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A COMPARATIVE STUDY OF ARDUINO, RASPBERRY PI, AND STM32F407 BASED ACTIVE NOISE CONTROL SYSTEM THROUGH NOISE LEVEL REDUCTION USING MATLAB FOR ADAPTIVE SIGNAL PROCESSING

by

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APPROVAL SHEET

This Project Study entitled "**A COMPARATIVE STUDY OF ARDUINO, RASPBERRY PI, AND STM32F407 BASED ACTIVE NOISE CONTROL SYSTEM THROUGH NOISE LEVEL REDUCTION USING MATLAB FOR ADAPTIVE SIGNAL PROCESSING**", has been prepared and submitted by the following proponents:

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Sincerely,

The Proponents

ABSTRACT

The active noise control system cancels the unwanted sound by generating an anti-sound of equal amplitude and phase, when combined results to the reduction of both sounds. This is a comparison of Arduino Due, Raspberry Pi, and STM32F407 in terms of their optimum noise reduction capability. NLMS algorithm was used in the ANC systems to reproduce the desired output. The maximum reduction the system can acquire for both Raspberry Pi and STM32F407 modules is 5 dBA, the optimum frequency where the reduction of noise is most stable for both Raspberry Pi and STM32F407 modules is 100 Hz and a step size of 0.2 is the most suitable step size to be used in the Simulink model of the systems for a greater noise reduction. Raspberry Pi fitted best for deployment. Two set ups were made: parallel and perpendicular. Perpendicular set up produced 0 dBA - 3 dBA reduction, thus making it suitable for final deployment.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

CHAPTER 1

THE PROBLEM AND ITS BACKGROUND

1.1 Introduction

Noise is a term accustomed describe any unwanted sound that is apprehended from the surroundings or the environment of the perceiver. The recognition of noise as a significant peril is a development of contemporary times. An excessive amount of noise clearly impairs physical and mental presence. In this way, it is sensible to seek after Technology Assessment concerning boisterous technologies. In other words, noise has become one amongst the foremost vital among the environmental factors on which industry sets down a major piece of its endeavors and concerns.

To attenuate these noises there is a noise control technology which intends to lessen undesirable surrounding sound and is enforced through two completely different ways which are the Passive and Active Noise reduction techniques. Passive methods are straightforward, their development is reduced to the study of materials for the manufacture of soundproofing whereas Active methods of noise reduction are way more tough. Be that as it may, they have been broadly utilized in different fields of human activities. Sadly, solutions or devices utilizing active noise control are not generally used.

Active Noise Control includes an electro-acoustic system that cancels the unwanted noise supporting the principle of superposition or damaging interference, it introduces an analogous sound from the noise however, it is one hundred eighty degrees out of section signal to comparatively cancel the noise from the environment (Patent No. US 9.202456 B2, 2015).

1.2 General Objective

To conduct a comparative study of Arduino, Raspberry Pi, and STM32F407 based active noise control system through noise level reduction using MATLAB for adaptive signal processing.

1.3 Specific Objectives

1. To develop a low-cost implementation of a NLMS based adaptive signal processing algorithm using Arduino and Raspberry Pi as an alternative to STM32F407 microcontroller to encourage the widespread development and application of active noise control systems based on digital adaptive signal processing technology.
2. To compare the autonomy with regards to the installation, product specifications, self-adaptability, robustness and reliability of the Arduino, Raspberry Pi, and STM32F407 based noise control system.
3. To determine suitable peripherals in consideration of the design of the acoustical installation to attenuate undesired noise adequately.
4. To establish a noise control system based on the sound pressure level generated depending on the type of industrial noise source, distance from the source to the receiver, and the nature of the working environment.
5. To deploy the project.

1.4 Background of the Study

The concept of this study began when the proponents found out that noise may cause many health and behavioral effect, such as sleep distractions, hearing loss and stress that may lead to heart disease, aggression, and mental instabilities. Based on clinical studies, exposure to continuous noise of 85–90 dB, can lead to a progressive loss of hearing, with an increase in the threshold of hearing sensitivity. Hearing impairments due to noise are a direct consequence of the effects of sound energy on the inner ear moreover noise exposure during sleep may increase blood pressure, heart rate and finger pulse amplitude as well as body movements. There are also after-effects during the day following disturbed sleep or perceived sleep quality, mood and performance in terms of reaction time are all decreased (Stansfeld & Matheson, 2003).

Noise control techniques are presently broadly utilized in various applications to give acoustical treatments. Passive mediums have been utilized broadly in the industry to cut back noise, however the implementation of those mediums is comparatively costly, so researchers designed foams that are either regular or produced using reused materials frequently a substantial option in contrast to customary engineered materials. Nonetheless, these materials can be harmful for human well-being if their filaments are breathed in, since they can set down in the lung alveoli, and can cause skin aggravation. On the opposite hand, Active noise control technique is developing quickly because it permits important enhancements in noise control, usually with potential advantages however this system is extensively applied solely to headphones and not in wide areas like closed rooms. This project study introduces a system that can reduce noise using adaptive filters and high-speed digital signal processors (DSPs) to cancel out disturbing noise.

1.5 Statement of the Problem

Active noise control is developing speedily because it permits critical upgrades in noise control, usually with potential edges in size, weight, volume, and value of the system. The successful application of active noise control is decided through its effectiveness compared with passive attenuation techniques. Active attenuation is an appealing way to attain massive amounts of noise reduction in an exceedingly tiny package, significantly at low frequencies (below 600 Hz). At low frequencies, wherever lower testing rates are satisfactory and solely plane wave propagation is allowed, active noise control offers real benefits. Specific applications for active noise control now being worked on incorporates lessening of unavoidable noise sources in Industrial sources of noise, for example, fan, air conduit, stack, transformer, blower, siphon, cutting tool, wind burrow, uproarious plant, open telephone stall, office desk area parcel, ear defender, earphones, and so on.

The principle of ANC is simple; however, when it is applied in the real world, the following questions must be answered:

- Which algorithm should be used?
- Where should speakers and microphones be placed?
- What kind of microphone and speaker to be utilized?

1.6 Significance of the Study

Regarding item improvement, active noise control systems are innovative and advanced. Users can install them simply, which bolsters a fast and intensive establishment in business settings. By facilitating vital attenuation of low frequency noises, active noise control systems will be helpful in a scope of applications.

The general design of the active noise system fits the space necessities. In a progression of active noise control systems, an acoustic coupling between frameworks empower a stable operation.

Inferable from the individual working sources of active noise control systems, they are an economical answer in modern conditions. Vast scale generation of active noise control systems can be composed viably and does not require alignment calibrations. In addition, the productivity of active noise control systems in numerous applications make them a financial substitute to the traditional noise control systems created on passive noise control techniques.

1.7 Scope and Limitations of the Study

This project study aims to develop an active noise control system that uses adaptive signal processing implemented on a low-cost, high-performance digital signal processing that reduces acoustic noise. The active noise system cancels the unwanted sound by producing an associate anti-sound (anti-noise) of equivalent amplitude and inverse phase. The initial, undesirable sound and the anti-noise acoustically mix, leading to the cancellation of each sounds. The undesirable noise (the primary noise), the canceling noise (the anti-noise), and the residual noise results after they pose. The effectiveness of cancellation of the primary noise depends on the precision of the amplitude and phase of the generated anti-noise.

The type of acoustic noise that will be dealt with is narrowband noise, it concentrates majority of its vitality at explicit frequencies. This kind of noise is identified with pivoting or redundant machines, so it is occasional or about intermittent or nearly periodic. Instances of narrowband noise incorporate the noise of burning motors in transportation, blowers as auxiliary power sources and in coolers, and vacuum siphons used to move mass materials in several industries. Active noise control is usually restricted to low-frequency noise.

CHAPTER 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents a review of different related literatures, background theories, principles and studies which include some technical terminologies from previous and present project related to the development of the project.

2.1 Conceptual Literature

2.1.1 Active Noise Control Technology

The technology of active noise control is a relatively old idea that has received considerable attention in recent years. This is primarily due to the development of improved signal processing theory and hardware that enables more sophisticated approaches to this problem. Many of the traditional problems with this technology can now be treated more effectively with proper signal processing rather than with the direct acoustical approaches of the past, that was according to the patented paper (Patent No. US 8,750,531 B2, 2014).

The active noise control or ANC, actively reduces ambient noise by generating a waveform that is an inverse form of the noise wave, sometimes called an “anti-phase” or “anti-noise” waveform. Also, an ANC system generally uses one or more microphones to pick up an external noise reference signal, generates an anti-noise waveform from the noise reference signal, and reproduces the anti-noise waveform through one or more loudspeakers. This anti-noise waveform interferes destructively with the original noise wave to

reduce the level of the noise that reaches the ear of the user. (Lee, Park, & Toman, 2015)

2.1.2 Passive Noise Reduction Technique

An article written by (Azimi, 2017), explains that the passive control involves reducing the radiated noise by energy absorption. Sound absorbing materials are passive mediums that disseminate energy to lower noise and turning it into heat. In this technique, porous materials are obtained from synthetic fibers, such as mineral wool or glass wool because of their high performance and low cost. On the other hand, they have several cons which they can be harmful for human health if their fiber are inhaled and can cause skin irritation.

Furthermore, the effectiveness of absorption is directly related to the thickness of the material. When their thickness is between one-fourth and one-half the wavelength of the sound, with the maximum performance where the thickness is one-fourth the wavelength, absorbers are most effective. This means that sound absorbers do a very good job at high frequencies, which have short wavelengths.

2.1.3 Hardware

2.1.3.1 Arduino Due

Arduino Due is the first Arduino board based on a 32-bit ARM core microcontroller. With 54 digital input/output pins (of which 12 can

be used as PWM outputs), 12 analog inputs, 4 UARTs (hardware serial ports), an 84 MHz clock, an USB OTG capable connection, 2 DAC (digital to analog), 2 TWI, a power jack, an SPI header, a JTAG header, a reset button and an erase button. It is perfect board for powerful larger scale Arduino projects. The Arduino Due boards runs at 3.3V. The maximum voltage that the I/O pins can tolerate is 3.3V. Applying voltages higher than 3.3V to any I.O pin could damage the board. (usa: arduino-due, n.d.)

2.1.3.2 Raspberry Pi

A Raspberry Pi is a credit card sized computer originally designed for education, inspired by the 1981 BBC Micro, Eben Upton's goal was to create a low-cost device that would improve programming skills and hardware understanding at the pre-university level. It is open hardware, with the exception of the primary chip in the Raspberry Pi, the Broadcomm SoC (System on a Chip), which runs many of the main components of the board – CPU, graphics, memory, the USB controller, etc. (Faqs: Raspberry Pi, n.d.)

2.1.3.3 Microphone

A microphone is a device that translates sound vibration in the air into electronic signals or scribes them to a recording medium. Frequently, microphones are designed for a given purpose. One of the

main considerations, aside from the type of device, is what is being recorded. Directionality of microphones is one such consideration in microphone design. Omnidirectional microphones are suited to recording all sounds in all area but poor for focusing on a single subject amongst background noise. (Margaret Rouse, n.d.)

2.1.3.4 STM32F407

The STM32F407 evaluation board is a complete demonstration and development platform for the STM32 F1 series of ultra-low-power MCUs and includes an STM32L152ZDT6 ARM Cortex-M3 32-bit microcontroller with 384 KB of Flash memory. An ST-LINK/V2 is integrated on the board as an embedded in-circuit debugger / programmer for the STM32L152ZDT6. The full range of hardware features in the boards helps you to develop your own applications and evaluate all peripherals such as USB FS, USART, audio DAC, microphone ADC, dot-matrix LCD, LCD glass, IrDA, LDR, SRM, NOR Flash, MicroSD Card, temperature sensor and so on. (STM32L152D-EVAL evaluation board, 2012)

2.2 Related Literature

2.2.1 Foreign Literatures

2.2.1.1 A High-Performance Approach to Local Active Noise Reduction *(Chirman Kwan, 2016)*

This paper creates a small quite zone for astronauts in noisy spacecraft environment. Parabolic speakers are used to cancel noise with minimal spillover to other places. The proponents implemented both FX-LMS in a Linus PC, which is very powerful. Also, they've tried to attenuate broadband noise. However, it was not successful. In result to this, the future works includes the use of FPGA to implement the FD-FXLMS algorithm and performs real-time experiments.

2.2.1.2 Digital sound processing using Arduino and MATLAB

(Sergio Silva, 2015)

This paper presents an approach to Digital Sound Processing using the Arduino platform and MATLAB. Some sound capabilities and specific limitations of the Arduino platform, enfacing its connection and installation with MATLAB software was discussed. For the future work of this paper, the Arduino platform can be use together with MATLAB for real time sound processing, but some precautions should be taken in to account when using it, because the sampling process introduces noise. Furthermore, for the recommendation of this paper, the consideration of the availability of Arduino Due should here remember, it is faster than

Arduino Uno. It has 12 bits ADC instead of the current 10 bits of the Uno.

2.2.1.3 Fundamentals of Active Noise Control for Local Cancellation of Noise *(Ms. Padma P. Hirave, 2011)*

A noise free environment for a room is developed in this paper. It is applicable for attenuating external noise inside a car, and office cubical partition. Anti-phase signal is generated for noise cancellation, and they implemented the use of LMS algorithm achieved by using TMS320C6713 DSP processor. Feedback ANC structure was used. In addition to this, the recommendation for this paper is the consideration of the acoustic parameters for the increase of performance of destructive interference of noise.

2.2.1.4 The Choice of Method of Construction and the Hardware Core of the Active Noise Reduction System for Room *(Ivan S. Zorin, 2017)*

This article was written aimed at creating an active noise reduction system for rooms. The main purpose is to choose method of construction and the hardware core of the active noise reduction for rooms. In this paper, basic requirements are established and options for implementing the hardware core of the processing unit are proposed. According to *(Ivan S. Zorin, 2017)* in selecting hardware core of active

noise reduction, must consider the following: availability, productivity, cost, energy saving and selection of peripherals.

2.2.1.5 Effect of Transducer Positioning in Active Noise Control *(Sajil C. K., 2018)*

This study, demonstrated anti-noise source position optimization using room acoustics models in achieving better noise control. It shows that level of cancellation can be improved up to 7.34dB. Loophole for this paper is that the measurement of real RIRs are time-consuming and tedious. As a result, recommendation for this paper is the optimization of anti-noise source location to improve level of cancellation and several other physical parameters including, transducer orientation, room shape, etc., in achieving better noise control.

2.2.1.6 Active Noise Cancellation for Underwater Environment Using Raspberry Pi *(Nanang Syahroni, 2014)*

In this study, ANC techniques was discussed to reduce acoustic noise signal using Raspberry Pi board as the hardware. Normalized Least Means Square (NLMS) algorithm was used for calculating sampled signal. The system is designed using MATLAB and Simulink and it can reduce noise level until 0.894 dB in underwater environment 1.97 dB in 10 cm depth, 1.02 dB in 40 cm depth. But this research was

less effective at high frequencies due to the presence of other noise that affects during signal processing.

2.2.1.7 Implementation Challenges for Feedback Active Noise Cancellation *(Nitish Krishnamurthy, 2012)*

This paper describes the factors limiting the performance in practical implementations of digital active noise cancellation (ANC) in commercial systems. It significantly improved the system performance and robustness. Also, this paper includes the discussion of challenges in designing wide-band ANC systems for headphones and portable audio devices using a single microphone. For the recommendations of this paper, consideration of the secondary path variation in depth and approaches varies to overcome temporal variations. Furthermore, according to the researchers, we must refer to this paper in developing practical ANC systems with commercial quality.

2.2.1.8 Invisible speakers in home windows for simultaneous auxiliary audio playback and active noise cancellation *(Shan Hu, 2012)*

In this study, researchers utilize a transparent thin film speaker in a window for simultaneous noise cancellation. The integrate wave separation and secondary estimation algorithm is proposed to prevent audio signals from entering the control loop. Correlation of audio

signals and external noise is not a problem when using white noise for secondary path estimation, but white noise in ANC could sound annoying to dwellers. In result to this, according to this paper, white noise need not be added to the ANC system all the time, which could alleviate its annoyance to the users, but the correlation of audio signals and external noise will become a problem.

2.2.1.9 Active Noise Control on Workplaces *(Jie Pan, 2015)*

This paper presents examples of active noise control in three different workplaces, namely the cabin of a mining truck, the wheelhouse of a high-speed patrol boat and cabin of a locomotive on a mining site. This study says that ANC are most suitable for the following; workplaces where the existing overall noise level is a few decibels above assigned level and low frequency tonal components are significant and workplaces where comfort can be improved by significantly reducing low-frequency “booming noise”.

2.2.1.10 Active Minimization of Acoustic Energy Density to Attenuate Radiated Noise from Enclosures *(Boone)*

In this paper, ANC is applied to the problem of noise radiating from diesel generator enclosures. It shows that the active minimization of energy density within an enclosure can lead to global reduction of the externally radiated noise. FXLMS based adaptive ANC algorithm is

used to minimize energy density (ED). The control was performed using a TMS320VC33 DSP processor and custom I/O board. And the measurements and post processing was performed using MATLAB. According to this paper, to help maximize the attenuation of noise radiating from the enclosure, hybrid system must be developed.

2.2.2 Local Literatures

2.2.2.11 Internal Sound De-noising for Traditional Stethoscope Using Inverse Chebyshev IIR Band-stop Filter *(Alonzo Alterado, 2016)*

In this paper, an IIR Chebyshev II Band-stop filter was used to simulate the removal of ambient noise in a traditional stethoscope. Infinite Impulse Response (IIR) that can filter high frequency was developed in this paper. As a recommendation to this paper, the use of other filtering method like Bessel and Elliptic filters must be considered, and the use of de-noising techniques like adaptive filtering for better accuracy and enhancement.

2.2.2.12 Noise Monitoring Device and Audio Advisory System for the COE Resource Center *(Jonathan B. Redonga)*

This research paper, study about a system that monitor noise level and advice "SILENCE" through display and playback voice record when a certain level of noise is reached. But this paper has its loophole

wherein the project has a playback voice recorder that will advise the students to be silent but will add up to the noise in the area.

2.2.2.13 Accuracy Enhancement Performance of Least Mean-Squares Filter on Root-MUSIC-Extracted Direction-of-Arrival Estimates for Passive RFID Application *(Reynaldo Ted L. Penas, 2014)*

The study aims to enhance the accuracy of Root-MUSIC direction-of-arrival (DoA). It estimates a passive radio frequency identification (RFID) tag system with a reader that utilizes a two-element uniform linear array (ULA). Least Mean Squares algorithm (LMS) was used to reduce the effect of noise and carrier leakage before extracting the DoA.

2.2.2.14 Staff Solutions for Noise Reduction in the Workplace *(Alison Connor, 2008)*

In this paper, a comprehensive noise-reduction project was initiated in response to low patient-satisfaction scores on an inpatient neuroscience unit at St Luke's Hospital and Health Network. The effects of noise on the health of patients and staff provided additional rationale for the project. If the staffs and patients did not cooperate there is no success for the project. Furthermore, the recommendation for this paper

is to provide a dB monitoring device installed in the area to measure sound levels.

CHAPTER 3

METHODOLOGY

This chapter presents the procedures in making the system of the project and its output. It includes the application of the principles and theories, materials and equipment used, program algorithm, circuit designs and design flow process.

3.1 Research Design

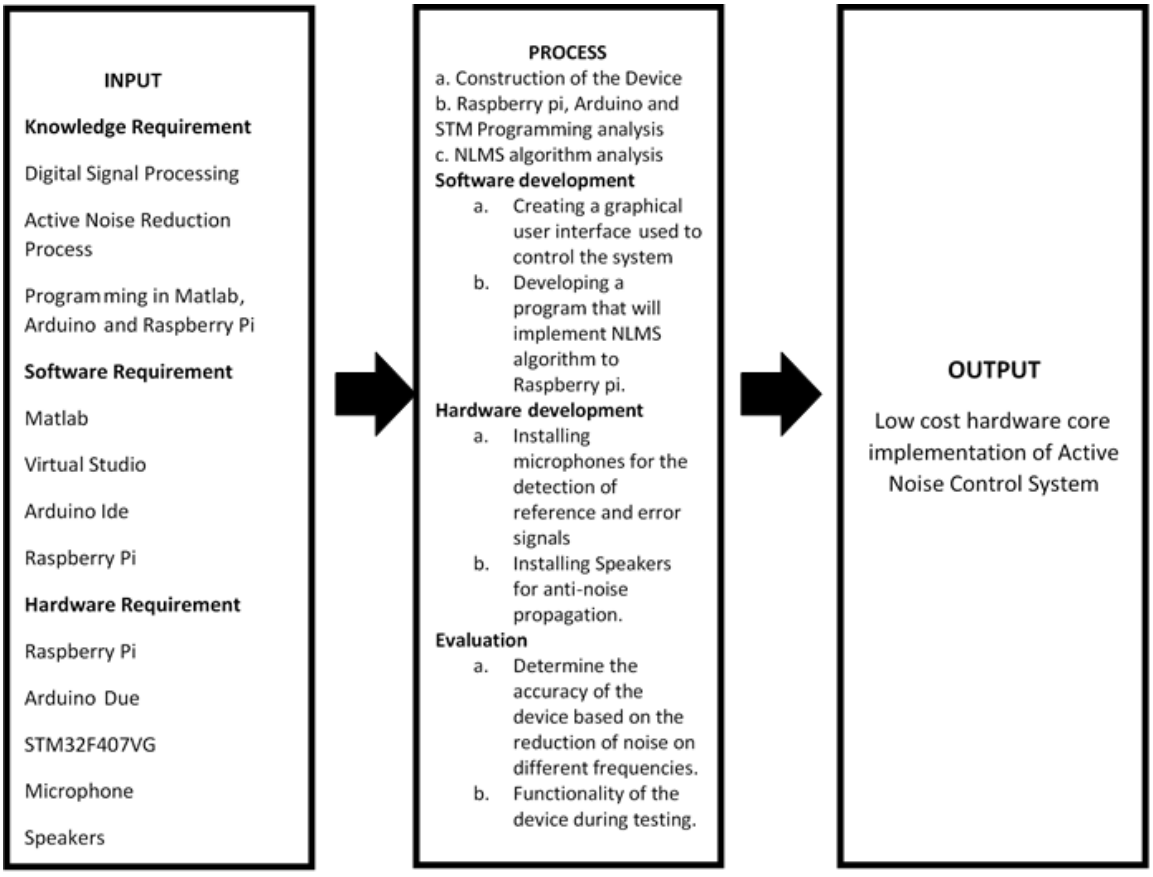


Figure 1. Conceptual Model of the Study

Figure 1 presents the conceptual framework of the study. It describes the different variables further classified as inputs, process, and output variables. For the input, understanding digital signal processing and active noise reduction process are required as

well as the programming language that will be used. The hardware requirements will be based on the design of each circuit in the project and to the low-cost hardware implementation of the active noise control system. The process consists of the integration of hardware to achieve the developed algorithm.

3.1.1 Gathering of Related Facts/Information

- Research about Arduino Due, Raspberry Pi, and STM32F407 specification and configuration.
- Research on the process and examples of Arduino Due, Raspberry Pi, and STM32F407 configuration.
- Research for the process flow and configuration of active noise reduction system.
- Research on the NLMS algorithm.
- Research about power amplifiers specifications.
- Research about standard acoustic parameters.

3.1.2 Design of the Overall System

The system of the project is composed of three parts namely the acoustic sensor, the digital signal Processor and the power amplifier. The low frequency noise will be the input of the system. Figure 2 shows the block diagram of the Active Noise Control system wherein the sensing microphone to the filter and the pre-amplifying circuit. The digital signal processor will receive this data and will produce an anti-noise signal. The DSP uses the received data to adaptively update

filter coefficient. The adaptive filter that will be used is the Normalized Least Mean Square (NLMS) algorithm. NLMS algorithm is very simple to implement and has an efficiency of the computing process (Nanang Syahroni, 2014). NLMS algorithm has an average reduction of -27.9 dB with variable step size that is stable for arbitrary signals. That makes this algorithm suitable for implementation in real-time systems (Hutson, 2003). NLMS algorithm is found in the block diagram in Simulink Signal Processing so no need to program the coding to simplify and shorten the implementation of the model. Figure 2 shows the block diagram of the feedforward ANC system and Figure 3 shows the block diagram of NLMS algorithm.

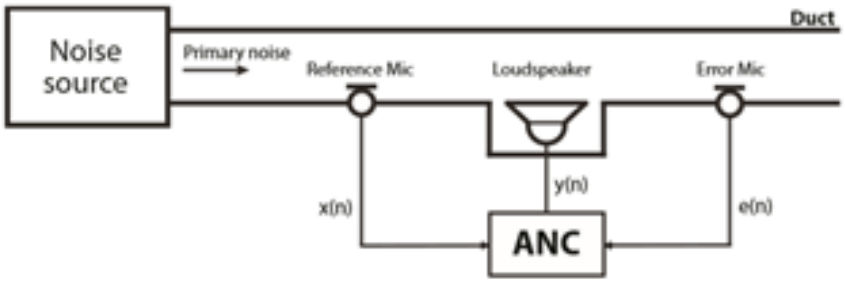


Figure 2. Block Diagram of Feedforward ANC System (Perego, 2016)

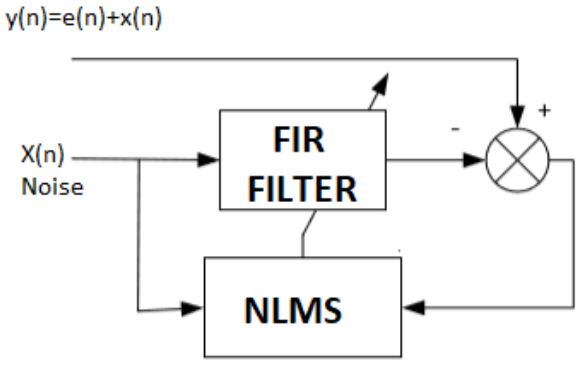


Figure 3. Block Diagram of NLMS Algorithm (Nanang Syahroni, 2014)

Figure 3 shows the block diagram of NLMS algorithm wherein it can be summarized as follows (Chirman Kwan, 2016):

1. Input the reference signal x(n) and the error signal e(n) from the input ports.
2. Compute the anti-noise y(n).
3. Output the anti-noise y(n) to the output port to drive the canceling speaker.
4. Perform the NLMS operation.
5. Update the coefficients of the adaptive filter.
6. Repeat the algorithm for the next iteration.

3.2 Hardware Development

The needed materials and equipment for the development of the project will be gathered from different sources. The main hardware parts such as Arduino Due, Raspberry Pi and STM32F407 was bought online through Amazon, Lazada etc. Other electronic parts such as op amps, microphones, resistors and integrated circuits was purchased from Dee Hwang Liong Electronics Equipment Corporation (DEECO), E-Gizmo Mechatronics Central, Alexan and other distributors in Manila, Philippines. This also includes installing microphones for the detection of reference and error signals.

Figure 4. Raspberry Pi

(http://www.amazon.com/ELEMENT-Element14-Raspberry-Pi-Motherboard/dp/B07BDR5PDW)

Figure 5. Arduino Due

(http://m.reichelt.com/de/en/arduino-due-at91sam3x8e-micro-usb-arduino-due-p130169.html)

Figure 6. STM32F407

(https://rlx.sk/en/stmicroelectronics/657-stm32f4discovery-for-stm32-f4-series-with-stm32f407-mcu.html)

3.3 Software Development

The set of programs needed in this project study were done using MATLAB and Simulink Support Package for Raspberry Pi, Embedded Coder Support Package for STMicroelectronics Discovery boards, DSP system toolbox for ARM Cortex-M Processors and Arduino 1.8.19 IDE. This includes the development of a program that will implement NLMS algorithm to Arduino Due, STM32F407 and Raspberry Pi. Figure 7 shows the modified NLMS algorithm for ANC system while Figure 8 shows the flow process of NLMS algorithm.

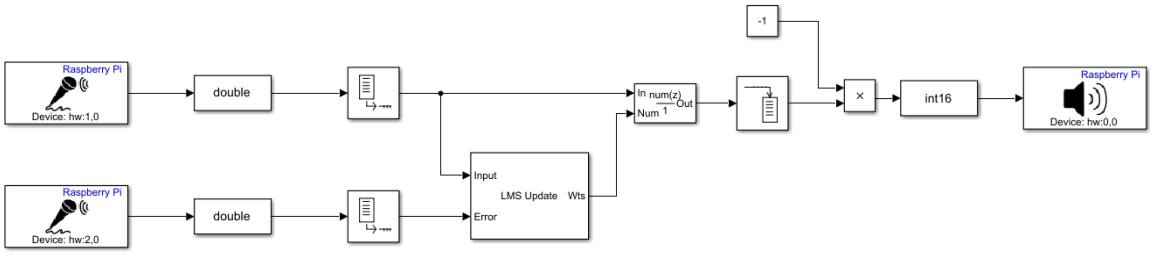


Figure 7. Modified NLMS Algorithm for ANC System

A USB mic with internal ADC was used for the input of the Raspberry Pi. A "double" block is then connected to the input to convert the digital data (purely positive) from the mic into double type that contains both positive and negative values. This will ensure that positive and negative peaks of the noise will be reconstructed accordingly.

An "A-weighing" block is used to test if the combination of the noise and the system are compatible with the A-weighing standard since the noise to be reduced is in the range of human perception. A switch is connected directly on the input and the A-weighing block for easier test trials.

As shown in Figure 4, the desired output of the system is the inverse equivalent of the input. A simple mathematical function of (Desired = Input * -1) is used.

The NLMS function generates the correct coefficient thru continuous calculations and outputs the Inversed input, the Anti-Noise Source.

The NLMS function contains an internal filter which readily outputs the desired signal using the calculated coefficient. Still, NLMS outputs the calculated coefficient if any other calculations are needed. An FIR Filter is connected on the W(X) output of the NLMS function, to test since the block is more manageable than the internal filter included

on the NLMS function. A switch is then connected on the NLMS output and the IIR Filter output to test the compatibility of the two outputs on the system.

All data is converted into Int16 which correspond to the data type of the Raspberry Pi's 3.5mm audio jack for DAC.

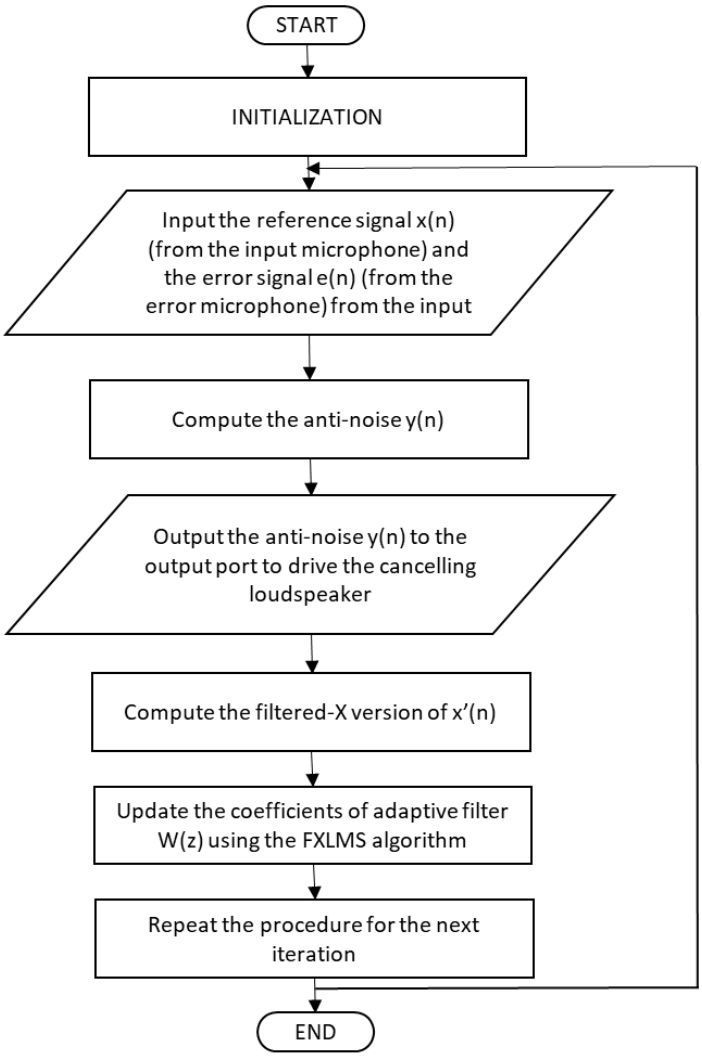


Figure 8. Flow Process of the NLMS Algorithm

3.4 Evaluation Procedure

The accuracy of the device is determined based on the reduction of noise on different frequencies using different meters: Benetech GM1351, MATLAB Simulink Spectrum Analyzer, and Sound Meter mobile app to observe the functionality of the device during testing. Several trial and errors were performed to configure the MATLAB settings for the implementation of the algorithm.

A backbone program was made for the following tests to be done on the actual deployment, from the simplest simulation up to the addition of the real-world factors like harmonics, delays in air, distortion, etc. Normalized Least Mean Square algorithm was used in the ANC systems to reproduce the desired output which is the inverted noise. In this kind of set-up, only one mic was used. The noise used is a generated sine wave, which closely resembles the noise that the ANC systems will produce. After the addition of real-life factors, it was observed that the ANC systems are stable, so it is proven that the algorithm is 100% working, the other factor to consider again in case of unstable noise reduction is the capability of the microphone and the microcontrollers. Furthermore, engine noises like fans, hisses, growls, and other wave files are used to test the ANC systems. The NLMS algorithm was not a perfect algorithm to fully cancel the noises 100% but there was a significant reduction.

In evaluating the speakers to be used these are the factors to be considered:

1. Power consumption in a noise cancelling device is very important. Using the system for a very long time, would consume a lot of power that can detriment its significance due to electricity cost. For a specific implementation, low power consumption is needed to ensure that no other insignificant electrical cost will be entailed during deployment.

2. Impedance: High-end speakers have a higher power rating and low impedance for high quality sounds. Depending on the quality of noise, and its fundamental frequencies, the quality of speaker is a large factor for it would determine the quality of anti-noise that it can produce.

3. Loudness: Matching the Anti-Noise to its Noise counterpart, would require a speaker that can equal the loudness of the Noise.

4. Frequency of Operation: Having a wide range of frequency, would ensure that all fundamental frequency of the noise will be reproduced.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the data collected from the study and then followed by the interpretation and analysis of results.

