

ADI 低成本无线 ECG Holter 监视器解决方案

ADI公司的低成本无线ECG Holter监视器解决方案主要采用 12 位精密模拟微控制器 ADuC7022, 高性能ISM频段FSK/ASK收发器 ADF7022, 低成本仪表放大器AD623, 低功耗精密CMOS运算放大器AD8500 和低功耗JFET放大器AD8641 等器件.本文介绍了典型的单通道心电图方框图, 低功耗低成本无线ECG Holter 监视器方框图以及主要器件的主要特性和应用电路.

The ECG signal is characterized by six peaks and valleys labeled with successive letters of the alphabet P, Q, R, S, T, and U.

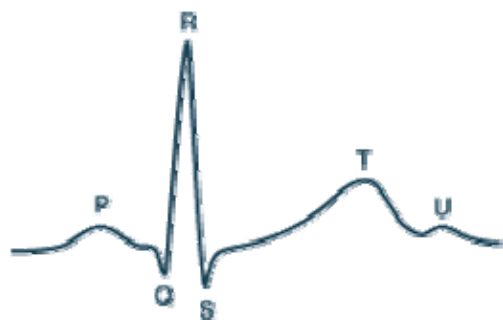


图 1.心电图(ECG)的信号波形

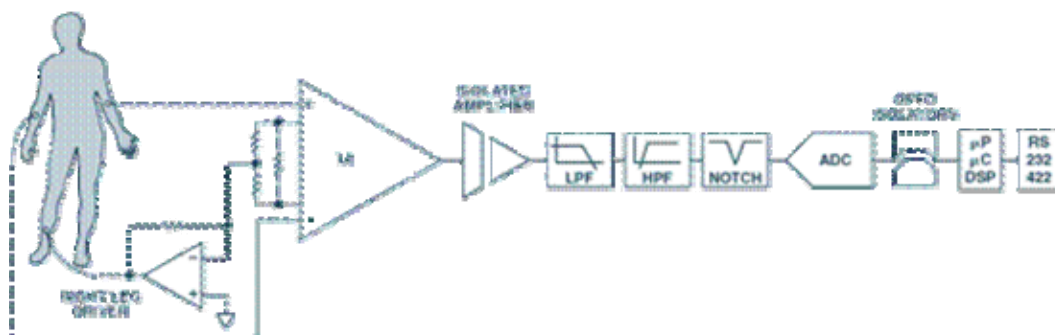


图 2. 典型的单通道心电图方框图

A wireless Holter monitor—small enough to fit on the back side of an electrode—provides more accurate signals than traditional designs because noise and interference are greatly reduced. The circuit is inexpensive and capable of providing diagnostic-quality 1-lead ECG traces. A driven leg eliminates the need for a 60 Hz notch filter. Depending on the frequency band used, the transceiver (the ADF702x is shown below) and its surrounding circuitry will change. Patient comfort and privacy is greatly improved because all circuitry can be worn under clothing.

