CROWD SUPPLY

BES-AFE-1: Analog Front-End Module for ECGs

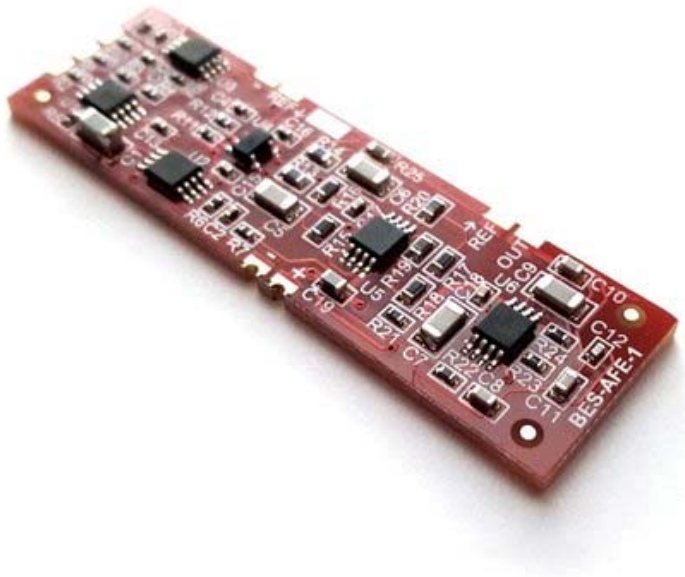
A fully functional single lead electrocardiograph analog front-end module designed for prototyping and integration in user designs.

As Featured In

DesignSpark

DESIGNSPARK "Designed to offer the user a low noise, low offset, and low power solution in a compact easy-to-use form factor."

The BES-AFE-1 is a fully functional single lead electrocardiograph (ECG) analog front-end module designed for prototyping or for integration in user designs. This module provides an easy to use solution to the problem of acquiring electrical heart activity for those wanting to incorporate heart monitoring functionality in their project or product. Typical users include makers, hobbyists, students, teachers, and engineers who want to concentrate on developing their project or product without having to deal with the arduous task of developing, characterizing, and testing an ECG analog front-end. This module has been designed to offer the user a low noise, low offset, and low power solution in a compact easy-to-use form factor with the benefits of built-in right-leg drive, baseline wander rejection, notch filtering, and anti-aliasing.



What Does It Do?

The BES-AFE-1 takes care of the problem of designing analog circuitry needed to convert a low level, variable impedance, and often noisy electrical signal from the heart into a more usable form that can be directly fed into an analog to digital converter (ADC) of a microcontroller or oscilloscope. Without such a front-end, it would be very hard for the ADC to pick up the heart's electrical activity because the signal itself is often on the order of tenths of a millivolt on the surface of the body. In addition, noise and offset are big concerns when attempting to amplify such signals because both line interference (from the AC power in a building) and contact induced offset/baseline wander (from breathing) will be many orders of magnitude larger than the signal itself. Attempts by other people to build an EKG often results in poor acquisition secondary to not only persistent noise despite filtering but waveform distortion as well to the point that the morphologies of various key components of the EKG signal (such as QRS complex) are no longer representative of the electrical activity of the heart. Therefore, under many applications such as heart rate monitoring, the module can reduce or even remove the need for filtering while avoiding unacceptable distortion from inadequately designed analog circuitry.

Target Audience

- **Makers and Hobbyists:** Use it to easily test ideas and rapidly develop projects pertaining to fitness, biometrics, and electrophysiology applications
- **Students** Use it to quickly develop and validate designs for use in various class projects such as the Senior Design/Capstone Project
- **Teachers** Use it as a teaching aid in the lab and to demonstrate concepts in both fields of biology and engineering in the classroom
- **Engineers** Use it to easily acquire authentic real-time data to help you further define, develop, and test your next MVP or maturing product within the areas of fitness, automotive, security, gaming, and medicine.

