

# Patient monitoring 101: Part-4

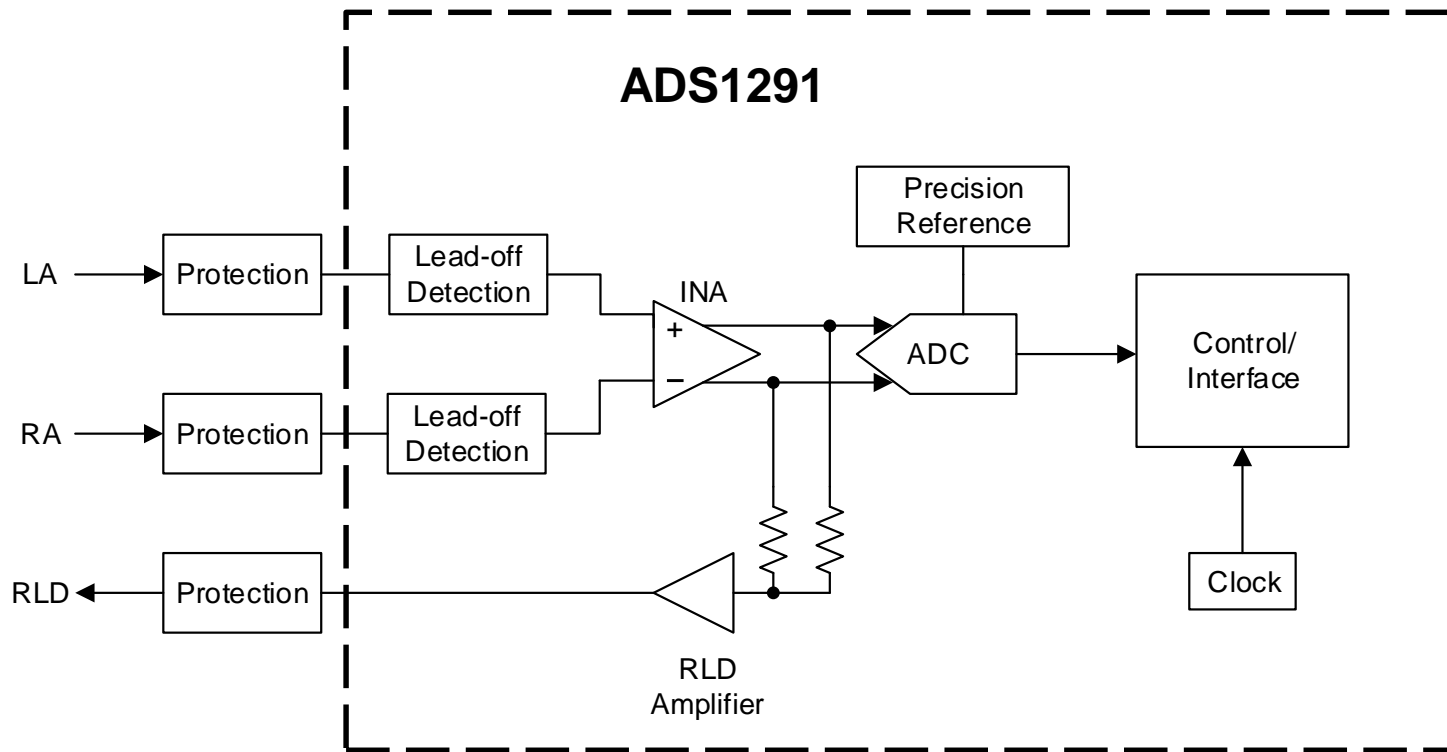
## Choosing right electrocardiogram (ECG) front-end for your design