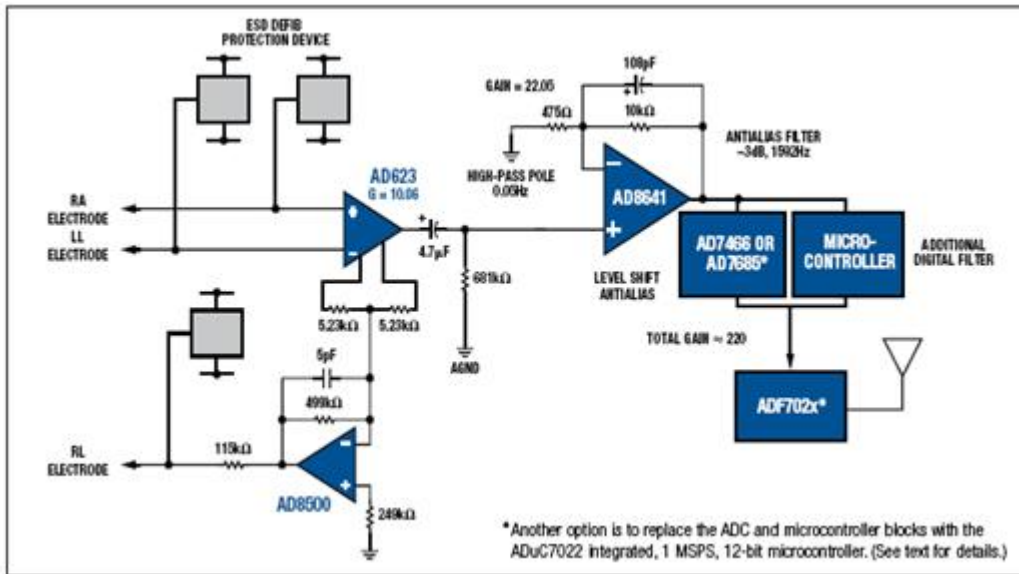


图 3.低功耗低成本无线ECG Holter 监视器方框图(1)

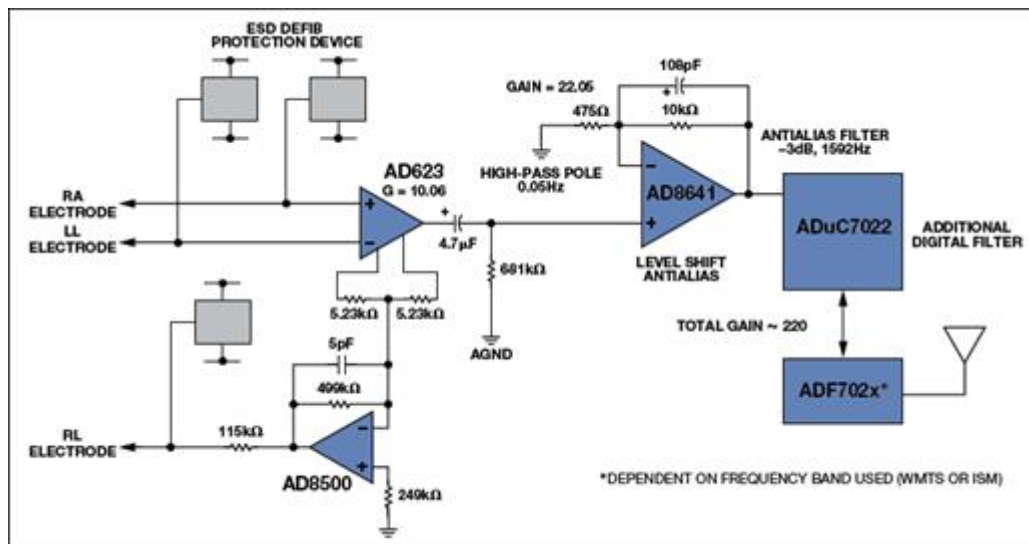


图 4.低功耗低成本无线ECG Holter 监视器方框图(2):ADuC7022 替代AD7466+MCU

主要元件性能介绍:

ADUC7022: Precision Analog Microcontroller, 12-Bit Analog I/O, ARM7TDMI® MCU

The ADuC7019/20/21/22/24/25/26/27/28 are fully integrated, 1 MSPS, 12-bit data acquisition systems incorporating high performance multichannel ADCs, 16-bit/32-bit MCUs, and Flash/EE memory on a single chip.

The ADC consists of up to 12 single-ended inputs. An additional four inputs are available but are multiplexed with the four DAC output pins. The four DAC outputs are only available on certain models (ADuC7020 and ADuC7026). However, in many cases where the DAC outputs are not

present, these pins can still be used as additional ADC inputs, giving a maximum of 16 ADC input channels. The ADC can operate in single-ended or differential input modes. The ADC input voltage is 0 V to V_{REF} . A low drift band gap reference, temperature sensor, and voltage comparator complete the ADC peripheral set.

