2822	High-Speed Amp	Dual, 2nV/√Hz input noise, 1.2mV input offset, 240MHz GBWP, 90mA output, 4.8mA/ch I_Q, +5V to +12V supply	High speed, wide input and output voltage swing, excellent DC accuracy	OPA2690, OPA842
OPA333	Precision Op Amp	1.8V (min) V_S, 0.017mA (max)/ch I_Q, V_{OS} 10µA (max), V_{OS} drift 0.05 µV/°C (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, **OPA330**
OPA365	Op Amp	Zero crossover, 0.0006% THD+N, 100dB CMRR, RRIO, 4.5nV/√Hz noise, 50MHz GBW, 200µV input offset	Superior performance, excellent for driving single-supply ADCs	OPA333, OPA211
OPA695	High-Speed Amp	1400MHz BW (G = +2), 4300V/µs slew rate, 129mW power, ±4.2V output voltage swing	Wide bandwidth, current feedback, low power, excellent accuracy	OPA847, OPA691
THS4521	Low Power FDA	1.14mA (typ) quiescent current, fully differential rail-to-rail output, negative rail input	Low power, fully differential	THS4522, THS4524
TPA2006D1	Analog-Input Class-D Amp	1.45W mono, filter-free Class D, 1.8V shutdown		
TPA2010D1	Analog-Input Class-D Amp	2.5W mono, fully differential, filter-free Class D, in WCSP	Loud audio, long battery life, small package size	TPA2031D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA751
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	
Power Management				
TPS40054	DC/DC Controller	Wide V_{IN} buck controller with selectable switching frequency	Allows designer to select best combination of input voltage and switching frequency	
TPS40077	DC/DC Controller	Buck controller with 5-/12-/24-input voltage ranges	Covers most common intermediate voltage buses	
TPS54310	DC/DC Controller	3A switcher with intregrated FETS	Provides controller and FETS in one package for best solution size	
TPS54350	DC/DC Converter	4.5 to 20V_{IN} 3A DC/DC with integrated switch FET, sync pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS61040	White LED Driver	28V boost converter for white-LED supply	Allows ultra-small two- or three-cell alkaline or one-cell Li-Ion operation	
TPS61042	LED Boost Converter	Current source with overvoltage protection	Simple backlight boost for improved visibility of LCD	TPS61140
TPS65010	Linear Charge Management	Multi-channel 1-cell Li-Ion power management IC, USB/AC charger, 2 DC/DCs, 2 LDOs, I2C interface	Provides complete solution in one package	
TPS65020	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I2C interface and dynamic voltage scaling	Provides complete solution in one package	
TPS65023	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I2C interface and DVS, optimized for DaVinci™ DSPs	Provides complete DaVinci solution in one package	
TPS75003	Linear Charge Management	Integrated triple-supply power management IC for Xilinx® Spartan®	Provides all three rails in one package	
TPS72501	LDO	Single-output LDO, 1.0A, adjustable (1.22V to 5.5V), any cap, low-input voltage, integrated SVS	Combines the LDO and SVS function in one small package to save space	TPS726xx family

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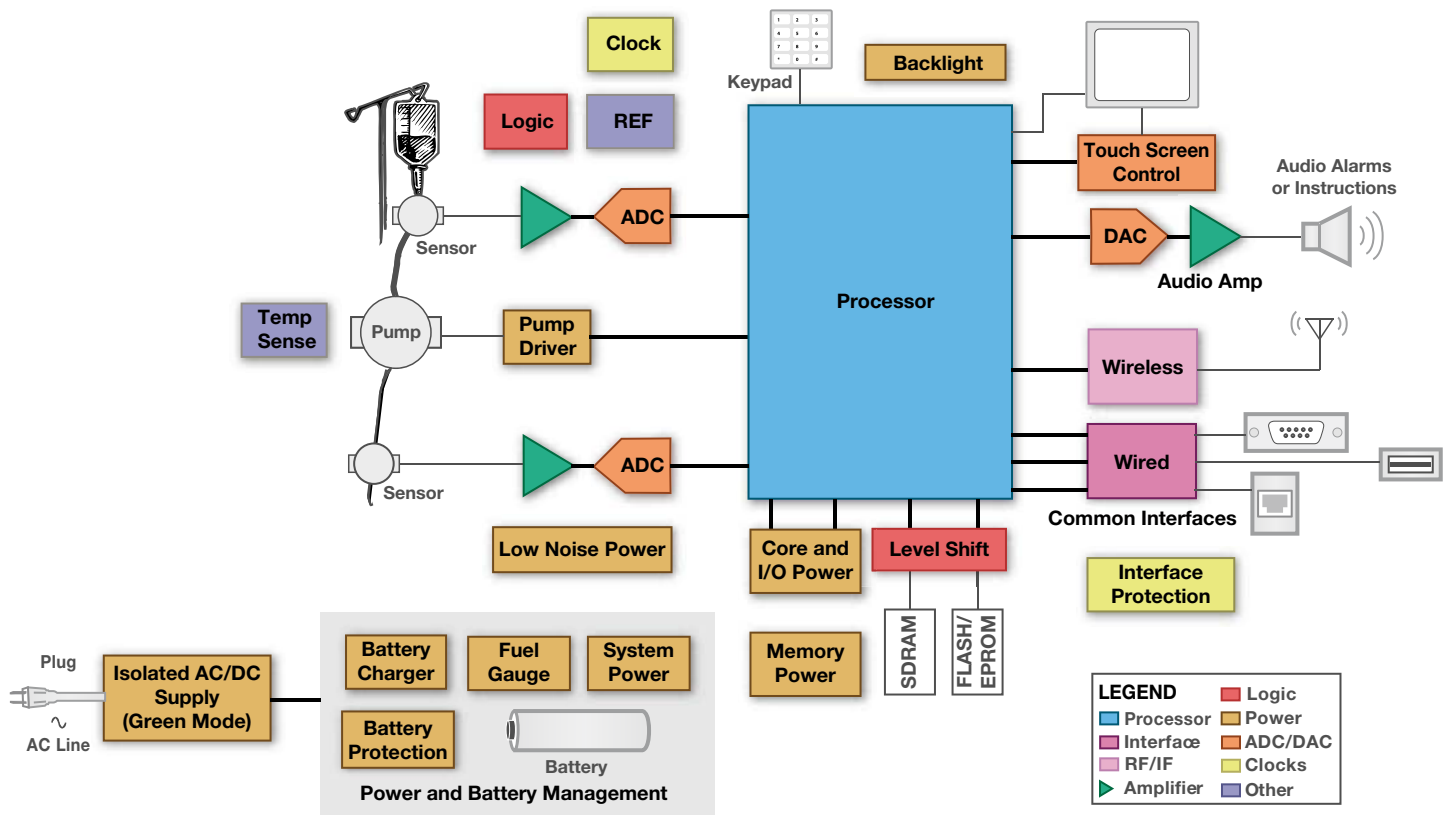
诊断、患者监测及治疗

➜ 输液泵

输液泵是为患者的生理器官供给溶液、血液及治疗药物的有效途径。由于人类身体的整体血液供给可在60秒内完成周期循环，物质介入循环系统可实现快速的分散。

输液设备通常由三大主要元件组成：输液容器、用于为人体输送溶液的导管系统、用以产生并调节流动的电子及机械组合设备。调节人体内药物浓度的功能是达到并保持期望的治疗结果所不可或缺的，特别是在处于输液不足或输液过度的时间过长的情况下。输液不足可能不需要过多的治疗，但输液过度则有可能产生更为严重的毒副作用。

所输液的药物必须保持高度精确的流速 (flow-rate) 及流体均匀性。可采用传感器计数通过滴注室 (drip chamber) 的液滴数量。传感器还可提供流速反馈，以用于自动速率调整并检测抽送机械装置的顺流阻塞状况。尽管如此，流速的精度仍然受限于液滴的速率及粘度，并受运转状态下非恰当转角的影响。由于液滴检测器固有的离散特性，低流速下的流体均匀性也将受影响。

尽管存在这些局限性，但处理器具有高级的图形用户界面、智能及实时的生理学处理流程、有线及无线的连通性选项，可用于患者监测及数据记录应用，从而通过快速检测复杂状况及产生告警提供更高层次的安全性。

液滴传感器可采用体积计量腔 (volumetric metering chamber) 替代。具有步进或伺服控制直流电机的泵可通过机械式地排开体积计量腔内的容纳物来为流体提供驱动力。步进的分辨率以及计量腔的弹性都有可能影响流体的均匀性。当机械周期内腔体积非恒定时，可采用软件控制实现对改变量的补偿。

输液泵系统方框图

→ **输液泵**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
MSP430F44x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 8-channel 12-bit ADC, comparator, 2x SPI + UART, SVS, 160-segment LCD controller	Ultra-low-power, integrated analog peripherals, hardware communication channels	
MSP430FG461x	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, 12-channel 12-bit ADC, dual 12-bit DAC, comparator, 3 op amps, 3-channel DMA, SPI + UART, USCI, SVS, 160-segment LCD controller	Ultra-low-power signal-chain-on-chip (SCoC), configurable op amps, multiple hardware communication channels	MSP430FG43x
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Application Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI, and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
Stellaris® LM3S3xxx	Microcontroller	ARM® Cortex-M3, up to 256KB flash, up to 64kB RAM, USB host/device	USB, 10-bit ADC, temperature sensor	
TMS320F28022	Low-End 32-Bit MCU with Analog Integration	Small packages, integration, real-time control performance	System cost optimization	F2802x Piccolo™ series
TMS320F28032	Mid-End 32-Bit MCU with Analog Integration	Integration, up to 128KB Flash, control-law accelerator, real-time control performance	System cost optimization, performance at lower power	F2803x Piccolo series
Data Converters				
ADS1246	Delta-Sigma ADC	24-bit, 2kHz with PGA, 50/60Hz noise rejection	Integration with performance and low power	ADS1247, ADS1248,
ADS1258	Delta-Sigma ADC	16-channel, 24-bit, 125kSPS, 23.7kSPS/channel	Fastest multi-channel, delta-sigma ADC, measures all 16 inputs in <675µs	ADS1256, ADS1255, ADS8344, ADS1158
ADS7952	SAR ADC	12-bit, 1MSPS, 70dB SNR, 11.5mW power	Zero latency, ideal for multi-channel systems	ADS7951, ADS7953
ADS8317	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Excellent linearity, micropower, high speed	ADS8422
ADS8318	High-Speed SAR	16-bit, 500kSPS, 18mW at 500kSPS power, ±1 LSB INL	Precision, excellent AC/DC performance	
ADS8326	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Low noise, low power, high speed	ADS8325
ADS8331/32	SAR ADC	16-bit, 500kSPS, 4/8 channels, with serial interface	Mux out feature can be used to reduce system part count and overall cost	ADS8342
ADS8472	SAR ADC	16-bit, 1MSPS, ±0.4LSB (typ) INL	Zero latency, low power	
TLV320DAC3120	Low-Power Audio DAC	Mono DAC with 2.5W mono Class-D speaker amplifier; miniDSP for audio processing	Longer battery life, better audio quality, lower cost	TLV320DAC3101
TLV320DAC32	Audio DAC	Low-power stereo DAC, 4 outputs, HP/speaker amplifier, 3D effects		
Amplifiers				
OPA211	Precision Op Amp	1.1nV/√Hz noise at 1kHz, ±2.25V to ±18V supply, 80MHz BW	Unity gain stable, RRO, wide supply range	OPA227
OPA365	Op Amp	Zero crossover, 0.0006% THD+N, 100dB CMRR, RRIO, 4.5nV/√Hz noise, 50MHz GBW, 200µV input offset	Superior performance, excellent for driving single-supply ADCs	OPA333, OPA211
OPA376	Precision Op Amp	7.5nV/√Hz noise, 760µA(typ)/ch Iq, 5µV (typ) offset, input EMI filter, RRO	Low noise, low power, low input bias	OPA340, OPA337
OPA378	Op Amp	0.4µV$_{PP}$ low noise, 125µA (typ) quiescent current, 0.15µV offset voltage, 2.2V to 5V supply	microPower, rail-to-rail I/O, excellent PSRR	**OPA330**, OPA333, OPA335
OPA827	Precision JFET Op Amp	4nV/√Hz noise at 1kHz, ±4V to ±18V supply, 15pA (typ) input bias current, 22MHz BW	High precision, low noise, low input bias, wide supply range	OPA177, OPA627, OPA132, OPA141
INA118	Instrumentation Amp	110dB CMRR, 5nA (max) bias current, 50µV (max) offset	Wide BW at high gains, ±1.35V to ±18V supply	INA128, INA822
INA333	Instrumentation Amp	20µV (max) offset, 50nV/°C drift, 200pA input bias	Low power, low drift, tiny package	INA326
TPA2006D1	Analog-Input Class-D Amp	1.45W mono, filter-free Class D, 1.8V shutdown		

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推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers (Continued)				
TPA2010D1	Analog-Input Class-D Amp	2.5W mono, fully differential, filter-free Class D, in WCSP	Loud audio, long battery life, small package size	TPA2031D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA2016D2	Analog-Input Class-D Amp	1.7W stereo, Class D with dynamic range compression and automatic gain control		
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA6204A1
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	
THS4521	Low power FDA	1.14mA (typ) quiescent current, low distortion, 4.6nV/√Hz voltage noise	Low power, high accuracy	THS4522, THS4524
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency hopping systems	CC2500
CC1150	Sub-1GHz Transmitter	Programmable data rate from 1.2 to 500 kBaud; fast startup time (0.3µs); low current consumption	Fast development time and low system cost; flexible optimization of range vs. power; small solution size	
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2520
RF Systems-on-Chip				
CC2560	2.4GHz Bluetooth® 2.1 chipset	Single-chip Bluetooth® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2431	System-on-Chip Solution for ZigBee location engine	CC2431 has 32/64/128 KB hardware AES encryption engine, excellent selectivity, blocking performance and hardware location	Ideal for battery operated systems; suitable for proprietary and ZigBee systems; adds location awareness and accuracy of 3 to 5 meters	
CC2530/31	Second Gen System-on-Chip Solution for 2.4GHz IEEE 802.15.4/ RF4CE/ZigBee	Excellent RX sensitivity, low power, easy-to-use development tools	RF design SOC for quick time to market; provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz Bluetooth® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market Bluetooth® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity and blocking performance systems; excellent coexistence with Bluetooth® technology and Wi-Fi.	
Power Management				
bq2000	Battery Management	Multi-chemistry charger	One charge for both Li-Ion and NiCad/NiMH cells	
bq2016	Battery Management	High-discharge-rate battery monitor	Provides true discharge rate for high-current battery pack	
bq20z80A-V110	Battery Management	Patented Impedance Track™ ICs	Accurately measures available cell charge	

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推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
TPS40054/5	DC/DC Controller	Wide V_{IN} controller with adjustable switching frequency	Allows flexibility for the input and the switching frequency	TPS40057
TPS40057	DC/DC Controller	Wide V_{IN} controller with adjustable switching frequency	Allows flexibility for the input and the switching frequency	TPS40054/5
TPS40077	DC/DC Controller	4.5 to 28V input	Supports 5-/12-/24-V intermediate bus voltages	
TPS51020	DC/DC Controller	Synchrounous dual buck controller	Provides two outputs 180° apart in one package	TPS5124
TPS51116	DC/DC Controller	Complete DDR/DDR2 solution	Provides all output and active termination for DDR	
TPS5124	DC/DC Controller	Synchrounous dual buck controller	Provides two outputs 180° apart in one package	TPS51020
TPS54110	DC/DC Converter	Externally compensated — adjustable 1.5A integrated FET switcher	Provides flexibility and ease of design	
TPS54310	DC/DC Converter	Externally compensated — adjustable 3A integrated FET switcher	Provides flexibility and ease of design	
TPS54350	DC/DC Converter	4.5 to 20V input, 3A DC/DC with integrated switch FET, sync pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS62040	DC/DC Converter	Adjustable 1.2A, 95%-efficient step-down converter, 18μA, MSOP-10	Maximizes battery life with high efficiency and low I_Q	
TPS62220	DC/DC Converter	300mA step-down converter in a SOT-23 package	Small solution size with high-side FET	
TPS62300/1/2/3/5	Step-Down Converter	500mA, 3MHz synchronous step-down converter	Very small inductor and high efficiency	TPS62040
TPS62350	DC/DC Converter	Step-down DC/DC converter with I²C interface for dynamic voltage scaling	Provides ability to increase conversion efficiency	
TPS65010	Linear Charge Management	Fully intregrated power and battery management IC	Provides complete solution in one package	
TPS65020	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I²C interface and dynamic voltage scaling	Provides complete solution in one package	
TPS65023	Linear Charge Management	6-channel power management IC with 3 DC/DCs, 3 LDOs, I²C interface and DVS, optimized for DaVinci™ DSPs	Provides complete DaVinci solution in one package	
TPS71701	LDO	Low-noise, high-bandwidth-PSRR, low-dropout 150mA linear regulator	Filters out wider range of incoming noise with the high PSRR	TPS718xx family
TPS73101	LDO	Single-output LDO, 150mA, adjustable (1.2V to 5.5V), cap free, low noise, fast transient response	Responds to transients faster to keep output voltage in regulation	TPS725xx family
TPS74201	LDO	Single-output LDO, 1.5A, adjustable (0.8V to 3.3V), any or no cap, programmable soft start	Adjust the voltage ramp rate for your processor requirements	
TPS76725	LDO	1A single-output LDO with low I_Q and fast transient response	Efficient design allows quick response to dynamic current requirements	
TPS76733	LDO	1A LDO with fastest transient response plus ultra-low supply current	Ultra-low 85μA supply current and 230mV dropout voltage stretch battery life	
TPS76750	LDO	1A LDO with fastest transient response plus ultra-low supply current	Ultra-low 85μA supply current and 230mV dropout voltage stretch battery life	
TPS79912	LDO	High-performance 200mA in chip-scale package	Very small solution size	
TPS79925	LDO	High-performance 200mA in chip-scale package	Very small solution size	

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诊断、患者监测及治疗

→ 自动外部去纤颤器 (AED)

自动外部去纤颤器（AED）是高精细的、基于微处理器的设备，可监测、评估并自动地治疗心律搏动危及生命的患者。该设备通过治疗电极采集心电图信号，并通过心电图分析算法确定冲击节奏，随后为操作人员提供是否需要去纤颤的建议。基本的去纤颤器包括了高压电源、存储电容器、可任选的电感器以及连接至患者的电极（见方框图）。该设备通过充电使电容器达到某一确定电压，以产生用于驱动电流的电动势。电压越高，则可能驱动更大的电流。AED输出音频指令及可视化提示以指导操作人员完成去纤颤流程。在典型的去纤颤顺序中，AED将提供语音提示，以指示用户敷贴电极至患者，并开始采集ECG数据。如果AED分析患者的ECG并检测出电击的节奏 (shock rhythm)，则电容器将被充电，电容器所存储的能量为$W_C = 1/2CV_C^2$；电容电压$V_{C(t)} = V_{C(0)}e^{-t/RC}$，其中的 $R = R(lead) < < R(chest)$。

然后根据指令，操作人员按下电击 (shock) 按钮，并输出高电压脉冲；于是电流开始流经人体，并实现大多数心脏细胞的去极化 (depolarize)，通过这种方式通常可以重新调整心脏壁的收缩并恢复正常的节奏。电流的总量由电容及人体阻抗确定。附带的图表显示了电流电平以及电流流经人体时的持续时间。

许多司法部门及医疗主管还要求AED具有音频录制功能，以用于心脏骤停 (cardiac arrest) 事发现场的录音，便于事后分析。所有的AED均包括了存储及调出 (retrieve) 患者心电图波形的功能。

AED的前端信号源于敷贴至患者的心电图电极，该信号非常微弱（小于10mV），须采用仪表放大器进行放大。INA118/INA128/INA333仪表放大器的设计具有下列特点：

- 感应微弱信号的能力，范围从0.1mV至10mV，

- 超高输入阻抗 (>5MΩ)，
- 超低输入漏电流 (<1μA)，
- 平坦的频率响应区间，范围从0.1Hz至100Hz，以及
- 高共模抑制比 (CMRR)（大于100dB）。

AED的另一个前端信号是话筒的输入，以用于心脏骤停事发现场的记录。心电图及话筒的输入都必须数字化并由DSP进行处理。绝大多数的AED设计采用16位的处理器，因此可很好地配合使用16位ADC来实现心电图及话音输入的数字化。（接下页）
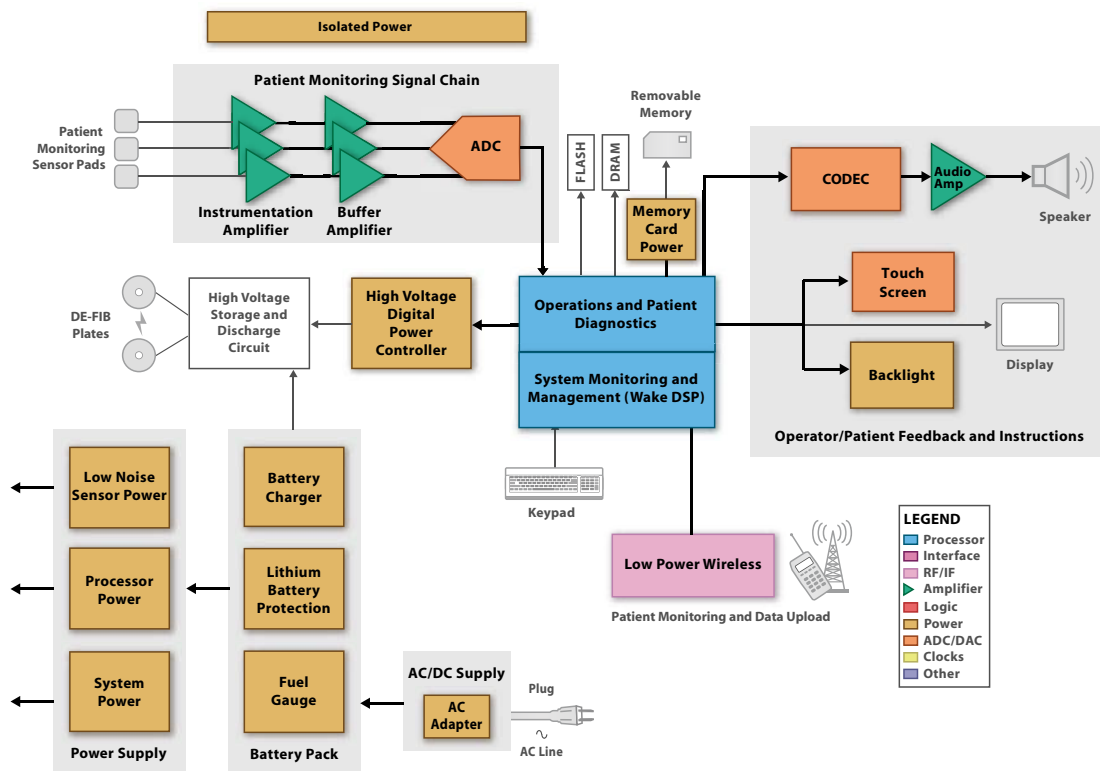
AED系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

→ 自动外部去纤颤器 (AED)

（接上页）放大后的心电图信号具有0.1Hz至100Hz的带宽，并需要最小50dB的信噪比 (SNR)。音频记录/回放信号的典型带宽为8kHz，需要65dB的最小信噪比。话筒的输入同样需要放大，所需的最大可编程增益为40dB。AED还可合成音频指令，具有音量控制功能，并可输出至耳机扬声器或8Ω扬声器。TLV320AIC20K集成了两个ADC、两个DAC、一个话筒放大器、一个头戴式耳机驱动器以及一个8Ω驱动器（均带音量控制），系统设计人员可采用该器件使AED的前端数字化更为简单、更为轻松，并可实现与DSP的无缝连接。
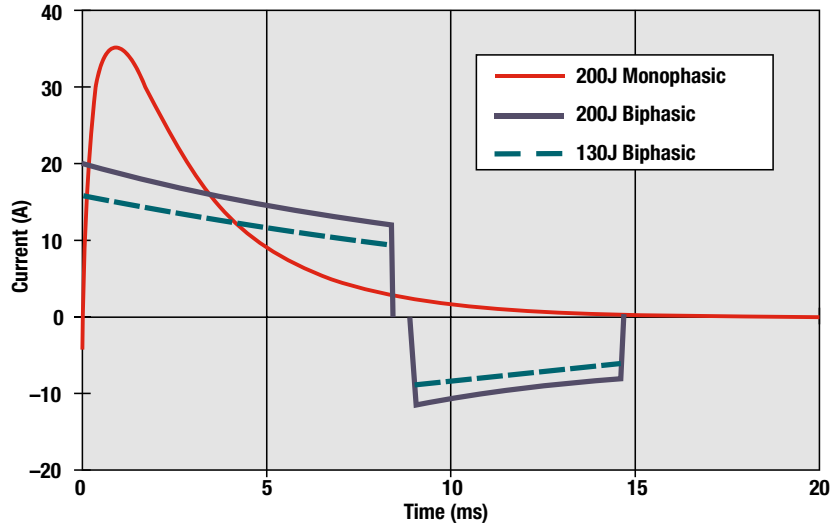
典型AED驱动电流。AED可输出单阶段或两阶段的去纤颤波形至心脏。单阶段的输出电流在整个冲击期间单向流动。新近的两阶段技术允许电流在冲击期间中途反向，从而潜在性地降低了灼伤及心肌损伤的风险。

单电源、微功率、轨至轨输出CMOS仪表放大器
INA321

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主要特点

- 低静态电流：每通道40μA
- 高增益精度：增益G = 5时，漂移为2ppm/°C，误差为0.02%
- 低失调电压：±200μV
- 高共模抑制比 (CMRR)：94dB
- 低偏置电流：10pA
- 带宽：500kHz，增益为5V/V
- 通过外部电阻设定增益
- 封装：MSOP-8（单通道器件）；TSSOP-14（双通道器件）

应用

- 生理学放大器：心电图、脑电图、肌电图
- 测试设备
- 带增益的差分线路接收器
- 工业传感器放大器：电桥、RTD（阻抗温度检测）、热敏电阻、定位

INA321是轨至轨输出CMOS仪表放大器，提供了差分信号放大能力，微功耗的电流消耗量仅为40μA。在待机模式下，该器件的电流消耗小于1μA，恢复正常运作的时间处于微秒量级，从而使其成为低功耗电池供电或多路复用应用的上佳选择。INA321所配置的内置增益为5V/V，但用户也可以通过外部电阻编程设定增益，提供了非同一般的灵活性。INA321在整个频率范围内实现了共模误差抑制，而且由于共模抑制比在高达3kHz的频率条件下仍然保持高水平，因而抑制了线路噪声和线路谐波。

$$Gain = 5 + 5(R_2/R_1)$$

$$V_{OUT} = (V_{IN+} - V_{IN-}) \cdot Gain$$
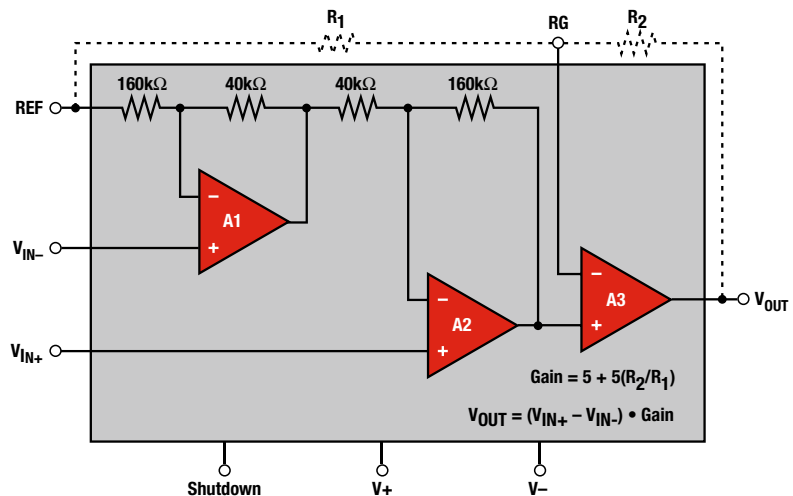
🔴→ 自动外部去纤颤器 (AED)

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
INA118	Instrumentation Amp	110dB CMRR, 5nA (max) bias current, 50μV (max) offset	Wide BW at high gains, ±1.35V to ±18V supply	INA128
INA128	Instrumentation Amp	50μV offset voltage, drift (0.5μV/°C) and high common-mode rejection (120dB at G ≥ 100)	Wide BW at high gains	INA129
INA321 *Page 75	CMOS Instrumentation Amp	0.02% accuracy, 2ppm/°C drift for gain=5; 10pA input bias current	High gain accuracy	INA2321 (dual)
INA333	Instrumentation Amp	25μV (max) offset, 50nV/°C drift, 50μA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA326
OPA333	Precision Op Amp	1.8V min supply, 0.017mA/ch (max), 10μV offset (max), 0.05 μV/°C drift (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, **OPA330**
OPA369	Zero-Crossover Amp	1.8V, 700nA, RRIO, 114dB CMRR, 0.4μV/°C drift	Low power, unmatched DC precision	OPA379, OPA2369 (dual)
TPA2005D1	Analog-Input Class-D Amp	1.4W mono, fully differential, filter-free Class D	Loud audio, long battery life	TPA2006D1
TPA2010D1	Analog-Input Class-D Amp	2.5W mono, fully differential, filter-free Class D, in WCSP	Loud audio, long battery life, small package size	TPA2031D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA3007D1	Analog-Input Class-D Amp	Mono, medium power, filter-free Class D		
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA6204A1
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	
THS452x	Low power FDA	1.14mA (typ) quiescent current,+2.5V to 5.5V supply	Low power, single and dula supply, low distortion	THS4522, THS4524
Data Converters				
ADS1115	Delta-Sigma ADC	16-bit, 860SPS, 4 SE, 2 diff input, PGA, MUX, comparator, V_{REF}	Smallest 16-bit ADC, 2.0 x 1.5 x .04 mm leadless WFN pkg; reduces system size and componenent count	**ADS1113/4, ADS1013/14/15**
ADS1298	ECG/EEG AFE	24-bit, 8 PGA, 8 ADC, plus RLD and RESP	Complete front end, reduction in power and size, increase reliability	**ADS1294, ADS1296, ADS1198,** ADS1251/58
ADS7866	SAR ADC, Serial	1.2V, 12-bit, 200kSPS (max), 85dB SFDR		ADS7924, ADS8201
ADS8317	SAR ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL, differential input	Low power, small package, and wide supply range	ADS8326
ADS8326	Low-Power ADC	16-bit, 250kSPS, 2.7V to 5.5V supply, ±1.5 LSB (max) INL	Small package, wide supply range	
ADS8331/32	SAR ADC	16-bit, 500kSPS, 4/8 channels, with serial interface	Mux out feature can be used to reduce system part count and overall cost	ADS8342
MSC1210	Data Acq. System	Enhanced 8051 core w/Flash memory and 24-bit ADC		
TLV320AIC12K	Audio Codec	Low-power, mono, voice-band codec with 8Ω speaker amp		
TLV320AIC20K	Audio Codec	Low-power, stereo, voice-band codec with 8Ω speaker amp	Fully compatible with TMS320C54x™ DSP power supplies	TLV320AIC24K
TLV320AIC3104	Audio Codec	Low-power stereo codec, 6 inputs, 6 outputs, headphone amp, enhanced digital effects		
TLV320DAC3120	Low-Power Audio DAC	Mono DAC with 2.5W mono Class-D speaker amplifier; miniDSP for audio processing	Longer battery life, better audio quality, lower cost	TLV320DAC3101
TLV320DAC32	Audio Converter	Low-power stereo DAC, 4 outputs, HP/speaker amplifier, 3D effects		
TSC2003	Touch-Screen Controller	I²C interface for standard, fast, high-speed modes	Direct battery measurement	ADS7845, TSC2000, **TSC2007**
TSC2046	Touch-Screen Controller	Low voltage I/O, touch-pressure measurement, 2.2V to 5.2V operation	QSPI™ and SP™ 3-wire interface	
References				
REF30xx	Low-Power, Low-Drift Series Reference	50μA, 0.2% initial accuracy, 50ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF31xx, REF33xx, REF29xx
REF31xx	Series Voltage	0.2% (max) initial accuracy, 15ppm/°C (max) drift, 100μA 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Low power consumption for portable applications	REF3120, REF3125, REF3133
REF32xx	Ultra-Low-Drift Series Reference	100μA, 0.2% initial accuracy, 7ppm/°C max drift, ±10mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Improves system accuracy	
REF33xx	Very-Low-Power Series Reference	5μA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF50xx	High-Precision, Very-Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V	Improves system accuracy	REF02

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➡ 自动外部去纤颤器 (AED)

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
MSP430F20xx	Ultra-Low-Power 16-Bit MCU	1KB/2KB Flash, 128B RAM, SPI+I²C	8 ch. 12-bit ADC or 4 ch. 16-bit SD ADC, 4 x 4mm package	
MSP430F22x4	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 512B/1KB RAM, SPI + I²C + UART/LIN + IrDA	12 ch. 10-bit ADC, 2 op amps	
MSP430F23x0	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 1KB/2KB RAM, SPI + I²C + UART/LIN + IrDA	Analog comparator, HW multiplier	
MSP430F41x	Ultra-Low-Power 16-Bit MCU	4 to 32KB Flash, 256B to 1KB RAM, SVS, 96 segment LCD	Analog comparator	
MSP430F42x	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 256B to 1KB RAM, SPI + UART, SVS, 128 segment LCD	3 x 16-bit SD ADC	
MSP430F42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430F43x	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 512B/1KB RAM, SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, analog comparator	
MSP430F44x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 2x SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, HW multiplier	
MSP430F47xx	Ultra-Low-Power 16-Bit MCU	60KB Flash, 256B RAM, (4) USCI, 160 segment LCD	(4) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F241x	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, SVS, temp. sensor	8 ch. 12-bit ADC, analog comparator, HW multiplier	
MSP430F261x	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, SVS, DMA, temp. sensor	Analog comparator, 2 ch. 12-bit DAC, 8 ch. 12-bit ADC, HW multiplier	
MSP430F471xx	Ultra-Low-Power 16-Bit MCU	120KB Flash, 8KB RAM, (4) USCI, DMA, 160 segment LCD	(7) SD16 ADC, HW multiplier, temp. sensor, analog comparator	
MSP430F54xxA	Ultra-Low-Power 16-Bit MCU	128 to 256KB Flash, 16KB RAM, (4) USCI, PMM, DMA, temp. sensor	16 ch. 12-bit ADC, analog comparator, RTC, internal voltage regulator for power optimization	
MSP430FG42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD	5 ch. 16-bit SD ADC, 12-bit DAC, 2 integrated op amps	
MSP430FG43x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, SPI + UART, SVS, 128 segment LCD	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, DMA, 3 op amps	
MSP430FG461x	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I²C + UART/LIN + IrDA, 160 LCD	12 ch.12-bit ADC, 2 ch.12-bit DAC, A-comp, 3 op amps, HW multiplier	
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
Stellaris® LM3S3xxx	Microcontroller	ARM® Cortex-M3, up to 256KB flash, up to 64kB RAM, USB host/device	USB, 10-bit ADC, temperature sensor	
TMS320C5000™	DSP	Power efficient, high performance	Fixed-point DSP with industry's best combination of standby and dynamic power consumption	
TMS320VC5506	DSP	200MHz, dual MAC, very low standby power of 0.12mW	Supported by eXpressDSP™ and many other software packages and tools	TMS320VC5509A, TMS320VC5502
Power Management				
bq20z90-V110	Battery Fuel Gauge	Instant accuracy better than 1% error over lifetime of the battery	Automatically adjusts for battery aging, battery self discharge and temperature inefficiencies	bq77PL900
bq24100	Battery Charge Management	Switch mode, 1100kHz switching frequency, >2A charge current	d/dt, min current primary charge termination method	
bq24721C	Battery Charge Management	Multi-chemistry and multi-cell sync switch-mode charger	High efficiency, pack and system protection functions	
bq29330	Battery Safety	Battery pack full-protection analog front end	Provides individual cell voltages and battery voltage to battery management host	
DCP020515D	Isolated DC/DC Converter	2W, unregulated, up to 89% efficiency, 106W/in3 power density	EN55022 Class B EMC performance, UL1950 component	DCP02 series
TPS2041B	USB Power Switch	USB-compliant power source, short-circuit protection	Single-chip power source solution for USB and memory cards	TPS2550, TPS2061

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➡ ## 自动外部去纤颤器 (AED)

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
TPS22902	Load Switch with Controller Turn-On	Low on resistance, controlled turn-on, ultra small 64mm² package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS22946	Current Limited Load Switch	Configurable current limit, ultra-small package, 1µA quiescent current at 1.8V	Ultra-small, low quiescent current current limited switch	TPS22949, TPS22945
TPS2550	USB Power Switch	Precision OC USB power switch with UL approval	Provides precise adjustable current limit for multiple applications	TPS2551
TPS2828	MOSFET Driver	2A output, 14ns rise and fall time, 24ns prop delay, inverting	Drives FETs for high-voltage transformer	TPS2829 non-inverting version
TPS3836	Voltage Supervisor	220nA supervisor with 10ms/200ms selectable delay time	Circuit initialization and timing supervision	TPS3809
TPS61042	White LED Driver	30V, 500mA switch boost converter, 1MHz switching frequency	Higher switching frequency requires smaller size inductor and capacitor	TPS61140
TPS717xx	Low-Noise Single-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS793xx, TPS795xx, TPS799xx
TPS718xx-yy	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719xx-yy
TPS780xx	LDO with DVS	Dynamic voltage scaling (DVS) with low I_Q 500nA	DVS voltage designed to operate with MSP430 to increase power savings	TPS78101
UCC38C4x	PWM Controller	14.9/9V on/off UVLO thresholds, 1MHz frequency, 50% duty cycle		UCC3804, UCC3809
UCD7100	Digital Control Driver	Adjustable current limit, 3.3V, 10mA internal regulator	Applications requiring fast local peak current limit protection	
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz Bluetooth® 2.1 chipset	Single-chip Bluetooth® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2431	System-on-Chip Solution for Zigbee location engine	CC2431 has 32/64/128 KB hardware AES encryption engine, excellent selectivity, blocking performance and hardware location	Ideal for battery operated systems;suitable for proprietary and ZigBee systems; adds location awareness and accuracy of 3 to 5 meters	
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/ RF4CE/ZigBee	Excellent RX sensitivity, low power, easy-to-use development tools	RF design SOC for quick time to market; provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz Bluetooth® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market Bluetooth® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity and blocking performance systems; excellent coexistence with Bluetooth® technology and Wi-Fi.	

