DATA ACQUISITION TECHNIQUES
PROJECT REPORT

NAME: SRISHTI CHOPRA
REG. NO.: 20BML0046

PAPER-1

A 1.2V improved operational amplifier for bio-medical applications

ABSTRACT

In this paper, an improved low-power Complementary Metal Oxide Semiconductor (CMOS) programmable operational amplifi er for bio-medical applications is presented. The op-amp includes a rail-to-rail input stage, folded cascode stage with class AB biasing and a constant Gm stage. The op-amp is programmed to operate in low-power mode and low noise mode. Simulation results show that the circuit attains a dc open loop gain of 97.75 dB and Common Mode Rejection Ratio (CMRR) of 112.41 dB under a 22 kΩ and 13.5 pF load. The op-amp is realised in 130 nm CMOS technology using Synopsis tool.

METHODOLOGY

The respiration-monitoring system is fully integrated on chip with the exception of an external capacitor for low-pass fi ltering. The measurement principle is based on bio-electric impedance measurement on the patient’s thorax and allows the measurement of respiration concurrently with an ECG-measurement using two ECG-electrodes. The circuit is also used to detect open-leads by measuring the absolute impedance between leads. If this impedance exceeds a certain threshold, the leads are assumed to be open. The on-chip oscillator generates two differential 40 kHz sine-signals, which are applied to the body-electrodes through additional impedances forming a voltage divider. The applied carrier-signal is modulated by a change of body impedance owing to breathing of the patient.

RESULT OBTAINED

A 130 nm programmable CMOS operational amplifier with cascode current mirror has been proposed. The op-amp proposed consumes very less power, offers less noise and it amplifi es the weak cortical input signals to a larger extent. Simulation results prove that the proposed op-amp shows an improvement in gain of about 2.755 dB, CMRR of about 7.41 dB, slew rate of about 3.3815 V/µS and reduction in noise of about 2.685 nV/ Hz compared with that of the existing op-amp. So, the proposed op-amp can be used as a preamplifier in bio-medical applications

PAPER 2:

A LOW POWER FULLY INTEGRATED BANDPASS OPERATIONAL AMPLIFIER FOR BIOMEDICAL NEURAL RECORDING APPLICATIONS

ABSTRACT:

This paper presents a low power fully integrated bandpass amplifier for a variety of biomedical neural recording applications. A standard two-stage CMOS amplifier in a closed-loop resistive feedback configuration provides stable AC gain of 39.5 dB at 1 kHz. A PMOS input transistor, biased near the sub-threshold region acting as a high value resistor in the range of hundreds of mega ohms, is utilized to clamp the large and random DC open circuit potential that normally exists at the electrode-electrolyte interface. The 3 dB bandwidth of the amplifier is measured to be 26 Hz - 6.5 kHz and the tolerable DC input range is measured to be at least 1 V. The amplifier measures 0.107 mm2 in die area and dissipates 133 pW from a 3 V power supply. It is fabricated in MOSS AMI 1.5 pm double poly double metal n-well CMOS process. Bench tests show complete functionality of the amplifier in both light and dark conditions and for a wide range of recording electrode capacitance.

METHODOLOGY:

A standard two-stage CMOS operational amplifier is utilized in a closed-loop resistive feedback configuration to provide stable AC gain of 39.5 dB set by the resistors' ratio (R?/RI). At the non-inverting input terminal, a PMOS transistor, M,, is biased in the sub-threshold region to act as a high value resistor in the range of hundreds of mega ohms. This resistor together with the recording probe capacitance, C,, creates a low cut-off frequency below 50 Hz. Resistor R, is laser programmable so that the PMOS transistor can be always biased in the sub-threshold region even in the presence of f15% variations in process parameters. No control voltage is applied externally. A two-dimensional common-centroid layout is chosen for the differential input stage to maintain a low input offset voltage. Compensation capacitor C, is about 4 pF and is present in the circuit layout.

RESULTS OBTAINED:

The amplifier proved to be equally functional with higher values of C, up to 1.5 nF. In addition, because the channel resistance is inversely proportional to carrier mobility in silicon, the PMOS transistor in this work can theoretically provide a higher resistance compared to its NMOS counterpart.

PAPER: 3

An Improved Dynamic-Biased CMOS Operational Amplifier for Biomedical Circuit Applications

ABSTRACT:

An improved dynamic-biased CMOS operational amplifier for biomedical circuits is presented in this paper. The proposed ultra-low power operational amplifier comprises a weak-inversion biased differential input stage, a pseudo classAB output stage and a multi-phase master bias dynamic biasing circuit. Using GLOBALFOUNDRIES 0.18 µm CMOS process, the proposed amplifier, without dyamic biasing circuit, consumes a static supply current of 5.94 µA at a 1.8V supply. The simulated result shows a DC gain of 89.63dB and an unity gain bandwidth of 2.55 MHz at a capacitive load of 30.5 pF. When activating the proposed dynamic biasing circuit to the same amplifier in a reported sample-and-hold (S/H) circuit for biomedical application, the S/H circuit consumes 8.16 µW at a sampling frequency of 128 kHz. In response to 1-Vpp and 1-kHz sinusoidal input, the S/H circuit has achieved -76.67 dB of total harmonic distortion (equivalent to 12.73 bits of linearity-based ENOB) and 5.21×10-3 µA/MHz of Figure of Merit .

RESULTS OBTAINED:

The op-amp and its respective S/H circuit is realized using GLOBALFOUNDRIES 0.18 ʒm CMOS process technology. It is simulated using Cadence Spectre and BSIM3 models. All the circuits are designed to work with a supply voltage of 1.8 V. For S/H circuits, the dynamic performance parameters are verified using an input of 1-Vpp and 1-kHz sinusoidal input at 128 kHz of sampling frequency.

The proposed master bias dynamic biasing op-amp offers reduced power consumption and sustains low-distortion characteristic with respect to the continuous-time counterpart. It achieves the best FOM value when compared to the same S/H circuits using op-amp with either static biasing technique or the current source dynamic biasing technique. The improved dynamic biasing op-amp will be useful for ultralow power biomedical circuit applications.

PAPER:4

An Ultra Low Power Low noise Operational Transconductance Amplifier for Biomedical Front-end Applications

ABSTRACT:

This work represents a novel low noise amplifier, designed for biomedical front-end applications. The proposed circuit is designed using 180 nm CMOS technology. The simulation results exhibit very good performance showing a gain of 57.9 dB and unity gain bandwidth of 330 KHz. The proposed design shows enhanced phase margin of 84 degree due to its sub-threshold region of operation for the devices. The circuit performs under the supply voltage of 1.8 V and consumes only 400 nW of DC Power. The input-referred noise voltage of the designed circuit is obtained V Hzμas 0.6 at 5 KHz, which makes it suitable for biomedical applications. Also, the CMRR of the designed circuit is obtained as 82.6 dB.

RESULTS OBTAINED:

The designed circuit is simulated using 180 nm CMOS technology at 1.8V supply voltage. The designed circuit has been simulated in cadence environment. In this work an ultra low power, low nose operational transconductance amplifier have been designed which can be used for any biomedical front-end applications. The proposed circuit consumes only 400nW of DC power while working at a supply voltage of 1.8V. Due to sub-threshold operation of the devices the phase margin of the designed circuit is obtained as 84 degree. The noise contribution for the proposed circuit is measured as V Hzμ0.6 at 5 KHz. A two stage cascode configuration has been used in the design to improve the gain of OTA. The gain the OTA is achieved as 57.9 dB. The maximum CMRR of the designed OTA is obtained as 82.6 dB. So it can be concluded that the proposed ultra low power OTA shows good performance for all the specifications taken into consideration.

PAPER: 5

Design of Low Noise Low Power Two Stage CMOS Operational Amplifier Using Equivalent Transistor Replacement Technique for Health Monitoring Applications

ABSTRACT:

The recent interest of mankind on various personal and real time health monitoring system has accelerated the demand for more efficient and advanced biomedical devices. Physiological signals are comparatively weaker in magnitude (few µV to few mV) and also exhibit lower frequencies. Therefore a low power, low input-referred noise analog front end circuitry is to be designed for filtering and amplifying the biopotential signals before digitizing it. A design methodology using the Equivalent Transistor Replacement Technique (ETRT) for low power and low noise Two Stage Operational Amplifier is the front end circuitry of Biopotential Signal Acquisition System. For providing high output swing a Common Source stage is connected at the output and for the reduction of the input– referred noise a differential PMOS input stage is used. The designed circuit of Op-Amp gives a gain of 61 dB, power consumption 60µw, input-referred noise 37nV/sqHz and bandwidth 20.1 KHz for the 60µA external bias current

RESULTS OBTAINED:

This paper presents a design approach for Low Noise and Low power operational amplifier providing the rail-to-rail output swing. The design approach has also been implemented. The design procedure along with the calculation of different aspect ratios has been presented. The major requirement of the amplifier designed for biopotential applications has to be designed with a low noise and our design suggests an output-referred noise of 9nV/sqHz which is quite low. The designed amplifier has a phase margin of 80˚ which indicates that the designed circuit is stable.

PAPER: 6

Integrated Trans-impedance Amplifiers Dedicated to Low-Noise and Low-Power Biomedical Applications

ABSTRACT:

This paper addresses the application of trans-impedance amplifier (TIA) front-ends in biomedical imaging. Different topologies are studied and characterized, and then the most appropriate structures are introduced. Three new TIA front-ends are proposed and implemented using standard submicron CMOS technology. The implemented TIA front-ends offer high gain-bandwidth product (GBW), low-power consumption.

RESULTS OBTAINED:

The main challenges to design an efficient TIA for biomedical imaging applications are addressed in this paper following by introducing 3 new miniaturized, reconfigurable and low-noise photodetector front-ends implemented onchip using standard CMOS technology. The implemented TIA front-ends offer high GBW, low power consumption, high-transimpedance gain, tunable bandwidth and very low input and output noise. These characteristics make them a proper candidate to be applied for detection of ultra-low intensity bio-signals such as in fNIRS and EEG and will drive a great expansion in their application for low-power and low-noise wireless biomedical imaging applications

PAPER: 7

Performance Analysis of CNTFET Based Low Power Operational Amplifier in Analog Circuits for Biomedical Applications

ABSTRACT:

VLSI technology is being adopted widely nowadays for biomedical applications to improve healthcare diagnosis, monitoring and cure. Analog devices such as A/D converters for biomedical applications can be of modest precision but need to be very energy efficient in order to operate for decades. CNTFET can be the future alternative to be used in various high performance, low power devices. In this paper we have presented a low power CNTFET based two stage Op-Amp for biomedical A/D converters. A sample and hold circuit is also implemented using CNTFET based Op-Amp to be used in biomedical ADCs. Simulation results of CNTET based circuits are compared with MOSFET circuits. Results indicate improvement of power consumption up to 80%. The proposed circuit simulations are carried out in HSPICE. It is concluded that CNTFET based circuits can be prime choice for low power applications.

RESULTS OBTAINED:

In this paper we learnt CNTFET based low power Op-Amp and Sample and hold circuits. Simulations are carried out using HSPICE software [11]. Performance parameters of CNTFET based Op-Amp circuit obtained are shown in table II. A comparative analysis of power consumption of CNTFET and MOSFET based analog circuits is done as shown in table IV and the comparison of various performance parameters of CNTFET Based Op-Amp circuit with MOSFET based Op-Amp circuit. It is analyzed that CNTFET based circuits are less power consuming and have better performance. By using CNTFET power of the proposed Op-Amp is reduced upto 80.8% and power of sample and hold circuit is reduced upto 71.14%. It is also concluded that CNTFET technology is very much suitable for analog circuit designs. Future work for this concept could be in the exploration of various ADC architectures for biomedical applications. CNTFET based circuits presented in this work could be employed with A/D converters for biomedical application.

PAPER: 8

A Compact Nano-power Low Output Impedance CMOS Operational Amplifier for Wireless Intraocular Pressure Recordings

ABSTRACT:

Wireless sensing has shown potential benefits for the continuous-time measurement of physiological data. One such application is the recording of intraocular pressure (IOP) for patients with glaucoma. Ultra-low-power circuits facilitate the use of inductively-coupled power for implantable wireless systems. Compact circuit size is also desirable for implantable systems. As a first step towards the realization of such circuits, we have designed a compact, ultra-low-power operational amplifier which can be used to record IOP. This paper presents the measured results of a CMOS operational amplifier that can be incorporated with a wireless IOP monitoring system or other low-power application. It has a power consumption of 736 nW, chip area of 0.023 mm2 , and output impedance of 69 Ω to drive low-impedance loads.

RESULTS OBTAINED:

Low-power and minimal sized implantable electronics are desired for wireless sensing of IOP due to inherent issues associated with inductive power supplies and implantation area, respectively. We have designed and fabricated a CMOS operational amplifier that could be used within such systems as it consumes only 736 nW of power and requires only 0.023 mm2 of area. Additionally, the amplifier has a low output impedance of 69 Ω which is useful for driving low-impedance loads. Although IOP recordings have been targeted, this research has potential use in other applications that require ultra-low-power consumption and minimal device area. In the future, we plan on continuing the development of lowpower circuits that can be used to continuously record IOP signals in vivo.

PAPER: 9

Design of Low-Power Low-Voltage Biomedical Amplifier for Electrocardiogram Signal Recording

ABSTRACT:

The demand for health-monitoring products is increasing worldwide. Low-power and low-voltage attributes are important concerns that need to be addressed in circuits used for personal health-monitoring applications, to achieve a long battery life. In this paper, a biomedical amplifier is designed for electrocardiogram (ECG) signal detection. The design comprises of a high pass filter (HPF), an operational transconductance amplifier (OTA), two dB-linear variable gain amplifiers, three low pass filters (LPF), and an operational transresistance amplifier (ORA). In particular, the VGA and the LPF uses the log companding technique. The bio-amplifier consumes less than 20 µW of power from a 1 V single supply. The circuit is implemented in 0.18µm CMOS technology

METHODOLOGY:

The architecture of the bio-amplifier is shown in below. It consists of several building blocks: a high pass filter (HPF), an operational transconductance amplifier (OTA), three low pass filters (LPF), two dB-linear variable gain amplifiers (VGA), and an operational transresistance amplifier (ORA). The bio-amplifier is able to achieve a variable gain from 40 dB to 80 dB with dB-linear characteristic, and bandwidth from 0.5 Hz to 500 Hz. Power consumption is also within a few tens of microwatt.

