

Flexi Optode Prototype

Hardware Design and Initial Tests

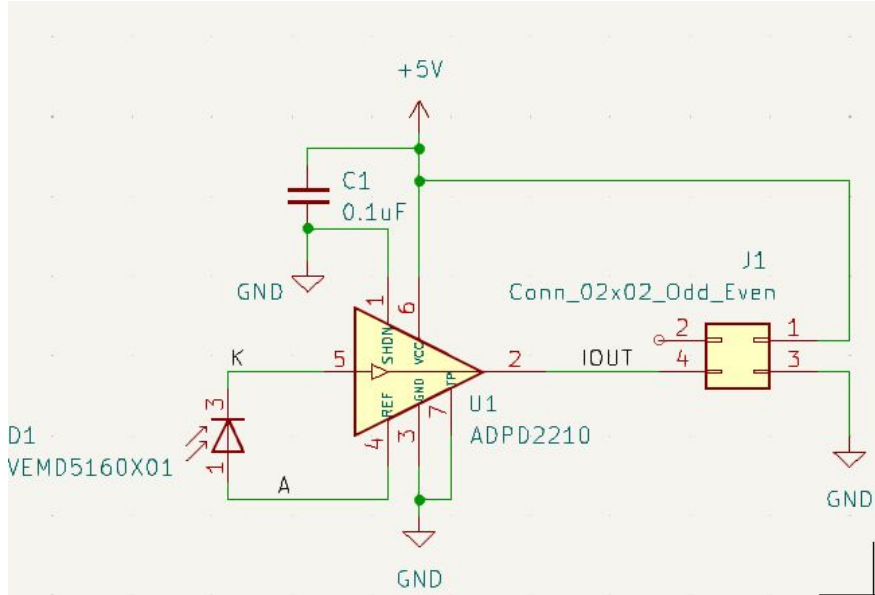
Eric Hazen - 8/31/23

Prototyping Plan

- Develop a prototype optode at low cost
- Test the idea of a flexi circuit to replace the (expensive) cable
 - Flexi up to < 400mm are now very inexpensive
- Preamplify the signal at the photodetector, then again in the connector box
- Work so far:
 - Design a flexi with Vishay VEMD516X01 photodiode and Analog Devices ADPD2210 amp
 - Design a connector/transimpedance amp 8-channel box mechanically compatible with the existing breakout boxes
 - Start testing (Joe)

Flexi Design

Schematic

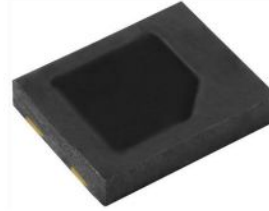


www.vishay.com

VEMD5110X01

Vishay Semiconductors

Silicon PIN Photodiode



DESCRIPTION

VEMD5110X01 is a high speed and high sensitive PIN photodiode. It is a low profile surface mount device (SMD) including the chip with a 7.5 mm² sensitive area and a daylight blocking filter matched with IR emitters operating at wavelength 870 nm or 950 nm.

FEATURES

- Package type: surface mount
- Package form: top view
- Dimensions (L x W x H in mm): 5 x 4 x 0.9
- Radiant sensitive area (in mm²): 7.5
- AEC-Q101 qualified
- High radiant sensitivity
- Daylight blocking filter matched with 870 nm to 950 nm emitters
- Fast response times
- Angle of half sensitivity: $\phi = \pm 65^\circ$
- Floor life: 72 h, MSL 4, according to J-STD-020
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE
GRADE



RoHS
COMPLIANT
HALOGEN
FREE
GREEN
(Pb-free)

APPLICATIONS

- High speed detector for infrared radiation



Data Sheet

Ultralow Noise, Low Power Current Amplifier

ADPD2210

FEATURES

- Ultralow noise, low power current amplifier
- 80 fA/√Hz (typical) noise floor
- 140 µA (typical) of supply current when active ($E_c = 0 \mu\text{W}/\text{cm}^2$)
- 100 nA (typical) of supply current in standby
- Flexible output configuration
- Optimized for pulsed systems
- Nominal linear output: 240 µA
- Space-saving 2 mm x 2 mm LFCSP package