4.1 Signal Output Performance of Modules

The proponents tested the three modules (Arduino Due, Raspberry Pi and STM32F407) input and output capability in handling analog signals using Function generator and oscilloscope. The results are as follows:

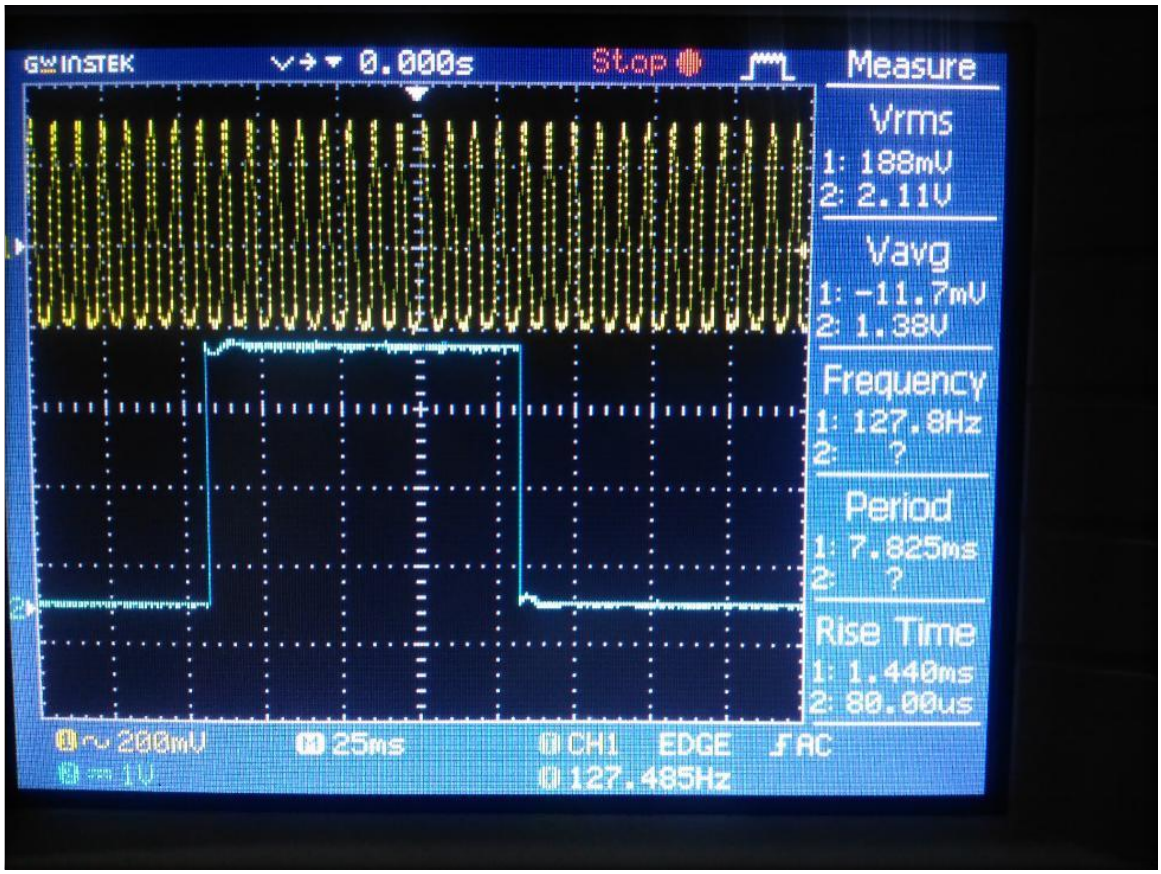


Figure 9. Result from the Oscilloscope using Raspberry Pi

(Yellow=Input; Blue=Output)

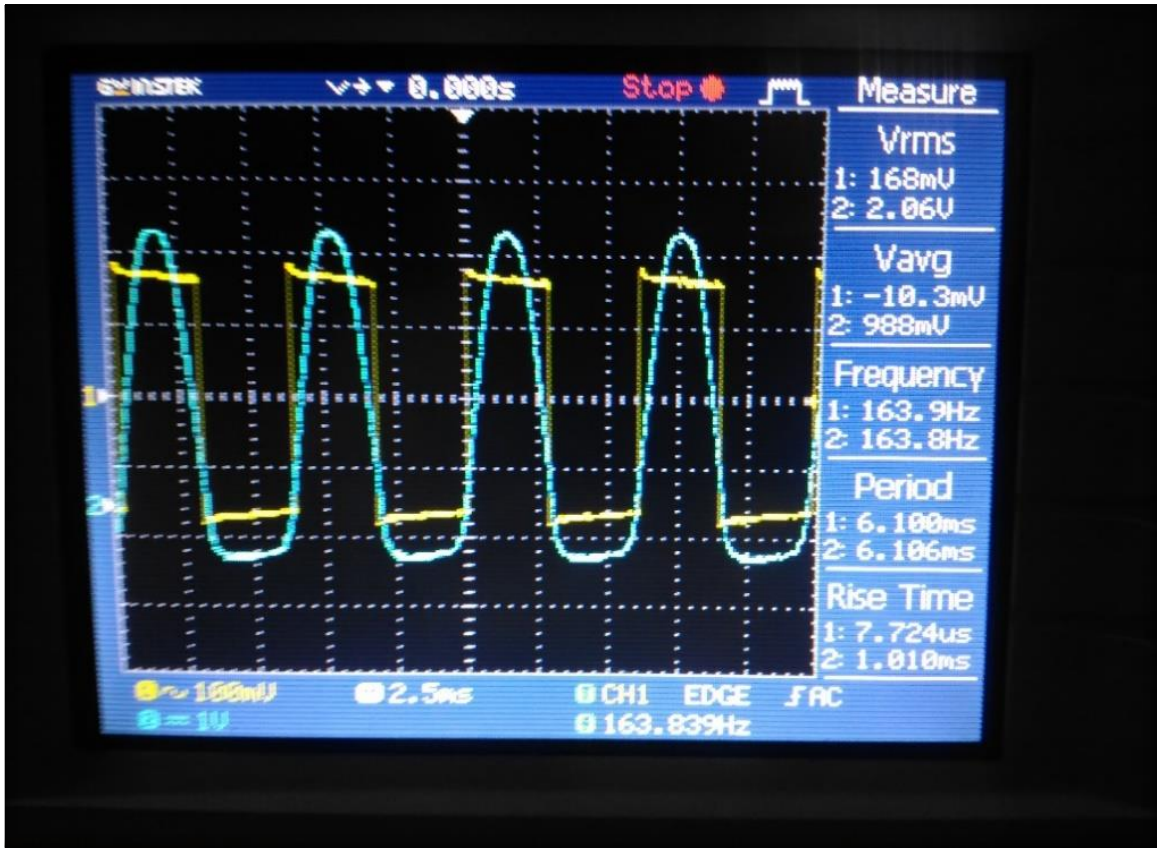


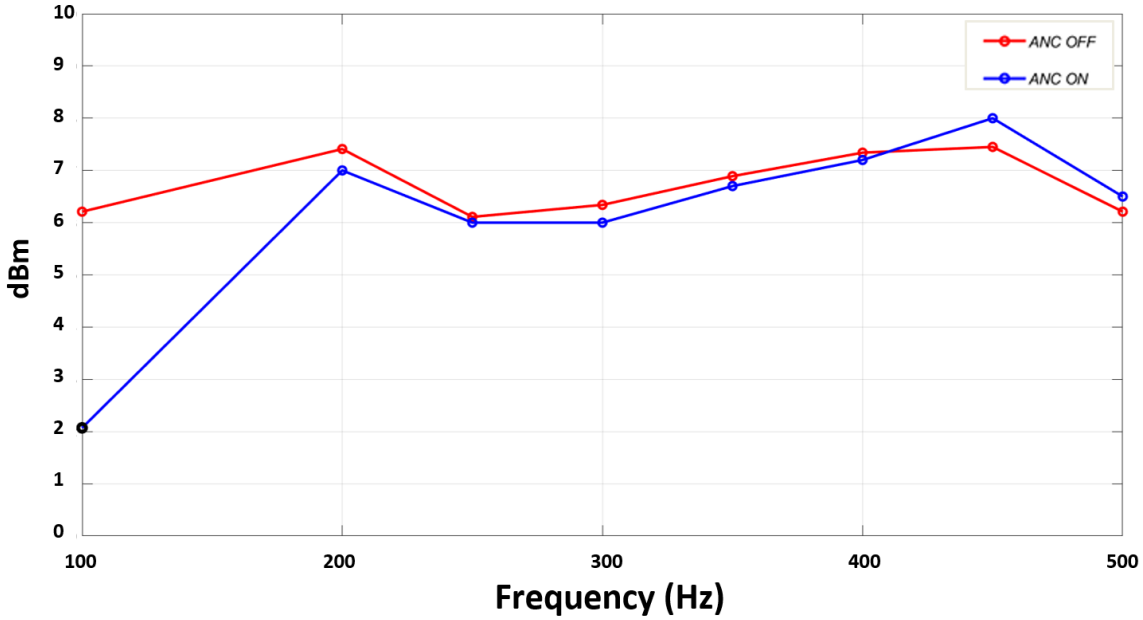
Figure 10. Result from the Oscilloscope using Arduino Due

(Yellow=Input; Blue=Output)

Figure 9 and Figure 10 shows that even though Arduino Due has no true analog input, it can reproduce the exact same input frequency, but the Raspberry Pi and STM32F407 was unable to process direct analog signal.

4. 2 Trial Results Prior to Deployment

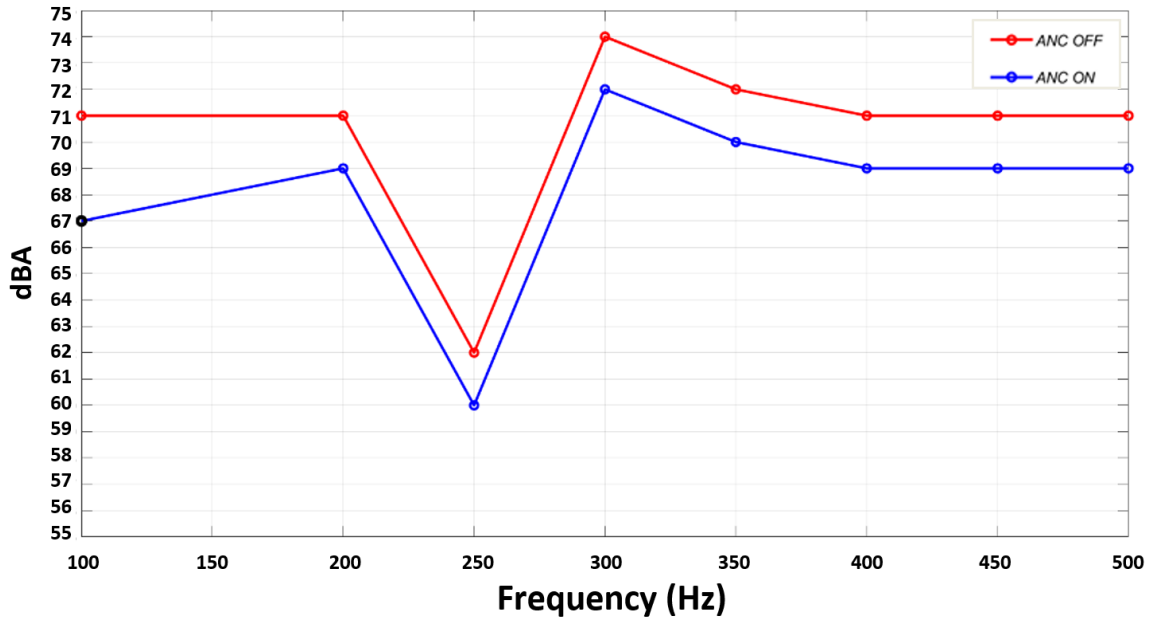
4.2.1 Raspberry Pi System Testing using Three Different Mediums (Sound Meter, Mobile Application, and MATLAB)



Note. See Appendix A, Table A1

Figure 11. Results for Raspberry Pi System Testing using MATLAB

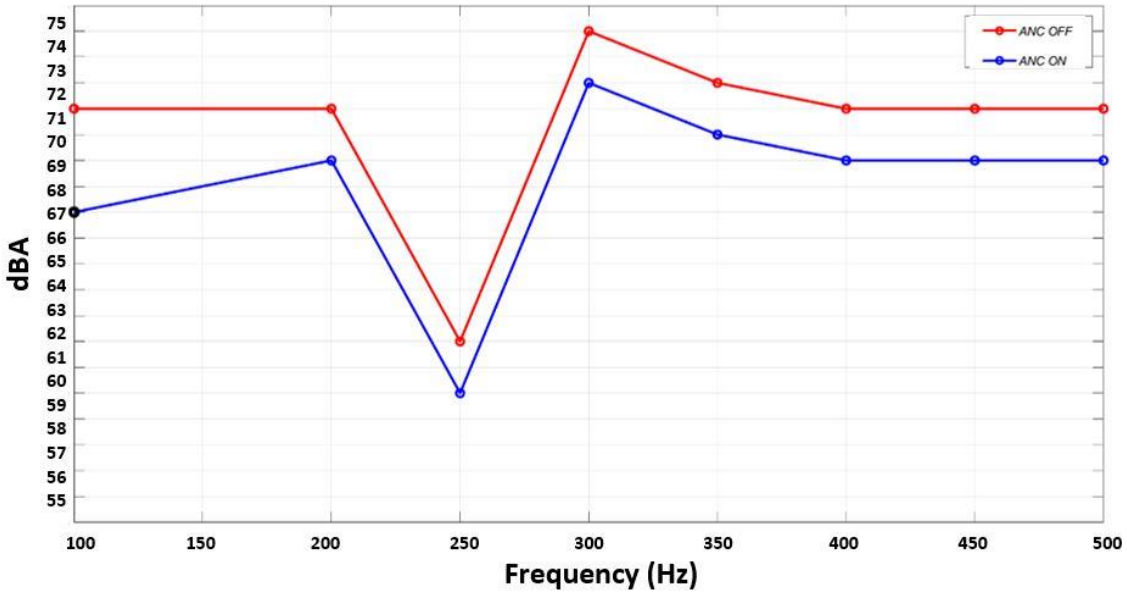
Figure 11 shows that the system can acquire an approximate of 5 dBm reduction of noise in the 100 Hz which means that the higher the frequency, the lesser reduction the system can get using MATLAB for the Raspberry Pi system testing.



Note. See Appendix A, Table A2

Figure 12. Results for Raspberry Pi Program System Testing using Mobile Application

Figure 12 shows that the system can acquire an approximate of 5 dBA reduction of noise in the 100 Hz which means that the higher the frequency, the lesser reduction the system can get using Mobile Application for the Raspberry Pi system testing.

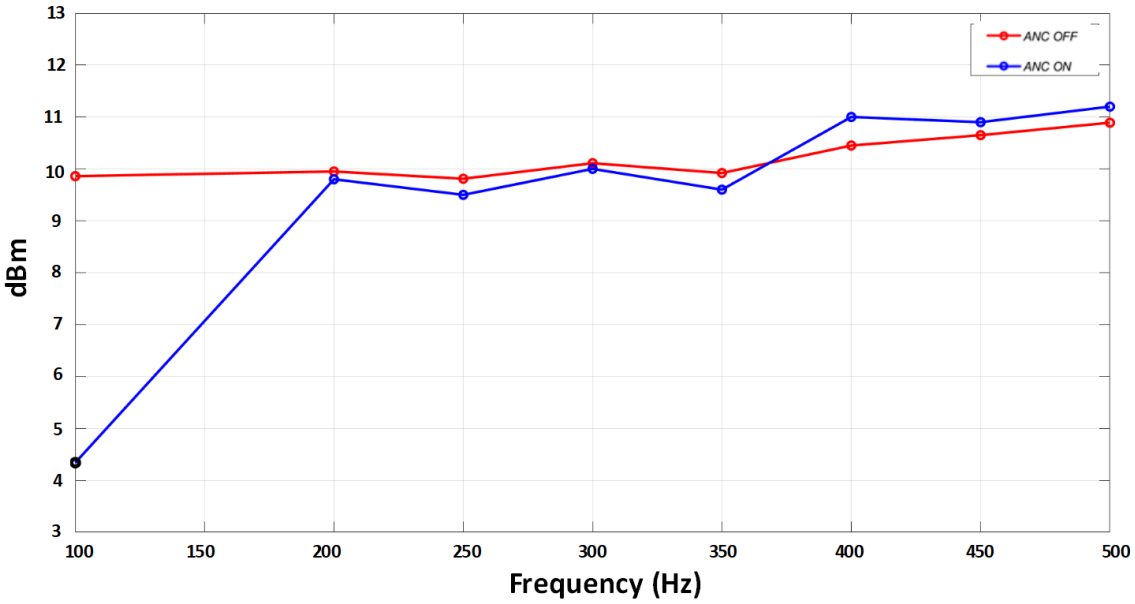


Note. See Appendix A, Table A3

Figure 13. Results for Raspberry Pi System Testing using Sound Meter

Figure 13 shows that the system can acquire an approximate of 5 dBA reduction of noise in the 100 Hz which means that the higher the frequency, the lesser reduction the system can get using Sound Meter for the Raspberry Pi system testing.

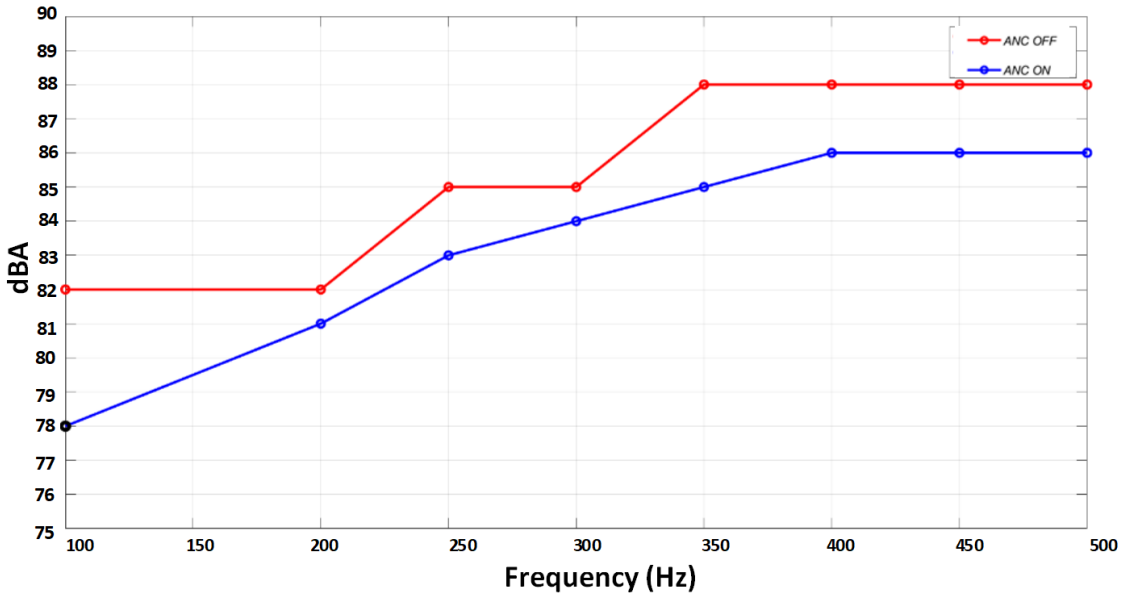
4.2.2 STM32F407 System Testing using Three Different Mediums (Sound Meter, Mobile Application, and MATLAB)



Note. See Appendix A, Table A4

Figure 14. Results for STM32F407 System Testing using MATLAB

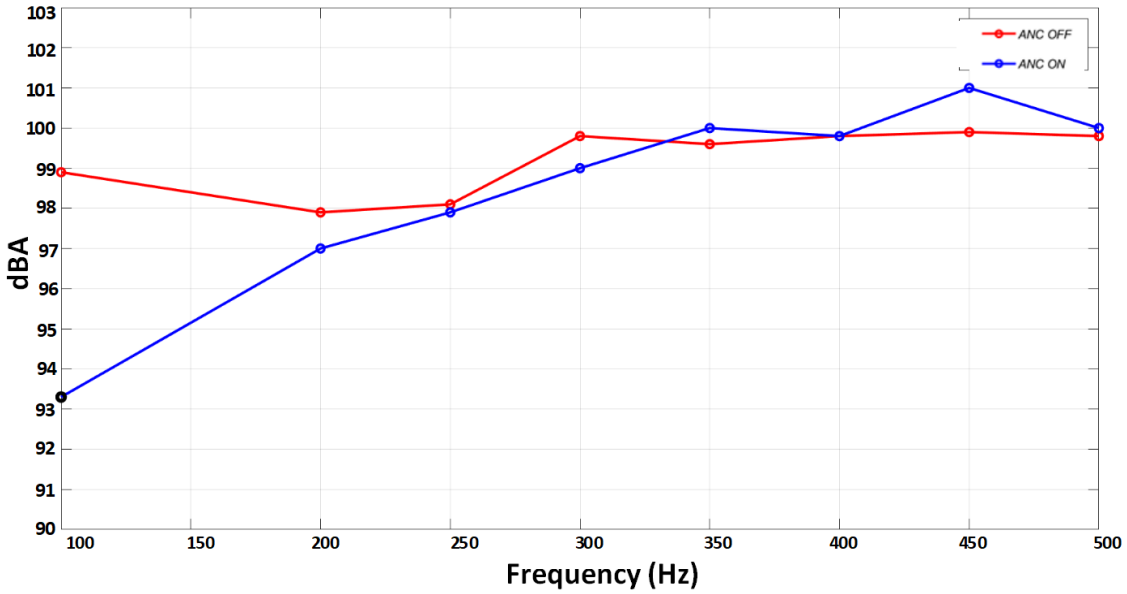
Figure 14 shows that the system can acquire an approximate of 5 dBm reduction of noise in the 100 Hz which means that the higher the frequency, the lesser reduction the system can get using MATLAB for the STM32F407 system testing.



Note. See Appendix A, Table A5

Figure 15. Results for STM32F407 System Testing using Mobile Application

Figure 15 shows that the system can acquire an approximate of 5 dBA reduction of noise in the 100 Hz which means that the higher the frequency, the lesser reduction the system can get using Mobile Application for the STM32F407 system testing.



Note. See Appendix A, Table A6

Figure 16. Results for STM32F407 System Testing using Sound Meter

Figure 16 shows that the system can acquire an approximate of 5 dBA reduction of noise in the 100 Hz which means that the higher the frequency, the lesser reduction the system can get using Sound Meter for the STM32F407 system testing.

4.2.3 Raspberry Pi and STM32F407 System Testing for Continuous 100 Hz Test Tone Signal for 10 Minutes

Table 1
Raspberry Pi System Testing for Continuous 100 Hz Test Tone Signal for 10 Minutes

	Without ANC System	With ANC System
Sound Meter	97.7 dBA	92.8 dBA
Mobile Application	85 dBA	82 dBA
MATLAB	8.11 dBm	3.20 dBm

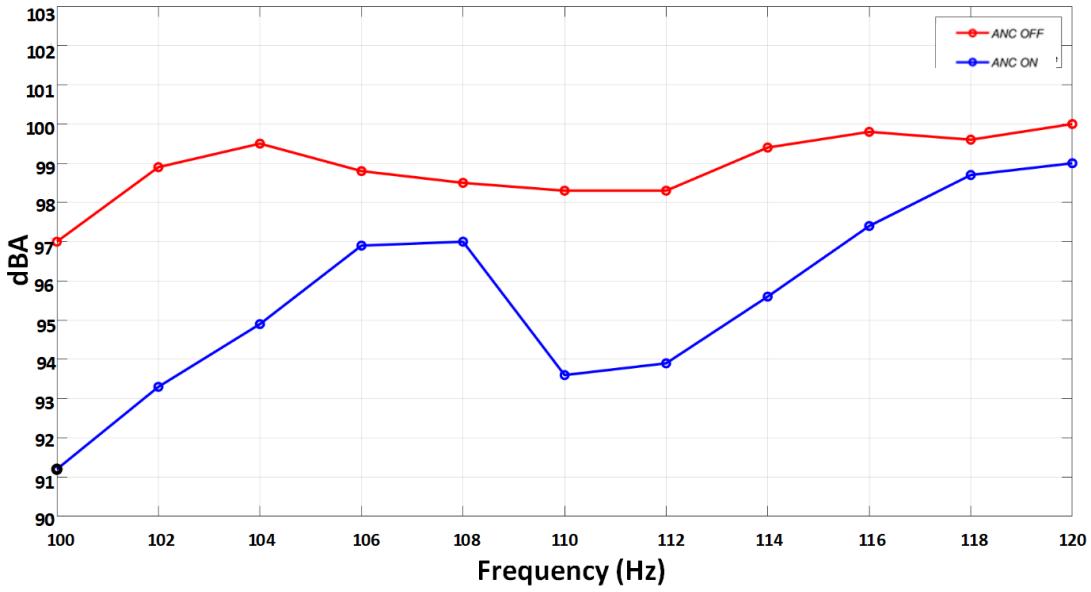
Table 1 shows that the Raspberry Pi system tested for 10 minutes long continuous test tone signal of 100 Hz has a stable reduction of approximately 5 dBm using MATLAB and 5 dBA using Sound Meter and Mobile Application.

Table 2
STM32F407 System Testing for Continuous 100 Hz Test Tone Signal for 10 Minutes

	Without ANC System	With ANC System
Sound Meter	98.9 dBA	93.3 dBA
Mobile Application	85 dBA	82 dBA
MATLAB	9.86 dBm	4.34 dBm

Table 2 shows that the STM32F407 system tested for 10 minutes long continuous test tone signal of 100 Hz has a stable reduction of approximately 5 dBm using MATLAB and 5 dBA using Sound Meter and Mobile Application.

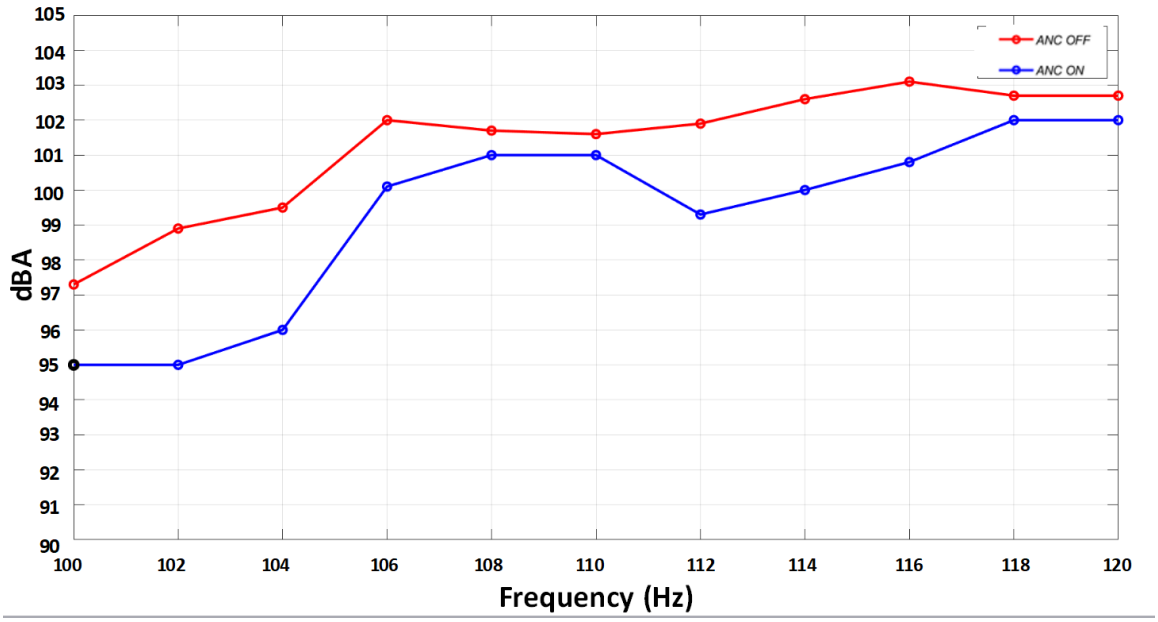
4.2.4 Raspberry Pi and STM32F407 System Testing using Different Step Size



Note. See Appendix A, Table A7

Figure 17. Results for Raspberry Pi System Testing using 0.2 Step Size

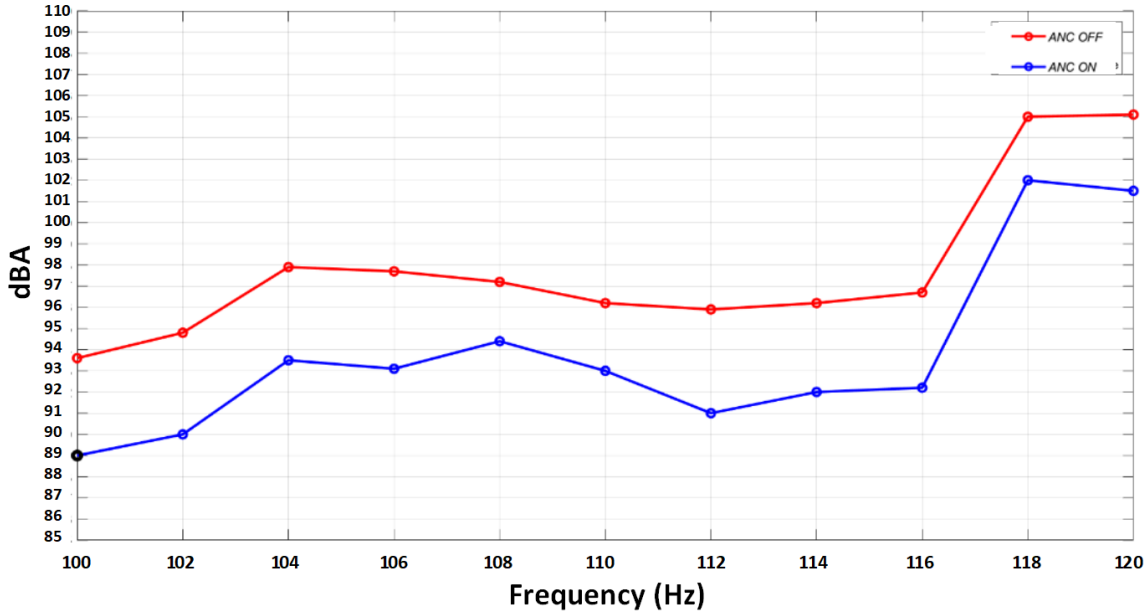
Figure 17 shows that the Raspberry Pi system tested using 0.2 step size has a stable reduction of approximately 5 dBA from 100 Hz to 120 Hz frequency range.



Note. See Appendix A, Table A8

Figure 18. Results for Raspberry Pi System Testing using 0.09 Step Size

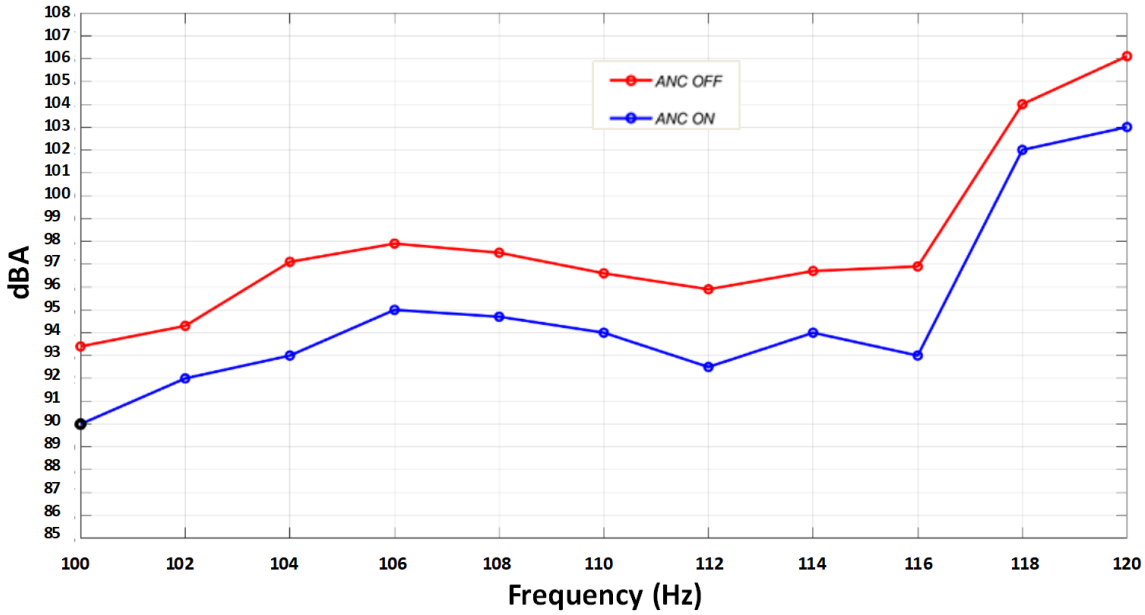
Figure 18 shows that the Raspberry Pi system tested using 0.09 step size has a stable reduction of approximately 3 dBA from 100 Hz to 120 Hz frequency range.



Note. See Appendix A, Table A9

Figure 19. Results for STM32F407 System Testing using 0.2 Step Size

Figure 19 shows that the Raspberry Pi system tested using 0.2 step size has a stable reduction of approximately 5 dBA from 100 Hz to 120 Hz frequency range.



Note. See Appendix A, Table A10

Figure 20. Results for STM32F407 System Testing using 0.09 Step Size

Figure 20 shows that the STM32F407 system tested using 0.09 step size has a stable reduction of approximately 3 dBA from 100 Hz to 120 Hz frequency range.

4.2.5 30 Trials for Raspberry Pi and STM32F407 in Different Frequencies using Sound Meter

Table 3
Summary of Data Findings for the 30 Trials for Raspberry Pi in Different Frequencies using Sound Meter

Frequency	Average Noise Level (Without ANC)	Average Noise Level (With ANC)	Noise Reduction
100 Hz	**97.58 dBA**	**91.18 dBA**	**6.4 dBA**
102 Hz	99.02 dBA	93.15 dBA	5.87 dBA
104 Hz	99.45 dBA	94.97 dBA	4.48 dBA
106 Hz	98.74 dBA	96.89 dBA	1.85 dBA
108 Hz	98.58 dBA	97.20 dBA	1.38 dBA
110 Hz	98.27 dBA	93.59 dBA	4.68 dBA

Note. See Appendix A, Table A11 – Table A16 for table breakdowns.

Table 3 shows that using 0.2 step size through 30 trials, the Raspberry Pi system has an optimum frequency of 100 Hz wherein there is a greater reduction of 6.4 dBA.

Table 4
Summary of Data Findings for the 30 Trials for STM32F407 in Different Frequencies using Sound Meter

Frequency	Average Noise Level (Without ANC)	Average Noise Level (With ANC)	Noise Reduction
100 Hz	**93.52 dBA**	**87.17 dBA**	**6.35 dBA**
102 Hz	94.76 dBA	87.45 dBA	7.31 dBA
104 Hz	97.94 dBA	90.89 dBA	7.05 dBA
106 Hz	97.70 dBA	93.23 dBA	4.47 dBA
108 Hz	97.24 dBA	94.32 dBA	2.92 dBA
110 Hz	97.18 dBA	90.53 dBA	6.65 dBA

Note. See Appendix A, Table A17 – Table A22 for table breakdowns.

Table 4 shows that using 0.2 step size through 30 trials, the STM32F407 system has an optimum frequency of 100 Hz having a greater stable reduction of 6.35 dBA.

4.2.6 Average Noise Level Reduction With and Without the System

Table 5
Summary of Data Findings for the Average Noise Level Reduction of Raspberry Pi System Testing for 100 Hz with Different dBA

Decibel Level	Average Noise Level (Without ANC)	Average Noise Level (With ANC)	Noise Reduction
100 dBA	100 dBA	94.86 dBA	5.14 dBA
102 dBA	102 dBA	96.70667 dBA	5.29 dBA
104 dBA	104 dBA	98.93667 dBA	5.06 dBA
106 dBA	106 dBA	101.0167 dBA	5.08 dBA
108 dBA	108 dBA	103.03 dBA	5.07 dBA

Table 5 shows that the trials performed using different decibel levels ranging from 100dBA-108dBA of the same optimum frequency which is 100Hz. The Active Noise

Control system using 0.2 step size is still stable and at its maximum noise reduction of approximately 5 dBA as the dBA levels of its frequency increases.

4. 3 Set-Up

Parallel set-up works best with higher frequency since the wavelength is shorter and the distance is almost impractical. Destructing the noise is easier in perpendicular since wavelength is very short and peaks are easier to hit sideways.

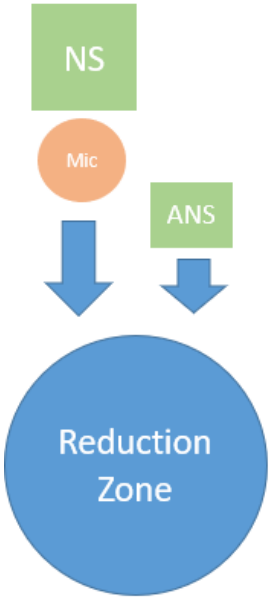


Figure 21. Deployment Parallel Set-Up

Perpendicular set-up which works best with low frequency since the wavelength is longer and the distance of NS and ANS is workable. Destructing the Noise is easier since wavelength is long and pos/neg peaks are easy to hit.

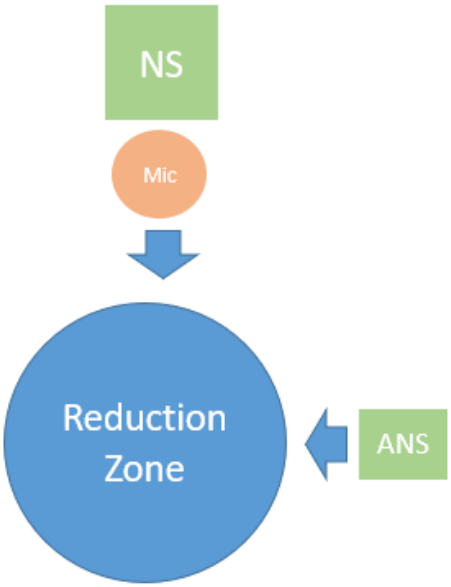


Figure 22. Deployment Perpendicular Set-Up

Table 6
Noise Reduction at 100Hz with Different Loudness and Set-Up

100Hz				
Noise	Loudness	Setup	Reduction	Remarks
Deep Humming (Tolerable)	75dBA	Parallel	0dBA to 1 dBA	Noise is almost inaudible. Reduction is low due to almost inaudible noise.
Deep Humming (Tolerable)	75dBA	Perpendicular	0dBA	Same observation but no reduction.
Loud Deep Humming	100dBA	Parallel	0dBA to 2dBA	Noise is audible with less-to-no reduction.
Loud Deep Humming	**100dBA**	**Perpendicular**	**3dBA to 5dBA**	**Noise is audible with significant reduction.**

Table 6 shows that the loud deep humming in the audible noise has a significant reduction of 3 dBA to 5 dBA in a perpendicular set-up as compared to other types of noise in two different set-ups.