Prepared by: Ryan Andrews

# Typical ECG system

## Block diagram – single-lead ECG

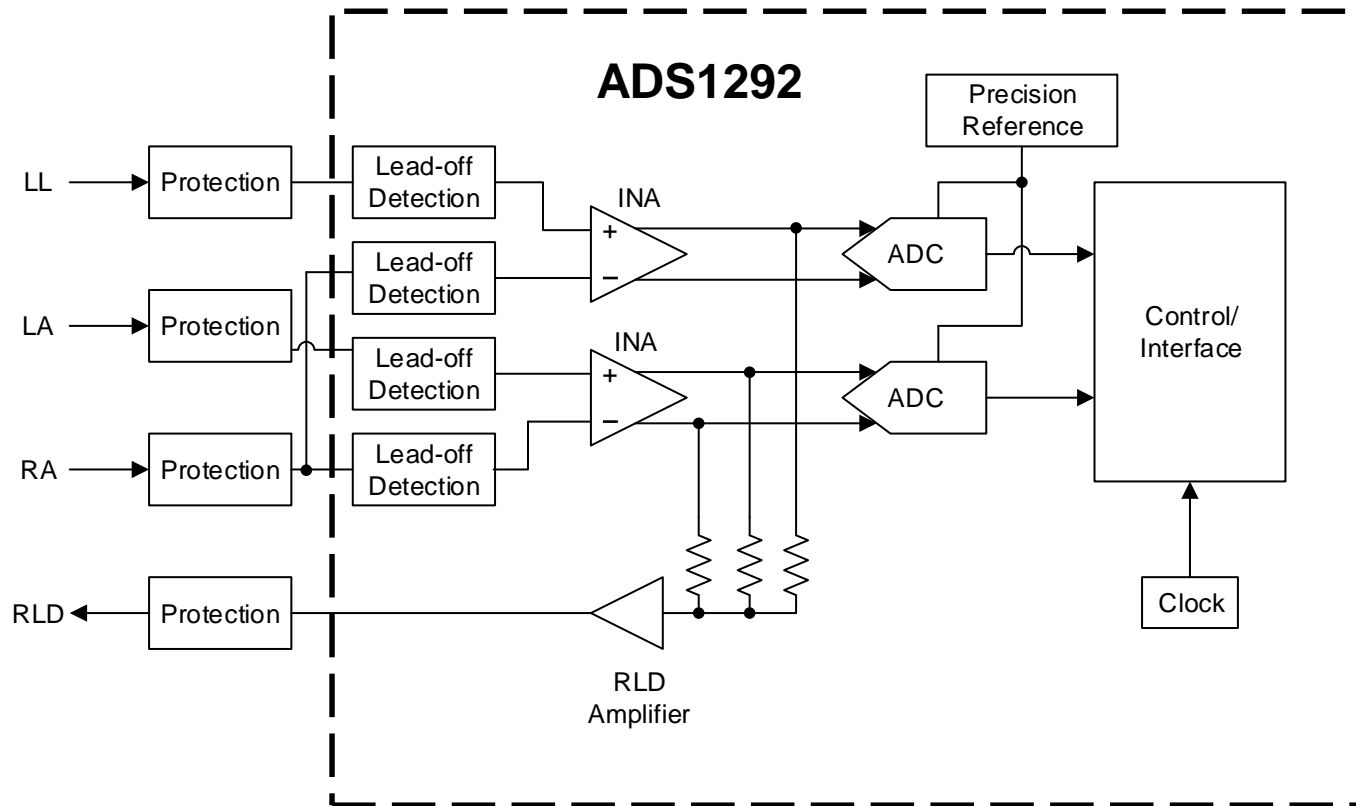
[ADS1291](#) datasheet



# Typical ECG system

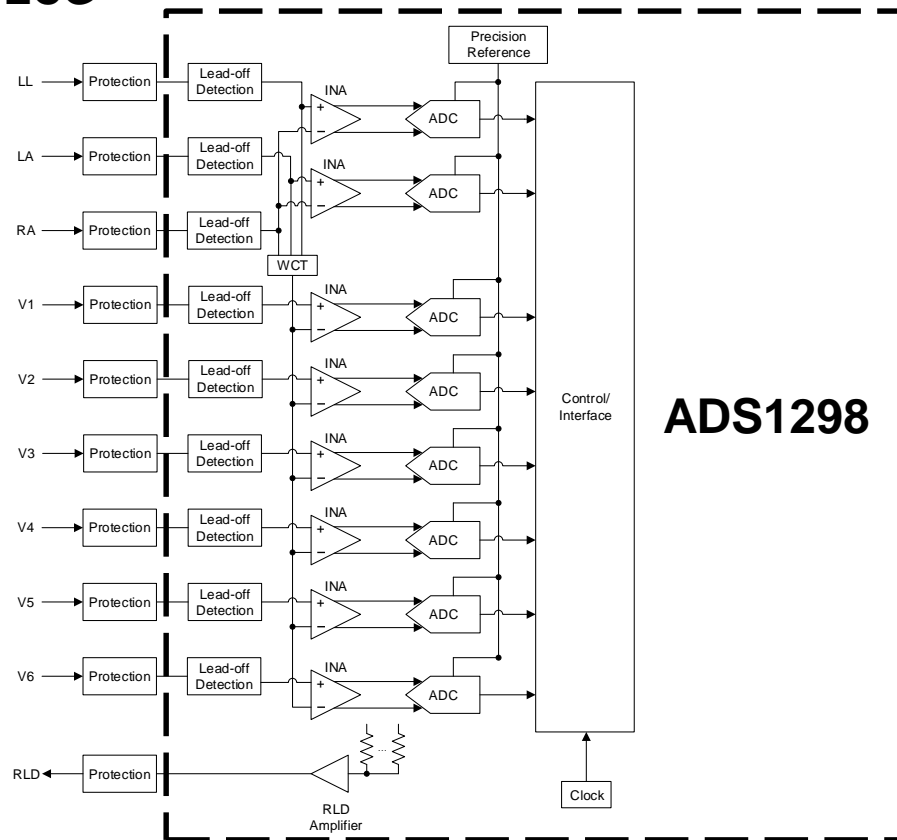
## Block diagram – 3-lead ECG

[ADS1292 datasheet](#)



# Typical ECG system

## Block diagram – 12-lead ECG

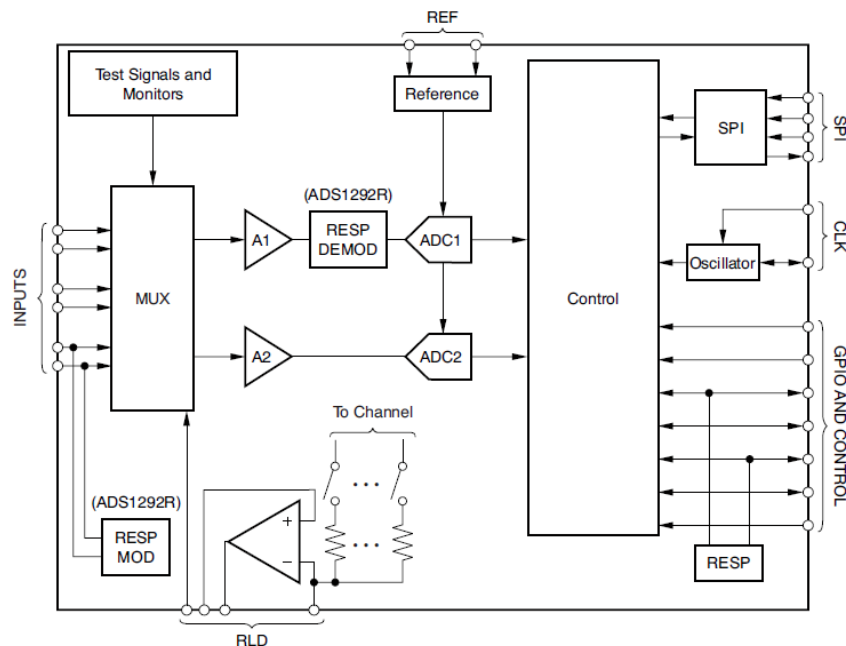


[ADS1298](#) datasheet

# ADS1291/2

## ADC specifications

- Low-noise, high input impedance front end PGAs
- 24-bit simultaneous sampling delta-sigma ADCs (data rates 125 SPS – 8 kSPS)
- 8  $\mu\text{V}$  pk-pk noise (PGA gain = 6, BW = 150 Hz)
- CMRR: -105 dB
- Integrated Right-Leg Drive amplifier
- Integrated Lead-off detection
- Integrated respiration impedance measurement (ADS1292R)
- Integrated test signals for verification
- Integrated low-drift ADC reference
- Integrated oscillator