APPLICATIONS

- Photoplethysmography
- Photodiode measurements
- Small current pulsed amperometry
- Any application requiring the ultralow noise amplification of small currents

FUNCTIONAL BLOCK DIAGRAM

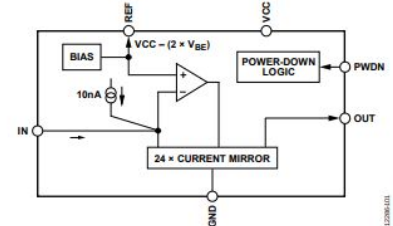
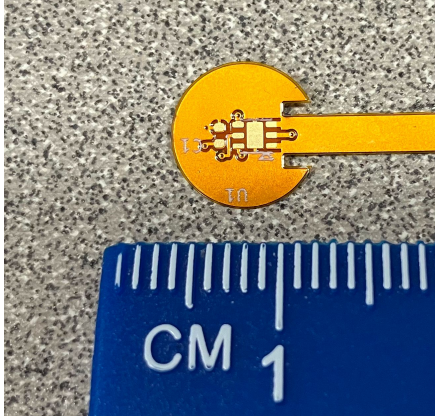


Figure 1.

Flexi prototype

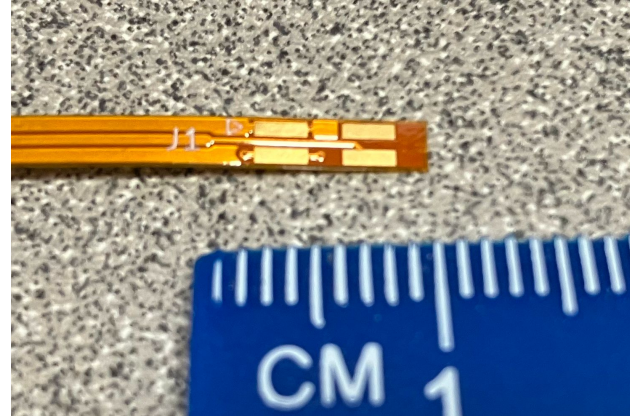
Amplifier side



Photodetector side



Connector footprint (0.05 in pitch)