Depending on the part model, up to four buffered voltage output DACs are available on-chip. The DAC output range is programmable to one of three voltage ranges.

The devices operate from an on-chip oscillator and a PLL generating an internal high frequency clock of 41.78 MHz. This clock is routed through a programmable clock divider from which the MCU core clock operating frequency is generated. The microcontroller core is an ARM7TDMI, 16-bit/32-bit RISC machine, which offers up to 41 MIPS peak performance. Eight kilobytes of SRAM and 62 kilobytes of nonvolatile Flash/EE memory are provided on-chip. The ARM7TDMI core views all memory and registers as a single linear array.

ADuC7022 应用:

Industrial control and automation systems

Smart sensors, precision instrumentation

Base station systems, optical networking

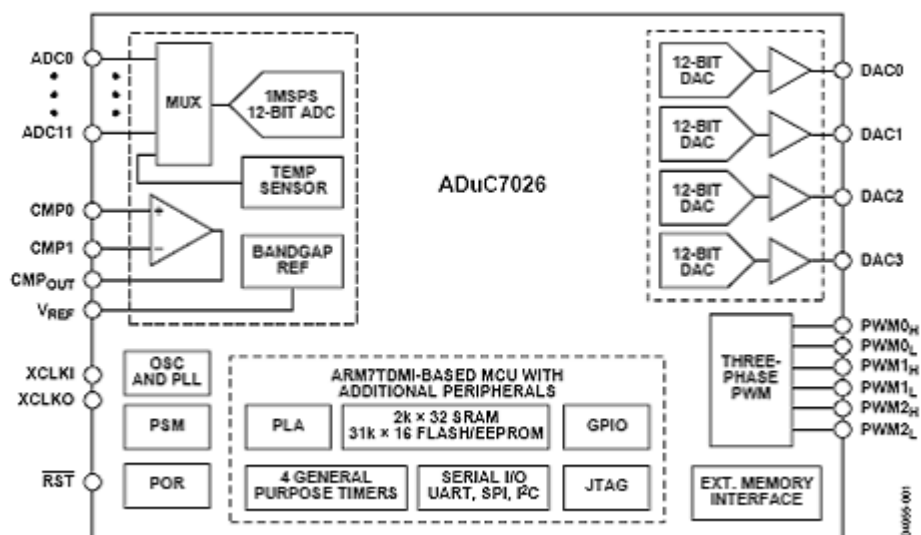


图 5.ADuC7026 功能方框图

http://www.analog.com/static/imported-files/data_sheets/ADUC7019_7020_7021_7022_7024_7025_7026_7027_7028.pdf

High Performance, ISM Band, FSK/ASK Transceiver IC ADF7020

The ADF7020 is a low power, highly integrated FSK/ASK/OOK transceiver designed for operation in the license-free ISM bands at 433 MHz, 868 MHz, and 915 MHz, as well as the proposed Japanese RFID band at 950 MHz. A Gaussian data filter option is available to allow either GFSK or G-ASK modulation, which provides a more spectrally efficient modulation. In addition to these modulation options, the ADF7020 can also be used to perform both MSK and GMSK modulation, where MSK is a special case of FSK with a modulation index of 0.5. The modulation index is calculated as twice the deviation divided by the data rate. MSK is spectrally equivalent to O-QPSK modulation with half-sinusoidal Tx baseband shaping, so the ADF7020 can also support this modulation option by setting up the device in MSK mode.