PAPER: 10

An Ultra-Compact and Efficient Li-ion Battery Charger Circuit for Biomedical Applications

ABSTRACT:

This paper describes an ultra-compact analog lithium-ion (Li-ion) battery charger for wirelessly powered implantable medical devices. The charger presented here takes advantage of the tanh output current profile of an operational transconductance amplifier (OTA) to smoothly transition between constant current (CC) and constant voltage (CV) charging regimes without the need for additional area- and power-consuming control circuitry. The proposed design eliminates the need for sense resistors in either the charging path or control loop by utilizing a current comparator to detect end-of-charge. The power management chip was fabricated in an AMI 0.5 µm CMOS process, consuming 0.15 mm2 of area. This figure represents an order of magnitude reduction in area from previous designs. An initial proof-of-concept design achieved 75% power efficiency and charging voltage accuracy of 99.8% relative to the target 4.2 V.

RESULTS OBTAINED:

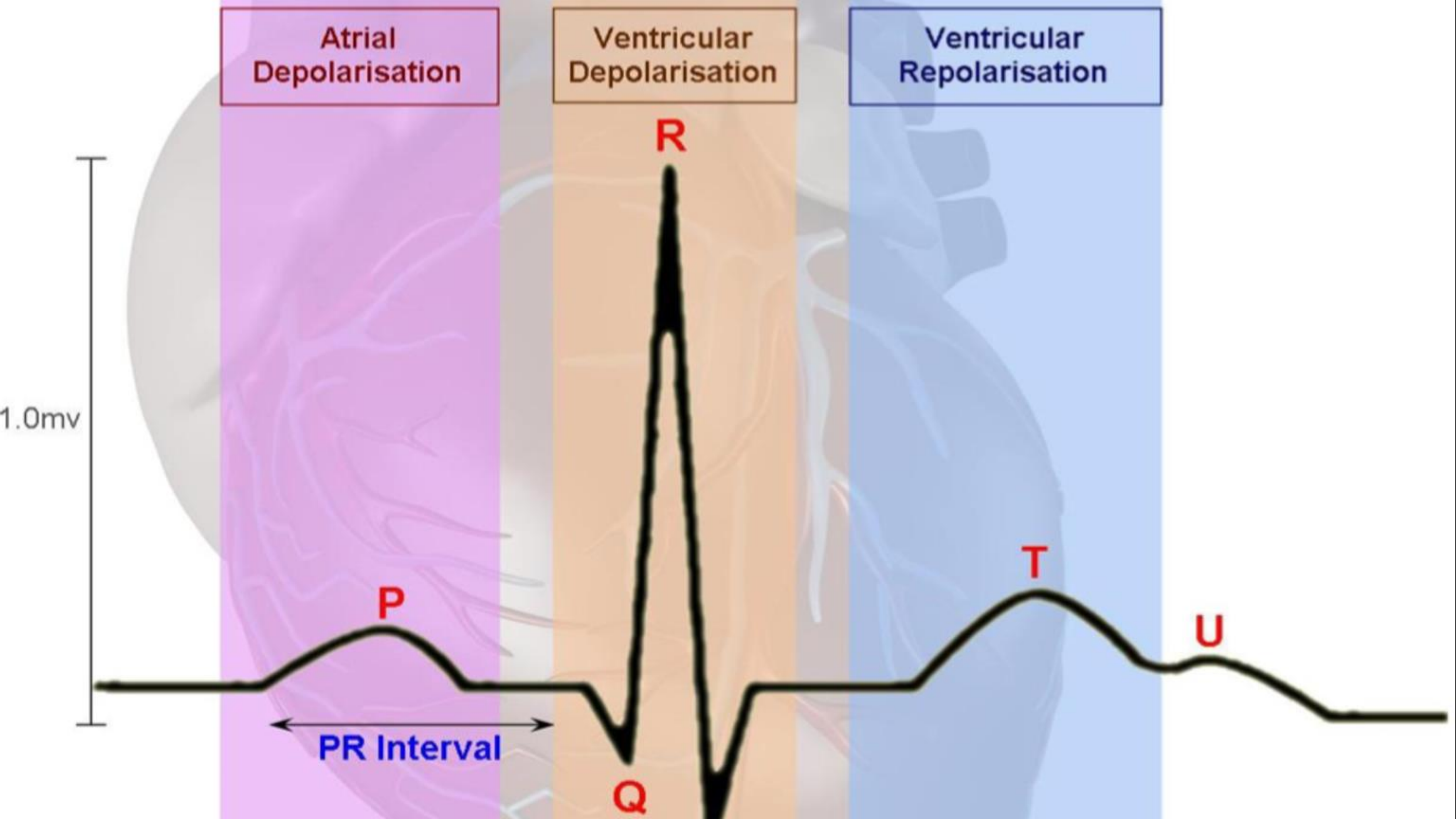
The battery management chip was fabricated in an AMI 0.5 µm CMOS process, consuming 0.15 mm2 of chip area. Fig. 5 shows the die micrograph of the test chip. We obtained a power efficiency of approximately 75% during constant current mode. The limiting factor in efficiency is the fact that the test circuit was designed for a 5 V supply. One can easily design for a lower supply voltage, increasing the overall power efficiency of the system. By simply reducing the supply voltage from 5 V to 4.5 V, the efficiency of this circuit can be increased to approximately 83%. In our chip we were not able to reduce the supply voltage to 4.5 V because of the Wilson current mirrors in the OTA. Nevertheless, if these mirrors are replaced with current mirrors that require less voltage headroom, the supply voltage can be easily reduced to 4.5 V.

OVERVIEW

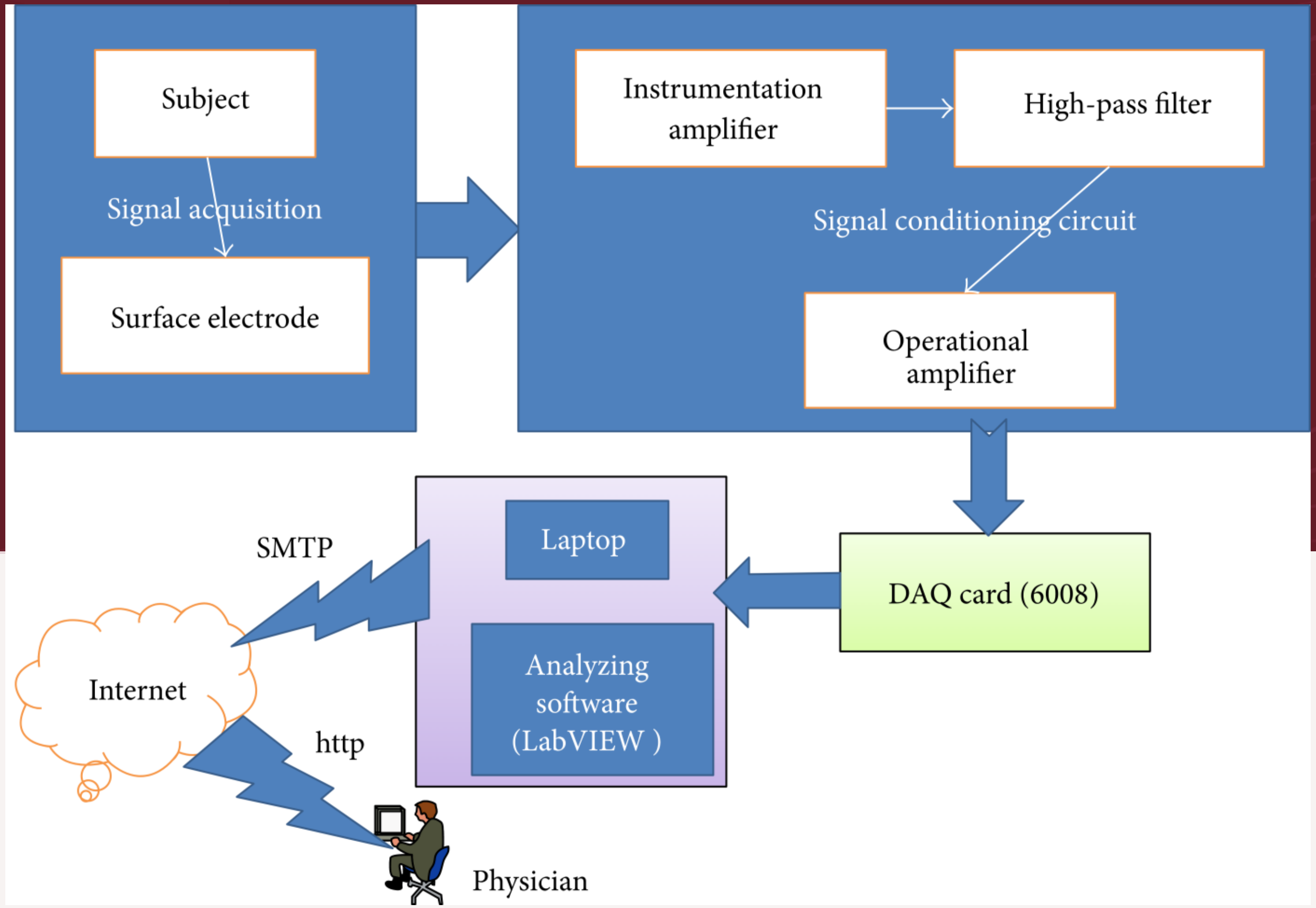
In this project I had collected 5 research papers related to the project title and read them carefully to analyse how the ECG works, its characteristics and limitations and what are the modifications that can be done to improve its accuracy.

After this, I tried to implement the model in the LABVIEW software for virtual implementation.

- ECG is used to measure the rate and regularity of heartbeats, the presence of any damage to the heart, and the effects of drugs or devices used to regulate the heart (such as a pacemaker). Normally, the frequency range of ECG signal is 0.05–100 Hz and its dynamic range is 1–10 mV. The ECG signal as depicted in Figure 1 is characterized by five peaks and valleys labeled by the letters P, Q, R, S, and T. The performance of ECG analyzing system depends mainly on the accurate and reliable detection of the QRS complex, as well as T- and P-waves.



Atrial Depolarisation
Ventricular Depolarisation
Ventricular Repolarisation
R
1.0mv
P
T
U
PR Interval
Q