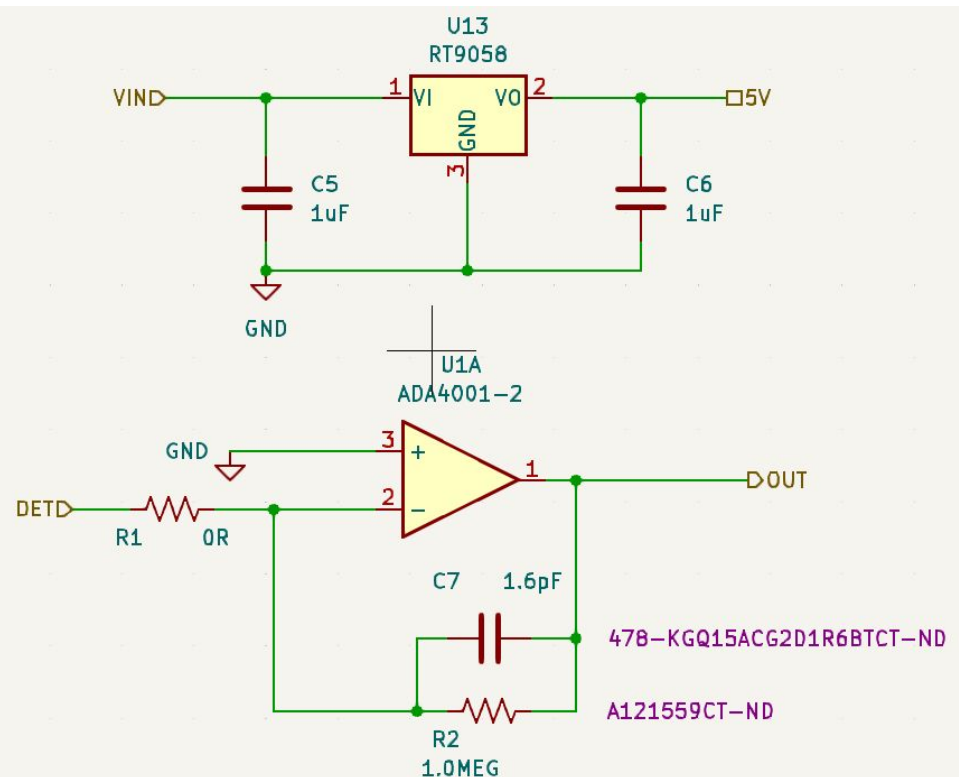


TIA design (1 of 8 channels)

Separate 5V linear regulator per channel to supply preamp

Low-noise op-amp in transimpedance application

(Powered by +6.5 / -20V power compatible with existing system)



Low Noise, Low Input Bias Current, Rail-to-Rail Output, JFET Dual Operational Amplifier

Data Sheet

ADA4001-2

FEATURES

Low $T_C V_{OS}$: $\pm 5 \mu V/^\circ C$ typical

Low input bias current: 20 pA typical at $V_{SY} = \pm 15 V$

Low noise

7.7 nV/ \sqrt{Hz} typical at $f = 1 kHz$

1.2 μV rms at 20 Hz to 20 kHz

Low distortion: 0.00006%

No phase reversal

Rail-to-rail output

Unity-gain stable

APPLICATIONS

Instrumentation

Medical instruments

Multipole filters

Precision current measurement

Photodiode amplifiers

Sensors

Audio

PIN CONFIGURATION

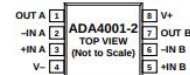


Figure 1. 8-Lead SOIC_N (R Suffix)

RICHTEK®

RT9058

36V, 2 μA I_Q , 100mA Low Dropout Voltage Linear Regulator

General Description

The RT9058 is a low dropout (LDO) linear voltage regulator that features high input voltage, low dropout voltage, ultra-low operating current, and miniaturized packaging. With quiescent current as low as 2 μA , the RT9058 is ideal for battery-powered equipment.

The RT9058's stability requirements are easily met with all types of output capacitors, including tiny ceramic capacitors, over its wide input range (3.5V to 36V) and its load current range (0mA to 100mA). The RT9058 offers standard output voltages of 2.5V, 3V, 3.3V, 5V, 6V, 9V and 12V.