Features & Specifications

- **Voltage Supply:** Single and dual rail ranging from 1.8v (±0.90) to +5.5v (±2.75v)
- **Current consumption:** 180µA to 290µA. Typical 220µA @ 3.3v

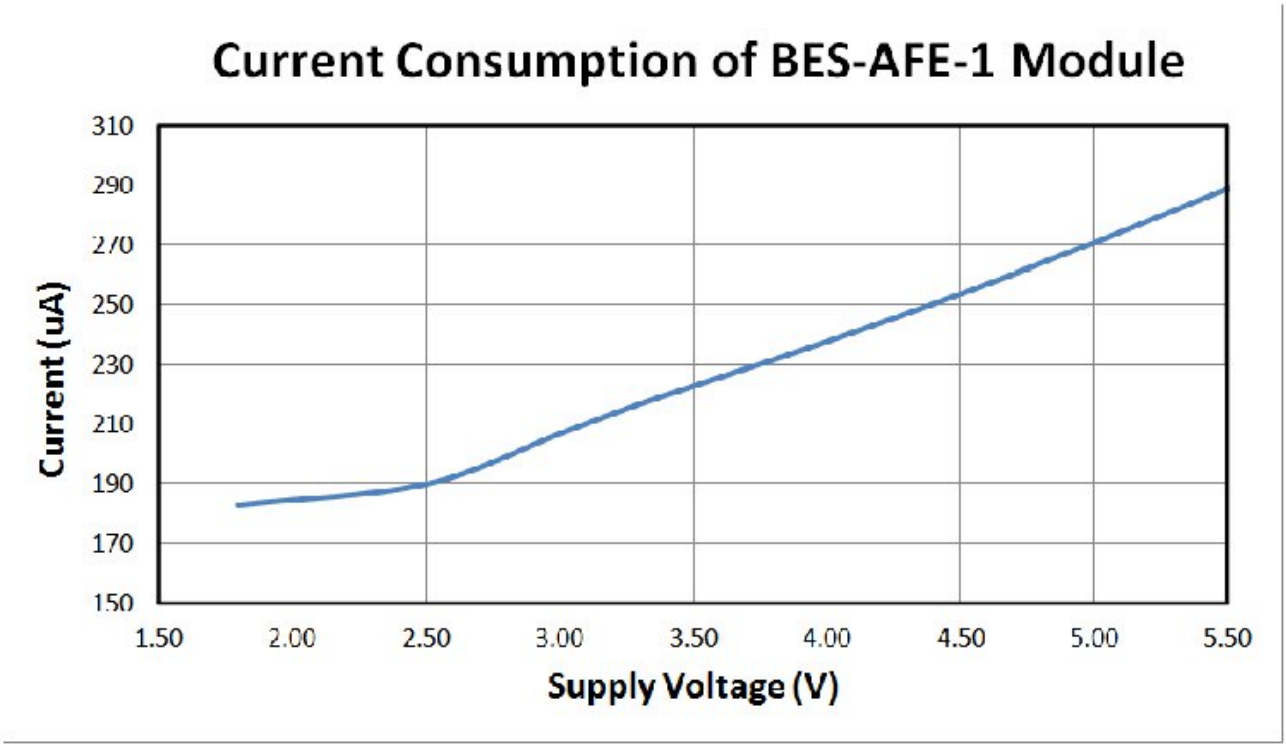
- **Internal Reference:** (Vdd-Vss)/2 which can be easily overridden by the user with an external reference
- **Bandwidth:** 100Hz
- **Low-Pass:** First order at 0.8Hz
- **Notch:** 50Hz or 60Hz with >20dB Notch Depth
- **High-Pass:** Fourth Order Bessel at 100Hz, First Order at 96.6Hz on secondary gain stage
- **Size:** 2" by 0.6" (50.8mm by 15.24mm)
- **Design Criteria:** Module has been designed to preserve waveform morphology and maximize noise immunity at the expense of bandwidth and absolute gain accuracy.