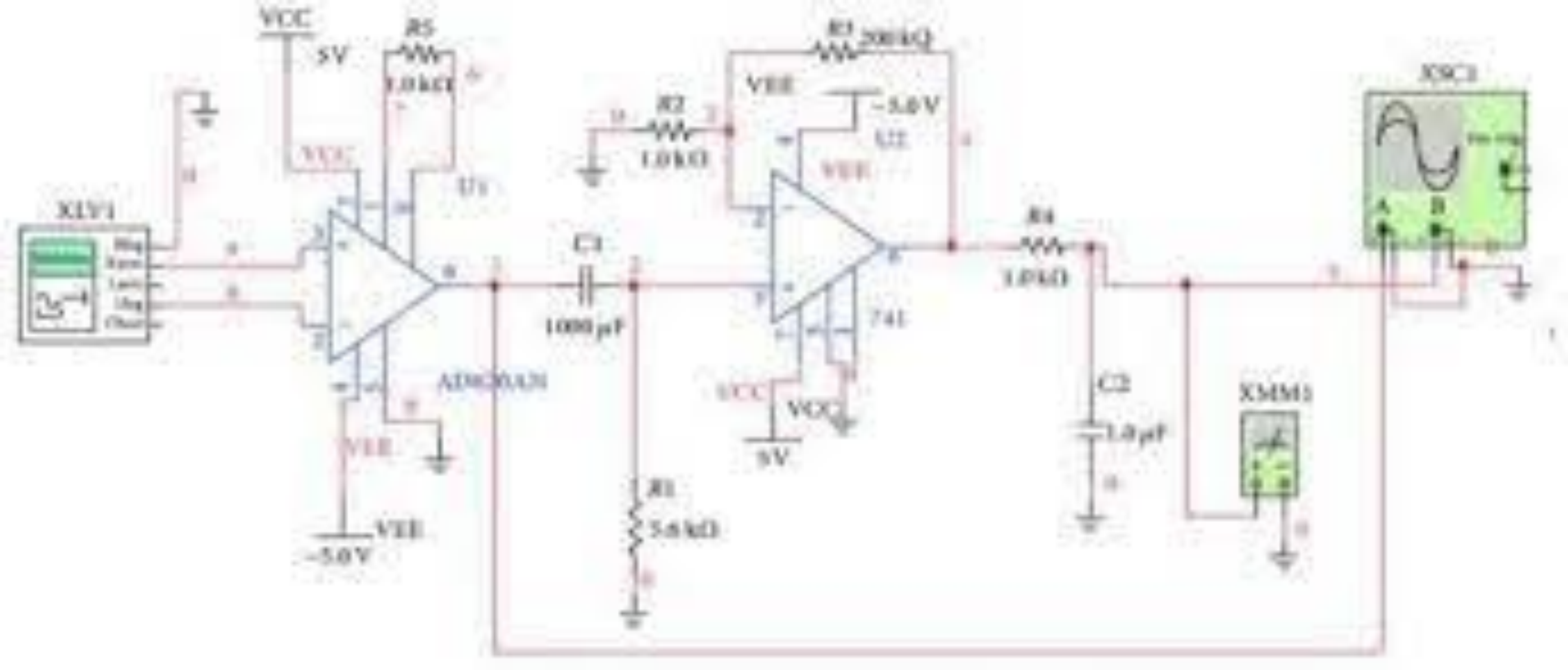


BLOCK DIAGRAM

Design of Op-Amp Based ECG Signal Acquisition Using MULTISIM

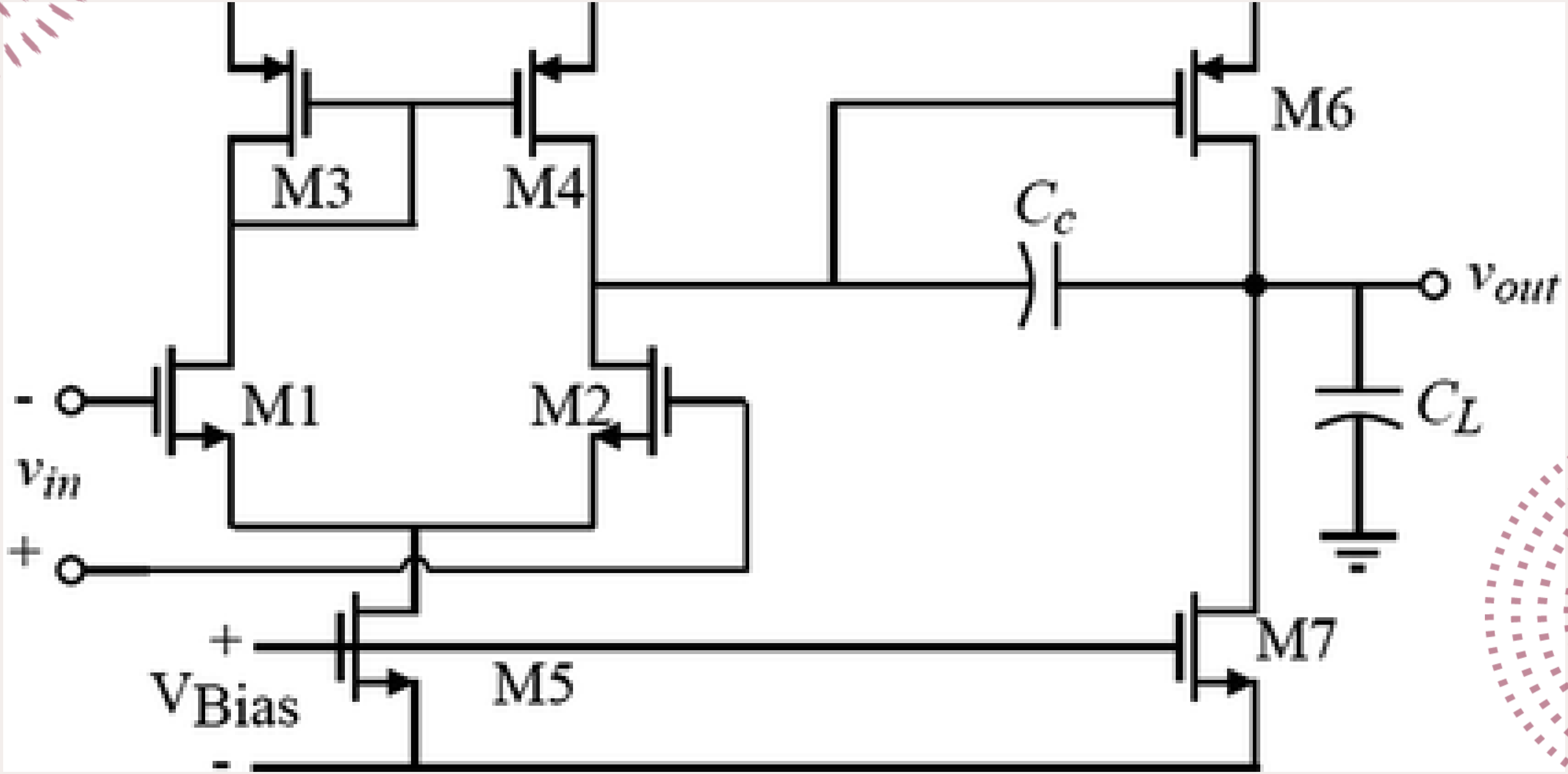
- In this paper the circuit is designed to de-noise the noisy ECG signal from the bioelectrical signal generated by the human body. It tends to be gathered that electrical obstruction is hard to manage on the grounds that, because of its similarity to the ECG signal recurrence, it can't be sifted without harming the ECG complex, so it is smarter to follow away from different gadgets, guaranteeing that link and lead wires don't cross the force links of to her hardware or vent tubing. Try to warm a shuddering patient or make them more loose in a leaned back position, if important, rather than changing a channel climate to limit muscle quake and patient development, and afterward continually check lead wire to anode connection and cathode to-persistent skin grip to guarantee ECG consistency and dodge bogus alerts. It is important to pick an adequate lead that shows the biggest abundancy and cleanest signal so that specifically, a QRS complex and R-wave can be precise by the screen.

- Click to add text



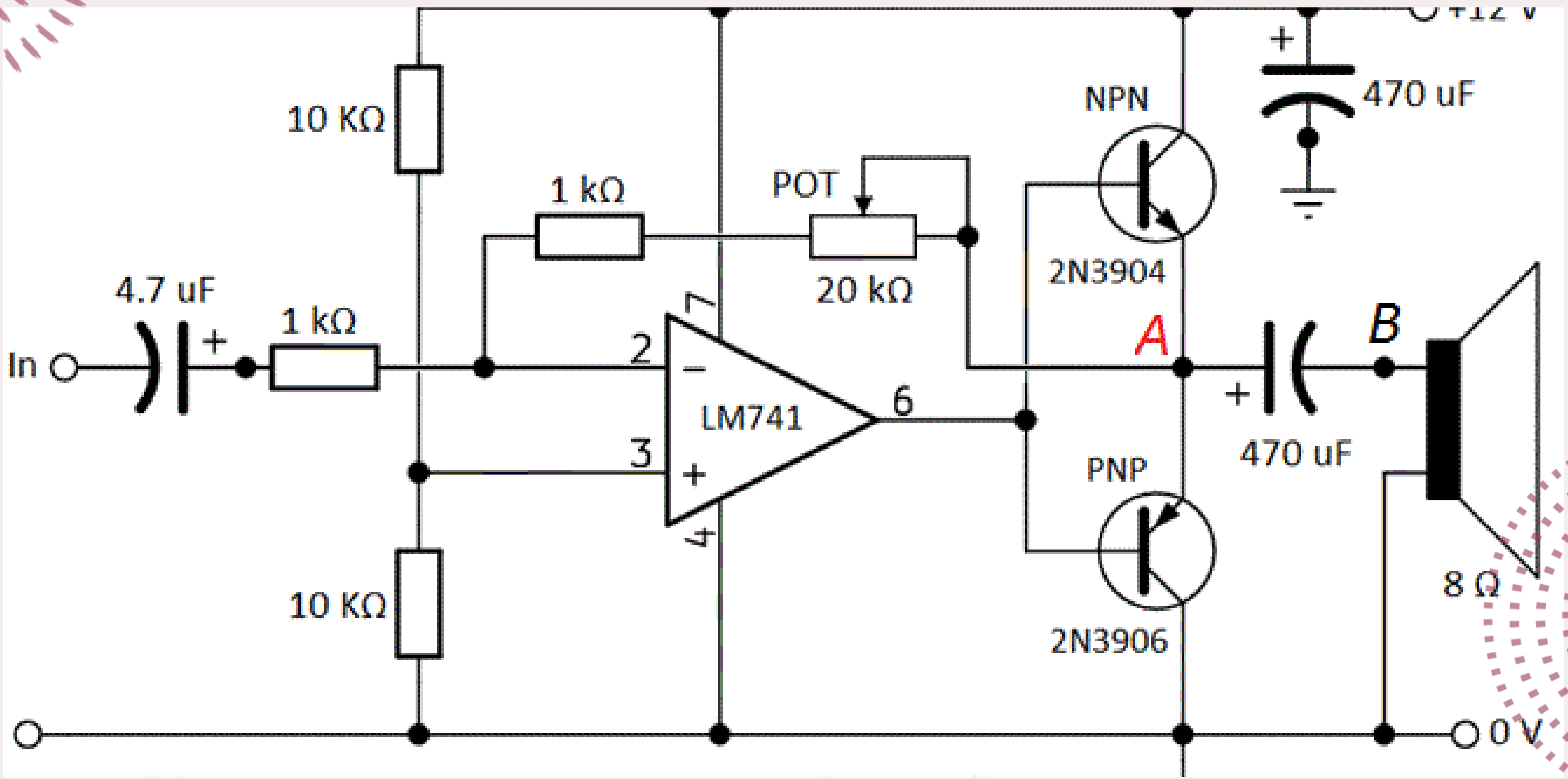
Design of CMOS Two-stage Operational Amplifier for ECG Monitoring System Using 90nm Technology

- This paper presents a high performance Two-stage operational amplifier for biomedical applications. This Two-stage is designed for low noise, low power, high PSRR and high CMRR. The Miller compensation technique (Cc) is used with a nulling active resistance (Rz) implemented using Transmission gate transistors for stable operation in feedback mode. The operational amplifier was manufactured in a SPECTRE using GPDK 0.90-um CMOS technology with threshold voltages of a 0.17 V and - 0.14 V achieve a low power 2.6uW, high CMRR up to 130dB and PSRR up to 70dB at 1V power supply.


M6
M3
M4
C_c
v_{out}
M1
M2
C_L
-
v_{in}
+
+
V_{Bias}
-
M5
M7

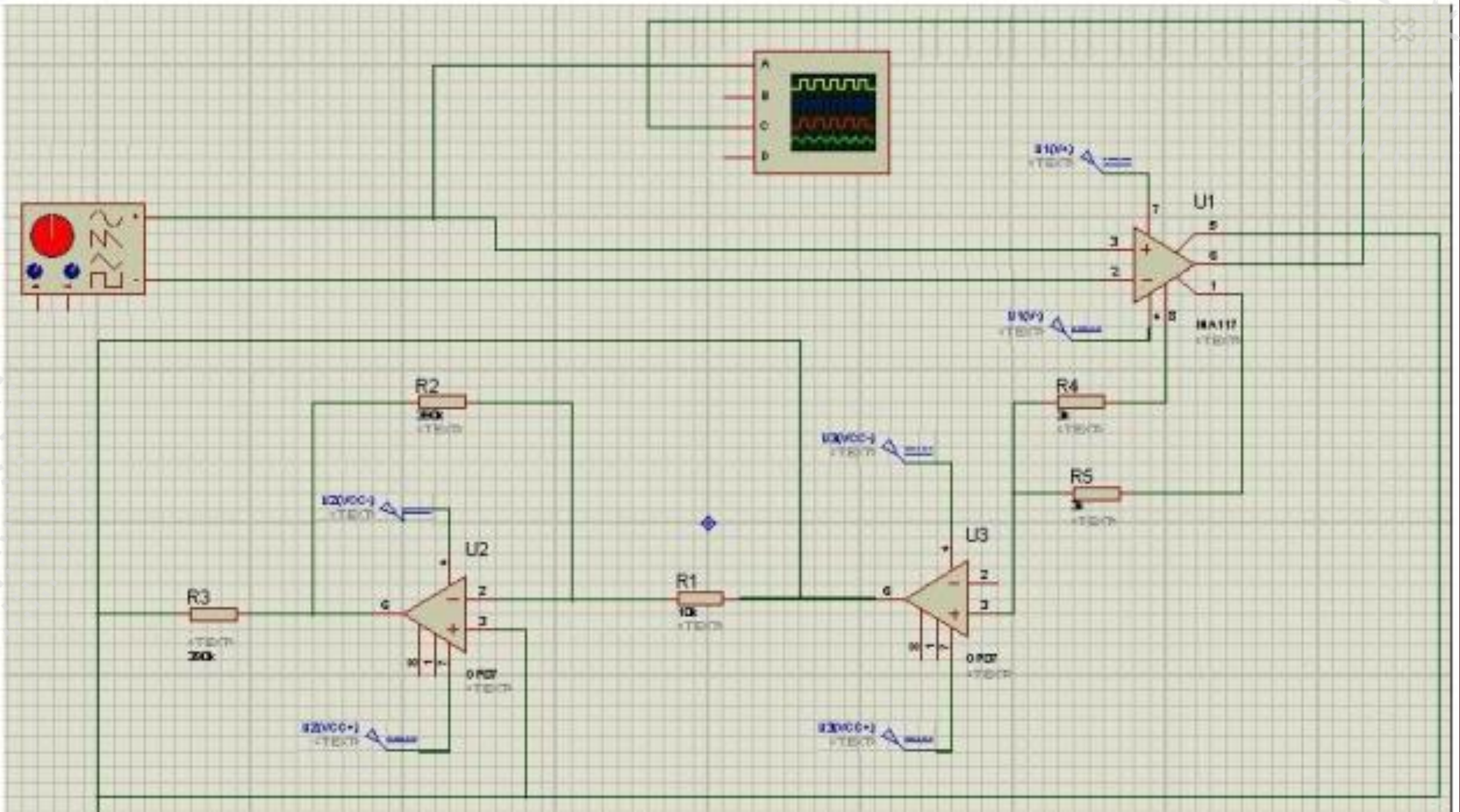
CURRENT-MODE INSTRUMENTATION AMPLIFIERS USING 0.25µM CMOS PROCESS FOR ECG SIGNALS

- All the current-mode in-amp topologies achieve impressively high CMRR. Hence, any of the implemented current-mode circuits is an outstanding differential amplifier and thus, a potential ECG system block. However, the 2-CC with Op-Amp provides the lowest output impedance that is essential for connecting the in-amp into a larger system. It also has the advantage of being able to adjust its output reference voltage, allowing it to handle both negative and positive signals with respect to the reference voltage.


+12 V
10 KΩ
1 kΩ
POT
20 kΩ
NPN
2N3904
470 uF
4.7 uF
1 kΩ
In
2
3
7
4
6
LM741
A
B
470 uF
PNP
2N3906
8 Ω
10 KΩ
0 V

Wireless ECG Monitor Using Labview

- The purpose of this work is to acquire, transmit and display the ECG signal. In this work, it can be divided into two stages. The first stage is how the ECG signal is acquired using electrodes. Electrode is a sensor that is used to collect electrical activity from the heart. Three limb leads, based on Einthoven's Triangle theory will be used in this work. The signal collected by electrode will be amplified using instrumentation amplifier INA118 with the gain amplification, G = 9. After the first amplification, the signal will go through a band pass filter, which allows frequency from 0.5Hz to 150Hz to pass through. The signal is then amplified, using 741 operational amplifier with gain, G = 51 to boost the signal into more readable signal. The total amplification for the first stage was 459. The signal is then send to ADC for wireless transmission via XBee. In the second stage, the USB port or Serial port of the laptop will be configured using LabVIEW software so that the ECG signal can be received. The LabVIEW software was programmed to receive, read, and display the ECG signal received. The ECG signal is successfully transmitted wirelessly via XBee to a laptop without it losing its characteristic (PQRST wave).