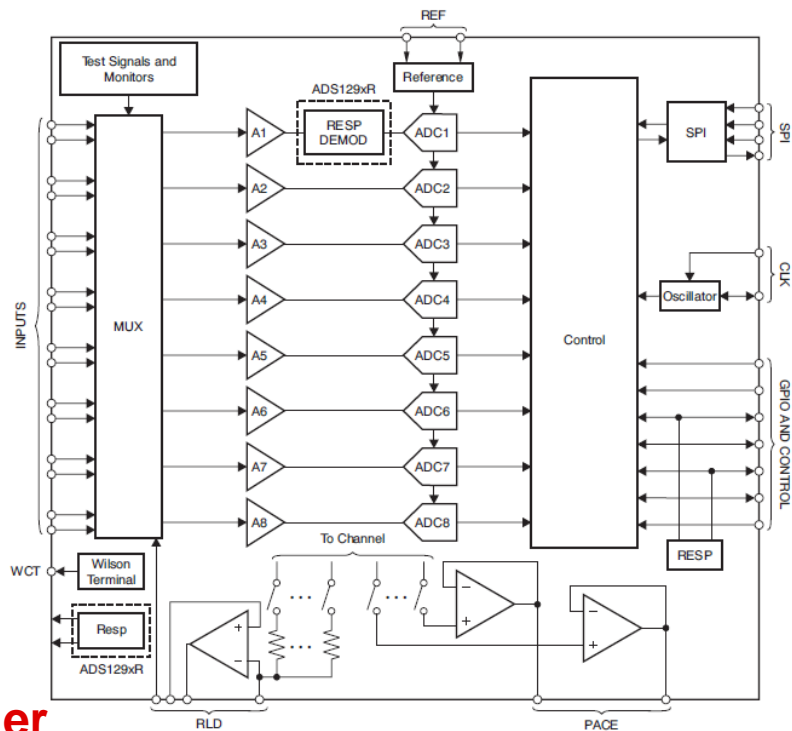
# ADS1294/6/8

## ADC specifications

- Low-noise, high input impedance front end PGAs
- 24-bit simultaneous sampling delta-sigma ADCs (data rates 250 SPS – **32 kSPS**)
- **4  $\mu\text{V}$  pk-pk noise** (PGA gain = 6, BW = 150)
- **CMRR: -115 dB**
- Integrated Right-Leg Drive amplifier
- Integrated Lead-off detection
- Integrated respiration impedance measurement (ADS129xR)
- Integrated test signals for verification
- Integrated low-drift ADC reference
- Integrated oscillator

