<u>Date: Oct 13, 2012</u>
[Re] DC Offset
Components: TL 082 amplifier, 2 TCRT 1000 IR sensors,
Design: 9 DC voltage power supply
[Test] We tested multiple times putting fingers, but failed to have any regular AC waveforms. When we put each fingers to each different IR sensors, we expect to see no signal at oscilloscope due the perfect offset.
[Output] We haven't made much progress during this weekend.

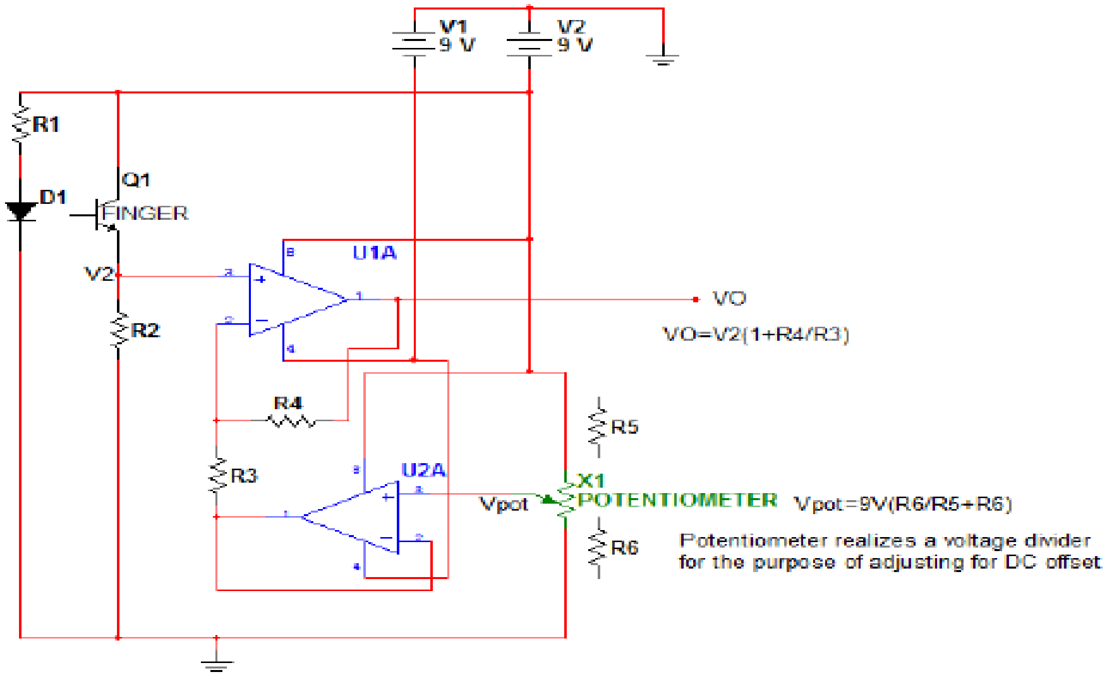
<u>Date: October 16,2012</u>
[Re]: Assembling the old products designed by previous team
[Test]: Just trying to hook on the sensors with the previous team's product in order to test the IR sensors. Without having the schematics from the previous team it is really hard to figure where the problems come from.

<u>Date: October 20,2012</u>

<u>[Test 1)</u>
[Re: checking the circuit]
[Objective]
If the previous design team's circuit does not work, we need to rebuild the whole circuit.

[Method]
1. Input signal: the AC sinusoidal signal (60 mV peak-to-peak] from function generator (NI PXI-1042Q); Output signal we expect to see is certainly amplified sinusoidal waveform at oscilloscope.
2. Regarding the amplified ratios: we set up 1:10 ratios voltage divider(R

The input signal is amplified by a potentiometer mainly.
We put the different ratios of resistors at op amp, expecting that the ratio of voltage divider 1:10 (R3:R4).



1. The first way for amplifier (R3 vs. R4] divider: If we assume that no amplifier does work, the output signal is dividend, as like 1/11, the magnitude of signal is 60mV * 1/11= 5.454 mV, but oscilloscope displays the mixed signals along with noises
2. The second way for amplifier: when an input is sinusoidal AC signal (peak to peak by 1 V), trimming potentiometer's positions (changing the resistor values, expecting output signal to be lowered).