A
B
C
D
U1
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R5
10k

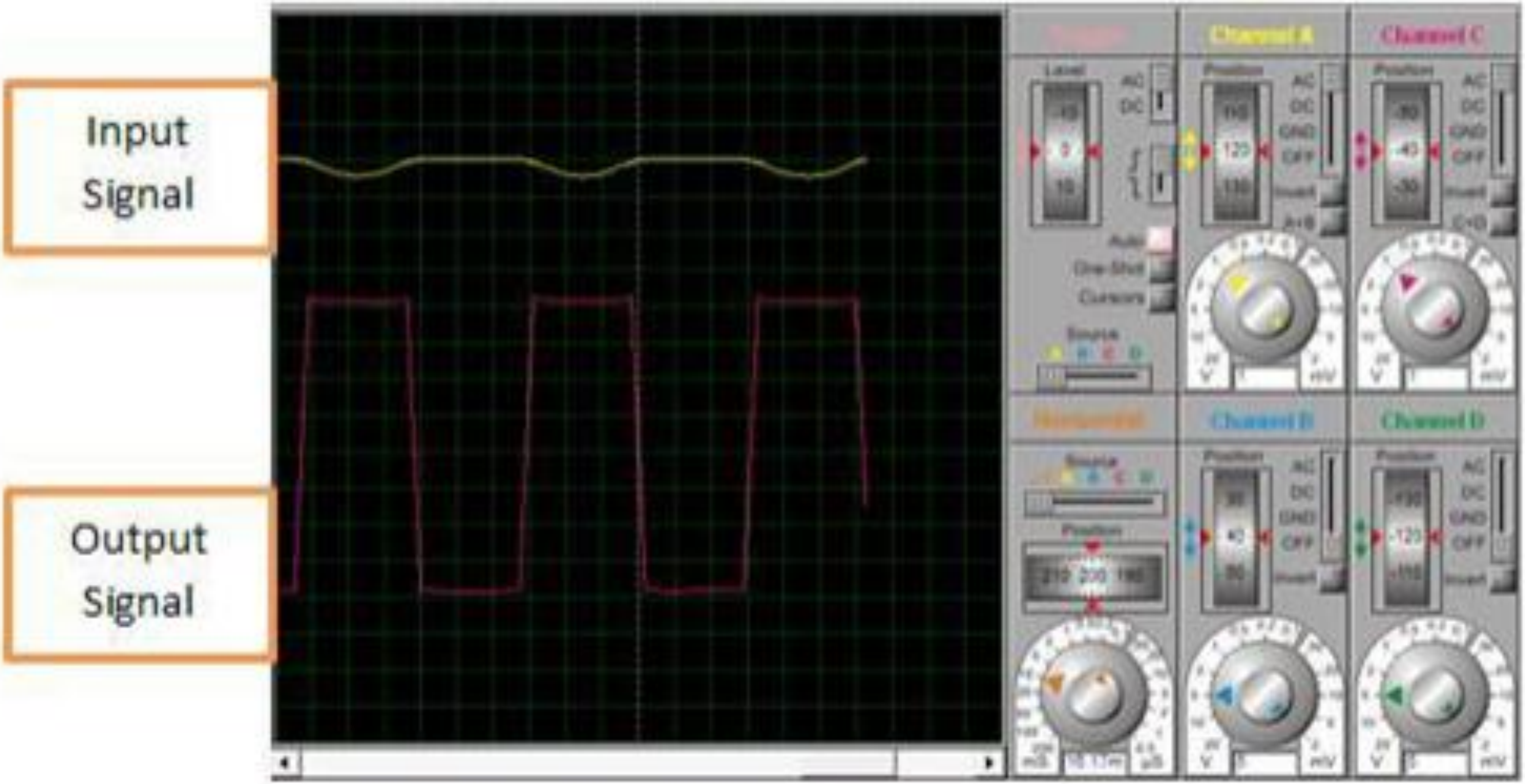
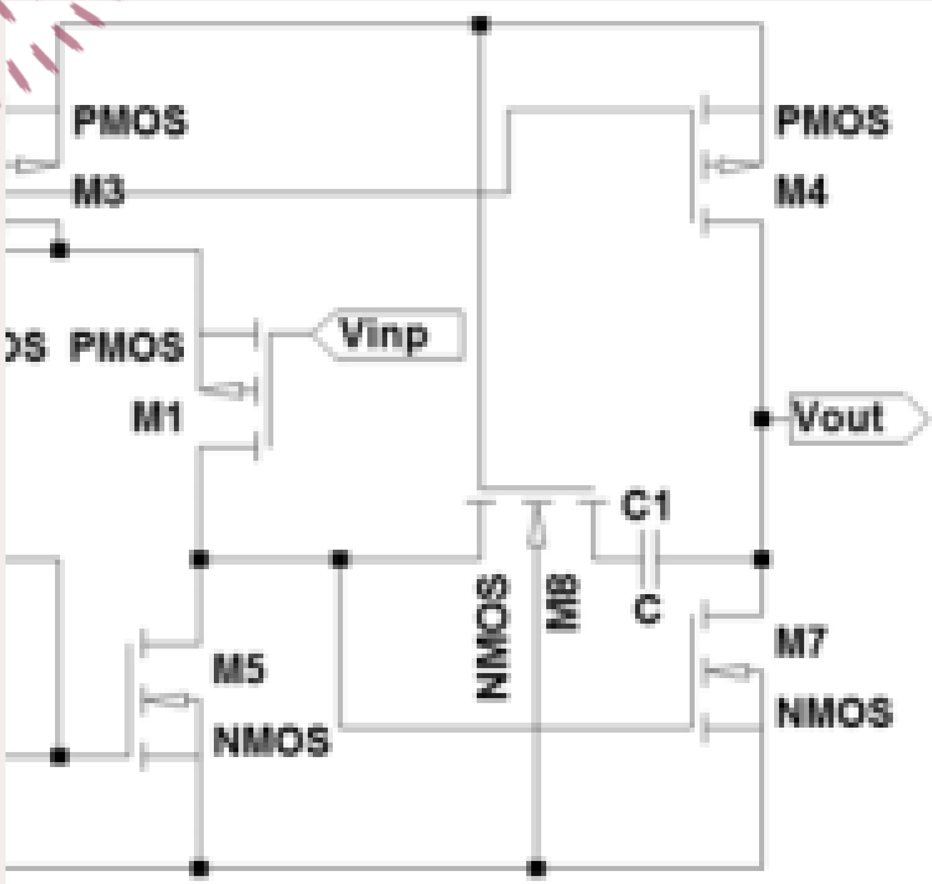
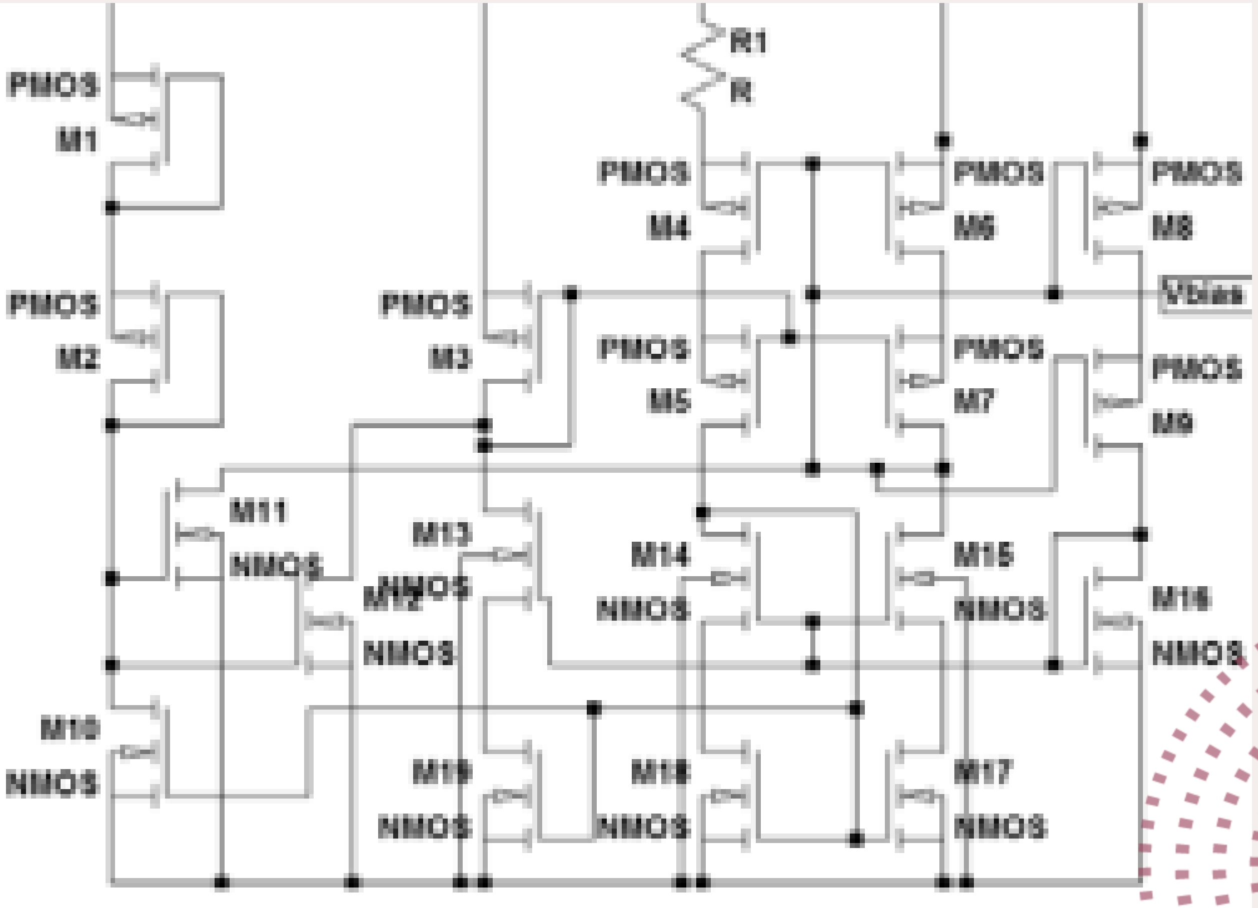


Fig. 3 - The sine wave before and after amplification

Low-Power Instrumentation Amplifier IC Design for ECG System Applications

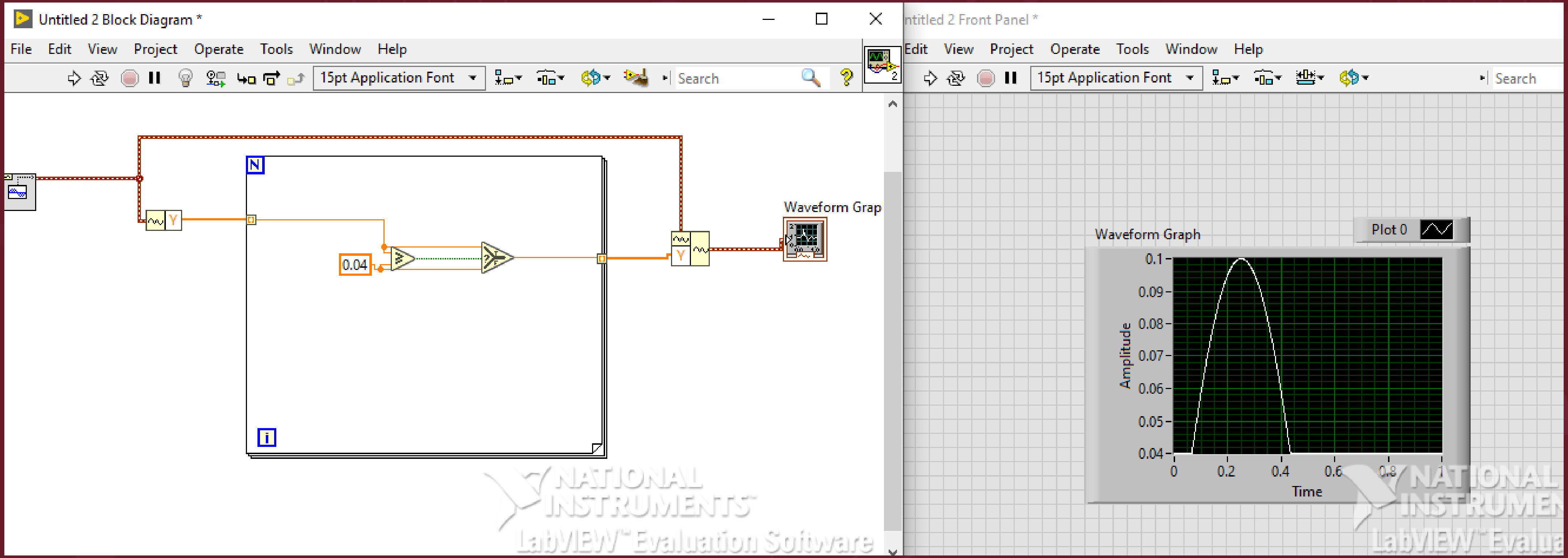
- This paper describes the development of a low-power instrumentation amplifier (IA) intended for use in recording of the human electrocardiogram (ECG). With the wide-swing cascade bias circuit design, the IA realizes a very high power-supply rejection ratio (PSRR), and can be operated at signal supply voltage in the rage between 2.5 and 5.5V. It was fabricated using 0.5um double-poly triple-metal CMOS technology, and occupies a die area of 0.2mm2 .The amplifier provides a gain of 40dB and has high common-mode rejection ration (CMRR) better than 100dB. The IA has a power consumption of 160uW operating from a 3.3V power supply.

