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The Acquisition of EMG Signals.

Getting EMG(Electromyography) signals from the muscles is quite a difficult task.Because amplitude of the EMG signal is varying between 50uV and 30mV. Therefore amplifiers with higher Gain must be needed for amplification.Since the input signals is in an ultra low voltage rage, lots of noise signals pick-up during the amplification process.So series of filters are used with cutoff frequencies 0 and 500Hz. Because frequency rage of the EMG signals is in between 0Hz and 500Hz.
There are several steps or stages for getting EMG signals from the muscles.

Electrodes

Copper(Cu) is a good conductive material which can be find easily. Therefore electrodes can be made using copper plates.The signal condition of the signal depends on the shape and the area which touches with skin. According to researches about Surface Electrodes, circular shape is better than others shapes and optimum diameter of electrode is 10mm.

Filters & Amplifies

Three electrodes are used for getting signals. One electrode is placed on non muscular part of the body and it's the reference electrode (Ground Electrode /Passive Electrode) which is connected to the ground terminal of the circuit. Other two electrodes (Active Electrodes) are placed on the muscle. (An electrode is placed on middle point of the muscles and another one is placed on edge off the muscles). For this experiment, calf muscle is the target muscle.
At the beginning high frequencies are cutoff before differential amplification stage. Also input impedance of the differential amplifier must be at higher level. So an instrumentation amplifier is used as the differentials amplifier. Because it has high stable gain and the high input impedance. Therefore Low Pass Passive Filters with 486Hz cutoff frequency are used as first stage for both active electrodes inputs.
It does not decrease the input impedance. The second stage is the instrumentation amplifier stage. According spectrum and output waveform, it can be identified that the frequencies below the 16Hz does not affected to the output signals and there was a kind of floating output. Therefore the instrumentation amplifier is configured as High Pass Filter with 16Hz cutoff frequency.
Schematic is shown below.

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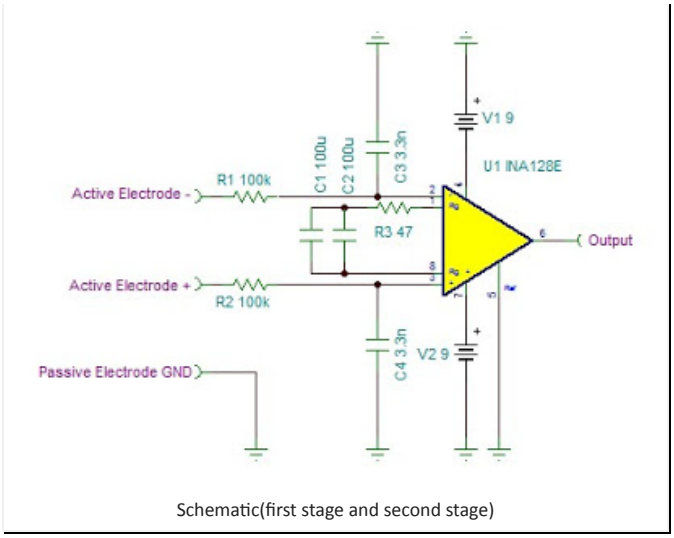
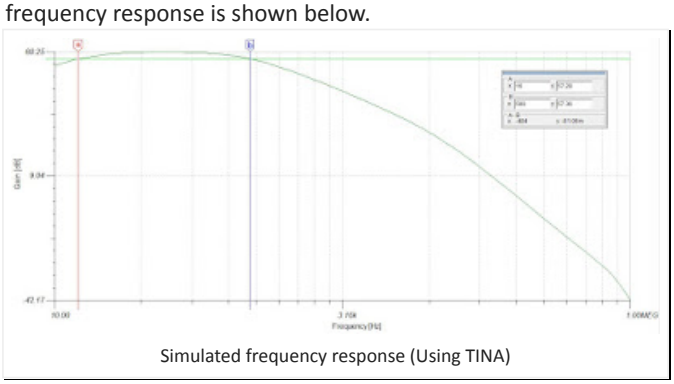


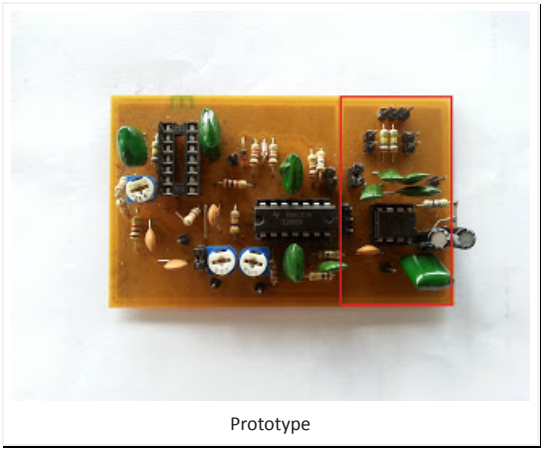
Schematic(first stage and second stage)

The characteristic of the of above circuit is based on the frequency response. Simulated frequency response is shown below.



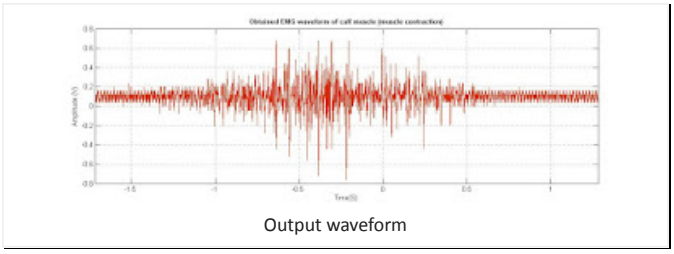
Simulated frequency response (Using TINA)

According to the frequency response curve the whole circuit acts as a band pass filter with 16Hz of lower cutoff frequency and the 500Hz with upper cutoff frequency (approximately). The prototype of the circuits is shown below and its consist of other circuits (Notch filter, Gain Amplifier, Rectification Circuit and Pass Filters). The relevant part of both stages have been mentioned on image.



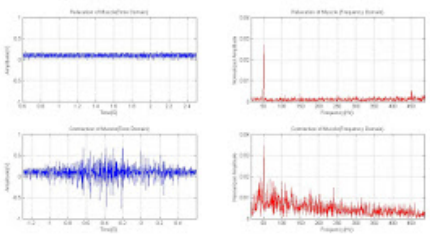
Prototype

The instrumentation amplifier which is used in circuit is INA128 (datasheet). It has a high CMRR (120dB). The output waveform of the circuit is shown below.



Output waveform

The EMG analysis of output for contraction and relaxation of the calf muscle can be shown below. There are time domain wave-forms(blue) and frequency domain wave-forms(red) for both states. 50Hz supply frequency can be seen here.



Comparison

Posted by Chamith Udayanga at 9:11 AM

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