如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical**

新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

医疗成像

→ 概述

医疗成像技术处在不断演进与发展之中，其目的均在于改善患者的护理水平。TI完整的模拟信号链路、电源管理、接口和嵌入式处理产品库通过以下手段在医疗成像领域实现了创新：

- 更快、更准确地获得诊断结果。
- 提高全球范围内医疗保健产品的交付和上市速度。
- 改善最终设备的易维护性和价格合理性。

在针对医疗成像市场的半导体产品创新当中，有两个普遍的发展趋势：

- 由于对较高图像质量的需求而促使性能的不断提升。
- 缩减功耗和外形尺寸，以改善设备设计的便携性、易维护性和价格合理性。

TI规模庞大的产品库和专用半导体产品可满足主要医疗成像模式的需要，例如：超声波、计算机体层成像 (CT)、核磁共振成像 (MRI)、正电子放射层析成像 (PET) 和数字式X光，以及后期出现的创新型成像模式（比如：高光谱成像、光学相干X线断层摄影术[OCT]）、甚至包括人们尚未预见到的成像解决方案。

对于上述所有的成像模式以及全体医疗应用而言，功耗仍将是一个关键性的问题，为此我们在这一部分的末尾专门辟出一个章节对此加以阐述。

> 如需了解更多有关TI医疗成像产品的信息，敬请访问：
> *www.ti.com/medicalimaging*

→ 超声波 (Ultrasound)

超声波系统

随着超声波设备的日益紧凑和便携，宣告诸多保健应用成为现实，这些应用展示了医疗技术的进步为患者所带来的关爱，使得他们无需为诊疗而来回奔波。TI的嵌入式处理器和模拟产品凭借低功耗和高性能简化了先进超声波系统的设计，并实现了便携性和高品质图像。

医疗和工业超声波系统运用聚焦成像技术来实现远优于单通道方法的成像性能。采用大量的接收器，通过时域平移 (time shifting)、缩放 (scaling) 以及智能累加回波能量，TI面向超声波应用的最新产品可构建出高分辨率的图像。这提供了对扫描区域进行单点"聚焦"的能力；通过一定的顺序聚焦于其他的点，最终汇集成像。

当启动扫描时，将产生一个脉冲信号并通过8至512个传感器单元中的每一个发出。这些脉冲将定时且定量地"照射"人体的特定区域。在发射之后，传感器单元立即切换至接收模式。上述脉冲此时将构成机械能的形态，以高频声波传播通过人体，典型频率范围介于1MHz至15MHz之间。随着传播的进行，信号急剧衰减，衰减量与传播距离的平方成反比。而随着信号的传播，一部分波前能量将被反射回传感器/接收器。

可传输至人体内部的总能量是有限的，因此业界必须开发出极为敏感的接收电子器件。在接近于皮肤的聚焦点，接收的回波非常强，仅需稍微放大乃至不需要放大，此区域被称为近区 (near field)。在深入人体的聚焦点，接收回波将异常得微弱，需要放大上千倍乃至更多，此区域被称为远区 (far field)。这两个区域分别处于接收电子器件所必须处理的两个极端。

在高增益模式（远区）下，性能主要受限于接收链路中所有噪声源的总和。对接收噪声影响最大的两个因素分别为传感器/电缆线的装配以及用于接收的低噪声放大器 (LNA)。在低增益模式（近区）下，性能主要受限于对输入信号量级的界定。上述两个区域信号之间的比率定义了系统的动态范围。许多接收链路都集成了带压控衰减器 (VCA) 的低噪声放大器以及可编程增益放大器 (PGA)。

→ 超声波 (Ultrasound)

Integrated HV Pulser

OR
Standard Signal Chain

High Voltage Linear Amplifier

Front End

HV MUX/DEMUX

Transmit Beamformer

Beamformer Control Unit

Passive LPF

DAC

Receive Beamformer

T/R Switches

Signal Chain Power · Temp Sense · REF

Core and I/O Power

Mid

Clocking

Preprocessing

Amplifier Stage

Amplifier + Filter

Analog Front End

LNA → VCA → PGA → Low Pass Filter → ADC

Transducer

Back End

B Mode Processing

Color/Power Doppler Processing

Time Gain Control

DAC

Spectral Doppler Processing

Scan Conversion Post Processing

CW (analog) Beamformer

ADC

Ultrasound OS/UI

Power

LPW RS232 USB 1394 802.11

Audio Amp

Audio Output

Plug

AC Line

AC/DC Supply With Green Mode Controller

System Power

Supply Voltage Supervisor

Main Power Supply

Common Interfaces

IDE/ATA

MMC/SDIO

Display

Backlight

Touchscreen

LEGEND
Processor · Interface · RF/IF · Amplifier · Logic · Power · ADC/DAC · Clocks · Other

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

超声波系统方框图

低通滤波器通常应用于VCA/PGA及ADC之间，作为抗混叠 (anti-aliasing) 滤波器并限制噪声带宽。取决于系统的特定规范，在此可采用具有线性相位拓扑结构的2至5极点滤波器。在选择运算放大器时，首要的考虑因素包括信号摆幅、最低及最高输入频率、谐波失真及增益需求。

模数转换器 (ADC) 通常为10位至12位。信噪比 (SNR) 及功耗是最着重考虑的问题，随后是通道集成。ADC的另一个趋势就是实现ADC与波束成型器 (beamformer) 之间的低电压差分信号 (LVDS) 接口连接。通过ADC输出数据的串行化，接口线路的数量可减少。这种减少可实现更高的系统集成密度，因此可转而采用更小、更低成本的PC载板——这对于便携式成像系统来说是极为重要的一部分。

系统数字部分的前端接收来自若干ADC的数据，其数量通常以通道数来衡量。对于极其便携的系统而言，其通道数可低至8个；而对于高端系统来说，其通道数可高达512个。3D及4D系统的通道数可能更多。数字前端的主要功能是实现对某一给定深度及方向的聚焦。这种波束形成的实现方式如下：以更高的速率对ADC输出进行再采样 (resampling)，适当地延迟再采样数据、乘上相应的权重（变迹因子 [apodization factor]），随后对所有的加权及延迟输出进行求和运算。针对该处理流程的I/O及计算要求均极高。

传统方法中，FPGA及定制的ASIC被用于实现数字波束形成，而当今的DSP也提供了处理大部分所需计算负载的能力。DSP还非常适用于处理波束形成控制器的实时性问题，基于波束的指向及深度，波束形成对延迟及轨迹 (apodization) 波型的需求都可能有所不同。

波束形成的数据随后通过中间处理模块，

在这里，不同的滤波处理电路用于实现噪声抑制，并正确地抽取超声波射频数据。随后将通过解调以产生复数基带数据。基于测量深度及角度的自适应处理有时可用于获取优化的超声波成像。

中间处理阶段的输出在后端中以不同的方式进行处理。对于B模式成像，数据包络 (data envelop) 将被压缩以使其显示于人眼的动态范围。附加的图形增强、噪声抑制及相干斑抑制 (speckle reduction) 算法也将在此执行。（接下页）

→ **超声波 (Ultrasound)**

（接上页）数据随后通过扫描转换至最终的输出显示格式及尺寸。对于多普勒 (Doppler) 处理而言，速度及湍流将以彩色流动模式进行估算，而功率则以能量多普勒模式进行估算。这些估算结果将再次扫描转换至最终的输出显示格式及尺寸。

为了实现正确的显示，估计量相关的色彩分配是必不可少的。在频谱多普勒模式中，可通过加窗 (windowed) 及重叠 (overlapped) 的FET对频谱进行估算。同样，在分离了前向及反向流之后，惯常的做法是以音频格式来表现多普勒数据。所有这些密集的信号处理计算都非常适合使用DSP。

面向超声波的产品库

模拟专用信号链路产品

• 超声波系统中数字前端的主要功能是聚焦于某个给定的深度和方向。与同类竞争解决方案相比，AFE58xx全集成化模拟前端系列所提供的器件其外形尺寸缩小了50%，并具有低功耗和低噪声特性（旨在实现上佳的图像质量）。

• T/R开关的主要功能是防止高电压脉冲损坏接收电子线路。TX80是一款8通道集成T/R开关，专为满足设计师构建较小便携式超声波系统并加速产品面市进程的需要而设计。

• 发送波束形成器、高电压 (HV) 脉冲发生器和HV多路复用器构成了发送通路，该通路负责传感器元件的脉冲激励。TX734是一款采用有源阻尼的集成化、四通道、±90V脉冲发生器，它降低了噪声并最大限度地缩减了外形尺寸。

嵌入式处理器

•TMS320C6474和TMS320C6455高性能DSP适合于超声波处理，比如：B模式成像、彩色多普勒 (Doppler)、图像相干斑点抑制、3D/4D及其他处理和滤波算法。

•OMAP35x SOC非常适合于应对便携式和手持式超声波系统中的操作系统、连通性和用户接口要求，同时还能够操纵诸如彩色扫描转换等处理算法。

上述产品以及TI的电源管理产品、时钟和接口提供了针对超声波应用的目标集成电路解决方案的完整信号链路产品库。

敬请访问下面的网址，以观看"超声波系统的灵活设计、低功耗"视频播客：

www.ti.com/ultrasoundvideo

TI的AFE5851模拟前端荣获2009年《Design News》杂志 Golden Mousetrap最佳产品奖。

集成8/16通道模拟前端
AFE5801、AFE5851

敬请访问**www.ti.com/sc/device/AFE5801**或**www.ti.com/sc/device/AFE5851**，以获取样片、数据表及评估板。

主要特点

• 集成VCA、PGA、LPF、12位65MSPS ADC

• AFE5801：
  ◦ 8通道
  ◦ 30MSPS时，每通道功耗为50mW

• 50MSPS时，每通道功耗为58mW

• AFE5851：
  ◦ 16通道
  ◦ 32.5MSPS时，每通道功耗为39mW

• 数字增益控制，免除了外部DAC，实现了更小的占板面积及最小化的噪声

• 封装：9 x 9mm QFN

应用

• 超声波

AFE5851是首款针对超声波市场的16通道模拟前端 (AFE)。该器件在 32.5MSPS采样速率时每通道功耗为39mW，并包含了16个可变增益放大器 (VGA)，后续跟随8个12位65MSPS模数转换器 (ADC)。每个ADC由两个VGA共享，且每个VGA的差分输出以交替的时钟周期进行采样，以实现功耗的优化。ADC具有可变的功耗选项，以支持低采样速率情况下的低功耗。AFE5851的多通道数量及低功耗特性可提升手持超声波系统的通道密度。

AFE5851及AFE5801均可前置一个片外的低噪声放大器 (LNA)，该LNA可位于探针上，也可以是一个变换器。此类新型架构使得用户可为手持式超声波系统降低至少40%的功耗及70%的模拟前端占位面积。

AFE5851原理框图

→ **超声波 (Ultrasound)**
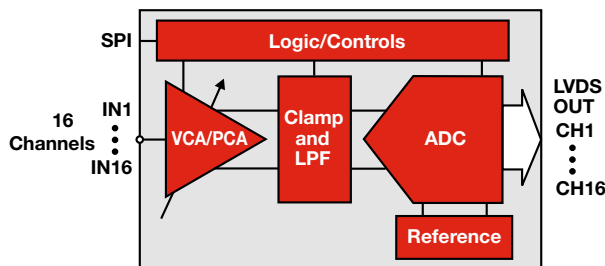
全集成化8通道模拟前端
AFE5804、AFE5805

TI的AFE5805模拟前端荣获
《电子产品设计》杂志e-Legacy奖。

敬请访问**www.ti.com/sc/device/AFE5804**或**www.ti.com/sc/device/AFE5805**，以获取样片、数据表及评估板。
敬请访问**www.ti.com/afe5805video**，以观看"用于超声波设备的AFE5805 8通道模拟前端"视频播客。

主要特点

- 集成LNA、VCA、PGA、LPF、12位50MSPS ADC
- AFE5805
  - 40MSPS时，每通道功耗为122mW
  - 2MHz时，噪声为0.85nV/$\sqrt{Hz}$
  - 250mVPP线性输入范围
- AFE5804
  - 40MSPS时，每通道功耗为101mW
  - 2MHz时，噪声为1.23nV/$\sqrt{Hz}$
  - 280mVPP线性输入范围
- LNA固定增益：20dB
- VCA增益可通过0V至1.2V的控制电压在46dB的范围内变化
- PGA增益可编程设定：20dB、25dB、27dB及30dB
- 封装：135引脚15 x 9mm BGA

应用

- 超声波

AFE5804及AFE5805是集成的模拟前端解决方案，针对中等大小至便携式超声波系统进行了特别的设计。AFE5804具有针对功率/噪声优化的模式控制特性，且具有每通道101mW的低功耗性能，同时可提供出众的成像品质。AFE5805具有优异的低噪声特性（2MHz时噪声为0.85nV/$\sqrt{Hz}$），其性能不仅适用于便携式设备，还适用于高通道密度、中等大小的超声波系统。

AFE5804及AFE5805均为8通道，包括了低噪声放大器 (LNA)、压控衰减器 (VCA)、可编程增益放大器 (PGA)、低通滤波器 (LPF) 及12位50MSPS并带LVDS数据输出的模数转换器 (ADC)。ADC的LVDS输出可降低连接至ASIC或FPGA的接口线路数量，从而实现了更高的系统集成密度，这正是便携式系统所期望的。

AFE5805超声波模拟前端

医疗成像
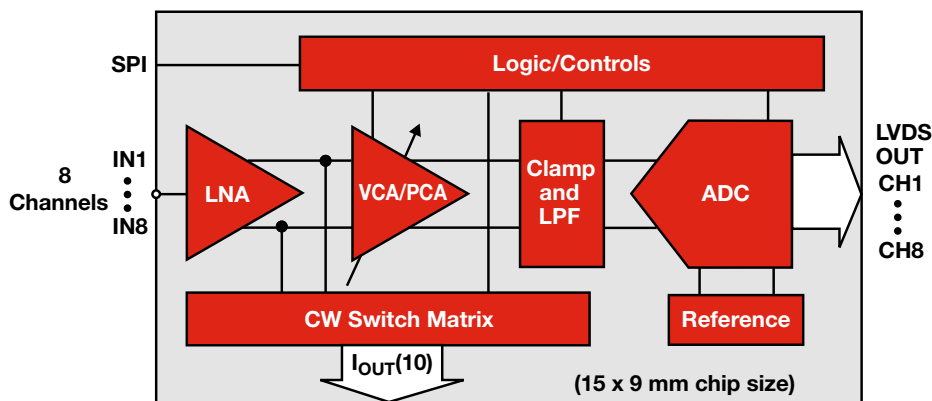
集成、8通道T/R开关
TX810

TI的TX810入围2010年《Design News》杂志Golden Mousetrap最佳产品奖最终候选名单。

主要特点

- 集成了用于其所有8个通道的保护二极管电桥和箝位二极管
- 可编程偏置电流
  - 用于设置一个7mA偏置电流范围的3位接口
  - 用于降低功耗的断电模式
- 在400Ω负载条件下提供了优化的插入损失：0.9dB（在7mA偏置电流时）和1.3dB（在1mA偏置电流时）

应用

- 超声波

TX810满足了设计师构建较小便携式超声波系统并加速产品面市进程的需要。TX810集成了用于其所有8个通道的保护二极管电桥和箝位二极管，旨在防止发送器的高电压脉冲损坏超声波系统的接收电子线路。在便携式至中等大小超声波系统中，该器件所占用的板级空间较之分立型解决方案缩减了50％～75％以上（取决于T/R架构），而且，元件的减少和处理的简化还为设计带来了可靠性的提升。
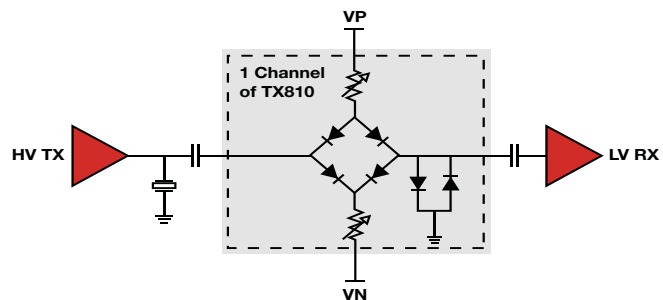
TI的TX734因其对医疗成像未来发展的推动而入围《ElectronicProduct Design》杂志2009年e-Legacy奖最终候选名单。

±100V、2A、四通道脉冲发生器
TX734

主要特点

- 四通道
- 电压：±100V
- 峰值输出电流：±2A
- 有源阻尼
  - 真正的3级RTZ
  - 在内部起动
- 成像输出频率：高达20MHz
- 逻辑输入：2.5V至5V
- 低HD2失真：−40dBc（在5MHz频率下）

应用

- 超声波

通过将4个通道的电平转换器、驱动器、高电压输出级和有源阻尼电路集成在单片64引脚、9mm x 9mm QFN封装之中，TX734满足了那些需要3级、高电压脉冲图形的高密度系统的要求。

有源阻尼（也被称作"至地电位的快速箝位"）提供了干净的3级归零(RTZ)波形。这改善了脉冲对称性，并提供了−40dB的低二阶失真。TX734内置的这种有源阻尼功能可防止噪声注入传感器，使得信号灵敏度至少提升了5dBc，从而实现了更佳的图像质量。
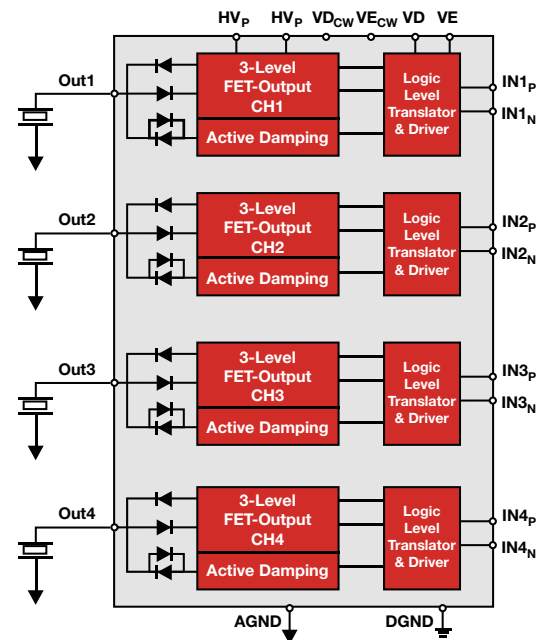
医疗成像

→ **超声波 (Ultrasound)**

带串行化LVDS接口的8通道、超低功耗、12/10位、50至65MSPS模数转换器
ADS5281、ADS5282、ADS5287

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片、数据表及评估板。
（**PARTnumber**请使用**ADS5281、ADS5282**或**ADS5287**替换）

主要特点

- 单片小型64引脚QFN封装内包含8通道的12位或10位ADC
  - ADS5821还可提供80引脚TQFP封装版本，与ADS527x系列引脚兼容
- 65MSPS时，每通道功耗为77mW；
- 50MSPS时，每通道功耗为64mW
- 12位分辨率及10MHz中频时，信噪比(SNR) 为70dB
- 1/f（闪烁）噪声抑制
- 每个时钟周期中高达6dB的过载恢复
- 独立的通道断电功能
- 可直接连接至VCA8500 8通道可变增益放大器
- Xilinx®支持型解串器编码

应用

- 医疗及其他成像：
  - 超声波
  - 核磁共振成像 (MRI)
  - 正电子放射层析成像 (PET)

ADS5281系列以单片小型的64引脚QFN封装提供了8通道的高性能ADC，可支持实现多通道数量的高性能超声波及其他医疗成像系统。其每通道低功耗的特性还有助于实现紧凑的超声波设备，可获取额外的空间及电池寿命裕量，并可与VCA8500相结合以提供高性能的LNA至数字解决方案，适用于每通道功耗低于130mW的超声波应用。

ADS5281系列还整合了若干高级特性以优化系统性能，包括了可编程增益（0至12dB，1dB步进）、1/f（闪烁）噪声抑制以及单个时钟周期内的6dB输入过载恢复。ADS5281系列可提供12位分辨率（在50MSPS和65MSPS）及10位分辨率（在65MSPS）的性能，具有很强的灵活性，可针对各种成像系统给出最理想的解决方案。

ADS5281/2/7原理图

医疗成像
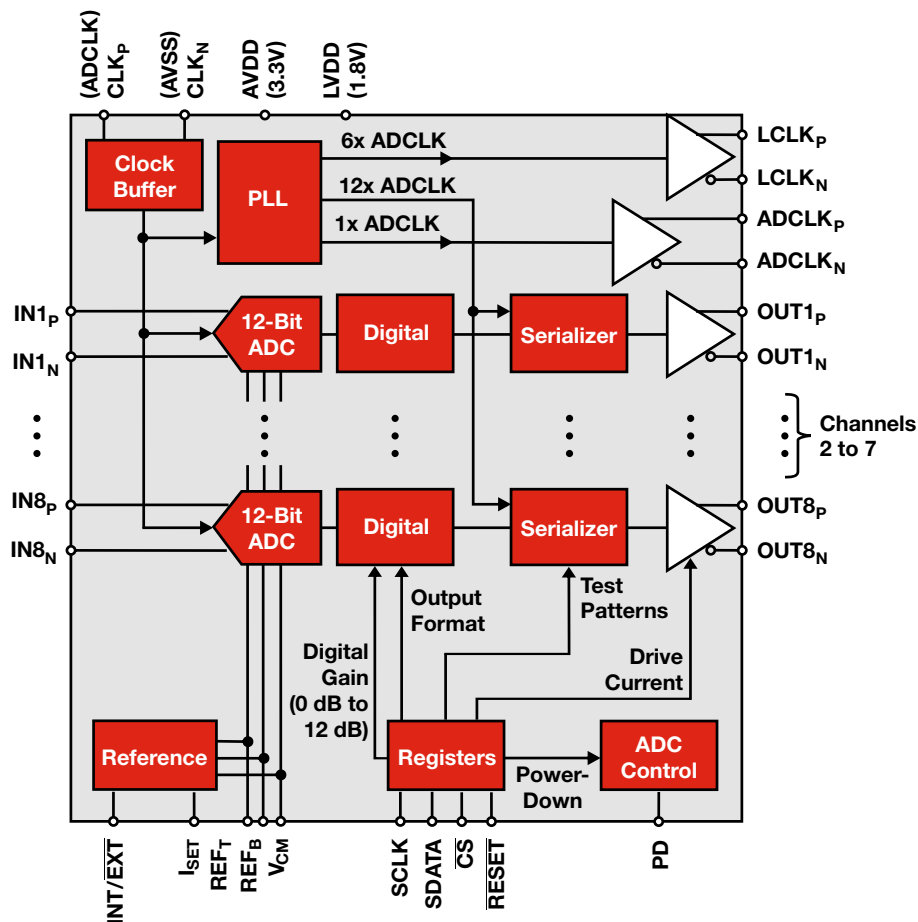
→ *超声波 (Ultrasound)*

带低噪声放大器的8通道可变增益放大器
VCA8500

敬请访问**www.ti.com/sc/device/VCA8500**，以获取样片、数据表及评估板。

主要特点

- 超低功耗：每通道65mW
- 低噪声：0.8nV/√Hz
- 低噪声放大器 (LNA)：
  - 20dB固定增益
  - 250mVPP线性输入范围
- 可变增益放大器：
  - 增益控制范围：46dB
  - 可选择的ＰＧＡ增益：20/25/27/30dB
  - 快速过载恢复
  - 输出箝位控制

应用

- 医疗成像：
  - 超声波
  - 声纳

VCA8500是8通道可变增益放大器，整合了一个低噪声放大器 (LNA) 及一个可变增益放大器 (VGA)。这种组合及器件所具有的特性使得VCA8500成为了各类超声波系统的理想选择。

该器件针对需要低功耗的便携式超声波系统进行了优化，具有每通道65mW的超低功耗规格，并可用于中等大小的系统以增加单系统的通道数量，同时保持严格的低功耗要求。

该器件还具有0.8nV/√Hz的低噪声规格、20dB的固定LNA增益、46dB的VGA增益控制范围，为改善超声波系统的成像品质提供了卓越的噪声及信号处理特性。

原理图

医疗成像
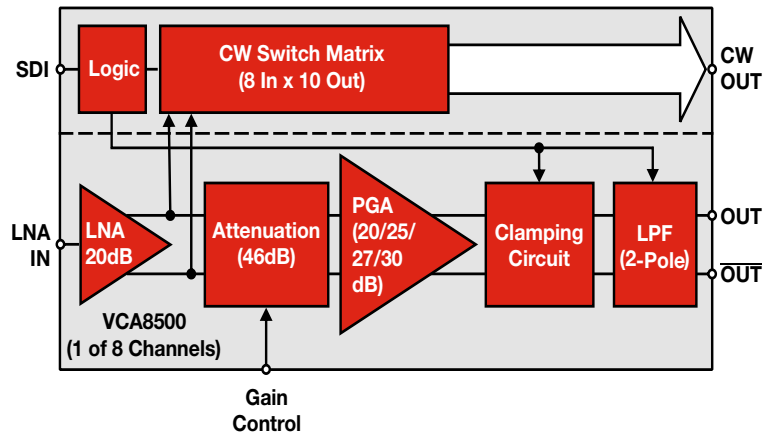
带停用 (disable) 模式的超宽带、电流反馈运算放大器
OPA695

敬请访问 **www.ti.com/sc/device/OPA695**，以获取样片、数据表、工具及应用报告。

主要特点

- 增益 = +2时，带宽为1400MHz
- 增益 = +8时，带宽为450MHz
- 输出电压摆幅：±4.2V
- 超高转换速率：4300V/μs
- 低功耗：129mW
- 停用模式中的低功耗：0.5mW
- 封装：SOT23-6、SO-8

应用

- 超宽带ADC驱动器
- 低成本精密中频 (IF) 放大器
- 宽带视频线路驱动器

OPA695是单通道超宽带电流反馈运算放大器。作为一款增益为+2V/V的线路驱动器，它能够以2900V/μs的转换速率提供1.4GHz的带宽，从而可在0.8ns的上升时间内实现2V的输出阶跃——完全足以满足最高速视频的需求。OPA695的单电源运作范围从+5V至+12V，涵盖了固定增益中频放大器最常用的电源范围。OPA695较低的12.9mA电源电流在25℃条件下精确修整，再结合其低温度漂移特性，从而在整个温度范围内实现了低系统功耗。
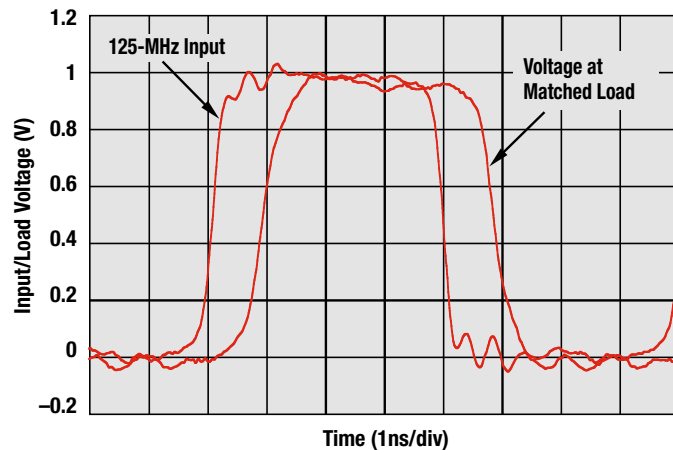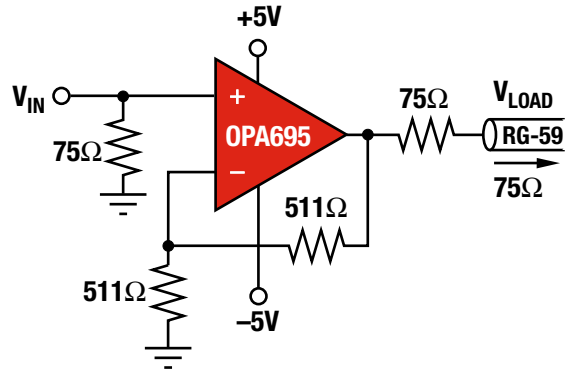
+2V/V增益的视频线路驱动器及其典型脉冲响应波形

医疗成像

→ *超声波 (Ultrasound)*

带停用模式的双通道、宽带、电流反馈运算放大器
OPA2695

敬请访问**www.ti.com/sc/device/OPA2695**，以获取样片、数据表及评估板。

主要特点

- 增益 = +2V/V时，带宽为850MHz，或
- 增益 = +8V/V时，带宽为450MHz
- 转换速率：2900V/μs
- 输出电压摆幅：±4.1V
- 低静态电流：每通道12.9mA
- 低停用模式电流：每通道200μA
- 可提供单通道版本 (OPA695) 及三通道版本 (OPA3695)
- 封装：SO-8（不带停用模式），QFN-16（带停用模式）

应用

- 超宽带ADC驱动器
- 便携式仪器
- 有源滤波器
- 低成本精密中频 (IF) 放大器

OPA2695是带停用模式的大带宽电流反馈放大器，具有出众的2900V/μs转换速率及1.8nV/$\sqrt{\text{Hz}}$的低输入电压噪声。该器件针对高增益运转进行了优化，其引出脚配置提供了对称的输入及输出通路，使得OPA2695非常适合作为差分ADC驱动器。OPA2695较低的每通道12.9mA电源电流在+25℃条件下精确修整，再结合其低温度漂移特性，从而在整个温度范围内实现了低系统功耗。
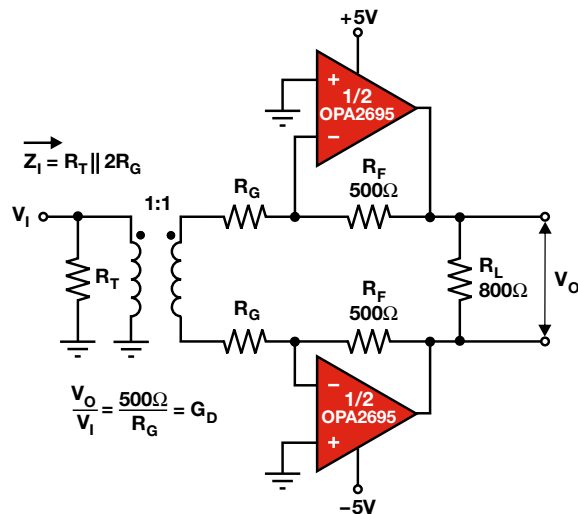
差分驱动器

带停用模式的双通道、低功耗、宽带电压反馈运算放大器
OPA2889

敬请访问**www.ti.com/sc/device/OPA2889**，以获取样片、数据表及评估板。

主要特点

- 灵活的电源范围：
  - +2.6V至+12V单电源
  - ±1.3V至±6V双电源
- 转换速率：250V/μs
- 输出电压摆幅：±4V
- 宽带±5V操作：60MHz (G = +2V/V)
- 低静态电流：每通道460μA
- 低停用模式电流：每通道18μA
- 封装：SO-8、MSOP-10

应用

- 高速成像通道
- ADC缓冲器
- 便携式仪器
- 有源滤波器

OPA2889是带停用模式的双通道、宽带、低功耗放大器，其新型内部架构提供了不俗的转换速率及全功率带宽特性，此特性先前仅见于宽带电流反馈放大器。OPA2889的上述性能，并结合每通道460μA的超低静态电流，使其非常适合于便携式仪表。OPA2889采用±5V电源供电运转，可给出±4V的输出摆幅、超过40mA的驱动电流以及60MHz的带宽，从而使其成为RGB线路驱动器、单电源模数转换器 (ADC) 输入驱动器或低功耗双绞线线路接收器的理想选择。
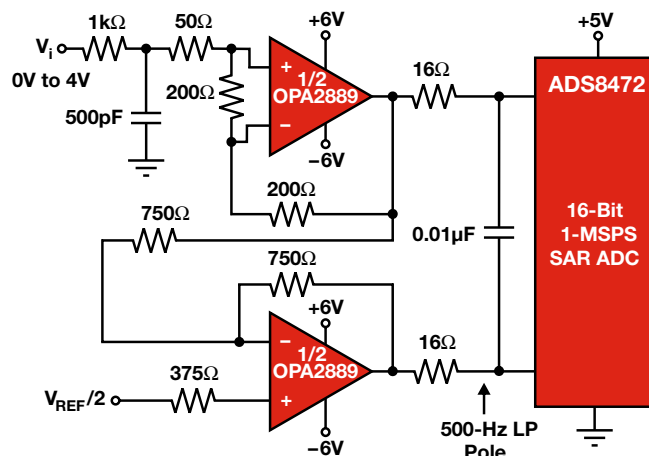
针对≤100kHz输入的低功耗、直流耦合、单端至差分驱动器

医疗成像

→ **超声波 (Ultrasound)**

运用DaVinci™ 技术的TMS320DM6446数字媒体处理器
TMS320DM6446

敬请访问**www.ti.com/davinci**，以获取样片、数据表、工具及应用报告。

主要特点

- 高性能数字媒体片上系统 (SoC)
  - 594MHz C64x+™时钟频率
  - 297MHz ARM926EJ-S时钟频率
  - 每周期执行8条32位C64x+指令
  - 4752 C64x+ MIPS
  - 与C64x+/ARM9完全软件兼容
- 具非一致性 (non-aligned) 支持能力的负载储备 (load-store) 架构
- 64个32位通用寄存器
- 指令分组 (instruction packing) 降低了代码长度
- 视频处理子系统
  - CCD及CMOS成像器接口
  - 预览引擎，用于实时图像处理
  - 无缝连接至通用视频解码器
- 嵌入式追踪缓冲器 (ETB11)，带4kB存储器以用于ARM9调试

应用

- 医疗成像
- 数字媒体
- 网络媒体编码/解码

TMS320DM6446数字媒体处理器是超声波系统及其他各类医疗成像产品的理想选择。TMS320DM6446数字媒体处理器是高度集成的片上系统 (SoC) 芯片，基于ARM926EJ-S处理器以及TMS320C64x+™ DSP核心。这些器件运用了TI的DaVinci™技术，旨在满足下一代嵌入式IC对网络媒体编码及解码应用处理的要求。倚仗全集成混合信号处理器解决方案的极大灵活性，TMS320DM6446/41使得开发人员能够向市场推出具有牢固可靠的操作系统支持、丰富的人机接口、高处理性能以及长电池使用寿命的设备。

TMS320DM6446方框图

医疗成像

→ **超声波 (Ultrasound)**
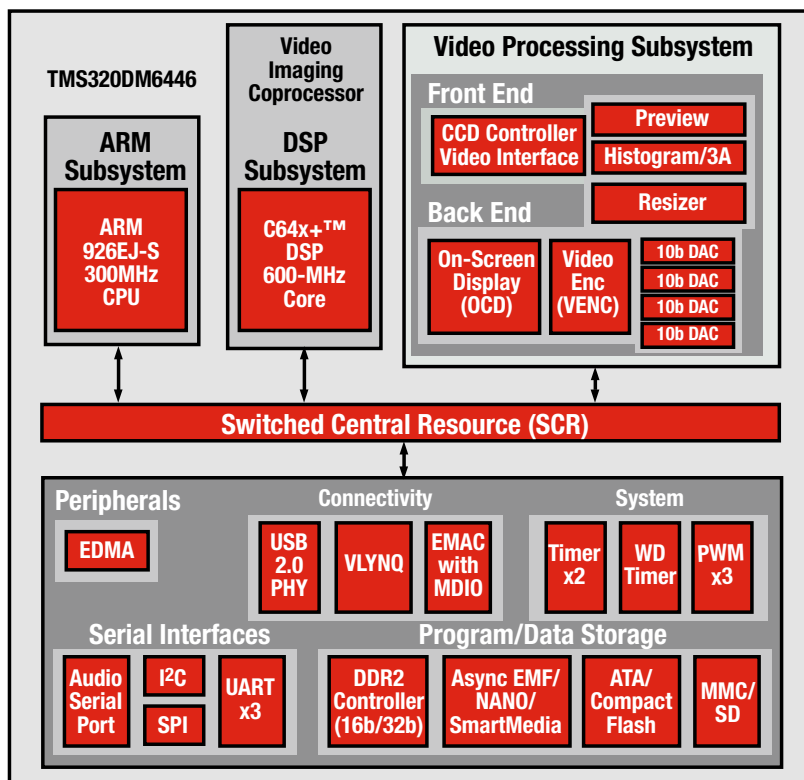
非常适合高性能、严格功耗预算应用的六核TMS320C6472
TMS320C6472

敬请访问**www.ti.com/sc/device/TMS320C6472**，以获取样片及数据表。

主要特点

- 在单颗芯片上集成了6个片上 TMS320C64x+ DSP内核
- 可提供500/625/700MHz速度版本
- 每周期可执行8条32位指令
- 在500MHz频率下，处理性能可达 4000MIPS/MMACS（16位）
- 共享内存架构：768k字节
- 每个C64x+具有608k字节的局部L2 RAM
- 专用SPLOOP指令
- 交换结构DMA引擎
- 串化/并化器 (SERDES) 接口
- DDR2内存接口：533MHz
- 10/100/1G以太网
- 高性能接口 (HPI)
- 24 x 24mm FC-BGA封装

应用

- 超声波
- 医疗成像
- 高性能系统
- 具高性能/严格功耗预算的工程项目

TMS320C6472多核数字信号处理器 (DSP) 通过在单芯片内集成6颗业界领先的内核（运行频率均高达700MHz）而实现了成本、功耗及板级空间的节省。C6472提供了高达4.2GHz的原始DSP性能，与6个单独的TMS320C6415 DSP相比，其功耗仅相当于后者的60%，而占用的板级空间与后者相比则少了 80%。器件的单位功率为3.7W，其节能幅度甚至超过了同等性能范围的通用型处理器。在许多高性能应用中，提供大容量的片上存储器是一项常见的关键要求，用于在处理过程中操控数量庞大的数据。由于每个C64x+超大型模块 (Mega-module) 具有768k字节的共享RAM和608k字节的局部L2 RAM，因此TMS320C6472器件能够免除增设外部存储器的需要，从而降低了系统功耗和系统成本，并优化了电路板密度。

TMS320C6472方框图

医疗成像
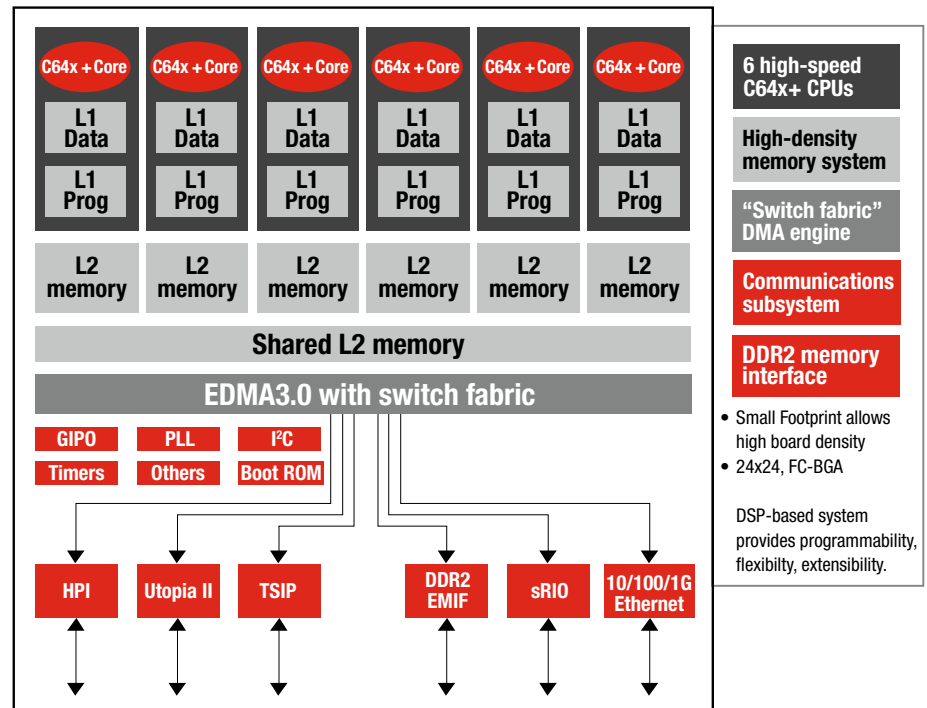
→ **超声波 (Ultrasound)**

集成三个1GHz 内核的高性能处理器
TMS320C6474

敬请访问**www.ti.com/sc/device/TMS320C6474**，以获取样片、数据表、工具及应用报告。

主要特点

- 提供了三倍于原始DSP的处理性能
- 原始性能增益：每W功耗达50%
- 在单颗芯片内集成了三个1.2GHz内核
- 具多通道处理能力
- 串化器/解串器 (SERDES) 接口
- 每个内核均具有32kB的L1程序内存和L1数据内存
- DDR2内存接口：667MHz
- 处理工艺缩小至65nm的特征尺寸

应用

- 医疗成像
- 高性能系统
- 多芯片系统设计
- 具严格功耗预算的工程项目

TMS320C6474多核数字信号处理器 (DSP) 通过在单芯片内集成三个业界领先的内核（运行于1GHz）而实现了成本、功耗及板级空间的节省。C6474提供了高达1.2GHz的原始DSP性能，与分立型处理解决方案相比，功耗和DSP成本分别降低了1/3和2/3。该DSP为使用DSP群 (farms) 实现各种应用的设计人员提供了重要的系统集成。
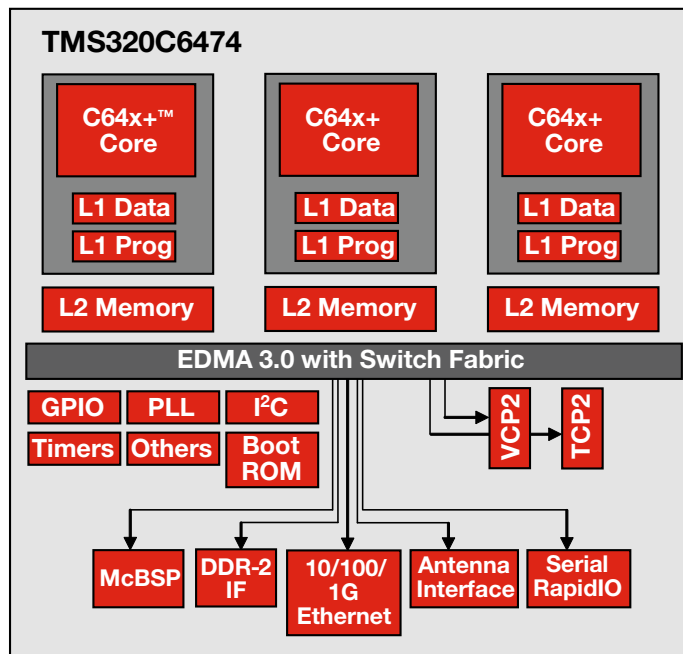
TMS320DM6474 DSP方框图