Table 7
Noise Reduction at 300Hz with Different Loudness and Set-Up

300Hz				
Noise	Loudness	Setup	Reduction	Remarks
Fairly deep Humming (Tolerable)	75dBA	Parallel	1dBA to 2dBA	Noise is audible. Reduction is low due to low volume.
	75dBA	Perpendicular	0dBA to 1 dBA	Same observation but with less reduction.
Loud Deep Humming	100dBA	Parallel	5dBA to 6dBA	Noise is audible with significant reduction.
	100dBA	Perpendicular	0dBA to 2dBA	Noise is audible with less-to-no reduction.

Table 7 shows that the loud deep humming in the audible noise has low reduction due to low volume or no reduction at all in all types of noise in different set-ups.

Table 8
Noise Reduction at 500Hz with Different Loudness and Set-Up

500Hz				
Noise	Loudness	Setup	Reduction	Remarks
Middle Pitch tone (Tolerable)	75dBA	Parallel	2dBA to 3dBA	Noise is audible. Reduction is low due to low volume.
	75dBA	Perpendicular	0dBA to 2 dBA	Same observation but with less reduction.
Loud Deep Humming	100dBA	Parallel	4dBA to 5dBA	Noise is audible with significant reduction.
	100dBA	Perpendicular	2dBA to 3dBA	Noise is audible with greater reduction as compared to lower frequencies.

Table 8 shows that the loud deep humming in the audible noise has a significant reduction of 2 dBA to 5 dBA.

Table 9
Noise Reduction at 1000Hz with Different Loudness and Set-Up

1000Hz				
Noise	Loudness	Setup	Reduction	Remarks
High Pitch tone (Intolerable)	75dBA	Parallel	0dBA to 1dBA	Noise is unbearable even at low volume. No reduction
	75dBA	Perpendicular	3dBA to 4dBA	Same observation but with greater reduction. No reduction
High Pitch tone (Intolerable)	100dBA	Parallel	0dBA to 1dBA	Noise is unbearable even at low volume.
	100dBA	Perpendicular	3dBA to 4dBA	Same observation but with greater reduction.

Table 9 shows that the audible noise is unbearable and has no reduction in the different set-ups.

The overall data gathered shows that low frequencies are perceived as quieter than high frequencies, thus reduction is almost impractical. Higher frequencies, even at low volumes are intolerable. Equipment used tend to react better at high frequency and thus easier to detect and work with.

4.4 Evaluation of Speakers

Table 10
Specifications of Different Speakers

Brand	Power	Impedance	Loudness	Frequency of Operation
Kevler Pro Eon-12	500 Watts	4 Ohms	95 dB	45 Hz to 20 kHz
SPL Professional	800 Watts	4 Ohms	96 dB	42 Hz to 20 kHz
Cort MX30R	365 Watts	7 Ohms	85 dB	43 Hz to 21 kHz
MIKATA M-SUB1302BT	100 Watts	4 Ohms	85 dB	18 Hz to 20 kHz

Table 10 shows the specifications of the different speakers that have been evaluated during the study.

Figure 23. MIKATA M-SUB1302BT Multimedia Speaker System

Figure 23 shows the MIKATA M-SUB1302BT Multimedia Speaker System and its product specifications shown in Table 11 that is used in the specific deployment due to the following factors (Shan Hu, 2012):

1. With only 100 Watts power consumption, the deployment will not cause any additional cost to the consumer thus; can be more significant than irrelevant.

2. As measured to the proposed deployment area, the maximum loudness of the noise is 81 dBA. A smaller speaker with 85 dB maximum output is more than enough for the deployment.

3. Has a wide range of frequency response from 18 Hz - 20 kHz.

4. Has low harmonic distortion of < 0.1 %.

Table 11 *Product Specifications of MIKATA M-SUB1302BT Multimedia Speaker System*	
Product Specifications	
Power Output	100 w + 50 w x2
Speaker Unit	Subwoofer 6.5" 4 Ohm
Satellite	3" x 2 4 Ohms
S/N	> 70 dB
Distortion	< 0.1%
Separation	> 65 dB
Frequency Response	18 Hz – 20 kHz

4.5 Actual Deployment

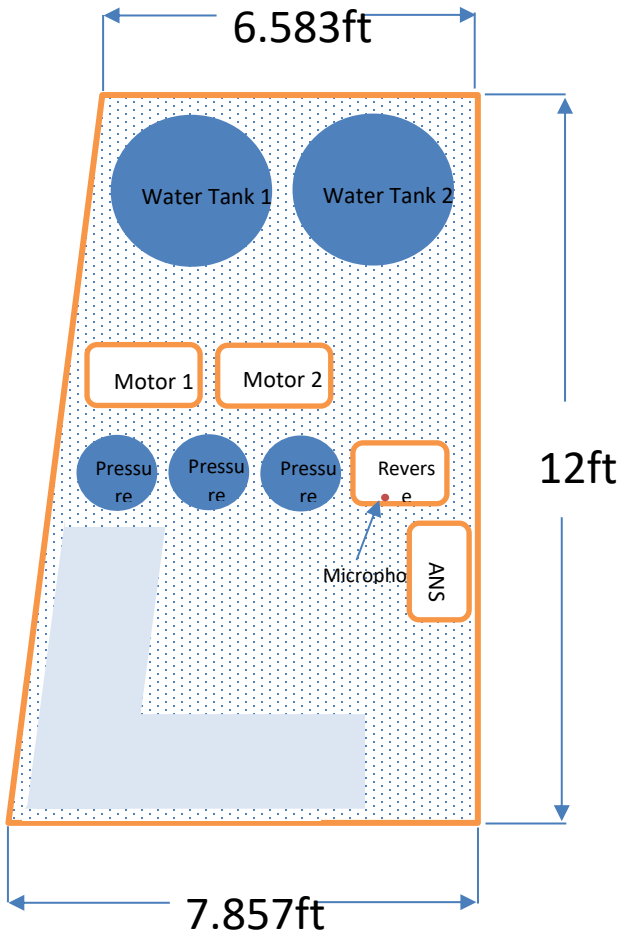


Figure 24. Deployment Set-Up in the Refilling Station

The system was deployed in Chelesea Water Refilling Station in 177 Fernandez St., Brgy. San Antonio, San Francisco del monte, Quezon City. The location was chosen because of the following factors:

- Noise experienced by the employees is loud measuring 81-83 dBA.
- Rumbling sounds (low frequency: 100Hz) is significant in the area.

Figure 25 and Figure 26 shows the perpendicular setup used in the actual deployment area for effective noise level reduction.

Figure 25. Perpendicular Set-Up at the Right Motor Pump of the Water Refilling Station

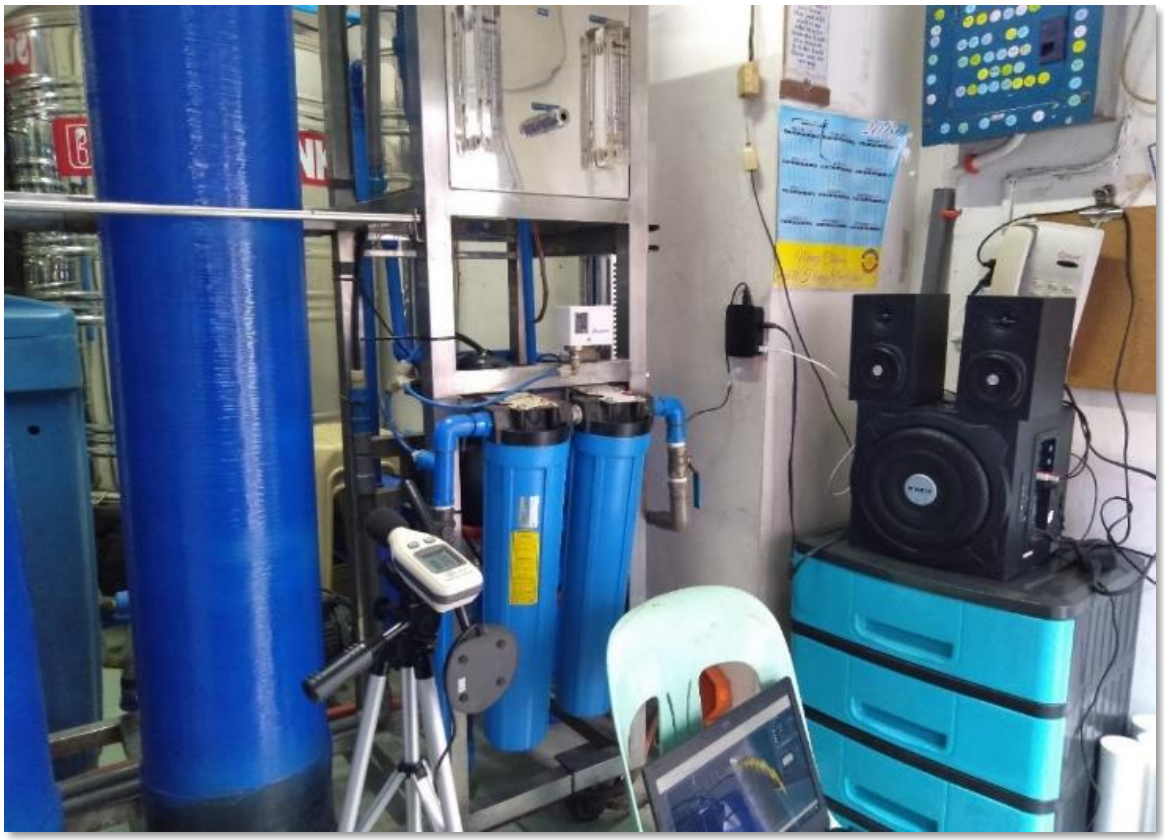
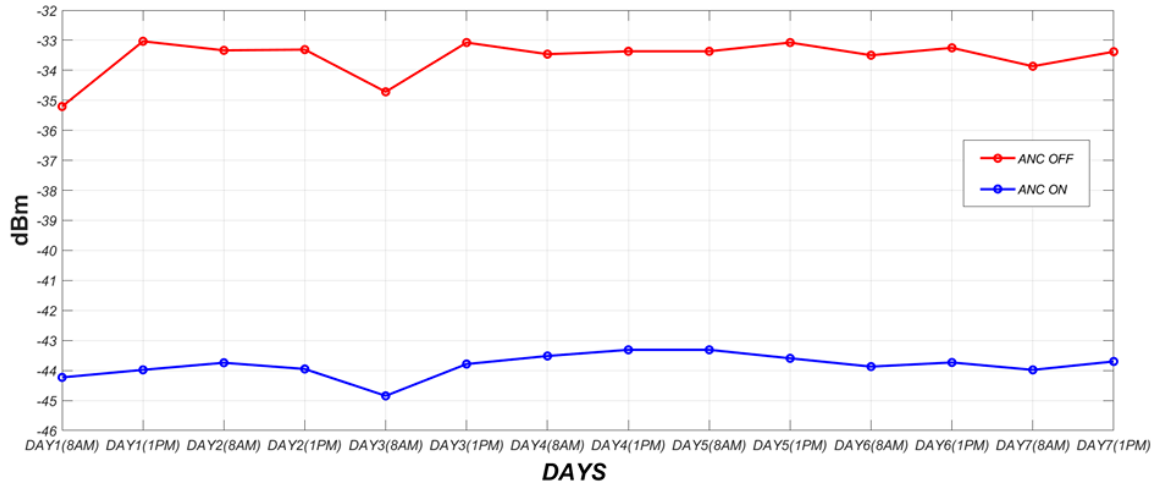


Figure 26. Perpendicular Set-Up at the Left Motor Pump of the Water Refilling Station

Table 12
Noise Reduction in Different Set-Up in Deployment Area

Data Gathered for Noise Reduction				
Noise	Loudness	Setup	Reduction	Remarks
Water pumps Noise perceived as mix of rumbling and hissing noises.	85 dBA	Perpendicular	0-3 dBA	Hissing noises are still present but rumbling noises are significantly reduced
	85 dBA	Parallel	0 dBA	No reduction and as observed the anti-noise source adds more noise to the environment from 2-3 dBA

Table 12 shows the two set ups tested in the deployment area to find the best configuration to achieved optimum reduction.



Note. See Appendix A, Table A37

*See Appendix A, Table A23 – A36 for table breakdowns.

Figure 27. Results for Data Gathered in 7 Days

Figure 27 shows that the system is stable with 10dBm reduction at 100Hz frequency component of the noise both from morning and afternoon as observed in 7 days.

4.6 Comparison of the Three Modules

Table 13
Autonomy with Regards to Installation between each ANC System

	Is the microcontroller available in the Philippines?	Total Cost of the System	Can the system be installed alone by one person?	Does the system need professional assistance when in use?
Arduino Due	Yes	-	-	-
Raspberry Pi	Yes	Php 12,019	Yes	No
STM32F407	No	Php 12,500	No	No

Table 13 shows that the Arduino due was not installed in the system due to the lack of capability for noise reduction. Raspberry Pi has the cheapest total cost of the system with its ability to be installed alone by one person and there is no need for professional assistance.

Table 14
Product Specifications

Specification	Raspberry Pi	Arduino Due	STM32F407
Clock speed	1.2 GHz	84 MHz	168 MHz
Interfaces	4 USB ports for devices 3.5mm Audio Jack GPIO pins	All GPIO pins	Cavity Mems Mic 3.5mm Audio GPIO pins
ADC/DAC	Yes	Yes	Yes
Implementation	Simulink/MATLAB	Manual C#/C++ Programming Code	Simulink/MATLAB

Table 14 shows that the Raspberry Pi has the greatest capability in terms of its clock speed, interfaces, ADC/DAC, and implementation.

Table 15
Self-Adaptability between each ANC System

	Operating Temperature	Frequency (Hz) at which the system is stable	Distance (m) at which the system is stable	Response to command signal (Delay in s)
Arduino Due	-40°C to + 85°C	-	-	-
Raspberry Pi	0°C to + 50°C (Environment)	100 Hz	< 1 ft.	0.5 sec
STM32F407	-40°C to + 105°C	100 Hz	< 1 ft.	No delay

Table 15 shows that the STM32F407 has the greatest factor in terms of its self-adaptability having no delay and higher operating temperature.

Table 16
Robustness and Reliability between each ANC System

	How frequent does the system needs update? (mins, hours, or days)	Frequency (Hz) at which the system is stable	Distance (m) at which the system is stable	Response to command signal (Delay in s)
Arduino Due	-	-	-	-
Raspberry Pi	every 6 hours	low	7-10	28% - 33% reduction in 100 Hz
STM32F407	every 6 hours	high	7-10	28% - 30% reduction in 100 Hz

Table 16 shows that both Raspberry Pi and STM32F407 need to be updated for every 6 hours and amount of distance by which the system is stable with almost the same response to command signal but has opposite frequencies by which they are stable.

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary of Findings

The most basic and biggest factor determined for the implementation, is the clock speed of the platforms. STM32F407 and Arduino are microcontrollers thus; do not require very high clock speed for their implementations. Signal/Audio processing would require very fast system since algorithms will calculate the outputs in high number of iterations. Raspberry Pi is advantageous with its 1.4 GHz processing speed.

The project will not be possible without the correct interfacing of the mics and speakers. STM32F407 contains an on-board cavity mems mic that reproduces high quality sound. STM32F407, like the Raspberry Pi, also contains an on-board 3.5 mm Audio jack for the speaker. Using the Arduino, on the other hand, would require the system to use additional modules to interface the addition of mic and an audio jack for the speaker. Adding modules would entail adding white noise to the system. STM32F407 is advantageous with its Cav-mems mic and audio jack. However, the flexibility of positioning of microphone will be compromised since the microphone of STM32F407 is embed on-board.

All platforms can perform ADC & DAC and do not pose any disadvantage on this aspect. Using the Arduino Due, would require the system to be design with using hard coding and ultimately, may cause errors. Simulink/MATLAB supports both Raspberry Pi and STM32F407. Using the programmer, the system can be designed using ready-made blocks that are accurate and easy to use.

5.2 Conclusions

This project was aimed to conduct a comparative study of Arduino, Raspberry Pi, and STM32F407 based active noise control system through machine noise level reduction using MATLAB for adaptive signal processing. The study focused on the following:

1. Normalized Least Mean Square algorithm was used in the ANC systems to reproduce the desired output which is the inverted noise. After the addition of real-life factors, it was observed that the ANC systems are stable, so it is proven that the algorithm is 100% working, the other factor to consider again in case of unstable noise reduction is the capability of the microphone and the microcontrollers. Upon final deployment of the project, the NLMS algorithm was not a perfect algorithm to fully cancel the noises 100% but there was a significant reduction.

2. Interpreting the results taken, the Raspberry Pi and STM32F407 modules does not have a true analog output, the maximum reduction the system can acquire for both Raspberry Pi and STM32F407 modules is 5 dBA, the optimum frequency where the reduction of noise is most stable for both Raspberry Pi and STM32F407 modules is 100 Hz and a step size of 0.2 is the most suitable step size to be used in the Simulink model of the systems for a greater reduction. Raspberry Pi and STM32F407 were compared, based on the results, Raspberry Pi fitted best for the final implementation. Two set ups were made, parallel and perpendicular set up, parallel set up produces no reduction and perpendicular set up produces 0-3 dBA reduction, thus making it suitable for final implementation.

3. Prior to deployment, different speakers were tested and compared, result showed that MIKATA M-SUB1302BT was the appropriate speaker to use because of the following

factors: (a) With only 100 Watts power consumption, the deployment will not cause any additional cost to the consumer thus; can be more significant than irrelevant; (b) As measured to the proposed deployment area, the maximum loudness of the noise is 81 dBA. A smaller speaker with 85 dB maximum output is more than enough for the deployment; (c) Has a wide range of frequency response from 18 Hz – 20 kHz; (d) Has low harmonic distortion of < 0.1 %.

4. Final implementation was into the water station pumps for it produces noise with significant 100 Hz frequency component thus making the device effective if implemented. The system was observed for 7 days during peak hours of operation of the water station, actual dBA was measured, and spectrum analyzer was also used to observed different frequency components of the noise. Data were gathered and analyzed, results shows that the system was able to reduce 0 dBA - 3 dBA of sound, and 10 dBm reduction to the 100 Hz frequency component, thus reducing the rumbling sound (caused by 100 Hz) of the noise.

5.3 Recommendations

The following can be recommended for the future progress of the study:

• Use multiple speakers, amplifiers and module for a greater reduction of noise.

• A high-performance DSP module is recommended for a lesser delay of performance.

• For effective implementation find a noise source with significant and stable low frequency component.

• Consider combining passive and active control for broader frequency operations.

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Appendix A – Tables

Table A1

Raspberry Pi System Testing using MATLAB

Frequency (Hz)	Without ANC System (dBm)	With ANC System (dBm)
100	6.21	2.07
200	7.41	2.87
250	6.11	2.13
300	6.34	2.15
350	6.89	2.44
400	7.34	2.54
450	7.45	2.77
500	6.21	2.03

Table A2

Raspberry Pi System Testing using Mobile Application

Frequency (Hz)	Without ANC System (dBA)	With ANC System (dBA)
100	71	67
200	71	69
250	62	60
300	74	72
350	72	70
400	71	69
450	71	69
500	71	69

Table A3

Raspberry Pi System Testing using Sound Meter

Frequency (Hz)	Without ANC System (dBA)	With ANC System (dBA)
100	80	74
200	80	79.8
250	70	69.5
300	75	73.8
350	80	77.7
400	80	79.5
450	80	79.5
500	80	79.6

Table A4

STM32F407 System Testing using MATLAB

Frequency (Hz)	Without ANC System (dBm)	With ANC System (dBm)
100	9.86	4.34
200	9.95	4.49
250	9.81	4.61
300	10.11	5.56
350	9.92	5.12
400	10.45	6.14
450	10.65	6.44
500	10.89	6.86

Table A5

STM32F407 System Testing using Mobile Application

Frequency (Hz)	Without ANC System (dBA)	With ANC System (dBA)
100	82	79
200	82	78
250	85	83
300	85	84
350	88	85
400	88	86
450	88	86
500	88	86

Table A6

STM32F407 System Testing using Sound Meter

Frequency (Hz)	Without ANC System (dBA)	With ANC System (dBA)
100	98.9	93.3
200	97.9	93.1
250	98.1	93.2
300	99.8	94.6
350	99.6	94.9
400	99.8	94.8
450	99.9	94.9
500	99.8	95.8

Table A7

Raspberry Pi System Testing using 0.2 Step Size

Frequency (Hz)	Without ANC (dBA)	With ANC (dBA)
100	97	91.2
102	98.9	93.3
104	99.5	94.9
106	98.8	96.9
108	98.5	97
110	98.3	93.6
112	98.3	93.9
114	99.4	95.6
116	99.8	97.4
118	99.6	98.7
120	100	99

Table A8

Raspberry Pi System Testing using 0.09 Step Size

Frequency (Hz)	Without ANC (dBA)	With ANC (dBA)
100	97.3	90
102	98.9	91.8
104	99.5	95.5
106	102	100.1
108	101.7	101
110	101.6	101
112	101.9	99.3
114	102.6	97.2
116	103.1	100.8
118	102.7	102
120	102.7	102

Table A9

STM32F407 System Testing using 0.2 Step Size

Frequency (Hz)	Without ANC (dBA)	With ANC (dBA)
100	93.6	87.1
102	94.8	87.5
104	97.9	90.8
106	97.7	93.1
108	97.2	94.4
110	96.2	90.4
112	95.9	91
114	96.2	90.1
116	96.7	89.4
118	105	97.7
120	105.1	101.5

Table A10

STM32F407 System Testing using 0.09 Step Size

Frequency (Hz)	Without ANC (dBA)	With ANC (dBA)
100	93.4	87.2
102	94.3	87.1
104	97.1	90.6
106	97.9	93.3
108	97.5	94.7
110	96.6	91
112	95.9	91
114	96.7	90.6
116	96.9	89.6
118	104	96.7
120	106.1	102.5

Table A11

Raspberry Pi System Testing for 100 Hz using 0.2 Step Size

100 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	97	91.2
2	97.2	91.1
3	97	91.2
4	97.1	91.3
5	97	91.4
6	97.1	91.2
7	97.3	91.1
8	97	91.1
9	97.6	91.3
10	97.4	91.2
11	97.3	91.3
12	97.2	91.2
13	97.2	91.1
14	97.2	91.2
15	97.7	91.2
16	97.7	91.2
17	97.7	91.1
18	97	91.3
19	97	91.2
20	98	91.3
21	98.2	91
22	98	91
23	98.3	91.1
24	98	91.3
25	98.5	91
26	98	91.1
27	98.4	91
28	98	91.1
29	98.1	91.2
30	98.2	91.3
AVERAGE	97.58	91.17666667

Table A12

Raspberry Pi System Testing for 102 Hz using 0.2 Step Size

102 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	98.9	93
2	98.9	93.3
3	98.9	93
4	99	93
5	99.1	93
6	99.1	93.5
7	99	93.5
8	98.9	93
9	98.9	93.2
10	99	93.3
11	99	93.3
12	99	93.3
13	99	93.3
14	99.1	93
15	99.1	93
16	99.1	93
17	99.1	93
18	99.1	93.2
19	99	93.2
20	99.1	93.2
21	99	93.2
22	99	93.1
23	99.1	93.1
24	99.1	93.1
25	99	93
26	99.1	93
27	99	93.4
28	99.1	93.2
29	99	93
30	99	93.1
AVERAGE	99.02333333	93.15

Table A13

Raspberry Pi System Testing for 104 Hz using 0.2 Step Size

104 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	99.5	95
2	99.5	95.4
3	99.5	95.1
4	99.5	95
5	99.4	95
6	99.4	95.3
7	99.4	95
8	99.4	95
9	99.4	95.2
10	99.4	94.9
11	99.4	94.9
12	99.2	94.6
13	99.5	94.9
14	99.5	94.8
15	99.5	94.5
16	99.5	94.6
17	99.4	94.9
18	99.4	94.9
19	99.4	94.9
20	99.4	94.3
21	99.4	94.9
22	99.4	94.8
23	99.5	95
24	99.5	95
25	99.5	95
26	99.5	95.5
27	99.5	95.1
28	99.5	95.4
29	99.5	95.2
30	99.5	95
AVERAGE	99.44666667	94.97

Table A14

Raspberry Pi System Testing for 106 Hz using 0.2 Step Size

106 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	98.8	97
2	98.8	97.1
3	98.7	97
4	98.8	97
5	98.9	96.9
6	98.8	96.9
7	98.6	96.9
8	98.8	96.6
9	98.8	96.8
10	98.7	96.9
11	98.8	96.5
12	98.8	96.9
13	98.9	96.6
14	98.8	96.9
15	98.8	96.4
16	98.8	96.9
17	98.4	96.6
18	98.8	97.1
19	98.5	97.3
20	98.8	97.1
21	98.8	97.1
22	98.8	97.5
23	98.8	97.1
24	98.4	97.6
25	98.8	96.9
26	98.7	96.8
27	98.8	96.9
28	98.9	96.2
29	98.8	96.9
30	98.4	96.3
AVERAGE	98.74333333	96.89

Table A15

Raspberry Pi System Testing for 108 Hz using 0.2 Step Size

108 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	98.5	97.2
2	98.5	97
3	98.7	97.1
4	98.8	97
5	98.5	97.2
6	98.5	97.1
7	98.9	97.1
8	98.5	97.1
9	98.5	97.3
10	98.6	97.1
11	98.5	97.4
12	98.4	97.1
13	98.7	97.1
14	98.5	97.5
15	98.6	97.4
16	98.5	97.1
17	98.5	97.2
18	98.4	97
19	98.5	97.3
20	98.7	97
21	98.5	97.5
22	98.5	97
23	98.8	97.5
24	98.5	97
25	98.9	97.8
26	98.5	97
27	98.6	97.4
28	98.5	97.3
29	98.5	97
30	98.7	97.1
AVERAGE	98.57666667	97.19666667

Table A16

Raspberry Pi System Testing for 110 Hz using 0.2 Step Size

110 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	98.3	93.6
2	98.2	93.6
3	98.3	93.5
4	98.1	93.7
5	98.4	93.6
6	98.3	93.6
7	98.3	93.6
8	98.3	93.5
9	98.2	93.6
10	98.3	93.4
11	98.3	93.6
12	98.5	93.7
13	98.3	93.6
14	98.3	93.8
15	98.4	93.4
16	98.3	93.5
17	98.3	93.6
18	98.2	93.6
19	98.1	93.6
20	98.3	93.6
21	98.3	93.5
22	98.4	93.6
23	98.3	93.7
24	98.3	93.6
25	98.2	93.6
26	98.1	93.8
27	98.1	93.6
28	98.3	93.5
29	98.2	93.6
30	98.2	93.5
AVERAGE	98.27	93.59

Table A17

STM32F407 System Testing for 100 Hz using 0.2 Step Size

100 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	93.6	87.1
2	93.6	87.1
3	93.4	87.2
4	93.6	87.1
5	93.5	87.3
6	93.6	87.1
7	93.5	87.3
8	93.6	87.1
9	93.5	87.3
10	93.5	87.3
11	93.4	87.2
12	93.4	87.2
13	93.6	87.1
14	93.5	87.3
15	93.6	87.1
16	93.6	87.1
17	93.4	87.2
18	93.4	87.2
19	93.6	87.1
20	93.5	87.3
21	93.6	87.1
22	93.6	87.1
23	93.5	87.3
24	93.6	87.1
25	93.4	87.2
26	93.6	87.2
27	93.3	87
28	93.6	87.1
29	93.5	87.3
30	93.6	87.1
AVERAGE	93.52333333	87.17333333

Table A18

STM32F407 System Testing for 102 Hz using 0.2 Step Size

102 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	94.8	87.5
2	94.7	87.4
3	94.8	87.5
4	94.7	87.4
5	94.8	87.5
6	94.8	87.5
7	94.8	87.5
8	94.6	87.3
9	94.8	87.5
10	94.6	87.3
11	94.8	87.5
12	94.7	87.4
13	94.8	87.5
14	94.6	87.3
15	94.7	87.4
16	94.8	87.5
17	94.8	87.5
18	94.9	87.5
19	94.9	87.5
20	94.8	87.5
21	94.8	87.5
22	94.6	87.3
23	94.8	87.5
24	94.8	87.5
25	94.7	87.4
26	94.7	87.4
27	94.8	87.5
28	94.9	87.5
29	94.7	87.5
30	94.9	87.5
AVERAGE	94.76333333	87.45333333

Table A19

STM32F407 System Testing for 104 Hz using 0.2 Step Size

104 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	97.9	90.8
2	97.8	90.7
3	97.9	90.8
4	97.8	90.7
5	97.9	90.8
6	97.7	90.6
7	97.7	90.6
8	97.9	90.8
9	97.8	90.7
10	97.9	90.8
11	97.9	90.8
12	97.7	90.6
13	97.7	90.6
14	97.9	90.8
15	97.8	90.7
16	97.9	90.8
17	97.9	90.8
18	98	91
19	98.2	91.2
20	98	91
21	98.1	91.1
22	98.1	91.1
23	98	91
24	98.3	91.3
25	98.1	91.1
26	98	91
27	98.2	91.2
28	98.2	91.2
29	98	91
30	98	91
AVERAGE	97.94333333	90.88666667

Table A20

STM32F407 System Testing for 106 Hz using 0.2 Step Size

106 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	97.7	93.1
2	97.7	93.1
3	97.7	93.1
4	97.8	93.2
5	97.7	93.1
6	97.7	93.1
7	97.6	93.3
8	97.7	93.1
9	97.5	93.2
10	97.6	93.3
11	97.7	93.1
12	97.7	93.1
13	97.9	93.5
14	97.8	93.6
15	97.7	93.1
16	97.7	93.1
17	97.7	93.1
18	97.6	93.2
19	97.7	93.1
20	97.5	93.2
21	97.7	93.4
22	97.7	93.1
23	97.8	93.3
24	97.7	93.1
25	97.9	93.5
26	97.9	93.5
27	97.7	93.1
28	97.8	93.3
29	97.7	93.1
30	97.5	93.8
AVERAGE	97.70333333	93.23

Table A21

STM32F407 System Testing for 108 Hz using 0.2 Step Size

108 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	97.3	94.4
2	97.2	94.1
3	97.2	94.4
4	97.1	94
5	97.2	94.1
6	97.2	94.1
7	97.2	94.1
8	97.3	94.2
9	97.2	94.1
10	97.1	94
11	97.1	94.4
12	97.2	94.3
13	97.5	94.5
14	97.2	94.1
15	97.5	94.4
16	97.2	94.3
17	97.4	94.2
18	97.2	94.4
19	97.3	94.1
20	97.2	94.4
21	97.1	94.4
22	97.2	94.4
23	97.1	94.7
24	97.1	94.4
25	97.2	94.6
26	97.3	94.4
27	97.3	94.9
28	97.2	94.4
29	97.5	94.3
30	97.4	94.6
AVERAGE	97.24	94.32333333

Table A22

STM32F407 System Testing for 110 Hz using 0.2 Step Size

110 Hz Frequency		
Trial	Without ANC (dBA)	With ANC (dBA)
1	96.1	90.2
2	96	90.1
3	96.1	90.5
4	96.2	90.1
5	96.3	90.2
6	96.2	90.3
7	96.2	90.4
8	96.2	90.6
9	96.3	90.7
10	96.4	90.3
11	96.5	90.5
12	96.5	90.8
13	96.9	90.3
14	97.8	90.2
15	97.9	90.6
16	97.9	90.8
17	97	90.9
18	97.7	90.5
19	97.5	90.7
20	97	90.6
21	97.6	90.8
22	98	90.8
23	98.1	90.7
24	98.2	90.9
25	98	90.5
26	98.2	90.4
27	98.3	90.6
28	98	90.7
29	98.1	90.6
30	98.1	90.5
AVERAGE	97.17666667	90.52666667

Table A23

Day 1 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-33.4538	-44.0854
	-34.3874	-39.0457
	-34.6126	-54.6132
	-36.0227	-42.7614
	-36.4985	-52.443
	-36.7855	-41.1921
	-37.1738	-47.2534
	-37.5033	-39.6936
	-38.7502	-41.7013
	-40.6414	-44.4594
	-42.7749	-39.2791
AVERAGE	-35.2057	-44.2297

Table A24

Day 1 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-36.3573	-45.3837
	-34.4892	-41.1921
	-33.6343	-40.7353
	-29.2879	-48.4726
	-30.4747	-52.443
	-32.0735	-42.7614
	-34.3439	-57.6671
	-31.3298	-37.9173
	-30.8238	-41.2534
	-29.7487	-39.6936
	-35.5393	-51.6587
	-28.9237	-48.5436
	-33.5286	-40.6742
	-35.9163	-47.2534
	-33.5746	-38.4888
	-28.1013	-36.4923
	-36.1628	-41.7013
	-40.2941	-39.2791
AVERAGE	-33.03354444	-43.97838333

Table A25

Day 2 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-33.0603	-41.477
	-33.5486	-39.0698
	-34.7071	-52.2331
	-32.4076	-40.9173
	-29.0818	-40.9237
	-33.5971	-43.9272
	-33.0501	-57.667
	-29.0231	-41.3038
	-29.2879	-42.7073
	-30.0994	-44.3824
	-34.4892	-42.3043
	-35.9163	-43.5302
	-39.9604	-43.9688
	-36.1628	-40.4496
	-28.1013	-42.5067
	-40.2941	-42.5048
AVERAGE	-33.33570588	-43.7420625

Table A26

Day 2 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-27.7467	-42.8864
	-30.7442	-45.3837
	-32.7849	-44.9042
	-37.8223	-40.2379
	-34.6892	-50.247
	-32.7942	-47.2034
	-33.4892	-40.0575
	-27.4589	-42.9304
	-31.7891	-39.9412
	-35.3421	-38.7832
	-33.8924	-40.7773
	-30.9189	-41.5918
	-38.2283	-53.2448
	-34.9792	-48.9841
	-37.3692	-51.4719
	-30.7652	-45.9364
	-29.8964	-37.239
	-38.8722	-39.2791
AVERAGE	-33.31014444	-43.94996111

Table A27

Day 3 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-26.8638	-52.2331
	-31.3418	-40.9173
	-30.3284	-40.9237
	-29.3167	-43.9272
	-32.3767	-57.667
	-33.4538	-44.0854
	-34.8974	-39.0457
	-35.6126	-54.6132
	-34.8429	-42.5067
	-35.5744	-42.5048
	-36.2332	-42.7614
	-32.9754	-52.443
	-36.7855	-41.1921
	-37.1738	-47.2534
	-37.5033	-39.6936
	-38.7571	-41.7013
	-40.6414	-44.4594
	-40.2249	-39.2791
AVERAGE	-34.71683889	-44.84485556

Table A28

Day 3 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-33.2895	-44.4978
	-35.7382	-40.4791
	-32.237	-42.7814
	-30.7829	-40.3212
	-31.8953	-54.7014
	-34.8733	-45.5891
	-36.7814	-39.4619
	-29.3331	-41.9413
	-28.7831	-44.4719
	-30.3895	-38.4108
	-37.1941	-51.6587
	-26.1689	-48.5436
	-30.5073	-41.6793
	-38.5031	-43.7962
	-30.918	-38.4888
	-29.8957	-35.1946
	-38.7901	-40.189
	-39.2834	-55.9341
AVERAGE	-33.07577222	-43.78556667

Table A29

Day 4 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-33.9199	-40.9173
	-33.0603	-41.477
	-33.5486	-39.0698
	-35.6126	-42.5067
	-34.7071	-52.2331
	-32.4076	-40.9173
	-29.0818	-40.9237
	-33.5971	-43.9272
	-33.0501	-57.667
	-29.0231	-41.3038
	-29.2879	-42.7073
	-30.0994	-44.3824
	-34.4892	-42.3043
	-35.9163	-43.5302
	-39.9604	-43.9688
	-36.1628	-40.4496
	-28.1013	-42.5067
	-40.2941	-42.5048
AVERAGE	-33.4622	-43.5165

Table A30

Day 4 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-26.4024	-51.6587
	-31.4894	-48.5436
	-32.7849	-41.6793
	-38.1193	-43.7962
	-35.0257	-38.4888
	-35.3703	-35.1946
	-33.4892	-40.0575
	-27.4589	-42.9304
	-29.4389	-39.9412
	-30.3987	-38.7832
	-34.3981	-40.7773
	-33.4918	-41.5918
	-37.4982	-53.2448
	-34.9792	-48.9841
	-38.7202	-51.4719
	-30.7652	-45.9364
	-31.8964	-37.239
	-38.8722	-39.2791
AVERAGE	-33.36661111	-43.31099444

Table A31

Day 5 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-30.8238	-52.2331
	-31.3298	-40.9173
	-33.5286	-40.9173
	-28.9237	-41.477
	-34.4567	-39.0698
	-33.4538	-42.5067
	-34.8974	-52.2331
	-34.7071	-40.9173
	-32.4076	-42.5067
	-29.0818	-42.5048
	-33.5971	-42.7614
	-33.0501	-52.443
	-29.0231	-41.1921
	-37.1738	-47.2534
	-37.2961	-39.6936
	-38.7571	-41.7013
	-38.3414	-44.4594
	-40.2249	-39.2791
AVERAGE	-33.94855	-43.55924444