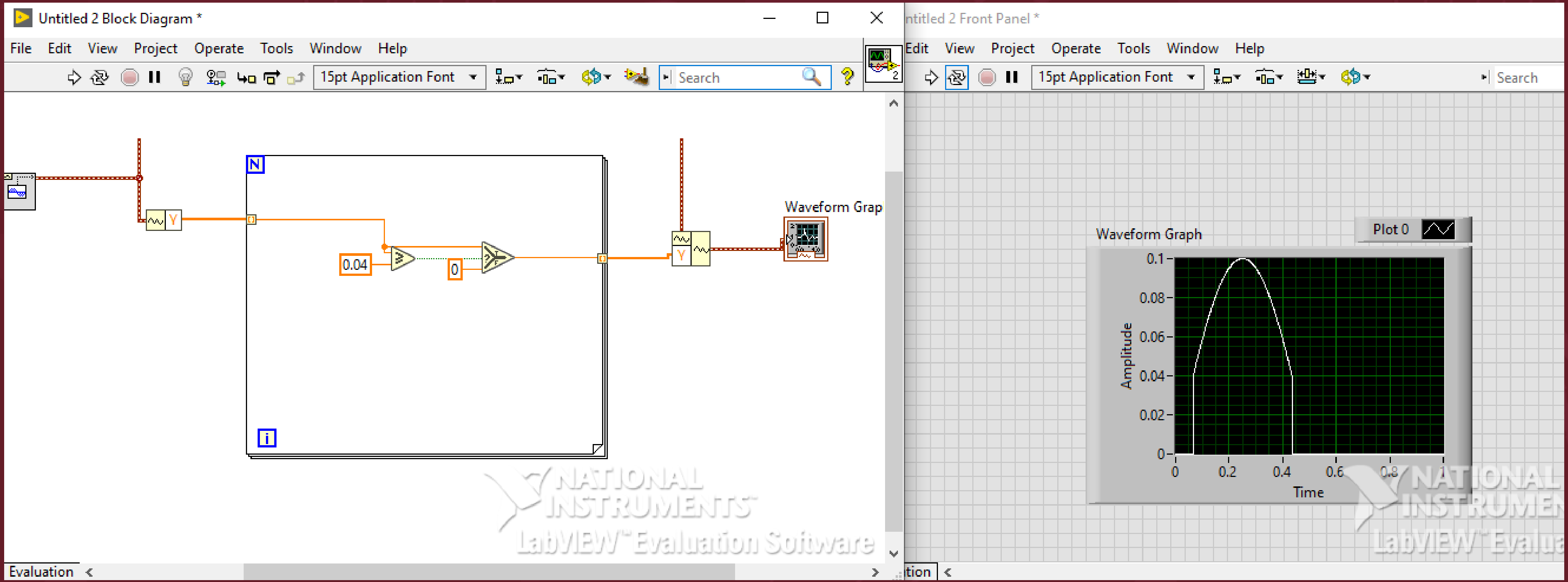




liagram of the two stage op amp circuit; Fig.4 Schematic diagram of the wide-swing cascade bias circuit

LAB-VIEW IMPLEMENTATION





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LabVIEW Evaluation Software
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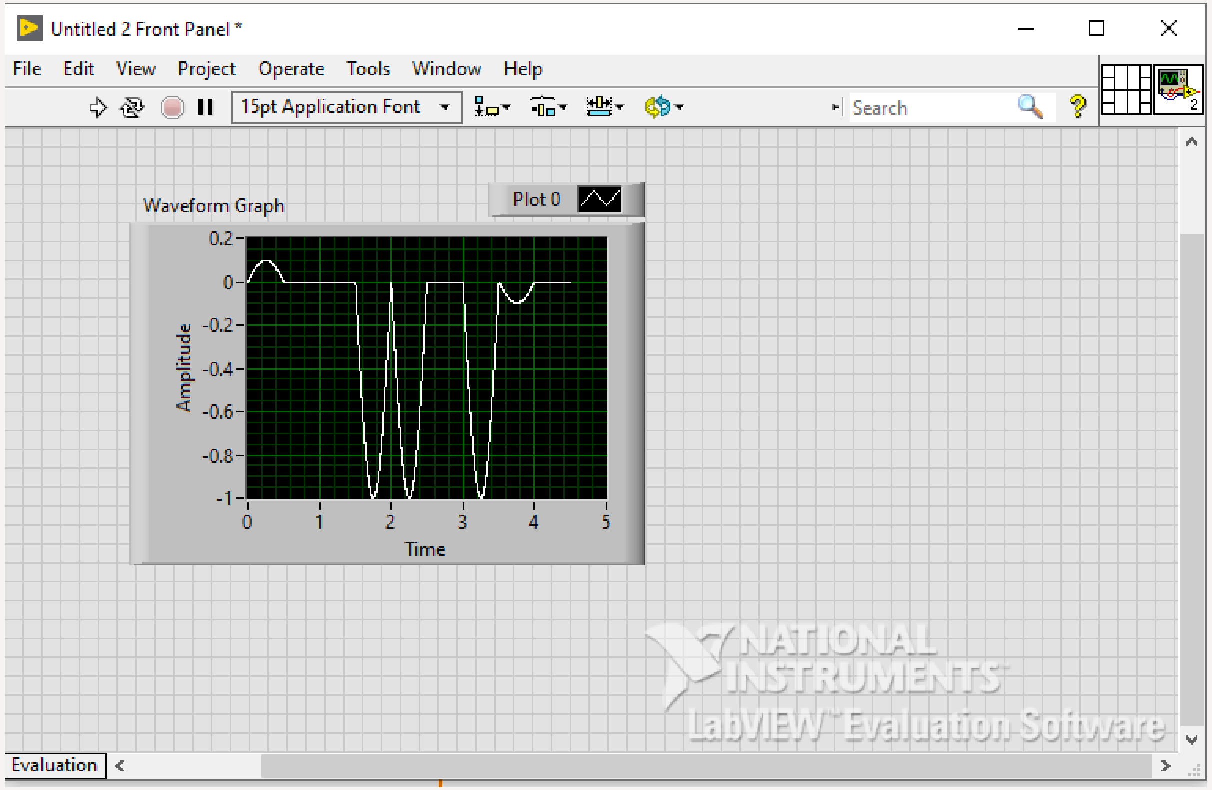
Untitled 2 Front Panel *
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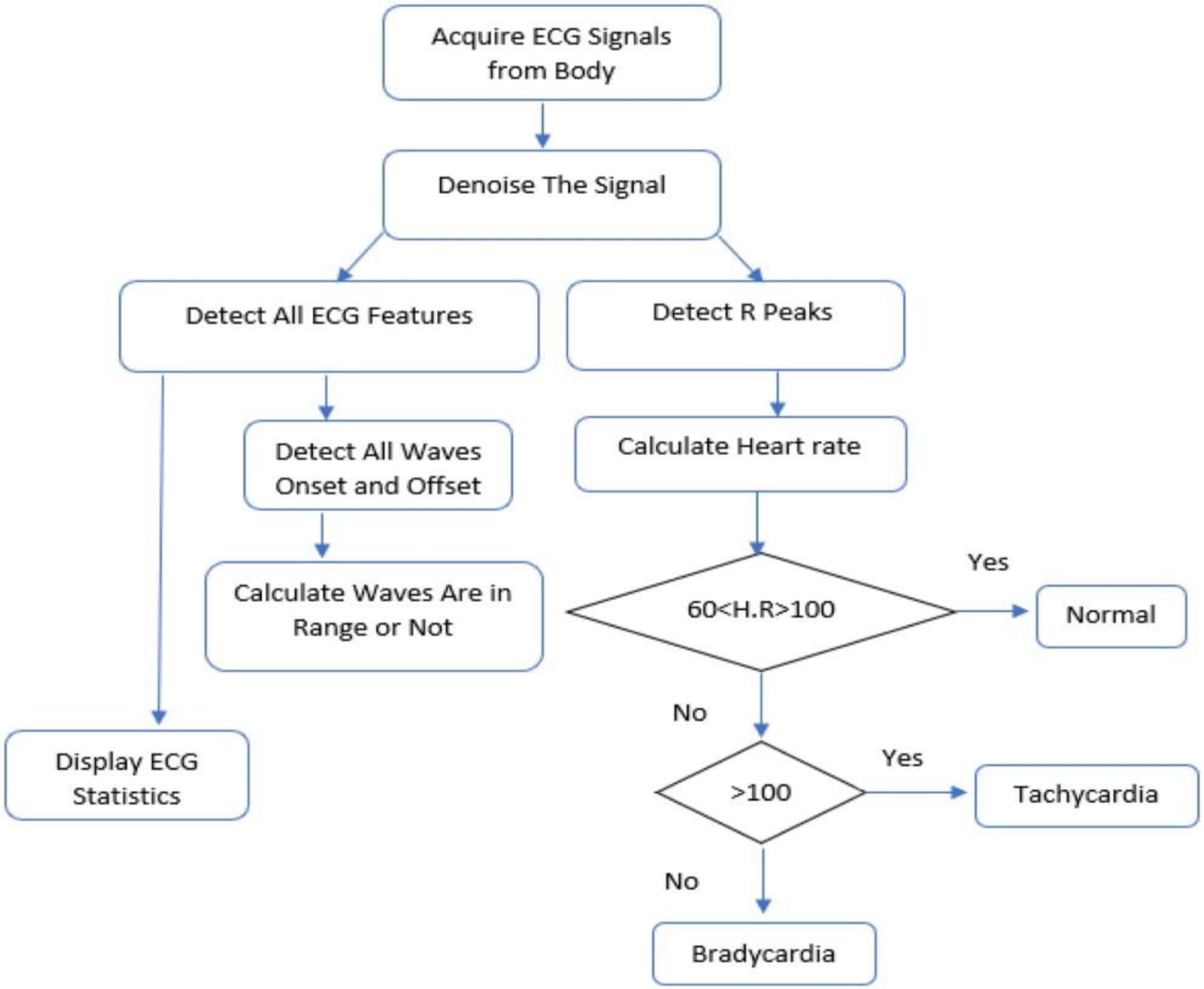
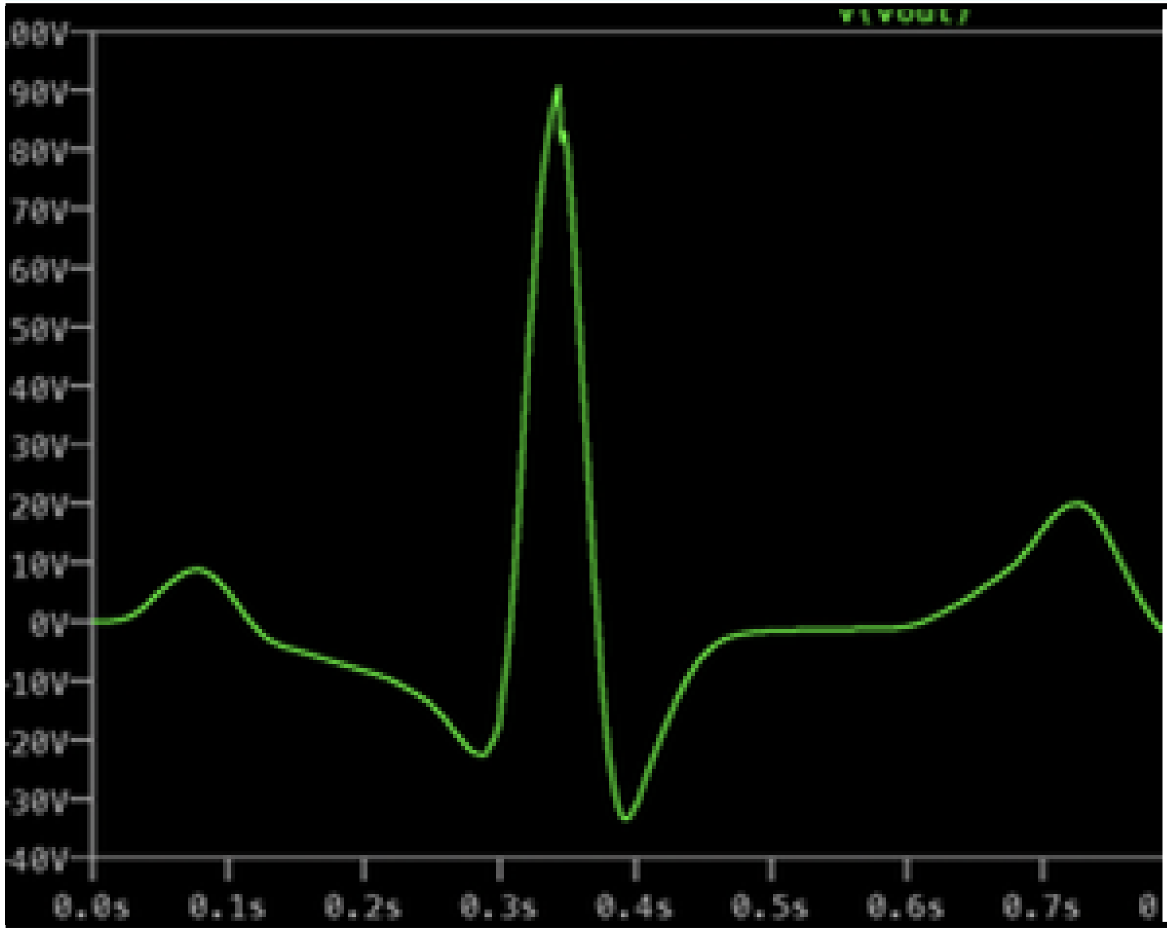
LabVIEW Evaluation Software
Evaluation