TMS320C645x DSP系列——定点、最高性能的DSP
TMS320C6455

敬请访问**www.ti.com/sc/device/TMS320C6455**，以获取样片、数据表、工具及应用报告。

主要特点

- 基于新型TMS320C64x+™ 核心：720MHz、850MHz、1GHz、1.2GHz
- 存储器：
  - 32kB L1数据缓存、32kB L1程序缓存/SRAM
  - 2MB L2内存，其中256k为缓存/SRAM，其余全为SRAM
- 加速器：
  - Viterbi解码协处理器 (VCP)
  - Turbo解码协处理器 (TCP)
- 外设：
  - 串行快速输入/输出（RapidIO）：10Gb/s全双工

TMS320C64x+™ DSP（包括TMS320C6455芯片）是TMS320C6000™ DSP平台中最高性能的定点DSP系列。C6455 IC基于TI所开发的第三代高性能的高级VelociTI™超长指令字 (VLIW) 架构，可允许这些DSP用于包括医疗成像、视频及电信基础设施、成像及无线基础设施 (WI) 等应用。C64x+™ IC可向上代码兼容属于C6000™ DSP平台部分的早期芯片。

- 两个外部存储器接口 (EMIF)：32位DDR2、64位EMIF
- 其他大带宽外设：千兆位以太网MAC、UTOPIA、PCI-66、HPI

应用

- 超声波
- 数字式X光
- 医疗成像

医疗成像

→ **超声波 (Ultrasound)**

业界最低功耗的浮点型DSP
TMS320C6747

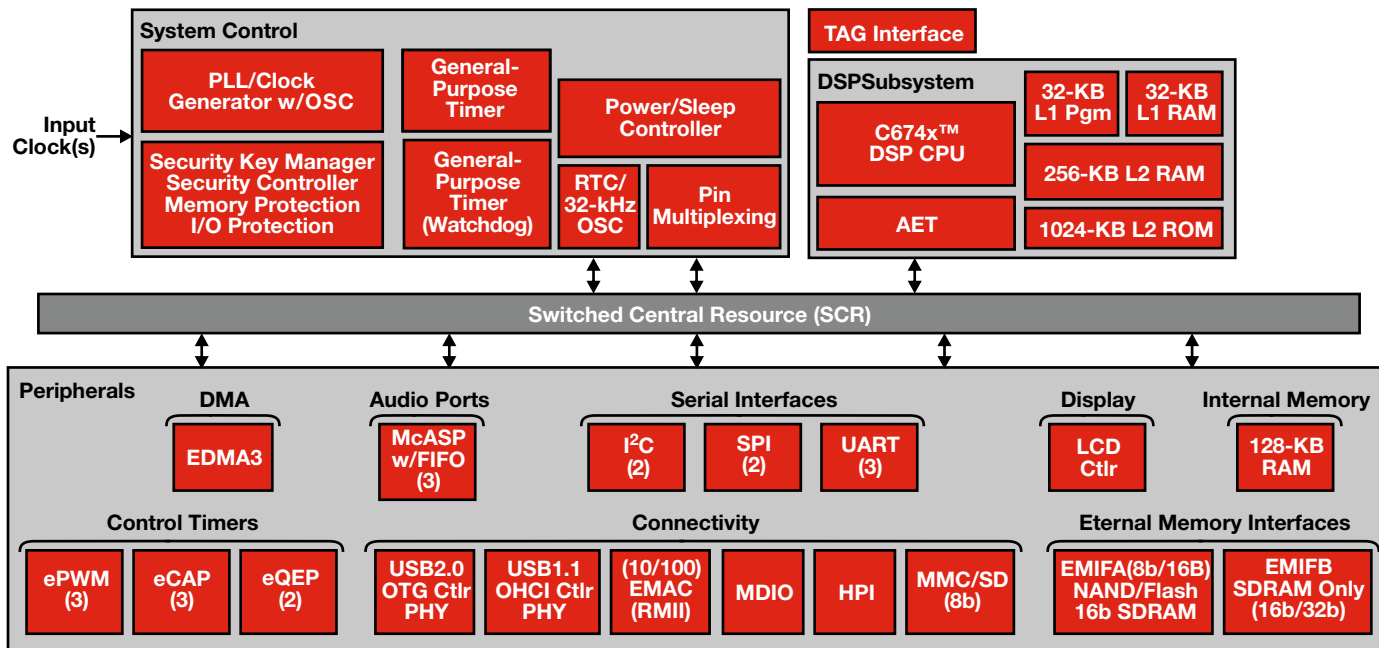敬请访问**www.ti.com/sc/device/TMS320C6747**，以获取样片、数据表、工具及应用报告。

主要特点

- 业界最低功耗的浮点型DSP
- 通过浮点DSP内核的32/64位准确度实现了高精度及宽动态范围
- 通过低功耗及丰富的连通性外设实现了传统有线应用的便携性
- 通过高功能集成度及低价格实现了系统成本降低
- 与现有的浮点型器件相比，待机功耗降低了20倍之多，运转功耗降低至1/3

TMS320C6747 DSP整合了低功耗及高精度的特性，使设计人员可以自由地为需求浮点型DSP所拥有的高精度、宽动态范围及上市时间优势的医疗及其他应用增添便携性能。与现行的浮点型DSP相比，C674x器件仅消耗1/3的功率，并支持32位单精度及64位双精度的浮点型架构，是业界最低功耗的浮点型DSP。

应用

- 便携式超声波
- 工业
- 电话会议
- 音乐音效

TMS320C6747 DSP方框图

医疗成像

➡️ **超声波 (Ultrasound)**

数字媒体处理器
TMS320DM355

敬请访问**www.ti.com/sc/device/TMS320DM355**，以获取样片、数据表、评估板及相关应用报告。

主要特点

- 高性能数字媒体处理器
- 与ARM9™完全软件兼容
- 216MHz及270MHz ARM926EJ-STM核心
- TI的DaVinci™软件技术
- MPEG-4/JPEG协处理器
- 视频处理子系统
- 16位宽DDR/mDDR SDRAM EMIF，具有256MB地址空间
- MMC及SD/SDIO闪存卡接口
- USB、UART、SPI及I²C外设
- 多达104个可配置的多用途I/O端口(GPIO)

应用

- 多参数患者监护仪
- 便携式超声波设备
- 自动外部去纤颤器 (AED)
- 心电图 (ECG)

TMD320DM355是高度集成的可编程平台，适用于开发低成本的便携式医疗视频应用。DM355的核心内具有ARM9™处理器，作为高性能的数字媒体片上系统 (DMSoC)，可充分发挥TI DaVinciTM技术的优势以提供高性能视频MPEG-4 HD (720p) codec及JPEG codec，为用户开发提供了并不昂贵的高品质、低功耗视频解决方案。DM355具有视频处理子系统 (VPSS)，可通过一个可配置的视频处理前端 (VPFE) 连接至CCD/CMOS成像器模块或视频解码器；或将可配置的视频处理后端 (VPBE) 用于硬件屏显 (OSD) 支持，并兼容复合NTSC/PAL及数字LCD输出。此外，DM355的外设集还包括了一系列的接口，诸如USB、I²C、音频串行端口 (ASP)、UART、串行外设接口 (SPI)、外部存储器接口 (EMIF) 及GPIO端口。DM355具有全范围的ARM®开发工具，包括C编译器、汇编器及Windows®调试界面，支持可视化的源代码执行。DM355为医疗设备提供了低成本的便携式视频备选方案。

对于无需视频的医疗应用，不带视频加速功能且成本更低的DM335是上佳的备选方案。

TMS320DM355处理器

医疗成像

→ **超声波 (Ultrasound)**
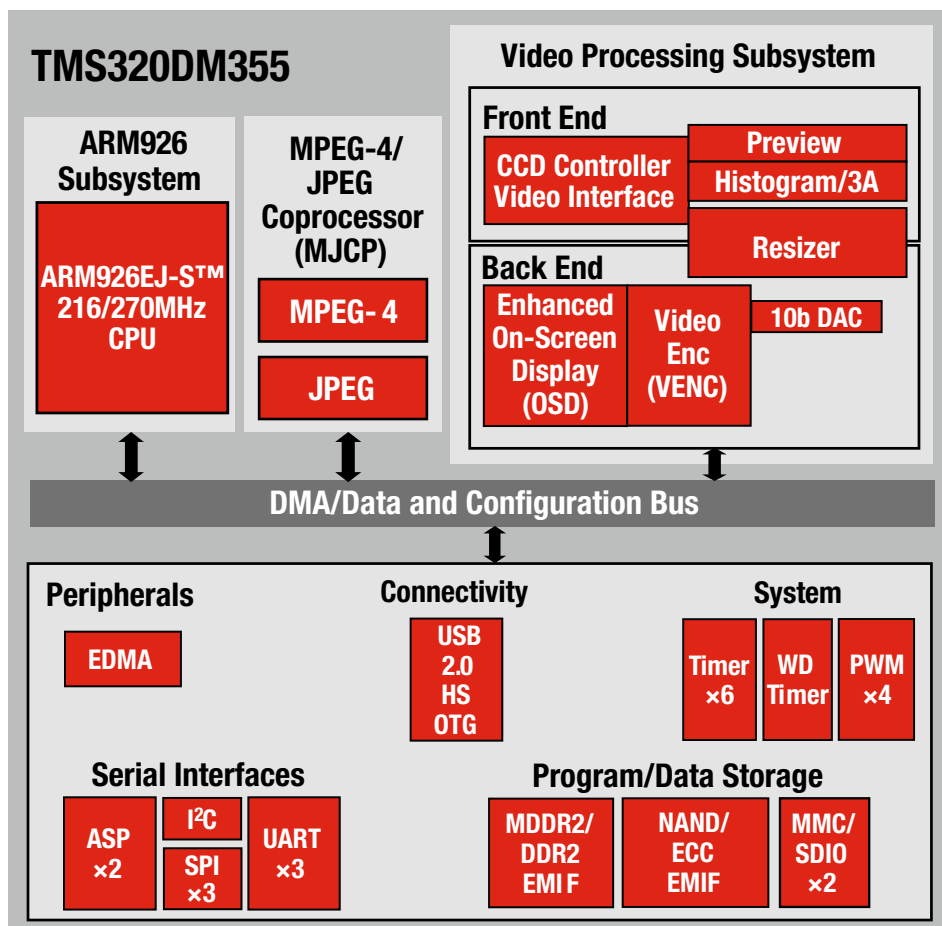
高性能应用处理器
OMAP3530

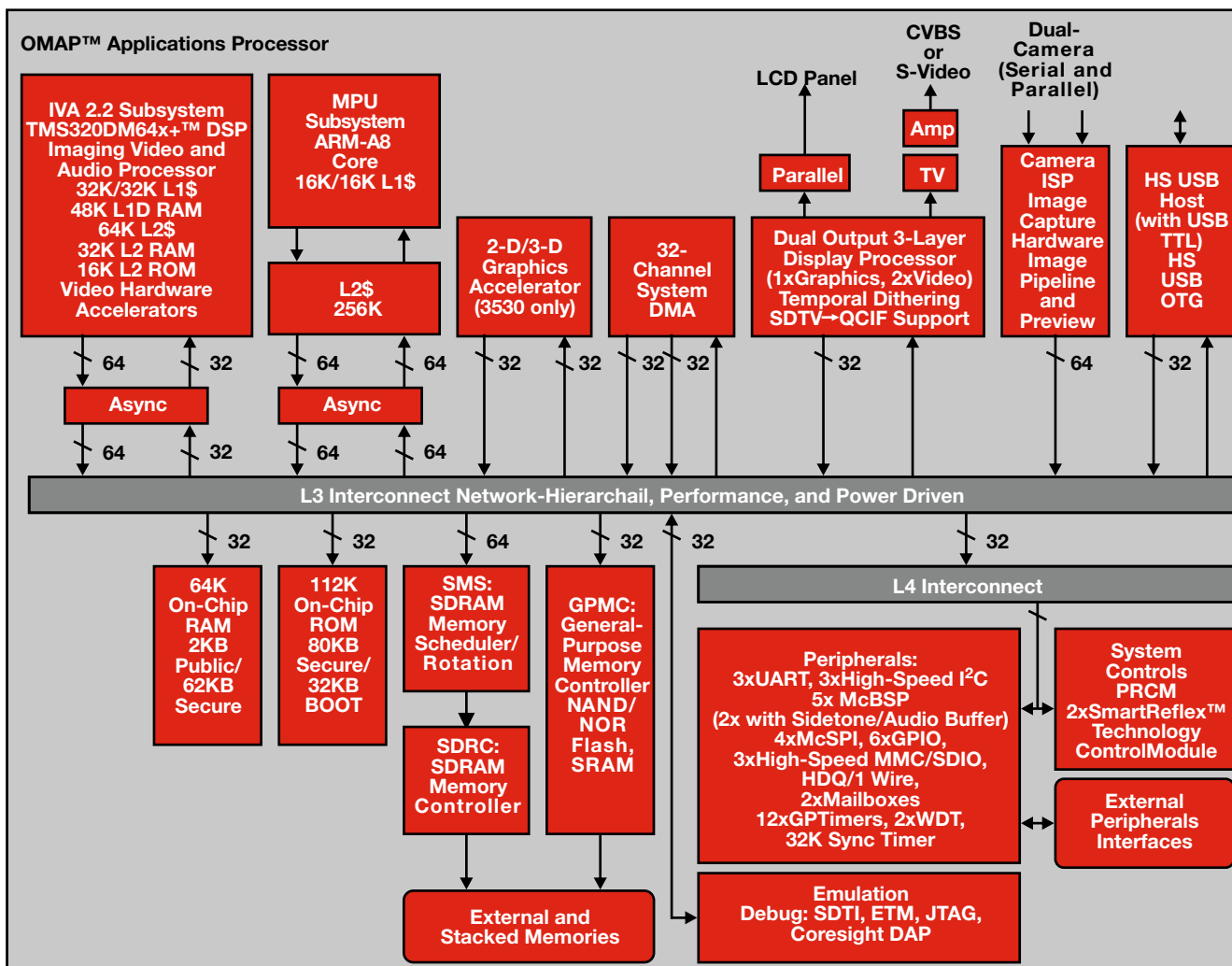敬请访问 **www.ti.com/sc/device/OMAP3530**，以获取样片、数据表、工具及应用报告。

主要特点

- OMAP3530/25应用处理器
- 高级超长指令字 (VLIW)
  TMS320C64x+™ DSP核心
- C64x+™ L1/L2内存架构
- C64x+指令集特性
- ARM® Cortex-A8核心
- ARM Cortex-A8内存架构
- 112kB ROM
- 64kB共享SRAM

OMAP3530和OMAP3525是基于增强型OMAPTM 3架构的高性能应用处理器。OMAP 3架构专为提供同类最佳的视频、图像以及足以支持流式视频、2D/3D移动游戏 (mobile gaming)、视频会议以及高分辨率静态图像的图形处理能力而设计。此类器件还支持2.5G无线终端、3G无线终端、具丰富多媒体功能的手机以及高性能个人数字助理 (PDA) 中的视频捕捉。

应用

- 超声波
- 便携式数据收集
- 超便携移动设备
- 数字视频摄像机

OMAP3530原理图

→ **超声波 (Ultrasound)**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Analog Front Ends				
AFE5801 *Page 81*	8-Channel Integrated Analog VCA, PGA, LPF and 12-bit, 65 MSPS ADC	50mW/channel at 30MSPS, 58mW/channel at 50MSPS, 64-pin 9 x 9 QFN package	Low power enables handheld ultrasounds	AFE5851
AFE5804 *Page 82*	8-Channel Integrated Analog LNA, VCA, PGA, LPF and 12-bit, 50-MSPS ADC	101mW/channel low power, 1.23nV/√Hz low noise, 135-pin 15 x 9 BGA package	Enables portability, greater number of channels per system and maintains good image quality	AFE5805, VCA8500 with ADS5281
AFE5805 *Page 82*	8-Channel Integrated Analog LNA, VCA, PGA, LPF and 12-bit, 50-MSPS ADC	122mW/channel low power, 0.85nV/√Hz low noise, 135-pin 15 x 9 BGA package	Enables portability, greater number of channels per system and maintains good image quality	AFE5804
AFE5851 *Page 81*	16-Channel Integrated Analog VCA, PGA, LPF and 12-bit, 65-MSPS ADC	39mW/channel at 32.5MSPS, 64-pin 9 x 9 QFN package	High channel count and low power allows increased channel density in handheld ultrasounds	AFE5801
Amplifiers				
OPAx695	High-Speed Op Amp	G = +2 BW 1400MHz, G = +8 BW 450MHz, 4300V/μs SR	Ultra-wideband, current feedback	OPA2695 (dual)
OPAx832	Video Buffer Op Amp	G = +2 BW 80MHz, 3.9mA supply, 350V/μs SR	Low power, fixed gain	OPA2832 (dual)
OPA847	VFB Op Amp	3.9GHz GBW, 0.85nV/√Hz noise, 950V/μs SR	High DC accuracy, stable for gains ≥12V/V	
OPA211	Precision Op Amp	1.1nV/√Hz noise at 1kHz, ±2.25V to ±18V supply, 80MHz BW	Unity gain stable, RRO, wide supply range	OPA227
OPA369	Nanopower Zero-Crossover Op Amp	1.8V to 5.5V, 700nA I_Q, CMRR 114dB RRIO, 0.4μV/°C, V_{OS} drift	Zero-crossover input offers excellent CMRR over entire input range	OPA379, OPA349
OPA695 *Page 86*	Ultra-Wideband, Current-Feedback Operational Amp	±4.2V output voltage swing, low disabled power of 0.5mW, ultra-high slew rate	Gives more than adequate 0.8ns rise time for a 2V output step for the highest speed video requirements	
OPA2695 *Page 87*	Dual, Wideband, Current-Feedback Operational Amp	±4.2V output voltage swing, low quiescent current, low disable current	Optimized for high gain operation	
OPA2889 *Page 87*	High-Speed Op Amp	460μA/channel quiescent current	Very low power	OPA2890
THS4131	High-Speed Op Amp	150MHz (−3dB) BW, 51V/μs SR, −100dB THD	Differential input/differential output	THS4120, THS4150
THS4304	High-Speed Op Amp	3GHz BW, 830V/μs SR, 2.4nV/√Hz noise, 7.5ns settling time (001%)	High bandwidth and fast settling time	
THS4509	High-Speed Op Amp	1900MHz BW, 6600V/μs SR, 2ns settling time (1%)	Low distortion, fully differential	THS4508, THS4511
THS4524	Very Low Power Quad Channel Rail-to-Rail Output Fully Differential Amplifier	Fully differential, 1.14-mA/ch current consumption	Low power signal conditioning	THS4521
TPA2010D1	Analog-Input Class-D Amp	2.5W mono, fully differential, filter-free Class D, in WCSP	Loud audio, long battery life, small package size	TPA2031D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA4411	Audio Headphone Amp	Audio headphone amp		TPA6130A2
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB	Loud audio, low cost	TPA6204A1
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	
VCA2615	Dual, Low-Noise LNA and VCA	Very low noise: 0.7nV/√Hz	For high-end systems requiring high dynamic range and flexibility	VCA2611
VCA2617	Dual, Low-Power VCA	Differential I/O VCA, low power: 52mW/ch	Low-power, low-noise VCA to follow an off-chip LNA	VCA2614
VCA8500 *Page 85*	8-Channel Ultrasound Front End	Complete with LNA, VCA and LPF; low noise and power: 0.8nV/√Hz and 65mW/ch	Best-in-class noise-power combination	AFE5805
VCA8613	8-Channel Ultrasound Front End	Complete with LNA, VCA and LPF; low power: 75mW/ch	Best-in-class power	VCA8500
VCA8617	8-Channel Ultrasound Front End	Complete with LNA, VCA and LPF; low noise of 1.0nV/√Hz	Best-in-class noise	VCA8500

*更多产品信息请参见指定页码。
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医疗成像

 超声波 (Ultrasound)

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Data Converters				
ADS1610	Delta-Sigma ADC	16-bit, 10MSPS, parallel interface	SYNC pin for simultaneous sampling	
ADS1605	Delta-Sigma ADC	16-bit, 5MSPS (10MSPS in 2x mode), 88dB SNR, −99dB THD	Selectable on-chip reference	
ADS5121	High-Speed ADC	8-channel, 10-bit, 40MSPS, 1.8V analog/digital supply	Low power, individual channel power down	ADS5122
ADS5232	High-Speed ADC	Dual 12-bit, 65MSPS, 3.3V analog/digital supply	Internal or external reference	
ADS5240	High-Speed ADC	4-channel, 12-bit, 65MSPS, 3.3V analog/digital supply	Serialzed LVDS outputs, integrated frame and bit patterns	ADS5242
ADS5281 *Page 84*	High-Speed ADC	8-channel, ultra-low-power, 12- and 10-bit, 50 to 65MSPS analog-to-digital converter	77mW per channel, serialized LVDS outputs, 1/F noise-suppression	ADS5282, ADS5287
ADS5282 *Page 84*	High-Speed ADC	Ultra-low-power, 8-channel, 12-bit, 65MSPS	77mW per channel, serialized LVDS outputs, 1/f noise suppression	ADS5281
ADS5287 *Page 84*	High-Speed ADC	Ultra-low-power, 8-channel, 10-bit, 65MSPS	77mW per channel, serialized LVDS outputs, 1/f noise suppression	ADS5281
ADS7809	AR ADC	16-bit, 100kHz sample rate, 86dN SINAD with 20kHz input, serial ouput	Output sync pulse for ease of use with standard DSP processors	
ADS8284	SAR ADC	18-bit, 1MSPS, 4 MUX inputs, 98.5dB (typ) SNR at 10kHz	Integrated op amp, ultra-high DC and AC performance	
ADS8380	SAR ADC	18-bit, 600kHz sample rate, ±2 LSB (typ), pseudo-differential input	Zero latency, serial interface with clock up to 40MHz	
ADS8422	SAR ADC	16-bit, 4MSPS, parallel w/reference, pseudo bipolar, fully differential input	Low power	
ADS8484	High-Speed SAR	18-bit, 125MSPS, 98dB (typ) SNR, −110dB (typ) THD	Excellent drift performance	
ADS8519	Bipolar ADC	±10V bipolar, 16-bit, 250kSPS, 10mW at 250kSPS (typ)	Flexible voltage digital interface supports 1.8V I/O	
DAC2900	High-Speed DAC	10-bit, 125MSPS dual DAC	Supports 3.3/5V	DAC2902, DAC2904
DAC7568	12-Bit Octal Channel, Ultra-Low Glitch, Voltage Output DAC With 2.5V, 2-ppm/°C Internal Reference	DSP-compatible 3-wire serial interface with power on reset and power down features	Useful for portable ultrasound data conversion	DAC8168, DAC8568
DAC8168	14-Bit Octal Channel, Ultra-Low Glitch, Voltage Output DAC With 2.5V, 2ppm/°C Internal Reference	DSP compatible 3-wire serial interface with power on reset and power down features	Useful for portable ultrasound data conversion	DAC7568, DAC8568
DAC8560	V_{OUT} DAC	16-bit, 0.15nV-s glitch, ±10µs to 0.003% FSR settling time	Small package, low power	DAC8554, DAC8551, DAC8552
DAC8568	16-Bit Octal Channel, Ultra-Low Glitch, Voltage Output DAC With 2.5V, 2ppm/°C Internal Reference	DSP compatible 3-wire serial interface with power on reset and power down features	Useful for portable ultrasound data conversion	DAC7568, DAC8168
DAC8330	Precision DAC	16-bit, V_{OUT}, 1LSB INL	Very low power, serial interface	DAC8331, DAC8830
DACx311	8 to 16-Bit, Single Channel, Low Power, Ultra-Low Glitch DAC	±2 LSB, scalable output range, SPI interface with 1.8V to 5.5V logic	Very low noise and fast settling time	
References				
REF02	Precision V_{REF}	0.2% (max) initial accuracy, 10ppm/°C (max) drift, 1.4mA (max)	Excellent line/load regulation, low noise	REF5050
REF30xx	Low-Power, Low-Drift Series Reference	50µA, 0.2% initial accuracy, 50ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V , 3.3V, 4.096V		REF31xx, REF33xx, REF29xx
REF31xx	Voltage Reference	15ppm/°C (max) drift, 5mV low dropout, 115µA (max) I_Q, 0.2% (max) accuracy, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	No load capacitor required	REF32xx, REF33xx

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推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
References (continued)				
REF32xx	Low Drift, Bandgap	0.2% (max) accuracy, 7ppm/°C (max) drift, 0.1mA (max) I_Q	Multiple output voltages, SOT23-6	
REF33xx	Very-Low-Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF5010	Low Noise, Very-Low-Drift, Precision Voltage Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 10V	Improves system accuracy	REF102
REF50xx	High-Precision, Very-Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V	Improves system accuracy	REF02
Processors				
OMAP3530 *Page 93*	Applications Processor	ARM® Cortex A-8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
TMS320C6452	DSP	900MHz, 1.4MB L2 cache, 2x SGMII/Gigabit EMAC	High-performance DSP with improved system cost	
TMS320C6455 *Page 90*	DSP	1.2GHz, SRIO, 2MB RA	High-performance, fixed-point 16-bit processor	TMS320C6454BZTZ
TMS320C6472 *Page 89*	DSP	6x 700MHz C64x+ cores, 4.8MB RAM, SRIO, HPI	High-performance multiprocessor solution	
TMS320C6474 *Page 90*	DSP	3x 1.2GHz C64x+ cores, 3MB RAM, SRIO	High-performance multiprocessor solution	
TMS320C6745	DSP	1800MFLOPS, 256KB L2	Low cost floating point, combines C64x+ and C67x cores	TMS320C671x
TMS320C6747 *Page 91*	Industry's Lowest Power Floating-Point DSPs	32-/64-bit accuracy, 1.8V to 3.3V I/O supply, low power and rich connectivity peripherals	Uses three times less power than existing floating-point DSPs	
TMS320DM355 *Page 92*	Highly Integrated, Programmable Platform for Low Cost Portable Digital Video Apps	ARM926 at 216/270MHz; MPEG4 HD (720p) and JPEG up to 50M pixels per second	High quality, low-power consumption at low price	TMS320DM365, TMS320DM368
TMS320DM6446 *Page 88*	Highly Integrated Video SoC	Robust operating systems support, rich user interfaces, high processing performance, and long battery life	High quality, low-power consumption at low price	TMS320DM6443, TMS320DM6441
TMS320F2802x/3x Piccolo™	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F283x Delfino™	32-Bit Floating-Point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
Interface				
SN65LVDS387	16-Channel LVDS Driver	630Mbps	High-density LVDS driver	SN65LVDS386
SN65LVDS93A	24-Bit RGB LVDS Serdes	10MHz-135MHz, BGA and TSSOP; supports 1.8V to 3.3V TTL i/p	Wide frequency range, saves space, no level shifter for 1.8V powered uP	SN75LVDS83B
SN65MLVD047	4-Channel M-LVDS Driver	Higher differential swing	Industry standard	SN65LVDS348
Clocking				
CDCE62005	Clock Generator	RMS jitter <1ps, recommended clocking solution for AFE580x and ADS528x/527x	Integrated VCO saves system cost	CDCE72010, CDCM7005
CDCE(L)949	Clock Synthesizer	Recommended clocking solution for TI DSPs	0ppm multiple-frequency generation	CDCE(L)937, CDCE(L)925
CDCE906	Clock Synthesizer	Recommended clocking solution for TI DSPs	0ppm multiple-frequency generation	CDCE706
Power Management				
bq20z40-R1	SBS-Compliant Gas Gauge with Impedance Track™ Technology for use with BQ29330	Impedance Track Technology, Supports the Smart Battery SBSV1.1 specification	Provides better than 1% error over lifetime of Li-Ion and Li-Polymer Batteries	bq20Z95
bq24721	Battery Charge Management	Multichemistry and multicell sync switch-mode charger	High efficiency, pack and system protection functions	bq24105
bq78PL114	High Power and High Capacity Battery Pack Management Controller	Designed for managing 3- to 8-series cell battery systems, high-resolution 18-bit integrating delta-sigma Coulomb Counter for precise charge-flow measurements and gas gauging	Expandable from 3 – 12 Li-Ion cells in series, active cell balancing	bq76PL102

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*新产品以***粗体红色***标明。*

→ **超声波 (Ultrasound)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (continued)				
DCH010505	Galvanic Isolated, DC/DC Converters	1W, 3kV isolation, minimal external components	Safety isolation, removal of ground loops, reducing board space	DCH010512, DCH010515
DCP01B	DC/DC Converter	5V, 15V, 24V input bus, 1W, unregulated, dual, isolated	1W P_{OUT} or I_{OUT}, ±5V, ±12V, ±15V V_O range	DCP02
PTB48500A	DC/DC Converter	48V input bus, 30W, dual, isolated	30W P_{OUT} to I_{OUT}, 3.3V/1.2V V_O range	PTB48501A/B
PTH04T240	Power Module	10A, 2.2V to 5.5V V_{IN}, adjustable V_{OUT}, with TurboTrans™ Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH04T241
PTH08T220	Power Module	16A, 4.5V to 14V V_{IN}, adjustable V_{OUT}, with TurboTrans Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH08T221
TPS3307	Voltage Supervisor	Triple processor supervisor	Two fixed and one adjustable supervisor for system flexibility	TPS3808
TPS386000	4-Channel Supervisor	0.25% acc, down to 0.4V, watchdog	High integration and high accuracy	TPS3808
TPS54317	DC/DC Converter	3.0 to 6.0V_{IN} 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	
TPS54350	DC/DC Converter	4.5 to 20V_{IN} 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS62110	DC/DC Converter	3.1 to 17V_{IN} 1.5A DC/DC with integrated switch FET, synchronization pin, enable, Low battery indicator, PFM mode	Very low noise/high efficiency	
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62420
TPS63000	Buck-Boost Converter	1.8A switch, automatic transition between step down and boost mode	Stable output voltage over entire entire V_{IN} range	TPS63010
TPS65073	PMU with charger and WLED	Integrates charger, WLED, DCDC and LDO.	Highest integration for portable applications	TPS650250
TPS727xx	Single Channel LDO	High PSRR/low noise/ultra low I_Q	Battery power applications	TPS717xx
TPS7A45xx	Single Channel LDO	High PSRR/low noise/ultra low I_Q	High Performance with $V_{IN} <= 20V$	TL1963xx
TPS74201	Single-Channel LDO	1.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat	TPS74301, TPS74801
TPS74401	Single-Channel LDO	3.0A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat	TPS74901
TPS74701	Single-Channel LDO	0.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat	
UCD90120	12-Channel Sequencer	GUI for programming 12 power rails	Sequencing, monitoring and margining	UCD9081, UCD90124
Pulsers and Switchers				
TX734 *Page 83*	Quad-Channel, High-Voltage Ultrasound pulser	Quad, 3-level RTZ, ±100V, ±75V, 2A integrated ultrasound pulser	Low-noise operation	TX810
TX810 *Page 83*	8-Channel Integrated T/R Switch	Eight bias current settings; eight power/performance combinations; accepts 200VPP input signals	Compact T/R switch; flexible programmability; easy power-up/down control; fast wake-up time; dual supply operation; optimized insertion loss	TX734
Temperature Sensor				
TMP441	±Temperature Sensor with Automatic Beta Compensation, Series-R and n-Factor in a 8-pin SOT23	±1°C remote diode sensor with ±1°C local temp sensor	Recommended for FPGA Temp monitoring in ultrasound	TMP421
Toolkits				
STK-MED *Page 126*	A collection of several standard ultrasound algorithms optimized for TI's C64x+ DSP architecture	Standard APIs; tested, benchmarked and documented library modules	Shortens customer development time by providing highly opttimized C64x+ DSP source code of common ultrasound processing blocks	
DLP® Discovery™ 4100	An optical semiconductor module that allows digital manipulation of light	±12° mirror operation, works with Visible, UV and near-IR light	This device can surpass the speed, precision and efficiency of other spatial light modulators	DLP® Pico™
DLP® Pico™ Kit	Projector Development Kit that fully integrates projection solutions for a vast array of portable medical devices	44.8x67.4x14.2mm³, I²C command interface	Well suited for incorporating digital projection into portable devices	DLP® Discovery™

*更多产品信息请参见指定页码。

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医疗成像

→ **超声波 *(Ultrasound)***

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards-compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee/IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400 m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz *Bluetooth*® 2.1 chipset	Single-chip *Bluetooth*® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/RF4CE/ZigBee	Excellent Rx sensitivity, low power, easy to use development tools	RF design made easy for fast time to market; provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz *Bluetooth*® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market *Bluetooth*® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth*® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and *Bluetooth*® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with *Bluetooth*® technology and Wi-Fi.	

如欲查阅更多系统方框图兼容的产品，敬请访问 **www.ti.com/*medical***   新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

➡ 计算体层成像（Computed Tomography，简称CT）

计算体层成像

计算体层成像是一种医疗成像技术，可通过一系列为数众多、采用单轴旋转结构（称为"滑动托架"[gantry]）获得的二维X射线图像（称为"断面"[profile]）构建人体内部某些部分的三维图像。传统的X射线成像是多个平面成层叠加所形成的单个图像，与之相比，CT成像在对比度方面有了显著的改善。

随着诸如CT等需要复杂且强大的图像处理能力的诊断成像系统的出现，半导体器件在开发具有更高密度、灵活性和高性能的系统的过程中起到了非常重要的作用。

使用一个X射线源围绕目标旋转，并通过一个处于X射线源圆周对称相反位置的探测器成像，可产生X射线切片数据。随着目标逐渐地通过滑动托架 (gantry)，更大量的数据扫描将不断展开。较新型的螺旋 (helical) 或旋转 (spiral) 式CT机使用更快速的计算机系统及优化软件，可在目标以恒定速度通过托架的同时连续地处理横截面图像。

探测器系统由大量具有闪烁体光电二极管 (scintillator-photodiode) 固态探测器的通道卡 (channel card) 组成。X射线与闪烁体相互作用并产生可见光，该可见光又由光电二极管转换成电流。X射线波束方向上被射线照相术所忽略的深度信息将通过观察多个不同方向上的幻灯切片得以复原。

通道卡具有前端系统，在此，至检测器的电荷将由放大器进行积分、增益放大并通过ADC转换为数字值。源自所有通道卡的数字数据经由高速链路传输至控制卡 (control card)，并到达图像调节卡 (image conditioning card)。图像调节卡连接至可观察CT图像的主控计算机。这里，数字数据将通过被称为体层成像重构 (tomographic reconstruction) 的数学程序组合在一起。电源、时钟及时钟分配电路、基准及基准缓冲器、逻辑器件及接口产品是通道卡子系统的一些关键模块。

控制卡可包括DSP及FPGA、电源、时钟及时钟分配电路以及接口模块。DSP可用于提供精确的控制，包括托架的旋转、平台的移动（上/下及进/出）及托架的倾斜（以实现角度成像），并可实现诸如X射线波束开启及关闭等其他功能。DSP的另一个重要控制功能是心电图选通 (ECG gating)，用以降低人体心脏跳动所导致的人为动作干扰。在此，将谨慎地使数据采集与心跳同步。

面向CT扫描仪的产品组合

- 通道卡前端和控制卡子系统，包括数据转换器、处理器、电源管理解决方案和其他模拟产品。
- 单芯片解决方案，用于直接对来自CT扫描仪中的光电二极管阵列的低电平电流进行数字化处理。
- 采用TI的VelociTI™ VLIW架构的DSP可用于提供精确的控制，包括托架的旋转、平台的移动和托架的倾斜（以实现角度成像），以及其他的实时控制和处理功能。
- 电压监控器、DC/DC转换器、非隔离型电源模块和低压降线性稳压器，用于满足排序要求。
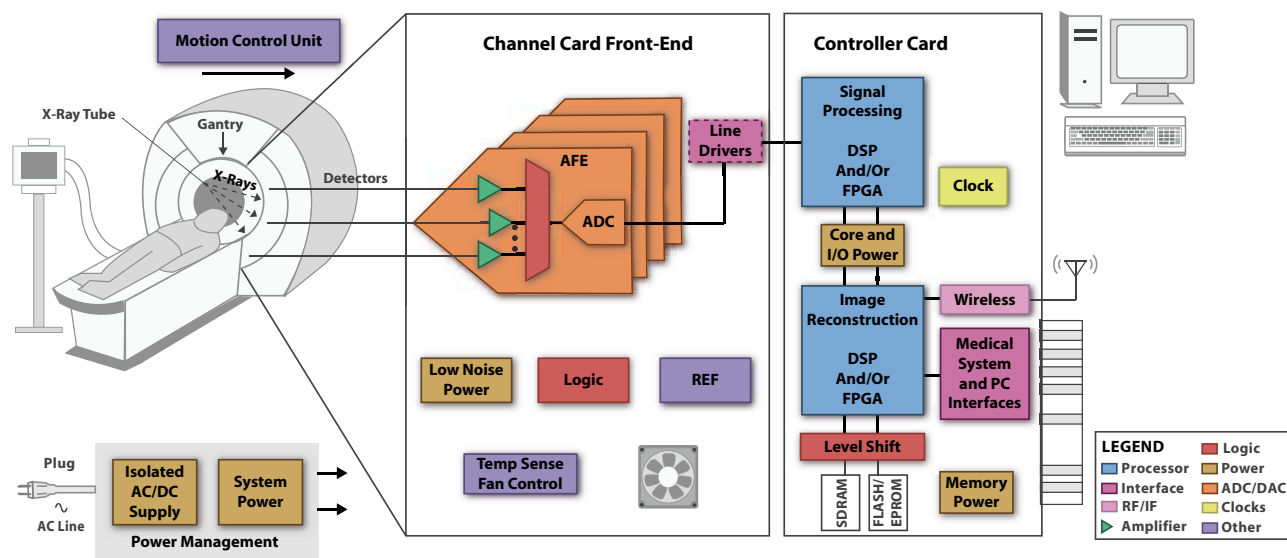
CT扫描仪系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

医疗成像

→ **计算体层成像（*Computed Tomography*，简称*CT*）**

双通道、电流输入、20位ADC
DDC232

敬请访问**www.ti.com/sc/device/DDC232**，以获取样片、数据表、应用报告及评估板。

主要特点

- 完整的解决方案，能够以20位的分辨率测量32个光电二极管
- 持续的电荷收集
- 可调积分时间：160μs至超过1s
- 可编程满标度：12.5pC至高达350pC
- 低噪声：5ppm，rms
- 积分非线性度：±0.025%，读取±1ppm FSR
- 单电源，每通道功耗为7mW
- 串行数字接口，可支持菊环链接 (daisy chaining)
- 封装：8mm x 8mm BGA