Table A32

Day 5 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-33.2895	-38.7832
	-35.7382	-40.7773
	-32.237	-41.5918
	-30.7829	-53.2448
	-31.8953	-48.9841
	-34.8733	-51.4719
	-36.7814	-39.4619
	-29.3331	-41.9413
	-28.7831	-44.4719
	-30.3895	-38.4108
	-37.1941	-51.6587
	-26.1689	-43.8941
	-30.5073	-41.6793
	-38.5031	-43.7962
	-30.918	-38.4888
	-29.8957	-35.1946
	-38.7901	-40.189
	-39.2834	-50.6583
AVERAGE	-33.07577222	-43.59433333

Table A33

Day 6 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-33.9199	-40.9173
	-33.0603	-41.477
	-33.5486	-39.0698
	-35.6126	-42.5067
	-30.8238	-52.2331
	-31.3298	-40.9173
	-33.5286	-40.9237
	-28.9237	-43.9272
	-34.4567	-57.667
	-33.4538	-41.3038
	-29.2879	-42.7073
	-30.0994	-52.443
	-34.4892	-41.1921
	-35.9163	-47.2534
	-39.9604	-39.6936
	-36.1628	-41.7013
	-28.1013	-44.4594
	-40.2941	-39.2791
AVERAGE	-33.49828889	-43.87067222

Table A34

Day 6 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-33.2895	-38.7832
	-31.8953	-53.2448
	-32.7849	-51.4719
	-29.3331	-44.4719
	-35.0257	-38.4888
	-35.3703	-50.6583
	-30.3895	-40.0575
	-27.4589	-42.9304
	-29.4389	-39.9412
	-30.3987	-38.7832
	-38.5031	-40.7773
	-33.4918	-41.5918
	-37.4982	-51.6587
	-34.9792	-48.9841
	-38.7202	-51.4719
	-30.7652	-38.4888
	-29.8957	-35.1946
	-39.2834	-40.189
AVERAGE	-33.2512	-43.73263333

Table A35

Day 7 Morning: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Morning (Peak Hours: 8:00AM-11:00AM)	Without ANC (dBm)	With ANC (dBm)
	-28.9267	-41.4772
	-29.0231	-45.3837
	-29.0808	-42.4888
	-30.5971	-42.7614
	-31.0501	-51.6587
	-31.6298	-40.9173
	-32.8816	-47.5117
	-33.4538	-43.1427
	-34.4567	-39.0698
	-34.4739	-39.6936
	-34.5986	-40.7773
	-34.7071	-41.5918
	-34.8974	-52.2331
	-36.1738	-47.2534
	-36.4182	-50.2331
	-38.3414	-44.4594
	-38.7571	-41.7013
	-40.1173	-39.2791
AVERAGE	-33.86580556	-43.97963333

Table A36

Day 7 Afternoon: Data Gathered as Observed in the 100 Hz Noise Component of the Water Pump

Afternoon (Non-Peak Hours: 1:00PM-4:00PM)	Without ANC (dBm)	With ANC (dBm)
	-32.4345	-40.7811
	-29.7411	-37.7141
	-30.9841	-42.6392
	-31.6894	-53.2448
	-35.6794	-48.9841
	-37.8941	-51.4719
	-36.7814	-39.4619
	-30.7749	-41.9413
	-28.7831	-44.4719
	-30.3895	-39.6381
	-37.1941	-51.6587
	-26.1689	-44.5678
	-33.6891	-41.6793
	-38.5031	-43.7962
	-35.2523	-38.4888
	-27.2938	-35.1946
	-38.7901	-40.189
	-38.7942	-50.6583
AVERAGE	-33.37983889	-43.69895

Table A37

Data Gathered in 7 Days

Day and Time	Without ANC	With ANC
Day 1 (8:00AM-11:00AM)	-35.2057	-44.2297
Day 1 (1:00PM-4:00PM)	-33.03354444	-43.97838333
Day 2 (8:00AM-11:00AM)	-33.33570588	-43.7420625
Day 2 (1:00PM-4:00PM)	-33.31014444	-43.94996111
Day 3 (8:00AM-11:00AM)	-34.71683889	-44.84485556
Day 3 (1:00PM-4:00PM)	-33.07577222	-43.78556667
Day 4 (8:00AM-11:00AM)	-33.4622	-43.5165
Day 4 (1:00PM-4:00PM)	-33.36661111	-43.31099444
Day 5 (8:00AM-11:00AM)	-33.36661111	-43.31099444
Day 5 (1:00PM-4:00PM)	-33.07577222	-43.59433333
Day 6 (8:00AM-11:00AM)	-33.49828889	-43.87067222
Day 6 (1:00PM-4:00PM)	-33.2512	-43.73263333
Day 7 (8:00AM-11:00AM)	-33.86580556	-43.97963333
Day 7 (1:00PM-4:00PM)	-33.37983889	-43.69895

Appendix B – Bill of Materials

Table B1

Materials and Equipment Used and their Price

COMPONENTS	PRICE
SPEAKER - 6.5' free-air subwoofers	PHP 800.00
MICROPHONE - I2S MEMS Microphone Breakout Module SPH0645LM4H Microphone Output Winder	PHP 350.00
MICROPHONE - USB Desktop Noise Cancelling Mic Microphone for PC Computer	PHP 600.00
AUDIO CONVERTER - Unitek Y-247A Aluminum USB to Stereo Sound Card Audio Converter Controller	PHP 400.00
MICROCONTROLLER - STM32F407	PHP 2981.23.00
MICROCONTROLLER- Raspberry Pi 3 Model B	PHP 2500.00
MICROCONTROLLER - Arduino Due	PHP 1400.00
AMPLIFIER - MIKATA M-SUB1302BT Multimedia Speaker System	PHP 3200.00
DIGITAL POTENTIOMETER - DC 3v-5v X9c103s Digital Potentiometer Board Module	PHP 434.00
USB ETHERNET ADAPTER - USB 2.0 10/100Mbps RJ45 LAN Ethernet Network Adapter Dongle - White	PHP 400.00
MISCELLANEOUS	PHP 3335.00
TOTAL:	**PHP 16400.23**

DSR ELECTRONICS PARTS SU

669 Ronquillo St., Zone 030 Brgy. 307 Quiapo, Manila
SHANIE RHONE' P. PROFUGO - Prop.
NON-VAT Reg. TIN: 471-175-481-000

SALES INVOICE

No. 3399

Sold to: _____ Date: 9-18-18
TIN: _____ Terms: _____
Address: _____ OSCA/PWD ID No.: _____
SC/PWD
Bus. Style: _____ Signature: _____

QTY.	UNIT	ARTICLES	Unit Price	Amount
2		6" MOX	250	500
			Total Sales	750
			Less: SC/PWD Discount	
			TOTAL AMOUNT DUE	

100 Bkts. (50x2) 0501-5500
BIR Permit No. OCN1AU0001405401
Date Issued: 09/21/2015 Valid Until: 09/20/2020
QUEZON BLVD. COMPUTER PRTG. CENTRE
HILARIO D.G. FERNANDEZ - Prop.
#5 Quezon Blvd., Brgy. 310 Zone 031 Sta. Cruz, Manila * TIN: 146-782-939-000 NON-VAT

Cashier / Authorized Representative

Printer's Accreditation No.: 031MP20130000000021
Date of Accreditation: December 27, 2013

"THIS DOCUMENT IS NOT VALID FOR CLAIM OF INPUT TAX"
"THIS SALES INVOICE SHALL BE VALID FOR FIVE (5) YEARS FROM THE DATE OF ATP"

T.H.E. ELECTRONICS BOUTIQUE
OPRTD BY: T.H.E. ELECTRONICS BOUTIQUE
VATREG TIN: 006-750-574-003 SN: CTC46404
L3, 03163, ROBINSONS PLACE MANILA PEDRO
GIL ST. COR M ADRIATICO & PADRE FAUNA ST
BGY. 669 ZONE 072, ERMITA MANILA 1000

CASHIER : ROMINALD CRUZ #0691
SALESMAN: Re502 #0502
07/15/2018 16:11:04
#0000068597 OR#001-000055675

Qty	Description	Price	Amount
VAT SALES			
	5280101015065		
1	Y-247A UNITE	400.00	400.00
	4860101010010		
1	PAPER BAG NU	0.00	0.00

SUBTOTAL 400.00

CASH 400.00

CHANGE 0.00

TOTAL NO OF ITEMS: 2.00

VAT SALES	357.14
12% VAT SALES	42.86
NON-VAT SALES	0.00

BUYER NAME:
BUYER ADDRESS:
BUYER TIN:
BUSINESS STYLE:

POS Provider:
CHASE TECHNOLOGIES CORPORATION
5263 Diesel St. Palanan, Makati City
TIN: 202-086-098-000
Accred No.: 048-202086098-000014
Date Issued: 03/18/2005
PTU Number: 0308-033-28481-003

THIS INVOICE/RECEIPT SHALL BE VALID FOR
FIVE (5) YEARS FROM THE DATE OF PERMIT
TO USE.

OFFICIAL RECEIPT

MERCHADISE EXCHANGE IS ALLOWED
WITHIN 7 DAYS OF PURCHASE.
MIN: 080076970

ACKNOWLEDGMENT FORM

To _____ Date 06/27/18

Address _____ No. _____

_____ Terms _____

Item No.	Qty.	Unit	DESCRIPTION	Unit Price	Amount
	1	PC	RASPBERRY PI 3 MODEL B	2450	2,400.
	1	PC	OFFICIAL RPI 3 CASE BLACK	250	250
					2,650

Received

By: _____

By: _____

ACKNOWLEDGMENT FORM

To ______________________ Date June 22, 2018

Address ______________________ No. ______________________

______________________ Terms ______________________

Item No.	Qty.	Unit	DESCRIPTION	Unit Price	Amount
	1	pc	SPW2430 MEMS Microphone	350	350
	5	pc	M/M wires 40cm	3	15
				Total	365

By: ______________________

Received

By: ______________________

MEXPRESS COMPUTER CENTER

CZ 026 UGL SM City Manila Arroceros St., cor. Natividad Almeda Lopez St. and San Marcelino St.Brgy. 659 Zone 071, Ermita Manila
ROCKY L. HO - PROP * VAT REG. TIN: 271-979-468-000
Tel. No.:441-1496 Telefax No.: 441-1495

SALES INVOICE Date 6-22 ,20 18

Sold to: Vench Learry M. Anglo Terms: _____

Address _____

TIN: _____ Bus. Style _____

OSCA/PWD No. _____ SC/PWD Signature _____

Qty.	Unit	DESCRIPTION	Unit Price	Amount
1	pc	USB microphone		300
		One month warranty	Total Sales (VAT Inclusive)	
			Less: VAT	
VATable Sales			Amount: Net of VAT	
VAT-Exempt Sales			Less: SC/PWD Discount	
Zero Rated Sales			Amount Due	267.86
VAT Amount			Add: VAT	32.14
Total Sales			Total Amount Due	300

No. 125477

By: _____
Cashier/Authorized Representative

500 BKLTS. (50X3) 102501-127500 BIR ATP No. 1AU0001483463
DATE ISSUED: MAY 11, 2016 VALID UNTIL: MAY 11, 2021
A C PRINTERS TEL 5701374 \ 2122398
L22 B13 ST. LUKE ST., MARVI HILLS SUBD. GULOD MALAYA SAN MATEO RIZAL
PRINTERS ACCREDITATION NO.: 045MP20140000000004 ACCREDITATION DATE: JANUARY 8, 2014
MA. LEONORA BULALAQUE - PROP. TIN:223-885-849-002-VAT

"THIS SALES INVOICE SHALL BE VALID FOR FIVE (5) YEARS FROM THE DATE OF ATP"

MEXPRESS COMPUTER CENTER

CZ 026 UGL SM City Manila Arroceros St., cor. Natividad Almeda Lopez St. and San Marcelino St.Brgy. 659 Zone 071, Ermita Manila
ROCKY L. HO - PROP * VAT REG. TIN: 271-979-468-000
Tel. No.:441-1496 Telefax No.: 441-1495

SALES INVOICE Date Apr 22 ,20 18

Sold to: Angulo, Vench Leary M. Terms: _____

Address _____

TIN: _____ Bus. Style _____

OSCA/PWD No. _____ SC/PWD Signature _____

Qty.	Unit	DESCRIPTION	Unit Price	Amount
1	pc	USB CAM		400
One		month warranty		
		Total sales (VAT Inclusive)		
		Less: VAT		
VATable Sales		Amount: Net of VAT		
VAT-Exempt Sales		Less: SC/PWD Discount		
Zero Rated Sales		Amount Due		357
VAT Amount		Add: VAT		43
Total Sales		Total Amount Due		400

No. 125502

By: _____
Cashier/Authorized Representative

500 Bklts. (50x3) 102501-127500 BIR ATP No. 1AU0001483463
Date Issued: May 11, 2016 Valid Until: May 11, 2021
A C PRINTERS Tel: 5701374 \ 2122398
L22 B13 St. Luke St., Marvi Hills Subd. Gulod Malaya San Mateo Rizal
Printers Accreditation No.: 045MP20140000000004 Accreditation Date: January 8, 2014
Ma. Leonora Bulalaque - Prop. TIN:223-885-849-002-VAT

"THIS SALES INVOICE SHALL BE VALID FOR FIVE (5) YEARS FROM THE DATE OF ATP"

MEXPRESS COMPUTER CENTER

CZ 026 UGL SM City Manila Arroceros St., cor. Natividad Almeda Lopez St. and San Marcelino St.Brgy. 659 Zone 071, Ermita Manila
ROCKY L. HO - PROP * VAT REG. TIN: 271-979-468-000
Tel. No.:441-1496 Telefax No.: 441-1495

SALES INVOICE Date 7-22 ,20 18

Sold to: EZEKIEL QUIZON Terms:

Address

TIN: Bus. Style

OSCA/PWD No. SC/PWD Signature

Qty.	Unit	DESCRIPTION	Unit Price	Amount
1	PC	USB microphone		300
		Total sales (VAT Inclusive)		
		Less: VAT		
VATable Sales		Amount: Net of VAT		
VAT-Exempt Sales		Less: SC/PWD Discount		
Zero Rated Sales		Amount Due		267.86
VAT Amount		Add: VAT		32.14
Total Sales		Total Amount Due		300

No. 126368

By: Cashier/Authorized Representative

500 BKLTS. (50X3) 102501-127500 BIR ATP No. 1AU0001483463
DATE ISSUED: MAY 11, 2016 VALID UNTIL: MAY 11, 2021
A C PRINTERS TEL 5701374 \ 2122398
L22 B13 ST. LUKE ST., MARYI HILLS SUBD. GULOD MALAYA SAN MATEO RIZAL
PRINTERS ACCREDITATION NO.: 045MP20140000000004 ACCREDITATION DATE: JANUARY 8, 2014
MA. LEONORA BULALAQUE - PROP. TIN:223-885-849-002-VAT

"THIS SALES INVOICE SHALL BE VALID FOR FIVE (5) YEARS FROM THE DATE OF ATP"

DATE 7/13/18

SOLD TO

ADDRESS

QTY.	UNIT	ARTICLES	PRICE	AMOUNT
1		Amplifier		
		PV		450
1		adapter		
1		week		
		warranty		
		TOTAL ☞		450

Thank you come again!!!

№

SIGNATURE

DATE 07/01/12

SOLD TO

ADDRESS

QTY.	UNIT	ARTICLES	PRICE	AMOUNT
2	PC	ASUH SABUWOFOR	400	800
		TOTAL ☞		800

THANK YOU COME AGAIN

NO. ______________ SIGNATURE JACK

CASH SALES INVOICE

LIONGCO ELECTRONICS

(Owned & Operated By: Dee Hwa Liong Electronics Equipment Corp.)
B-5 731-735 G. Puyat St., Zone 030, Brgy. 308, Quiapo, Manila
VAT Reg. TIN 000-081-706-002
Tels.: 733-2847 to 52

Sold to: _____ Date: 7/15/18
TIN: _____ Bus. Style: _____ Terms: _____
Address: _____ OS/PWD ID No.: _____
_____ Signature: _____

Qty.	Unit	ARTICLES	Price	Amount
4	Pc.	Spare Parts		379 5
		Total Sales (VAT Inclusive)		
	VATable Sale	Less: VAT		338.39
	VAT-Exempt Sale	Amount: Net of VAT		
	VAT-Zero Rated Sale	Less: SC/PWD Discount		40.61
	VAT Amount	Amount Due		
		Add: VAT		
		TOTAL AMOUNT DUE		379

Parties expressly submit themselves to the jurisdiction of the courts of Laguna for any legal action arising out of this transaction.

By: _____
Cashier/Authorized Representative

5,000 Bkls. 50x3 400,001D-650,000D
BIR Permit No. OCN1AU0001507025
Date Issued: 08/01/16 Valid Until: 07/31/21
ISAROG PRINTING, INC.
VAT Reg. TIN 000-243-970-000
40 Reparo St., Potrero, Malabon City

519340 D

Printers Accreditation No.: 026MP20130000000011
Date Issued: 12/17/13

This cash sales invoice shall be valid for five years from date of ATP.

To Send

WESTERN UNION WU

Sender: EZEKIEL S QUIZON
My WUSM Number:
☐ Register for My WUSM Membership Program
Total My WU Points: 0
My WU Points Earned:0
Subject to terms and conditions,please visit www.westernunion.com/mywu/ph or Call 888-1200
Present Address:
ATIS ST BLK 32 L10 VILLA LUISA HOMES, DASMARINAS, , PH
ID Type/Number: Gov't Office or GOCC ID
*******003619
Test Question:

Receiver : ZIHAO YE
Destination Country: China
City & State:
(U.S., Canada & Mexico)

Optional Services: MONEY IN MINUTES

Receiver Mobile Number:
(U.S., Canada & Mexico)

IMPORTANT MESSAGE FOR YOU: EZEKIEL S QUIZON
Mahalaga sa amin ang iyong opinyon!
Pumunta sa westernunion.com/nakikinig at ipaalam sa amin ang iyong masasabi tungkol sa aming serbisyo.

MTCN:	761-615-0302
Date & Time:	03-07-2018 06:54 PM PHT
Agent details:	USSC SERVICE STORE MANILA - ROBINSONS PLACE, PEDRO GIL STREET LEVEL 4 ROBINSONS PLACE
Purpose of Transaction:	
Amount Sent:	2,481.23
Transfer Fee:	500.00
Delivery Charge:	0.00
Message Charge:	0.00
Discount:	0.00
TOTAL:	**2,981.23 PHP**
Exchange Rate:	0.0185351
Payout Amount:	45.99 USD

Your land line or mobile phone may be required to execute the money transfer, facilitate convenience activities or other requested services. Unless you inform Western Union as described in the Terms and Conditions not to receive commercial communications, Western Union or its affiliates and business partners may send you commercial communications by SMS/MMS regarding Western Union's products and services. You agree any changes by the service provider as your sole responsibility.
IMPORTANT NOTICE: The terms and conditions on which the service is provided are located at www.westernunion.com.ph and at the agent location. You are advised to read these terms and conditions, especially those restricting liability and data protection, before sighing this form. In addition to the transfer fee, Western Union (WU) and its agents also make money from the exchange of currencies. Please see further important information regarding currency exchange and legal restrictions that may delay the transaction set forth the terms and conditions. **Protect yourself from consumer fraud. Be careful when a stranger asks you to send money. Do not divulge the details of this transfer to a third party.**
By signing this form, I : 1. Expressly consent to the transfer of my personal data entered above to WU Affiliates,including to the U.S. for the purpose of providing the money transfer service to me and undertaking the additional data processing activities specified in the Data Protection section of the terms and conditions. 2. Expressly consent to the carrying out of profiling activities and marketing communications. I have the right to withdraw my consent at any time. 3. Confirm that the information I have provided above are updated and correct and that I have read and accepted the terms and conditions of the service and the loyalty program terms if applicable.

Customer signature:	Date:	Agent signature: 84050

FOR CUSTOMER SERVICE CALL: (02) 888-1200 or 1-800-1-888-1200 (PLDT toll free) or 1-800-9-888-1200(Globelines Toll free)

Delivered To LSIC CCC Plant Date July-19-16

Address _____ Delivered By _____

QTY	UNIT	ARTICLES	PRICE	AMOUNT
	1	V8 - Coun		130
				130
		TOTAL ☞ ₱		

1. 0170590 SIGNATURE

H.C.L. HARDWARE

1628 Singalong St., Near P. Gil St., Brgy. 687 Zone 75 Dist. V Paco Manila
Tel. Nos.: 523-3542, 525-2313, 521-7341
Peter Ong - Proprietor
VAT Reg. TIN: 435-959-710-000

Nº 27556

SALES INVOICE

Sold to: _____ Date: 07-23-2018
TIN: _____ Terms: _____
Address: _____ OSCA/PWD ID No.: _____
Bus. Style: _____ SC/PWD Signature: _____

QTY.	QTY.	ARTICLES	UNIT PRICE	AMOUNT
1	pc.	PVC Y Black		70 -
			Total Sales: (VAT Inclusive)	70 -
			Less: VAT	7.5
			Amount: Net of VAT	62.5
			Less: SC/PWD Discount	
		VATable Sales	Less: Withholding Tax	
		VAT - Exempt Sales	Amount Due	
		Zero Rated Sales	Add: VAT	
		VAT Amount	TOTAL AMOUNT DUE	70 -

Received the above goods in good order and condition.

_____
Cashier/Authorized Representative

100 Bks. (50x3) No. 26,501-31,500
BIR Permit No. OCN1AU0001743551
Date of ATP: 02/06/2018 Valid Until: 02/06/2023
Accurate Printing Inc. "VAT Reg. TIN: 000-334-341-000
944 Severino Reyes St., Brgy. 314 Zone 31 Sta. Cruz Manila
Printer's Accreditation No.: 031MP20130000000001
Date of Accreditation: 12/27/2013

"THIS SALES INVOICE SHALL BE VALID FOR FIVE (5) YEARS FROM THE DATE OF ATP"

1658 CONSTRUCTION SUPPLY

LUMBER * HARDWARE * ELECTRICAL & OTHER SUPPLIES

Angelito Cua Ting - Prop.
1623 Singalong St., Brgy. 695 Zone 075 Paco Manila
Tel. Nos.: 523-5059; 522-0920
VAT Reg.TIN 103-944-638-000

Nº 54879

CASH INVOICE

Sold to: C
TIN:
Address:
Business Style:

Date: 7-23-18
Terms:
OSCA/PWD ID No.
OSCA/SC/PWD
Signature:

QUANTITY	UNIT	ARTICLES	UNIT PRICE	AMOUNT
1	pc	PVC Pipe Blade 4"		270-
1	pc	PVC Wye 4x4		65-
			Total Sales (VAT Inclusive)	
			Less: VAT	
			Amount: NET of VAT	
			Less: SC/PWD Discount	
		VATable Sales	Less:Withholding Tax	
		VAT-Exempt Sales	Amount Due	299.11
		Zero Rated Sales	Add: VAT	35.89
		VAT Amount	Total Amount Due	335-

100 Bklts. (50X3) 52501-57500
BIR Authority to Print No. OCN1AU0001640238
Date Issued 05-30-2017 Valid Until 05-30-2022

GEKCO PRESS / LEE TAY CHEONG
1319 Narcisa Rizal St., Brgy. 259 Zone 023, Sta. Cruz, Manila
Email: gekco_press@yahoo.com.ph
TIN No.: 100-656-177-000 VAT

THIS CASH INVOICE SHALL BE VALID FOR FIVE (5) YEARS FROM THE DATE OF ATP

By: _____
Cashier's / Authorized Representative

Printer's Accreditation No. 031MP20130000000003
Date Issued 12-27-2013

Appendix C – Survey Forms

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

* Required

General Information

1. **Name** *
   Pangalan

2. **Age** *
   Edad

3. **Gender** *
   Kasarian
   Mark only one oval.
   - ◯ Female
   - ◯ Male

4. **Company** *

5. **Department** *

6. **Occupation** *
   Trabaho

Questions

Mga tanong

7. **1. How long have you been in your current work?** *
   Gaano katagal ka na sa iyong kumpanyang pinapasukan?
   Mark only one oval.
   - ◯ Less than 1 year (Mababa sa 1 taon)
   - ◯ 1 to 3 years (1 hanggang 3 taon)
   - ◯ 4 to 6 years (4 hanggang 6 na taon)
   - ◯ 7 years and above (7 na taon pataas)

8. **2. In your normal day does high sound level annoy you?** *
   Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?
   Mark only one oval.

   - Yes (Oo)
   - No (Hindi)

9. **3. How is it important for you to have a quiet and comfortable area?**
   Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?
   Mark only one oval.

	1	2	3	4	5	
Not important (Hindi importante)						Very important (Sobrang importante)

10. **4. Have you experience any noise in your workplace?** *
    Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?
    Mark only one oval.

    - Yes
    - No

11. **5. Does noise affect you physically or mentally?** *
    Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?
    Mark only one oval.

    - Yes (Oo)
    - No (Hindi)

12. **6. Have you ever experienced discomfort due to high level of noise?** *
    Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?
    Mark only one oval.

    - Yes (Oo)
    - No (Hindi)

13. **7. Does your company provide protective equipment or devices against such loud noises?** *
    Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?
    Mark only one oval.

    - Yes (Oo)
    - No (Hindi)

14. **If yes, please specify**
    Kung oo, ilahad kung ano ito

    _____

    _____

    _____

    _____

    _____

15. **8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?**
    Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?
    Mark only one oval.

    - Yes (Oo)
    - No (Hindi)
    - Never notice (Hindi napapansin)

16. **If yes, please specify**
    Kung oo, ilahad kung ano ito

17. **9. How long could you tolerate such noise?**
    Gaano mo ito kayang pagtiisan?

18. **Leave a comment or suggestions**
    Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Arax

Age *
Edad

24

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Shopping Center Management Corporation

Department *

Engineering-Operations

Occupation *
Trabaho

Resident Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
- ( ) 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	(●)	( )	( )	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- (●) Yes
- ( ) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- (●) Yes (Oo)
- ( ) No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- (●) Yes (Oo)
- ( ) No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

Earbuds, headphones

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ( ) Yes (Oo)
- ( ) No (Hindi)
- (●) Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

Up to 2hours

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

John Harley J. Ganiota

Age *
Edad

23

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Rockwell Land Coporation

Department *

Retail

Occupation *
Trabaho

Tenancy Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- ○ Less than 1 year (Mababa sa 1 taon)
- ◉ 1 to 3 years (1 hanggang 3 taon)
- ○ 4 to 6 years (4 hanggang 6 na taon)
- ○ 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- ◉ Yes (Oo)
- ○ No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	○	○	○	◉	○	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- ○ Yes
- ◉ No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- ○ Yes (Oo)
- ◉ No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ○ Yes (Oo)
- ◉ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

5minutes

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Lando

Age *
Edad

23

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Rockwell Property Management Corp

Department *

Engineering

Occupation *
Trabaho

Building Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
- ( ) 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	(●)	( )	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- (●) Yes
- ( ) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- (●) Yes (Oo)
- ( ) No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ○ Yes (Oo)
- ○ No (Hindi)
- ◉ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

30mins

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Darryl

Age *
Edad

23

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Edison electric

Department *

Design

Occupation *
Trabaho

Design engr

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
- ( ) 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	(●)	( )	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- (●) Yes
- ( ) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- (●) Yes (Oo)
- ( ) No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ○ Yes (Oo)
- ◉ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Ace Garcia

Age *
Edad

22

Gender *
Kasarian

- (●) Female
- ( ) Male

Company *

Soft Toys Inc.

Department *

QC

Occupation *
Trabaho

QC Manager

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- ○ Less than 1 year (Mababa sa 1 taon)
- ◉ 1 to 3 years (1 hanggang 3 taon)
- ○ 4 to 6 years (4 hanggang 6 na taon)
- ○ 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- ◉ Yes (Oo)
- ○ No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	○	○	◉	○	○	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- ◉ Yes
- ○ No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- ◉ Yes (Oo)
- ○ No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ○ Yes (Oo)
- ○ No (Hindi)
- ◉ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Zhiankyle Ikushima

Age *
Edad

21

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Telus International PH

Department *

Productions

Occupation *
Trabaho

Team Leader

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- ○ Less than 1 year (Mababa sa 1 taon)
- ◉ 1 to 3 years (1 hanggang 3 taon)
- ○ 4 to 6 years (4 hanggang 6 na taon)
- ○ 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- ◉ Yes (Oo)
- ○ No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	○	○	○	◉	○	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- ◉ Yes
- ○ No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- ○ Yes (Oo)
- ◉ No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ○ Yes (Oo)
- ◉ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

-

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Opo

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Mynil Radam

Age *
Edad

22

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Well-Built Specialty Contractors, Inc.

Department *

Engineering

Occupation *
Trabaho

Project-in-Charge

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
- ( ) 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	(●)	( )	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- (●) Yes
- ( ) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- (●) Yes (Oo)
- ( ) No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- (●) Yes (Oo)
- ( ) No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

Ear Plugs

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ( ) Yes (Oo)
- (●) No (Hindi)
- ( ) Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

Siguro nakasanayan ko na siya sa trabaho.

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Charlemagne Sotelo

Age *
Edad

23

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

GAKKEN Phil.

Department *

Research and Design

Occupation *
Trabaho

System Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
- ( ) 7 years and above (7 na taon pataas)

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- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	( )	(●)	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- ( ) Yes
- (●) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- (●) Yes (Oo)
- ( ) No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

30mins

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Charlemagne Sotelo

Age *
Edad

23

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

GAKKEN Phil.

Department *

Research and Design

Occupation *
Trabaho

System Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
- ( ) 7 years and above (7 na taon pataas)

2. In your normal day does high sound level annoy you? *
Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	( )	(●)	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- ( ) Yes
- (●) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

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- ( ) No (Hindi)

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Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

30mins

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Bryan Nahibuan

Age *
Edad

23

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

Asiaphil

Department *

Projects

Occupation *
Trabaho

Peoject engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
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Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

- (●) Yes (Oo)
- ( ) No (Hindi)

3. How is it important for you to have a quiet and comfortable area?
Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	( )	(●)	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- (●) Yes
- ( ) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
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7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

Ringing noise in ears

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

10mins

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Jamaica Rollo

Age *
Edad

23

Gender *
Kasarian

- (●) Female
- ( ) Male

Company *

Fluor Daniels

Department *

Research and Development

Occupation *
Trabaho

Research Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
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Nagdudulot ba ng pagkainis/pagkairita ang malakas na ingay sa iyo?

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	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	( )	(●)	Very important (Sobrang importante)

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- ( ) Yes
- (●) No

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Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ○ Yes (Oo)
- ○ No (Hindi)
- ◉ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

5mins

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Survey Form

MAGANDANG ARAW SAYO!

Kami po ay mga estudyante ng TUP-Manila, na nagnanais na hingiin ang inyong oras upang sagutan ang mga sumusunod na tanong nang may buong puso at katapatan upang makatulong sa aming proyekto na may kinalaman sa ingay na nararanasan sa inyong komunidad at kung paano ito maiibsan.

Ang lahat ng mga impormasyong makakalap sa "Survey" na ito ay kompidensyal

General Information

Name *
Pangalan

Charles Mesa

Age *
Edad

24

Gender *
Kasarian

- ○ Female
- ◉ Male

Company *

FOPM

Department *

Engineering Department

Occupation *
Trabaho

Property Engineer

Questions

Mga tanong

1. How long have you been in your current work? *
Gaano katagal ka na sa iyong kumpanyang pinapasukan?

- (●) Less than 1 year (Mababa sa 1 taon)
- ( ) 1 to 3 years (1 hanggang 3 taon)
- ( ) 4 to 6 years (4 hanggang 6 na taon)
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- (●) Yes (Oo)
- ( ) No (Hindi)

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Gaano kaimportante sa iyo ang magkaroon ng tahimik na lugar?

	1	2	3	4	5	
Not important (Hindi importante)	( )	( )	( )	(●)	( )	Very important (Sobrang importante)

4. Have you experience any noise in your workplace? *
Nakakaranas ka ba ng hindi kaaya-ayang ingay sa iyong pinagtatrabahuhan?

- (●) Yes
- ( ) No

5. Does noise affect you physically or mentally? *
Naapektohan ba ng mga ingay na ito sa iyong pisikal na pangagatawan at pagiisip?

- (●) Yes (Oo)
- ( ) No (Hindi)

6. Have you ever experienced discomfort due to high level of noise? *
Naranasan mo nabang ma-"stress", mawalan ng konsentrasyon, dahil sa ingay?

- (●) Yes (Oo)
- ( ) No (Hindi)

7. Does your company provide protective equipment or devices against such loud noises? *

Nagbibigay ba ang kumpanya ng aparato na makakatulong upang maibsan ang ingay sa iyong paligid?

- ○ Yes (Oo)
- ◉ No (Hindi)

If yes, please specify

Kung oo, ilahad kung ano ito

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

Nakaranas kana ba ng panandaliang pagkawala ng pandinig dahil sa malakas na ingay?

- ◉ Yes (Oo)
- ○ No (Hindi)
- ○ Never notice (Hindi napapansin)

If yes, please specify

Kung oo, ilahad kung ano ito

Ringing in my ears

9. How long could you tolerate such noise?

Gaano mo ito kayang pagtiisan?

10mins

Leave a comment or suggestions

Magiwan ng komento o mungkahi

Results from Survey

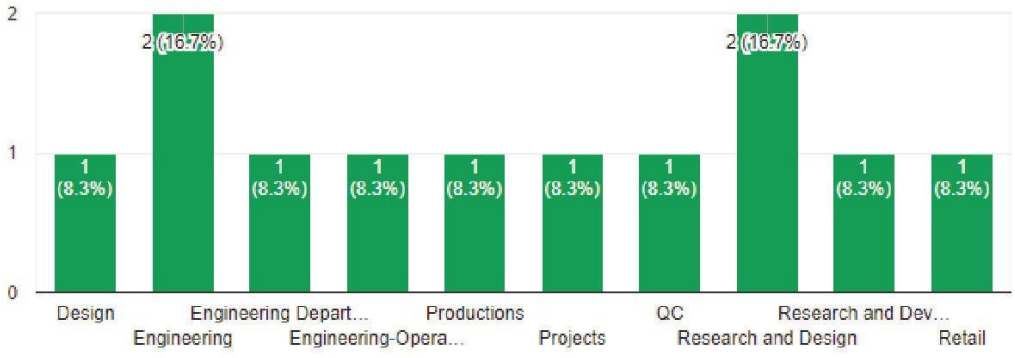
Company

12 responses

GAKKEN Phil. (2)
Shopping Center Management Corporation
Rockwell Land Coporation
Rockwell Property Management Corp
Edison electric
Soft Toys Inc.
Telus International PH
Well-Built Specialty Contractors, Inc.
Asiaphil
Fluor Daniels
FOPM

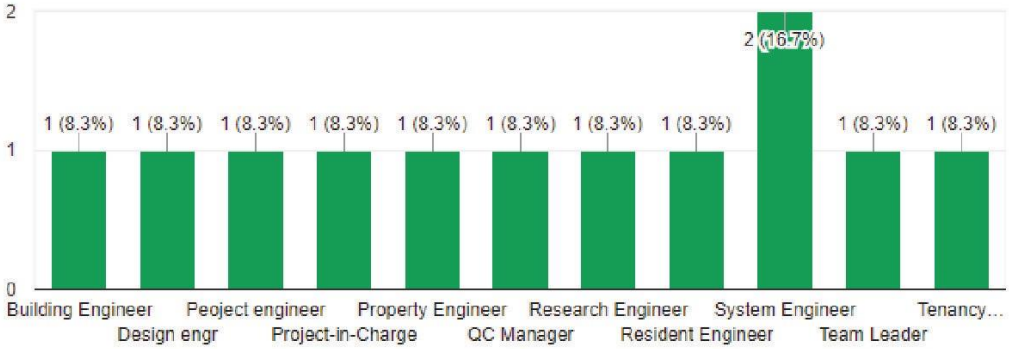
Department

12 responses



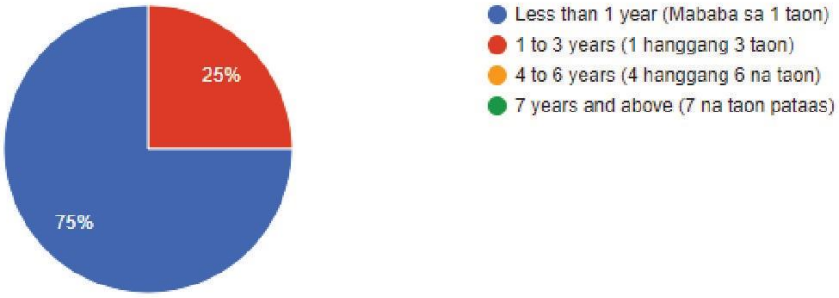
Occupation

12 responses



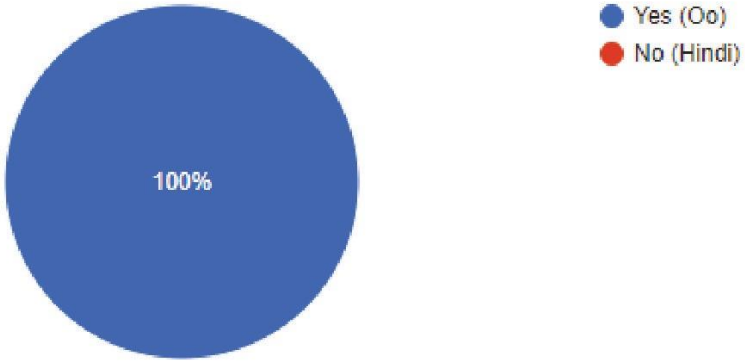
1. How long have you been in your current work?