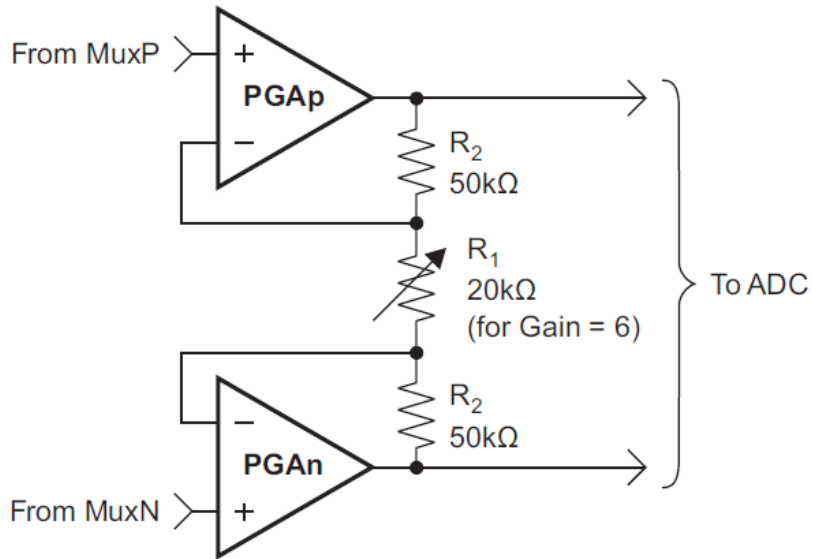
**+ Integrated WCT amplifier**

**+ Integrated analog pacemaker output**



# ADS129x

## Input amplifier specifications



### Key specifications:

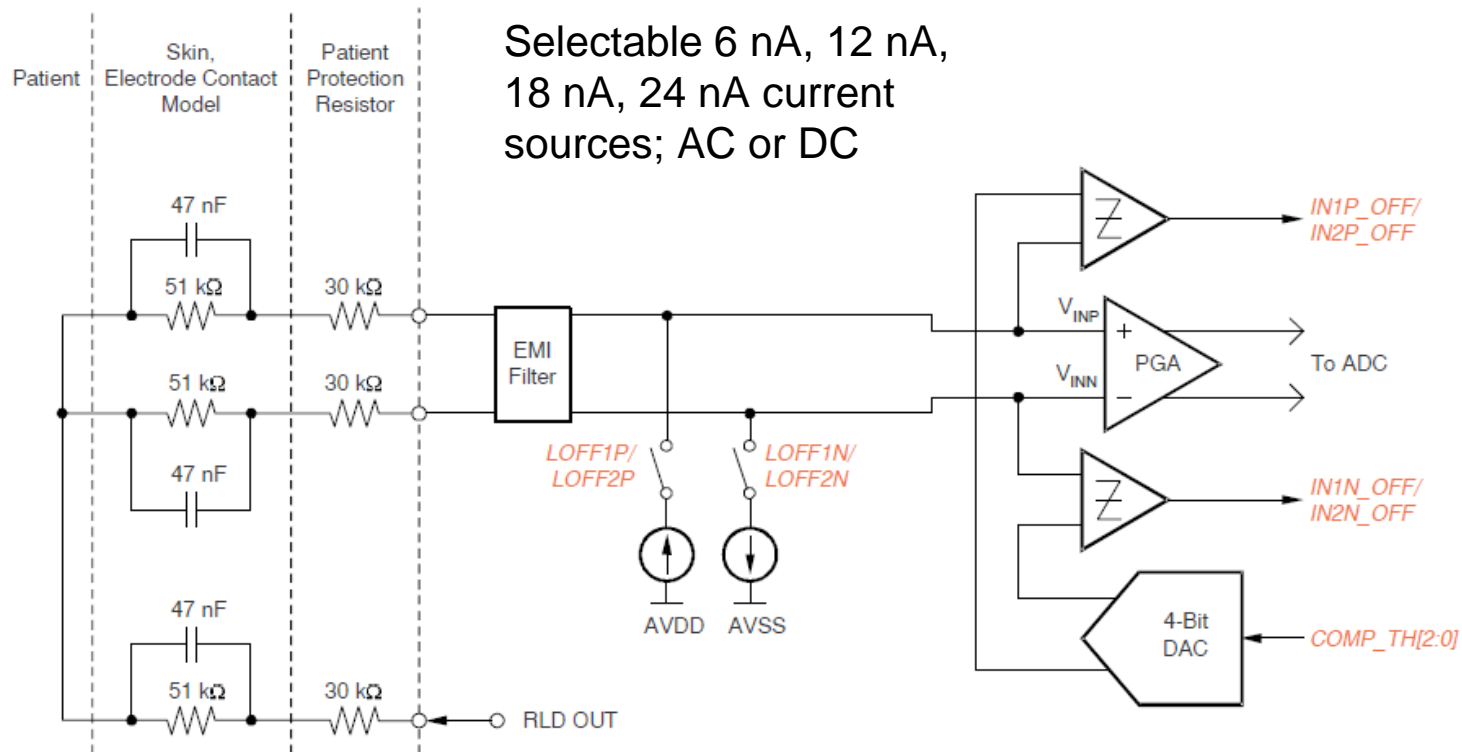
- CMOS input PGA,  $I_B = 200 \text{ pA MAX}$
- High input impedance:  $Z_{IN} > 100 \text{ M}\Omega$
- Low input voltage noise
- Negligible input current noise
- Gains of 1, 2, 4, 6, 8, 12