应用

- CT扫描仪
- X射线系统
- 光电二极管传感器阵列

通过支持计算体层成像 (CT) 扫描仪内部的光电二极管阵列所产生的低电平电流的测量，TI提供了多款能够满足医疗成像系统设计人员需求的产品。

DDC产品是单芯片解决方案，可用于CT扫描仪内部的光电二极管阵列所产生的低电平电流的直接数字化处理。双通道积分器前端可提供持续的电荷收集 (charge collection)。当某一积分器收集光电二极管电流时，另一个积分器则通过板载的20位ADC实现测量。用户可自行调节积分时间，输出数据可通过串行接口取回，该串行接口可以采用菊环链接以最大限度地减少多通道系统中的数字互连线。
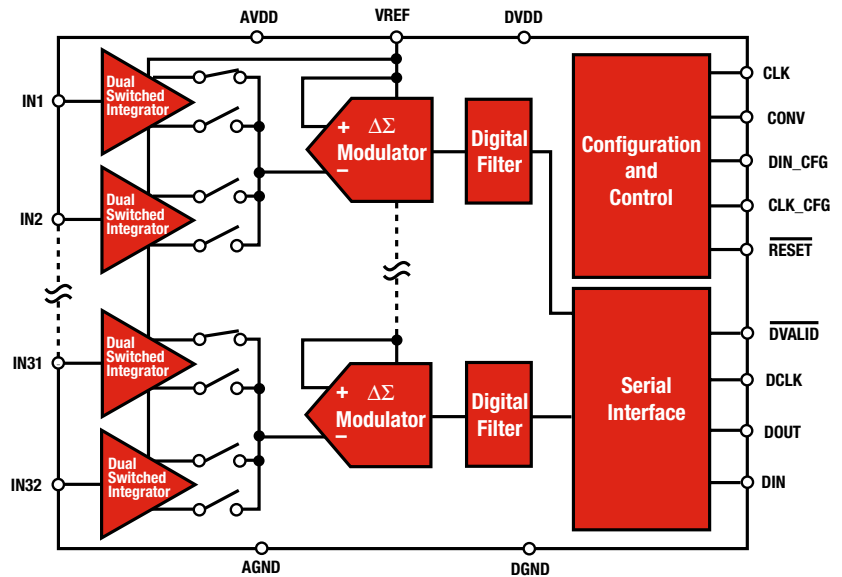
DDC232原理图
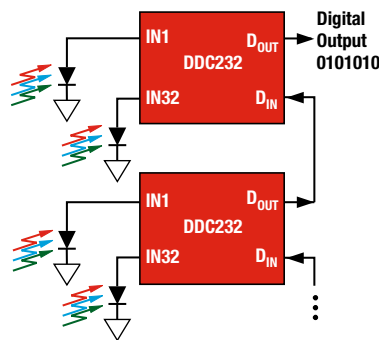
采用DDC232 ADC的光电二极管测量

DDC架构

医疗成像
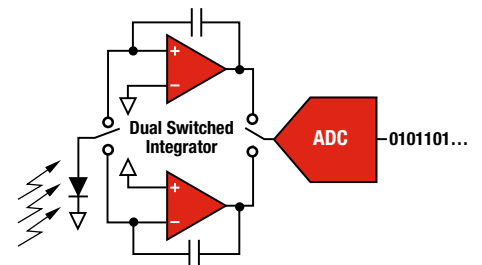
精密型高速跨阻抗放大器
OPA380

敬请访问**www.ti.com/sc/device/OPA380**，以获取数据表及应用报告。

OPA380跨阻抗放大器系列提供了高速度、高精度及长期稳定性。该器件在失调、漂移以及噪声性能上均优于传统的JFET运算放大器。

主要特点

- 超过1MHz的TIA带宽
- 动态范围：5个数量级
- 固有的长期稳定性
- 输出摆幅包括参考地
- 非常低的1/f噪声
- 偏置电流：50pA（最大值）
- 失调电压：2μV（最大值）
- 漂移：0.1μV/℃
- 增益带宽：90MHz
- 静态电流：6mA
- 电源范围：2.7V至5.5V
- 单通道及双通道版本
- 封装：MSOP-8及SO-8
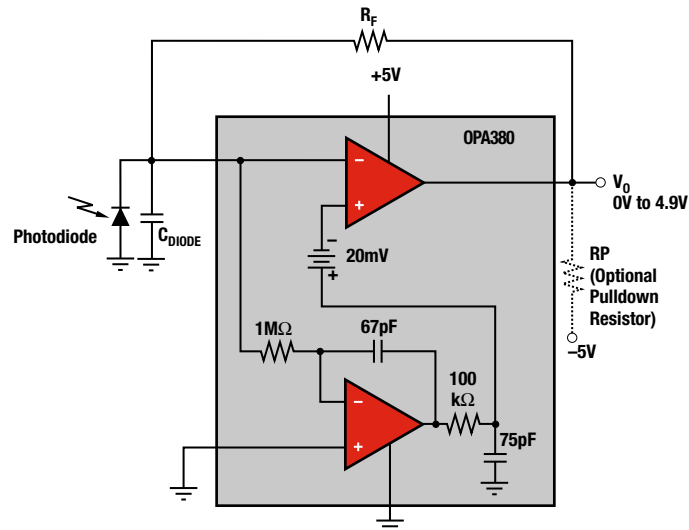
应用

- CT扫描仪前端
- 精密电流至电压测量
- 光学放大器
- 光电二极管监测

OPA380原理框图

带并行接口的18位、1MSPS、差分输入微功率ADC
ADS8482

敬请访问**www.ti.com/sc/device/ADS8482**，以获取样片、数据表、应用报告及评估板。

ADS8482是18位、1MSPS ADC，具有内部4.096V基准以及伪双极 (pseudo-bipolar) 全差分输入。该器件具有全18位接口、16位保持选项（数据读取耗用两个读周期）或8位总线选项（耗用三个读周期）。其他特点包括99dB SNR（信噪比）、－121dB THD（总谐波失真）、123dB SFDR（无杂散动态范围）、板载6ppm/℃漂移基准以及板载基准缓冲器。

主要特点

- 采样速率：0至1MHz
- 积分非线性：±1.2 LSB（典型值）；±2.5 LSB（最大值）
- 差分非线性：+0.75/－0.6 LSB（典型值）；+1.5/－1 LSB（最大值）
- 在整个温度范围内确保18位无漏失码（NMC）
- 偏置误差：±0.05mV
- 偏置误差漂移：±0.05ppm/℃
- 零延迟
- 宽数字电源范围：2.7V至5.25V
- 低功耗：225mW（在1MSPS）
- 封装：48引脚QFN，7mm x 7mm
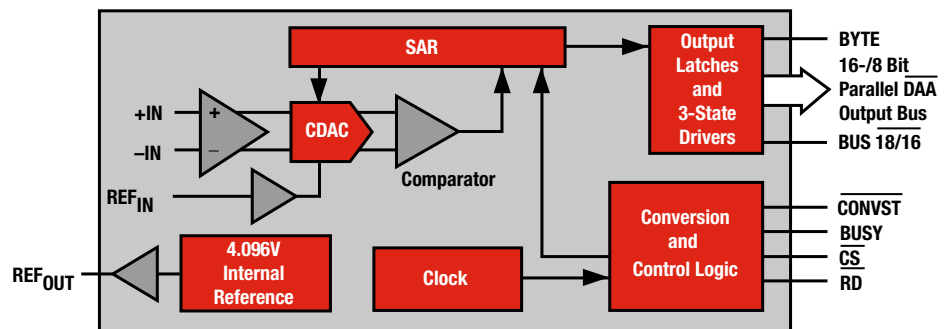
应用

- 医疗仪器
- 传感器接口
- 高精度数据采集系统

ADS8482原理框图

→ 计算体层成像（Computed Tomography，简称CT）

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifier				
OPA2211	Lowest Power, 1.1nV/√Hz Noise, Precision Operational Amplifier in DFN-8 (3 x 3mm) and SOIC-8	Extremely low voltage and low current noise, high speed and wide output swing	Allows 16-bit accuracy throughout 10V output swings	OPA627, OPA2111
OPA380 *Page 101*	Transimpedance Amp	90MHz GBW, over 1MHz transimpedance BW, 25µV offset (max), 0.1µV/°C drift (max)	Precision, dynamic range 4 to 5 decades, excellent long term stability	OPA350, OPA335
OPA827	Precision JFET Op Amp	4nV/√Hz noise at 1kHz, ±4V to ±18V supply, 15pA (typ) input bias current, 22MHz BW	High precision, low noise, low input bias, wide supply range	OPA177, OPA627,
Data Converters				
ADS8284	SAR ADC	18-bit, 1MSPS, 4 MUX inputs, 98.5dB (typ) SNR at 10kHz	Integrated op amp, ultra-high DC and AC performance	
ADS8317	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Excellent linearity, micropower, high speed	ADS8422
ADS8326	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Low noise, low power, high speed	ADS8325
ADS8482 *Page 101*	SAR ADC	18-bit, 1MSPS, 2.25mW power, 99dB SNR, ±2.5 LSB (max) INL	Pseudo bipolar, internal or external reference	ADS8472, ADS8484
ADS8484	High-Speed SAR	18-bit, 125MSPS, 98dB (typ) SNR, −110dB (typ) THD	Excellent drift performance	
DDC112	2 Channels	50 to 100pC full-scale	Up to 3kSPS data rate, 40mW/Ch	SOIC-28 or TQFP-32
DDC114	4 Channels	12.5 to 350pC full-scale	Up to 3.1kSPS data rate, 13.5mW/Ch	QFN-48
DDC118	8 Channels	12.5 to 350pC full-scale	Up to 3kSPS data rate, 40mW/Ch	QFN-48
DDC232 *Page 100*	32 Channels	12.5 to 350pC full-scale	Up to 6kSPS data rate, 7mW/Ch	BGA-64
References				
REF02	Precision V_{REF}	0.2% (max) initial accuracy, 10ppm/°C (max) drift, 1.4mA (max)	Excellent line/load regulation, low noise	REF5050
REF102	10V, Ultra Precision	0.05% (max) initial accuracy, 2.5ppm/°C (max) drift, 1.4mA (max)	Excellent stability and line/load regulation	REF5010
REF31xx	Voltage Reference	15ppm/°C (max) drift, 5mV low dropout, 115µA (max) I_Q, 0.2% (max) accuracy, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	No load capacitor required	REF3130, REF3120
REF32xx	Low Drift, Bandgap	0.2% (max) accuracy, 7ppm/°C (max) drift, 0.1mA (max) I_Q 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Multiple output voltages, SOT23-6	
REF33xx	Very Low Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF5010	Low Noise. Very Low Drift, Precision Voltage Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 10V	Improves system accuracy	REF102
REF50xx	High-Precision, Very Low Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V , 5.0V	Improves system accuracy	REF02
Processors				
TMS320C-6455BZTZ	DSP	1.2GHz, SRIO, 2MB RAM	High-performance, fixed-point 16-bit processor	TMS320C6454BZTZ
TMS320F2808	Digital Signal Controller	100MIPS, 8KB ROM, 36KB RAM, 128KB flash, 12-bit ADC	I²C, 4 SPI, 2 SCI, 2 CAN	
TMS320F2812	Digital Signal Controller	150MIPS, 8KB ROM, 36KB RAM, 256KB flash, 12-bit ADC	McBSP, 1 SPI, 2 SCI, 1 CAN	
TMS320F28015	Digital Signal Controller	60MIPS, 8KB ROM, 12KB RAM, 32KB flash, 12-bit ADC	I²C, 1 SPI, 1 SCI	
TMS320F2802x/3x Piccolo™	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F283x Delfino™	32-Bit Floating-Point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320C6474	DSP	3x 1GHz C64x+™ DSP cores, 3MB RAM, SRIO	High-performance multiprocessor solution	

*更多产品信息请参见指定页码。如欲查阅更多系统框图兼容的产品，敬请访问**www.ti.com/medical***

→ 计算体层成像（Computed Tomography，简称CT）

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Interface				
XIO1100	x1 PCIe PHY	Interface FPGA to PCIe fabric between channels	PCIe 1.1 compliant, flexible MAC interface	
TLK1221	Gigabit Ethernet Serdes	Power 250mW	Smallest package	TLK2208B
SN65LVCP40	Dual 1:2 Mux/Buffer	Input EQ, output pre-emp	Improves signal range	
SN65LVDS93A	24-bit RGB LVDS Serdes	10MHz-135MHz, BGA and TSSOP; supports 1.8V to 3.3V TTL i/p	Wide frequency range, saves space, no level shifter for 1.8V powered uP	SN75LVDS83B
Clocking				
CDCLVP12xx/21xx	1:2/4/8/12/16 or Dual 1:2/4/6/8 Universal-to-LVPECL Clock Buffers	Very low additive jitter <100ps RMS; 2.5V / 3.3V operation	Improved clock signal quality by 10x; saves additional interface logic / external components	CDCLVP111, CDCLVP215
Analog Multiplexers				
TS3A5017	Dual SP4T 3.3-V/2.5-V Analog Multiplexer/Demultiplexer	Low total harmonic distortion	Excellent signal integrity in both digital and analog applications	
TS3A5018	Quad SPDT 3.3V/2.5V Analog Switch	Low on state resistance and matching (R_{ON} = 10)	Minimizes signal loss and ensures less variance	
Power Management				
PTH04T240	Power Module	10A, 2.2V to 5.5V V_{IN}, adjustable V_{OUT}, with TurboTrans™ Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH04T241
PTH08T220	Power Module	16A, 4.5V to 14V V_{IN}, adjustable V_{OUT}, with TurboTrans Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH08T221
TPS3307	Voltage Supervisor	Triple processor supervisor	Two fixed and one adjustable supervisor for system flexibility	TPS3808
TPS386000	4-Channel Supervisor	0.25% acc, down to 0.4V, watchdog	High integration and high accuracy	TPS3808
TPS40020	2.25V to 5.5V DC/DC Controller	Synchronization pin, PG, enable	Eliminate beat noise/ceramic caps/FPGA/regulation from main power supply	TPS40042
TPS40057	8V to 40V DC/DC Controller	Synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/regulation from main power supply	TPS40200
TPS54317	DC/DC Converter	3.0 to 6.0V_{IN} 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54610/TPS54910
TPS54350	DC/DC Converter	4.5 to 20V_{IN} 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS6206x	Step-Down Converter	High frequency operation, 2x2 QFN package, power save mode	High efficiency, small solution size	TPS62290
TPS62110	Step-Down Converter	3.1V to 17V V_{IN}, 1.5A conversion, synchronization pin, Low battery indicator, power save mode	Very low noise/high efficiency	TPS62050
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62420
TPS74201	Single-Channel LDO	1.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74301, TPS74801
TPS74401	Single-Channel LDO	3.0A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74901
TPS74701	Single-Channel LDO	0.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	
UCD90120	12-Channel Sequencer	GUI for programming 12 power rails	Sequencing, monitoring and margining	UCD9081, UCD90124

如欲查阅更多系统方框图兼容的产品，敬请访问www.ti.com/medical　　　　　　　*新产品以**粗体红色**标明。*

医疗成像

→ 计算体层成像（Computed Tomography，简称CT）

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards-compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400-m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC2560	2.4GHz *Bluetooth®* 2.1 chipset	Single-chip *Bluetooth®* solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/RF4CE/ZigBee	Excellent Rx sensitivity, low power, easy to use development tools	RF design made easy for fast time to market; provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP, CC2531
CC2540	2.4GHz *Bluetooth®* Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market *Bluetooth®* low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth®* 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth®* solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth®* operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and *Bluetooth®* 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and *Bluetooth®* solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth®* operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity and blocking performance systems; excellent coexistence with *Bluetooth®* technology and Wi-Fi.	

如欲查阅更多系统方框图兼容的产品，敬请访问 **www.ti.com/medical**

*新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。*

医疗成像

→ 核磁共振成像 (MRI)

核磁共振成像 (MRI)

核磁共振成像 (MRI) 是非侵入性的诊断技术，可生成人体的生理学图像。MRI系统采用强磁铁产生磁场，该磁场将迫使人体内的氢原子产生特定的排列。贯穿分布在患者体内的射频 (RF) 能量因人体组织而产生扰动 (disrupted)。这些扰动对应于不同的返回信号，经处理后产生图像。

精确的信号处理是获得高质量图像的关键。对于接收通道来说，一个关键的系统考虑因素就是高信噪比 (SNR)。返回信号具有较窄的带宽，其中频 (IF) 定位取决于主磁体的强度。一些系统采用高速流水线型ADC以及宽带放大器对中频进行采样，从而为数字降频转换器或FPGA的后处理增益留出了很大的提升空间。其他系统则将中频混频至基带，可以使用更低速度、更高分辨率的SAR及Δ-Σ型ADC。

为控制核磁共振成像中的磁场及射频能量，高分辨率、高速的DAC是必不可少的。高分辨率用于精确地定位所扫描的患者部位，高速则是匹配由主磁体产生的高中频所必需的。

DSP可用于提供梯度式的 (gradient) 处理器控制，旨在准确地控制核磁共振成像系统的磁体。DSP还可用于实现MRI设备中的信号处理功能。MRI的图像重构主要基于2D傅立叶变换。此外，诸如自相关及互相关、曲线拟合、合并子图像及运动稳定等功能性均需要对图像进行预处理及后处理，以降低各种人为干扰。

模拟IC和嵌入式处理器在改善核磁共振图像的输送速度和鲜明细节方面起着重要的作用，可实现更加准确的诊断和有效的治疗。准确的信号处理是是获得高质量MRI图像的关键。

面向MRI的产品组合

- 一些系统采用高速流水线型ADC以及宽带放大器对由主磁铁产生的中频(IF)进行采样。
- 其他系统则将中频混频至基带，因而允许使用更低速度、更高分辨率的逐次逼近型寄存器 (SAR) 及Δ-Σ型ADC。
- 高分辨率DAC能够控制MRI中的磁能和射频能量。
- 诸如TMS320C6452等DSP可提供梯度式的 (gradient) 处理器控制，旨在准确地控制磁铁并在信号到达图像重构引擎之前对其进行预处理。
- 为MRI系统和设备制造商提供的其他产品包括运算放大器、时钟分配、接口及电源管理器件。
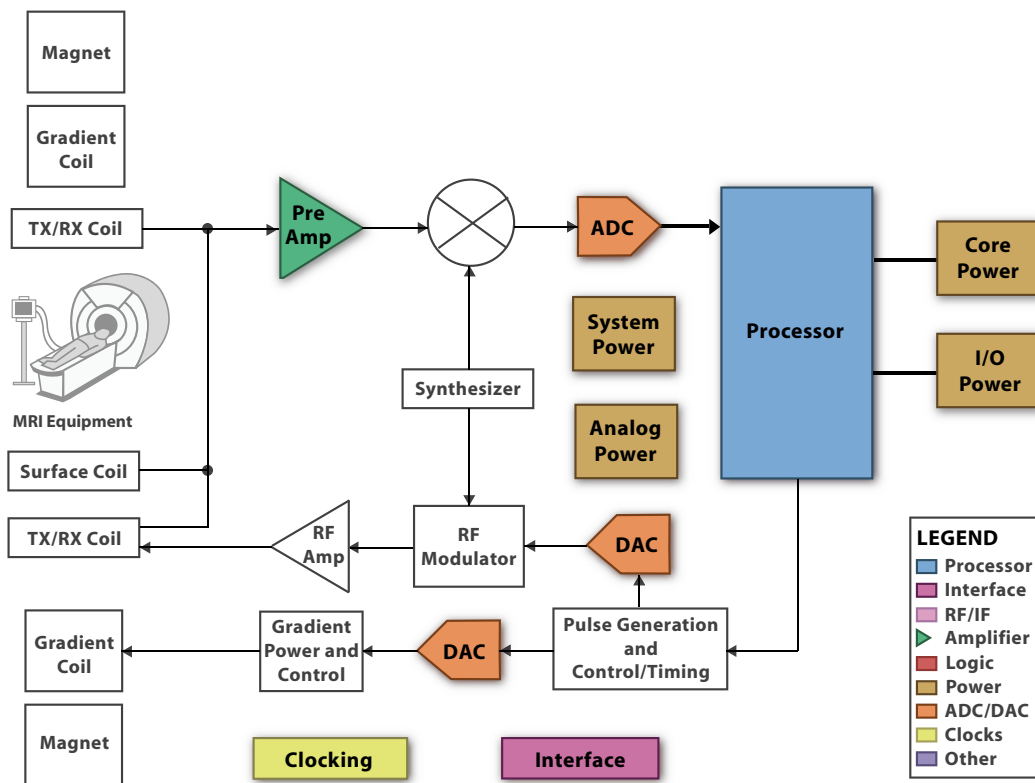
核磁共振成像 (MRI) 系统方框图

医疗成像

→ **核磁共振成像 (MRI)**

针对科学仪表的16位、10MSPS Δ-Σ ADC
ADS1605、ADS1610

敬请访问**www.ti.com/sc/device/ADS1605**或**www.ti.com/sc/device/ADS1610**，以获取样片、数据表、评估板及应用报告。

主要特点

- 输出数据速率：10MSPS (ADS1610)，5MSPS (ADS1605)
- 信号带宽：4.9MHz
- 信噪比 (SNR)：86dBFS
- 总谐波失真 (THD)：−94dB
- 无杂散动态范围 (SFDR)：95dB
- 片上数字滤波器简化了对抗混叠的要求
- 低群延迟：3μs
- 并行接口
- 可直接连接至TMS320 DSP
- 封装：TQFP-64

应用

- 科学仪表
- 测试设备
- 通信

ADS1610的 Δ-Σ 拓扑结构在抗混叠滤波及时钟抖动方面提供了重要的系统级设计优势。其输出数据通过一个并行接口提供，可以很容易地连接至TMS320™ DSP。该器件的功耗可通过单个外部电阻器来调节，允许以较低的运转速度换取功耗的降低。
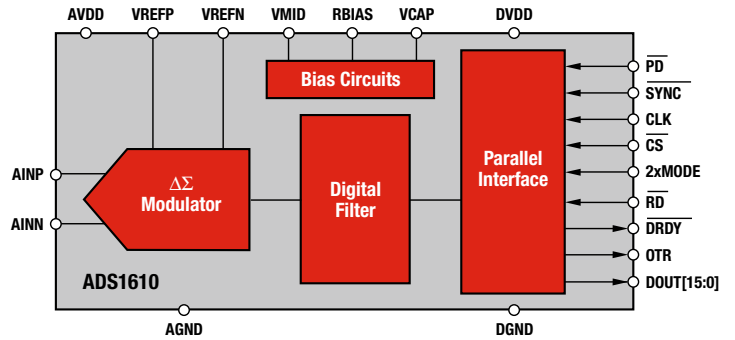
ADS1610原理框图

65至250MSPS 12位、14位、单通道、双通道和四通道ADC
ADS64xx、ADS62xx、ADS62Pxx、ADS61xx、ADS61Bxx

敬请访问**www.ti.com/sc/device/ADS6424**，以获取样片、数据表及评估板。

主要特点

- 11位、12位和14位分辨率（65至250MSPS）
- 可提供四通道、双通道和单通道版本
- 总功耗：每通道260mW至780mW
- SNR：70dBFS（在F$_{IN}$ = 250MHz，125MSPS）
- SFDR：81dBc（在F$_{IN}$ = 250MHz，125MSPS）
- 3.5dB粗调增益，可以SFDR/SNR的轻微下降换取高达6dB的可编程细调增益
- 串行化（四通道、双通道器件）和并行（双通道、单通道器件）输出选项
- 可编程输出终端及LVDS驱动能力
- 模拟和数字电源：3.3V

应用

- 软件定义无线电
  - 多天线接收机
  - 高中频 (IF) 接收机
- 无线通信：
  - DPD反馈环路
  - 宽带数字中继器
- 高密度通用型数字化转换器

ADC6000系列包括65至250MSPS的高性能单通道和双通道ADC解决方案以及65至125MSPS的四通道ADC解决方案，具有并行和串行化输出选项。该系列专为要求苛刻的无线应用而设计，在高中频 (IF) 条件下具备高性能——在250MHz频率下可提供高达70dB SNR及81dBc SFDR。ADS6000系列极为灵活，具有可编程增益设定值、LVDS终端电阻器和LVDS驱动能力。此外，该系列中通道数和输出格式相同的所有器件均具有引脚对引脚的兼容性，从而简化了速度和分辨率之间的变迁。

原理框图

医疗成像
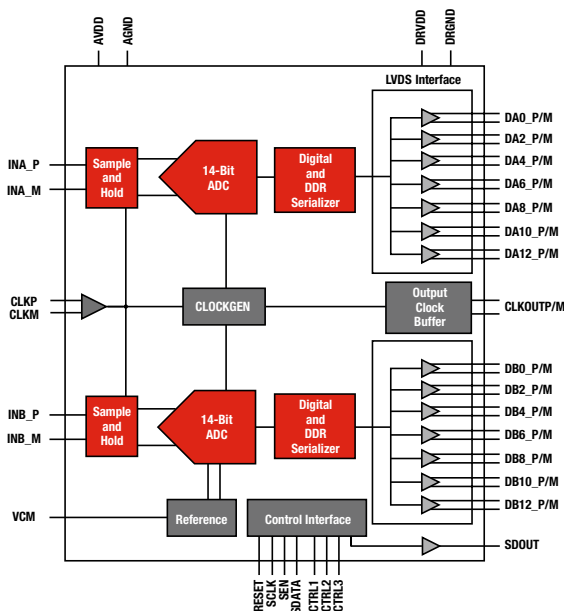
宽带运算跨导放大器
OPA861

敬请访问**www.ti.com/sc/device/OPA861**，以获取样片、数据表、评估板及应用报告。

主要特点

- 大带宽：80MHz，开环，增益 = +5
- 高转换速率：900V/μs
- 大跨导：95mA/V
- 外部I_Q控制
- 低静态电流：5.4mA

OPA861是宽带、双极型运算跨导放大器 (OTA)。OTA或压控电流源可被看作是理想晶体管。和普通晶体管一样，理想晶体管具有三个接线端——高阻抗输入端（基极）、低阻抗输入/输出端（发射极）、电流输出端（集电极）。然而，OPA861属于自偏压双极型放大器。由于基极-发射极之间的零电压，使得输出集电极电流为零。以零电平为中心的交流输入产生一个输出电流，该电流也为双极型并以零电平为中心。OPA861的跨导可通过单个外部电阻器进行调节，从而优化了带宽、静态电流与增益之间的折衷方案。

应用

- 视频设备
- 通信
- 高速数据采集
- 宽带LED驱动器
- 控制环路放大器
- 宽带有源滤波器
- 线路驱动器
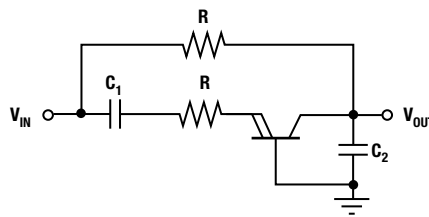
低通负阻抗转换器 (NIC) 滤波器
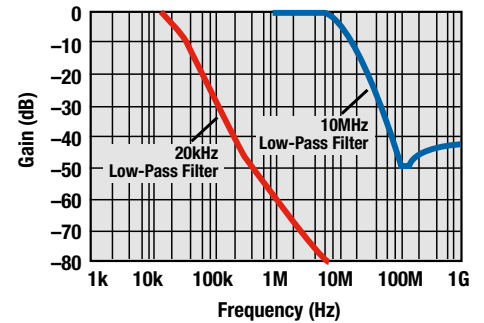
20kHz及10MHz低通NIC滤波器的频率响应

高性能定点型DSP
TMS320C6452

敬请访问**www.ti.com/sc/device/TMS320C6452**，以获取样片、数据表、工具及应用报告。

主要特点

- 720MHz、900MHz C64x+™时钟频率
- 1.39、1.11ns指令周期时间
- 5760、7200 MIPS
- 每周期可执行8条32位C64x+指令
- 扩展至VelociTI™高级超长指令字 (VLIW) TMS320C64+™ DSP核心
- C64x+指令集特性
- C64x+ L1/L2内存架构

应用

- 核磁共振成像 (MRI)
- 成像
- 电信基础设施
- 通信

TMS320C64+™ DSP是TMS320C6000™ DSP平台中最高性能的定点型DSP系列。C6452器件基于第三代高性能高级VelociTI™超长指令字 (VLIW) 架构，使得此类DSP成为了医疗成像、电信基础设施及通信应用的绝佳选择。C64x+™系列芯片可向上代码兼容属于C6000™ DSP平台部分的早期芯片。

TMS320C6452原理框图

医疗成像

→ **核磁共振成像 (MRI)**

带串行化LVDS接口的8通道、超低功耗、12/10位、50至65MSPS模数转换器
ADS5281、ADS5282、ADS5287

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片、数据表及评估板。
（**PARTnumber**请使用**ADS5281**、**ADS5282**或**ADS5287**替换）

主要特点

- 单片小型64引脚QFN封装内包含8通道的12位或10位ADC
  - ADS5821还可提供80引脚TQFP封装版本，与ADS527x系列引脚兼容
- 65MSPS时，每通道功耗为77mW；
- 50MSPS时，每通道功耗为64mW
- 12位分辨率及10MHz中频时，信噪比（SNR）为70dB
- 1/f（闪烁）噪声抑制
- 单个时钟周期中高达6dB的过载恢复
- 独立的通道断电功能
- 可直接连接至VCA8500 8通道可变增益放大器
- Xilinx®支持型解串器编码

应用

- 医疗及其他成像：
  - 超声波
  - 核磁共振成像 (MRI)
  - 正电子放射层析成像 (PET)

ADS5281系列以单片小型的64引脚QFN封装提供了8通道的高性能ADC，可支持实现多通道数量的高性能超声波及其他医疗成像系统。其每通道低功耗的特性还有助于实现紧凑的超声波设备，可获取额外的空间及电池寿命裕量，并可与VCA8500相结合以提供高性能的LNA至数字解决方案，适用于每通道功耗低于130mW的超声波应用。

ADS5281系列还整合了若干高级特性以优化系统性能，包括了可编程增益（0至12dB，1dB步进）、1/f（闪烁）噪声抑制以及单个时钟周期内的6dB输入过载恢复。ADS5281系列可提供12位分辨率50MSPS和65MSPS以及10位分辨率65MSPS的性能，具有很强的灵活性，可针对各种成像系统给出最理想的解决方案。

ADS5281/2/7原理图

医疗应用指南　　　　　　　　　　　　108　　　　　　　　　　　　德州仪器 2010

→ **核磁共振成像 (MRI)**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
OPA861 *Page 107*	Transconductance Amp	80MHz, open loop, G = +5BW, 900V/µs SR	95mA/V high transconductance, 5.4mA I_Q	
PGA870	Fully Differential PGA	650MHz BW, gain range: -11.5dB to +20dB, OIP3 +47dBm at 100MHz	Optimized for low distortion, accomodates varying signal levels	
THS4503	High-Speed Op Amp	370MHz BW, 3700V/µs SR, 5V, ±5V, 12V and 15V supply	Low distortion, fully differential	THS4504, THS4141
THS9000	Cascadeable Amp	50MHz to 400MHz, 50Ω input/output impedance	High dynamic range, single supply	
Data Converters				
ADS1605 *Page 106*	16-bit, 10-MSPS Delta-Sigma ADC	10 to 5MSPS, parallel interface with direct connection to TMS320 DSPs	Provides key system-level design advantages with respect to anti-aliasing filtering and clock jitter.	ADS1610
ADS1610 *Page 106*	Delta-Sigma ADC	16-bit, 10MSPS, parallel interface	SYNC pin for simultaneous sampling	ADS1605
ADS5281 *Page 108*	High-Speed ADC	8-channel, ultra-low-power, 12- and 10-bit, 50 to 65MSPS analog-to-digital converter	77mW per channel, serialized LVDS outputs, 1/F noise-suppression	ADS5282, ADS5287
ADS5282/87 *Page 108*	High-Speed ADC	Ultra-low-power, 8-channel, 12-bit, 65MSPS	77mW per channel, serialized LVDS outputs, 1/f noise suppression	ADS5281, ADS5287
ADS5423	High-Speed ADC	14-bit, 80MSPS, 74dBc at 80MSPS and 50MHz IF SNR	3.3V CMOS-compatible outputs, 2s-complement output format	ADS5424, ADS5433
ADS5545	High-Speed ADC	14-bit, 170MSPS, DDR LVDS/CMOS outputs	Programmable output clock position to ease data capture	ADS5546, ADS5547
ADS5547	High-Speed ADC	14-bit, 210MSPS, user-selectable DDR LVDS or CMOS parallel outputs	High performance	ADS5545, ADS5546
ADS5562	High-Speed ADC	Low-power, 16-bit ADC with up to 84dBFS SNR	High SNR, 1/f noise suppression with low power and small package ease data capture	ADS5560
ADS61xx/61Bxx *Page 106*	High-Speed ADC	11- /12- /14-bits, 65 to 250MSPS, 3.3V, 260 to 780mW per channel	High performance	ADS62xx, ADS62Pxx, ADS64xx
ADS62xx/62Pxx *Page 106*	High-Speed ADC	11- /12- /14-bits, 65 to 250MSPS, 3.3V, 260 to 780mW per channel	High performance	ADS61xx, ADS61Bxx, ADS64xx
ADS64xx *Page 106*	High-Speed ADC	11- /12- /14-bits, 65 to 250MSPS, 3.3V, 260 to 780mW per channel	High performance	ADS61xx, ADS61Bxx, ADS62xx, ADS62Pxx
ADS6425	High-Speed ADC	4-channel, 12-bit, 125MSPS, serial LVDS interface, 1.65W total power	High performance, multiple input option	
DAC904	High-Speed DAC	14-bit, 165MSPS DAC	Low-power DAC	
DAC5672	High-Speed DAC	14-bit, 275MSPS dual DAC	High sample rate with low power	DAC5662, DAC5652
DAC5681Z	High-Speed DAC	16-bit, 1GSPS 2x-4x interpolating DAC	High sample rate allows direct launch to low RF	DAC5681, DAC5682Z
DAC5687	High-Speed DAC	16-bit, 500MSPS interpolating with NCO	Digital integration and superior AC performance for flexible application and high-quality transmission	DAC5686
DAC7725	V_{OUT} DAC	Quad, 12-bit, 250mW (max) power, 10µs to 0.012% settling time	Double-buffered data inputs	DAC7724, DAC902, DAC900
References				
REF02	Precision V_{REF}	0.2% (max) initial accuracy, 10ppm/°C (max) drift, 1.4mA (max)	Excellent line/load regulation, low noise	REF5050
REF102	10 V, Ultra Precision	0.05% (max) initial accuracy, 2.5ppm/°C (max) drift, 1.4mA (max)	Excellent stability and line/load regulation	REF5010
REF31xx	Voltage Reference	15ppm/°C (max) drift, 5mV low dropout, 115µA (max) I_Q, 0.2% (max) accuracy, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	No load capacitor required	REF31xx, REF32xx, REF33xx
REF32xx	Low Drift, Bandgap	0.2% (max) accuracy, 7ppm/°C (max) drift, 0.1mA (max) I_Q, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Multiple output voltages, SOT23-6	
REF33xx	Very Low Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF5010	Low Noise, Very Low Drift, Precision Voltage Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 10V	Improves system accuracy	REF102
REF50xx	High-Precision, Very Low Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V	Improves system accuracy	REF02

* 更多产品信息请参见指定页码。
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*新产品以**粗体红色**标明。*

➡️ **核磁共振成像 (MRI)**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at portable power levels	OMAP3503, OMAP3515, OMAP3525
TMS320C6452/55 *Page 107*	DSP	900MHz, 1.4MB L2 cache, 2 x SGMII/Gigabit EMAC	High-performance DSP with improved system cost	TMS320C6414, TMS320C6455, TMS320C6454, TMS320C6747
TMS320C-6455BZTZ	DSP	1.2GHz, SRIO, 2MB RAM	High-performance, fixed-point 16-bit processor	TMS320C6454BZTZ
TMS320F2808	32-Bit MCU	100MIPS, 8KB ROM, 36KB RAM, 128KB flash, 12-bit ADC	I^2C, 4 SPI, 2 SCI, 2 CAN	
TMS320F28015	32-Bit MCU	60MIPS, 8KB ROM, 12KB RAM, 32KB flash, 12-bit ADC	I^2C, 1 SPI, 1 SCI	
TMS320F28234	32-Bit MCU	150MIPS, 8KB ROM, 68KB RAM, 256KB flash, 12-bit ADC	McBSP, 1 SPI, 2 SCI, 2 CAN	
TMS320F283x Delfino™	32-Bit Floating-point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320C6474	DSP	3 x 1GHz C64x+ cores, 3MB RAM, SRIO	High-performance multiprocessor solution	
Interface				
SN65MLVD128	1:8 Fanout Buffer	200Mbps	Standardized M-LVDS	SN65MLVD2
SN65LVDS93A	24-Bit RGB LVDS Serdes	10MHz-135MHz, BGA and TSSOP; supports 1.8V to 3.3V TTL i/p	Wide frequency range, save space, no level shifter for 1.8V powered uP	SN75LVDS83B
Clocking				
CDCE62005	Clock Generator	rms jitter <1ps, recommended clocking solution for AFE580x and ADS528x/527x	Integrated VCO saves system cost	CDCE72010, CDCM7005
CDCE(L)949	Clock Synthesizer	Recommended clocking solution for TI DSPs	0ppm multiple-frequency generation	CDCE(L)937, CDCE(L)925, CDCE(L)913
CDCE906	Clock Synthesizer	Recommended clocking solution for TI DSPs	0ppm multiple-frequency generation	CDCE706
Digital Up/Down Converters				
GC5016	Digital Up/Down Converter	Quad, 160MSPS for 4 channels, 115dB SFDR	Many multiplex output options	
GC5018	Digital Down Converter	8-channel, real or complex DDC inputs, 115dB SFDR NCO	Final ACG	
Power Management				
PTH04T240	Power Module	10A, 2.2V to 5.5V V_{IN}, adjustable V_{OUT}, with TurboTrans™ Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH04T241
PTH08T220	Power Module	16A, 4.5V to 14V V_{IN}, adjustable V_{OUT}, with TurboTrans Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH08T221
PTQA430033	Isolated DC/DC Module	100W, 1500V DC isolation, differential remote sense	High efficiency, industry-standard pin-compatible	PTQB425080
TPS3307	Voltage Supervisor	Triple processor supervisor	Two fixed and one adjustable supervisor for system flexibility	TPS3808
TPS386000	4-Channel Supervisor	0.25% acc, down to 0.4V, watchdog	High integration and high accuracy	TPS3808
TPS40020	DC/DC Controller	2.25V to 5.5V$_{IN}$, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/ regulation from main power supply	TPS40042
TPS40075	DC/DC Controller	4.5V to 28V$_{IN}$, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/ regulation from main power supply	TPS40057
TPS54317	DC/DC Converter	3.0V to 6.0V$_{IN}$ 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/ integration	TPS54610/TPS54910
TPS54350	DC/DC Converter	4.5V to 20V$_{IN}$ 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/ integration	TPS54550
TPS6206x	Step-Down Converter	High frequency operation, 2x2 QFN package,power save mode	High efficiency, small solution size	TPS62290
TPS62110	Step-Down Converter	3.1V to 17V V_{IN}, 1.5A conversion, synchronization pin, Low battery indicator, power save mode	Very low noise/high efficiency	TPS62050
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62420
TPS74201	Single-Channel LDO	1.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74301, TPS74801

* 更多产品信息请参见指定页码。
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*新产品以**粗体红色**标明。*

医疗成像

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
TPS74401	Single-Channel LDO	3.0A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74901
TPS74701	Single-Channel LDO	0.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	
UCD90120	12-Channel Sequencer	GUI for programming 12 power rails	Sequencing, monitoring and margining	UCD9081, UCD90124
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling w/64-B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards-compatible w/existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temp range; AES-128 security module	Reliable RF link w/interference; 400m line-of-sight range with dev. kit; ideal for industrial apps; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	USB enabled System-on-Chip solution for 2.4GHz IEEE 802.15.4/ RF4CE/ZigBee	Excellent Rx sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market; provides a robust and complete ZigBee USB dongle or firmware upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz *Bluetooth*® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market *Bluetooth*® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth*® solution using TI's Digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1273
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity/blocking performance systems; excellent coexistence w/*Bluetooth*® technology and Wi-Fi.	