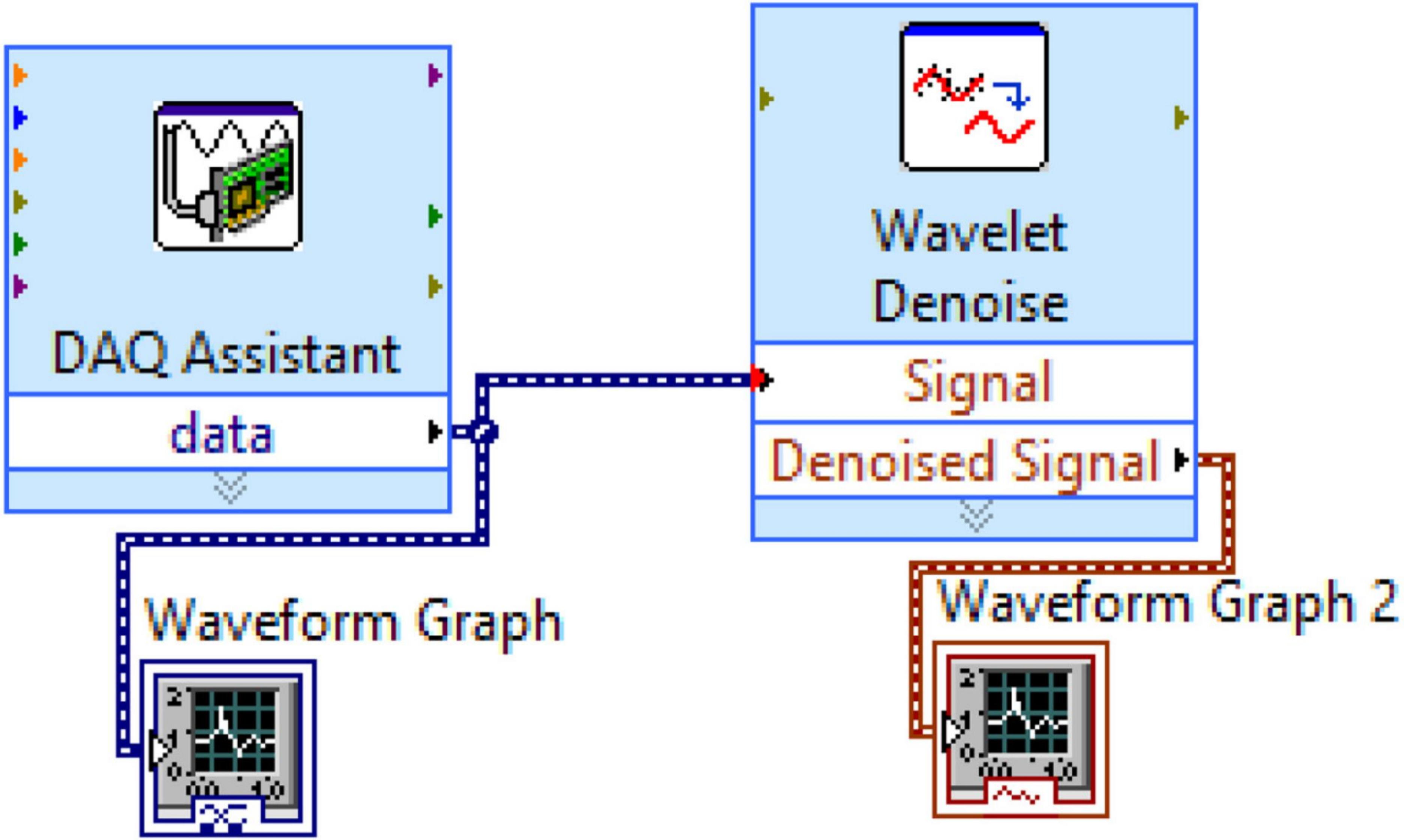
FLOW CHA

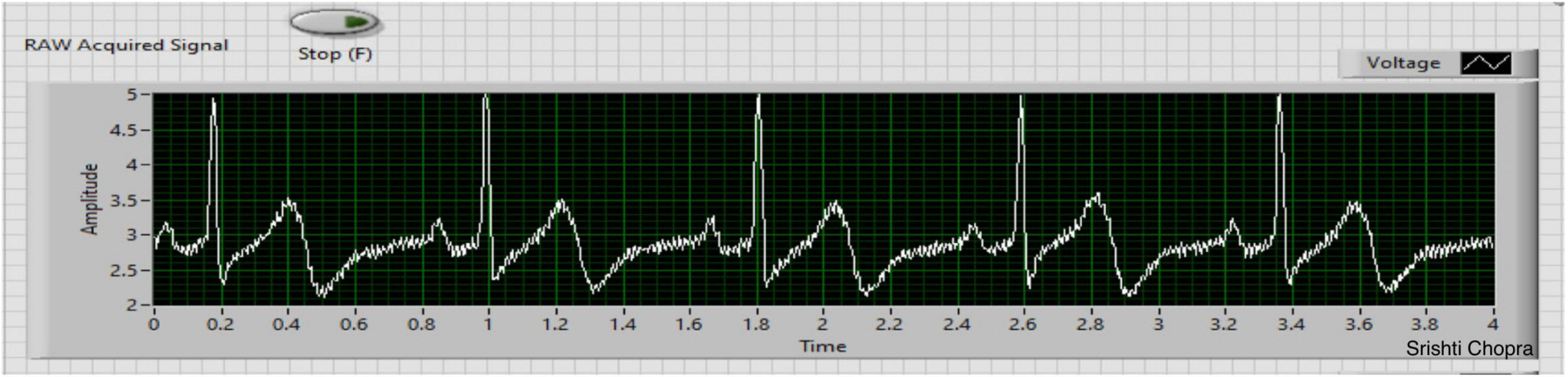

Acquire ECG Signals from Body
Denoise The Signal
Detect All ECG Features
Detect R Peaks
Detect All Waves Onset and Offset
Calculate Heart rate
Calculate Waves Are in Range or Not
60<H.R>100
Yes
Normal
No
Display ECG Statistics
>100
Yes
Tachycardia
No
Bradycardia

ACQUIRING ECG SIGNAL



In the first step, ECG Signals are acquired from the individual’s body with the help of sensors and myDAQ device. The LabVIEW “DAQ Assistant” is used, and it is configured with the myDAQ hardware device to acquire ECG signals. At the time of measurement, the most important point is the sampling rate. The analog to digital and vice versa conversion depends on the determination of the scan rate in the myDAQ device. Herein, the frequency-rate is taken as 250 Hz, and there are 1000 samples to read. The maximum and minimum range of input signal is set to +5 V and -5 V, respectively. In the timing setting of the acquisition, the mode was opted as continuous samples. After selecting all these parameters in the DAQ assistant, the raw ECG signal acquisition from the body commences.


DAQ Assistant
data
Wavelet
Denoise
Signal
Denoised Signal
Waveform Graph
Waveform Graph 2


RAW Acquired Signal
Stop (F)
Voltage
Amplitude
5
4.5
4
3.5
3
2.5
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0
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0.6
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1
1.2
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1.6
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3.2
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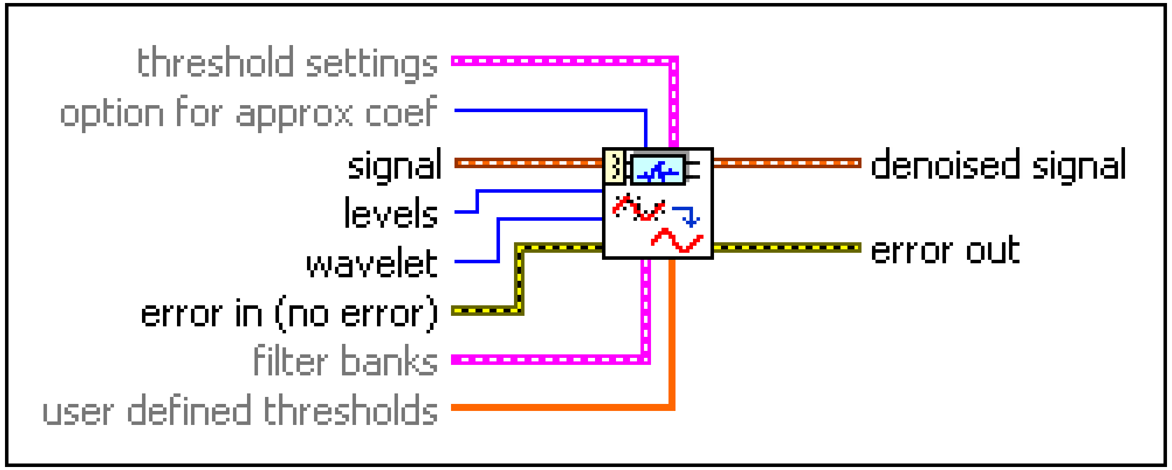
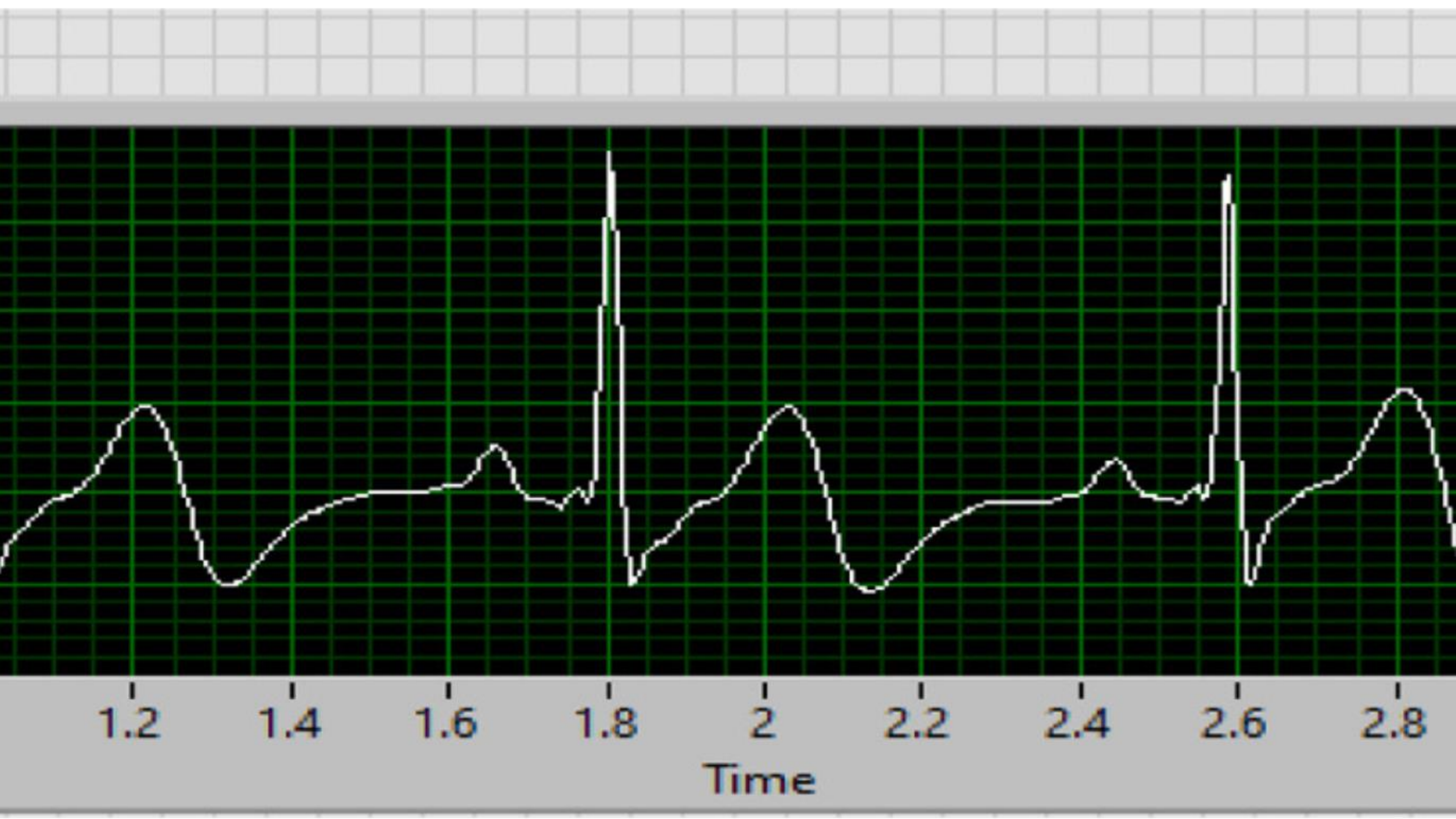
3.6
3.8
4
Time
Srishti Chopra

DENOISING ECG SIGNAL

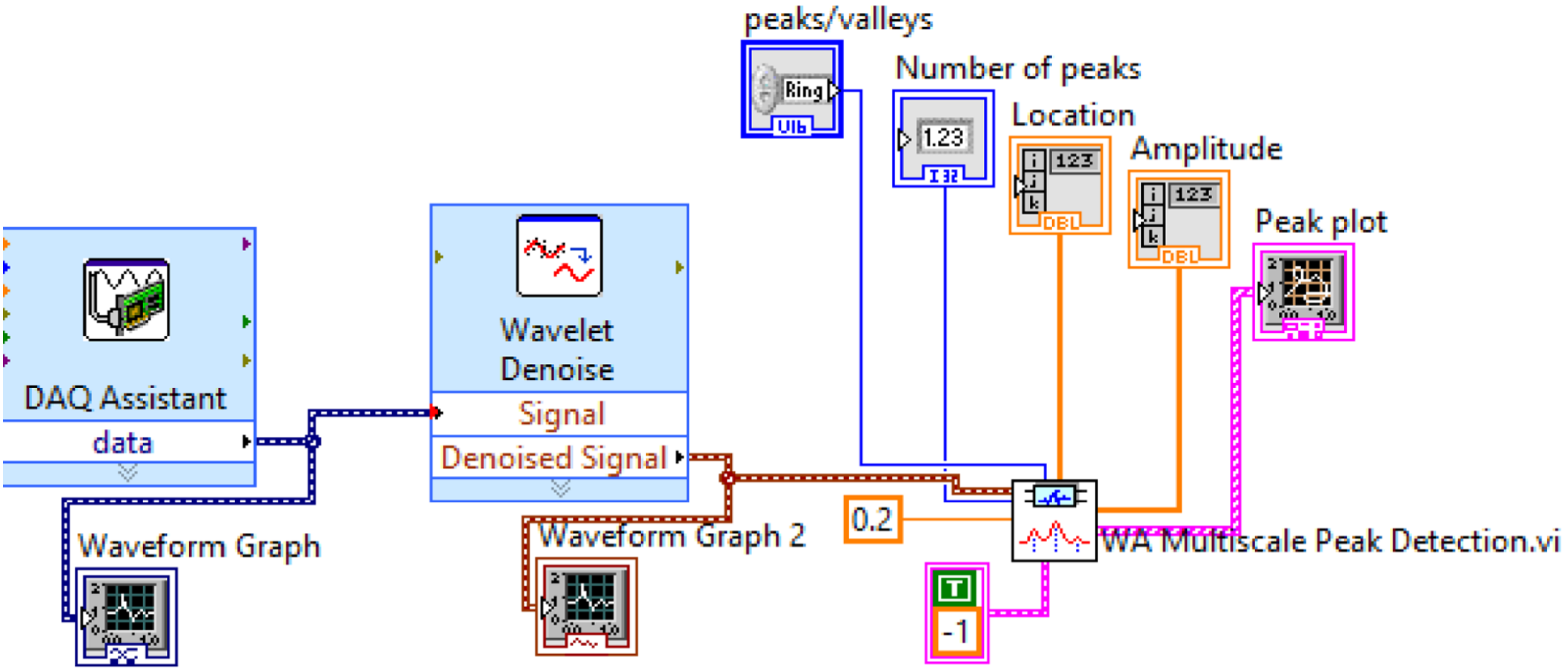
- WAVELET DENOISE FUNCTION IS USED




1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
Time

DETECTING R-PEAKS

- “Collector” and “WA Multi Peak Detection.vi” is used
- Teager energy method is used, which is based on squaring the signal amplitude.
- After squaring “Bio-signal rate Extractor.vi” is used