12 responses



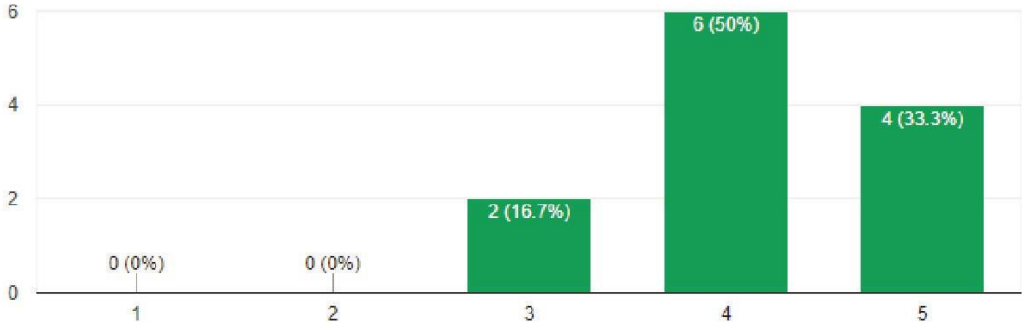
2. In your normal day does high sound level annoy you?

12 responses



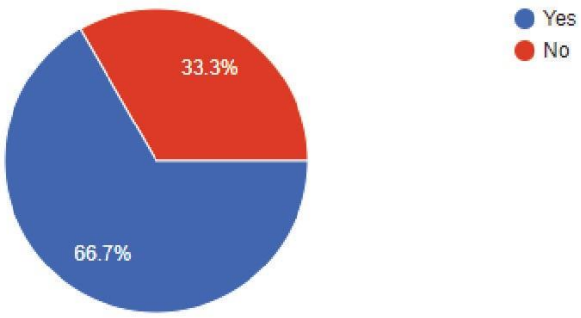
3. How is it important for you to have a quiet and comfortable area?

12 responses



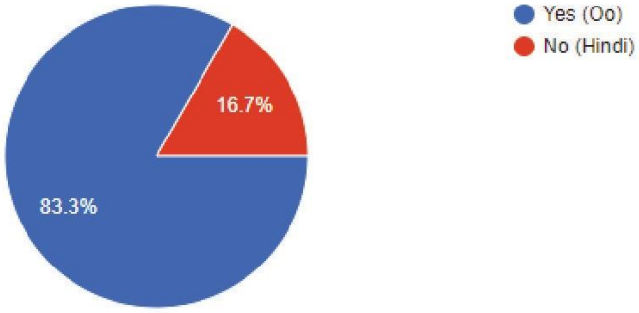
4. Have you experience any noise in your workplace?

12 responses



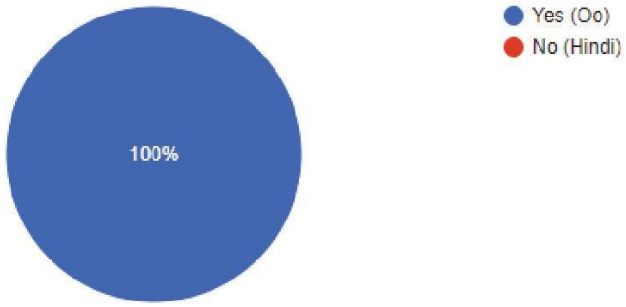
5. Does noise affect you physically or mentally?

12 responses



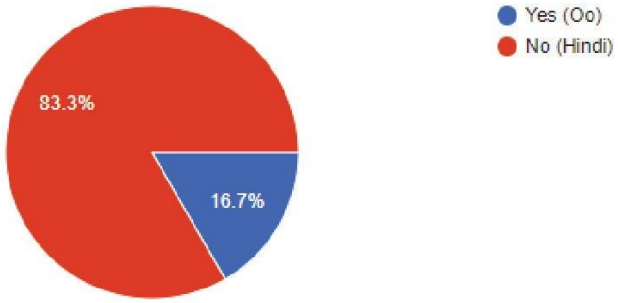
6. Have you ever experienced discomfort due to high level of noise?

12 responses



7. Does your company provide protective equipment or devices against such loud noises?

12 responses



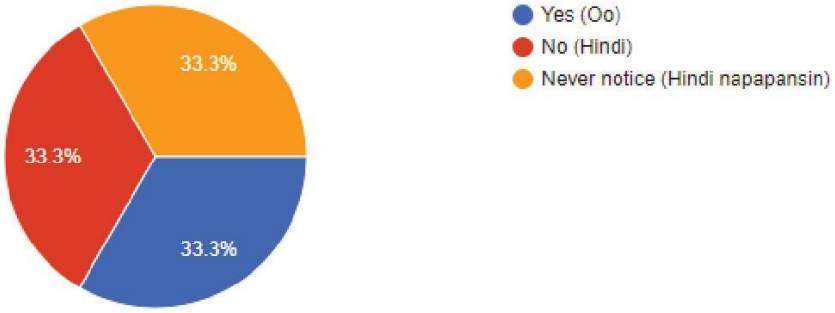
If yes, please specify

2 responses

Earbuds, headphones
Ear Plugs

8. Have you ever experienced or know hearing loss cases due to continuous loud noise at work?

12 responses



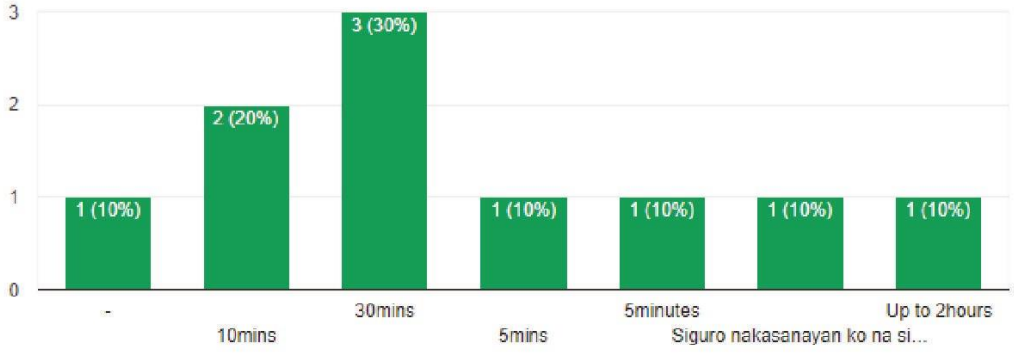
If yes, please specify

2 responses

Ringing noise in ears
Ringing in my ears

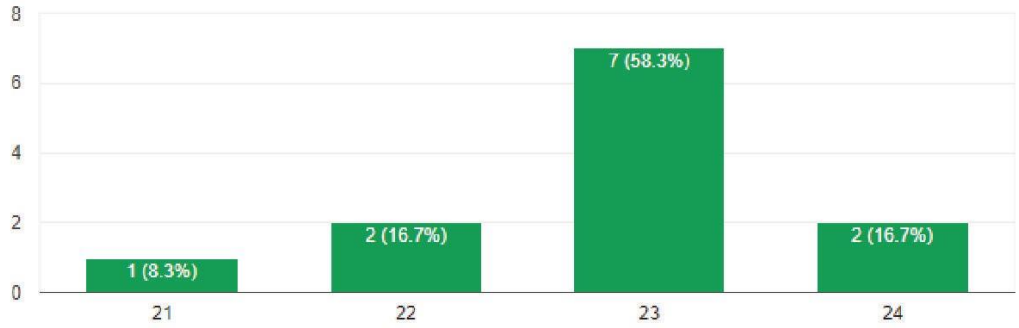
9. How long could you tolerate such noise?

10 responses



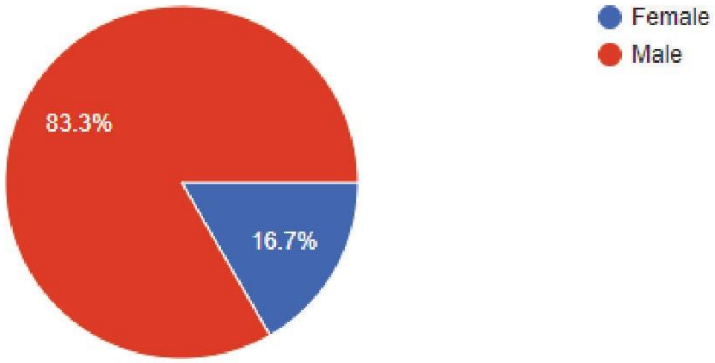
Age

12 responses



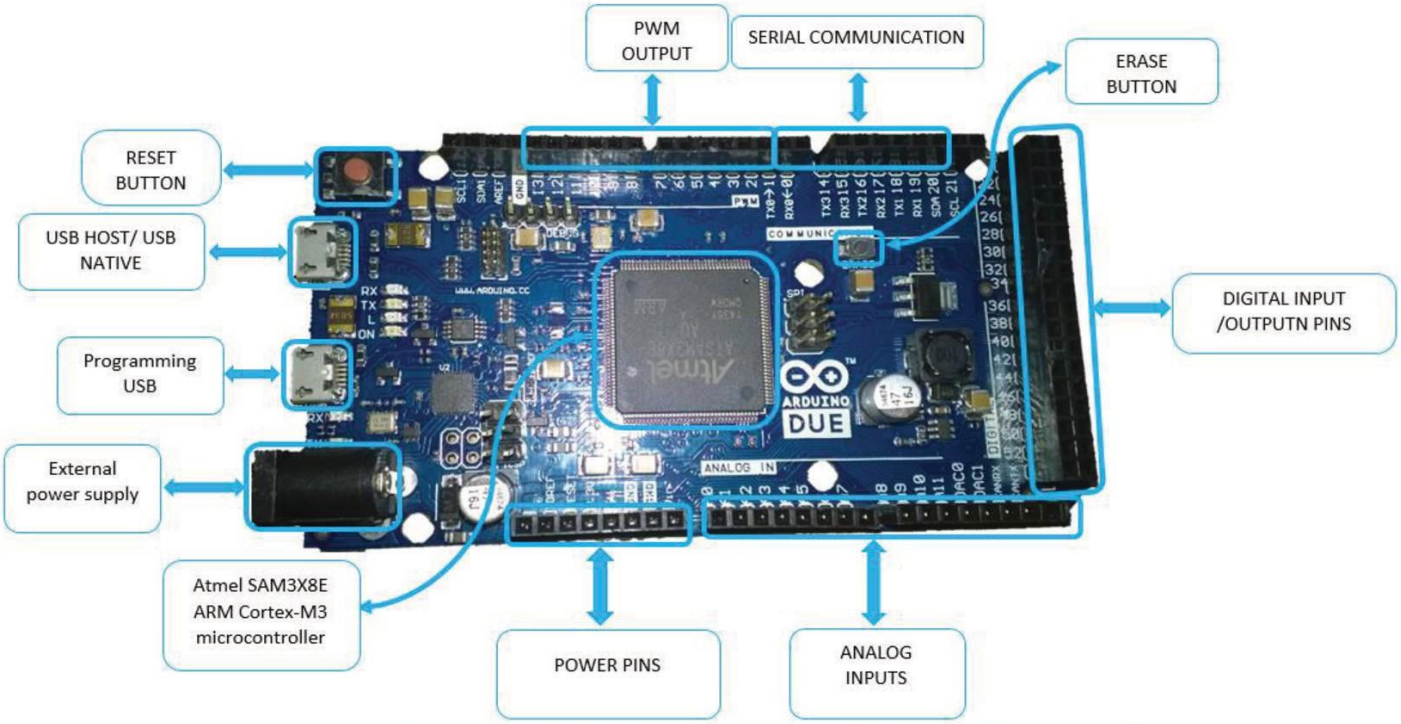
Gender

12 responses



Appendix D – Data Sheets

ARDUINO DUE



INTRODUCTION

The Arduino Due is the first Arduino board based on a 32-bit ARM core microcontroller. It is suitable for large scale projects and it differ from other Arduino kits as it runs at 3.3V as the maximum voltage.

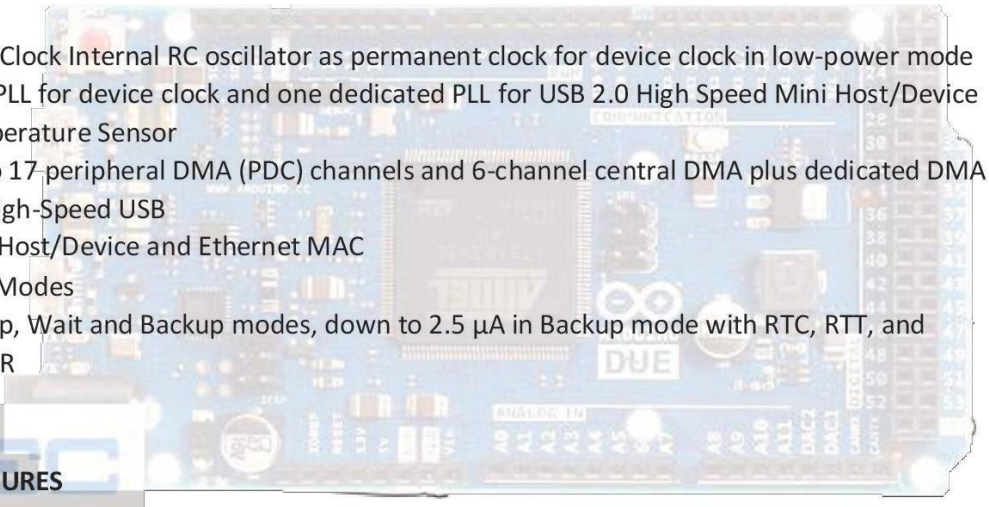
ARDUINO DUE PHYSICAL COMPONENTS

It based on **Atmel SAM3X8E ARM Cortex-M3** microcontroller is a member of a family of Flash microcontrollers based on the high performance 32-bit ARM Cortex-M3 RISC processor. It operates at a maximum speed of 84 MHz and up to 512 Kbytes of Flash memory and up to 100 Kbytes of SRAM. And its features as follow

- Core
  - ARM Cortex-M3 revision 2.0 running at up to 84 MHz
  - Memory Protection Unit (MPU)
  - 24-bit SysTick Counter
  - Nested Vector Interrupt Controller

- Memories
  - 256 to 512 Kbytes embedded Flash, 128-bit wide access, memory accelerator, dual bank
  - 32 to 100 Kbytes embedded SRAM with dual banks
  - 16 Kbytes ROM with embedded bootloader routines (UART, USB) and IAP routines
  - Static Memory Controller (SMC): SRAM, NOR, NAND support. NFC with 4 Kbyte RAM buffer and ECC

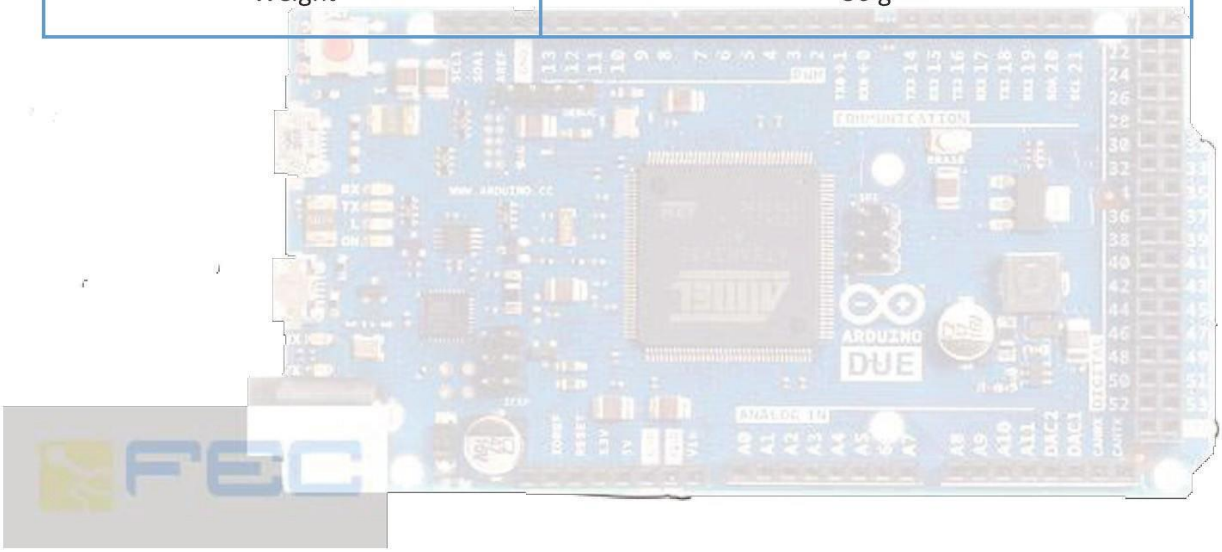
- System
  - Embedded voltage regulator for single supply operation
  - Power-on-Reset (POR), Brown-out Detector (BOD) and Watchdog for safe reset
  - Quartz or ceramic resonator oscillators: 3 to 20 MHz main and optional low power 32.768 kHz for RTC or device clock
  - High precision 8/12 MHz factory trimmed internal RC oscillator with 4 MHz default frequency for fast device
- startup
  - Slow Clock Internal RC oscillator as permanent clock for device clock in low-power mode
  - One PLL for device clock and one dedicated PLL for USB 2.0 High Speed Mini Host/Device
  - Temperature Sensor
  - Up to 17 peripheral DMA (PDC) channels and 6-channel central DMA plus dedicated DMA for High-Speed USB
  - Mini Host/Device and Ethernet MAC
- Low-power Modes
  - Sleep, Wait and Backup modes, down to 2.5 µA in Backup mode with RTC, RTT, and GPBR



ARDUINO DUE FEATURES

Microcontroller	AT91SAM3X8E
Operating Voltage	3.3V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-16V
Digital I/O Pins	54 (of which 12 provide PWM output)
Analog Input Pins	12
Analog Output Pins	2 (DAC)

Total DC Output Current on all I/O lines	130 mA
DC Current for 3.3V Pin	800 mA
DC Current for 5V Pin	800 mA
Flash Memory	512 KB all available for the user applications
SRAM	96 KB (two banks: 64KB and 32KB)
Clock Speed	84 MHz
Length	101.52 mm
Width	53.3 mm
Weight	36 g



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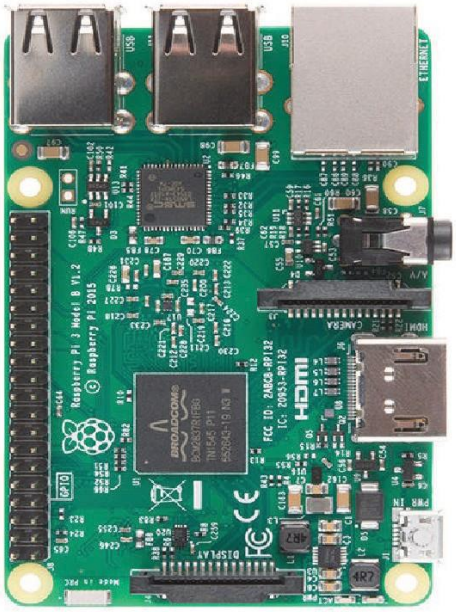
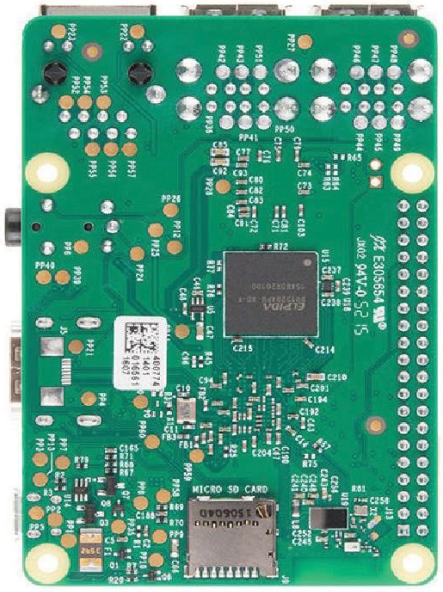
RASPBERRY PI 3 MODEL B





Product Name: RASPBERRYPI3-MODB-1GB

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Technical Specification:

Processor

- Broadcom BCM2387 chipset.
- 1.2GHz Quad-Core ARM Cortex-A53 (64Bit)

802.11 b/g/n Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)

- IEEE 802.11 b / g / n Wi-Fi. Protocol: WEP, WPA WPA2, algorithms AES-CCMP (maximum key length of 256 bits), the maximum range of 100 meters.
- IEEE 802.15 Bluetooth, symmetric encryption algorithm Advanced Encryption Standard (AES) with 128-bit key, the maximum range of 50 meters.

GPU

- Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode.
- Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure

Memory

- 1GB LPDDR2

Operating System

- Boots from Micro SD card, running a version of the Linux operating system or Windows 10 IoT

Dimensions

- 85 x 56 x 17mm

Power

- Micro USB socket 5V1, 2.5A

Connectors:

Ethernet

- 10/100 BaseT Ethernet socket

Video Output

- HDMI (rev 1.3 & 1.4)
- Composite RCA (PAL and NTSC)

Audio Output

- Audio Output 3.5mm jack
- HDMI
- USB 4 x USB 2.0 Connector

GPIO Connector

- 40-pin 2.54 mm (100 mil) expansion header: 2x20 strip
- Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply lines

Camera Connector

- 15-pin MIPI Camera Serial Interface (CSI-2)

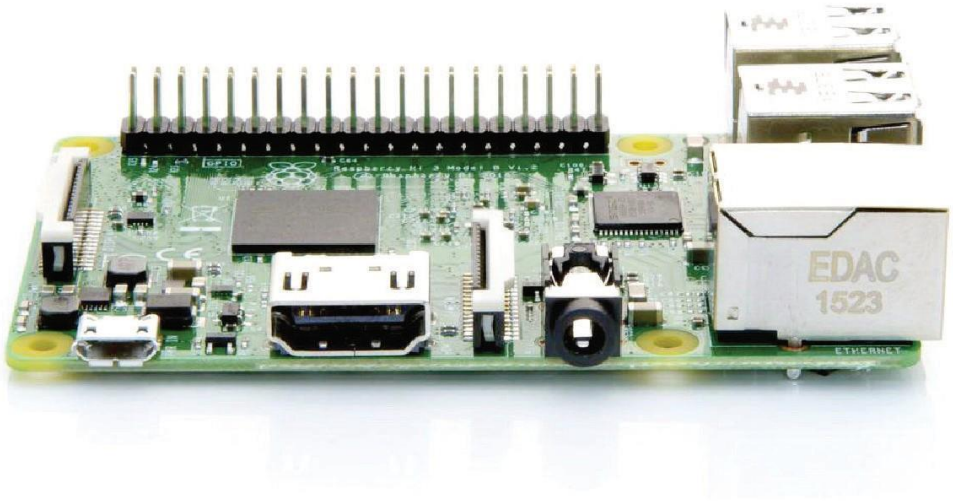
Display Connector

- Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane

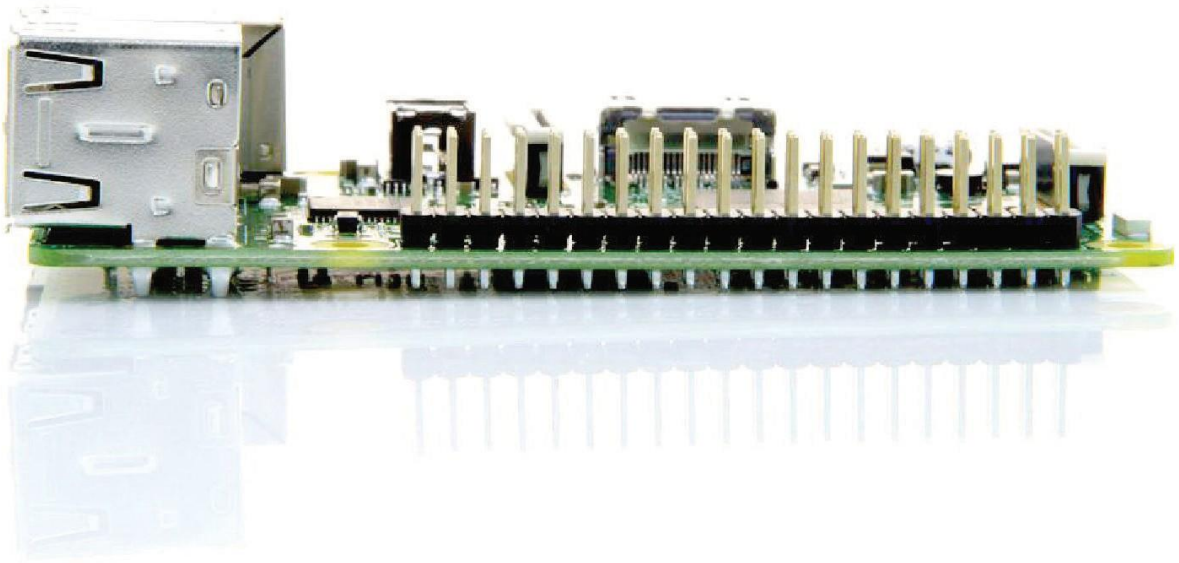
Memory Card Slot

- Push/pull Micro SDIO

The GPU provides Open GL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode and is capable of 1Gpixel/s, 1.5Gtexel/s or 24 GFLOPs of general purpose compute. What's that all mean? It means that if you plug the Raspberry Pi 3 into your HDTV, you could watch BluRay quality video, using H.264 at 40MBits/s



The biggest change that has been enacted with the Raspberry Pi 3 is an upgrade to a next generation main processor and improved connectivity with Bluetooth Low Energy (BLE) and BCM43143 Wi-Fi on board. Additionally, the Raspberry Pi 3 has improved power management, with an upgraded switched power source up to 2.5 Amps, to support more powerful external USB devices.



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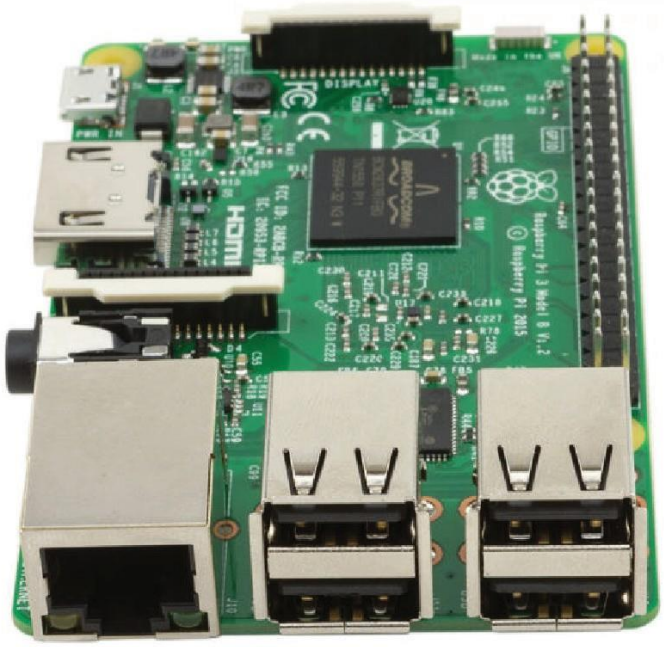
The Raspberry Pi 3's four built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the RPi needs, but if you want to add even more you can still use a USB hub. Keep in mind, it is recommended that you use a powered hub so as not to overtax the on-board voltage regulator. Powering the Raspberry Pi 3 is easy, just plug any USB power supply into the micro-USB port. There's no power button so the Pi will begin to boot as soon as power is applied, to turn it off simply remove power. The four built-in USB ports can even output up to 1.2A enabling you to connect more power hungry USB devices (This does require a 2Amp micro USB Power Supply)



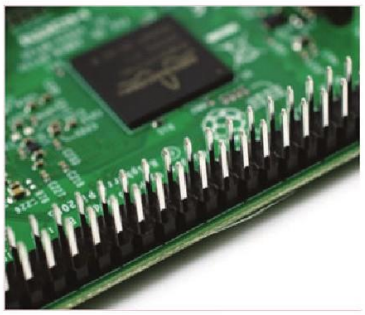
On top of all that, the low-level peripherals on the Pi make it great for hardware hacking. The 0.1" spaced 40-pin GPIO header on the Pi gives you access to 27 GPIO, UART, I^2C, SPI as well as 3.3 and 5V sources. Each pin on the GPIO header is identical to its predecessor the Model B+.

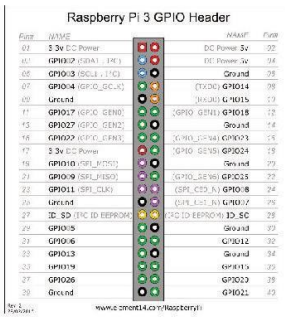
SoC

Built specifically for the new Pi 3, the Broadcom BCM2837 system-on-chip (SoC) includes four high-performance ARM Cortex-A53 processing cores running at 1.2GHz with 32kB Level 1 and 512kB Level 2 cache memory, a VideoCore IV graphics processor, and is linked to a 1GB LPDDR2 memory module on the rear of the board.

GPIO

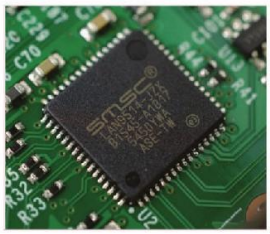
The Raspberry Pi 3 features the same 40-pin general-purpose input-output (GPIO) header as all the Pis going back to the Model B+ and Model A+. Any existing GPIO hardware will work without modification; the only change is a switch to which UART is exposed on the GPIO's pins, but that's handled internally by the operating system.





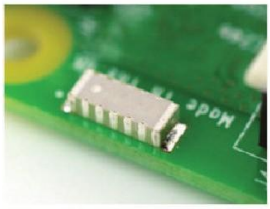
USB chip

The Raspberry Pi 3 shares the same SMSC LAN9514 chip as its predecessor, the Raspberry Pi 2, adding 10/100 Ethernet connectivity and four USB channels to the board. As before, the SMSC chip connects to the SoC via a single USB channel, acting as a USB-to-Ethernet adaptor and USB hub.



Antenna

There's no need to connect an external antenna to the Raspberry Pi 3. Its radios are connected to this chip antenna soldered directly to the board, in order to keep the size of the device to a minimum. Despite its diminutive stature, this antenna should be more than capable of picking up wireless LAN and Bluetooth signals – even through walls.



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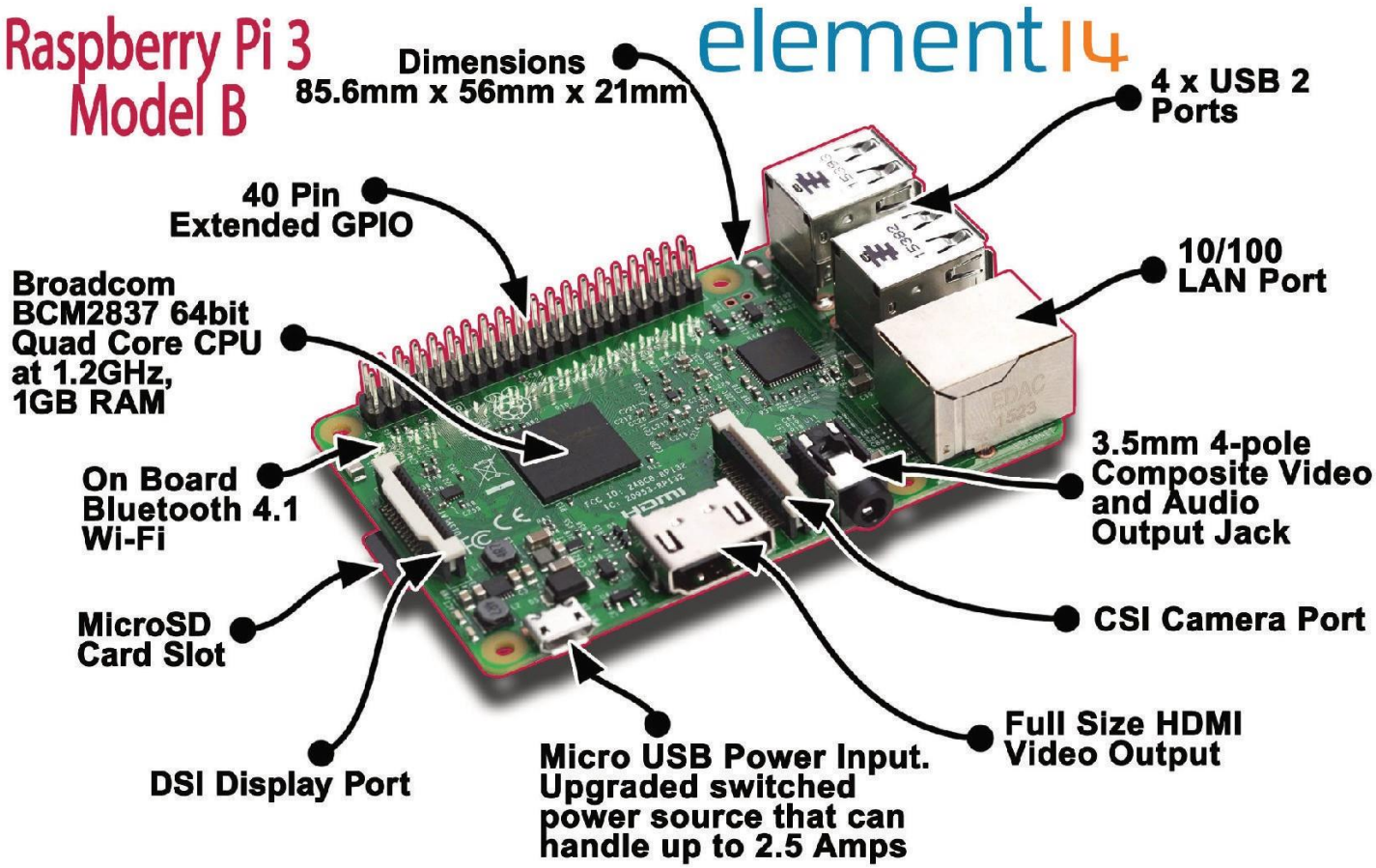

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Key Improvements from Pi 2 Model B to Pi 3 Model B:

- Next Generation QUAD Core Broadcom BCM2837 64bit ARMv7 processor
- Processor speed has increased from 900MHz on Pi 2 to 1.25Ghz on the RPi 3 Model B
- BCM43143 Wi-Fi on board
- Bluetooth Low Energy (BLE) on board
- Upgraded switched power source up to 2.5 Amps (can now power even more powerful devices over USB ports)

The main differences are the quad core 64-bit CPU and on-board Wi-Fi and Bluetooth. The RAM remains 1GB and there is no change to the USB or Ethernet ports. However, the upgraded power management should mean the Pi 3 can make use of more power hungry USB devices

For Raspberry Pi 3, Broadcom have supported us with a new SoC, BCM2837. This retains the same basic architecture as its predecessors BCM2835 and BCM2836, so all those projects and tutorials which rely on the precise details of the Raspberry Pi hardware will continue to work. The 900MHz 32-bit quad-core ARM Cortex-A7 CPU complex has been replaced by a custom-hardened 1.2GHz 64-bit quad-core ARM Cortex-A53

In terms of size it is identical to the B+ and Pi 2. All the connectors and mounting holes are in the same place so all existing add-ons, HATs and cases should fit just fine although the power and activity LEDs have moved to make room for the WiFi antenna.

The performance of the Pi 3 is roughly 50-60% faster than the Pi 2 which means it is ten times faster than the original Pi.

All of the connectors are in the same place and have the same functionality, and the board can still be run from a 5V micro-USB power adapter. This time round, we're recommending a 2.5A adapter if you want to connect power-hungry USB devices to the Raspberry Pi.