如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical**　　　　　　　　　新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

医疗成像

→ *数字式X光*

数字式X光因为诸如数字信号处理等技术的发展而得以成为现实，它正在彻底变革诊疗放射医学，并催生革命性的新型应用（比如：它们已被应用于外科手术）。数字式X光的关键优点之一是其能够存储和传输数字图像，从而实现了放射医学业务的外包，或者可以很容易地使用远程和/或专业分析。

传统的X光系统（无论其个别元件是否经过优化）只能捕获不到40%的原始图像信息。通过在X光成像中增添数字检测器，如今已经可以捕捉到80%以上的原始图像信息，并可使用多种后处理工具进一步地改善图像。

其他凭借半导体技术而实现的数字式X光技术进步包括：

- 通过免除相片冲印处理并简化借助网络连接进行的快速传输而缩短了诊断时间。
- 由于无需采用化学药剂处理相片而降低了成本。
- 仅处理那些突出显示所关注区域的图像数据，并抑制无关信息。
- 将图像数据与其他有关的放射信息系统 (RIS) 和医院信息系统 (HIS) 记录相结合。
- 高效完成所有相关信息的存档。

数字式X光技术包含了两种不同的方法：计算X光摄影 (CR) 及数字X光摄影 (DR)。

计算X光摄影通过包含光激励磷层 (photo-stimulated phosphor，PSP) 的成像平板 (imaging plate) 进行电子俘获，并将其曝光以产生图像数据。IP平板随后移动至CR读取器并通过激光光束扫描读出。

第二种方法（即数字X光摄影）同时采用了直接转换和间接转换。在直接转换中，平板硒检测器直接吸收X射线并将之转换为独立像素电荷。在间接转换中，X射线信号首先被转换为光信号，而后被转换为电荷。平面电荷耦合器件 (CCD) 阵列及计算体层成像 (CT) 均采用了间接转换技术。平面CCD转换技术采用了多个通过光纤耦合至闪烁体平板 (scintillator plate) 的CCD。
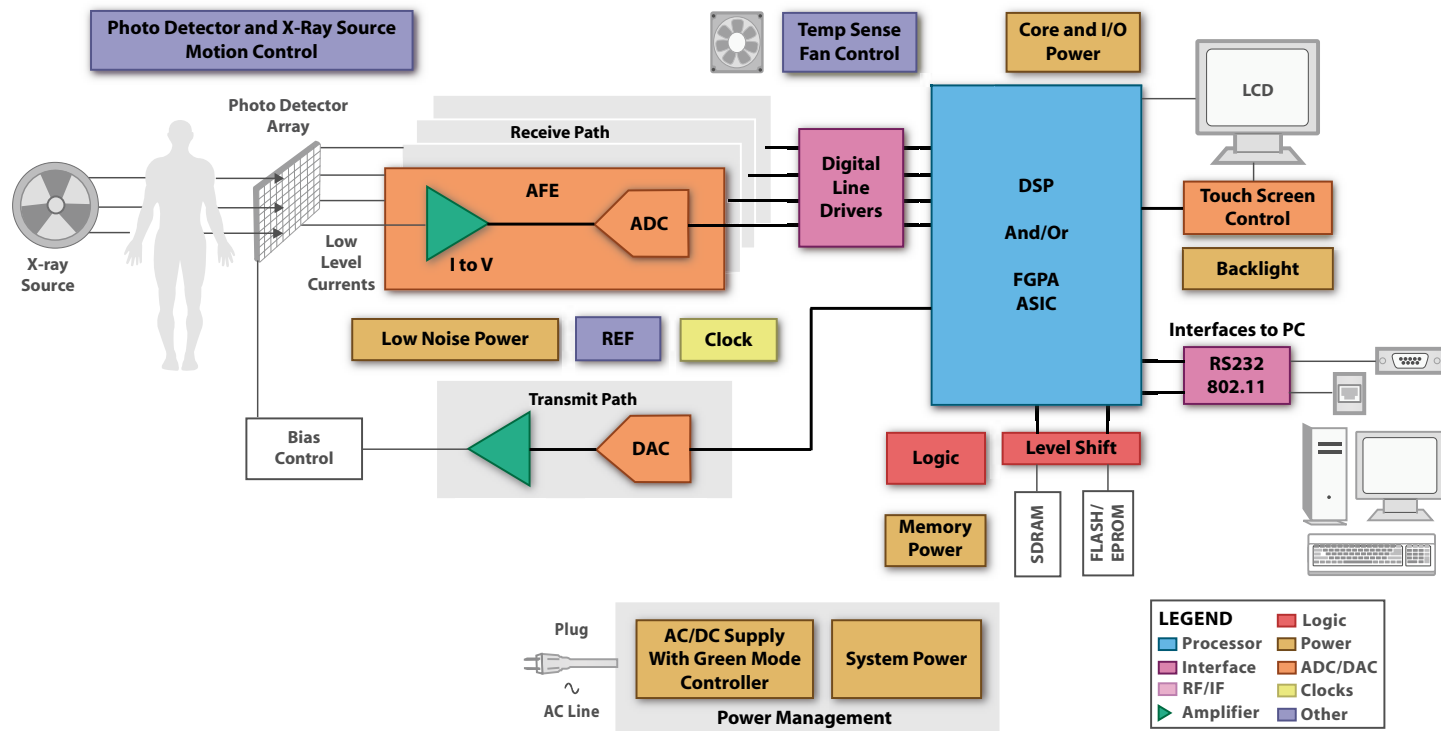
数字式X光系统方框图

产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

医疗成像

→ 数字式X光

计算体层成像在光激励平板上俘获电子，并对其进行曝光以产生图像数据。在上述这两种方法中，与像素所承受的X射线强度成比例的电荷均被存储于薄膜晶体管 (TFT) 存储电容器中。大量的此类像素形成了平面检测板 (FDP)。电荷通过读出电子元件从平面检测板上读取，并变换为数字数据。

下面的方框图示出了通过直接成像将平面检测板上的电荷转换为数字数据所需的读出电子器件。该方框图具有两条链路：采集链路及偏置链路。在采集链路的起始段，其模拟前端能够对不同FPD（通道）存储电容器上的电荷进行多路复用，并将这些电荷转换为电压。偏置链路则通过中间偏置 (intermediate bias) 及门控电路为TFT阵列提供偏置电压。数字控制及数据调节由DSP、FPGA、ASIC或它们的组合来控制。此类处理器还可利用外部图像处理单元通过高速接口（串行化接口、低压差分信号[LVDS]接口、光学接口）对高速串行通信进行管理。

其他重要的系统模块包括温度传感器、DAC、放大器以及能够承受高输入电压的开关稳压器。每个模块都必须具有使能 (enable) 引脚及频率同步能力，以避免与采集链路中的其他模块发生串扰。FPD像素的数量决定了ADC通道数与ADC速度的相互关系。静态或动态采集同样决定了ADC速度。静态采集意味着要在小于1s的时间内采集单幅图像，而动态采集则意味着需以30Hz的频率进行图像刷新，对于更加特殊的心血管、荧光检查或相关应用而言，在相同通道数的情况下需要进行快得多的数据转换。速度处于2MSPS乃至更高范围并具有卓越直流性能的ADC可实现良好的运作。

对于间接转换而言，CCD输出需要采用相关双采样 (CDS)。信号电平的复位电压及图像信号电平通过模拟前端 (AFE) 转换为数字数据。AFE的采样速率取决于CCD阵列中的像素数及帧速率。此外，AFE还负责校正传感器误差，例如暗电流校正、偏置电压校正及缺陷像素校正。视信号电平的不同，可编程增益放大器 (PGA) 的使用、PGA的线性度以及可用的增益范围可能也很重要。在数字化期间，ADC的位数决定了图像的对比度。一般情况下，建议以比最终图像所需的精度高2～4位的分辨率对初始数据进行数字化处理。例如：若最终图像数据的精度要求是8位，则采用10位精度进行初始数字化可避免在后续的图像处理过程中出现舍入误差。

图像质量的主要衡量标准是"检测量子效率 (DQE)"，该衡量方式结合了对比度和信噪比 (SNR)，以百分数来表示。对比度越高、噪声越低，则DQE越高。对比度是灰度的阶数，取决于ADC的输出分辨率。通常情况下，14位或16位可满足应用的需要。

SNR所指示的不仅是ADC的信噪比，而且还是受X射线强度、像素尺寸以及所有电子元件影响的系统信噪比。增加射线剂量、加大光电二极管的间距和降低电子元件噪声均有助于改善信噪比。增加X射线剂量对于患者或操作人员而言是不适宜的。加大光电二极管的间距会降低空间分辨率，因此可能也不合适。降低源自系统内电子器件的噪声是面临的主要挑战。

系统的总噪声是信号链路范围内所有噪声成分的均方根之和，在此假设所有的噪声成分之间是不相关的。这就意味着各个部分都必须具有超低的噪声或经过严格的滤波，在适用的情况下，包括ADC、运算放大器以及基准。温度稳定性是另一项重大挑战。由于功耗所引起的内部温升有可能导致灰度级别发生偏移并使图像产生失真，尤其是在动态采集期间。因此，ADC、运算放大器及基准应具有很高的温度稳定性。

数字X光数据在经历了多道处理步骤之后方可呈现于显示器上观看。第一步称为"描影" (shading)，在此对不理想的检测器像素进行校正。下一步将确定检测器中的未曝光区域，以便在后续处理中不使用该区域。然后对有效数据实施直方图均衡化处理。最后将采用若干图像增强技术来实现噪声抑制、对比度改善及影像边缘强化。

面向数字式X光的产品组合

- 实现控制功能和信号调节的高性能DSP，用于采集并改善图像的清晰度。
- 能够对不同平面检测板 (FPD)、存储电容器（通道）上的电荷进行多路复用，并将这些电荷转换为电压（以获得直接转换X光）的模拟前端 (AFE)。在间接转换X光中，AFE还负责将信号电平及其复位电压转换为数字数据，并校正传感器误差。
- 温度传感器、DAC、放大器以及能够承受高输入电压的开关稳压器是其他的关键系统模块。
- 电源管理及其他模拟产品。

医疗成像

➜ *数字式X光*

带并行接口及基准的16位、4MSPS、全差分输入ADC
ADS8422

敬请访问**www.ti.com/ADS8422**，以获取样片、数据表、评估析及应用报告。

主要特点

- 具伪双极输入范围的全差分输入：－4V至+4V
- 4MSPS时输出16位无漏失码 (NMC)
- 积分非线性度 (INL)：1 LSB（典型值）
- 信噪比 (SNR)：92dB
- 总谐波失真 (THD)：100kHz输入时的典型失真为－102dB（典型值）
- 内部4.096V基准及基准缓冲器
- 高速并行接口
- 低功耗：4MHz时仅为155mW（典型值）
- 灵活的断电方案
- $REF_{IN}/2$可用于设定模拟输入共模电压

应用

- 医疗仪器
- 仪表
- 谱分析
- 高速、高分辨率、零延迟数据采集系统

ADS8422是16位、4MSPS ADC，具有内部4.096V基准及全差分、伪双极型 (pseudo-bipolar) 输入。该器件包括了完全的16位接口以及8位的备选项，可在必要时采用两个8位读周期对数据进行读取。此器件在－40℃至+85℃的工业温度范围内进行了特性分析。
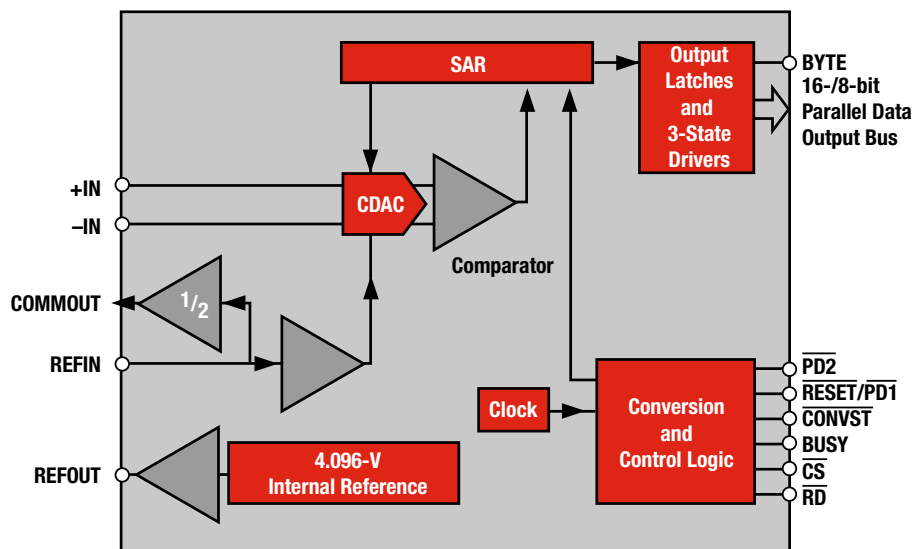
ADS8422原理框图

高速、低噪声、全差分输入/输出 (I/O) 放大器
THS4130、THS4131

敬请访问**www.ti.com/sc/device/THS4130**或**www.ti.com/sc/device/THS4131**，以获取样片、数据表、评估板及应用报告。

主要特点

- 带宽：150MHz (－3dB，V_{CC} = ±15V)
- 转换速率：51V/μs
- 250kHz时，三阶总谐波失真 (THD_3) 为－100dB
- 低噪声：1.3nV/$\sqrt{Hz}$输入参考噪声
- 差分输入/差分输出：
  - 平衡输出抑制了共模噪声
  - 差分输出降低了二次谐波失真
- 宽电源范围：
  - 单电源：V_{CC} = 5V
  - 双电源：±15V
- 封装：SOIC-8、MSOP-8、MSOP-8 PowerPAD™集成电路封装

THS4130及THS4131是全差分输入/差分输出放大器，具有真正的全差分信号输入至输出通路。该设计提供了卓越的共模噪声抑制能力并改善了总谐波失真。
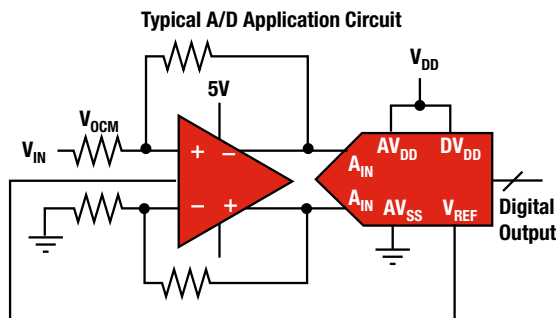
THS4130应用电路
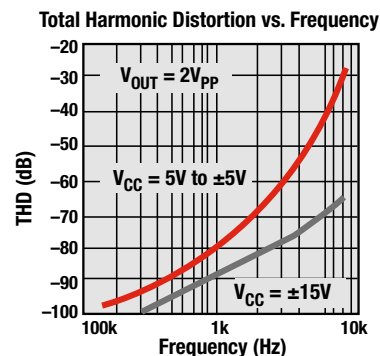
应用

- 单端至差分转换
- 差分ADC驱动器
- 差分抗混叠
- 输出电平移位器
- 差分发送器和接收器

医疗成像

→ **数字式X光**

低噪声、超低漂移、高精密电压基准
REF50xx

敬请访问**www.ti.com/sc/device/REF5020**，以获取样片、数据表及应用报告。

主要特点

- 高准确度：0.05%
- 超低温度漂移：3ppm/℃
- 大输出电流：±10mA
- 温度范围：−40℃ 至+125℃
- 封装：MSOP-8、SO-8

应用

- 医疗仪器
- 16位数据采集系统
- 工业过程控制
- ATE设备

REF50xx是低噪声、低漂移、高精度电压基准系列。REF50xx专为高精度数据采集系统而设计，兼具电流吸收和供应能力，而且对于任何的电压及负载变化均具有非常强的坚固性。REF50xx系列通过使用专利的设计方法及封装后精密校正，同时实现了卓越的温度漂移特性 (3ppm/℃) 以及高准确度。
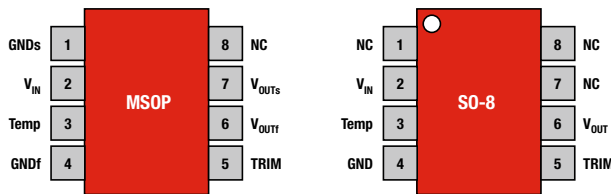
封装示意图

Model	Voltage Out
REF5020	2.048
REF5025	2.5
REF5030	3.0
REF5040	4.096
REF5045	4.5
REF5050	5
REF5010	10

TMS320C28x™控制器系列，定点MCU控制，DSP性能
TMS320F2810

敬请访问**www.ti.com/sc/device/TMS320F2810**，以获取样片、数据表、工具及应用报告。

主要特点

- 超快的检修时间，可在20ns至40ns的时间内响应任意中断
- 强大的20Mbps数据记录调试能力
- 32/64位饱和，单周期读取－修改－写入指令，以及64/32位与32/32位模数划分 (modulus division)
- 支持C及C++的增强型工具套件
- 独特的实时调试功能
- 32位单周期定点MAC
- 兼容TMS320C24x™ DSP及TMS320C2xLP源代码

外设

- 16至128k字扇区闪存或出厂编程ROM（具有代码安全性）
- 12位ADC，吞吐速率高达12.5MSPS，转换时间为80ns（最小值）
- 灵活的QEP、CAP、定时器以及PWM生成
- 高分辨率模式下，100kHz时的精度达16位，1.5MHz ePWM频率下的精度超过12位

TMS320F2810、TMS320F2811、TMS320F2812、TMS320C2810、TMS320C2811和TMS320C2812 IC均为TMS320C28x DSP系列的成员。是面向要求苛刻的控制应用的高集成度、高性能解决方案。C28x™ 控制器是基于控制的32位DSP，具有板上可再编程闪存、出厂前烧写的ROM或经济高效的单一RAM内存选项、以及100MIPS至150MIPS的性能。
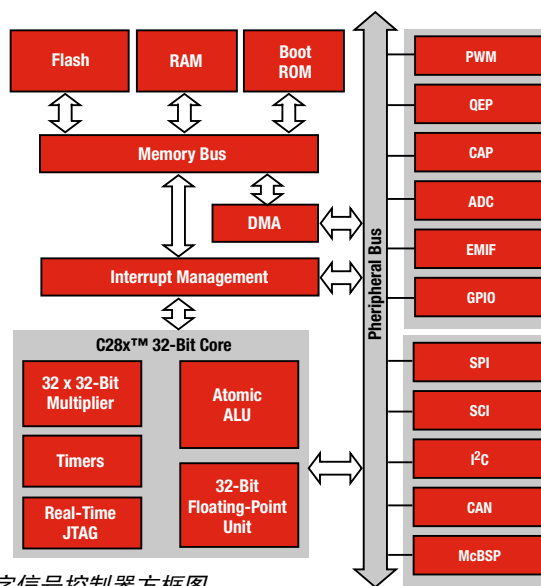
TMS320C28x数字信号控制器方框图

- 多达两个串行通信接口 (SCI/UART)
- 多达四个串行外设接口 (SPI)
- 多达两个增强型CAN 2.0B模块
- McBSP或I²C接口

→ **数字式X光**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
OPA211	Precision Op Amp	1.1nV/√Hz at 1kHz noise, 3.6mA/ch supply, 80MHz BW	Unity gain stable, RRO, shutdown	OPA227
OPA141	Precision Op Amp	10MHz, 6.5nV/√Hz, ±4.5V to ±18V, 1.8mA typical, FET input: I_B = 20pA max	Common mode voltage range includes GND	OPA827
OPA277	Precision Op Amp	10μV offset, ±0.1μV/°C drift, 134dB open-loop gain		OPA4277 (quad)
OPA827	Precision JFET Op Amp	4nV/√Hz noise at 1kHz, ±4V to ±18V supply, 15pA (typ) input bias current, 22MHz BW	High precision, low noise, low input bias, wide supply range	OPA177, OPA627, **OPA141**
OPAx890	High-Speed Op Amp	Wide output swing of ±4.1 (V_S = ±5V)	Minimizes distortion when used as an ADC driver	OPA2890 (dual) OPA2889 (dual)
THS403x	High-Speed Op Amp	100MHz, 1.6nV/√Hz noise, 100V/μs SR, 90mA output	Low distortion	THS4051, THS4081
THS413x *Page 114*	High-Speed Op Amp	150MHz (–3dB) BW, 51 V/μs SR, –100dB THD at 250kHz	Differential input/differential output	THS4120, THS4150
THS4520	High-Speed Op Amp	Fully differential, RRO	Minimizes distortion when used as an ADC driver	
Data Converters				
ADS8413	SAR ADC	16-bit, 2MSPS, serial LVDS	LVDS, serial interface, daisy-chain capable	ADS8410, ADS8406
ADS8422 *Page 114*	SAR ADC	16-bit, 4MSPS, int. ref and ref buffer	Zero latency	ADS8412, ADS8472
DAC8814	Multiplying DAC	16-bit, 0.5μs settling time, –105dB THD, 1 LSB (max) relative ac-curacy	Double-buffered serial data interface	DAC7715, DAC8811
VSP2562	12-Bit, 36MSPS, 1-Channel Analog Front End	Low noise, OB correct 2X 8b DAC, PGA amplifier	Better image quality; corrects for sensor dark current offset; used for system tuning and control of analog functions. Programmable gain supports wide range of light conditions.	
VSP2582	12-Bit, 36MSPS, 1-Channel Analog Front End	Low noise, OB correct PGA amplifier	Better image quality; corrects for sensor dark current offset. Programmable gain supports wide range of light conditions.	
Interface				
SN65EL11	PECL/ECL 1:2 fanout Buffer	Differential 1:2 PECL/ECL fanout buffer	Maintains a known logic level when inputs are in an open condition	SN65MLVD047
SN65ELT20	5 V TTL to Differential PECL Translator	1.25ns max prop delay	Built-in temperature compensation	SN65ELT21
SN65LV1023A	10:1 LVDS Serdes	Embedded clock	Smallest package	SN65LV1224B
SN65LVDS31	4-Channel LVDS Driver	400Mbps	Industry standard	SN65LVDS32
TLK6201EA	PC Board Equalizer	Up to 6.25Gbps operation, low power, high-input dynamic range	CML data outputs	
Clocking				
CDCLVP12xx/ 21xx	1:2/4/8/12/16 or Dual 1:2/4/6/8 Universal-to-LVPECL Clock Buffers	Very low additive jitter <100ps RMS; 2.5V / 3.3V operation	Improved clock signal quality by 10x; saves additional interface logic / external components	CDCLVP111, CDCLVP215
Temperature Sensor				
TMP175	Digital Temp Sensor	27 addresses, ±1.5°C (max) accuracy, 50μA I_Q, 9- to 12-bit resolution	Two-wire interface, serial output	TMP75
TMP275	Digital Temp Sensor	8 addresses, ±0.5°C (max) accuracy, 50μA I_Q, 9- to 12-bit resolution	Two-wire interface, serial output	
Power Management				
DCH010505	Galvanic Isolated DC/DC Converters	1W, 3kV isolation, minimal external components	Safety isolation, removal of ground loops, reducing board space	DCH010512, DCH010515
PTH04T240	Power Module	10A, 2.2V to 5.5V V_{IN}, adjustable V_{OUT}, with TurboTrans™ Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH04T241
PTH08T220	Power Module	16A, 4.5V to 14V V_{IN}, adjustable V_{OUT}, with TurboTrans Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH08T221
TPS3307	Voltage Supervisor	Triple processor supervisor	Two fixed and one adjustable supervisor for system flexibility	TPS3808
TPS386000	4-Ch. Supervisor	0.25% acc, down to 0.4V, watchdog	High integration and high accuracy	TPS3808

*更多产品信息请参见指定页码。
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新产品以**粗体红色**标明。

→ **数字式X光**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Power Management (Continued)				
TPS40020	DC/DC Controller	2.25V to 5.5V$_{IN}$, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/regulation from main power supply	TPS40042
TPS40075	DC/DC Controller	4.5V to 28V$_{IN}$, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/regulation	TPS40057
TPS54317	DC/DC Converter	3.0V to 6.0V$_{IN}$ 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54610/TPS54910
TPS54350	DC/DC Converter	4.5V to 20V$_{IN}$ 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/integration	TPS54550
TPS6206x	Step-Down Con.	High frequency operation, 2x2 QFN pkg, power save mode	High efficiency, small solution size	TPS62290
TPS62110	DC/DC Converter	3.1 to 17V$_{IN}$, 1.5A DC/DC w/integrated switch FET, synchronization pin, enable, low battery indicator, PFM mode	Very low noise/high efficiency	
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62420
TPS74201	Single-Channel LDO	1.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74301, TPS74801
TPS74401	Single-Channel LDO	3.0A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74901
TPS74701	Single-Channel LDO	0.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	
UCD90120	12-Ch. Sequencer	GUI for programming 12 power rails	Sequencing, monitoring and margining	UCD9081, UCD90124
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
TMS320C-6455BZTZ	DSP	1.2GHz, SRIO, 2MB RAM	High-performance, fixed-point 16-bit processor	TMS320C6454BZTZ
TMS320C6472	DSP	6 x 700MHz C64x+ cores, 4.8MB RAM, SRIO, HPI	High-performance multiprocessor solution	
TMS320C6474	DSP	3 x 1GHz C64x+ cores, 3MB RAM, SRIO	High-performance multiprocessor solution	
TMS320F2810 *Page 115*	DSP	150MIPS, controller area network (CAN) peripheral	CAN for board-level communication, combination of DSP performance and MCU integration	
TMS320DM-6446BZWT	DSP	C64x+™, ARM9, video accelerators	Image processing, display	TMS320DM6441, TMS320DM6437
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling w/64-B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards-compatible w/existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee/IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temp range; AES-128 security module	Reliable RF link w/interference; 400m line-of-sight range with dev. kit; ideal for industrial apps; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	USB enabled System-on-Chip solution for 2.4GHz IEEE 802.15.4/RF4CE/ZigBee	Excellent Rx sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market; provides a robust and complete ZigBee USB dongle or firmware upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz *Bluetooth*® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market *Bluetooth*® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth*® solution using TI's Digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1273
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity/blocking performance systems; excellent coexistence w/*Bluetooth*® technology and Wi-Fi.	
References				
REF50xx *Page 115*	High-Precision, Very-Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V, 10V	Improves system accuracy	REF02

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新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

医疗成像

→ **正电子放射层析成像 (PET) 扫描仪**

正电子放射层析成像 (PET) 是一种非侵入性的诊断技术。PET扫描可利用人体的放射性辐射（此类辐射源于由患者所吞服的放射性化学元素）来产生特定器官或组织的生理学图像，癌细胞的生长情况鉴别便是其应用实例之一。

放射性辐射将通过闪烁晶体 (scintillation crystal) 检测器转换为光信号，并经由光电倍增管 (PMT) 进行放大并转换为输出电流。PMT的电流输出随后被转换为电压，在经过放大及滤波之后由ADC转换为数字信号。

对于接收通道的检测器信号处理以及诸多控制功能而言，信号处理是必需的。

DSP、微控制器及数模转换器用于在该应用中实现一定的功能，例如改变输入放大器增益、控制PMT的高电压电源以及检测器环状装配部件和患者进入/退出的运动控制。

DSP可用于PET扫描仪控制及信号处理单元。滤波反投影 (filtered back projection) 算法则可用于图像重构。诸多的迭代法也已被提议用于PET图像重构。如欲校正各种人为干扰（例如衰减改变、检测器几何结构和效率改变、随机和散射重合等），则有可能需要额外的信号预调节功能。

面向PET扫描仪的产品组合

- 放大器、电源管理产品和其他模拟器件适用于将放射性辐射转换为光，以及图像的重构和校正
- 诸如TMS320C6455等DSP能够改变输入放大器增益、控制光电倍增管 (PMT) 的高电压电源以及检测器环状装配部件和患者进入/退出的运动控制。另外，DSP还适用于PET扫描仪控制和信号处理单元。
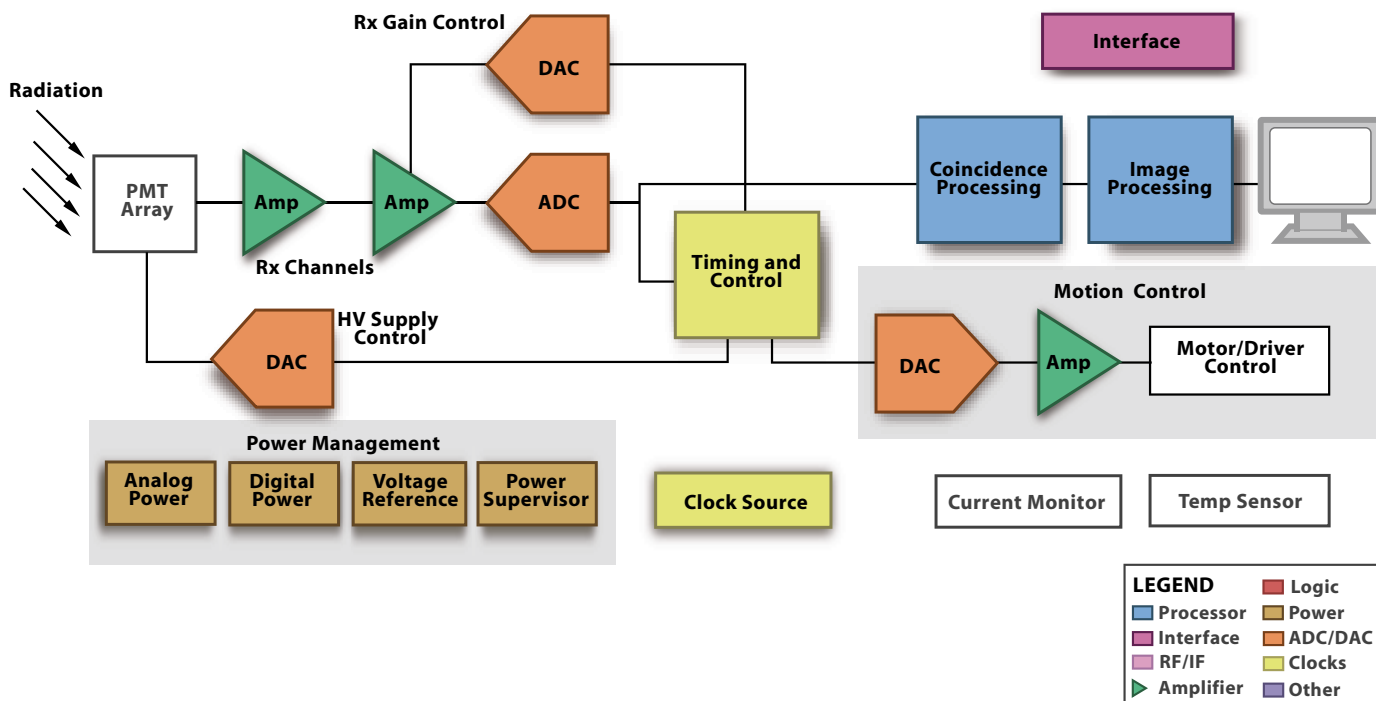
PET扫描仪系统方框图

医疗成像

→ **正电子放射层析成像 (PET) 扫描仪**

带串行化LVDS接口的8通道、超低功耗、12/10位、50至65MSPS模数转换器
ADS5281、ADS5282、ADS5287

敬请访问**www.ti.com/sc/device/PARTnumber**，以获取样片、数据表及评估板。
（**PARTnumber**请使用**ADS5281、ADS5282**或**ADS5287**替换）

主要特点

- 单片小型64引脚QFN封装内包含8通道的12位或10位ADC
  - ADS5821还可提供80引脚TQFP封装版本，与ADS527x系列引脚兼容
- 65MSPS时，每通道功耗为77mW；
- 50MSPS时，每通道功耗为64mW
- 12位分辨率及10MHz中频时，信噪比(SNR) 为70dB
- 1/f（闪烁）噪声抑制
- 单个时钟周期中高达6dB的过载恢复
- 独立的通道断电功能
- 可直接连接至VCA8500 8通道可变增益放大器
- Xilinx®支持型解串器编码

应用

- 医疗及其他成像：
  - 超声波
  - 核磁共振成像 (MRI)
  - 正电子放射层析成像 (PET)

ADS5281系列以单片小型的64引脚QFN封装提供了8通道的高性能ADC，可支持实现多通道数量的高性能超声波及其他医疗成像系统。其每通道低功耗的特性还有助于实现紧凑的超声波设备，可获取额外的空间及电池寿命裕量，并可与VCA8500相结合以提供高性能的LNA至数字解决方案，适用于每通道功耗低于130mW的超声波应用。

ADS5281系列还整合了若干高级特性以优化系统性能，包括了可编程增益（0至12dB，1dB步进）、1/f（闪烁）噪声抑制以及单个时钟周期内的6dB输入过载恢复。ADS5281系列可提供12位分辨率50MSPS和65MSPS以及10位分辨率65MSPS的性能，具有很强的灵活性，可针对所有的成像系统给出最理想的解决方案。

ADS5281/2/7原理图

医疗成像
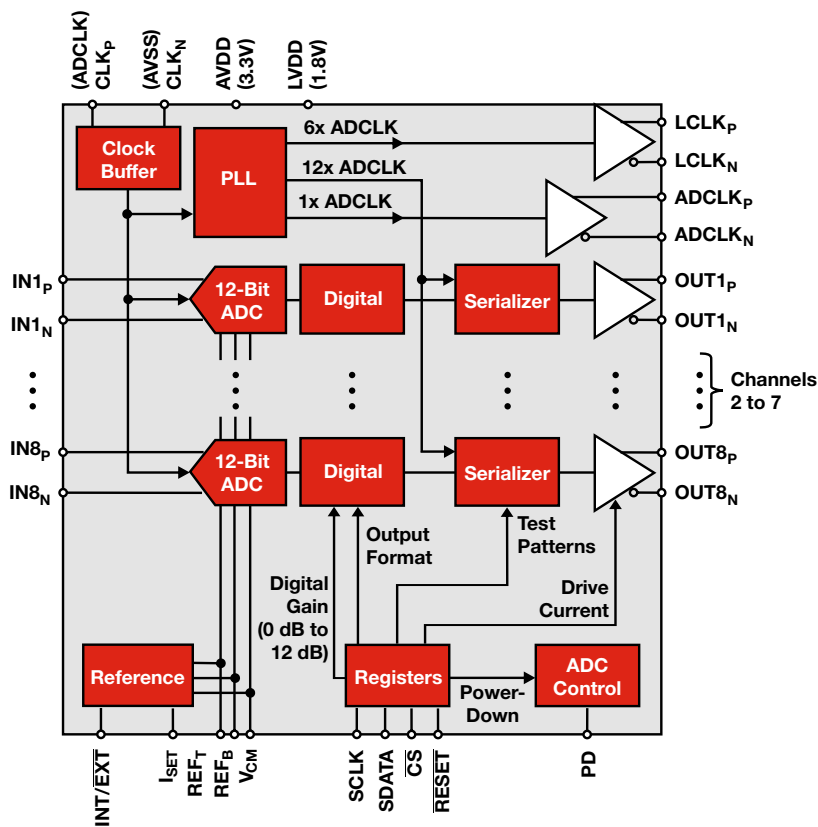
增益调节范围大于40dB的宽带可变增益放大器
VCA821

敬请访问 **www.ti.com/sc/device/VCA821**，以获取样片、数据表及评估板。

主要特点

- 增益调节范围大于40dB
- 高增益准确度：20dB±0.4dB
- 小信号带宽（G = +2）：710MHz (VCA821/824)，150MHz (VCA820/822)
- 转换速率：2500V/μs (VCA821/824)，1700V/μs (VCA820/822)
- 输出电流：±160mA (VCA820/822)，±90mA (VCA821/824)
- 电压噪声：8.2nV/√Hz (VCA820/822)，6nV/√Hz (VCA821/824)
- 封装：MSOP-10、SO-14

应用

- 具RSSI的AGC接收机 (VCA820/821)
- 脉冲幅度补偿
- 差分线路接收器
- 差分均衡器 (VCA822/824)
- 电压可调有源滤波器
- 可变衰减器

VCA821是直流耦合、宽带、可变增益放大器，具有超过40dB的线性增益可调控范围。该放大器提供了差分输入至单端转换，并采用一个高阻抗增益控制输入以线性dB增益调节的方式来改变增益。VCA821具有±3.9V的输出电压范围和±90mA的输出电流性能，因而有助于驱动各种各样的负载。该可变增益系列器件还包括VCA820（该器件提供线性dB增益调节）以及VCA822和VCA824（这两款器件提供线性V/V增益调节）。

带AGC环路的可变增益放大器

医疗成像

→ **正电子放射层析成像 (PET) 扫描仪**

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
OPA657	High-Speed Op Amp	FET-Input, 1.6GHz GBW, 4.8nV/√Hz noise, 70mA output	High dynamic range, fast overdrive recovery	
OPA860	Transconductance Amp	80MHz, open loop, G = +5 BW, 900V/µs SR	95mA/V high transconductance, buffer	
OPA827	Precision JFET Op Amp	4nV/√Hz noise at 1kHz, ±4V to ±18V supply, 15pA (typ) input bias current, 22MHz BW	High precision, low noise, low input bias, wide supply range	**OPA141**, OPA177, OPA627
OPA211	Precision Op Amp	1.1nV/√Hz noise at 1kHz, ±2.25V to ±18V supply, 80MHz BW	Unity gain stable, RRO, wide supply range	OPA227
OPA2690	VFB Op Amp	Dual, 220MHz, G = 2 BW, 1800V/µs SR, 190mA output	+5V supply, disable	OPA2691
THS4130	High-Speed Op Amp	150MHz BW (−3dB), 51V/µs slew rate, −100dB THD at 250kHz	High-speed, fully differential I/O	
THS7530	High-Speed VGA	1.1nV/√Hz noise, 300MHz BW, 11.6dB to 46.5dB continuously variable gain	High-speed, fully differential	
VCA810	Voltage-Controlled Amp	±40dB high gain adjust range, 2.4nV/√Hz noise, ±60mA output current	Differential in/single-ended out	
VCA821 *Page 120*	Voltage-Controlled Amp	>40dB gain adjust range with high gain accuracy	Adds flexibility and accuracy to design	VCA820
Data Converters				
ADS5240	High-Speed ADC	4-channel, 12-bit, 40MSPS, serial LVDS interface	Integrated frame and bit pattern, 4 current modes for LVDS	ADS5242, ADS5525
ADS5272	High-Speed ADC	8-channel, 12-bit, 65MSPS, 3.3-V analog/digital supply	Serialized LVDS outputs, integrated frame and bit patterns	
ADS5281 *Page 119*	High-Speed ADC	8-channel, ultra-low-power, 12- and 10-bit, 50 to 65MSPS analog-to-digital converter	77mW per channel, serialized LVDS outputs, 1/F noise-suppression	ADS5282, ADS5287
ADS5282 *Page 119*	High-Speed ADC	Ultra-low-power, 8-channel, 12-bit, 65MSPS	77mW per channel, serialized LVDS outputs, 1/f noise suppression	ADS5281, ADS5287
ADS5287 *Page 119*	High-Speed ADC	Ultra-low-power, 8-channel, 10-bit, 65MSPS	77mW per channel, serialized LVDS outputs, 1/f noise suppression	ADS5281, ADS5282
ADS5525	High-Speed ADC	12-bit, 170MSPS, DDR/LVDS CMOS outputs	Programmable gain up to 6dB for SNR/SFDR trade-off at high IF	ADS5527, ADS5545
ADS5527	High-Speed ADC	12-bit, 210MSPS, DDR/LVDS CMOS outputs	Internal/external reference support	ADS5545, ADS5440
ADS5562	High-Speed ADC	Low-power, 16-bit ADC with up to 84dBFS SNR	High SNR, 1/f noise suppression with low power and small package	ADS5560
DAC2900	High-Speed DAC	10-bit, 125MSPS dual DAC	Supports 3.3/5V	DAC2902, DAC2904
DAC5652	High-Speed DAC	10-bit, 275MSPS dual DAC	High sample rate with low power	DAC5662, DAC5672
DAC7554	V_OUT DAC	Quad, 12-bit, 2.7V to 5.5V supply, 5µs settling time	Ultra-low glitch, ultra-low crosstalk	DAC7614, DAC7615
DAC7731	V_OUT DAC	16-bit, 150mW (max) low power, 5µs settling time, +10V int. reference	Unipolar or bipolar operation	DAC8811
References				
REF02	Precision V_REF	0.2% (max) initial accuracy, 10ppm/°C (max) drift, 1.4mA (max)	Excellent line/load regulation, low noise	REF5050
REF102	10V, Ultra Precision	0.05% (max) initial accuracy, 2.5ppm/°C (max) drift, 1.4mA (max)	Excellent stability and line/load regulation	REF5010
REF31xx	Voltage Reference	15-ppm/°C (max) drift, 5mV low dropout, 115µA (max) I_Q, 0.2% (max) accuracy, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	No load capacitor required	REF3130, REF3120
REF32xx	Low Drift, Bandgap	0.2% (max) accuracy, 7ppm/°C (max) drift, 0.1mA (max) I_Q, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Multiple output voltages, SOT23-6	

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→ **正电子放射层析成像 (PET) 扫描仪**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
References (continued)				
REF33xx	Very-Low-Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF5010	10V, High-Precision, Very-Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 10V	Improves system accuracy	REF102
REF50xx	High-Precision, Very-Low-Drift Series Reference	0.05% initial accuracy, 3ppm/°C max drift, ±10mA output, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5.0V	Improves system accuracy	REF02
Interface				
SN65EL11	PECL/ECL 1:2 Fanout Buffer	Differential 1:2 PECL/ECL fanout buffer	Maintains a known logic level when inputs are in an open condition	SN65MLVD047
SN65LVCP40	Dual 1:2 Mux/Buffer	Input EQ, output pre-emp	Improves signal range	SN65LVCP404
SN65LVDS93A	24-Bit RGB LVDS Serdes	10MHz-135MHz, BGA and TSSOP; supports 1.8V to 3.3V TTL i/p	Wide frequency range, saves space, no level shifter for 1.8V powered uP	SN75LVDS83B
TLK1221	Gigabit Ethernet Serdes	Power 250mW	Smallest package	TLK2208B
Clocking				
CDCE62005	Clock Generator	rms jitter <1ps, recommended clocking solution for AFE580x and ADS528x/527x	Integrated VCO saves system cost	CDCE72010, CDCM7005
CDCE(L)949	Clock Synthesizer	Recommended clocking solution for TI DSPs	0ppm multiple-frequency generation	CDCE(L)937, CDCE(L)925, CDCE(L)913
CDCE906	Clock Synthesizer	Recommended clocking solution for TI DSPs	0ppm multiple-frequency generation	CDCE706
CDCLVP12xx/ 21xx	1:2/4/8/12/16 or Dual 1:2/4/6/8 Universal-to-LVPECL Clock Buffers	Very low additive jitter <100ps RMS; 2.5V/3.3V operation	Improved clock signal quality by 10x; saves additional interface logic / external components	CDCLVP111, CDCLVP215
Power Management				
PTH04T240	Power Module	10A, 2.2V to 5.5V V_{IN}, adjustable V_{OUT}, with TurboTrans™ Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH04T241
PTH08T220 *Page 125*	Power Module	16A, 4.5V to 14V V_{IN}, adjustable V_{OUT}, with TurboTrans Technology	Complete power supply designed to meet ultra-fast transient requirements	PTH08T221
PTQA430033 *Page 125*	Isolated DC/DC Module	100W, 1500VDC isolation, differential remote sense	High efficiency, industry-standard pin-compatible	PTQB425080
TPS3307	Voltage Supervisor	Triple processor supervisor	Two fixed and one adjustable supervisor for system flexibility	TPS3808
TPS386000	4-Channel Supervisor	0.25% acc, down to 0.4V, watchdog	High integration and high accuracy	TPS3808
TPS40020	DC/DC Controller	2.25 to 5.5V_{IN}, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/regulation from main power supply	TPS40042
TPS40075	DC/DC Controller	4.5 to 28V_{IN}, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/regulation from main power supply	TPS40057
TPS54317	DC/DC Converter	3.0 to 6.0V_{IN} 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/ integration	TPS54610/TPS54910
TPS54350	DC/DC Converter	4.5 to 20V_{IN} 3A DC/DC with integrated switch FET, synchronization pin, enable	Eliminate beat noise/ceramic caps/FPGA/ integration	TPS54550
TPS6206x	Step-Down Converter	High frequency operation, 2x2 QFN package,power save mode	High efficiency, small solution size	TPS62290
TPS62110	DC/DC Converter	3.1 to 17V_{IN}, 1.5A DC/DC with integrated switch FET, synchronization pin, enable, Low battery indicator, PFM mode	Very low noise/high efficiency	
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62420
TPS74201	Single-Channel LDO	1.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74301, TPS74801
TPS74401	Single-Channel LDO	3.0A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74901
TPS74701	Single-Channel LDO	0.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	
UCD90120	12-Channel Sequencer	GUI for programming 12 power rails	Sequencing, monitoring and margining	UCD9081, UCD90124

*更多产品信息请参见指定页码。
如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical**

*新产品以**粗体红色**标明。*

医疗成像

→ **正电子放射层析成像 (PET) 扫描仪**

推荐器件（续）

Component	Description	Key Features	Benefits	Other TI Solutions
Processors				
TMS320C6452	DSP	900MHz, 1.4MB L2 cache, 2 x S GMII/Gigabit EMAC	High-performance DSP with improved system cost	
TMS320C-6455BZTZ	DSP	1.2GHz, SRIO, 2MB RAM	High-performance, fixed-point 16-bit processor	TMS320C6454BZTZ
TMS320C6472	DSP	6 x 700Mhz C64x+™ cores, 4.8MB RAM, SRIO, HPI	High-performance multiprocessor solution	
TMS320C6474	DSP	3 x 1GHz C64x+ cores, 3MB RAM, SRIO	High-performance multiprocessor solution	
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling w/64-B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards-compatible w/existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temp range; AES-128 security module	Reliable RF link w/interference; 400m line-of-sight range with dev. kit; ideal for industrial apps; no external processor needed for secure communication	CC2530
RF Systems-on-Chip				
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	USB enabled System-on-Chip solution for 2.4GHz IEEE 802.15.4/ RF4CE/ ZigBee	Excellent Rx sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market; provides a robust and complete ZigBee USB dongle or firmware upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz *Bluetooth*® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market *Bluetooth*® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and *Bluetooth*® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and *Bluetooth*® solution using TI's Digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and *Bluetooth*® operations; supports ANT+ standard.	WL1273
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity/blocking performance systems; excellent coexistence w/*Bluetooth*® technology and Wi-Fi.	