ADF7020 主要特性:

Low power, low IF transceiver

Frequency bands

431 MHz to 478 MHz

862 MHz to 956 MHz

Data rates supported

0.15 kbps to 200 kbps, FSK

0.15 kbps to 64 kbps, ASK

2.3 V to 3.6 V power supply

Programmable output power

-16 dBm to +13 dBm in 0.3 dBm steps

Receiver sensitivity

-119 dBm at 1 kbps, FSK

-112 dBm at 9.6 kbps, FSK

-106.5 dBm at 9.6 kbps, ASK

Low power consumption

19 mA in receive mode

26.8 mA in transmit mode (10 dBm output)

-3 dBm IIP3 in high linearity mode

On-chip VCO and fractional-N PLL

On-chip 7-bit ADC and temperature sensor

Fully automatic frequency control loop (AFC) compensates for ± 25 ppm crystal at 862 MHz to 956 MHz or ± 50 ppm at 431 MHz to 478 MHz

Digital RSSI

Integrated Tx/Rx switch

Leakage current of $< 1 \mu\text{A}$ in power-down mode

ADF7020 应用:

Low cost wireless data transfer

Remote control/security systems

Wireless metering

Keyless entry

Home automation

Process and building control

Wireless voice

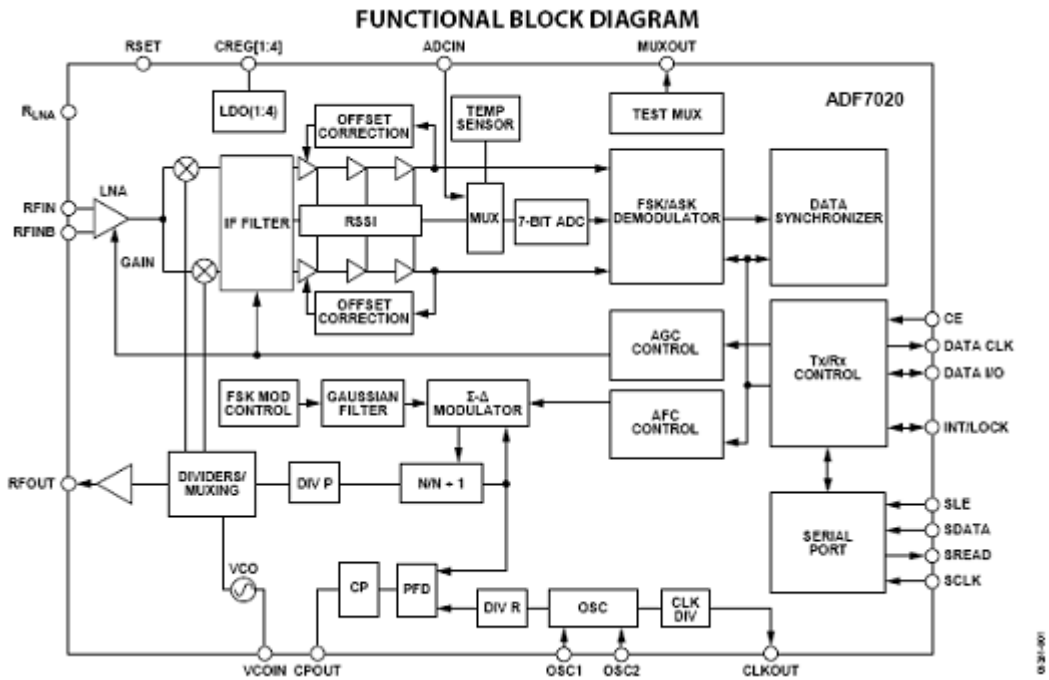


图 6. ADF7020 方框图

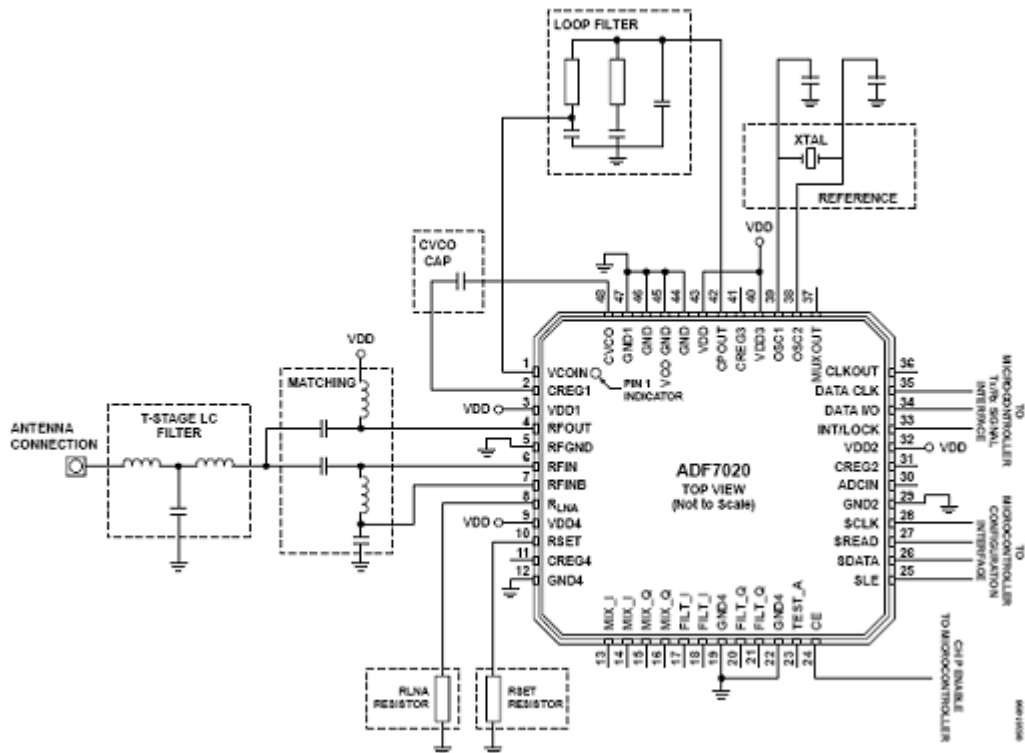


图 7. ADF7020 应用电路

http://www.analog.com/static/imported-files/data_sheets/ADF7020.pdf

AD623: Single Supply, Rail-Rail, Low Cost Instrumentation Amplifier

The AD623 is an integrated single-supply instrumentation amplifier that delivers rail-to-rail output

swing on a 3 V to 12 V supply. The AD623 offers superior user flexibility by allowing single gain set resistor programming and by conforming to the 8-lead industry standard pinout configuration. With no external resistor, the AD623 is configured for unity gain ($G = 1$), and with an external resistor, the AD623 can be programmed for gains up to 1000.

The AD623 holds errors to a minimum by providing superior ac CMRR that increases with increasing gain. Line noise, as well as line harmonics, are rejected because the CMRR remains constant up to 200 Hz. The AD623 has a wide input common-mode range and can amplify signals that have a common-mode voltage 150 mV below ground. Although the design of the AD623 was optimized to operate from a single supply, the AD623 still provides superior performance when operated from a dual voltage supply (± 2.5 V to ± 6.0 V).

Low power consumption (1.5 mW at 3 V), wide supply voltage range, and rail-to-rail output swing make the AD623 ideal for battery-powered applications. The rail-to-rail output stage maximizes the dynamic range when operating from low supply voltages. The AD623 replaces discrete instrumentation amplifier designs and offers superior linearity, temperature stability, and reliability in a minimum of space.

AD623 应用:

Low power medical instrumentation

Transducer interfaces

Thermocouple amplifiers

Industrial process controls

Difference amplifiers

Low power data acquisition

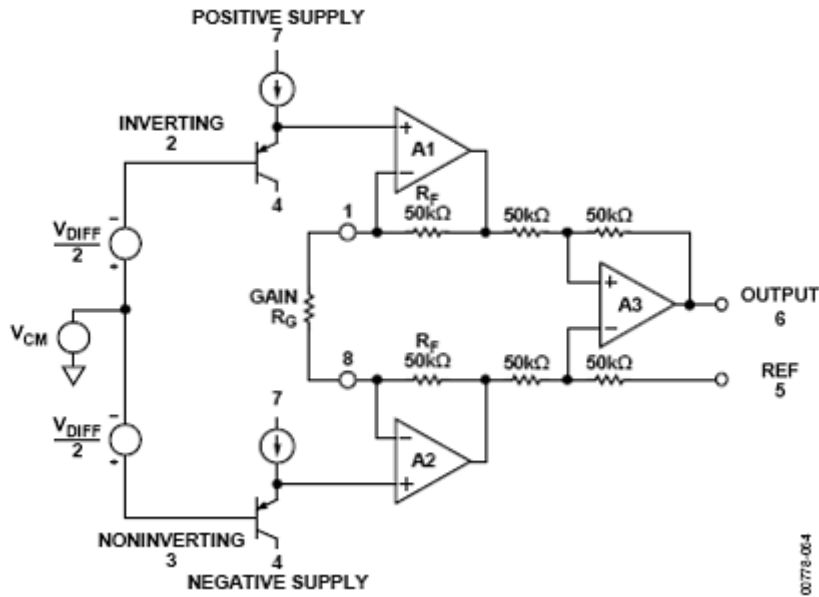


图 8.AD623 简化功能图

http://www.analog.com/static/imported-files/data_sheets/AD623.pdf

AD8500: Micropower Precision CMOS Operational Amplifier

The AD8500 is a low power, precision CMOS op amp featuring a maximum supply current of 1 μ A. The AD8500 has a maximum offset voltage of 1 mV and a typical input bias current of 1 pA, and it operates rail-to-rail on both the input and output. The AD8500 can operate from a single-supply voltage of +1.8 V to +5.5 V or a dual-supply voltage of ± 0.9 V to ± 2.75 V.

With its low power consumption, low input bias current, and rail-to-rail input and output, the AD8500 is ideally suited for a variety of battery-powered portable applications. Potential applications include ECGs, pulse monitors, glucose meters, smoke and fire detectors, vibration monitors, and backup battery sensors.

The ability to swing rail-to-rail at both the input and output helps maximize dynamic range and signal-to-noise ratio in systems that operate at very low voltages. The low offset voltage allows the AD8500 to be used in systems with high gain without having excessively large output offset errors, and it provides high accuracy without the need for system calibration.

The AD8500 is fully specified over the industrial temperature range (-40°C to $+85^{\circ}\text{C}$) and is operational over the extended industrial temperature range (-40°C to $+125^{\circ}\text{C}$). It is available in a 5-lead, SC70 surface-mount package.

AD8500 应用:

Portable Equipment

Remote Sensors

Low Power Filters

Threshold Detectors

http://www.analog.com/static/imported-files/data_sheets/AD8500.pdf

AD8641: Low Power, Rail - to - Rail Output Precision JFET Amplifier in 5-lead SC70 and 8-lead SOIC lead-free packages

The AD8641/AD8642/AD8643 are low power, precision JFET input amplifiers featuring extremely low input bias current and rail-to-rail output. The ability to swing nearly rail-to-rail at the input and rail-to-rail at the output enables designers to buffer CMOS DACs, ASICs, and other wide output swing devices in single-supply systems. The outputs remain stable with capacitive loads of more than 500 pF.

The AD8641/AD8642/AD8643 are suitable for applications utilizing multichannel boards that require low power to manage heat. Other applications include photodiodes, ATE reference level drivers, battery management, and industrial controls.

The AD8641/AD8642/AD8643 are fully specified over the extended industrial temperature range of -40°C to $+125^{\circ}\text{C}$. The AD8641 is available in 5-lead SC70 and 8-lead SOIC lead-free packages. The AD8642 is available in 8-lead MSOP and 8-lead SOIC lead-free packages. The AD8643 is available in 14-lead SOIC and 16-lead, $3\text{ mm} \times 3\text{ mm}$, LFCSP lead-free packages.

AD864x应用:

Line-/battery-powered instruments

Photodiode amplifiers

Precision current sensing

Medical instrumentation

Industrial controls

Precision filters

Portable audio