Raspberry Pi 3 Model B

Raspberry Pi 2 Model B

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	Raspberry Pi 3 Model B	Raspberry Pi 2 Model B	Model B+	Model A+	Model A	CMDK
Processor Chipset	Broadcom BCM2837 64Bit ARMv7 Quad Core Processor powered Single Board Computer running at 1250MHz	Broadcom BCM2836 32bit ARMv7 Quad Core Processor powered Single Board Computer running at 900MHz	Broadcom BCM2835 32bit ARMv6 SoC full HD multimedia applications processor	Broadcom BCM2835 32bit ARMv6 SoC full HD multimedia applications processor	Broadcom BCM2835 32bit ARMv6 SoC full HD multimedia applications processor	Broadcom BCM2835 32bit ARMv6 SoC full HD multimedia applications processor
GPU	Videocore IV	Videocore IV	Videocore IV	Videocore IV	Videocore IV	Videocore IV
Processor Speed	QUAD Core @1250 MHz	QUAD Core @900 MHz	Single Core @700 MHz	Single Core @700 MHz	Single Core @700 MHz	Single Core @700 MHz
RAM	1GB SDRAM @ 400 MHz	1GB SDRAM @ 400 MHz	512 MB SDRAM @ 400 MHz	256 MB SDRAM @ 400 MHz	256 MB SDRAM @ 400 MHz	512 MB SDRAM @ 400 MHz
Storage	MicroSD	MicroSD	MicroSD	MicroSD	SDCard	4GB eMMC
USB 2.0	4x USB Ports	4x USB Ports	4x USB Ports	1x USB Port	1x USB Port	1x USB Port
Power Draw / voltage	2.5A @ 5V	1.8A @ 5V	1.8A @ 5V	1.8A @ 5V	1.2A @ 5V	1.8A @ 5V
GPIO	40 pin	40 pin	40 pin	40 pin	26 pin	120 pin
Ethernet Port	Yes	Yes	Yes	No	No	No
Wi-Fi	Built in	No	No	No	No	No
Bluetooth LE	Built in	No	No	No	No	No

UM1472
User manual

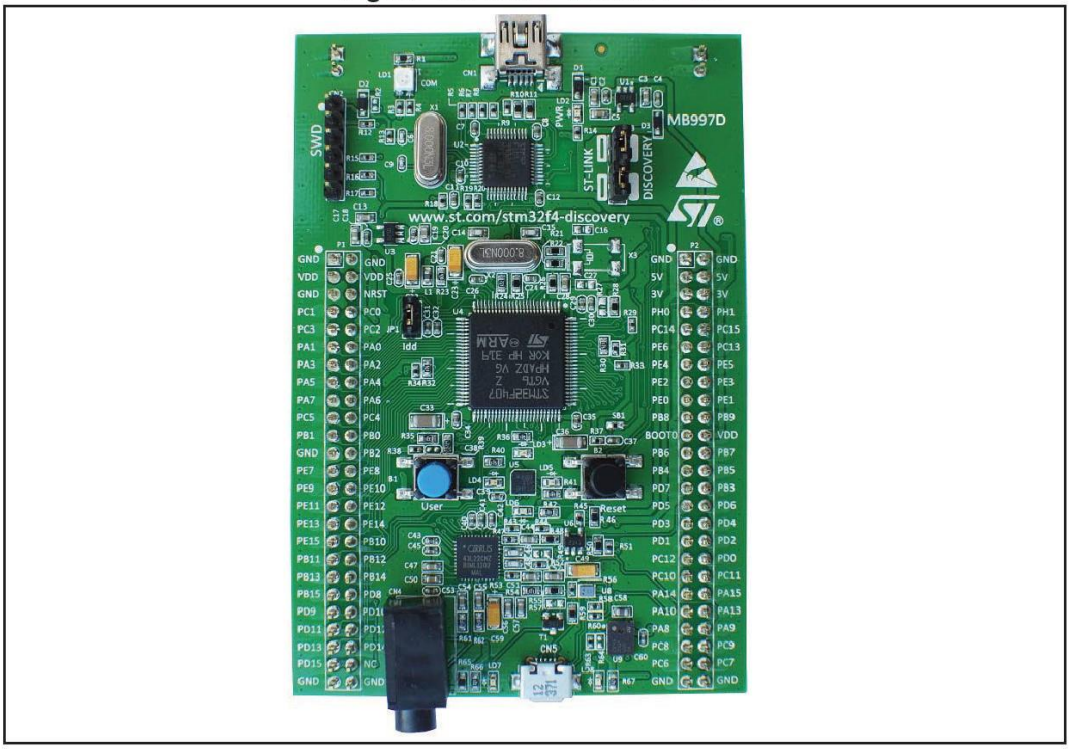
Discovery kit with STM32F407VG MCU

Introduction

The STM32F4DISCOVERY Discovery kit allows users to easily develop applications with the STM32F407VG high performance microcontroller with the ARM® Cortex®-M4 32-bit core. It includes everything required either for beginners or for experienced users to get quickly started.

Based on STM32F407VG, it includes an ST-LINK/V2 or ST-LINK/V2-A embedded debug tool, two ST-MEMS digital accelerometers, a digital microphone, one audio DAC with integrated class D speaker driver, LEDs, push buttons and a USB OTG micro-AB connector. To expand the functionality of the STM32F4DISCOVERY Discovery kit with the Ethernet connectivity, LCD display and more, visit the www.st.com/stm32f4dis-expansion webpage. The STM32F4DISCOVERY Discovery kit comes with the STM32 comprehensive free software libraries and examples available with the STM32Cube package, as well as a direct access to the ARM® mbed Enabled™ on-line resources at http://mbed.org.

Figure 1. STM32F4DISCOVERY



1. Picture is not contractual.

Contents

List of tables

List of figures

1 Features

The STM32F4DISCOVERY offers the following features:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex® -M4 with FPU core, 1-Mbyte Flash memory, 192-Kbyte RAM in an LQFP100 package
- On-board ST-LINK/V2 on STM32F4DISCOVERY or ST-LINK/V2-A on STM32F407G-DISC1
- ARM® mbed Enabled™ (http://mbed.org) with ST-LINK/V2-A only
- USB ST-LINK with re-enumeration capability and three different interfaces:
  - Virtual COM port (with ST-LINK/V2-A only)
  - Mass storage (with ST-LINK/V2-A only)
  - Debug port
- Board power supply:
  - Through USB bus
  - External power sources:
    3 V and 5 V
- LIS302DL or LIS3DSH ST MEMS 3-axis accelerometer
- MP45DT02 ST MEMS audio sensor omni-directional digital microphone
- CS43L22 audio DAC with integrated class D speaker driver
- Eight LEDs:
  - LD1 (red/green) for USB communication
  - LD2 (red) for 3.3 V power on
  - Four user LEDs, LD3 (orange), LD4 (green), LD5 (red) and LD6 (blue)
  - 2 USB OTG LEDs LD7 (green) VBUS and LD8 (red) over-current
- Two push buttons (user and reset)
- USB OTG FS with micro-AB connector
- Extension header for all LQFP100 I/Os for quick connection to prototyping board and easy probing
- Comprehensive free software including a variety of examples, part of the STM32CubeF4 package or STSW-STM32068 for legacy standard library usage

2 Product marking

Tools marked as "ES" or "E" are not yet qualified and as such, they may be used only for evaluation purposes. ST shall not be liable for any consequences related with other ways of use of such non-qualified tools, for example, as reference design or for production.

Examples of location of "E" or "ES" marking:

- On target STM32 microcontroller part mounted on the board (for illustration, refer to section “Package information” of a STM32 datasheet at *www.st.com*).
- Next to the evaluation tool ordering part number, as a label stuck or a silk-screen printed on the board.

3 Ordering information

To order the Discovery kit for the STM32F407 line of microcontrollers, refer to *Table 1*.

Table 1. List of the order codes

Order code	ST-LINK version
STM32F4DISCOVERY	ST-LINK/V2
STM32F407G-DISC1	ST-LINK/V2-A (mbed Enabled)

4 Conventions

Table 2 provides the definition of some conventions used in the present document.

Table 2. ON/OFF conventions

Convention	Definition
Jumper JP1 ON	Jumper fitted
Jumper JP1 OFF	Jumper not fitted
Solder bridge SBx ON	SBx connections closed by solder
Solder bridge SBx OFF	SBx connections left open

5 Quick start

The STM32F4DISCOVERY is a low-cost and easy-to-use development kit to quickly evaluate and start a development with an STM32F407VG high-performance microcontroller.

Before installing and using the product, accept the Evaluation Product License Agreement from the www.st.com/stm32f4-discovery webpage.

For more information on the STM32F4DISCOVERY and for demonstration software, visit the www.st.com/stm32f4-discovery webpage.

5.1 Getting started

Follow the sequence below to configure the STM32F4DISCOVERY board and launch the DISCOVER application:

1. Check jumper position on the board, JP1 on, CN3 on (DISCOVERY selected).
2. Connect the STM32F4DISCOVERY board to a PC with a USB cable 'type A to mini-B' through USB connector CN1 to power the board. Red LED LD2 (PWR) then lights up.
3. Four LEDs between B1 and B2 buttons are blinking.
4. Press user button B1 to enable the ST MEMS sensor, move the board and observe the four LEDs blinking according to the motion direction and speed. (If a second USB cable 'type A to micro-B' is connected between PC and CN5 connector, then the board is recognized as standard mouse and its motion will also control the PC cursor).
5. To study or modify the DISCOVER project related to this demonstration, visit the www.st.com/stm32f4-discovery webpage and follow the tutorial.
6. Discover the STM32F407VG features, download and execute programs proposed in the list of projects.
7. Develop the application using available examples.

5.2 System requirements

- Windows® OS (XP, 7, 8 and 10), Linux® 64-bit or macOS™
- USB type A to Mini-B cable.

5.3 Development toolchains supported

- Keil® MDK-ARM(a)
- IAR™ EWARM(a)
- GCC-based IDEs including free SW4STM32 from AC6
- ARM® mbed Enabled™ online

a. On Windows® only.

6 Hardware and layout

The STM32F4DISCOVERY is designed around the STM32F407VGT6 microcontroller in a 100-pin LQFP package.

Figure 2 illustrates the connections between the STM32F407VGT6 and its peripherals (ST-LINK/V2 or ST-LINK/V2-A, push buttons, LEDs, Audio DAC, USB, ST-MEMS accelerometer and microphone, and connectors).

Figure 3 and *Figure 4* help users to locate these features on the STM32F4DISCOVERY board.

Figure 2. Hardware block diagram

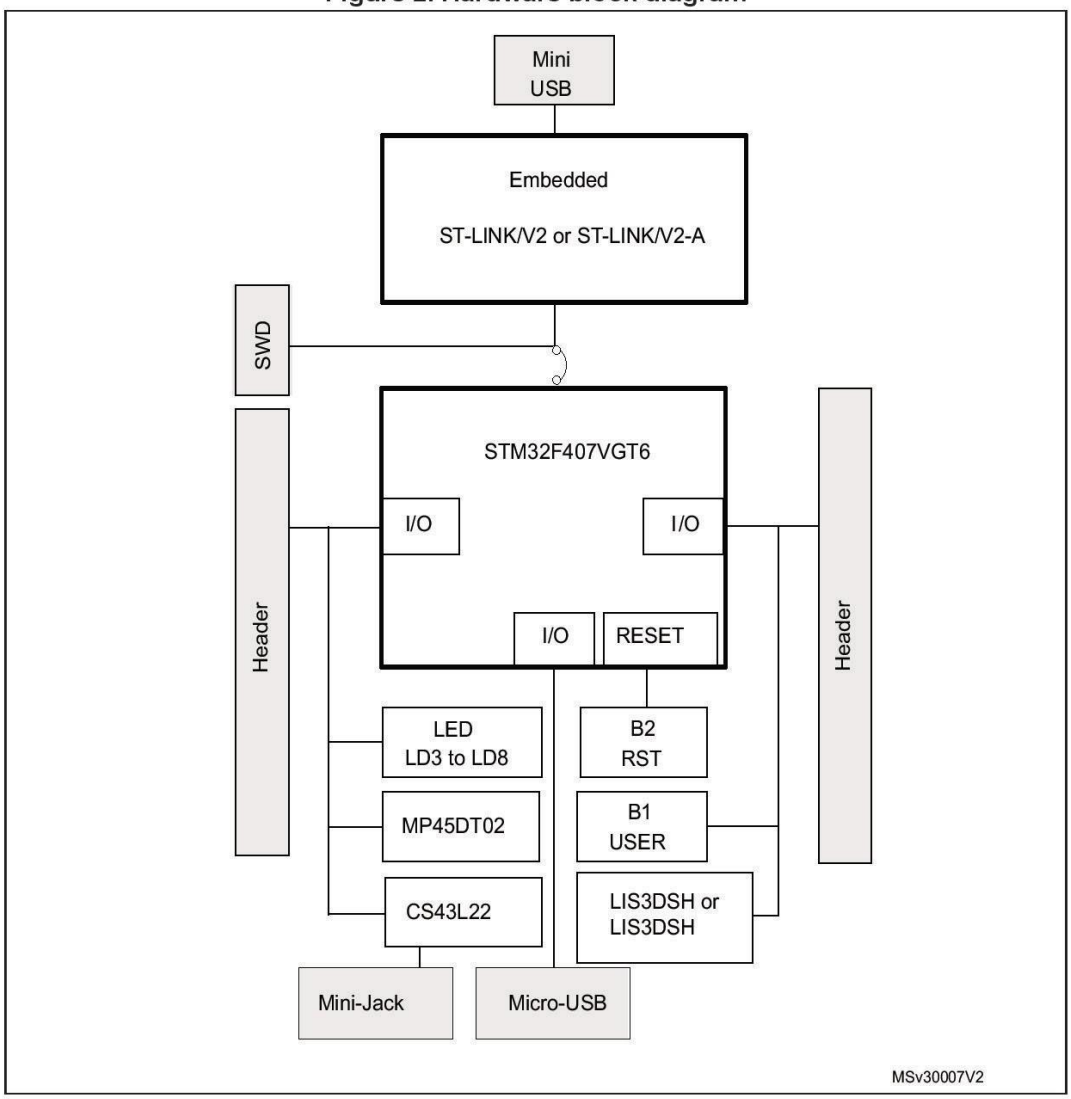
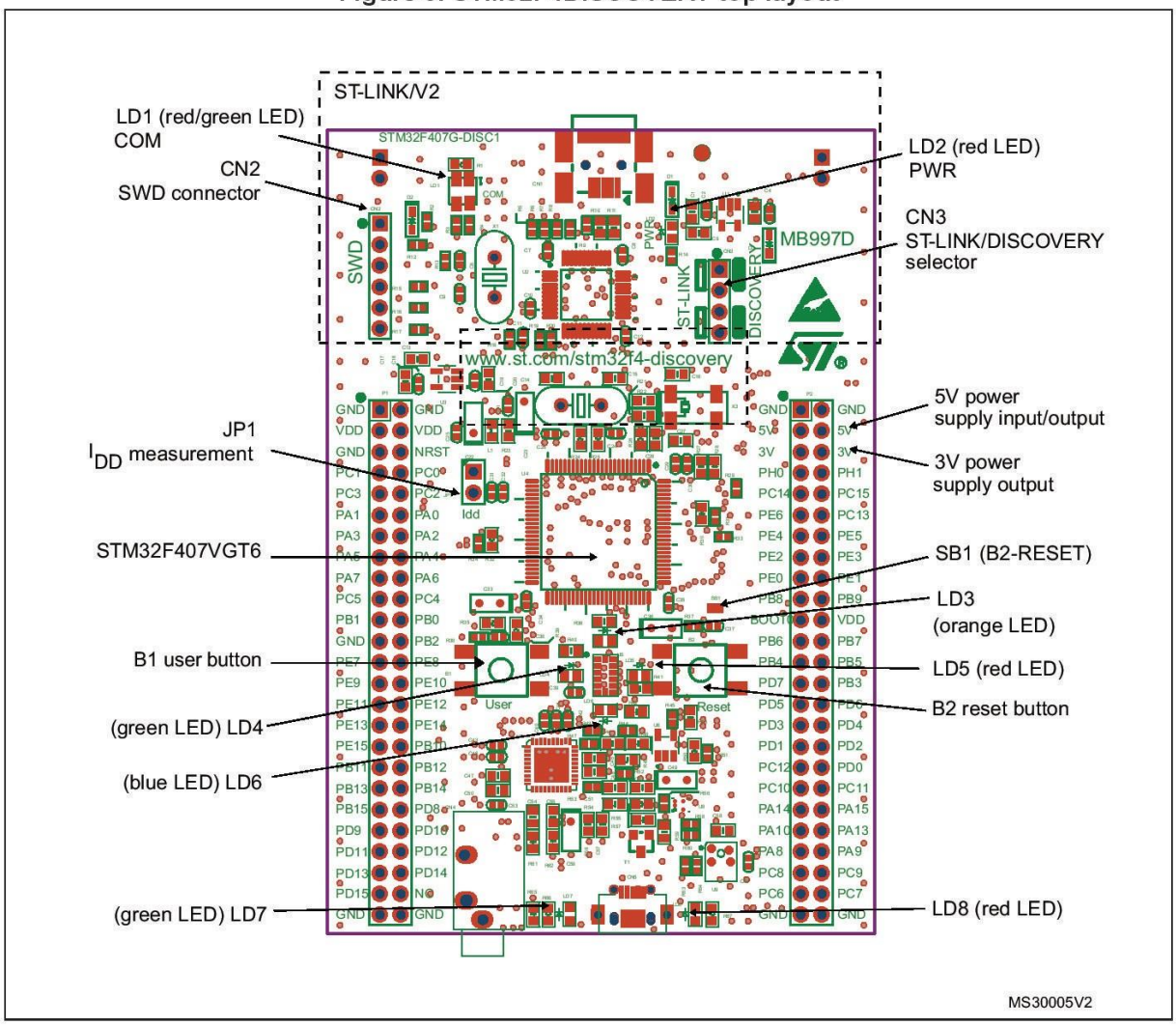
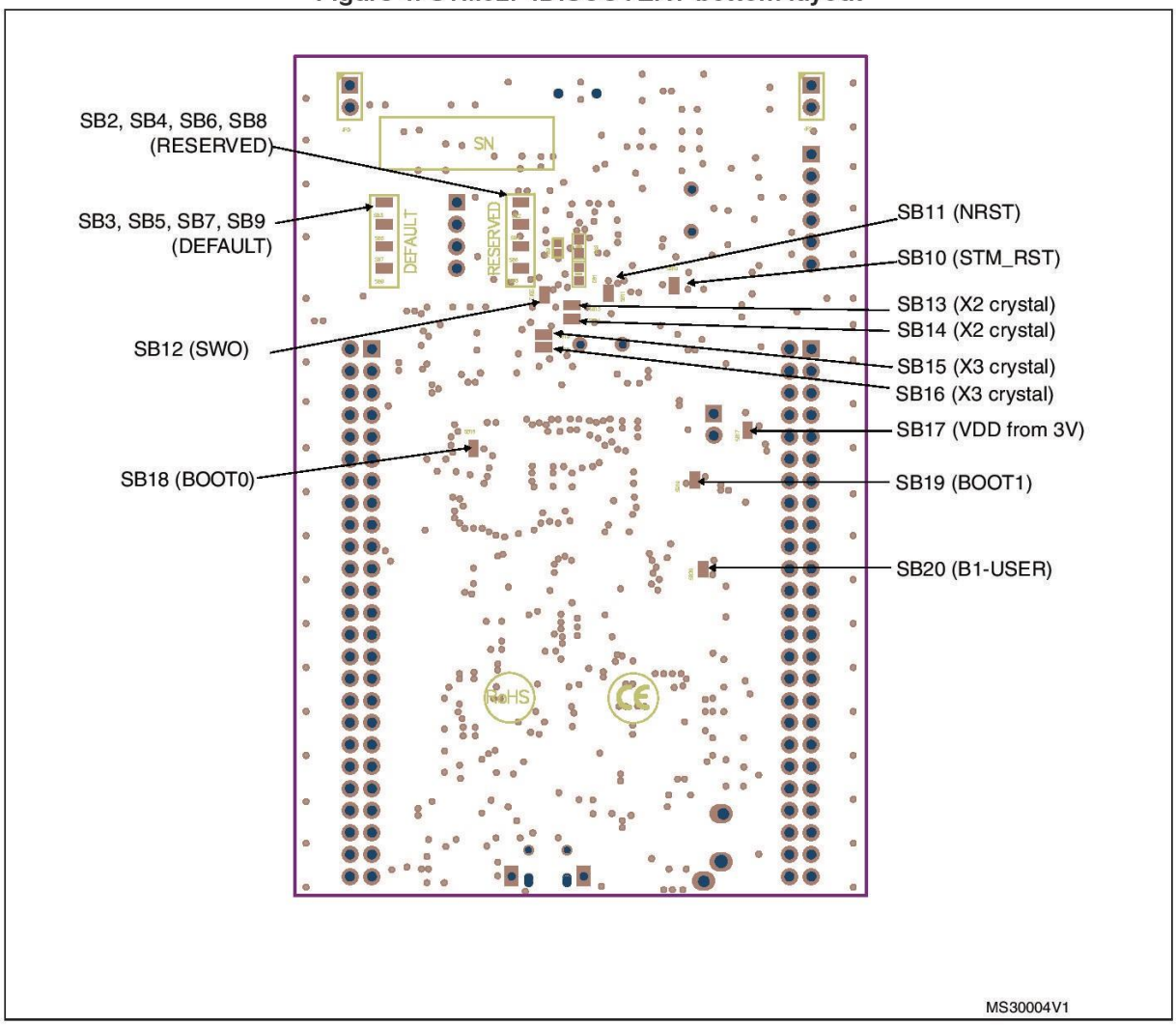


Figure 3. STM32F4DISCOVERY top layout



Note: Pin 1 of CN2, CN3, JP1, P1 and P2 connectors are identified by a red square.

Figure 4. STM32F4DISCOVERY bottom layout



6.1 Embedded ST-LINK/V2 (or V2-A)

ST-LINK/V2 on STM32F4DISCOVERY or ST-LINK/V2-A on STM32F407G-DISC1 is an embedded tool for programming and debugging.

The embedded ST-LINK/V2 (or V2-A) supports only SWD for STM32 devices. For information about debugging and programming features refer to *ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32*, UM1075 User manual, which describes in details all the ST-LINK/V2 features.

The changes on ST-LINK/V2-A versus ST-LINK/V2 version are listed below.

New features supported on ST-LINK/V2-A:

- Virtual COM port interface on USB (see *Section 6.1.3: ST-LINK/V2-A VCP configuration*)
- Mass storage interface on USB

Features not supported on ST-LINK/V2-A:

- SWIM interface
- Minimum supported application voltage limited to 3 V
- USB power management request for more than 100 mA power on USB

Known limitation:

- Activating the readout protection on ST-LINK/V2-A target, prevents the target application from running afterwards. The target readout protection must be kept disabled on ST-LINK/V2-A boards.

There are two different ways to use the embedded ST-LINK/V2 (or V2-A) depending on the jumper states (see *Table 3*):

- Program/debug the STM32 on board (refer to *Section 6.1.4: Using ST-LINK/V2 (or V2-A) to program/debug the STM32F407VG on board*)
- Program/debug the STM32 in an external application board, using a cable connected to SWD connector CN2 (refer to *Section 6.1.5: Using ST-LINK/V2 (or V2-A) to program/debug an external STM32 application*)

Table 3. Jumper states

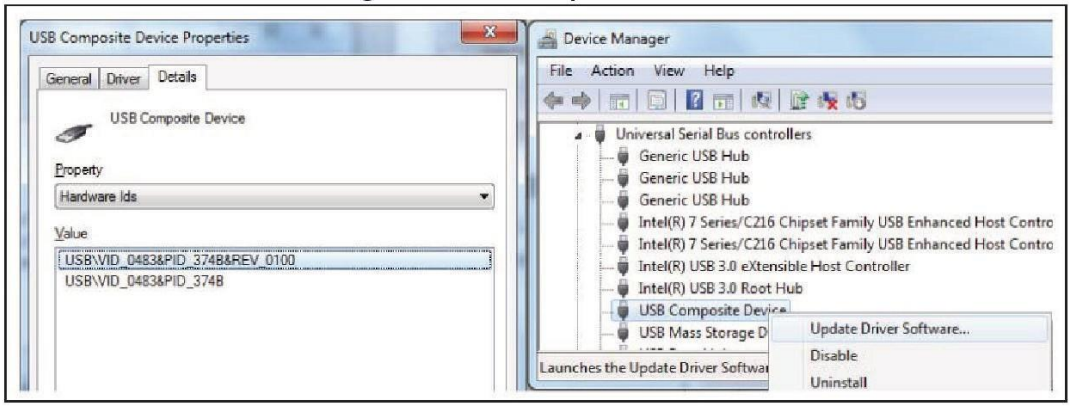
Jumper state	Description
Both CN3 jumpers ON	ST-LINK/V2 (or V2-A) functions enabled for on board programming (default)
Both CN3 jumpers OFF	ST-LINK/V2 (or V2-A) functions enabled for application through external CN2 connector (SWD supported)

6.1.1 Drivers

Before connecting the STM32F4DISCOVERY board to a Windows® PC (XP, 7, 8 and 10) through the USB, a driver for the ST-LINK/V2 (or V2-A) must be installed. It is available at the *www.st.com* website. In case the STM32 Discovery is connected to the PC before the driver is installed, some Discovery interfaces may be declared as “Unknown” in the PC device manager. To recover from this situation, after installing the dedicated driver, the association of “Unknown” USB devices found on the STM32F4DISCOVERY board to this dedicated driver, must be updated in the device manager manually.

Note: It is recommended to proceed by using USB Composite Device, as shown in Figure 5.

Figure 5. USB composite device



6.1.2 ST-LINK/V2 (or V2-A) firmware upgrade

The ST-LINK/V2 (or V2-A) embeds a firmware upgrade mechanism for in-situ upgrade through the USB port. As the firmware may evolve during the life time of the ST-LINK/V2 (or V2-A) product (for example new functionalities, bug fixes, support for new microcontroller families), it is recommended to visit the *www.st.com* website before starting to use the Discovery board and periodically, to stay up-to-date with the latest firmware version.

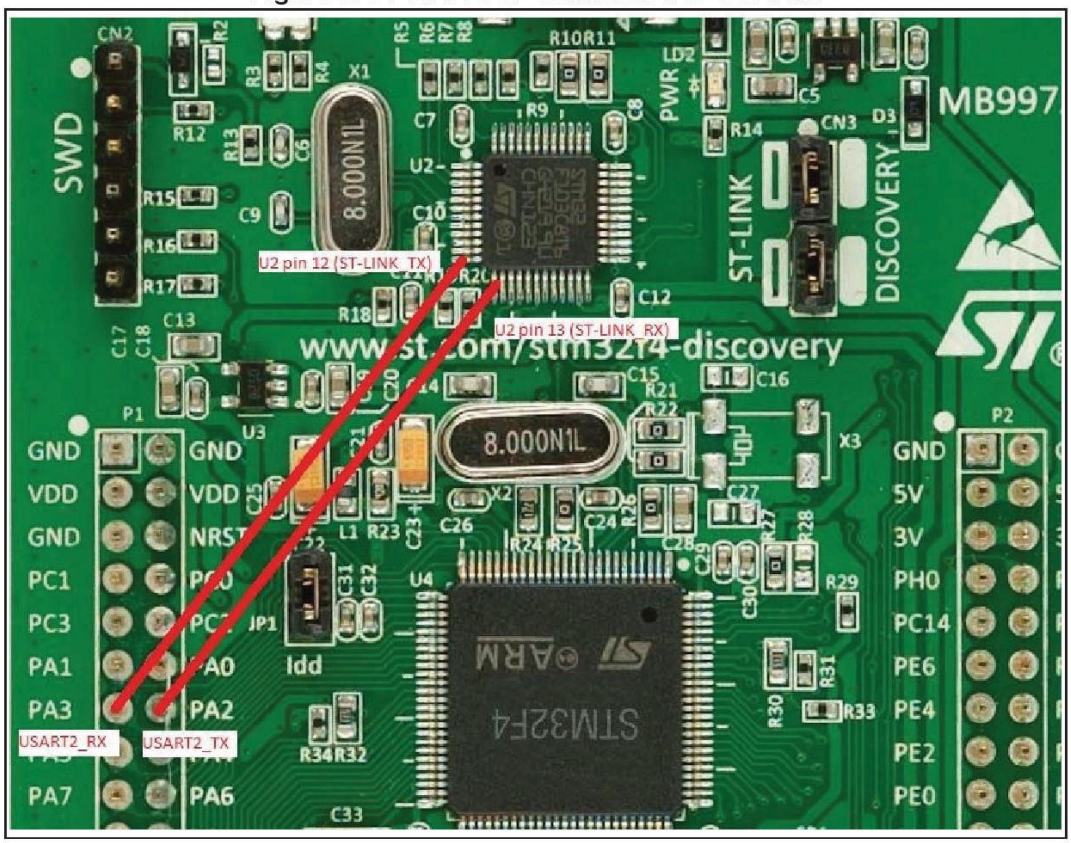
6.1.3 ST-LINK/V2-A VCP configuration

The ST-LINK/V2-A supports a virtual COM port (VCP) on U2 pin 12 (ST-LINK_TX) and U2 pin 13 (ST-LINK_RX) but these pins are not connected to the USART of the STM32F407 microcontroller for mbed support.

Two solutions are possible to connect an STM32F407 USART to the VCP on the PC:

- Using an USART to USB dongle from the market connected for instance to STM32F407 USART2 available on connector P1 pin 14 (PA2: USART2_TX) and P1 pin 13 (PA3: USART2_RX).
- Using flying wires to connect ST-LINK/V2-A virtual COM port (ST-LINK VCP on U2 pin 12 and 13) to STM32F407 USART2 (PA2 and PA3: P1 pin 14 and 13) as shown in the *Figure 6* below.

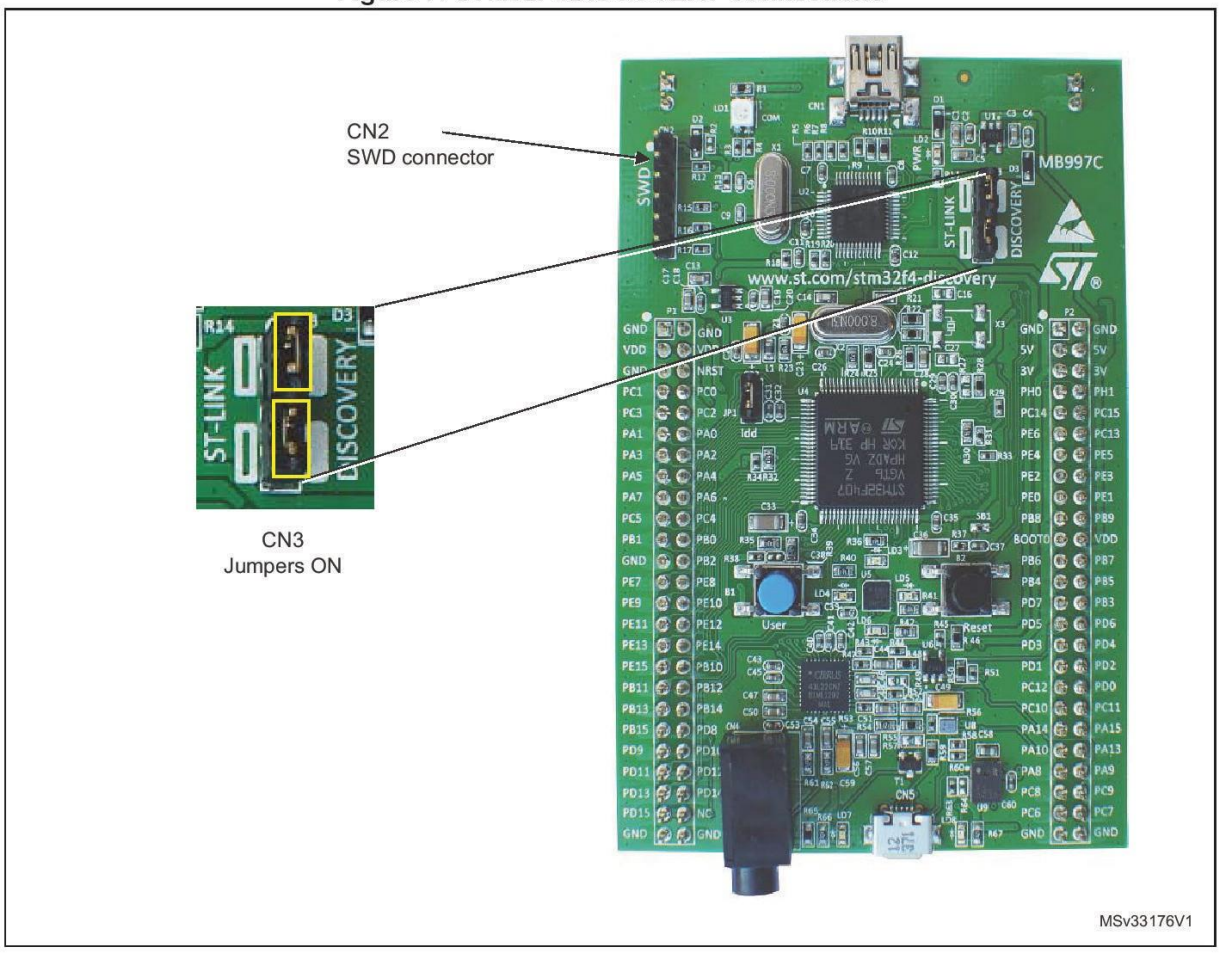
Figure 6. ST-LINK VCP connection to USART2



6.1.4 Using ST-LINK/V2 (or V2-A) to program/debug the STM32F407VG on board

To program the STM32F407VG on board, simply plug in the two jumpers on CN3, as shown in *Figure 7* in red, but do not use the CN2 connector as that could disturb communication with the STM32F407VG of the STM32F4DISCOVERY.

Figure 7. STM32F4DISCOVERY connections



6.1.5 Using ST-LINK/V2 (or V2-A) to program/debug an external STM32 application

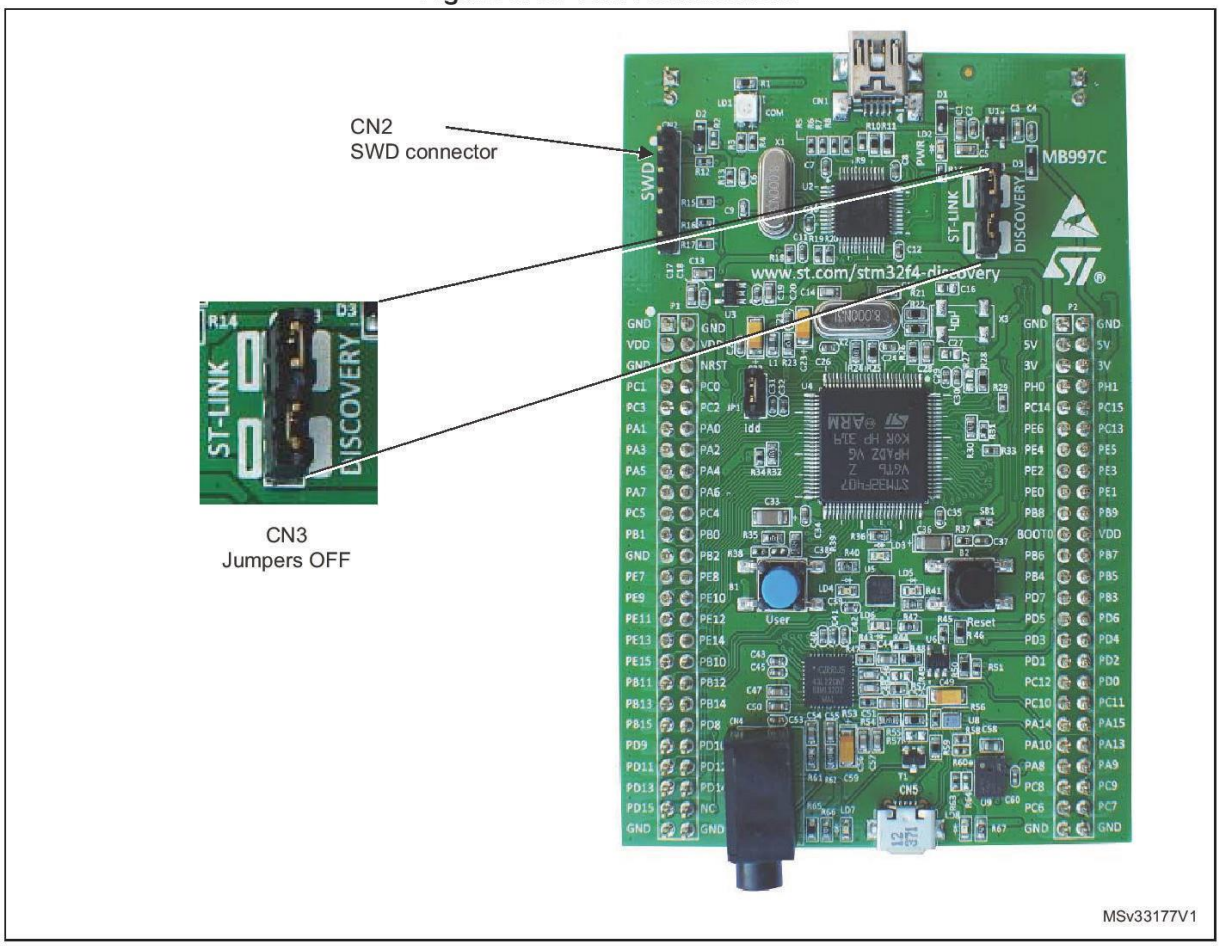
It is very easy to use the ST-LINK/V2 (or V2-A) to program the STM32 on an external application. Simply remove the two jumpers from CN3, as shown in *Figure 8*, and connect the application to the CN2 debug connector according to *Table 4*.