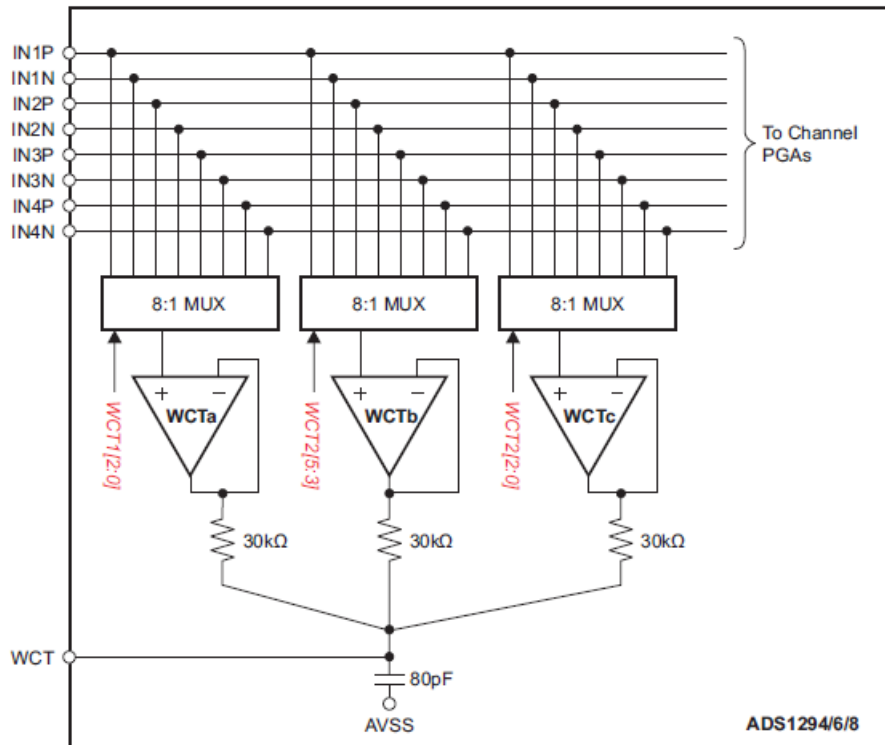
# ADS129x

## Lead-off detection



# ADS1294/6/8

## Wilson Central Terminal

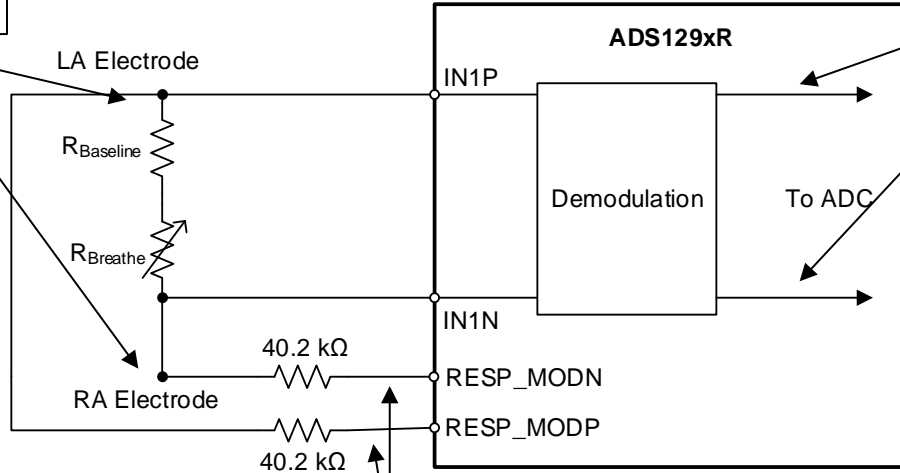


Select which inputs generate WCT using register settings

# ADS129xR

## Respiration rate measurement – basic principle

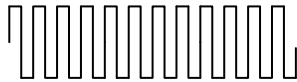
2. Change of impedance of chest from breathing modulates square wave