Applications

Features

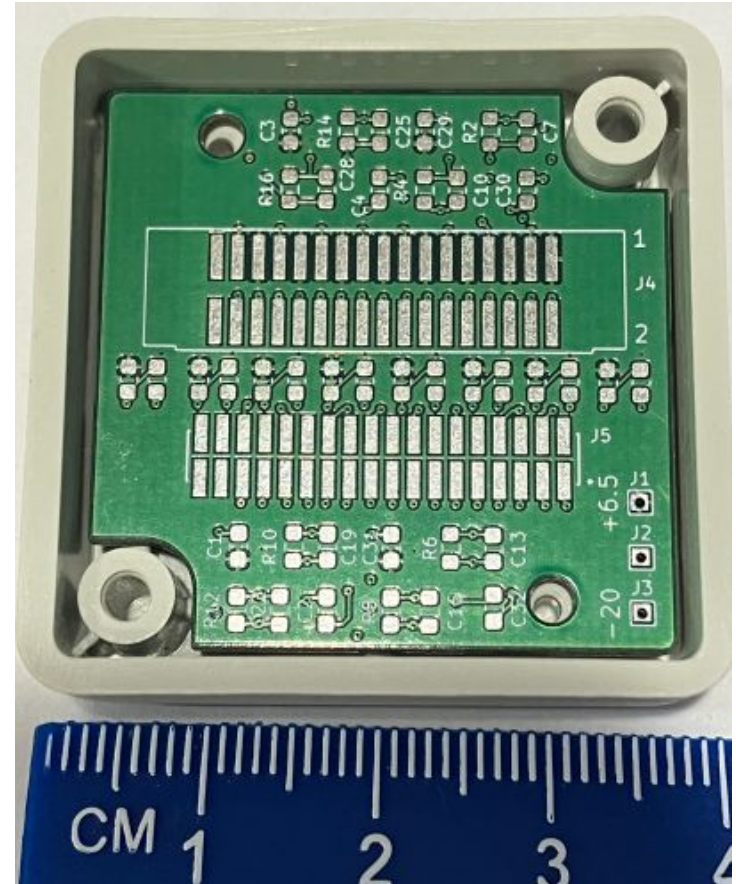
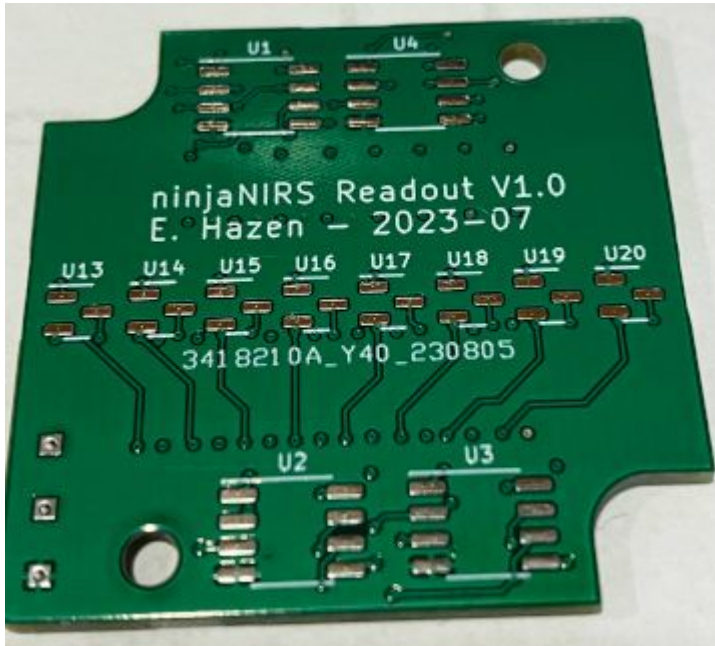
- 2 μA Quiescent Current
- $\pm 2\%$ Output Accuracy
- 100mA Output Current
- 3.5V to 36V Input Voltage Range
- Dropout Voltage : 0.35V at 10mA/ V_{CC} 5V
0.5V at 10mA/ V_{CC} 3.5V
- Fixed Output Voltage : 2.5V, 3V, 3.3V, 5V, 6V, 9V, 12V
- Stable with Ceramic or Tantalum Capacitors
- Current Limit Protection
- Over Temperature Protection
- SOT-23-3, SOT-89-3 Packages
- RoHS Compliant and Halogen Free