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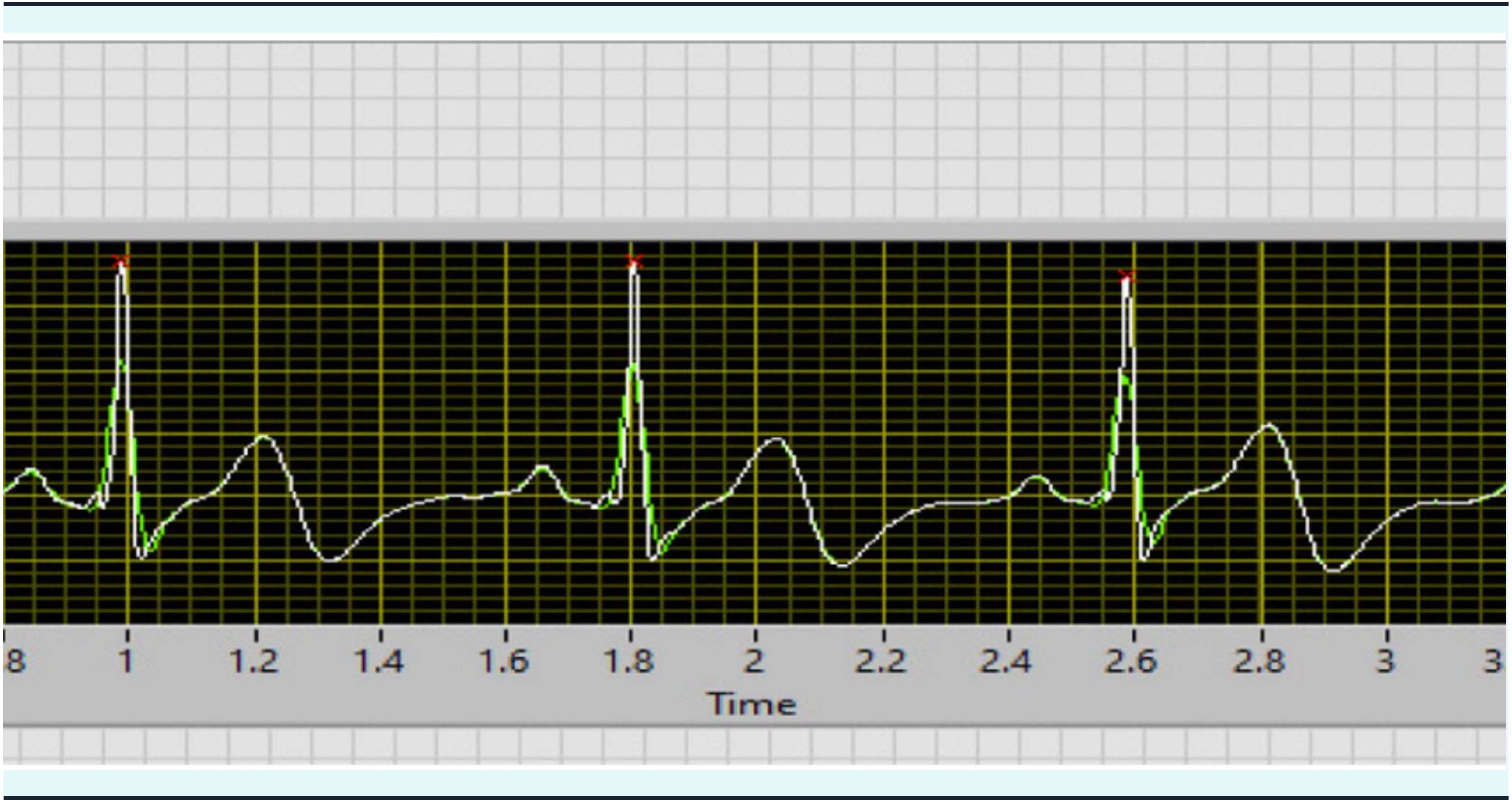
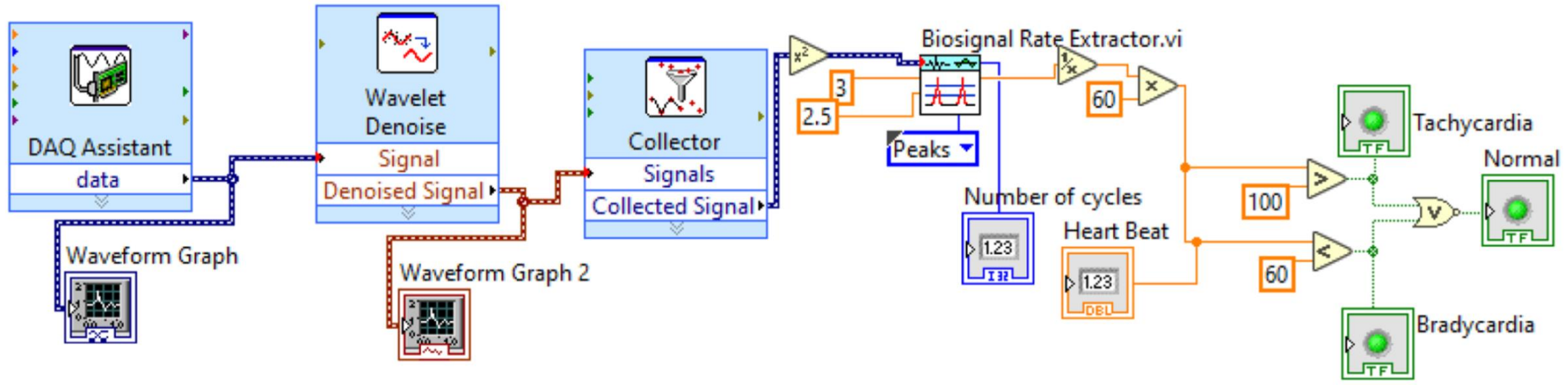
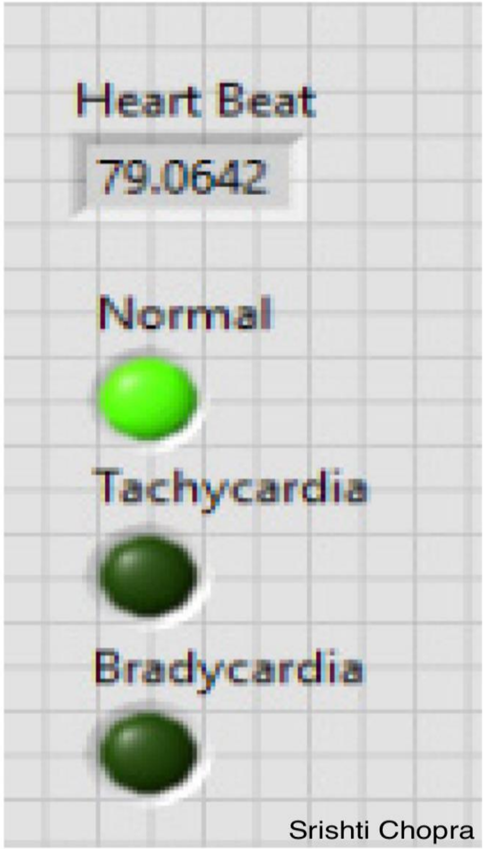

8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3
Time

DETECTING HEARTBEAT

After calculating the heartbeats, the system will indicate whether they are normal or affected with tachycardia or bradycardia.


DAQ Assistant
data
Waveform Graph
Wavelet
Denoise
Signal
Denoised Signal
Waveform Graph 2
Collector
Signals
Collected Signal
Biosignal Rate Extractor.vi
3
2.5
Peaks
Number of cycles
60
Heart Beat
100
60
Tachycardia
Normal
Bradycardia


Heart Beat
79.0642
Normal
Tachycardia
Bradycardia
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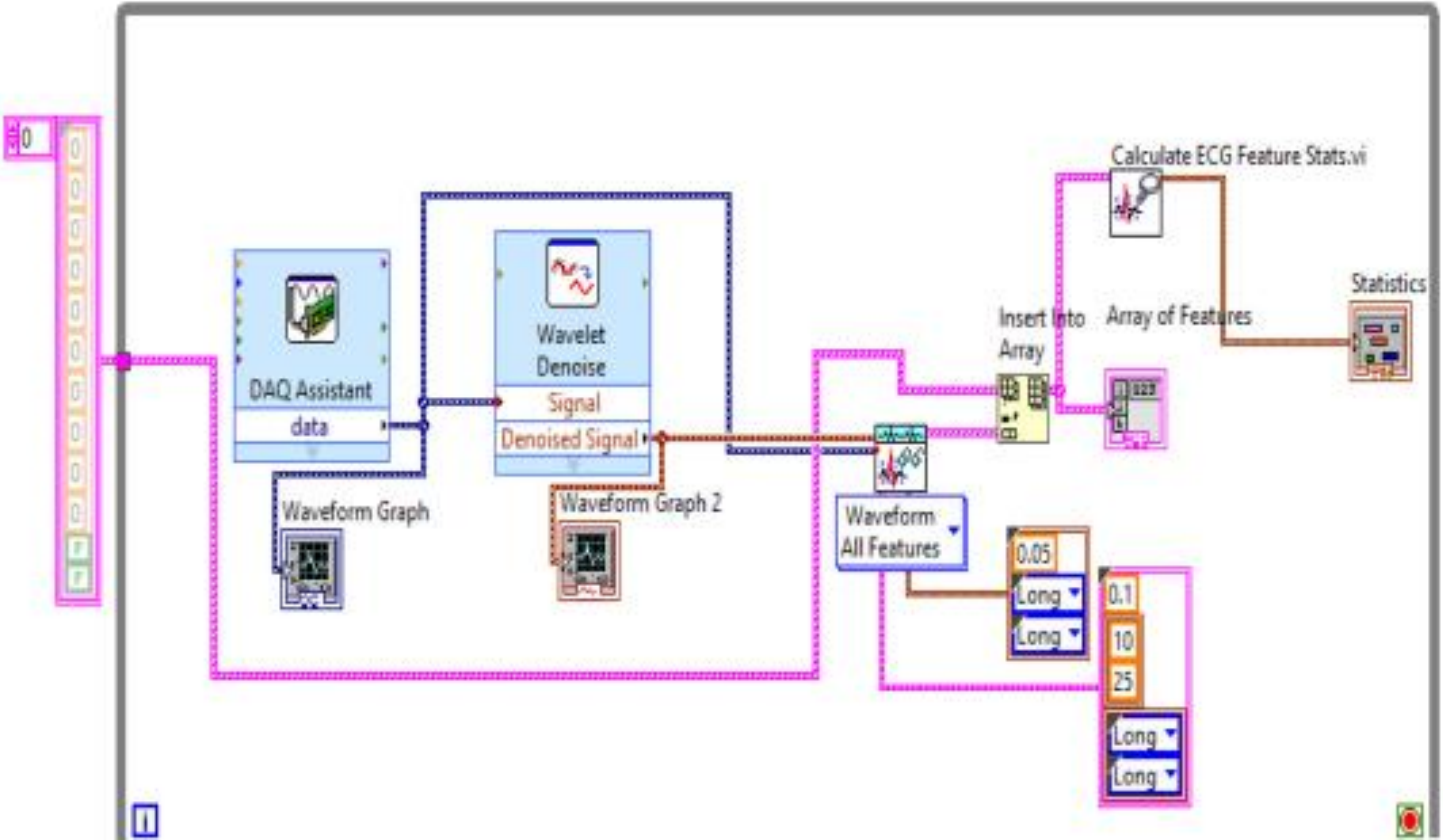
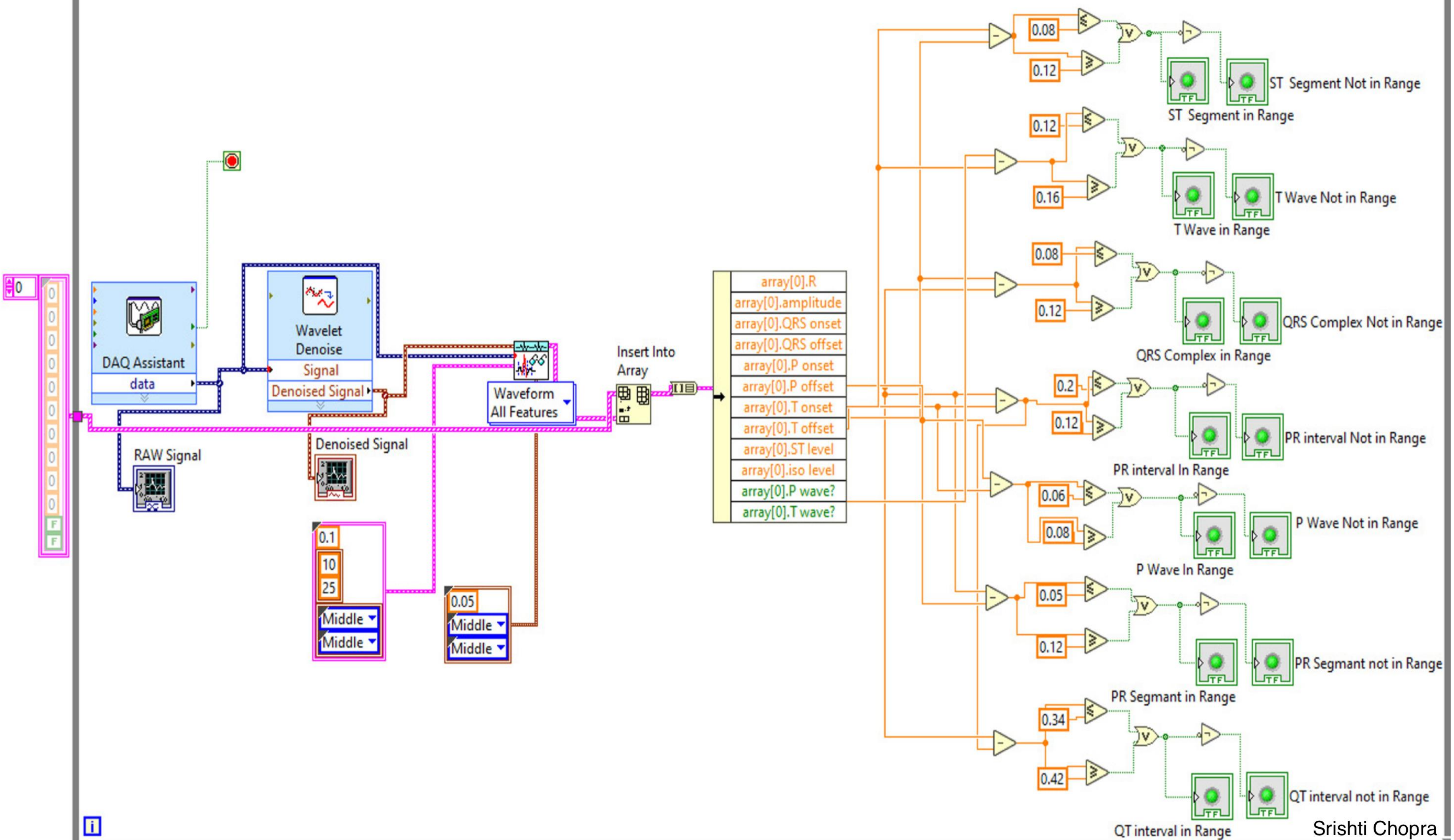
DETECTING ECG PARAMETERS (ALL)