Performance Graphs

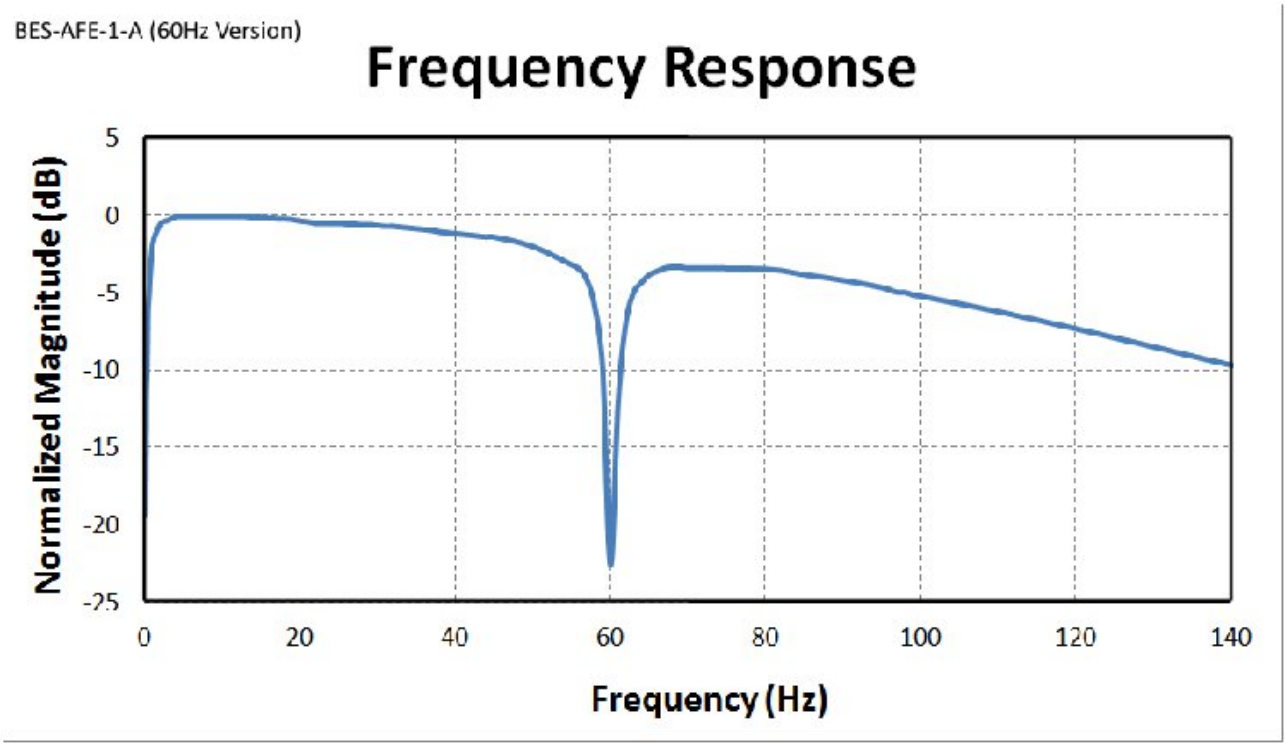
Simulated ECG with Noise Input [yellow] and Output from Module [green]

ECG signal through various stages of the AFE module. Yellow trace is the input and pink trace is the output.

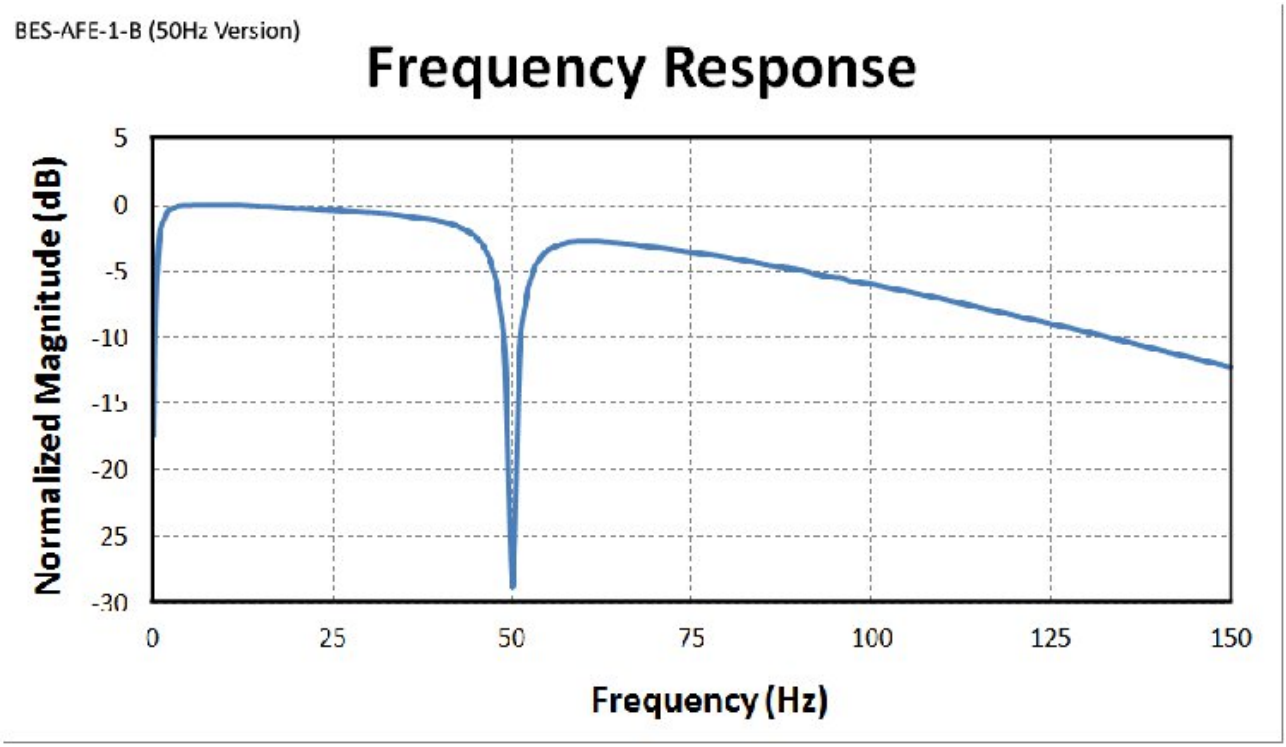
AFE module output when connected to a human subject in Lead II configuration using the modified Mason-Likar variant for electrode placement.