如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical**　　　　　　新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

医疗成像

→ **针对医疗成像的电源管理**

8通道电源排序器及监视器
UCD9080

敬请访问**www.ti.com/sc/device/UCD9080**，以获取样片、数据表、评估板、应用报告及软件工具。

主要特点

- 可实现对多达8个电压轨的排序和监视
- 全电源轨监视，每50μs进行一次更新，监视分辨率为3.5mV
- 可实现多达3个数字输出的排序，用于上电复位及其他功能
- 针对每个电源轨的欠压和过压门限

- I²C接口用于配置和监视
- Microsoft Windows GUI（图形用户界面）用于配置和监视
- 灵活的电源轨关断
- 电源电压：3.3V
- 低功耗：300μA，3.0V

应用

- 电信交换机服务器
- 网络设备
- 测试设备
- 任何需要对多个电压轨进行排序的系统

Component	Description
UCD9111	Single-phase POL digital power controller
UCD9112	Dual-phase POL digital power controller
UCD9501	32-bit digital signal controller for power management
UCD7100	Digital control, single low-side ±4-A MOSFET driver with current sense
UCD7201	Digital control, dual low-side ±4-A MOSFET driver with single common current sense
UCD7230	Digital power-compatible synchronous buck driver

UCD9080原理框图

医疗成像

→ **针对医疗成像的电源管理**
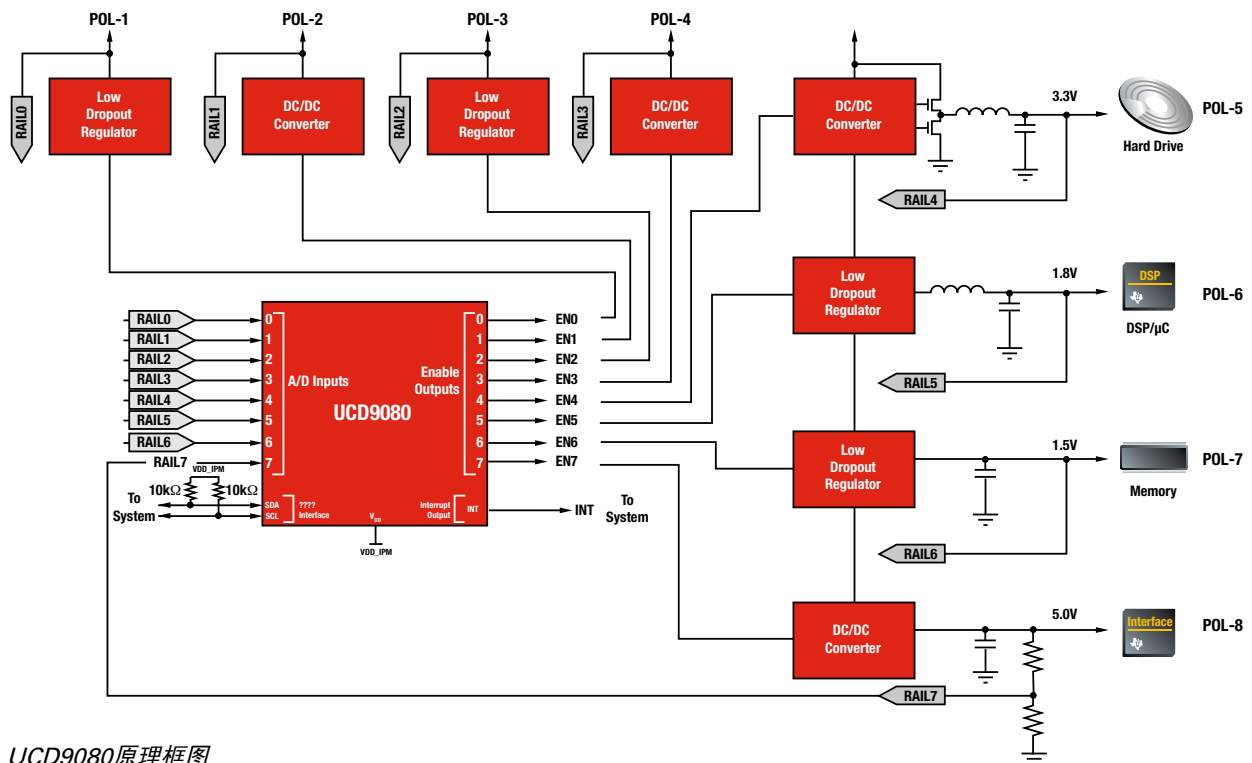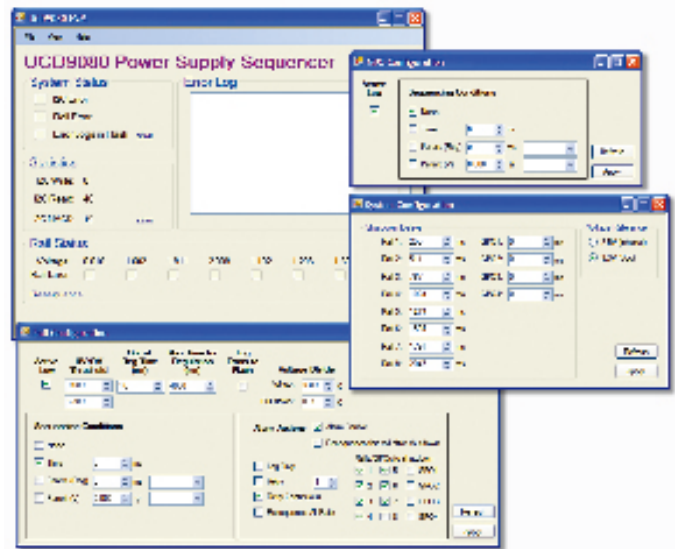
第二代PTH负载点模块
PTH08T2xx

敬请访问**www.ti.com/sc/device/PTH08T210W**，以获取样片、数据表、评估板、应用报告及软件工具。

主要特点

- TurboTrans™ 技术
- 1.5%输出稳压精度
- SmartSync同步
- 自动追踪 (Auto-Track™) 排序

优点

T2降低了开发成本并节省了PCB空间：

- 运用Auto-Track技术轻松地解决了排序问题
- SmartSync同步用于降低输入电容/简化滤波处理

- TurboTrans技术用于大瞬变负载应用
- 可在采用超低ESR电容器时保持稳定
- 1.5%容差满足了FPGA核心的规格要求

典型元件规格

Model	V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)
PTH04T260W	2.2 to 5.5	0.7 to 3.6	3
PTH08T260/261W	4.5 to 14	0.7 to 5.5	3
PTH04T230W	2.2 to 5.5	0.7 to 3.6	6
PTH08T230/231W	4.5 to 14	0.7 to 5.5	6
PTH04T240/241W	2.2 to 5.5	0.7 to 3.6	10
PTH08T240/241W	4.5 to 14	0.7 to 5.5	10
PTH04T220W	2.2 to 5.5	0.7 to 3.6	16
PTH08T220/221W	4.5 to 14	0.7 to 5.5	16
PTH05T210W	2.2 to 5.5	0.7 to 3.6	30
PTH08T210W	4.5 to 14	0.7 to 3.6	30
PTH08T250W	4.5 to 14	0.7 to 3.6	50
PTV08T250W	8 to 14	0.8 to 3.6	50
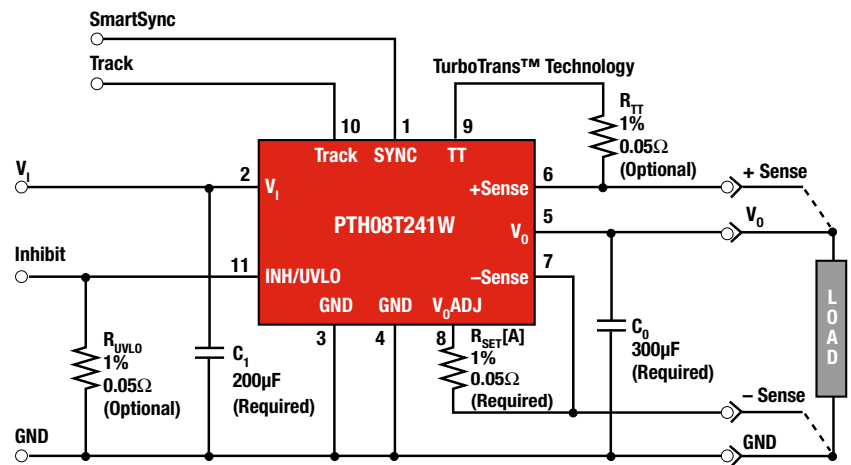
PTH08T2xx原理框图

100W、隔离型DC/DC模块
PTQA430033

敬请访问**www.ti.com/sc/device/PTQA430033**，以获取样片、数据表、评估板、应用报告及软件工具。

主要特点

- 48V输入（36V至75V范围）
- 标准的1/4砖占位面积
- 高效率：3.3V满负载时达92%
- 1500V DC I/O隔离度

- 导通/关断控制
- 过流保护
- 差分远端采样
- 欠压闭锁
- 输出过压保护
- 过热关断

优点

- 与业界标准产品引脚兼容
- 小尺寸、大电流应用

典型元件规格

Model	Input (V)	Output Current (A)	Output (V)
PTQA	4	30	025
	4 = 48	30 = 30	025 = 2.5
		20 = 20	033 = 3.3
			050 = 5.0
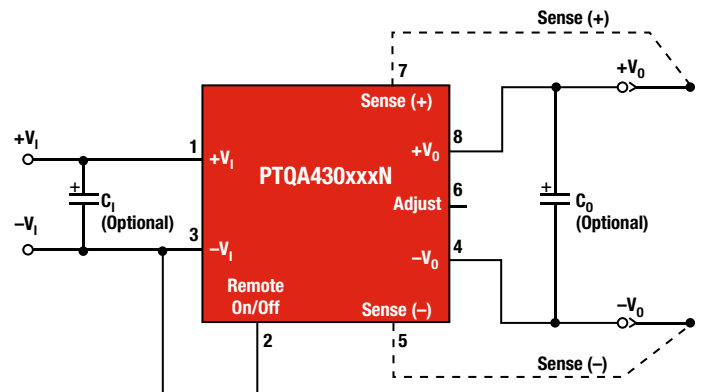
PTQA430033原理框图

医疗成像

→ **针对医疗成像的电源管理**

用于医疗成像的TI嵌入式处理器软件工具套件 (STK-MED)

敬请访问**www.ti.com/medicaltoolkit**，以获取更多信息。
敬请访问**www.ti.com/stkvideo**，以观看"基于OMAP3530的超声波扫描转换演示"视频播客。

主要特点

- 专为C64x+™ DSP架构而优化的公共医疗成像算法
- 标准API
- 经过测试、评效 (benchmarked)、归档的库模块

应用

- 医疗成像
- 医疗诊断超声波
- 光学相干X线断层摄影术 (OCT)

演示板/开源网址

www.ti.com/ultrasounddemo

- 运行于OMAP3530之上的扫描转换模块的演示
- OMAP3530演示板软件框架的开源

STK-MED是针对TI C64x+ DSP构架进行优化的多种标准医疗成像算法的集合。这些算法展示了开发人员如何利用C64x+ DSP架构在诸如诊断超声波和光学相干X线断层摄影术 (OCT) 等实时医疗成像应用中有效地提升性能和降低功耗。STK-MED的目标是：通过提供针对常见超声波处理模块的高度优化的C64x+ DSP源代码来缩短客户的开发时间。

STK-MED中的医疗成像处理功能

- B模式扫描
  - 多普勒处理（彩色血流、功耗估算器、壁滤波器）
- 射频 (RF) 解调和抽取
- DAS波束成形
- 扫描转换
- 优化的数学实用程序
  - 3D渲染
  - 用于光学相干X线断层摄影术 (OCT) 的实时成像处理

→ **针对医疗成像的电源管理**

医疗仪器

→ *概述*

在各种各样的护理机构和临床应用中都可以看到医疗仪器的身影。部分典型应用包括：

- 分析仪表、超声波设备、分光光度计，
- 内窥镜和智能药丸，
- 手术仪表、手术动力工具、手术机器人和手术相机，
- 实验室仪器、体外诊断设备（用于人体外部的分析）、血气分析、片上实验室、流式细胞仪、微流体分析，
- 机械假肢器官 (Robotic prosthetics)，
- 治疗学/病床和电动轮椅，
- 牙科设备、GaAlAs激光器、超声波洁牙器、高压灭菌器

这些应用具有非常特殊的设计，需要多种多样的传感器、致动或接收机械装置。大多数医疗仪器均采用普通常见的系统模块，并具有共同的需求。例如：对高精密电路的需求以支持精密的压力、光、温度数据采集，再例如：对利用超低功耗处理的需求以延长电池寿命。此类需求包括对小电容、电容及电流变化量、电压或阻抗变化量的采集。

TI的产品库为此类应用提供了诸多的集成电路 (IC) 解决方案。我们精密的线性产品库满足了典型IC的需求，可针对需要终身精密度 (precision-over-lifetime) 的应用提供具J-FET输入的低偏置放大器（精密型和高速型）和零漂移运算放大器，并针对敏感的测量电路提供低噪声放大器。

我们的数据采集产品库可提供高分辨率、低噪声模数及数模数据采集系统，因而可作为上述器件的补充。TI的超低功耗MSP430微控制器系列，或三大DSP系列（TMS320F28x、TMS320DM64x及TMS320C64x™）的器件均可轻松胜任

信号处理任务。TI的有线及无线接口集成电路产品能够为完成多种数据传输任务助一臂之力。

> 如需了解更多有关TI医疗仪器产品的信息，敬请访问：
> *www.ti.com/medicalinstruments*

超声波学

若非凭借超高性能模拟器件及嵌入式处理技术的优势，超声波技术并不会经常被人们所想起。如今，超声波器件已经普遍地用于超声波细胞破碎及均匀化处理，可支持门类宽泛的液体处理应用，诸如：

- 乳化
- 反应加速
- 散布 (dispersion)
- 细粒混合 (fine mixing)
- 脱气 (degasing)

超声波技术通常用于治疗、透皮给药 (dermally administered drugs) 及皮肤/伤口治疗。超声波以高于20kHz的频率产生，人类的听觉检测无法察觉，并在气态液体或固体介质内传播。采用超声波的优势之一是此项技术所拥有的奇妙 (esoteric) 方向性，可聚焦于所关注介质的密度和弹性。

压电换能器常用于将电子振荡转换为相应的机械振动，导致所选择的介质产生强烈的扰动。此类强烈的扰动将导致数百万微小空洞或空腔的形成及塌缩，即所谓的气穴现象 (cavitation)。当空洞塌缩或破裂时，它们将释放能量并产生期望的效应。

内窥镜 (Endoscope)

在医学领域，内窥镜用于窥探人体内部以检查诸如肠胃、呼吸和泌尿管道等体腔或中空器官。内窥镜的硬质或柔性导管可通过人体上天然存在的某种小孔或较小的切口插入人体，以提供器官的图像。

人们常常把手术仪器内置于内窥镜之中，旨在诸如胃肠道息肉的活检和切除过程中实现微创型手术。一些常见的手术包括结肠镜检查、胃镜检查、毛细血管镜检查和支气管镜检查。

内窥镜的主要组件包括：光源、导管（用于引导光线）、透镜或光纤系统（用于捕获器官所反射的光线）以及图像捕获系统（用于处理、显示和存储图像）。如需了解更多信息，请查阅第139页上的″内窥镜″章节。

智能药丸

智能药丸最早出现于1992年，可在无需患者参与且无设备介入的情况下释放药物或控制药物的释放。

智能药丸最常见的应用是用于控制肠胃消化道内的药物释放。其他应用包括肠胃消化道的监测及电子刺激，并结合受控的药物释放实现所期望的治疗效果。肠内的变量，例如时间、温度、压力、PH值和/或位置，将会被监视和测量。

医疗仪器

常见的智能药丸系统组成包括模拟信号转换、数据处理、射频收发器（ISM频段或其他）及针对致动器控制的数字信号转换。患者可以穿戴数据接收机，而该接收机将提供数据以待日后下载。数据接收机通常由射频收发器、可能的数据处理部分以及用于数据存储的内存所组成。

手术机器人

如今，尖端的手术机器人可运用微创方法完成复杂的手术。此类系统由一个利用了压力、加速度和角速率传感器的手术控制系统组成，这些传感器与前端上的高性能放大器和数据转换器相连，然后耦合至嵌入式处理器，与具有若干运动自由度和低电压直流电机的机器人手臂进行通信。有些系统还可能包括高分辨率或立体感的3D显示/视觉系统。这些系统进行过滤并将外科医生的手部动作转换为机器人手臂及相连的医疗器械的微小和精确的动作。

机械假肢器官

人们正在使机械假肢器官与各种不同的控制系统配合工作。所需的电气系统与手术机器人非常相似，仅有的差别是目前正在进行测试的此类方法之一包括了至肌电开关的接口，这些肌电开关通过导线连接至人体上身所残剩的神经和肌肉并对来自大脑的动作脉冲做出响应。当前，机械假肢器官受控于人的大脑思维。

此外，通过将碳毫微管与一种特别设计的聚合物相结合，研究人员正在制作一种从外观、触感到功能均与人类的皮肤相类似的材料。这种合成皮肤可能会导致下一代假臂的问世，患者借助这种假臂将有可能体验到触摸和握手的感觉，并更加轻松地完成普通的任务。

流式细胞仪

流式细胞仪是对悬浮于流动生理盐水中的单细胞特性（固体颗粒体积浓度[cvto]）进行测量（"计量"）的仪器。聚焦的激光光束将照亮每个移动的细胞，而光线则沿着各个方向散射。检测器放置于激光光束交叉点的前方或旁侧，用于接收散射光脉冲并将其转换为适合计算机分析和解释的形式。所检测到的前向散射光的总量取决于细胞的尺寸及折射率，但还与激光所照射的细胞横截面面积紧密相关。旁侧散射光的总量则指示了细胞核的形状或细胞间的间隔。

下面说明的改良型信号链路概念可支持将信号流从光电二极管传输至处理器所需的动态范围、速度和线性度。通过双绞线线路进行差分信号传输可提供共模噪声抑制性能，从而极大地改善信号品质。更优的信号品质将确保更加精确的测量及更可靠的统计分析。

流式细胞仪分析最重要的特性是其大量粒子（100,000或更多）的逐一连续分析，通常在一分钟左右的时间里完成。检测的下限可低至每细胞100个荧光分子(fluorescent molecules)。可以很好地解析诸如微小细菌和超微型浮游生物等亚微米粒子。

显微镜分析基于一块切片上所能看到的非常有限的细胞数量（1至100），与之不同，流式细胞仪则提供了关于各种各样细胞及其功能的有用信息。荧光分析使得流式细胞仪仅需对试管内的流动物质进行单次采样即可实现对单个细胞直到成千上万个细胞的荧光量化。统计数据（例如：平均荧光亮度及其随时间的变化或是与细胞

功能的相关性）已被证明是非常可靠的。

流式细胞仪的主要特点包括：
- 极少的模拟误差
- 小型化
- 针对脉冲吞吐量的分析速度有所提升
- 脉冲波形分析的灵活性有所增强
- 降低了电池供电设备的最终功耗

→ **DLP®技术**

DLP® Discovery™ 4100

敬请访问**www.ti.com/mems**，以获取更多的信息。

主要特点

- ±12°镜像运转
- 填充因子 (fill factor) 大于91%
- 可处理可见光、近红外光及紫外光
- DMD：选项包括0.95″ 1080p、0.7″ XGA、0.55″ XGA 2xLVDS
- DAD2000电源及复位驱动器
  - 生成16组DLP镜像的复位控制信号
- DDC4100数字控制器
  - 提供高速 (400MHz) LVDS数据及控制接口，并为DAD2000提供镜像复位及定时信息
  - 支持随机行寻址

应用

- 动脉血管成像
- 光线疗法
- 化学分析
- 微阵列 (Micro-array) 开发
- 3D度量
- 基因组学
- 外科手术照明

凭借0.95″ 1920 x 1080p 2xLVDS DLP芯片，D4100套件为开发人员提供了高性能和高分辨率，这款光学半导体模块可允许开发人员对光进行巧妙的数位处理。当集成了光源及光学模块后，该套独特的器件可产生二进制光发射图样 (light pattern)，具有比其他空间光调制器更优的速度、精度及效率。D4100套件提供了性能方面的改善，包括提升的数据率、帧速率及灵活、随机的行寻址。另外，D4100还支持0.55″（对角线尺寸）及0.7″XGA 2xLVDS芯片组。

DLP Discovery 4100芯片组包含了DLP芯片及其他支持元件。与其他针对投影仪显示进行优化的TI DLP控制器不同，D4100设计用于支持一系列基于DLP的应用，在数据光发射图样的格式化和排序上提供了最大的灵活性。

DLP Discovery 4100芯片组方框图

光的掌控方式

DLP Discovery 4100入门者套件

DLP Discovery 4100			
DMD (Digital Micromirror Device)	0.55-inch XGA	0.7-inch XGA	0.95-inch 1080p
Array	1024 x 768	1024 x 768	1920 x 1080
Mirror Pitch	10.8μm	13.68μm	10.8μm
Window Options (Visible, Ultraviolet, Near Infrared)	VIS	VIS, UV, NIR	VIS, UV
Clock Rate (Maximum)	400MHz (2 x LVDS)	400MHz (2 x LVDS)	400MHz (2 x LVDS)
Data Rate	25.6GbPs	25.6GbPs	48GbPs
Binary Frames Per Second (Maximum)	32,552	32,552	23,148

*如欲查阅更多系统方框图兼容的产品，敬请访问**www.ti.com/medical***

医疗仪器

→ *DLP ®技术*

DLP® Pico™ Projector开发套件v2
DLP1PICOKIT

敬请访问**www.ti.com/mems**，以获取更多的信息。

主要特点

- 外形非常小巧，尺寸为44.8 x 67.4 x 14.2mm³
- 可通过HDMI或DVI端口直接连接至PC
- 可选的DMD图形速率，高达2400Hz
- 同步信号输出
- 辅助连接器，用于直接访问I^2C总线

应用

- 便携式显示设备
- 3D光学测量
- 增强现实 (Augmented Reality)
- 嵌入式显示设备
- 显微镜检查
- 医疗成像

DLP Pico Projector开发套件v2使得开发人员能够将DLP技术融入创新和便携式应用之中。该投影器件采用了DLP 0.7″ HVGA芯片组和一个光学引擎 (light engine)，该光学引擎含有3个用作低功率光源的固态彩色LED。该套件包括一个电源、视频电缆和HDMI至DVI转接器。DLP Pico Projector开发套件是一款全集成化投影解决方案，能够造就众多新颖和便携的医疗设备。

Pico Projector的规格

Pico Projector Specifications	
DMD Resolution	0.17-inch HVGA
Brightness	Up to 10 lumens
Contrast ratio	1000:1
Light source	Solid-state 3 LED
Video input	DVI-D 888RGB VGA 50 and 60Hz
Dimensions	44.8 x 67.4 x 14.2mm³

DLP Pico Projector开发套件

DLP 0.17 HVGA芯片组

GPN	Description	Functions	Benefits
DLP1700	(DMD) Digital Micromirror Device	MEMS component containing an array of aluminum micromirrors, atop a CMOS substrate, that digitally switch in a binary state	Fast and reliable spatial light modulator to enable light processing and embedded display applications
DLPC100	DMD Digital Controller	Conveniently interfaces user electronics to the DMD	Provides developers the flexibility to control the mirrors independently and at high speeds
DLPR100	Controller Configuration PROM	Contains the DMD digital controller program data	Enables more advanced spatial light modulation than found in traditional projection systems

采用0.17 HVGA芯片组的投影系统方框图。

→ 设计考虑因素

电机控制示例

核心子系统

控制器

TI提供了一系列面向控制处理器的解决方案，从超低功耗MSP430微控制器到C2000™和Stellaris® ARM® Cortex M3微控制器等等不一而足。正确的控制器能够优化电机驱动效率、改善可靠性并降低总体系统成本。C2000控制器的32位DSP级性能和电机控制优化片上外设使得用户能够轻而易举地实现高级算法，比如三相电机的无传感器矢量控制。C2000 DSC系列提供了软件兼容的控制器，包括低成本的F28016和业界首款浮点DSC——TMS320F28335等等。

电机/螺线管驱动电路

诸如1.2A DRV104等PWM驱动器与采用单电源来驱动螺线管或气阀的阻性或感性负载兼容。新型PWM功率驱动器（比如：DRV8811）提供了一种集成化步进式电机解决方案，包括两个H桥驱动器以及用于步进控制的微步进分度器逻辑电路(microstepping indexer logic)。如需获得较高的驱动电流，则可尝试使用一个通过电阻器/电位器或电流输出DAC（比如：DAC7811或DAC8811）进行外部控制且具有0A至5A电流限值的高电压、高电流运算放大器 (OPA548)。诸如UCC37321或UCC37323等MOSFET驱动器能够直接驱动小型电机或驱动像MOSFET或IGBT这样的功率器件。

鉴于该医疗领域所具有的宽泛特性，这里我们把设计考虑因素分解到某些普通的电机控制和传感器接口应用之中，并提供了简单的系统方框图以及一些精选的模拟和嵌入式处理解决方案。

从上文给出的电机控制方框图示例可知，小型机电驱动器可以包括螺线管驱动器，单向小型机电驱动器包括螺线管驱动器、单向直流、双向直流或无刷直流系统，而且通常根据其框架尺寸和功率级别 (W) 来确定其规格。由TI提供的数字控制器、软件以及作为补充的模拟和数字解决方案可有助于满足大多数驱动要求。

注释："电机控制指南" (slyy017)
www-s.ti.com/sc/techlit/slyy017

医疗仪器

→ **设计考虑因素**

隔离

TI的数字隔离器具有由TI的二氧化硅 (SiO2) 隔离势垒 (isolation barrier) 加以分离的逻辑输入和输出缓冲器，可提供4kV的隔离度。这些器件与隔离电源一起使用，可阻断高电压、隔离参考地并防止噪声电流进入局部参考地并干扰或损坏敏感的电路。

设计人员可以考虑使用新推出的ISO1050，这是一款电流隔离CAN收发器，满足或超过了ISO11898标准的规范要求，并正在等待IEC 61010-1的审批。作为CAN收发器，ISO1050为总线提供了差分传输能力，并为CAN控制器提供了差分接收能力，信号传输速率高达每秒1兆位 (1Mbps)。

ISO1050专为苛刻环境而设计，提供了诸如故障保险输出、50kV/μs的瞬变免疫力以及可容忍5V电压的3.3V输入等额外特性。

控制器接口

对于许多系统而言，USB、RS-232或RS-422足以满足要求。RS-485信令可与诸如Profibus、Interbus、Modbus或BACnet等协议进行捆绑，这些协议均针对最终用户的特殊要求量身定制。由于网络要求的缘故，CAN或以太网/IP（工业协议）有些时候是优选方案。M-LVDS能够提供一种功耗较低的替代方案。

敬请访问
www.ti.com/comparingbussolutions，
查阅应用笔记，以了解更多有关接口选择的信息。

运动反馈

隔离型Δ-Σ调制器（AMC1203/AMC1210）非常适合于并联测量，用以降低干扰并提高电流反馈分辨率。这些调制器易于使用，并为编码器提供了过采样和滤波处理。当测量控制器输入和系统反馈时，INA159差分放大器采用5V或3.3V电源为模数转换器 (ADC) 提供了±10V (20Vpp) 的信号。诸如ADS7861/ADS7864或ADS8361/ADS8364等ADC提供了4通道或6通道同时电流采样。INA19x（x = 3至8）和 INA20x（x = 1至9）提供了宽共模电压，并能够实现低压侧和高压侧电流并联监视。

传感器信号链路
衡器传感器示例
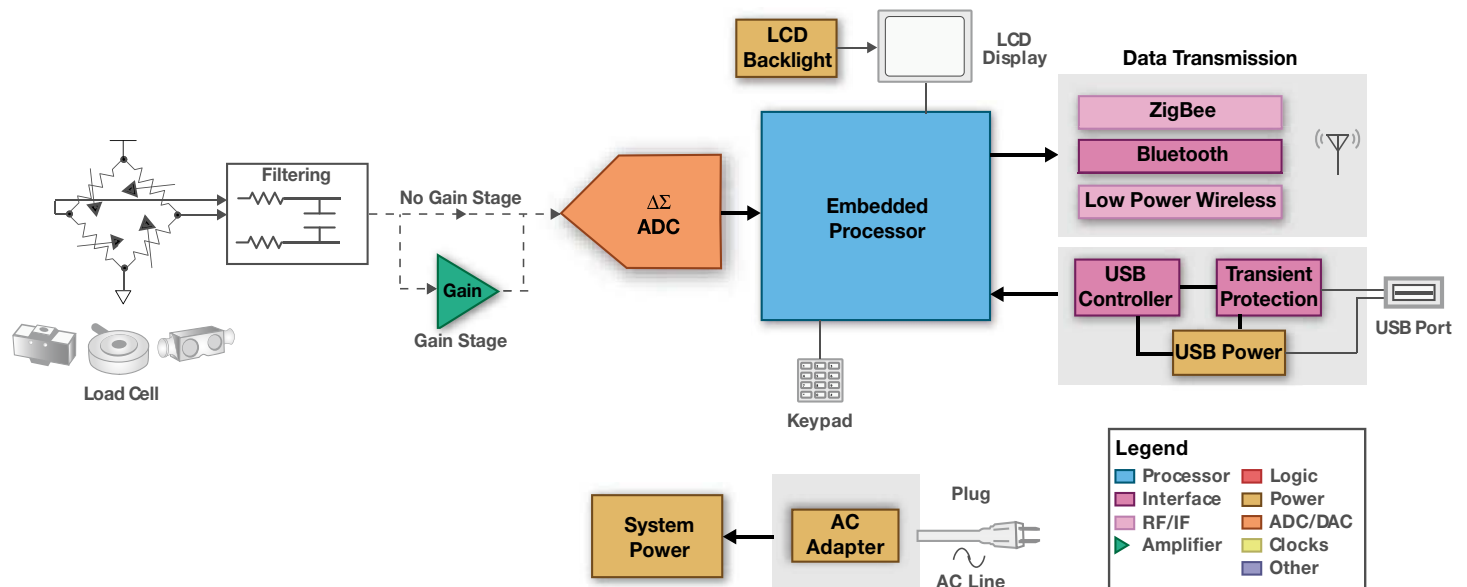
医疗仪器

➡️ *设计考虑因素*

传感器信号链路

压力传感器信号链路示例

流量计传感器信号链路示例

The Magnetic-Inductive Flowmeter

The Coriolis Flowmeter
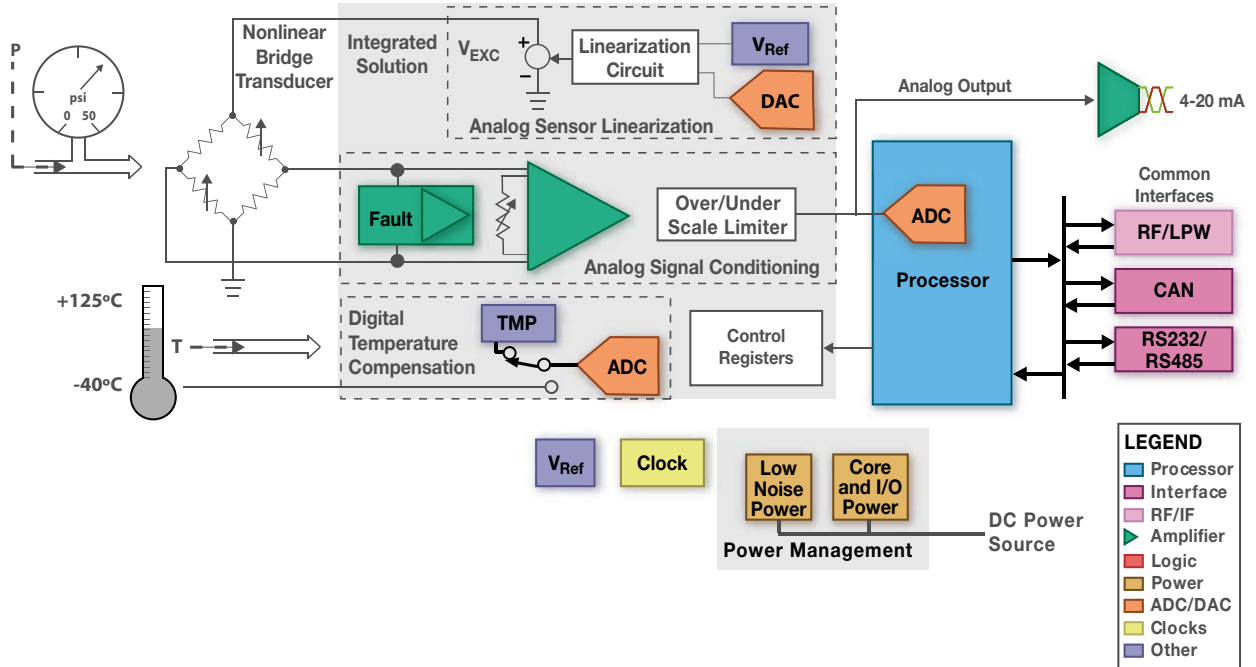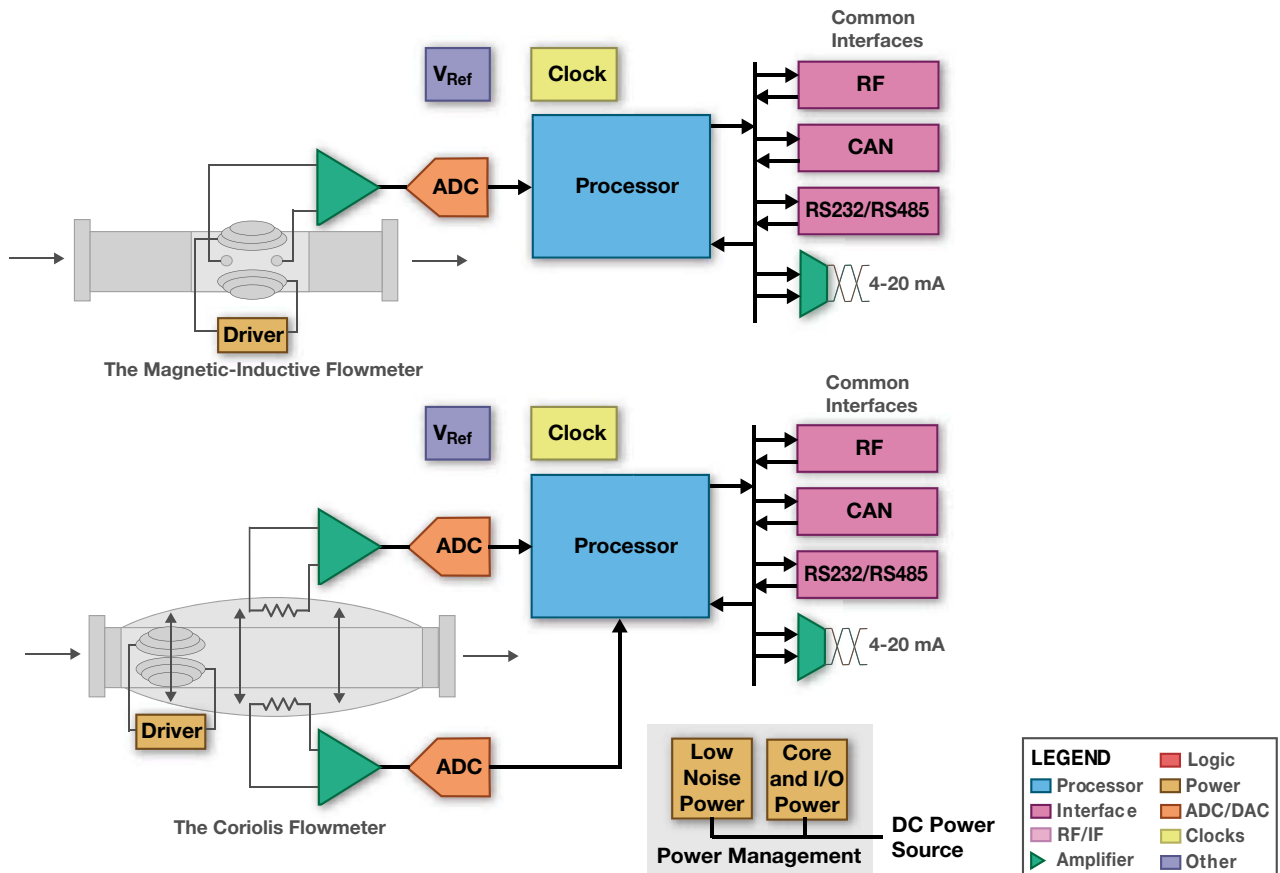
医疗仪器