8 channel transimpedance amp (TIA) board

Fits in Hammond 1551Q enclosure

Four dual op-amps provide 8 channels

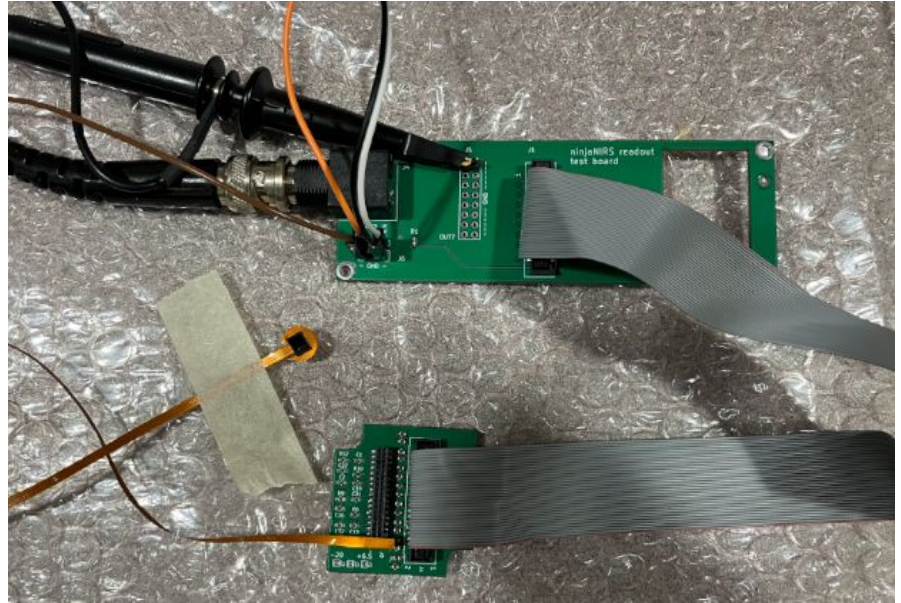
Relatively easy to solder (0603 size R/Cs)



Test setup

I also designed a simple test/breakout board

- Test pulse injection for small current pulses to the TIA
- Breakout for 8 channels of readout



Initial tests with LED pulse

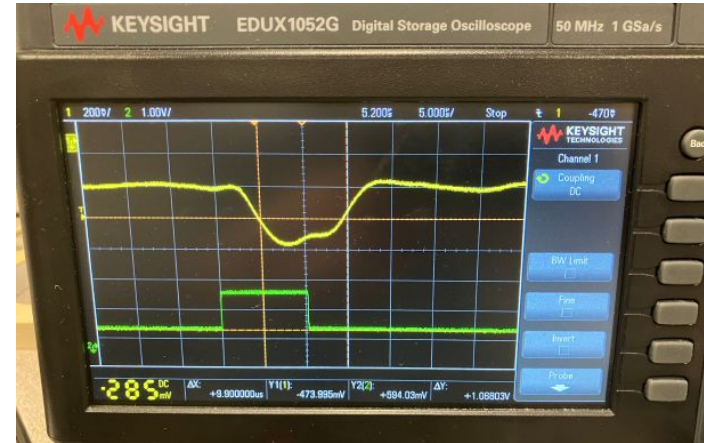
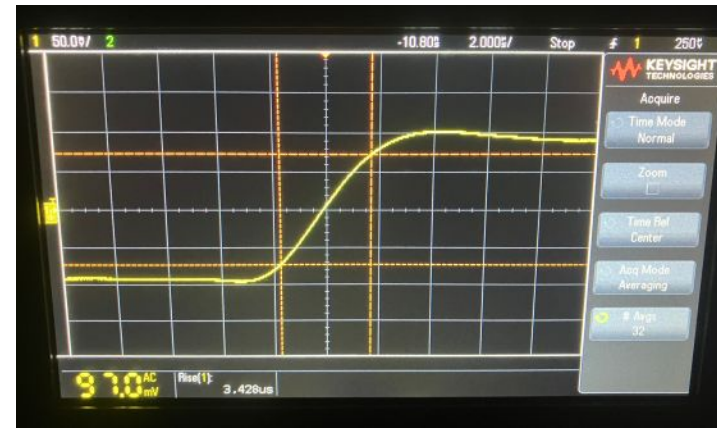
Response of flex sensor through TIA

Pulse with 850nm LED (logic signal)

Upper plot: risetime measurement
with 50% duty square wave
~ 3.5us risetime

Lower plot: 10us LED pulse

Shows ~ 100kHz bandwidth



5us/div Ch1: 200mV/div Ch2: 1V/div

Next Steps

- Finish testing to establish noise level
- Fabricate a longer flexi (could be a “serpentine” design to fit within inexpensive 300 x 400mm envelope)
- Optimise TIA gain and compensation capacitance
- Test other candidate op-amps (footprint is compatible with several parts)