Note: SB11 must be OFF if CN2 pin 5 is used in the external application.

Table 4. Debug connector CN2 (SWD)

Pin	CN2	Designation
1	VDD_TARGET	VDD from application
2	SWCLK	SWD clock
3	GND	Ground
4	SWDIO	SWD data input/output
5	NRST	RESET of target STM32
6	SWO	Reserved

Figure 8. ST-LINK connections



6.2 Power supply and power selection

The power supply is provided either by the host PC through the USB cable, or by an external 5V power supply.

The D1 and D2 diodes protect the 5V and 3V pins from external power supplies:

- 5V and 3V can be used as output power supplies when another application board is connected to pins P1 and P2.
  In this case, the 5V and 3V pins deliver a 5V or 3V power supply and power consumption must be lower than 100 mA.
- 5V can also be used as input power supplies e.g. when the USB connector is not connected to the PC.
  In this case, the STM32F4DISCOVERY board must be powered by a power supply unit or by auxiliary equipment complying with standard EN-60950-1: 2006+A11/2009, and must be Safety Extra Low Voltage (SELV) with limited power capability.

6.3 LEDs

- LD1 COM: LD1 default status is red. LD1 turns to green to indicate that communications are in progress between the PC and the ST-LINK/V2.
- LD2 PWR: red LED indicates that the board is powered.
- User LD3: orange LED is a user LED connected to the I/O PD13 of the STM32F407VGT6.
- User LD4: green LED is a user LED connected to the I/O PD12 of the STM32F407VGT6.
- User LD5: red LED is a user LED connected to the I/O PD14 of the STM32F407VGT6.
- User LD6: blue LED is a user LED connected to the I/O PD15 of the STM32F407VGT6.
- USB LD7: green LED indicates when VBUS is present on CN5 and is connected to PA9 of the STM32F407VGT6.
- USB LD8: red LED indicates an overcurrent from VBUS of CN5 and is connected to the I/O PD5 of the STM32F407VGT6.

6.4 Push buttons

- B1 USER: User and Wake-Up buttons are connected to the I/O PA0 of the STM32F407VG.
- B2 RESET: Push button connected to NRST is used to RESET the STM32F407VG.

6.5 On-board audio capability

The STM32F407VG microcontroller uses an audio DAC (CS43L22) to output sounds through the audio mini-jack connector.

The STM32F407VG microcontroller controls the audio DAC through the I^2C interface and processes digital signals through an I^2S connection or an analog input signal.

- The sound can come independently from different inputs:
  - ST-MEMS microphone (MP45DT02): digital using PDM protocol or analog when using the low pass filter
  - USB connector: from external mass storage such as a USB key, USB HDD, and so on
  - Internal memory of the STM32F407VG microcontroller
- The sound can be output in different ways through the audio DAC:
  - Using I^2S protocol
  - Using DAC to analog input AIN1x of the CS43L22
  - Using the microphone output directly via a low-pass filter to analog input AIN4x of the CS43L22

6.6 USB OTG supported

The STM32F407VG microcontroller is used on this board to only drive the USB OTG full speed. The USB micro-AB connector (CN5) allows the user to connect a host or device component, such as a USB key, mouse, and so on.

Two LEDs are dedicated to this module:

- LD7 (green LED) indicates when VBUS is active
- LD8 (red LED) indicates an overcurrent from connected device

6.7 Motion sensor (ST-MEMS LIS302DL or LIS3DSH)

Two different versions of motion sensors (U5 in schematic) are available on the board depending on the PCB version. The LIS302DL is present on board MB997B (PCB revision B) and the LIS3DSH is present on board MB997C (PCB rev C).

The LIS302DL and LIS3DSH are both ultra-compact low-power three-axis linear accelerometers.

The motion sensor includes a sensing element and an IC interface able to provide the measured acceleration to the external world through the I^2C/SPI serial interfaces.

The LIS302DL has dynamically user selectable full scales of +-2g/+-8g and it is capable of measuring acceleration with an output rate of 100Hz to 400Hz.

The LIS3DSH has ±2g/±4g/±6g/±8g/±16g dynamically selectable full-scale and it is capable of measuring acceleration with an output data rate of 3.125 Hz to 1.6 kHz.

The STM32F407VG microcontroller controls this motion sensor through the SPI interface.

6.8 JP1 (Idd)

Jumper JP1, labeled Idd, allows the consumption of STM32F407VG to be measured by removing the jumper and connecting an ammeter.

- Jumper on: STM32F407VGT6 is powered (default).
- Jumper off: an ammeter must be connected to measure the STM32F407VG current, (if there is no ammeter, the STM32F407VG is not powered).

6.9 OSC clock

6.9.1 OSC clock supply

If PH0 and PH1 are used as GPIOs instead of being used as a clock, then SB13 and SB14 are closed and R24, R25 and R68 are removed.

- **MCO from ST-LINK**. From MCO of the STM32F103. This frequency cannot be changed, it is fixed at 8 MHz and connected to PH0-OSC_IN of the STM32F407VG. Configuration needed:
  - SB13, SB14 OPEN
  - R25[(b)] removed
  - R68[(b)] soldered
- **Oscillator on board**. From X2 crystal. For typical frequencies and its capacitors and resistors, refer to the STM32F407VG Datasheet at *www.st.com*. Configuration needed:
  - SB13, SB14 OPEN
  - R25[(b)] soldered
  - R68[(b)] removed
- **Oscillator from external PH0**. From external oscillator through pin 7 of the P2 connector. Configuration needed:
  - SB13 closed
  - SB14 closed
  - R25 and R68 removed

6.9.2 OSC 32 KHz clock supply

If PC14 and PC15 are only used as GPIOs and not as a clock, then SB15 and SB16 are closed, and R21 and R22 are removed.

- **Oscillator on board**. From X1 crystal (not provided). Configuration needed:
  - SB15, SB16 OPEN
  - C16, C27, R21 and R22 soldered.
- **Oscillator from external PC14**. From external oscillator trough the pin 9 of P2 connector. Configuration needed:
  - SB16 closed
  - SB15 closed
  - R21 and R22 removed

b. As the frequency supplied by X2 is the same as MCO (8 MHz), R25 and R68 are soldered.

6.10 Solder bridges

Table 5. Solder bridges

Bridge	State[1]	Description
SB13,14 (X2 crystal)[2]	**OFF**	X2, C14, C15, R24 and R25 provide a clock. PH0, PH1 are disconnected from P2.
	ON	PH0, PH1 are connected to P2 (R24, R25 and R68 must not be fitted).
SB3, 5, 7, 9 (Default)	**ON**	Reserved, do not modify.
SB2, 4, 6, 8 (Reserved)	OFF	Reserved, do not modify.
SB15,16 (X3 crystal)	**OFF**	X3, C16, C27, R21 and R22 deliver a 32 KHz clock. PC14, PC15 are not connected to P2.
	ON	PC14, PC15 are only connected to P2. Remove only R21, R22
SB1 (B2-RESET)	**ON**	B2 pushbutton is connected to the NRST pin of the STM32F407VGT6
	OFF	B2 pushbutton is not connected the NRST pin of the STM32F407VG.
SB20 (B1-USER)	**ON**	B1 pushbutton is connected to PA0.
	OFF	B1 pushbutton is not connected to PA0.
SB17 (VDD powered from 3V)	**OFF**	VDD is not powered from 3V, depends on JP1 jumper.
	ON	VDD is permanently powered from 3V, JP1 jumper has no effect.
SB11 (NRST)	**ON**	NRST signal of the CN2 connector is connected to the NRST pin of the STM32F407VG.
	OFF	NRST signal of the CN2 connector is not connected to the NRST pin of the STM32F407VG.
SB12 (SWO)	**ON**	SWO signal of the CN2 connector is connected to PB3.
	OFF	SWO signal is not connected.
SB10 (STM_RST)	**OFF**	No incidence on STM32F103C8T6 (ST-LINK/V2) NRST signal.
	ON	STM32F103C8T6 (ST-LINK/V2) NRST signal is connected to GND.
SB18 (BOOT0)	**ON**	BOOT0 signal of the STM32F407VG is held low through a 510 ohm pull-down resistor.
	OFF	BOOT0 signal of the STM32F407VG is held high through a 10 Kohm pull-up resistor.
SB19 (BOOT1)	**OFF**	The BOOT1 signal of the STM32F407VG is held high through a 10 Kohm pull-up resistor.
	ON	The BOOT1 signal of the STM32F407VG is held low through a 510 ohm pull-down resistor.

1. Default SBx state is shown in bold.
2. SB13 and SB14 are OFF to allow the user to choose between MCO and X2 crystal for clock source.

6.11 Extension connectors

The male headers P1 and P2 can connect the STM32F4DISCOVERY to a standard prototyping/wrapping board. STM32F407VG GPIOs are available on these connectors. P1 and P2 can also be probed by an oscilloscope, a logical analyzer or a voltmeter.

Table 6. STM32 pin description versus board functions

STM32 pin			Board function													
Main function	Alternate functions	LQFP 100	CS43 L22	MP45 DT02	LIS302DL or LIS3DSH	Push button	LED	SWD	USB	OSC	Free I/O	Power supply	CN5	CN2	P1	P2
BOOT0	V_{PP}	94	-	-	-	-	-	-	-	-	-	-	-	-	-	21
NRST	-	14	-	-	-	RESET	-	NRST	-	-	-	-	-	5	6	-
PA0-WKUP	USART2_CTS/ USART4_TX/ ETH_MII_CRS/ TIM2_CH1_ETR/ TIM5_CH1/ TIM8_ETR/ ADC123_IN0/ WKUP	23	-	-	-	USER	-	-	-	-	PA0[1]	-	-	-	12	-
PA1	USART2_RTS/ USART4_RX/ ETH_RMII_REF_CLK/ ETH_MII_RX_CLK/ TIM5_CH2/ TIMM2_CH2/ ADC123_IN1	24	-	-	-	-	-	-	-	-	PA1	-	-	-	11	-
PA2	USART2_TX/ TIM5_CH3/ TIM9_CH1/ TIM2_CH3/ ETH_MDIO/ ADC123_IN2	25	-	-	-	-	-	-	-	-	PA2	-	-	-	14	-
PA3	USART2_RX/ TIM5_CH4/ TIM9_CH2/ TIM2_CH4/ OTG_HS_ULPI_D0/ ETH_MII_COL/ ADC123_IN3	26	-	-	-	-	-	-	-	-	PA3	-	-	-	13	-
PA4	SPI1_NSS/ SPI3_NSS/ USART2_CK/ DCMI_HSYNC/ OTG_HS_SOF/ I2S3_WS/ ADC12_IN4/ DAC1_OUT	29	LRCK/ AIN1x	-	-	-	-	-	-	-	-	-	-	-	16	-
PA5	SPI1_SCK/ OTG_HS_ULPI_CK/ TIM2_CH1_ETR/ TIM8_CHIN/ ADC12_IN5/ DAC2_OUT	30	-	-	SCL/ SPC	-	-	-	-	-	-	-	-	-	15	-
PA6	SPI1_MISO/ TIM8_BKIN/ TIM13_CH1/ DCMI_PIXCLK/ TIM3_CH1/ TIM1_BKIN/ ADC12_IN6	31	-	-	SDO	-	-	-	-	-	-	-	-	-	18	-
PA7	SPI1_MOSI/ TIM8_CH1N/ TIM14_CH1TIM3_CH2/ ETH_MII_RX_DV/ TIM1_CH1N/ RMII_CRS_DV/ ADC12_IN7	32	-	-	SDA/SDI /SDO	-	-	-	-	-	-	-	-	-	17	-
PA8	MCO1/ USART1_CK/ TIM1_CH1/ I2C3_SCL/ OTG_FS_SOF	67	-	-	-	-	-	-	-	-	PA8	-	-	-	-	43
PA9	USART1_TX/ TIM1_CH2/ I2C3_SMBA/ DCMI_D0/ OTG_FS_VBUS	68	-	-	-	-	GREEN	-	V_{BUS}	-	-	-	1	-	-	44

Table 6. STM32 pin description versus board functions (continued)

STM32 pin			Board function													
Main function	Alternate functions	LQFP 100	CS43 L22	MP45 DT02	LIS302DL or LIS3DSH	Push button	LED	SWD	USB	OSC	Free I/O	Power supply	CN5	CN2	P1	P2
PA10	USART1_RX/ TIM1_CH3/ OTG_FS_ID/ DCMI_D1	69	-	-	-	-	-	-	ID	-	-	-	4	-	-	41
PA11	USART1_CTS/ CAN1_RX/ TIM1_CH4/ OTG_FS_DM	70	-	-	-	-	-	-	DM	-	-	-	2	-	-	-
PA12	USART1_RTS/ CAN1_TX/ TIM1_ETR/ OTG_FS_DP	71	-	-	-	-	-	-	DP	-	-	-	3	-	-	-
PA13	JTMS-SWDIO	72	-	-	-	-	-	SWDIO	-	-	-	-	-	4	-	42
PA14	JTCK-SWCLK	76	-	-	-	-	-	SWCLK	-	-	-	-	-	2	-	39
PA15	JTDI/ SPI3_NSS/ I2S3_WS/ TIM2_CH1_ETR/ SPI1_NSS	77	-	-	-	-	-	-	-	-	PA15	-	-	-	-	40
PB0	TIM3_CH3/ TIM8_CH2N/ OTG_HS_ULPI_D1/ ETH_MII_RXD2/ TIM1_CH2N/ ADC12_IN8	35	-	-	-	-	-	-	-	-	PB0	-	-	-	22	-
PB1	TIM3_CH4/ TIM8_CH3N/ OTG_HS_ULPI_D2/ ETH_MII_RXD3/ OTG_HS_INTN/ TIM1_CH3N/ ADC12_IN9	36	-	-	-	-	-	-	-	-	PB1	-	-	-	21	-
PB2	BOOT1	37	-	-	-	-	-	-	-	-	-	-	-	-	24	-
PB3	JTDO/ TRACESWO/ SPI3_SCK/ I2S3_CK/ TIM2_CH2/ SPI1_SCK	89	-	-	-	-	-	SWO	-	-	PB3(1)	-	-	6		28
PB4	NJTRST/ SPI3_MISO/ TIM3_CH1/ SPI1_MISO/ I2S3ext_SD	90	-	-	-	-	-	-	-	-	PB4	-	-	-	-	25
PB5	I2C1_SMBA/ CAN2_RX/ OTG_HS_ULPI_D7/ ETH_PPS_OUT/ TIM3_CH2/ SPI1_MOSI/ SPI3_MOSI/ DCMI_D10/ I2S3_SD	91	-	-	-	-	-	-	-	-	PB5	-	-	-	-	26
PB6	I2C1_SCL/ TIM4_CH1/ CAN2_TX/ OTG_FS_INTN/ DCMI_D5/ USART1_TX	92	SCL	-	-	-	-	-	-	-	-	-	-	-	-	23
PB7	I2C1_SDA/ FSMC_NL/ DCMI_VSYNC/ USART1_RX/ TIM4_CH2	93	-	-	-	-	-	-	-	-	PB7	-	-	-		24

Table 6. STM32 pin description versus board functions (continued)

STM32 pin			Board function													
Main function	Alternate functions	LQFP 100	CS43 L22	MP45 DT02	LIS302DL or LIS3DSH	Push button	LED	SWD	USB	OSC	Free I/O	Power supply	CN5	CN2	P1	P2
PB8	TIM4_CH3/ SDIO_D4/ TIM10_CH1/ DCMI_D6/ OTG_FS_SCL/ ETH_MII_TXD3/ I2C1_SCL/ CAN1_RX	95	-	-	-	-	-	-	-	-	PB8	-	-	-	-	19
PB9	SPI2_NSS/ I2S2_WS/ TIM4_CH4/ TIM11_CH1/ OTG_FS_SDA/ SDIO_D5/ DCMI_D7/ I2C1_SDA/ CAN1_TX	96	SDA	-	-	-	-	-	-	-	-	-	-	-	-	20
PB10	SPI2_SCK/ I2S2_CK/ I2C2_SCL/ USART3_TX/ OTG_HS_ULPI_D3/ ETH_MII_RX_ER/ OTG_HS_SCL/ TIM2_CH3	47	-	CLK	-	-	-	-	-	-	-	-	-	-	34	-
PB11	I2C2_SDA/ USART3_RX/ OTG_HS_ULPI_D4/ ETH_RMII_TX_EN/ ETH_MII_TX_EN/ OTG_HS_SDA/ TIM2_CH4	48	-	-	-	-	-	-	-	-	PB11	-	-	-	35	-
PB12	SPI2_NSS/ I2S2_WS/ I2C2_SMBA/ USART3_CK/ TIM1_BKIN/ CAN2_RX/ OTG_HS_ULPI_D5/ ETH_RMII_TXD0/ ETH_MII_TXD0/ OTG_HS_ID	51	-	-	-	-	-	-	-	-	PB12	-	-	-	36	-
PB13	SPI2_SCK/ I2S2_CK/ USART3_CTS/ TIM1_CH1N/ CAN2_TX/ OTG_HS_ULPI_D6/ ETH_RMII_TXD1/ ETH_MII_TXD1/ OTG_HS_VBUS	52	-	-	-	-	-	-	-	-	PB13	-	-	-	37	-
PB14	SPI2_MISO/ TIM1_CH2N/ TIM12_CH1/ OTG_HS_DMUSART3_RTS/ TIM8_CH2N/ I2S2ext_SD	53	-	-	-	-	-	-	-	-	PB14	-	-	-	38	-
PB15	SPI2_MOSI/ I2S2_SD/ TIM1_CH3N/ TIM8_CH3N/ TIM12_CH2/ OTG_HS_DP	54	-	-	-	-	-	-	-	-	PB15	-	-	-	39	-
PC0	OTG_HS_ULPI_STP/ ADC123_IN10	15	-	-	-	-	-	-	Power On	-	-	-	-	-	8	-
PC1	ETH_MDC/ ADC123_IN11	16	-	-	-	-	-	-	-	-	PC1	-	-	-	7	-
PC2	SPI2_MISO/ OTG_HS_ULPI_DIR/ TH_MII_TXD2/ I2S2ext_SD/ ADC123_IN12	17	-	-	-	-	-	-	-	-	PC2	-	-	-	10	-

Table 6. STM32 pin description versus board functions (continued)

STM32 pin			Board function													
Main function	Alternate functions	LQFP 100	CS43 L22	MP45 DT02	LIS302DL or LIS3DSH	Push button	LED	SWD	USB	OSC	Free I/O	Power supply	CN5	CN2	P1	P2
PC3	SPI2_MOSI/ I2S2_SD/ OTG_HS_ULPI_NXT/ ETH_MII_TX_CLK/ ADC123_IN13	18	-	DOUT/AIN4x	-	-	-	-	-	-	-	-	-	-	9	-
PC4	ETH_RMII_RX_D0/ ETH_MII_RX_D0/ ADC12_IN14	33	-	-	-	-	-	-	-	-	PC4	-	-	-	20	-
PC5	ETH_RMII_RX_D1/ ETH_MII_RX_D1/ ADC12_IN15	34	-	-	-	-	-	-	-	-	PC5	-	-	-	19	-
PC6	I2S2_MCK/ TIM8_CH1/ SDIO_D6/ USART6_TX/ DCMI_D0/ TIM3_CH1	63	-	-	-	-	-	-	-	-	PC6	-	-	-	-	47
PC7	I2S3_MCK/ TIM8_CH2/ SDIO_D7/ USART6_RX/ DCMI_D1/ TIM3_CH2	64	MCLK	-	-	-	-	-	-	-	-	-	-	-	-	48
PC8	TIM8_CH3/ SDIO_D0/ TIM3_CH3/ USART6_CK/ DCMI_D2	65	-	-	-	-	-	-	-	-	PC8	-	-	-	-	45
PC9	I2S_CKIN/ MCO2/ TIM8_CH4/ SDIO_D1/ I2C3_SDA/ DCMI_D3/ TIM3_CH4	66	-	-	-	-	-	-	-	-	PC9	-	-	-	-	46
PC10	SPI3_SCK/ I2S3_CK/ UART4_TX/ SDIO_D2/ DCMI_D8/ USART3_TX	78	SCLK	-	-	-	-	-	-	-	-	-	-	-	-	37
PC11	UART4_RX/ SPI3_MISO/ SDIO_D3/ DCMI_D4/ USART3_RX/ I2S3ext_SD	79	-	-	-	-	-	-	-	-	PC11	-	-	-	-	38
PC12	UART5_TX/ SDIO_CK/ DCMI_D9/ SPI3_MOSI/ I2S3_SD/ USART3_CK	80	SDIN	-	-	-	-	-	-	-	-	-	-	-	-	35
PC13	RTC_AF1	7	-	-	-	-	-	-	-	-	PC13	-	-	-	-	12
PC14	OSC32_IN	8	-	-	-	-	-	-	-	OSC32_IN	PC14(1)	-	-	-	-	9
PC15	OSC32_OUT	9	-	-	-	-	-	-	-	OSC32_OUT	PC15(1)	-	-	-	-	10
PD0	FSMC_D2/ CAN1_RX	81	-	-	-	-	-	-	-	-	PD0	-	-	-	-	36
PD1	FSMC_D3/ CAN1_TX	82	-	-	-	-	-	-	-	-	PD1	-	-	-	-	33
PD2	TIM3_ETR/ UART5_RXSDIO_CMD / DCMI_D11	83	-	-	-	-	-	-	-	-	PD2	-	-	-	-	34
PD3	FSMC_CLK/ USART2_CTS	84	-	-	-	-	-	-	-	-	PD3	-	-	-	-	31
PD4	FSMC_NOE/ USART2_RTS	85	RESET	-	-	-	-	-	-	-	-	-	-	-	-	32

Table 6. STM32 pin description versus board functions (continued)

STM32 pin			Board function													
Main function	Alternate functions	LQFP 100	CS43 L22	MP45 DT02	LIS302DL or LIS3DSH	Push button	LED	SWD	USB	OSC	Free I/O	Power supply	CN5	CN2	P1	P2
PD5	FSMC_NWE/ USART2_TX	86	-	-	-	-	RED	-	Over current	-	-	-	-	-	-	29
PD6	FSMC_NWAIT/ USART2_RX	87	-	-	-	-	-	-	-	-	PD6	-	-	-	-	30
PD7	USART2_CK/ FSMC_NE1/ FSMC_NCE2	88	-	-	-	-	-	-	-	-	PD7	-	-	-	-	27
PD8	FSMC_D13/ USART3_TX	55	-	-	-	-	-	-	-	-	PD8	-	-	-	40	-
PD9	FSMC_D14/ USART3_RX	56	-	-	-	-	-	-	-	-	PD9	-	-	-	41	-
PD10	FSMC_D15/ USART3_CK	57	-	-	-	-	-	-	-	-	PD10	-	-	-	42	-
PD11	FSMC_A16/ USART3_CTS	58	-	-	-	-	-	-	-	-	PD11	-	-	-	43	-
PD12	FSMC_A17/ TIM4_CH1/ USART3_RTS	59	-	-	-	-	GREEN	-	-	-	-	-	-	-	44	-
PD13	FSMC_A18/ TIM4_CH2	60	-	-	-	-	ORANGE	-	-	-	-	-	-	-	45	-
PD14	FSMC_D0/ TIM4_CH3	61	-	-	-	-	RED	-	-	-	-	-	-	-	46	-
PD15	FSMC_D1/ TIM4_CH4	62	-	-	-	-	BLUE	-	-	-	-	-	-	-	47	-
PE0	TIM4_ETR/ FSMC_NBL0/ DCMI_D2	97	-	-	INT1	-	-	-	-	-	-	-	-	-	-	17
PE1	FSMC_NBL1/ DCMI_D3	98	-	-	INT2	-	-	-	-	-	-	-	-	-	-	18
PE2	TRACECLK/ FSMC_A23/ ETH_MII_TXD3	1	-	-	-	-	-	-	-	-	PE2	-	-	-	-	15
PE3	TRACED0/ FSMC_A19	2	-	-	CS_I2C/SPI	-	-	-	-	-	-	-	-	-	-	16
PE4	TRACED1/ FSMC_A20/ DCMI_D4	3	-	-	-	-	-	-	-	-	PE4	-	-	-	-	13
PE5	TRACED2/ FSMC_A21/ TIM9_CH1/ DCMI_D6	4	-	-	-	-	-	-	-	-	PE5	-	-	-	-	14
PE6	TRACED3/ FSMC_A22/ TIM9_CH2/ DCMI_D7	5	-	-	-	-	-	-	-	-	PE6	-	-	-	-	11
PE7	FSMC_D4/ TIM1_ETR	38	-	-	-	-	-	-	-	-	PE7	-	-	-	25	-
PE8	FSMC_D5/ TIM1_CH1N	39	-	-	-	-	-	-	-	-	PE8	-	-	-	26	-
PE9	FSMC_D6/ TIM1_CH1	40	-	-	-	-	-	-	-	-	PE9	-	-	-	27	-
PE10	FSMC_D7/ TIM1_CH2N	41	-	-	-	-	-	-	-	-	PE10	-	-	-	28	-
PE11	FSMC_D8/ TIM1_CH2	42	-	-	-	-	-	-	-	-	PE11	-	-	-	29	-

Table 6. STM32 pin description versus board functions (continued)

STM32 pin			Board function													
Main function	Alternate functions	LQFP 100	CS43 L22	MP45 DT02	LIS302DL or LIS3DSH	Push button	LED	SWD	USB	OSC	Free I/O	Power supply	CN5	CN2	P1	P2
PE12	FSMC_D9/ TIM1_CH3N	43	-	-	-	-	-	-	-	-	PE12	-	-	-	30	-
PE13	FSMC_D10/ TIM1_CH3	44	-	-	-	-	-	-	-	-	PE13	-	-	-	31	-
PE14	FSMC_D11/ TIM1_CH4	45	-	-	-	-	-	-	-	-	PE14	-	-	-	32	-
PE15	FSMC_D12/ TIM1_BKIN	46	-	-	-	-	-	-	-	-	PE15	-	-	-	33	-
PH0	OSC_IN	12	-	-	-	-	-	-	-	OSC_ IN	PH0(1)	-	-	-	-	7
PH1	OSC_OUT	13	-	-	-	-	-	-	-	OSC_ OUT	PH1(1)	-	-	-	-	8
-	-	-	-	-	-	-	-	-	-	-	-	5V	-	-	-	3
-	-	-	-	-	-	-	-	-	-	-	-	5V	-	-	-	4
-	-	-	-	-	-	-	-	-	-	-	-	3V	-	-	-	5
-	-	-	-	-	-	-	-	-	-	-	-	3V	-	-	-	6
-	-	-	-	-	-	-	-	-	-	-	-	VDD	-	-	3	-
-	-	-	-	-	-	-	-	-	-	-	-	VDD	-	-	4	-
-	-	-	-	-	-	-	-	-	-	-	-	VDD	-	-	-	22
-	-	-	-	-	-	-	-	GND	GND	-	-	GND	5	3	1	-
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	2	-
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	5	-
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	23	-
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	49	-
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	50	-
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	-	1
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	-	2
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	-	49
-	-	-	-	-	-	-	-	-	-	-	-	GND	-	-	-	50

1. Optional, for more details see *Section 7: Electrical schematics*.

7 Electrical schematics

Figure 9. STM32F407G-DISC1

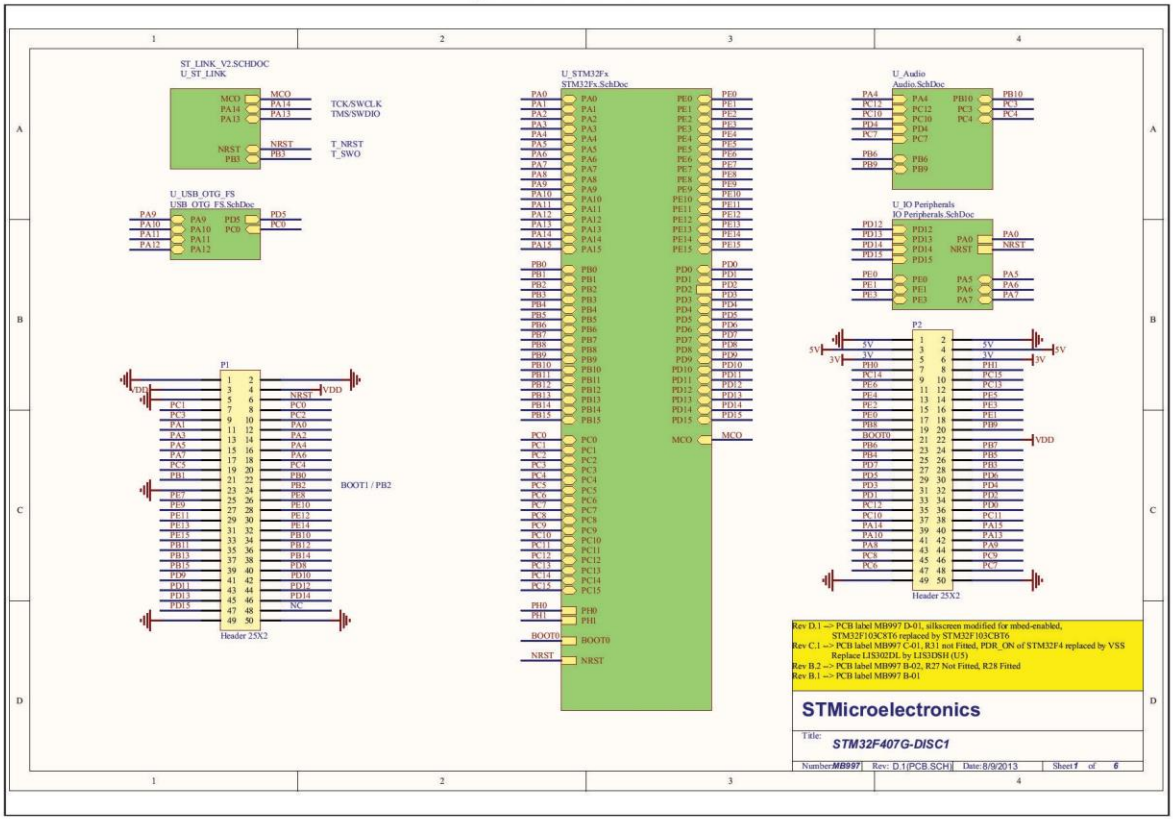


Figure 10. ST-LINK/V2 (SWD only)