- Extracted using “ECG Feature Extaractor.vi”
- Both the Raw ECG and denoised ECG are inserted
- “waveform all features” are selected.
- The output of this is inserted into the “Insert into Array” and into the “Array of Features”



Calculate ECG Feature Stats.vi
Statistics
Insert Into Array
Array of Features
Wavelet Denoise
DAQ Assistant
data
Signal
Denoised Signal
Waveform Graph
Waveform Graph 2
Waveform All Features
0.05
Long
Long
0.1
10
25
Long
Long

DETECTING WETHER THE SIGNAL IS IN RANGE OR NOT



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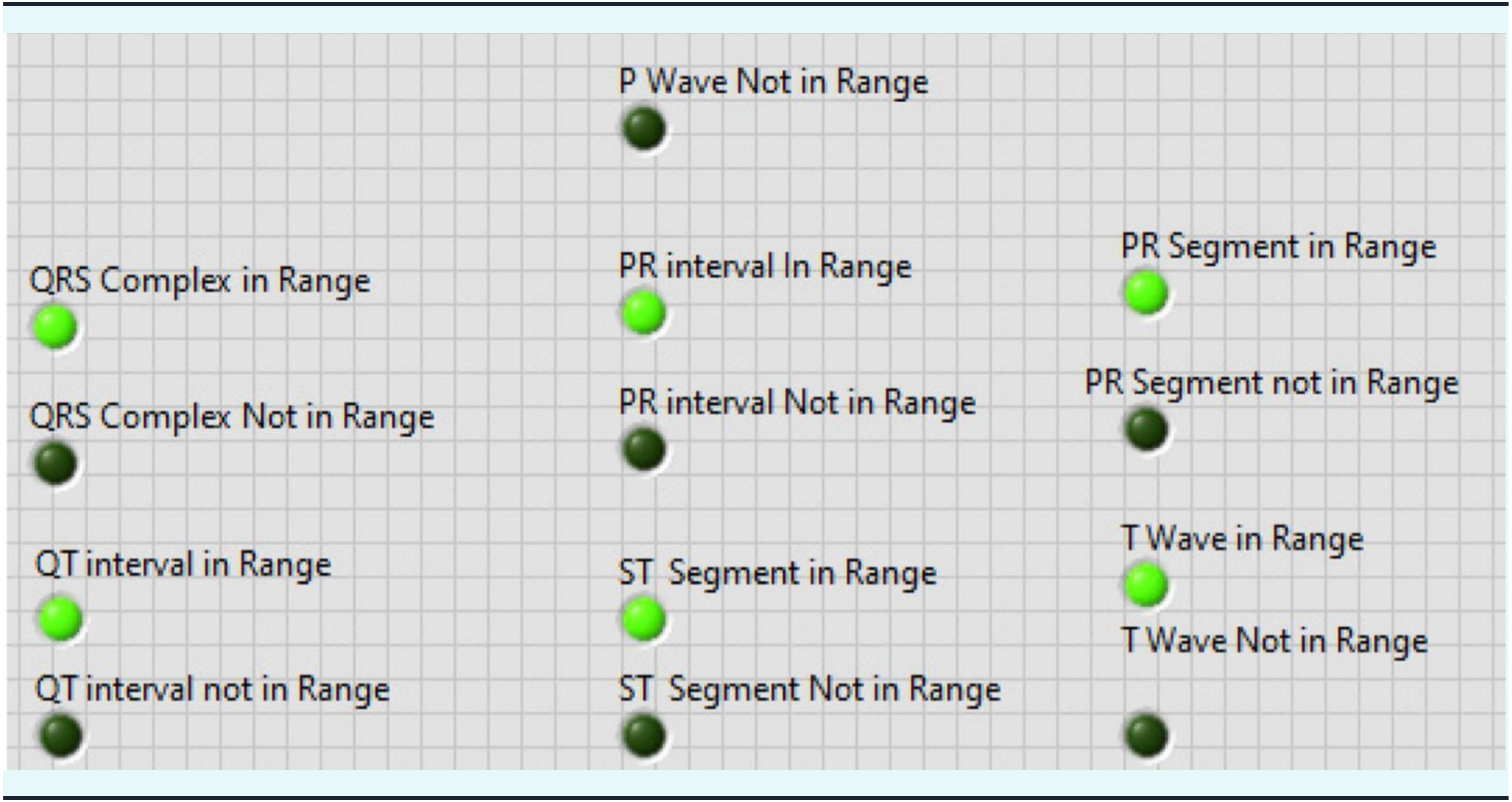
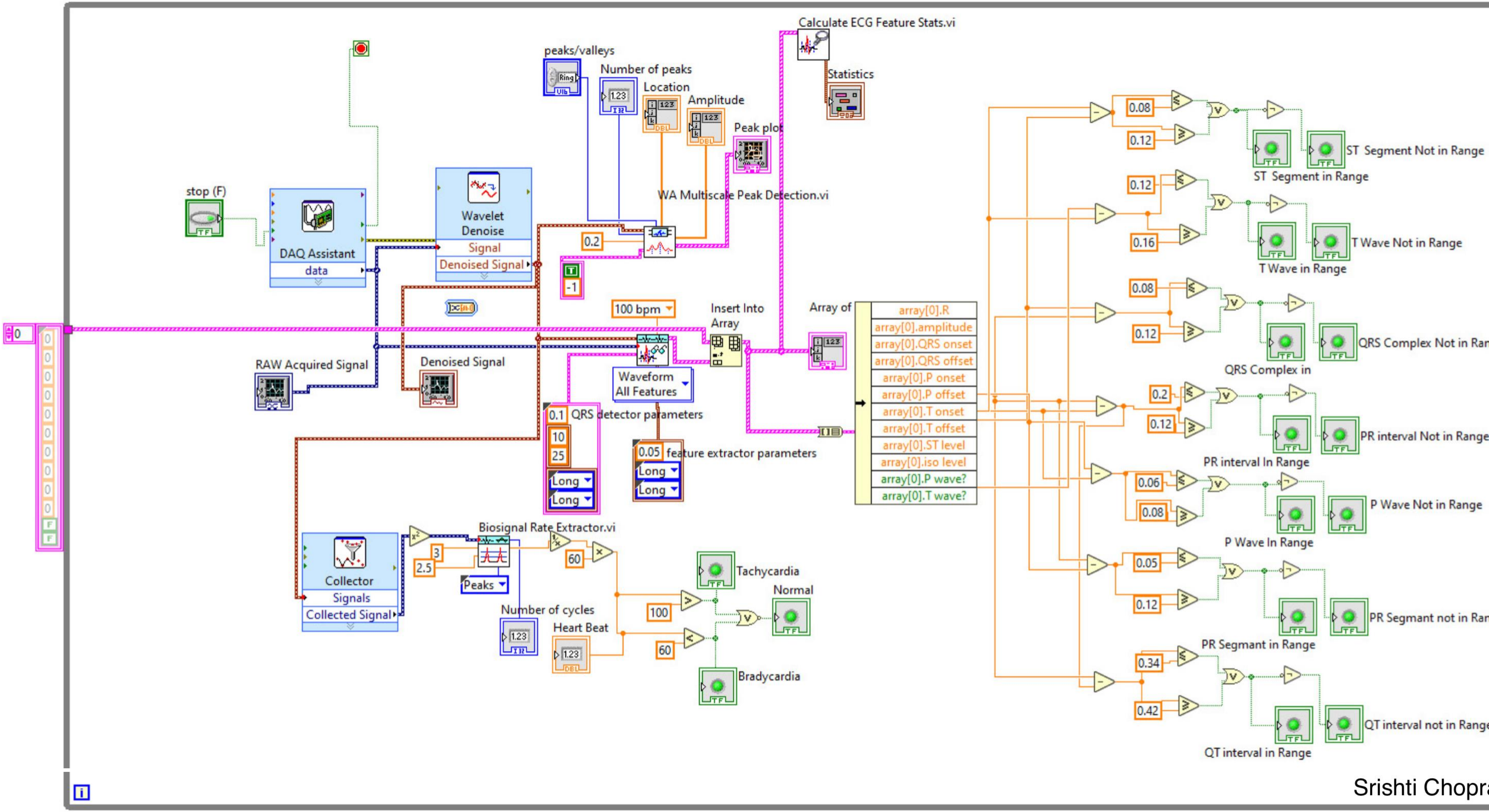

P Wave Not in Range
QRS Complex in Range
PR interval In Range
PR Segment in Range
QRS Complex Not in Range
PR interval Not in Range
PR Segment not in Range
QT interval in Range
ST Segment in Range
T Wave in Range
T Wave Not in Range
QT interval not in Range
ST Segment Not in Range

COMPLETE BLOCK DIAGRAM



Calculate ECG Feature Stats.vi
Statistics
peaks/valleys
Number of peaks
Location
Amplitude
Peak plot
WA Multiscale Peak Detection.vi
stop (F)
DAQ Assistant
data
Wavelet Denoise
Signal
Denoised Signal
0.2
-1
100 bpm
Insert Into Array
Array of
RAW Acquired Signal
Denoised Signal
Waveform All Features
0.1 QRS detector parameters
10
25
Long
Long
0.05 feature extractor parameters
Long
Long
array[0].R
array[0].amplitude
array[0].QRS onset
array[0].QRS offset
array[0].P onset
array[0].P offset
array[0].T onset
array[0].T offset
array[0].ST level
array[0].iso level
array[0].P wave?
array[0].T wave?
Collector
Signals
Collected Signal
Biosignal Rate Extractor.vi
3
2.5
Peaks
60
Number of cycles
Heart Beat
100
60
Tachycardia
Normal
Bradycardia
0.08
0.12
ST Segment Not in Range
ST Segment in Range
0.12
0.16
T Wave Not in Range
T Wave in Range
0.08
0.12
QRS Complex Not in Ran
QRS Complex in
0.2
0.12
PR interval Not in Range
PR interval In Range
0.06
0.08
P Wave Not in Range
P Wave In Range
0.05
0.12
PR Segmant not in Ran
PR Segmant in Range
0.34
0.42
QT interval not in Range
QT interval in Range
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RAW Acquired Signal
Stop (F)
Voltage
Amplitude
Time
Denoised Signal
Peak plot
peaks/valleys
peaks
Peaks
Signal
Trend
Array of Features
P onset
47.7
P offset
47.784
QRS onset
47.968
R
48.012
QRS offset
48.052
T onset
48.288
T offset
48.5
amplitude
3.24288
iso level
2.71372
ST level
0.277822
P wave?
T wave?
HR mean
75.4039
HR std
1.65899
Amp mean
3.22488
Amp std
QRS mean
0.0888
PR mean
0.2496
QT mean
0.5472
ST level mean
ST level std
Iso level mean
2.87359
Iso level std
Heart Beat
76.3951
Normal
Tachycardia
Bradycardia
Number of peaks
5
Number of cycles
279
Amplitude
1.96144
Location
QRS Complex in Range
QRS Complex Not in Range
QT interval in Range
QT interval not in Range
PR interval In Range
PR interval Not in Range
ST Segment in Range
ST Segment Not in Range
P Wave In Range
P Wave Not in Range
PR Segmant in Range
PR Segmant not in Range
T Wave in Range
T Wave Not in Range

RESOURCES

- 1.) https://www.researchgate.net/publication/349931849_Design_of_Op-Amp_Based_ECG_Signal_Acquisition_Using_MULTISIM
- 2.) Low-Power Instrumentation Amplifier IC Design for ECG System Applications ;Limei Xiu* , Zheying Li Institute of Micro-electronic Application Tech, Beijing Union University,Beijing,100101,China
- 3.) Wireless ECG Monitor Using Labview Muhammad Ikram Bin Mohammed Nazeri1 , M.F.L. Abdullah1* 1Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Parit Raja, Johor, Malaysia
- 4.) Design of CMOS Two-stage Operational Amplifier for ECG Monitoring System Using 90nm Technology Fateh Moulahcene, Nour-Eddine Bouguechal, Imad Benacer and Saleh Hanfoug