→ 设计考虑因素

传感器接口

在医疗仪表市场上，电子衡器、压力传感器和流量计是几种极为常见的测量形式。医疗仪器制造商有时候会开发专有的ASIC，以与模拟前端的性能相匹配，从而实现尽可能高的准确度和稳定性，同时在IP（知识产权）方面保持超越其竞争对手的优势地位。虽然TI支持并鼓励这种定制ASIC方法，不过也有采用标准产品提供高达23位无噪声分辨率的设计方法，其性能与定制解决方案不相上下。

在面向这些传感器接口的设计中所面临的一个重大挑战是：必需在提供极低输入参考 (RTI) 噪声的同时进行多个负载单元的采样。ADS1230、ADS1232和ADS1234可提供该应用中所要求的低RTI噪声。

另一个重要因素是模拟前端相对于随时间和温度而变化的失调漂移和增益的长期稳定性，特别是因为实际的传感器具有随温度的上升和下降而不断变化的量程和失调误差。此外，许多桥式压力传感器在受力的情况下会产生非线性输出。这里，放大后的输入信号（单端或差分）的准确度必须在为期数年的运作时间里得到保证。

通过实现0.05μV/℃（OPA335）和0.4μV/℃（INA326）的失调漂移，诸如OPA335和INA326仪表放大器等自动置零放大器轻松地满足了上述严苛的要求。

TI还提供了专门针对桥式压力传感器的高集成度解决方案，例如PGA309。这些传感器包含采用自动置零技术的精密、低漂移可编程增益仪表放大器，并包括可编程故障监测器以及过量程/欠量程 (over/under scale) 限制器。PGA309还提供了数字温度补偿电路。如果不需要温度补偿，可尝试使用PGA308。

推荐用于压力传感器调节的其他超低噪声放大器和仪表放大器包括OPAx227、OPAx132、INA118、INA112和INA333。

对于医疗仪表领域中的诸多应用而言，INA333凭借其低功耗、高准确度和增益设定能力而正在逐渐成为一种广受欢迎的选择。采用标准增益公式 $G = 1 + (100\text{k}\Omega / R_G)$，可由单个外部电阻来设定范围从1至1,000的任何增益。

模数转换

ADS125x系列器件是模数转换的理想选择。此类器件是具有18位至24位分辨率的精密、宽动态范围Δ-ΣADC，采用单+5V工作电源，并保证具有无漏失码特性。它们是专为心脏诊断和医疗仪表中的高分辨率测量应用而设计的。

如果需要进行多轴电机控制，则可考虑使用TI新推出的ADS8556/7/8转换器系列。该ADC系列包含6个基于低功耗16、14或12位逐次逼近型寄存器 (SAR) 的模数转换器 (ADC)，具有真正的双极型输入。每个通道包含一个采样及保持电路，该电路实现了同时的高速多通道信号采集，可支持高达740kSPS（在并行接口模式中）或高达500kSPS（在采用串行接口的情况下）的数据速率。由于可提供±1V至±12V的宽输入配置范围，因而是电机控制应用的合适之选。

时钟

CDCE9xx时钟系列包括基于锁相环 (PLL) 的模块化、低成本、高性能、可编程时钟合成器、倍频器和分频器。此类器件可从单个输入频率生成多达9个输出时钟。对于任何高达230MHz的时钟频率，均可采用独立的可配置锁相环对每个输出进行在线编程。

电源

低压降稳压器 (LDO) 适合作为放大器和数据转换器的低噪声电源，因为它们可提供低纹波电源轨，从而实现了更为优越的信号保真度。REF31xx系列包括精密、低功耗、低压降串联电压基准，采用纤巧的SOT23-3封装。REF31xx并不需要负载电容器，但可在采用任何容性负载的情况下保持稳定，并能够吸收/供应高达10mA的输出电流。

嵌入式处理

OMAP™/DaVinci™ 处理器

当今医疗仪器最重要的特点之一便是易用性。易用性可通过触摸屏显示及多级菜单驱动配置实现，具体配置可针对环境及患者的生理统计参数进行设定。另外，还必需能通过从无线至RS232的各种接口进行数据传输。医院可以在所有区域里支持一种特定的基础设施；而救护车、居家及其他环境则有可能需要支持不同的协议。

医疗仪器

→ 设计考虑因素

在实现这种易用性的过程中所面临的挑战与蜂窝电话系统惊人地相似。TI的OMAP技术具有嵌入式ARM® 及DSP处理器核心，可直接解决此类难题。OMAP 3处理器可执行进一步的数字信号处理、测量及分析，以监视设备和患者状况。TI强大的ARM处理器可运行高级操作系统(HLOS)，使得添加多模式监测更为简易，并可提供大量的用户接口及系统控制。异常状况或故障的检测以及与中心服务器或卫生保健提供者的通信是不可或缺的。OMAP 3具有宽泛的外设集，可支持不同的控制及接口/连通性选项，例如蓝牙(Bluetooth®) 技术、WiFi、ZigBee® 及其他新兴的标准。

C5000™ 处理器

TI的TMS320VC5504/05/14/15 DSP提供了业界最低的待机功耗 (<150μW) 和业界最低的运行功耗 (0.15mW/MHz)。这两款引脚对引脚兼容的新型处理器最大限度地提升了能量效率，从而延长了便携式设备的电池使用寿命，同时降低了系统成本并实现了用户友好型功能。在便携式监测领域取得成功的同时，这些器件还在医疗仪表领域发现了自己的用武之地，可提供很高的外设集成度，整合了诸如1024点可编程快速傅里叶变换 (FFT) 硬件加速器、具物理层器件 (PHY) 的高速USB 2.0、LCD显示控制器、多媒体卡/安全数字卡(MMC/SD) 及10位、4通道逐次逼近型寄存器 (SAR) 模数转换器等。

Stellaris® MCU系列处理器 (Luminary)

医疗仪表要求准确度、可靠性和响应度。无论是连接起来使用抑或是单独使用，Stellaris处理器均提供了有益于医疗设备制造商的解决方案。通过MPU（存储器保护单元）、处理器中的多种误差检测机构、

外设故障检测、用于处理故障和关键性操作的中断优先级以及高度确定性的操作增强了安全性。通信包括以太网通信和用于连接设备的串行通信。

Stellaris MCU和ARM Cortex-M3提供了一条至业界最强的开发工具、软件和专业知识生态系统的直通路径。转而采用Stellaris的设计人员将得益于绝佳的工具、小代码占用空间和出众的性能。

Stellaris系列在业界率先提供了最宽泛的Cortex-M3和Thumb-2指令集可实现方案。凭借超快的响应速度，Thumb-2技术组合了16位和32位指令，旨在实现代码密度与性能的最佳平衡。与单纯采用32位代码相比，Thumb-2所占用的内存减少了26%，因而降低了系统成本并将性能提升了25%。

通过收购，Stellaris微控制器成为了TI庞大微控制器产品库的新成员，其用户将得益于：

- 令人放心的产品寿命（位列全球三甲的半导体供应商凭借75年以上的丰富业界经验所给予的强大支撑）
- 除了遍布全球的分销渠道之外，规模庞大的全球直销队伍可直接面对用户并为其提供所需的支持
- 可使您的Stellaris MCU与只有TI能够提供的完整信号链路和电源管理解决方案、支持及应用程序结组工作

32位计算、控制和通信大行其道的时代已经到来。

其他嵌入式处理器

MSP430微控制器或TMS320C55x DSP提供了诸多的功能，包括计算和信号处理、用户友好型接口（比如LCD显示器和键区控制）以及无线/有线数据传输和连通性接口。TI的MSP430和MSC12xx系列集成微控制器解决方案通过整合集成ADC提供了滤波器的定义和关键性压力水平的阈值。

➡ 推荐器件

Amplifiers

Component	Description	Key Features	Benefits	Other TI Solutions
DRV104	PWM High-Side Driver Amp for Solenoids, Coils	1.2A output drive, +8V to +32V supply range	PWM operation conserves power and allows for fine control	DRV102, DRV101
INA159	High-Speed, Precision Gain Level Translation Difference Amp	Gain of 0.2 to interface ±10V signals to single-supply ADCs	Maintains gain accuracy and common-mode rejection over temperature	
INA333	Low Power, Precision Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50µA (typ) Iq	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA118, INA326
OPA211	Precision Op-Amp	1.1nV/$\sqrt{Hz}$ at 1kHz low noise, 0.2µV/°C offset drift, 80MHz (G = 100) BW	<1µs settling time to 16-bit accuracy	
OPA277	Precision Op-Amp	10µV offset voltage, ±0.1µV/°C low drift, 134dB open-loop gain, 140dB CMRR	Available in S, D, Q	OPA177, OPA627
OPA380	Transimpedance Amp	90MHz GBW, over 1MHz transimpedance BW, 25µV offset (max), 0.1µV/°C drift (max)	Precision, dynamic range 4 to 5 decades, excellent long term stability	OPA350, OPA335
OPA735	CMOS Op-Amp	0.05µV/°C zero drift (max), 750µA IQ (max), 5µV offset voltage	Zero-drift series, dual version available	OPA734
OPA827	JFET-Input Op-Amp	1µV/°C drift, 4.5mA/ch IQ, 250µV offset voltage, 18MHz BW	Outstanding DC precision w/excellent AC performance	**OPA141**
PGA309	Prog. Sensor Conditioner	Sensor error compensation: span, offset, temp drifts	Complete bridge sensor conditioner	PGA308
THS4520	High-Speed Op-Amp	450MHz (G = 2V/V), 570V/µs SR, 2nV/$\sqrt{Hz}$ noise (f>10MHz)	Single-to-differential conversion	
THS4131	High-Speed Op-Amp	150MHz (−3dB) BW, 51V/µs SR, −100dB HD3 at 250kHz	Low noise, fully differential I/O	
THS4631	High-Speed Op-Amp	210MHz GBW, 900V/µs (G = 2) SR, −76dB SFDR at 5MHz	±5 and ±15V supply operation, 95mA output current	

Data Converters

Component	Description	Key Features	Benefits	Other TI Solutions
ADS1115	Delta-Sigma ADC	16-bit, 860SPS, 4 SE, 2 diff input, PGA, MUX, comparator, V$_{REF}$	Smallest 16-bit ADC – 2.0 x 1.5 x .04 mm leadless QFN pkg – reduces system size/component count	**ADS1113/4, ADS1013/14/15**
ADS1248	Delta-Sigma ADC	24-bit, 2kSPS, 7 channels w/dual current sources, GPIO, low drift V$_{REF}$, and temp sensor	Flexible front end for flow or temperature measurement	**ADS1148, ADS1247, ADS1147**
ADS1258	Delta-Sigma ADC	16-channel, 24-bit, 125kSPS, 23.7kSPS/channel	Fastest multichannel delta-sigma ADC, measures all 16 inputs in <675µs	ADS1274, ADS1278, ADS1605, ADS1602, ADS1601
ADS1278	Delta-Sigma ADC	24-bit, 128kSPS, 8-channel, 111dB SNR	Simultaneous measurement, onboard decimation filter	ADS1271, ADS1274
ADS1298	ECG/EEG AFE	24-bit, 8PGA, 8ADC, plus RLD and RESP	Complete front end, reduction in power and size, increase reliability	**ADS1294, ADS1296, ADS1198,** ADS1251/58
ADS1610	Delta-Sigma ADC	16-bit, 10MSPS, parallel interface	SYNC pin for simultaneous sampling	ADS1605
ADS7861	SAR ADC	Dual, 500kHz, 12-bit 2+2ch	Simultaneous sampling	ADS7864, ADS8361, ADS8364
ADS8254/55	SAR ADC	16-bit, 1MSPS, 98dB (typ) SNR, 270mW power, onboard 4V int reference, driver amp and MUX	Flexible input configuration, multichannel modes	
ADS8284/85	SAR ADC	18-bit, 1MSPS, 98dB (typ) SNR, 270mW power, onboard 4V int reference, driver amp and MUX	Flexible input configuration, multichannel modes	
ADS8317	SAR ADC, Serial	16-bit, 250kSPS, 2.7 to 5.5V, pseudo-bipolar, diff inputs	Excellent linearity, micropower, high speed	ADS8422
ADS8326	SAR ADC, Serial	16-bit, 250kSPS, 2.7 to 5.5V, pseudo-bipolar, diff inputs	Low noise, low power, high speed	ADS8325
ADS8410	SAR ADC	16-bit, 2MHz, 87.5dB at 10kHz I/P SNR, int. ref.	200Mbps LVDS serial interface	ADS8413
ADS8413	SAR ADC	16-bit, 2MSPS, LVDS interface int. ref. and buffer	LVDS, serial interface, daisy-chain capable	ADS8410, ADS8406
ADS8422	SAR ADC	16-bit, 4MSPS, 1 LSB INL (typ), parallel interface	Zero latency	ADS8412, ADS8472
ADS8556	SAR ADC	16-bit, 6-channel, ±1V to ±12V input configuration	Six SAR ADCs grouped in 3 pairs, pin selectable input range	ADS8557, ADS8558
DAC7811	Multiplying DAC	12-bit, single channel, serial input, multiplying DAC	Multiplying, current output	DAC7613, DAC8811, DAC8871
DAC8550/2/4	Low-Power DAC	16-bit, 1-4 chs, ±3 LSB (typ) INL, 0.1 to 0.15nV-s glitch	Excellent AC/DC performance	DAC8560, ADS8564
DAC8560	V$_{OUT}$ DAC	16-bit, 0.15nV-s glitch, ±10µs to 0.003% FSR settling time	Small package, low power	DAC7731, DAC8411
DAC8564/5/8	Quad DAC	16-bit, 2.5V V$_{REF}$, 2ppm/°C drift, 0.15nV-s glitch	Quad and octal versions	DAC8551
DAC8812	MDAC	16-bit, ±1-LSB INL, −105dB THD, 0.5µs settling time	Multiplying, current output	DAC8814
DAC8814	Multiplying DAC	16-bit, 0.5µs settling time, −105dB THD, 1 LSB (max) relative accuracy	Double-buffered serial data interface	DAC7715, DAC8811
DAC8820	DAC	16-bit, parallel input multiplying, ±1.5 LSB DNL, ±1 LSB INL	2.7 to 5.5V supply, low noise, low power	DAC8814, DAC8822

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新产品以**粗体红色**标明。前瞻性产品以**粗体蓝色**标明。

医疗仪器

→ 推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Data Converters (Continued)				
TPDxE001	ESD Protection	Industry's lowest leakage spec, 15kV ESD solution in two-, three-, four- and six-channel packages	System-level ESD protection for USB 2.0, Ethernet, analog I/O interfaces	TPDxE004
TPDxF003	EMI Filter	-3dB bandwidth at 200MHz, 15kV contact ESD, and four-, six- and eight-channel available	System-level EMI immunity for high-speed data interface	TPD6F002
TPD2E007	ESD Protection	Back-to-back clamp for bipolar signal interface	System-level ESD protection for RS485, RS422, RS232, LVDS, and CAN interfaces	
TPD4S009	ESD Protection	Industry's lowest leakage spec, less than 0.05pF differential capacitance	System-level ESD protection for HDMI, eSATA, USB 2.0, and DisplayPort high-speed interfaces	TPD2E009, TPD8S009, TPD4S010
TXS0102	Autodirection Sensing Voltage-Level Translator	2-bit, 1.2V to 5.5V, works with push-pull and open drain (e.g. I²C) drivers	Bridges incompatible digital switching voltages	TXS010x, TXB010x, SN74AVCxxT245
Interface				
TPDxE001	ESD Protection	Industry's lowest leakage spec, 15kV ESD solution in two-, three-, four- and six-channel packages	System-level ESD protection for USB 2.0, Ethernet, analog I/O interfaces	TPDxE004
TPDxF003	EMI Filter	−3dB bandwidth at 200MHz, 15kV contact ESD, and four-, six- and eight-channel available	System-level EMI immunity for high-speed data interface	TPD6F002
TPD2E007	ESD Protection	Back-to-back clamp for bipolar signal interface	System-level ESD protection for RS485, RS422, RS232, LVDS, and CAN interfaces	
TPD4S009	ESD Protection	Industry's lowest leakage spec, less than 0.05pF differential capacitance	System-level ESD protection for HDMI, eSATA, USB 2.0, and DisplayPort high-speed interfaces	TPD2E009, TPD8S009, TPD4S010
TXS0102	Autodirection Sensing Voltage-Level Translator	2-bit, 1.2V to 5.5V, works with push-pull and open drain (e.g. I²C) drivers	Bridges incompatible digital switching voltages	TXS010x, TXB010x, SN74AVCxxT245
Clocking Products				
CDCE(L)9xx	1.8V Programmable VCXO Multi-PLL Clock Synthesizer	LVCMOS or Xtal Inputs; VCXO Input with ±150ppm (typ) pulling range	Low power consumption, low jitter, low skew; EEPROM programmable	CDCE706, CDCE906
CDCE72010	2:10 Ultra-Low Jitter Cleaner w/ VCXO	Wide-range integer divide; <35fs RMS jitter; on-chip EEPROM	Wide input/output freq. range supports high and low end of freq. standards	CDCE6200x
CDCM6100x	1:4/2/1 Xtal-In 44MHz - 683MHz Clock Generator	Fully integrated VCO and loop filter generates various frequencies; <1ps RMS jitter	One single device across multiple designs, replacing up to four discrete XOs	
CDCS50x	Xtal-In Clock Generator with Optional SSC	Selectable multiplier rates of 1x and 4x; selectable spread-spectrum modulation	Reduces EMI up to 10dB; replaces more costly crystal oscillators	
Power Products				
REF3130	SOT23-3 Series Voltage Reference	15ppm/°C, 0.2% accuracy at 25°C	Low power consumption, low dropout.	REF3112, REF3120, REF3125, REF3133
TPS3307	Voltage Supervisor	Triple processor supervisor	Two fixed and one adjustable supervisor for system flexibility	TPS3808
TPS61081	LED Boost Converter	Input-to-output isolation	Protection from short between any pins and between any pin to ground	TPS61042
TPS61093	OLED Boost Converter	Wide V_{IN} range, input-output disconnect	Flexible, fail safe solution	TPS61080
TPS62110	Step-Down Converter	3.1V to 17V V_{IN}, 1.5A conversion, synchronization pin, Low battery indicator, power save mode	Very low noise/high efficiency	TPS62050
TPS62400	Dual Output Step-Down Converter	180° out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62410
TPS62750	Step-Down Converter	Programmable input current limit, hot plug and reverse current protection	Supports USB powerde applications and large.output caps	TPS62040
TPS63000	Buck-Boost Converter	1.8A switch, automatic transition between step down and boost mode	Stable output voltage over entire entire V_{IN} range	TPS63010
TPS63030	Buck-Boost Converter	1A switch, automatic transition between step down and boost mode	Extending Application run time, Small Solution	TPS61020
TPS717xx	Single-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS799xx
TPS718xx-yy	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719xx-yy
TPS74201	Single-Channel LDO	1.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74301, TPS74801
TPS74401	Single-Channel LDO	3.0A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74901
TPS74701	Single-Channel LDO	0.5A ultra-low-dropout linear regulator	Split bias and supply pin minimize heat generation	
TPS79901	Single-Channel LDO	Very high rejection of power source noise	Low-noise power rails for sensitive analog components	TPS79501
UCC37321	Single 9A Peak Low-Side MOSFET driver	High-speed, 20ns typical rise and fall times	Industry standard pin-out, handles extreme Miller currents	UCC37323

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➜ 推荐器件

RF Transceivers

Component	Description	Key Features	Benefits	Other TI Solutions
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64-byte data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500Kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards-compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/ IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400-m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530

RF System-on-Chip

Component	Description	Key Features	Benefits	Other TI Solutions
CC2560	2.4GHz Bluetooth® 2.1 chipset	Single-chip Bluetooth® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/11	Sub-1GHz System-on-Chip	MCU, USB 2.0, flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power, battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2431	System-on-Chip Solution for ZigBee® location engine	CC2431 has 32/64/128 KB hardware AES encryption engine, excellent selectivity, blocking performance and hardware location	Ideal for battery operated systems; suitable for proprietary and ZigBee systems; adds location awareness and accuracy of 3 to 5 meters	
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/ RF4CE/ZigBee	Excellent RX sensitivity, low power, easy-to-use development tools	RF design SOC for quick time to market; provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4GHz Bluetooth® Low Energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	A fast-to-market Bluetooth® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and Bluetooth® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and Bluetooth® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and Bluetooth® operations; supports ANT+ standard.	WL1271

RF Network Processor

Component	Description	Key Features	Benefits	Other TI Solutions
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery-operated excellent selectivity and blocking performance systems; excellent coexistence with Bluetooth® technology and Wi-Fi.	

Processors

Component	Description	Key Features	Benefits	Other TI Solutions
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
LM3S800	Stellaris® Microcontroller	ARM® Cortex M3 core, 50MHz, 64kB single-cycle flash	Hardware-division and single-cycle multiplication, 21 interrupt channels	LM3S600
MSP430FG461x	Microcontroller	Ultra-low power, 16-bit operation, up to 120kB flash, up to 8kB RAM, 12-bit ADC, 12-bit DAC, three op-amps, LCD controller	Ultra-low-power, integrated SoC	
OMAP3530	Digital Signal Processor	Low power 64x + ARM® Cortex-A8 CPU, 3440 MMACS, 720MHz	PowerVR SGX graphics accelerator, HD resolution output	OMAP3525, OMAP3515, OMAP3503
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	
TMS320F2803x	Microcontroller	32-bit operation, 60MHz, up to 128kB flash, up to 20kB RAM, high-speed 12-bit ADC, high-resolution PWM	ADC capable of 5MSPS, programmable CLA (control law accelerator)	
TMS320VC5505	Digital Signal Processor	High-performance, low-power TMS320C55X DSP generation CPU core	GPIO, 10-bit SAR ADC and I/O for displays	TMS320VC5504

Toolkits

Component	Description	Key Features	Benefits	Other TI Solutions
DLP® Discovery™ 4100 *Page 129	An optical semi-conductor module that allows digital manipulation of light	±12° mirror operation, works with Visible, UV and near-IR light	This device can surpass the speed, precision and efficiency of other spatial light modulators	DLP® Pico™
DLP® Pico™ Kit *Page 130	Fully integrates projection solutions for portable medical devices	44.8x67.4x14.2mm^3, I^{2}C command interface	Well suited for incorporating digital projection into portable devices	DLP® Discovery™

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→ 内窥镜 (Endoscope)

在医学领域，内窥镜用于窥探人体内部以检查器官。通过较小的切口，内窥镜可检查肠胃、呼吸和泌尿管道以及其他内部器官。内窥镜可通过其硬质或柔软的长导管进行图像捕捉。通常把用于切割、固定及其他功能的附加仪器连接至内窥镜，以最大限度地减少侵入流程，从而改善患者的护理水平并尽可能地缩短康复时间。

当在某项技术应用中被用来检查限定的空间时，这种工具常常被归入内孔镜 (borescope) 一类。内孔镜用于检查机器内部、建筑物墙体以及倒塌建筑物内的遇难者搜索。
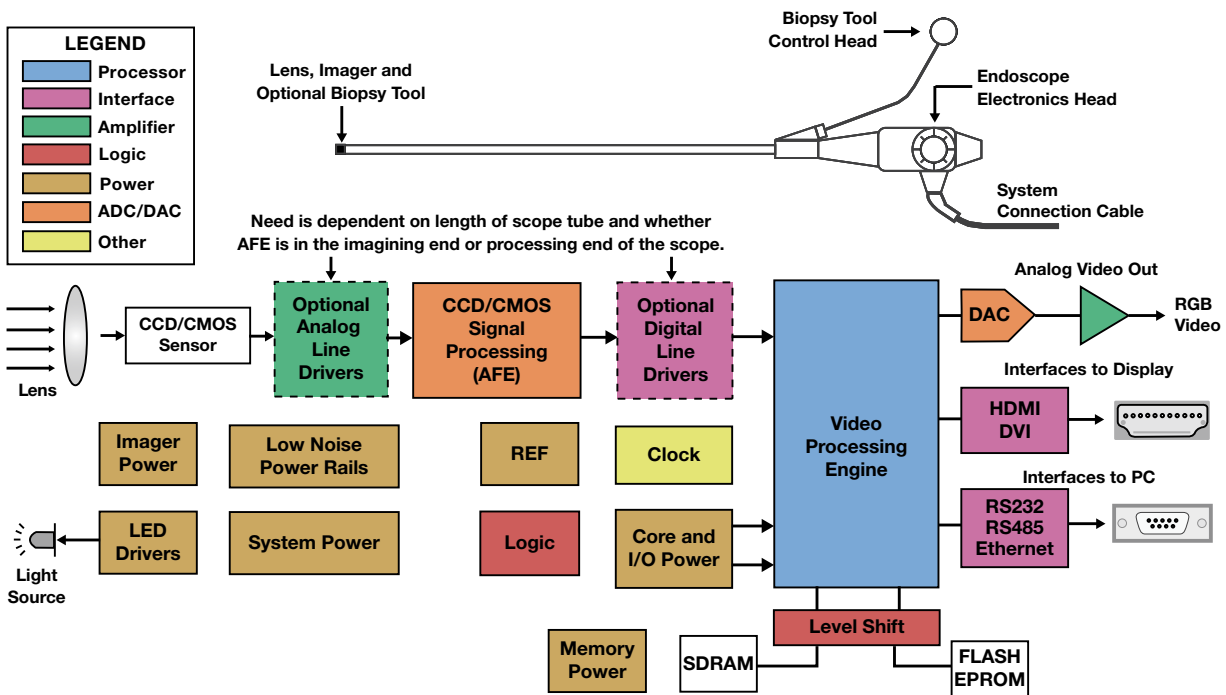
内窥镜和内孔镜具有四项基本要求：
- 光源，用于照亮目标
- 导管，用于引导光线至目标
- 透镜或光纤系统，用于捕获目标所反射的光线
- 图像捕获系统，用于捕获、处理及存储或显示图像

TI宽范围的产品组合可支持整个成像链路，包括生成光源、捕获图像、信号调节及图像处理。LED驱动器可提供具有出色方向性和极低发热损耗的明亮光源。此类驱动器具有上佳的通用性，并允许针对应用的光谱要求来优化LED的选择。电流步进 (step) 的分辨率将影响亮度控制的精度：TI的LED驱动器所提供的PWM和模拟调光实现了精确的亮度等级和定时控制。

图像传感器负责检测反射光并将光转换为模拟电信号。根据图像传感器位置的不同，可能需要采用低噪声线路驱动器来传输信号通过一定长度的光导管。线路驱动器的关键考虑因素是低功耗、噪声免疫力和数据速率。LVDS技术可提供高达800Mbps的数据速率及数十伏量级的电压摆幅，并具有较高的共模噪声抑制能力。

模拟前端 (AFE) 对最终图像品质具有本质的影响。AFE负责调节传感器的模拟电信号，并将图像信息转换为数字化的表述。AFE选择的关键在于其对传感器所导致的失真进行校正的信号调节能力，例如：暗电流消除、复位电平调节、缺陷像素校正、以及直流偏置调节。视信号电平的不同，可编程增益放大器 (PGA) 的使用、PGA的线性度以及可用的增益范围可能也是很重要的。在数字化处理期间，位数决定了图像的对比度。通常情况下，建议以比最终图像所需精度高2至4位的分辨率对初始数据进行数字化。例如：若最终图像数据的精度要求是8位，则采用10位精度进行初始数字化可避免在后续图像处理过程中出现舍入误差。当较为注重色彩重现时，应尽可能地降低差分非线性 (DNL) 及积分非线性 (INL)。

内窥镜系统方框图

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→ 内窥镜

推荐器件

Component	Description	Key Features	Benefits	Other TI Solutions
Analog Front Ends				
VSP2582	CCD/CMOS AFE	36MSPS, 12-bits (parallel output), CDS	Low noise, low power, smallest footprint	
VSP2562	CCD/CMOS Analog Front End	36MSPS, 12-bits (parallel output), CDS, w/two 8-bit DACs	Low noise, low power, small footprint, includes two 8-bit DACs to simplify system design	
VSP2566	CCD/CMOS Analog Front End	36MSPS, 16-bits (parallel output), CDS, w/two 8-bit DACs	Higher resolution, low noise, low power, small footprint, includes two 8-bit DACs to simplify system design	
Processors				
OMAP3530	Applications Processor	ARM® Cortex-A8, C64x+™, graphics accelerator, video accelerators	Laptop-like performance at handheld power levels	OMAP3503, OMAP3515, OMAP3525
TMS320DM355	Digital Media System-on-Chip	64-channel EDMA, 135/216/270MHz ARM926EJ-S clock rate	Encode/decode up to 720p H.264; optimized for power, cost, and efficiency, and is even suitable for three Li-ion AA battery inputs	
TMS320DM365	Digital Media System-on-Chip	64-channel EDMA, 216/270/300MHz ARM926EJ-S clock rate	Encode/decode up to 1080p H.264; high-performance ARM® and video processing capabilities	
TMS320DM6437	Digital Media Processor	64-channel EDMA, 400/500/600/660/700MHz C64x+™ clock rate	DSP architecture means programmable solution, Benefit from H.264 encode (D1)	
TMS320DM6446	Digital Media System-on-Chip	64-channel EDMA, 513/594MHz C64x+ clock rate	Encode/decode up to 720p MPEG-4, programmable DSP, with GUI and other processing offloaded to the ARM® for greater efficiency and scalability	
TMS320DM6467	Digital Media System-on-Chip	64-channel EDMA, 594/729/1000MHz C64x+™ clock rate	Encode/decode up to 1080p H.264; high-performance programmable DSP and ARM	
TMS320C6747	Industry's Lowest Power Floating-Point DSP	32-/64-bit accuracy, 1.8V to 3.3V I/O supply, low power and rich connectivity peripherals.	Uses three times less power that existing floating-point DSPs	
Data Converters				
THS8135	Video DAC	Triple 10-bit 240MSPS video DAC with tri-level sync and video-compliant (ITU-R.BT601) full-scale range		
THS8200	Video DAC	Triple 10-bit all-format video DAC		
Amplifiers				
OPA360	Video Amp	3V video amplifier with low pass filter, internal G=2 and SAG correction in SC70	Designed to work with video processors	OPA361, THS7303
OPA3693	Video Amp	Triple,ultra-wideband, fixed gain, video buffer with disable	Designed to work with video processors	OPA3832
OPA830	Buffer Amp	2.5MHz (G = +1) BW, 550V/µs slew rate, 9.2nV/$\sqrt{Hz}$ noise, 3.9mA supply current, single/dual supply	Ideal input buffer stage	OPA2830, OPA847
Interface				
SN65LV1023A	10-bit LVDS Serdes	10MHz-66MHz; QFN and TSSOP	Available in 70% smaller QFN package	SN65LV1224B
SN65LVDS93A	24-bit RGB LVDS Serdes	10MHz-135MHz, BGA and TSSOP; supports 1.8V to 3.3V TTL i/p	Wide frequency range, saves space, no level shifter for 1.8V powered µP	SN75LVDS83B
Power Management				
TPS65073	PMU w/charger/WLED	Integrates charger, WLED, DCDC and LDO.	Highest integration for portable applications	TPS65720
TPS61160	White LED Driver	White LED driver with digital and PWM brightness control in 2mm x 2mm package	Allows stepped brightness adjustment	TPS61061
TPS61220	Boost Converter	Down to 0.7V V_{IN} operation, pass-through function	Simple, small, low power solution	TPS61070
TPS62230	Step-Down Converter	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm² solution size	TPS62260
TPS62400	Dual Output Step-Down Converter	180 degrees out of phase operation, serial interface	Flexible voltage adjustment for processors and MCUs	TPS62410, TPS62111, TPS62260, TPS62290
TPS63030	Buck-Boost Converter	1A switch, automatic transition between step down and boost mode	Extending application run time, small solution	TPS61020
TPS71701	LDO	Low-noise, high-bandwidth-PSRR, low-dropout 150mA linear regulator	Filters out wider range of incoming noise with the high PSRR	TPS718xx family
TPS74201	Single Channel LDO	1.5A ultra low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS74401
TPS74301	LDO	Single-output LDO, 1.5A, adjustable (0.8V to 3.3V), any or no cap, programmable soft start	Adjust the voltage ramp rate for your processor requirements	
TPS74401	LDO	Single-output LDO, 3.0A, adjustable (0.8V to 3.3V), fast transient response, programmable soft start	Adjust the voltage ramp rate for your processor requirements	
TPS74701	Single Channel LDO	1.5A ultra low-dropout linear regulator	Split bias and supply pin minimize heat generation	TPS71718, TPS74801
TPS75003	Linear Charge Management	Integrated triple-supply power management IC for Xilinx Spartan FPGAs	Provides all three rails in one package	

如欲查阅更多系统方框图兼容的产品，敬请访问 **www.ti.com/medical**

新产品以**粗体红色**标明。

➡️ *概述*

连通性器件在临床、患者监测和消费类医疗设备中扮演着重要的角色。尽管有线 (USB) 连接仍在使用，但重点则放在了可实现连接设备或联网设备的无线通信能力上。消费者对便携性的渴望要求此类器件具备小尺寸、低功耗的特点，并具有高效、精确地将数据馈送至远程信源的能力。

TI在提供宽范围的无线技术革新上拥有长期的经验。部分此类技术包括ZigBee®、射频识别 (RFID)、低功耗无线 (ISM)、蓝牙 (Bluetooth®) 技术和WLAN。

面向医疗应用的USB

如今，由于消费者和护理人员需要把数据从医疗设备传递至诸如计算机和移动电话等数据集线器 (data hub)，因此便携式医疗应用的连通性变得至关重要。TI是"康体佳"健康联盟 (Continua Health Alliance) 的创立成员之一，目前为Agent Devices公司提供了首款经Continua认证的USB平台。更多信息请参见第142页。

如需了解更多有关Continua健康联盟的信息，敬请访问：

http://www.continuaalliance.org

面向医疗应用的ZigBee®和*Bluetooth*®低能耗解决方案

越来越多的医疗设备（特别是患者监测和家庭保健领域中的医疗设备）都能够从诸如ZigBee和Bluetooth Low Energy（蓝牙低能耗）等无线技术当中受益。

ZigBee标准使相关的公司拥有了一种基于简单、可靠、低成本和低功耗标准的无线平台，此平台可用于其医疗应用开发。

例如：通过使用ZigBee无线传感器，患者可在医院内甚至居家范围内走动，而传感器仍将负责监测并把关键性的健康数据发送至医院或医生那里。

蓝牙低能耗解决方案专为低成本、低功耗和短程连通性而设计。该技术实现了与蜂窝电话、笔记本电脑和其他具蓝牙功能的设备（比如：运动和健身手表、GPS/手持终端以及其他个人监测设备）的直接通信。

TI支持ZigBee个人健康 (PH) 配置 (profile) 以及Continua联盟 / EN11073配置。

如需了解更多信息，敬请访问：
www.ti.com/zigbee
www.ti.com/bluetoothlowenergy

射频识别 (RFID)

TI的高频RFID产品系列包括13.56MHz高频 (HF) 转发器和低功耗RFID阅读器，它们符合ISO/IEC 15693及ISO/IEC 18000-3全球性开放标准。

典型的RFID医疗应用包括血袋及医疗供给追踪、患者/工作人员鉴别、药品分类鉴别、医疗成像、产品鉴定及远程数字化保健管理应用。

TI的Tag-it™ HF-1系列转发器内嵌了符合ISO/IEC 15693及ISO/IEC 18000-3全球性开放标准的13.56MHz HF 转发器。此类产品可提供具频率偏移的6种不同的天线形状，以便集成至纸张、PVC或其他运用TI的激光修调工艺制造的衬底之中，以提供一致性的读取性能。
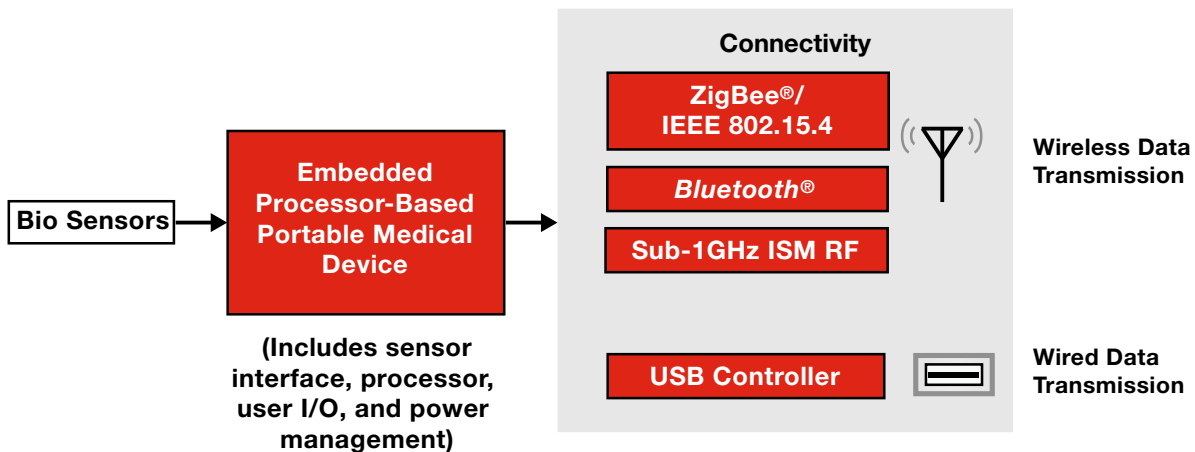
TI在设计旨在获得互操作性及共存性的连通性解决方案方面拥有相当丰富的经验。

面向医疗的连通性解决方案

→ 概述（续）

低功耗无线 (ISM)

TI提供了众多面向专有和标准无线应用的成本效益型低功耗射频解决方案。该产品库包括射频收发器、射频发送器及片上系统，适用于Sub-1GHz及2.4GHz频段的短程应用。

为了针对特定的应用选择正确的无线电器件，设计人员必需确定其工作的频段。TI的无线电器件可工作于全球标准的2.4GHz或Sub-1GHz的工业、科学及医学 (ISM) 频段。在世界上的大多数国家里，2.4GHz是无须申请许可证便可使用的频段，因此相同的解决方案可在多个不同地域的市场中销售，而无需变更软件/硬件。

低于Sub-1GHz的ISM频段具有地域性的限制，但在相同的输出功耗和电流消耗条件下，其性能优于2.4GHz频段。此外，Sub-1GHz的频带中存在的干扰也较少。由于不同地域的市场所采用的Sub-1GHz频段各异，因此客户必需根据自己的需要定制解决方案。

所需的互操作性及软件设计、开发成本的权衡折衷将在很大程度上决定软件平台的选择。TI的软件产品库门类宽泛，从具有高设计自由度和低复杂性的专有解决方案到具全面互操作性的ZigBee®解决方案均含于其中。