[Output] The output signal is expected to have a clear sinusoidal curve because the input signal is sinusoidal. Magnitude of the output signal seems be a within a linear ranges, even if there is noise components are included.

<u>Test 2.</u>

Re: Circuit Response from Input signal [AC + DC components]

[Objective]: A pulse waveform from a finger consists of both AC and DC frequency components. The circuit was built to eliminate DC frequency component via DC offset (U2A constitutes a feedback system], using unit gain buffer controlled by Potentiometer. And we need to be ensured if the DC offset properly work.

[Method]: The input signal comprises of DC component with 0.5 V (magnitude] and AC component with 6 mV [magnitude], and op amps are powered with 9V. The input signal is measured as 0.506V. The gains are dividend, setting up 1(R3]:11[R4] ratios of resistors' values at the op amp, and it is based on equation : Vout = V2(1 + R4/R3) – V1(R4/R3).

[Output] At DC coupling mode, the DC input signal was blocked; only AC signal is amplified by ten times. The amplified output signal is 50mV[0.05V], its peck to peak is 100 mV. The board design properly responds to the input (sinusoidal sine wave); the circuit that was built by previous is perfectly working.

[Challenges] Putting the output signal within a linear range is not an easy task. Vpot = 9V/(1+ R4/R3) and the potentiometer realizes a voltage divider for the purpose of adjusting for DC offset. We repeat changing the Pot position to keep Vo from U1A within the linear ranges.

<u>Test 3.</u>

[Re: testing with the IR sensor (TCRT 1000)]

Using the IR sensor TCRT 1000. Op amp is supplied with 9V. Input signal is collected from Tong's finger. Adjusting DC offset is done by Potentiometer.

[Output]

1. DC offset does work.
2. Output signal is able to avoid the saturation.
3. The output signal is properly amplified, ranging about 300mV, having a sinusoidal waveform.
4. Having sense of the main frequency component, distinguishing the main one from noisy components.

[Note] We are currently observing the inverted output signals, having a sinusoidal pattern. At the output port, the magnitude of pulse waveform is measured about 300 mV. Now, even if the oscilloscope is not able to decompose those frequency components, the primary frequency component is uniquely observed. We hope that might be some helpful factors in choosing the other type of IR sensors.

[Challenges]

1. The output signal is inverted; some power lines are misarranged.
2. The elimination of noise is remaining.
3. Not sure the specific resistor values arrangement (potentiometer), we just adjust it after checking whether the output signals is within the display ranges.
4. We haven't applied the DC offset (do we need the offset mode or not?].

<u>Test 4.</u>

[Re: testing the simple filter to block the DC components]

At this time, we are planning not to rely on Vpot, aiming to eliminate U2A(unit gain buffer] in order to adjust DC offset.

[Method]

1. Now, we are placing the capacity (1nF) in order to block the dc component from pulse wave from finger.
2. At this stage, we wanted to check whether capacity does effectively block the dc components of the pulse waveform measured from the finger. If the capacitor properly works, dc component is blocked, only ac pass

through it. As such, only the AC pulse waveform is to be displayed within the oscilloscope.

[Output]

1. Adjusting the potentiometer 2 was able to amplify the input pulse waveform.

[Challenges]

1. At dc-coupled mode, the output signal is just mixed noises components.
2. Single capacitor simply does not work
3. In order to block dc component, we are designing the RC filter, instead of this capacitor.

<u>Test 5</u>

[Re: filter design to eliminate DC components]

[Method]: Let's do it next week

[Note] Now we are thinking about building either a high pass filer or a band-pass filter for the purpose of DC offset. This filter will be located before the input pulse goes into the op amplifier. If that does work, we can fully detach the U 2A[unit gain buffer]. It is time to go home.