3. Demodulation circuitry extracts low frequency breathing waveform

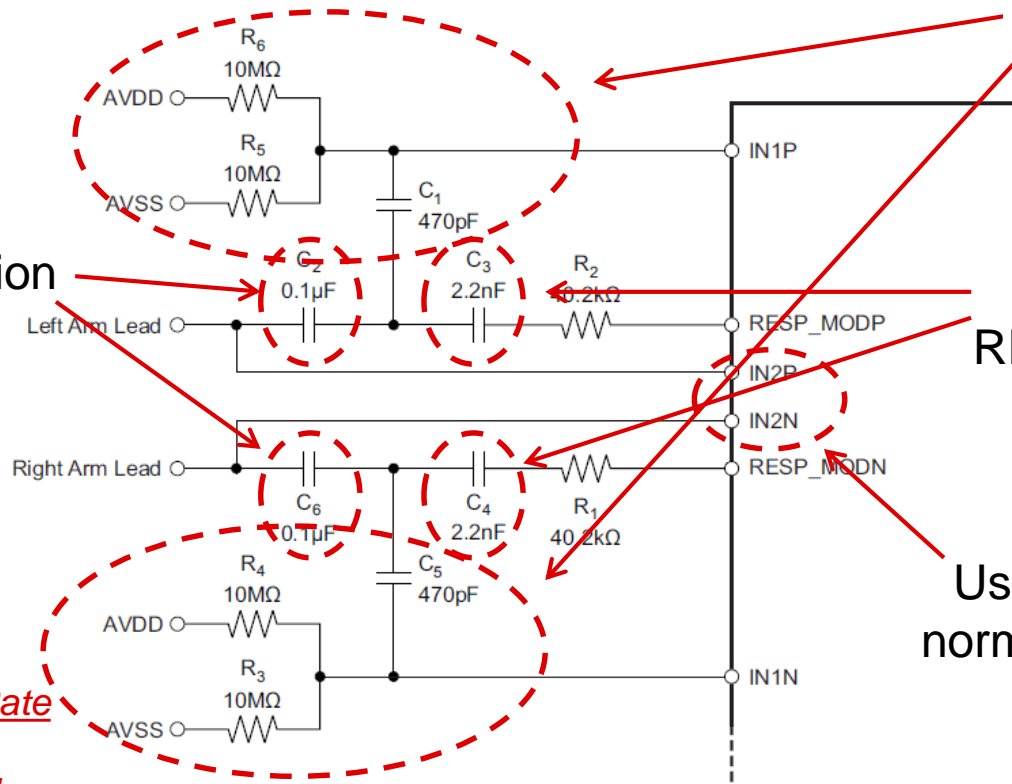


1. RESP\_MOD pins output high frequency square wave



# ADS129xR

## Respiration rate measurement – actual implementation



AC couple  
Channel 1 inputs

AC couple  
RESP\_MOD outputs

Use Channel 2 as  
normal ECG channel

Patient fault protection

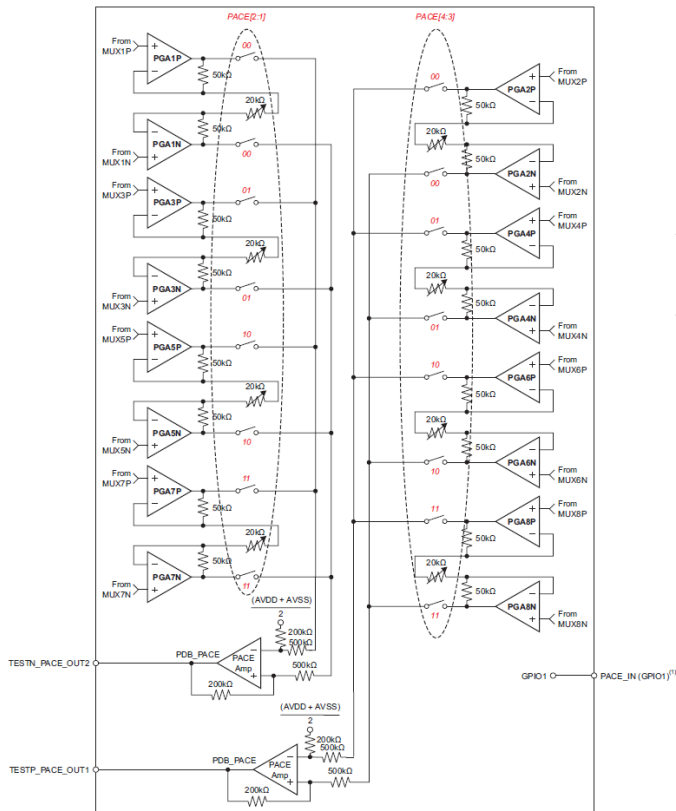
**SBA181:** Respiration Rate Measurement Using Impedance Pneumography

# ADS1294/6/8

## Pacemaker detection output

Registers settings select which lead is selected to be output by PACE amplifier

Amplifiers are configured as differential-to-single ended converters to output an ECG lead as a single-ended signal



ADS1294/6/8 have integrated pacemaker output amplifiers which allow for external detection of pacemaker pulse

# ADS119x and ADS129x family

End Equipment	ECG Leads	ADC Channels	Part Number (s)	Noise (BW=150HZ)	CMRR	Power/Chan	ADC Resolution	Comments
ECG Patch	Lead I	1	<a href="#">ADS1191</a>	24μVpp	95dB	335μW	16-bit	Integrated Right Leg Drive Amplifier, Lead-off detection
			<a href="#">ADS1291</a>	8μVpp	105dB	335μW	24-bit	Integrated Right Leg Drive Amplifier, Lead-off detection, ADS1294R supports respiration