Current consumption of a typical BES-AFE-1 Module with inputs shorted to right leg drive and a 1MΩ load on the output



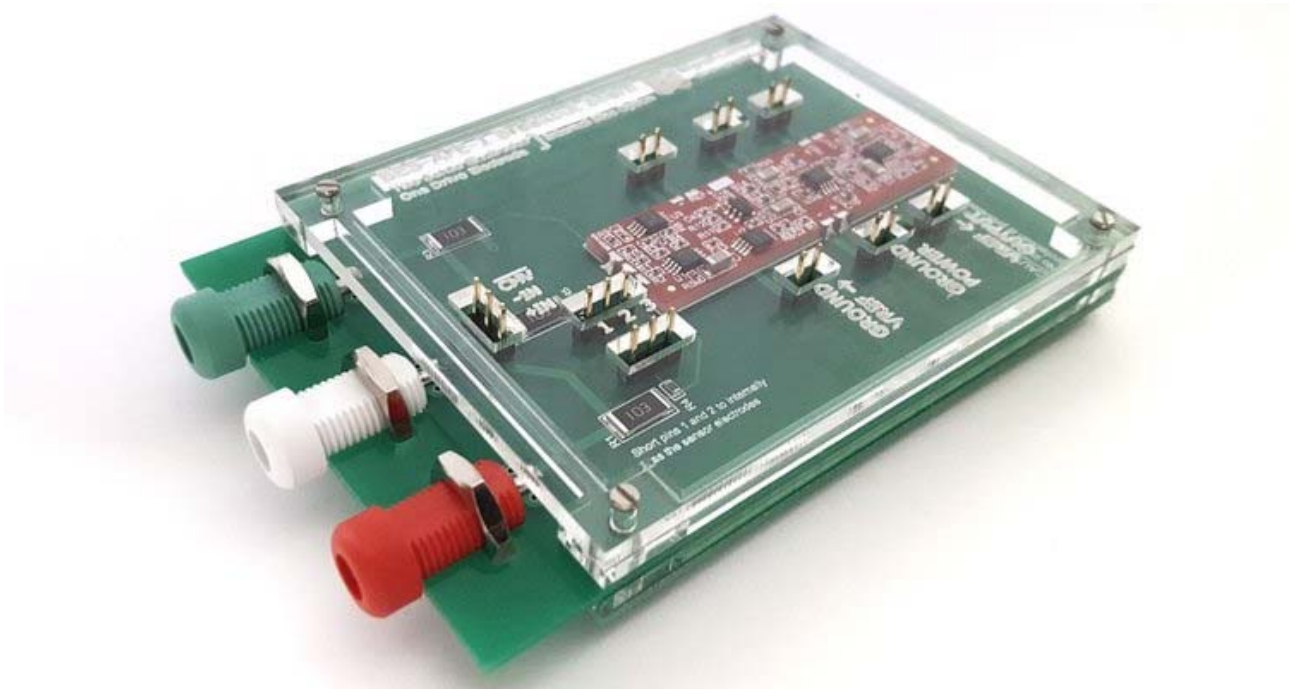
Typical frequency response of the BES-AFE-1-A module (60Hz Notch Option)



Typical frequency response of the BES-AFE-1-B module (50Hz Notch Option)