<u>Date: October 27, 2012 (11:30- 18:30)</u>

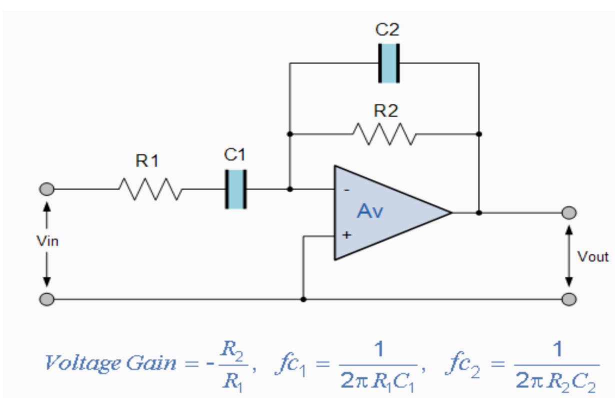
[Re: Filter design: band pass filter]

[Purpose]

(1) Simplify the circuit: one op amp (U1A) and a analog filter

(2) Design the analog filter; any frequency components lower than 0.1 Hz or higher than 10 Hz are noises

(3) Avoid saturations during the amplification stage.



C1 and R1 constitutes Low pass filter

C2 and R2 constitutes High pass filter

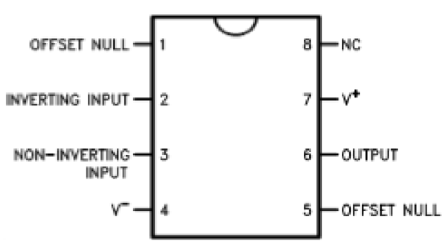
[Math]

C1 and C2: 47 μF

R1: 338.628 Ω

R2: 33.86 KΩ

The AV is LM 741.



[Method]

1. First, only for the test purpose, the Input signal is the pure sinusoidal waveform [not sure the specific value, but much higher than 30 Hz] from function generator (NI PXI-1042Q)
2. Output signal is displayed through oscilloscope (TDS 1001-EDU); it is also capable of displaying both the input signal and the output signal.
3. If this filtering works, when the input with a high frequency component (30-40 Hz] this must be eliminated at the output port via TDS 1001-EDU.

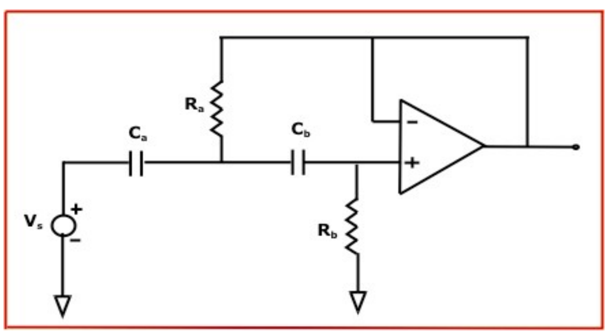
[Output]

1. No change; both in and out port demonstrates same sinusoidal waveforms; filtering did not work at all.
2. Investigated the filter several times, checked wiring issues, tried several tests with new AV, double checked our math method for proper R's and C's values to meet cut-off frequency.
3. Simply very painful!

[Note]

The main purpose this filter design is to eliminate the DC frequency components. So we can replace the U2A (plus Potentiometer 1] with this filter. That will make our circuit much simple than the previous team's product. If the DC frequency is the main target to be eliminated, then why not adopt the high pass filter. Let's build a high frequency filter!!

[Re: High pass filter]



R_a = Filter Resistor
R_b = Filter Resistor
C_a = Filter Capacitor
C_b = Filter Capacitor
($C_a = C_b$)

The high pass filter is a simple RC circuit, comprising of one capacitor (47 micro F) and two resistors (500 k ohms, and 250 k ohms) with one differential amplifier (LM 741). The cut-off frequency is set up 0.01 Hz.

[Output] The filter is feed it with a small signal (combined with both 4 Volt DC component and 33 mV AC components) from the function generator. At the output port, most of DC component is eliminated. Though (TDS 1001-EDU), at its output port, the DC reference is significantly tilted down from 4 V to 0.1 V, so we are able to conclude that the most DC offsetting role is effectively done.

[Note] We spent so much time for building both the band pass filter and high pass filter, having a fine result. It is time to go home.