→ 医疗USB平台

TI提供了一种经过Continua认证的USB硬件-软件平台，该平台执行个人保健设备类别 (PHDC) 及IEEE 11073标准。随着个人保健设备的日趋普及，有关公司正在开发具有连通性的产品以轻松实现数据交换。PHDC（个人保健设备类别）隶属于USB标准，专为那些能够将测量结果传送至诸如个人电脑、蜂窝电话等USB主机的便携式医疗及保健设备而设计。Continua健康联盟已经发布了执行USB标准的不同类型设备之间的互操作性指导准则。TI提供了一款硬件-软件平台，该平台在经历了严格的测试程序之后通过了Continua健康联盟的认证。客户可使用此平台的软件栈来缩短符合医疗行业标准（比如：Continua健康联盟）的设备的开发时间。这些软件栈可以在TI居业界领先地位的超低功耗MSP430™ MCU上使用。

如需了解更多有关医疗USB平台的信息，敬请访问：
http://www.ti.com/usbplatform。

如欲获悉更多关于Continua健康联盟的信息，可访问：
http://www.continuaalliance.org。

Continua®
HEALTH ALLIANCE

	Medical Application			
Device Specializations	IEEE 11073-104xx			
Data Exchange Protocol	IEEE 11073-20601			
USB API	PHDC	CDC	HID	MSD
	Physical Layer			

面向医疗的连通性解决方案
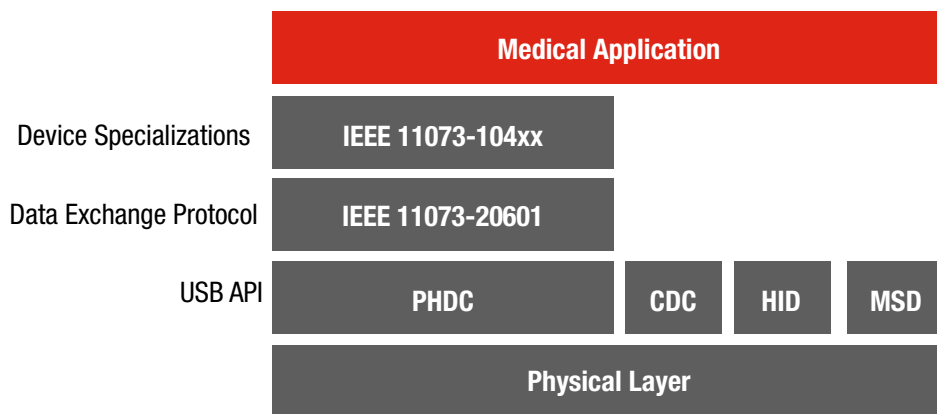
→ **有线解决方案**

USB至串行桥接器
TUSB3410

敬请访问**www.ti.com/sc/device/TUSB3410**，以获取样片、数据表、应用报告及评估板。

主要特点

- 符合USB全速 (12Mbps) 规格
- 具16k字节RAM的集成8052微控制器，可通过I2C总线从主机或外部存储器装入数据
- 集成的增强型UART特性包括：
  - 可编程软件/硬件流控制
  - 自动RS-485总线收发器控制，带和不带回波
  - 可利用软件来选择的波特率范围：50 至921.6k baud
  - 内置两通道DMA控制器，用于USB/UART成批输入/输出
- TUSB3410UARTPDK产品开发套件能够实现跨越式的USB至串行开发

应用

- 手持式仪表
- 健康状况度量/监测器
- 无老式接口的PC COM端口替换

通过建立USB端口与增强型UART串行端口的桥接，TUSB3410及TUSBWINVCP软件提供了一种将基于串行的老式设备连接至快速、灵活的USB接口的简易方法。TUSB3410包含所有必需的逻辑器件，旨在与采用USB总线的主机进行通信。TUSBWINVCP软件包使得TUSB3410能够充当虚拟的COM端口，与老式计算机背部的旧式COM端口相同。这样，现有设备和应用软件便可照常使用，而无需做任何变更。

Several new MSP430™ families such as F552x have integrated USB capabilities where an external USB controller is not required
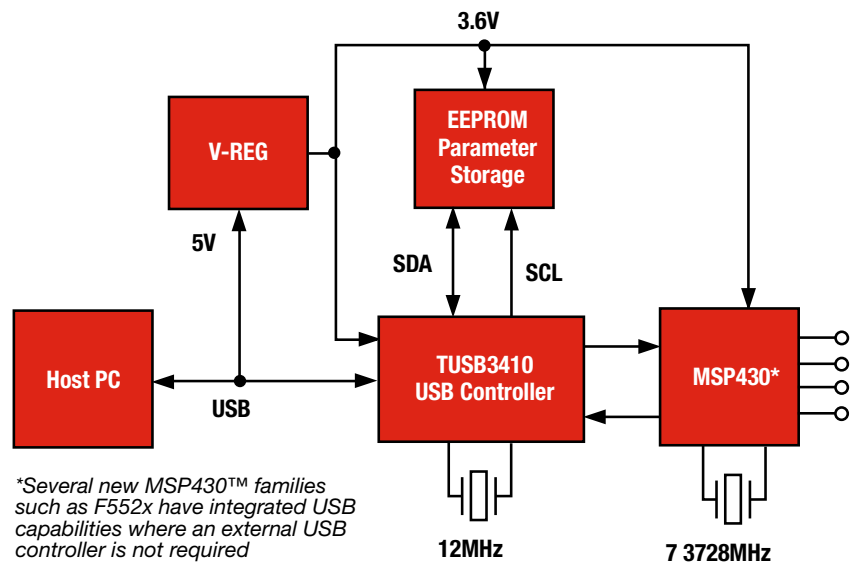
TUSB3410/MSP430™实现方框图

面向医疗的连通性解决方案

→ 无线接口、射频识别 (RFID) 及 Tag-it™

射频识别 (RFID)

TI的高频RFID产品包括13.56MHz高频 (HF) 转发器和低功耗RFID阅读器，它们符合ISO/IEC 15693及ISO/IEC 18000-3全球性开放标准。典型的RFID可实现方案包括资产追踪、访问控制、血袋追踪、医疗供给追踪、患者/工作人员鉴别、药品分类鉴别、医疗成像、产品鉴定、远程数字化保健管理应用以及许多非医疗相关的应用。

Tag-it HF-I转发器内嵌

TI的Tag-it HF-1系列转发器内嵌了符合ISO/IEC 15693及ISO/IEC 18000-3全球性开放标准的13.56MHz HF 转发器。此类产品可提供具频率偏移的6种不同的天线形状，以便集成至纸张、PVC或其他运用TI的激光修调工艺制造的衬底之中，以提供一致性的读取性能。在交货之前，转发器将经受全面的功能和参数测试，以提供客户所期望的高品质。

Tag-it HF-I系列

产品规范

- 支持的标准：ISO/IEC 15693-2，-3；ISO/IEC 18000-3
- 推荐工作频率：13.56MHz
- 出厂前写入的只读位数：64位
- 典型可重复烧写次数（在+25℃）：100,000次
- 数据保存时间（在+55℃）：超过10年

主要特点

- 每个模块采用用户锁定及出厂前锁定
- 应用系列标识码 (AFI)

标准

- 256比特用户内存，8 x 32比特
- FastSID（快速同步识别）

Pro

- 256比特用户内存，8 x 32比特
- 密码保护写入命令
- 停用IC功能的命令
- FastID（快速同步识别）

Plus

- 2k比特用户存储器，64 x 32 6比特
- 数据存储格式标识码 (DSFID)
- 组合式总量读取模块（Combined inventory read block）

Tag-it™ HF-1 Plus内嵌外形

Part Number	RI-I11-112A-03	RI-I11-112B-03	RI-I02-112A-03	RI-I02-112B-03	RI-I03-112A-03	RI-I15-112B-03	RI-I16-112A-03	RI-I17-112A-03
Available Memory	2K bits organized in 64 x 32-bit blocks							
Antenna Size (mm)	45 x 45	45 x 45	45 x 76	45 x 76	22.5 x 38	34 x 65	θ 24.2	θ 32.5
Foil Pitch (mm)	50.8 + 0.1/ −0.4 (2 in)	50.8 + 0.1/ −0.4 (2 in)	96 + 0.1/ −0.4 (~3.78 in)	96 + 0.1/ −0.4 (~3.78 in)	58 +0.1/ −0.4 (~1.89 in)	101.6 +0.1/ −0.4 (4 in)	50.8 +0.1/ −0.4 (2 in)	50.8 +0.1/ −0.4 (2 in)
Frequency Offset for Lamination Material	Paper	PVC	Paper	PVC	Paper/PVC	PVC	Paper/PVC	Paper/PVC
Delivery	Single tape row with 48mm foil width wound on cardboard reel							

Tag-it™ HF-1 Pro转发器内嵌

Part Number	RI-I11-114A-S1	RI-I11-114B-S1	RI-I02-114A-S1	RI-I02-114B-S1	RI-I03-114-S1	RI-I16-114-S1	RI-I17-114-S1
Available Memory	256 bits organized in 8 x 32-bit blocks						
Foil Width (mm)	48mm ±0.5mm						
Antenna Size (mm)	45 x 45	45 x 45	45 x 76	45 x 76	22.5 x 38	θ 24.2	θ 32.5
Foil Pitch (mm)	50.8 +0.1/ −0.4 (2 in)	50.8 +0.1/ −0.4 (2 in)	96 +0.1/ −0.4 (~3.78 in)	96 +0.1/ −0.4 (~3.78 in)	48 +0.1/ −0.4 (~1.89 in)	50.8 +0.1/ −0.4 (2 in)	50.8 +0.1/ −0.4 (2 in)
Frequency Offset for Lamination Material	Paper	PVC	Paper	PVC	Paper/PVC	Paper/PVC	Paper/PVC
Delivery	Single row tape wound on cardboard reel						

Tag-it™ HF-1标准转发器内嵌

Part Number	RI-I11-114A-01	RI-I11-114B-01	RI-I02-114A-01	RI-I02-114B-01	RI-I03-114-01	RI-I16-114-01	RI-I17-114-01
Available Memory	256 bits organized in 8 x 32-bit blocks						
Foil Width (mm)	48mm ±0.5mm						
Antenna Size (mm)	45 x 45	45 x 45	45 x 76	45 x 76	22.5 x 38	θ 24.2	θ 32.5
Foil Pitch (mm)	50.8 +0.1/ −0.4 (2 in)	50.8 +0.1/ −0.4 (2 in)	96 +0.1/ −0.4 (~3.78 in)	96 +0.1/ −0.4 (~3.78 in)	48 +0.1/ −0.4 (~1.89 in)	50.8 +0.1/ −0.4 (2 in)	50.8 +0.1/ −0.4 (2 in)
Frequency Offset for Lamination Material	Paper	PVC	Paper	PVC	Paper/PVC	Paper/PVC	Paper/PVC
Delivery	Single row tape wound on cardboard reel						

面向医疗的连通性解决方案

→ **无线接口、射频识别 (RFID) 及Tag-it™**

低功耗、多标准高频RFID读取器
TRF7960、TRF7961

敬请访问**www.ti.com/sc/device/TRF7960**或**www.ti.com/sc/device/TRF7961**，以获取样片及数据表。

主要特点

- 支持ISO14443A/B、ISO15693及Tag-it
- 高集成度缩减了总体成本、物料清单 (BOM) 及电路板面积
  - 完全集成的协议处理
  - 分离的内置高电源抑制比 (PSRR) 低压降稳压器 (LDO)，用于模拟、数字和功率放大器 (PA) 部分，可提供噪声隔离以获得出众的读取范围和可靠性
  - 用于MCU的集成LDO稳压器输出
  - 单晶体系统可为MCU提供输出时钟
- 11个用户可读写及编程的寄存器
- 低功耗器件，具有宽工作电压范围：2.7V 至5.5V
- 可编程输出功率：100mW或200mW
- 并行8位或串行4引脚SPI接口，带12字节 FIFO

TRF7960是高度集成的模拟前端及数字成帧系统，作为Tag-it™ HF-I转发器内嵌系列的补充产品，可用于任意13.56MHz RFID读取器系统。内置的可编程选项使得TRF7960成为众多应用的合适之选，包括相近及相邻的RFID系统。TRF7960拥有高集成度、卓越的性能、小外形尺寸和多种低功耗模式，因而使其适用于电池能量受限的医疗应用。

- 7种用户可选的超低功耗模式
  - 断电模式：＜1μA
  - 待机模式：120mA（典型值）
  - 运行模式：10mA（仅接收）
- 可提供MSP430™软件库
- 封装：超小型、5 x 5mm、32引脚 QFN
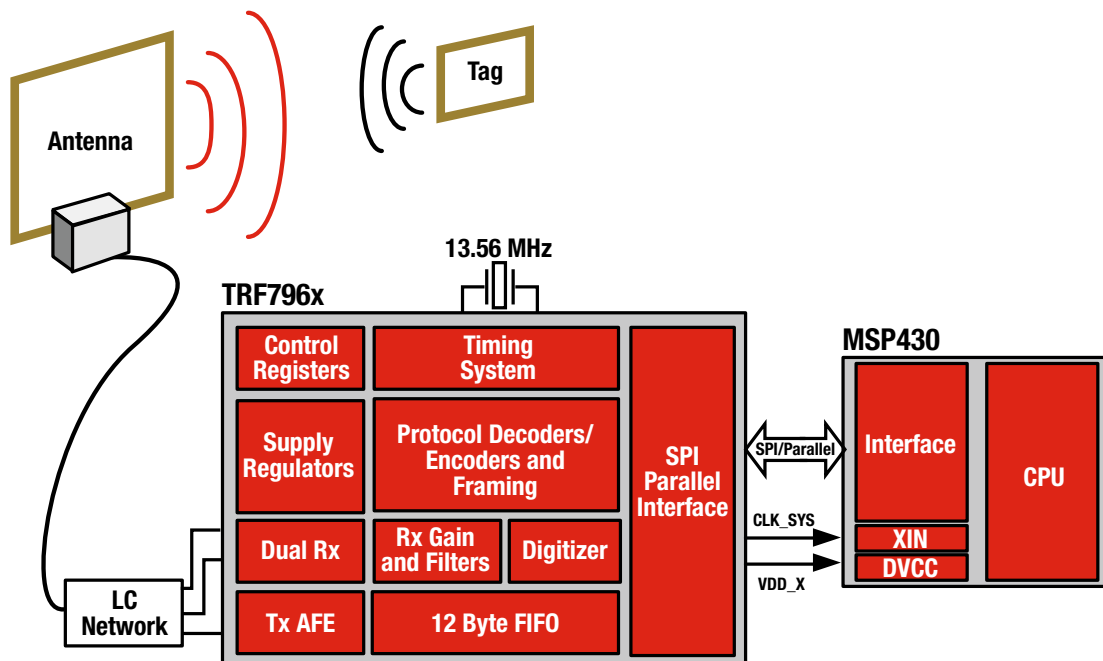
原理框图

→ 无线接口、射频识别 (RFID) 及 Tag-it™

低功耗、多标准高频RFID读取器（续）
TRF7960、TRF7961

敬请访问**www.ti.com/sc/device/TRF7960**或**www.ti.com/sc/device/TRF7961**，以获取样片及数据表。

应用

- 医疗
  - 患者及员工鉴别
  - 药品鉴别
  - 产品认证及校准
  - 远程数字化保健管理
- 资产追踪
- 访问控制
- 非接触式支付
- 预付式电表 (prepaid eMetering)
- 电子政务
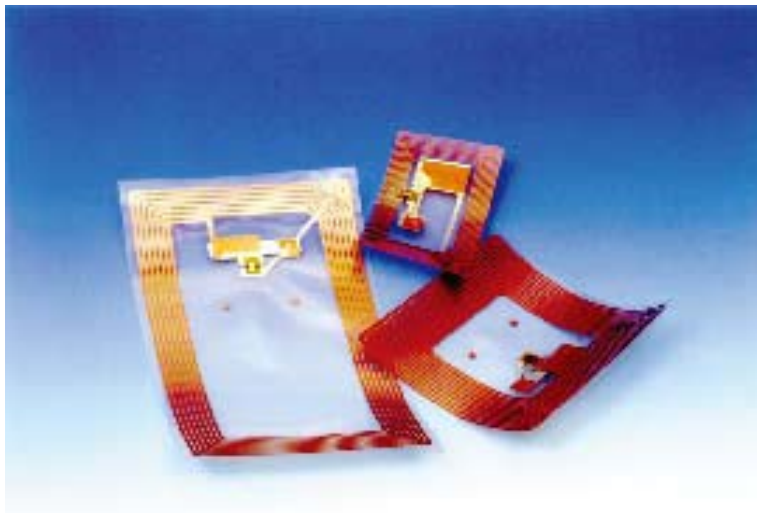
Tag-it™ 智能标签将不太昂贵的RFID技术引入到众多的新型应用之中

TRF7960评估板 (EVM)

TRF7960评估工具使系统设计得以加速和简化。TRF7960多协议RFID收发器整合了模拟前端、协议处理、组帧、误差校验和多个集成稳压器，并具有允许针对终端应用进行读取器的定制/配置的其他特点。

TRF7960评估板的特点包括：

- 全功能的RFID读取器，可采用板载和（任选的）非板载天线
- GUI可支持ISO14443A、ISO14443B、ISO15693及Tag-it命令
- 单独的LED用于指示标志检测——以独立模式运作，无需GUI
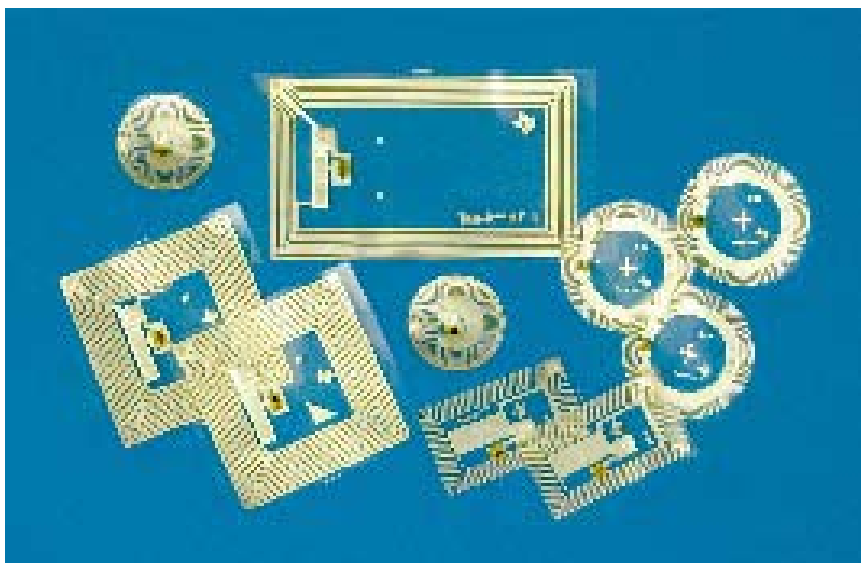
Tag-it™ HF-I系列转发器内嵌可提供多种封装选项，包括方形、圆形和矩形（普通型和迷你型）

面向医疗的连通性解决方案

→ *低功耗射频产品*

集成型多通道射频收发器
CC1101

敬请访问**www.ti.com/sc/device/CC1101**，以获取样片、数据表、评估板及应用报告。

主要特点

- Sub-1GHz FSK/GFSK/MSK/ASK/OOK射频收发器
- 1.2至500kbaud数据速率
- 低功耗、低系统成本
- 睡眠模式电流：−200nA
- 90μs锁相环 (PLL) 锁定时间：从睡眠模式转换至接收/发送 (Rx/Tx) 模式的时间为−240μs
- 针对同步字检测、地址校验、灵活分组长度及自动CRC（循环冗余校验）提供了板上支持
- 分离的64字节RX及TX数据FIFO实现了突发模式 (Burst Mode) 数据传输
- 适合于那些旨在符合EN 300、200（欧洲）和FCC CFR Part 15（美国）标准的系统

> 如需更长的射频工作距离，请尝试用于低功耗射频IC的CC2590/CC1190 2.4GHz和Sub-1GHz射频增距器。

CC1101是高度集成的多通道射频收发器，专为315/433/868/915MHz ISM频段的低功耗无线应用而设计。CC1101是CC1100收发器的升级版本，在杂散响应、带内相位噪声、输入饱和电平、输出功率斜坡上升及频率范围扩展方面均有所改善。

应用

- 无线告警及安全系统
- 自动化仪表读取 (AMR)
- 工业监测及控制
- 居家及楼宇自动化
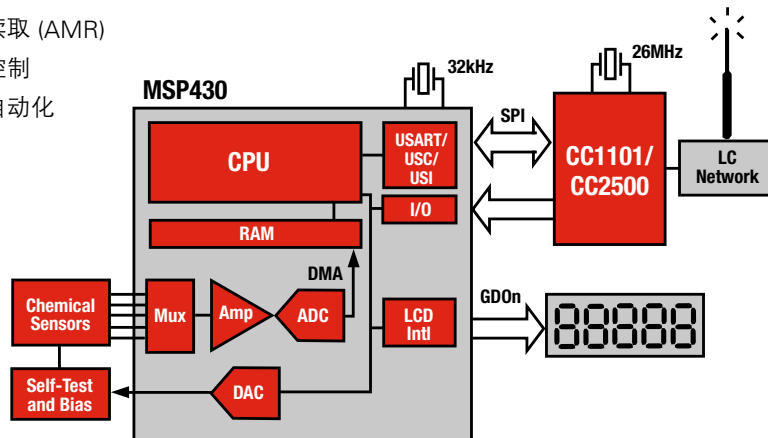
示例应用方框图——无线血气分析仪

Sub-1GHz片上系统射频解决方案
CC1110/F8/F16/F32

敬请访问**www.ti.com/sc/device/CC1110**，以获取样片及数据表。

主要特点

- 低电流消耗
- 高性能射频收发器内核（与CC1100相同）
- 具多达8个输入端的8位至14位ADC
- 21个通用I/O引脚
- 实时时钟及多个定时器
- 8/16/32kB在线可编程闪存
- 1/2/4kB RAM
- 封装：6 x 6mm QLP-36

> 请参见CC2510及CC2511——2.4GHz片上系统射频解决方案。

> 如需更长的射频工作距离，请尝试用于低功耗射频IC的CC2590/CC2591 2.4GHz射频增距器。
> 敬请访问：*www.ti.com/cc2591*

CC1110是低成本片上系统 (SoC) 集成电路，专为低功耗及低电压无线通信应用而设计。CC1110整合了CC1100射频收发器的卓越性能，具有业界标准的增强型MCU、8/16/32kB的在线可编程闪存 (in-system programmable Flash)、1/2/4kB RAM以及许多其他的可用外设。CC1110拥有多种高级的低功耗操作模式，专为那些要求超低功耗的系统而设计。
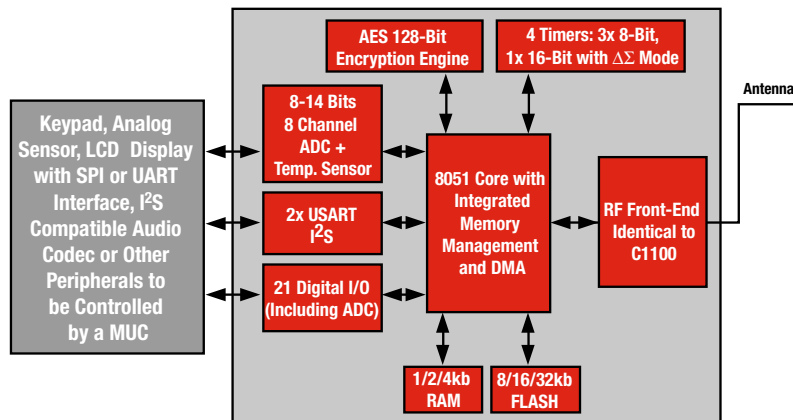
采用CC1110的多用途医疗设备。支持采用嵌入式128位AES硬件加密的安全射频链路。

→ ***ZigBee*** ® / ***Bluetooth*** ® **Low Energy**

面向医疗应用的ZigBee®和*Bluetooth*® Low Energy（蓝牙低能耗）解决方案

世界正在走向无线化，医疗产品也不例外。越来越多的医疗设备，尤其是患者监测设备，都可受益于无线技术。ZigBee和Bluetooth Low Energy可在消费者健康、保健及医疗领域中使用，应用范围十分广泛。

通过使用ZigBee无线传感器，患者可在医院内、乃至其居室范围内随意走动，而传感器仍将随时监测并把极为重要的健康数据传送给医院或医生。患者具体所处的位置将更为自由，这对于患者以及医院双方都是有益的。ZigBee标准为公司企业的应用开发提供了基于一种简易、可靠、低成本和低功耗标准的无线平台。

蓝牙低能耗解决方案专为低成本、低功耗及短程连通性而设计。该技术实现了与蜂窝电话、笔记本电脑和其他具蓝牙功能的设备（比如：运动和健身手表、GPS/手持终端以及其他个人监视设备）的直接通信。

TI是Continua健康联盟的成员之一，并为推动ZigBee和蓝牙低能耗以及联盟所选择的医疗应用无线标准的发展做出了积极的贡献。

TI的低功耗、高性能射频IC产品组合为多种医疗设备提供了牢固可靠且经济高效的无线连通性解决方案。

符合IEEE 802.15.4/ZigBee规范的射频IC

- CC2520：第二代2.4GHz ZigBee/IEEE 802.15.4射频收发器
- CC2530/31：带集成微控制器的真正片上系统 (SoC)
- CC2530ZNP：可通过SPI或UART接口实现与任意MCU通信的ZigBee网络处理器
- 可提供针对所有射频IC的参考设计下载

ZigBee软件及开发工具

- Z-Stack™：兼容ZigBee和ZigBee Pro的协议栈。TI可免费提供该完整的ZigBee栈。Z-Stack支持无线下载 (OAD) 以实现固件的现场升级。

- Z-Tool（调试工具）
- 开发套件：CC2520DK、CC2530DK和CC2530ZDK
- TIMAC：针对TI IEEE 802.15.4收发器及片上系统的IEEE 802.15.4媒体访问控制 (MAC) 软件栈

应用

- 患者监测
- 医院设备追踪

如需获悉更多信息，敬请访问：
www.ti.com/zigbee

蓝牙低能耗IC

- CC2540：适合蓝牙低能耗应用的2.4GHz片上系统 (SoC)
- 将于2010年第3季度上市

蓝牙低能耗开发工具

- CC2540DK-MINI
- CC2540DK

应用

- 消费者健康/医疗
- 蓝牙低能耗系统
- 无线传感器系统

如需了解更多信息，敬请访问：
www.ti.com/bluetoothlowenergy
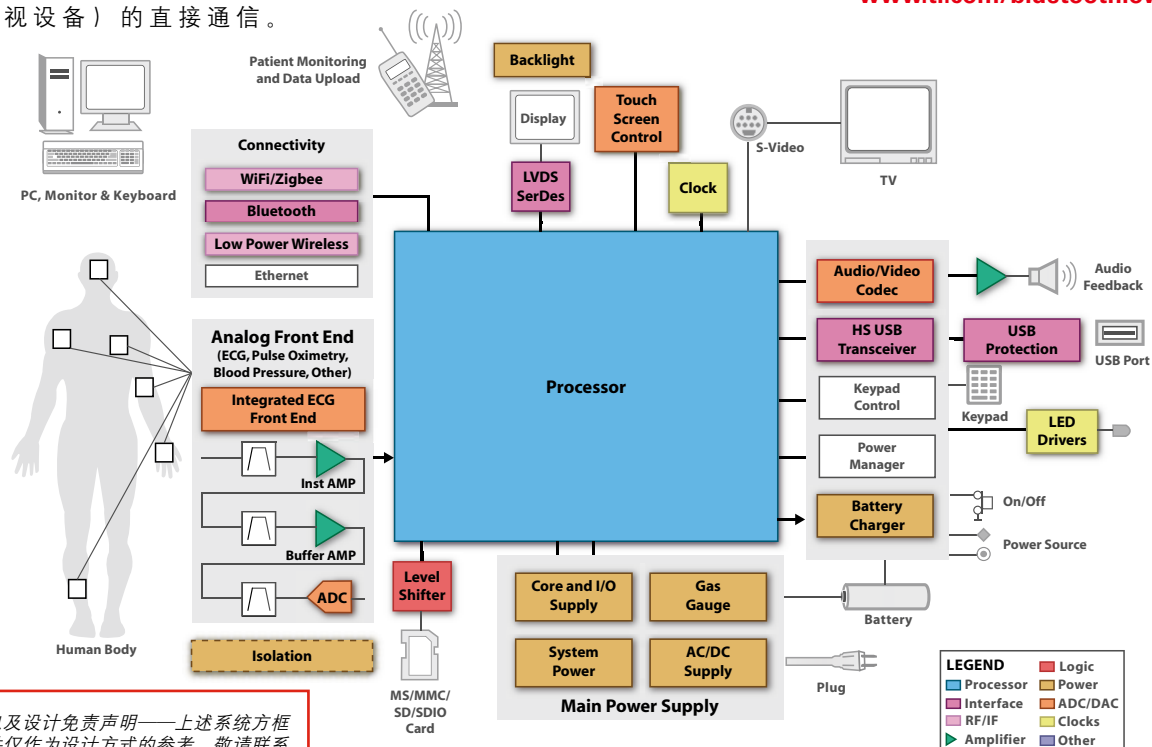
产品供货信息及设计免责声明——上述系统方框图及推荐器件仅作为设计方式的参考。敬请联系您所在地的TI销售办事处或分销商以获取详尽的系统设计说明及产品供货信息。

多参数患者监测系统方框图

→ *增强型产品/芯片及晶圆销售解决方案*

增强型产品

TI的增强型产品 (EP) 线在提供设计灵活性的同时依旧满足了HiRel和医疗标准，适合于那些需要高可靠性及长使用寿命的工作环境。EP产品线的推出可惠及航空电子、国防、宇宙空间、医疗和工业设计人员以及其他严苛工作环境和长使用寿命应用领域中的设计者。TI的增强型产品线是商贸现货供应 (COTS) 解决方案，具有以下主要优点：

- 制造/装配受控基线
- 延长了产品变更通知 (PCN) 时间
- 扩展了温度范围性能（通常为－55℃至+125℃）
- 可提供单独的数据表
- 品质认证体系
- 产品可追溯性
- 长寿命周期

在那些要求扩展温度范围（通常为－55℃至+125℃）的环境中，TI的EP产品保证能够达到数据表规范所描述的性能。针对目标应用，为了确保器件呈现出尽可能高的质量和可靠性，TI在器件发布之前将执行以下的品质认证程序：

- 所有的EP器件都将经历大量的再认证
- 对认证数据进行准确度和相符性评审
- 在目标封装中执行最大推荐工作条件下的可靠性和电迁移监测。
- 鉴定合格的测试程序和测试硬件
- 在规定的温度范围内进行电特性分析
- 在扩展的温度范围内确认封装性能（某些模制化合物不适合在扩展的温度范围内使用）。
- 镍/钯/金/铅涂层消除了"锡须"可靠性问题
- 在涉及医疗的ISO标准要求（ISO13485和ISO14971）方面拥有渊博的专门知识
- 与数据表电气规范的相符性鉴定
- 可提供军用（－55℃/125℃）、工业（－40℃/85℃）、商用 (0℃/70℃) 和定制温度范围器件

从TI的EP线预计可获得：

- 认证总结报告
- 尖端的商用技术
- 对于工业、医疗、航空电子及国防市场的承诺
- 客户导向型产品库
- 增强型停产管理

此外，TI还将根据客户的要求对采用EP版本的其他TI类别器件的发布进行评估。

如需获得更多有关TI增强型产品的信息，敬请访问：www.ti.com/ep。

TI芯片/晶圆解决方案

德州仪器为那些要求较高集成度以缩减板级空间的应用提供了裸片/晶圆解决方案。TI提供了众多裸片和晶圆形式的产品。根据产品的成熟度和复杂性以及客户的要求，TI给出了多种测试和认证选项。典型的筛选选项包括DC探针或温度条件下的AC/DC探针。

TI提供了三类芯片筛选：

- 商用晶圆和芯片
  ○ 标准TI晶圆制造
- 确优芯片 (KGD)
  ○ 独立的数据表且性能在整个温度范围内得到保证
- 客户定义的认证
  ○ QML Class Q (MIL-STD)
  ○ QML Class V（空间）
  ○ 可提供附加选项

典型的处理和能力包括：

- 安装和焊接示意图
- 可在－55℃至+210℃范围内或特殊温度条件下进行芯片探测
- 装运：卷带包装、层叠包装、定制托盘、Gel-Pak®（凝胶包装）
- 侧壁和外观检查

如需了解更多关于TI的芯片及晶圆产品的信息，敬请访问**www.ti.com/hirel**或发送电子邮件至：**diesales@list.ti.com**

资源

→ *TI设计工具*

下表为您选取了部分TI所提供的设计工具，用以简化您的设计流程。如需下列任何应用报告，可通过链接**www-s.ti.com/sc/techlit/***litnumber*
获取，其中litnumber请采用Lit Number（文献编号）竖列中的编号替换。
如需模拟应用报告的完整列表，敬请访问：**analog.ti.com/appnotes**
如需DSP应用报告的完整列表，敬请访问：**www.dspvillage.ti.com/tools**

标题	文献编号
放大器	
隔离放大器的单电源运作	SBOA004
具电源的非常低成本模拟隔离	SBOA013
采用共模驱动型电源来提升仪器放大器CMR	SBOA014
直流电机转速控制器：在没有转速计反馈的情况下控制直流电机	SBOA043
PWM功率驱动器调制方案	SLOA092
采用TMS320F2812 DSP和DRV592功率放大器的热电冷却器控制	SPRA873
隔离放大器提升了准确度和可靠性	SBOA064
制作一款-10V至+10V可调精密电压源	SBOA052
具共模电压监视器的±200V差分放大器	SBOA005
AC耦合仪表和差分放大器	SBOA003
扩展差分放大器的共模范围	SBOA008
采用差分放大器来实现信号的电平移位	SBOA038
采用运算放大器的光电二极管监视	SBOA035
隔离放大器的单电源运作	SBOA004
精密IA在采用单5V电源时具有轨至轨摆幅	SBOA033
压力传感器至ADC应用	SLOA056
缓冲运算放大器至ADC电路集	SLOA098
放大器与位数：数据转换器用放大器选择入门	SLOA035B
连接了二极管的FET可保护运算放大器	SBOA058
信号调节压电传感器	SLOA033A
基于二极管的温度测量	SBOA019
桥接器网络的单电源、低功率测量	SBOA018
热敏电阻温度传感器至ADC应用	SLOA052
信号调节惠斯通阻性电桥传感器	SLOA034
用于压力传感器的低功率信号调节	SLAA034
连接MSP430和TMP100温度传感器	SLAA151
数据转换器	
配置I2S以生成BCLK（由编解码器件）和WCLK（由McBSP端口）	SLAA413
将ADS8361连接至TMS320F2812 DSP	SLAA167
将TLC2552和TLV2542连接至MSP430F149	SLAA168
MSC1210在应用中闪存编程	SBAA087
压力传感器至ADC应用	SLOA056
利用ADS1216、ADS1217或ADS1218来测量温度	SBAA073
采用TLC2551串行ADC并基于SPI的数据采集/监视器	SLAA108A
实现热电偶与MSP430x4xx和ADS1240的直接连接	SLAA125A
将ADS7846触摸屏控制器与Intel SA-1110 StrongArm处理器配合起来使用	SBAA070
采用单+5V电源的完整温度数据采集系统	SBAA050
将ADS1210与一个8xC51微控制器相连接	SBAA010
利用ΔΣ转换器来实现较高转换速度的编程技巧	SBAA005
用DDC112来恢复数据	SBAA026
选择一款ADC	SBAA004
利用ΔΣ A/D转换器来实现外部模拟多路复用器的同步	SBAA013
DDC112的测试模式	SBAA025
了解DDC112的连续和不连续模式	SBAA024
热敏电阻传感器至ADC应用	SLOA052

→ **TI设计工具（续）**

标题	文献编号
用于压力传感器的低功率信号调节	SLAA034
数据转换器（续）	
采用低电源电压的信号采集和调节	SLAA018
一款基于AMC7820的光放大器泵浦激光器参考设计	SBAA072
处理器/微控制器	
采用JTAG接口对基于闪存的MSP430进行编程	SLAA149
利用MSP430来实现C语言与汇编语言的混合使用	SLAA140
利用MSP430来实现超低功耗键区接口	SLAA139
采用MSP430FG439的心率监测器和EKG监测器	SLAA280
采用MSP430的单芯片脉搏血氧测定仪设计	SLAA274
至CC1100/2500程序代码库的MSP430接口	SLAS325
选择一款超低功耗MCU	SLAA207
基于C5505处理器的ECG、脉搏血氧测定仪、数字听诊器开发套件	SPRT523
采用TUSB3410的MSP430 USB连通性	SLAA276A
MSP430闪存特性	SLAA334
采用MSP430的数字滤波	SLAA331
利用MSP430来实现一个实时时钟	SLAA076A
接口	
CAN	
CAN收发器的系统评估	SLLA109
控制器区域网络介绍	SLOA101
将CAN仲裁用于电气层测试	SLLA123
RS-485	
适合TIA/EIA-485 (RS-485) 的接口电路	SLLA036B
422和485标准概述和系统配置	SLLA070C
RS-485在电表中的应用	SLLA112
TIA/EIA-485与M-LVDS，功耗及速度的比较	SLLA106
USB	
VID、PID和固件：采用TI USB设备控制器时的设计决策	SLLA154
采用TUSB3410/5052和VCP软件的USB/串行应用	SLLA170
CardBus	
PCI1520可实现方案指南	SCPA033
LVDS	
LVDS设计笔记	SLLA014A
利用LVDS来降低EMI	SLLA030C
基于电缆的LVDS的性能	SLLA053B
M-LVDS	
M-LVDS介绍	SLLA108
M-LVDS速度与传输距离的关系	SLLA119
Serdes（串化/并化器）	
通过电缆进行的千兆位传输	SLLA091
电源控制器	
采用TPIC2101的直流电刷电机控制	SLIT110
电源管理	
低压降稳压器操作和性能的技术评审	SLVA072
ESR、稳定性和LDO稳压器	SLVA115
扩展LDO稳压器的输入电压范围	SLVA119
大电流LDO线性稳压器 (UCCx81-ADJ、UCCx82-ADJ、UCCx83-ADJ、UCCx85-ADJ)	SLUA256
PowerPAD™耐热性能增强型封装	SLMA002

Product Information Center

德州仪器 免费热线：800-820-8682   www.ti.com.cn/contactus

产品

DSP – 数字信号处理器	http://www.ti.com.cn/dsp
电源管理	http://www.ti.com.cn/power
放大器和线性器件	http://www.ti.com.cn/amplifiers
接口	http://www.ti.com.cn/interface
模拟开关和多路复用器	http://www.ti.com.cn/analogswitches
逻辑	http://www.ti.com.cn/logic
RF/IF 和 ZigBee® 解决方案	http://www.ti.com.cn/radiofre
RFID 系统	http://www.ti.com.cn/rfidsys
数据转换器	http://www.ti.com.cn/dataconverters
时钟和计时器	http://www.ti.com.cn/clockandtimers
标准线性器件	http://www.ti.com.cn/standardlinearde
温度传感器和监控器	http://www.ti.com.cn/temperaturesensors
微控制器 (MCU)	http://www.ti.com.cn/microcontrollers

应用

安防应用	http://www.ti.com.cn/security
工业应用	http://www.ti.com.cn/industrial
计算机及周边	http://www.ti.com.cn/computer
宽带网络	http://www.ti.com.cn/broadband
汽车电子	http://www.ti.com.cn/automotive
视频和影像	http://www.ti.com.cn/video
数字音频	http://www.ti.com.cn/audio
通信与电信	http://www.ti.com.cn/telecom
无线通信	http://www.ti.com.cn/wireless
消费电子	http://www.ti.com.cn/consumer
医疗电子	http://www.ti.com.cn/medical
GPS—个人导航设备	http://www.ti.com.cn/gps
便携式医疗仪表	http://www.ti.com.cn/pmi

最新书籍/CD索取   http://www.ti.com.cn/literature

热门产品   TI 高性能模拟 >> 您的成功之道™

CC28070/UCC28060	让 PFC 爱上新的台阶，效率更高、设计更简便，可升级至更高功率。	http://www.ti.com.cn/ucc28070
ADS5281	8 倍电源效率，功耗最低的 8 通道 10 位和 12 位 ADC – 最高 65MSPS。	http://www.ti.com.cn/ads5281
TAS5706	聆听不同之处，业界领先闭环、数字输入D类放大器	http://www.ti.com.cn/tas5706
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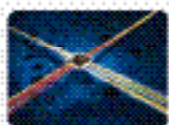
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