AED, Holter	Lead I, Lead II, Lead III	2 3	<a href="#">ADS1191</a>	24μVpp	95dB	335μW	16-bit	Integrated Right Leg Drive Amplifier, Lead-off detection
			<a href="#">ADS1292</a> , <a href="#">ADS1293</a>	8μVpp, 7μVpp	120dB, 105dB	335μW, 300μW	24-bit	Integrated Right Leg Drive Amplifier, Lead-off detection, ADS1292R supports respiration.
Patient Monitors	Lead I, Lead II, Lead III, aVR, aVL, aVF	2	<a href="#">ADS1192</a>	24μVpp	95dB	335μW	16-bit	Integrated Right Leg Drive Amplifier, Lead-off detection
			<a href="#">ADS1292</a>	8μVpp	105dB	335μW	24-bit	Integrated Right Leg Drive Amplifier, Lead-off detection, ADS1292R supports respiration.
Patient Monitors ECG Recorder	Lead I, Lead II, Lead III, aVR, aVL, aVF, V1 – V6	8	<a href="#">ADS1194</a> , <a href="#">ADS1196</a> , <a href="#">ADS1198</a>	12μVpp	105dB	550μW	16-bit	Integrated Right Leg Drive Amplifier, Lead-off detection
			<a href="#">ADS1294</a> , <a href="#">ADS1296</a> , <a href="#">ADS1298</a>	4μVpp	115dB	750μW	24-bit	Integrated Right Leg Drive Amplifier, Lead-off detection, ADS1294R, ADS1296R, ADS1298R supports respiration



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