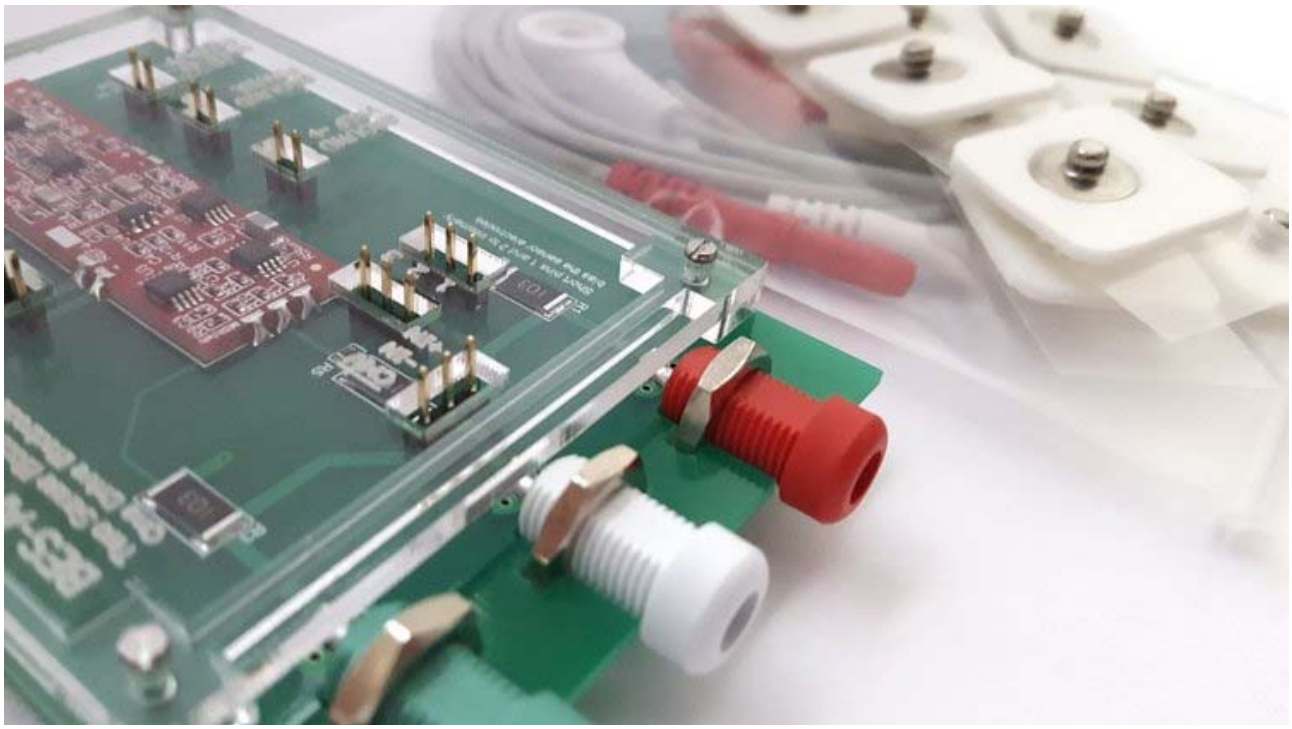
Breakout Board

A breakout board option (with a BES-AFE-1 module already mounted) is also available to make interfacing with the BES-AFE-1 module very straight-forward. The inputs/outputs are all broken out into standard 0.1" headers. In addition, the inputs are also connected to 1.5mm protected DIN jacks to allow for connecting the breakout board to standard ECG input electrodes. The top of the breakout board is enclosed in acrylic for protection. The bottom is covered as well and showcases the derivations used to calculate the leads for a 12-lead system.



Quick Startup Package

A quick startup package is available as well that includes the breakout board, 3 electrodes, and a set of electrode pads to get you up and running in as little as a minute.



Notch Filter Option Selection

The various reward tiers will have a dropdown box that requires you to select for either the 60Hz or 50Hz version. This is used to specify the line noise rejection frequency. Please select the option which matches the line frequency of the environment you plan on deploying your project in.

Manufacturing Plan

All final prototypes have been built and characterized. If this campaign reaches its goal, the plan is to purchase the needed parts, assemble the PCBS (via Circuit Hub), test them, and then ship the rewards in late March to early April 2017.

Risks & Challenges

All prototypes have been built and function as designed. The potential sources of delay to fulfillment include securing an adequate amount of parts for assembly as well as shipping to all the backers.

Disclaimer

This module has NOT been approved for independent use in the diagnosis, treatment, or monitoring of any physiological activity and/or illness. This device is NOT a final medical product. Thus, this device is provided “as-is” for prototyping/development and all necessary precautions and standards must be taken into account. In addition, this device does not provide any isolation between its inputs and the rest of its circuitry