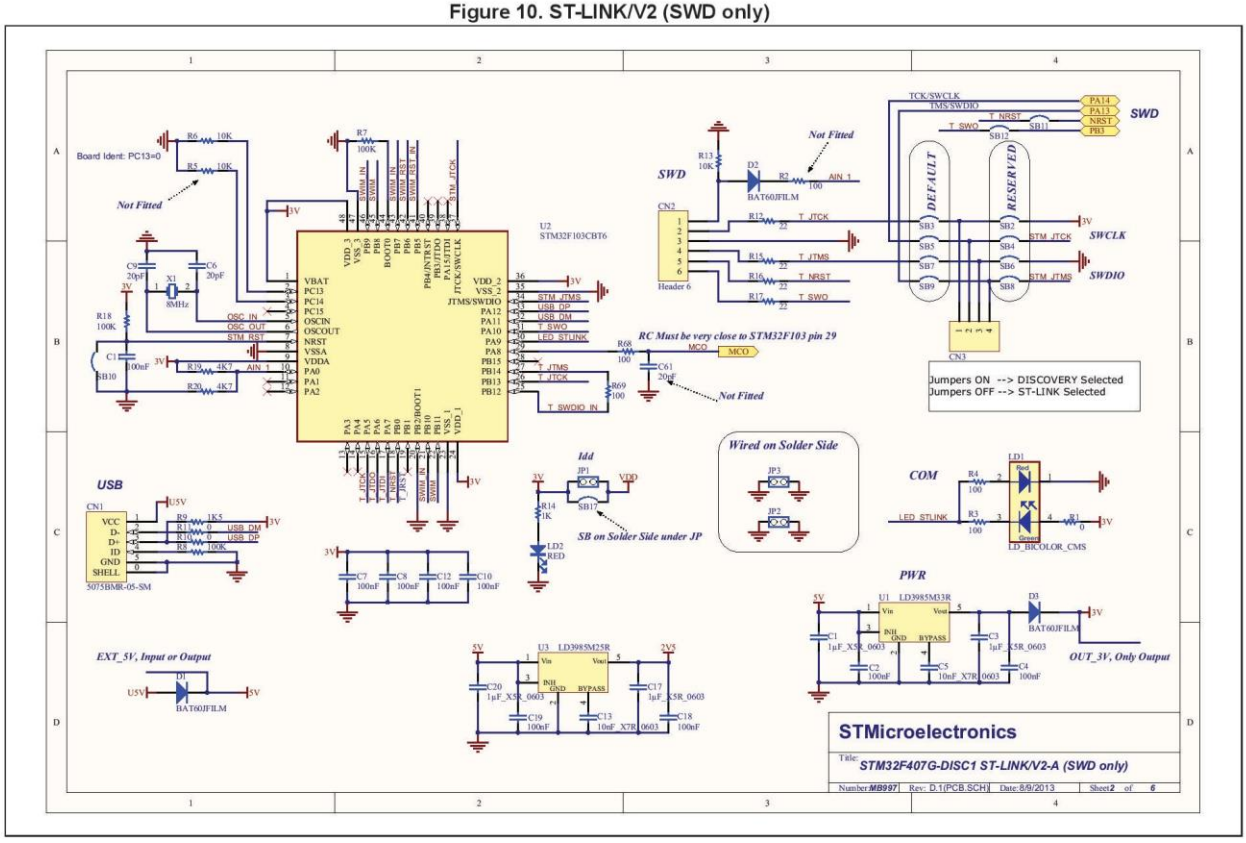


Figure 11. MCU

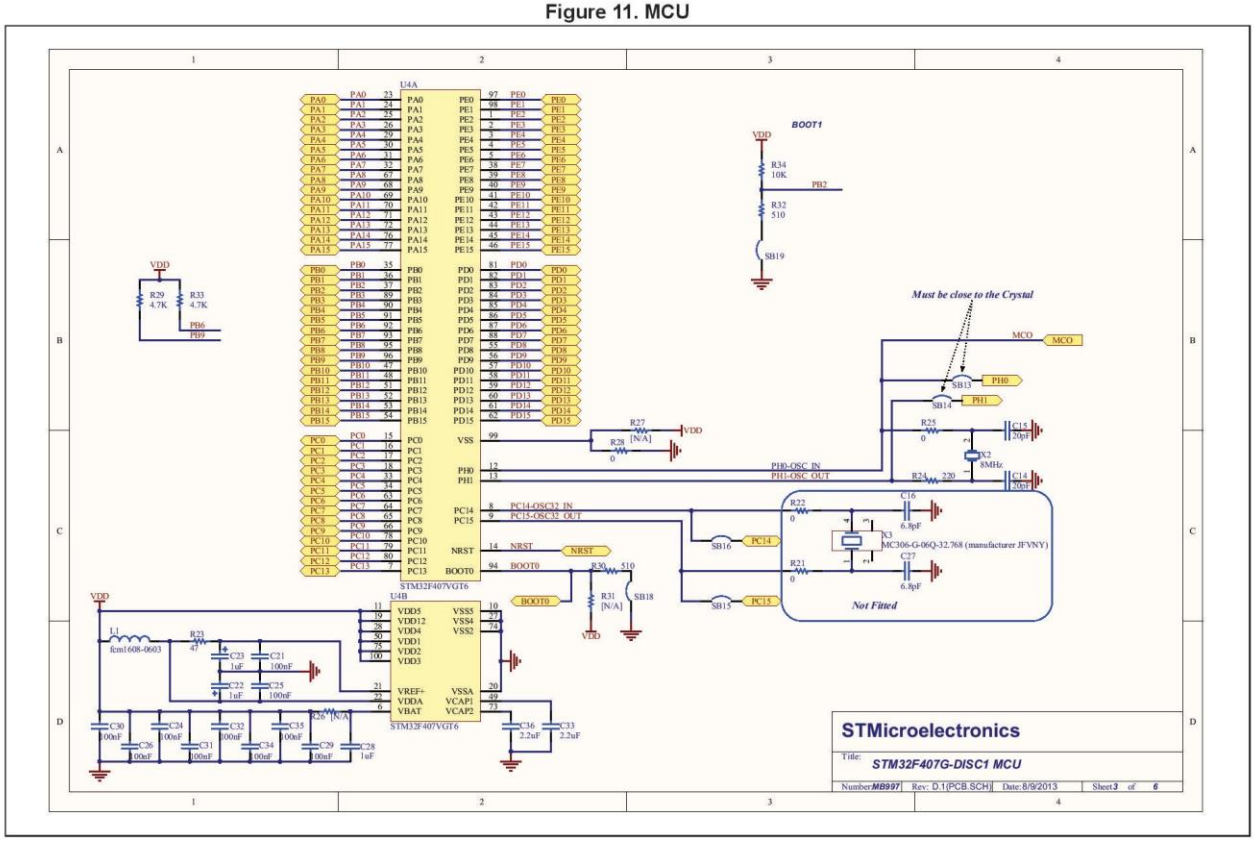


Figure 12. Audio

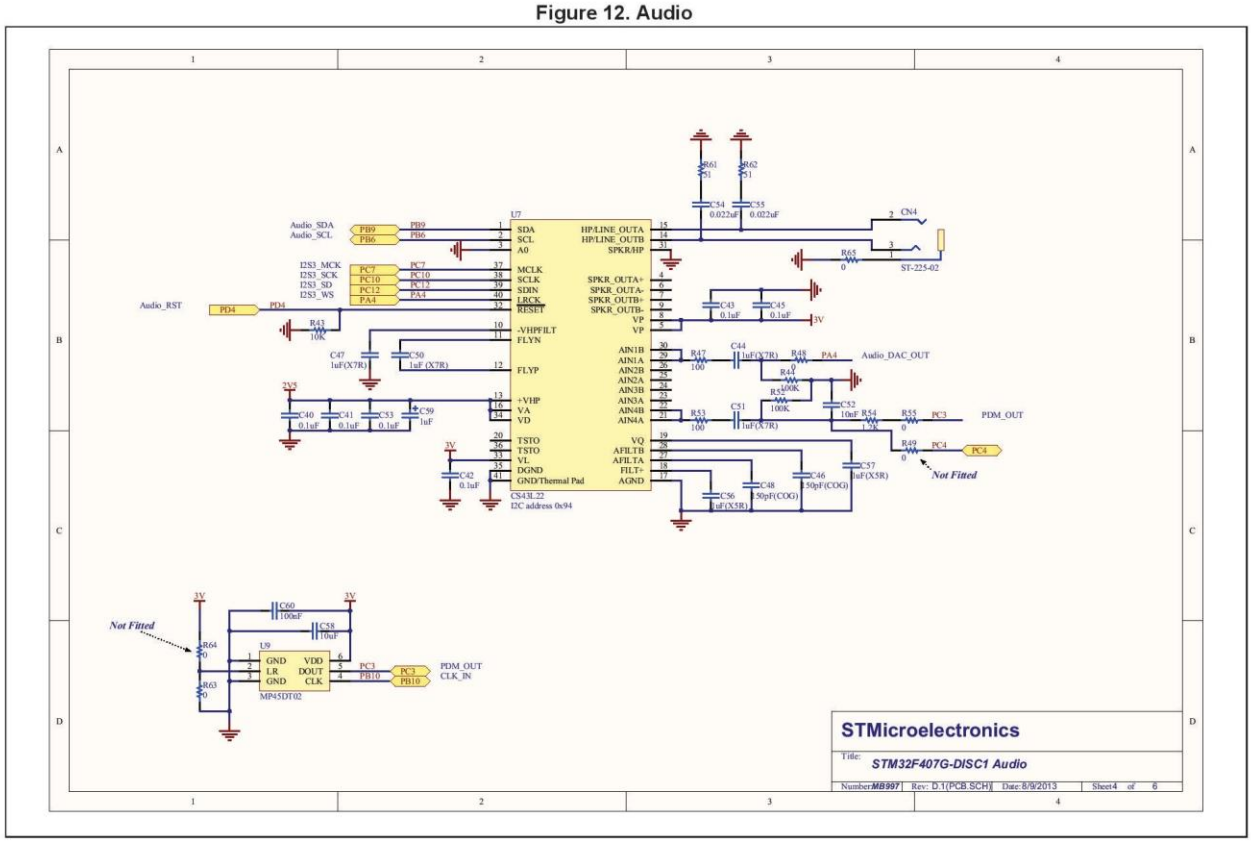


Figure 13. USB_OTG_FS

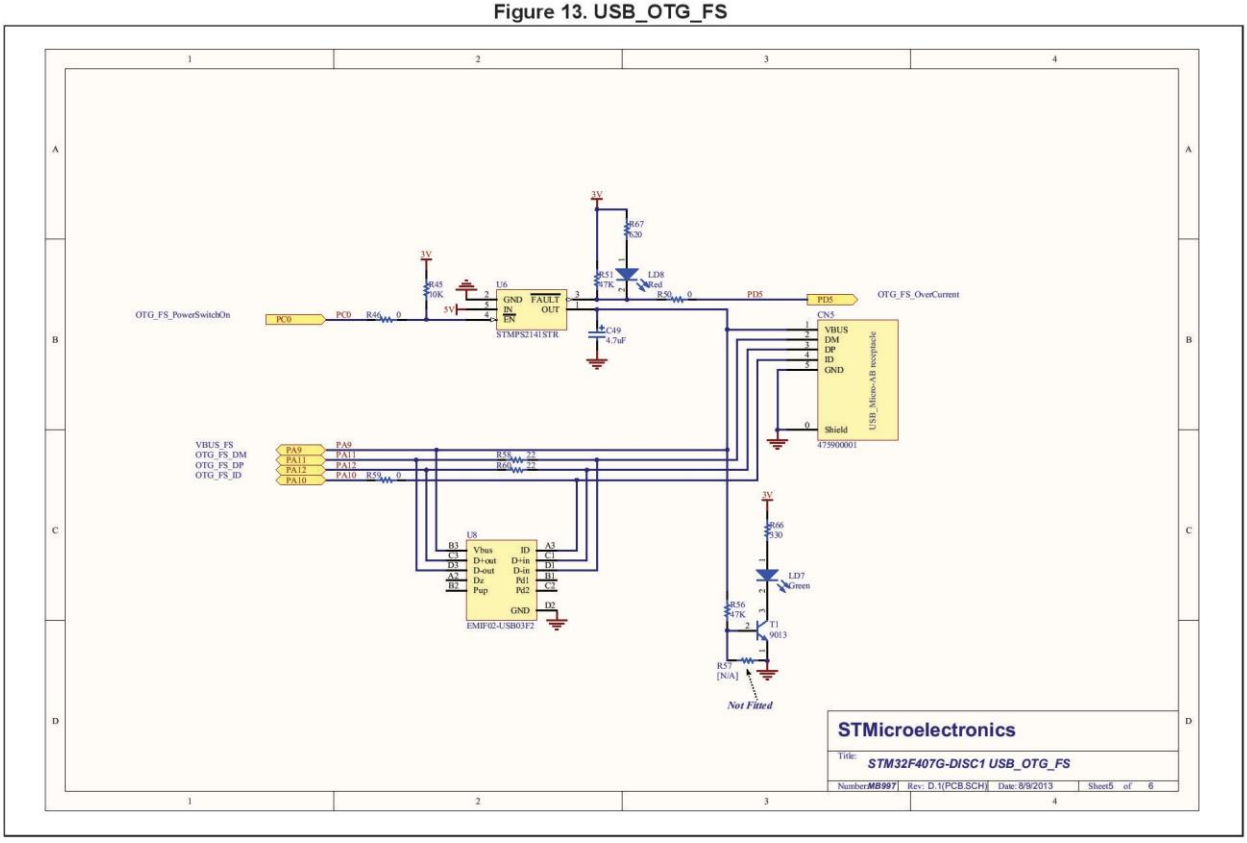
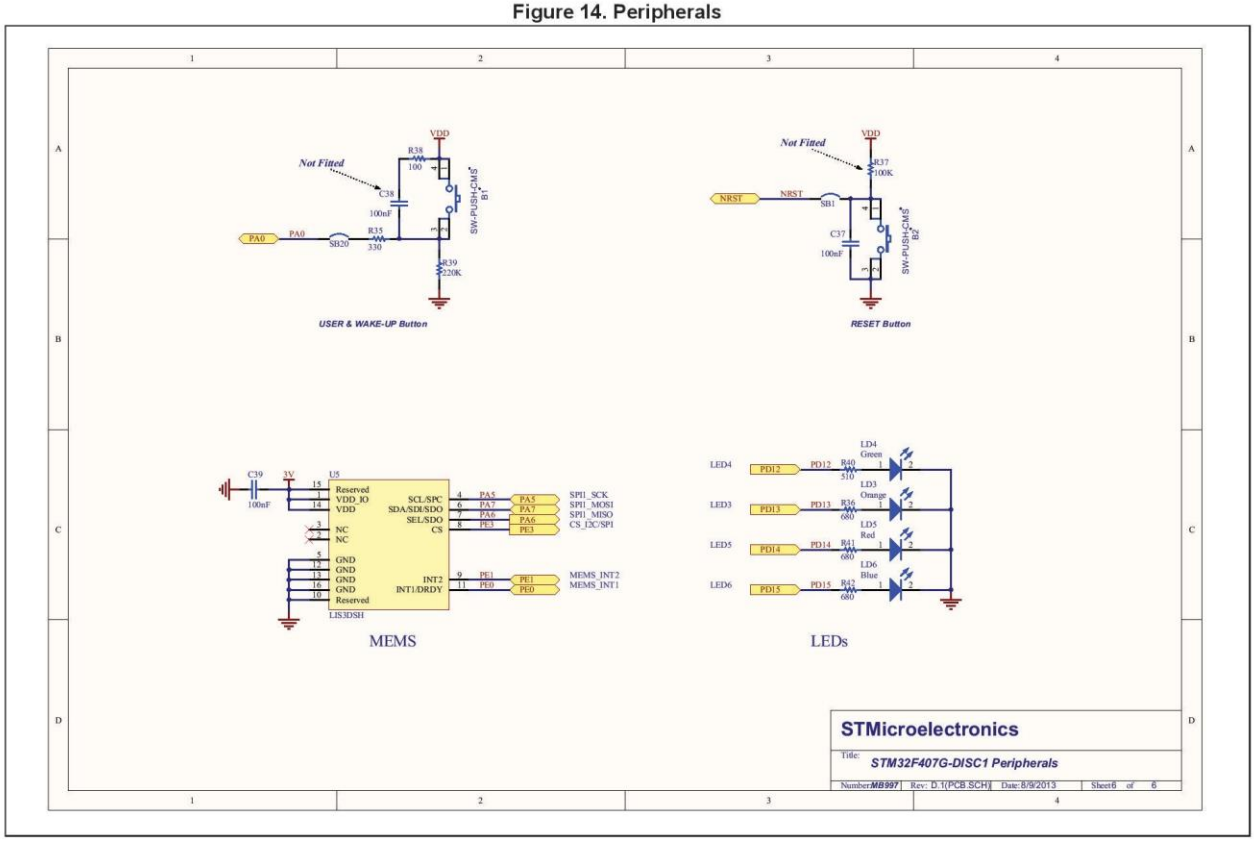
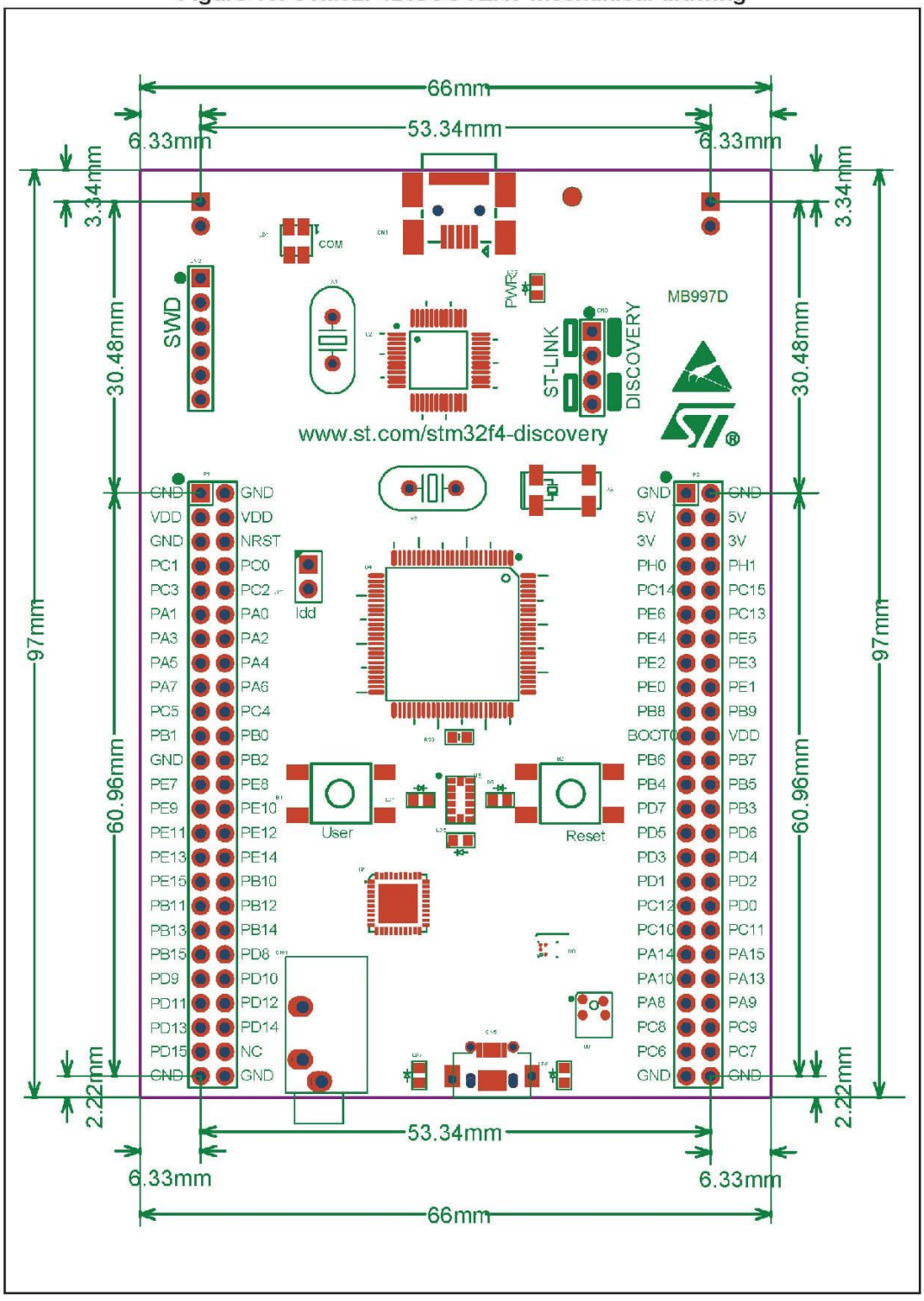


Figure 14. Peripherals



8 Mechanical drawing

Figure 15. STM32F4DISCOVERY mechanical drawing



9 Revision history

Table 7. Document revision history

Date	Revision	Changes
27-Sept-2011	1	Initial release.
30-Jan-2012	2	Added Section 5.1: STM32F407VGT6 microcontroller corrected *Figure 3* MCU name, modified *Figure 2* and *Section 7: Electrical schematics*. Modified *Table 6* PE2 and PE3 entries.
28-Nov-2013	3	Updated for board rev. C. Modified title. Modified *Section 6.7: Motion sensor (ST-MEMS LIS302DL or LIS3DSH)* Updated *Section 7: Electrical schematics*
29-Jan-2014	4	Modified *Section 6: Hardware and layout*, *Figure 2*, *Section 6.7: Motion sensor (ST-MEMS LIS302DL or LIS3DSH)* , *Table 6* adding ST MEMS LIS302DL reference.
04-Feb-2016	5	New revision to introduce STM32F407G-DISC1 additional CPN that corresponds to mbed-enabled Discovery Kit. Updated *Introduction*, *Features*, *Section 5: Quick start*, *Section 6: Hardware and layout*, *Section 6.1: Embedded ST-LINK/V2 (or V2-A)*,*Section 7: Electrical schematics*. Removed Section 4.1 STM32F407VG microcontroller.
31-May-2017	6	Updated *Table 6: STM32 pin description versus board functions*.

Appendix E – Program

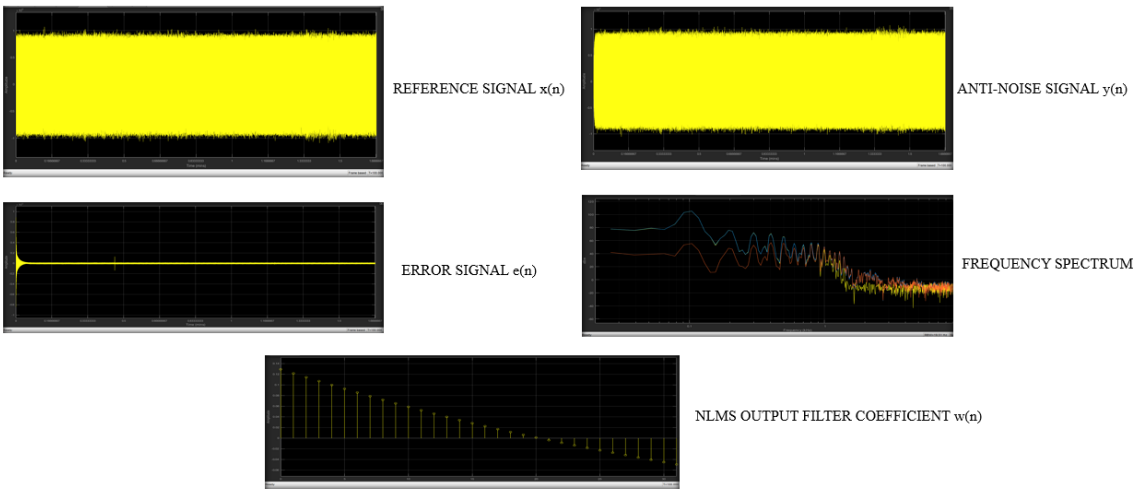


Figure E3. Simulation Result for 100 Hz Sine Wave

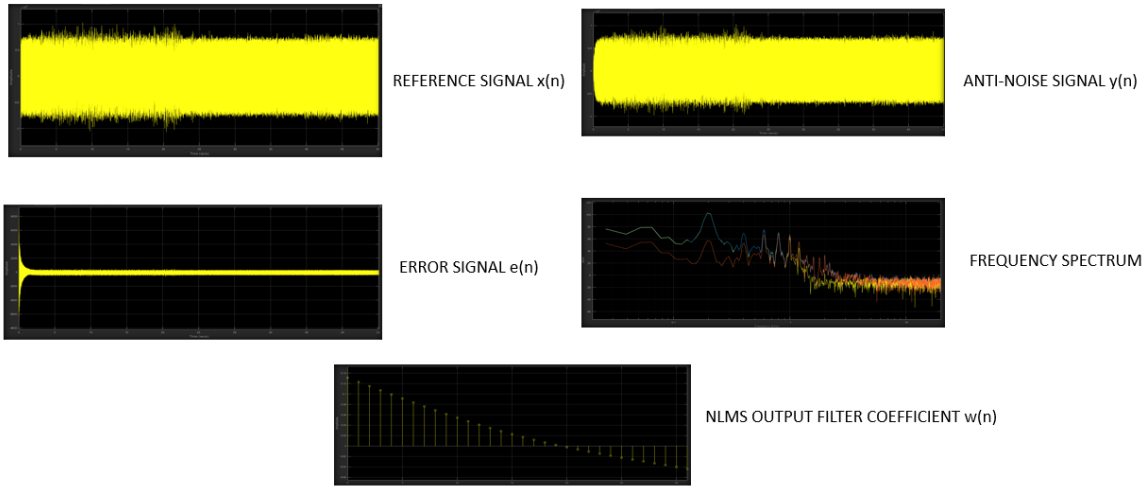


Figure E4. Simulation Result for 200 Hz Sine Wave

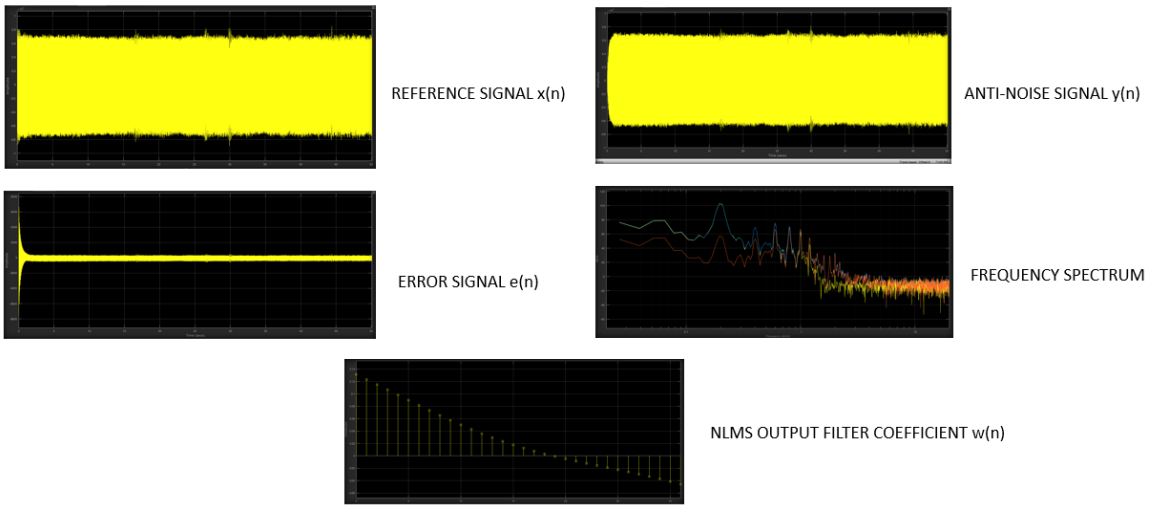


Figure E5. Simulation Result for 300 Hz Sine Wave

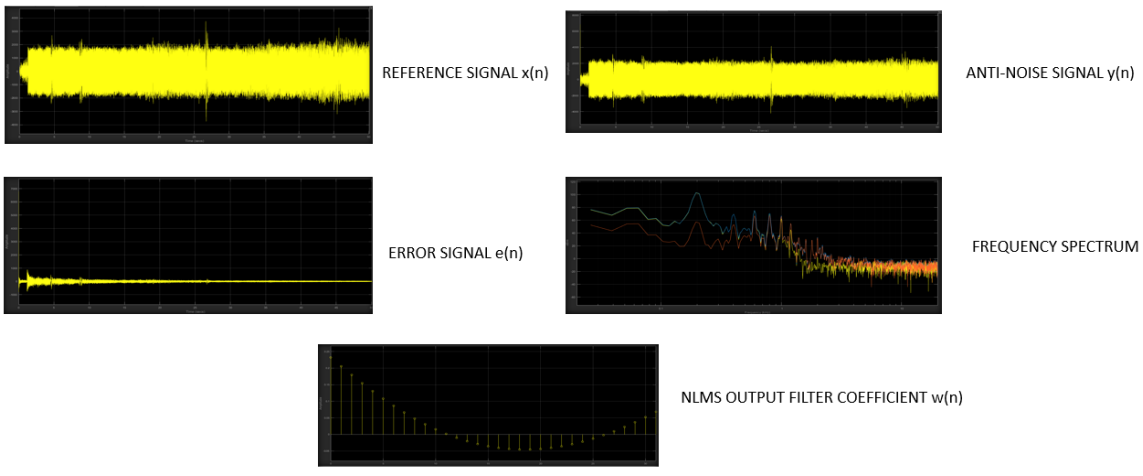


Figure E6. Simulation Result for 500 Hz Sine Wave

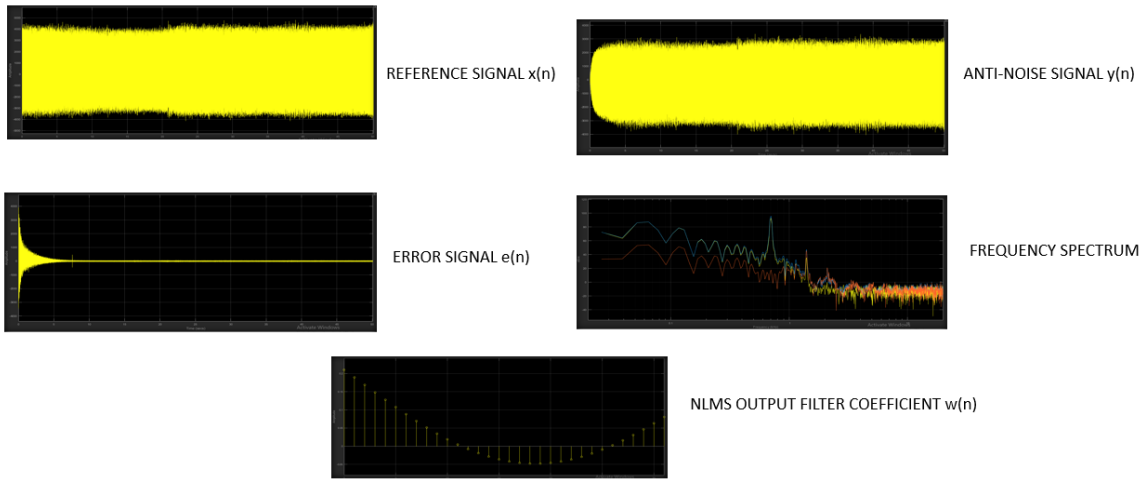


Figure E7. Simulation Result for 700 Hz Sine Wave

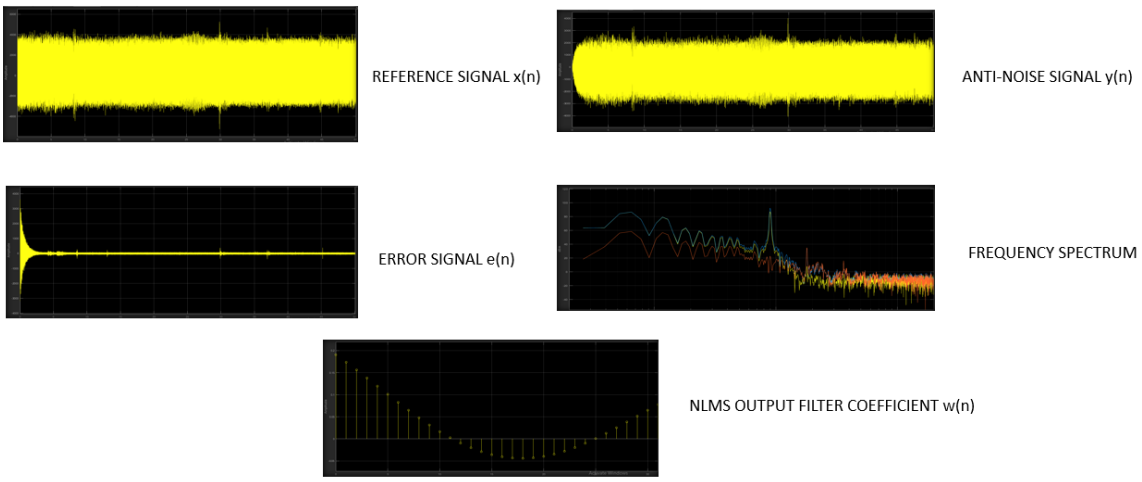


Figure E8. Simulation Result for 900 Hz Sine Wave

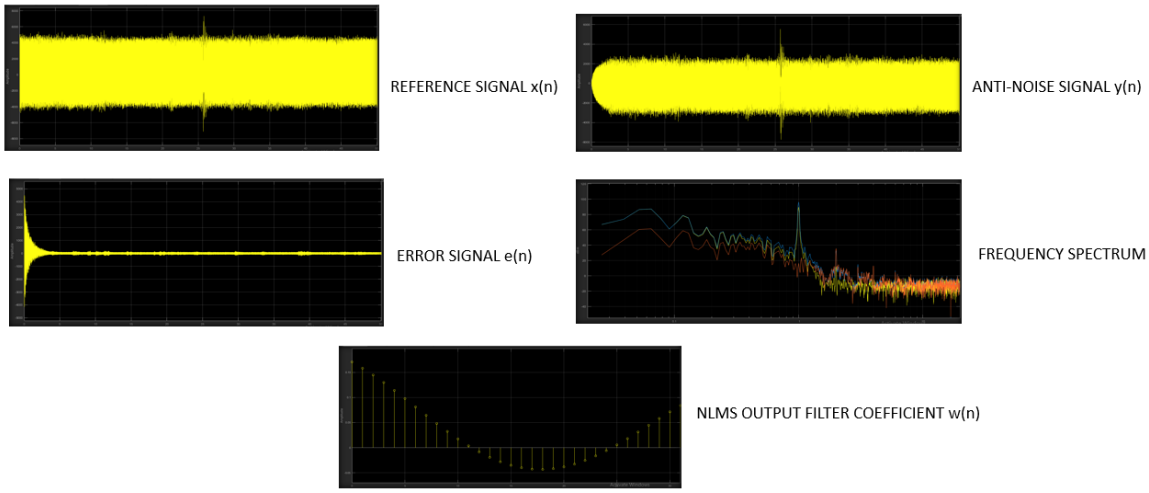


Figure E9. Simulation Result for 1000 Hz Sine Wave

Appendix F – How to Use ANCIOUS

ANCious

Active Noise Controller System

INSTRUCTION MANUAL

Contact us:

TeamANCious

@TeamANCious

teamancious

AND DURABILITY

1. Do not expose the active noise controller to direct sunlight or rain.

2. Do not install the system around a damp place.

3. Do not sprinkle water over the microphones, controller data ports and power port.

4. When plugging out the power cord, do not hold the wire.

5. Keep children away from the active noise controller system.

6. Keep the system away from fire or heat source.

7. Do not wipe the system with volatile material, gasoline, etc.

Active Noise Controller Parts List

USB Microphone

ANC Controller

Audio Jack

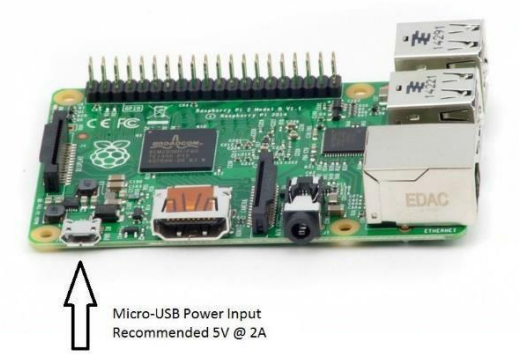
MIKATA Audio Amplifier

Operating Instructions

1. Connect the microphones to the controller.

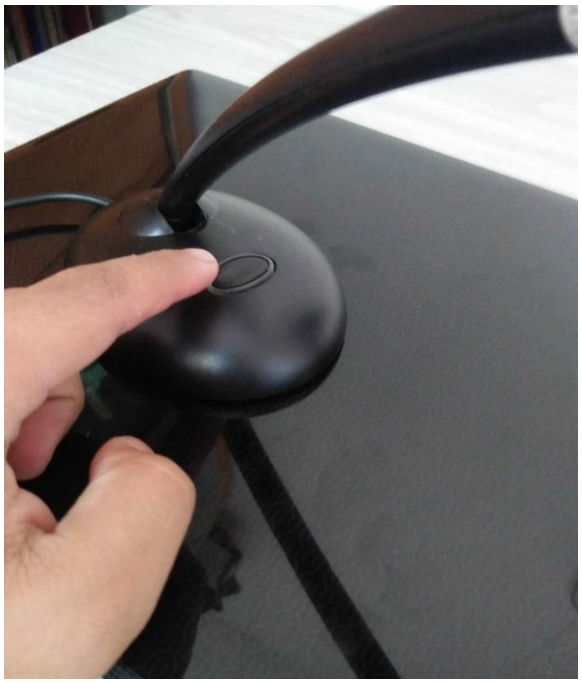
2. Connect the audio jack from the controller to the amplifier.

3. Plug in the power chords of the active noise controller system.



4. Turn on the switch, the program will automatically run after the controller booting process. (Note: LED lights of the microphones will blink to indicate that the program is running.)

5. Push the button on the reference microphone to shut down the controller and then switch off the main switch.



IMPORTANT REMINDER

All pre-calibration procedures will be performed by authorized personnel of the Team ANCIOUS such as microphone positioning and amplifier volume configurations. Any changes to the configured settings will cause system dysfunctionality.

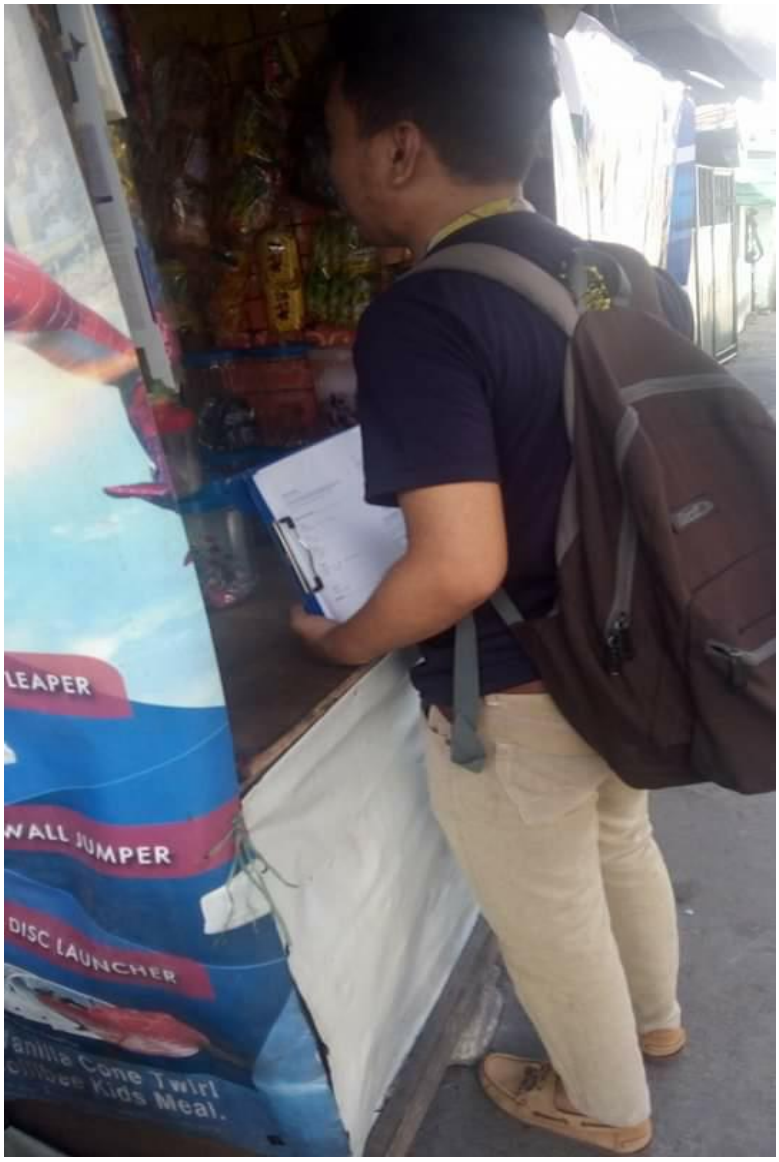
Appendix G – Gantt Chart

Activity	Dec. 2017	Jan. 2018	Feb. 2018	Mar. 2018	Apr. 2018	May 2018	June 2018	July 2018	Aug. 2018	Sept. 2018	Oct. 2018	Nov. 2018	Dec. 2018	Jan. 2019	Feb. 2019	Mar. 2019
Researching of the Problems for Topic Defense																
Drafting and Finalization of the Presentation for the Topic Defense																
Topic Defense																
Drafting of the Proposal Paper (Chapter 1-3) for Title Defense																
Project Research and Consultation for the Project Title and Proposal Paper																
Canvassing of Materials and Equipment																
Initial Hardware Set-Up and MATLAB Simulink Programming																
Title Defense																
Further Research and Adviser Consultation																
Finalization of the MATLAB Programming																
Data Gathering in the Simulation Set-Up																
Data Gathering in the Experimental Set-Up																
Testing and Evaluation of the System																
Progress Presentation																
Inquiries for Possible Deployment Area																
Data Gathering for Initial Deployment																
Pre-Final Defense																

Project Validation																
Pre-Final Re-defense																
Finalization of Chapter 1-3 and Drafting of Chapter 4-5 for Final Defense																
Panel Consultation																
Final Implementation of the System																
Data Gathering in the Final Deployment Area																
Final Defense																
A.P.P.R.E.C.I.A.T.E.																
Finalization of the Project Study Paper																

Appendix H – Documentation

Proponents doing survey in San Dionisio, Parañaque City



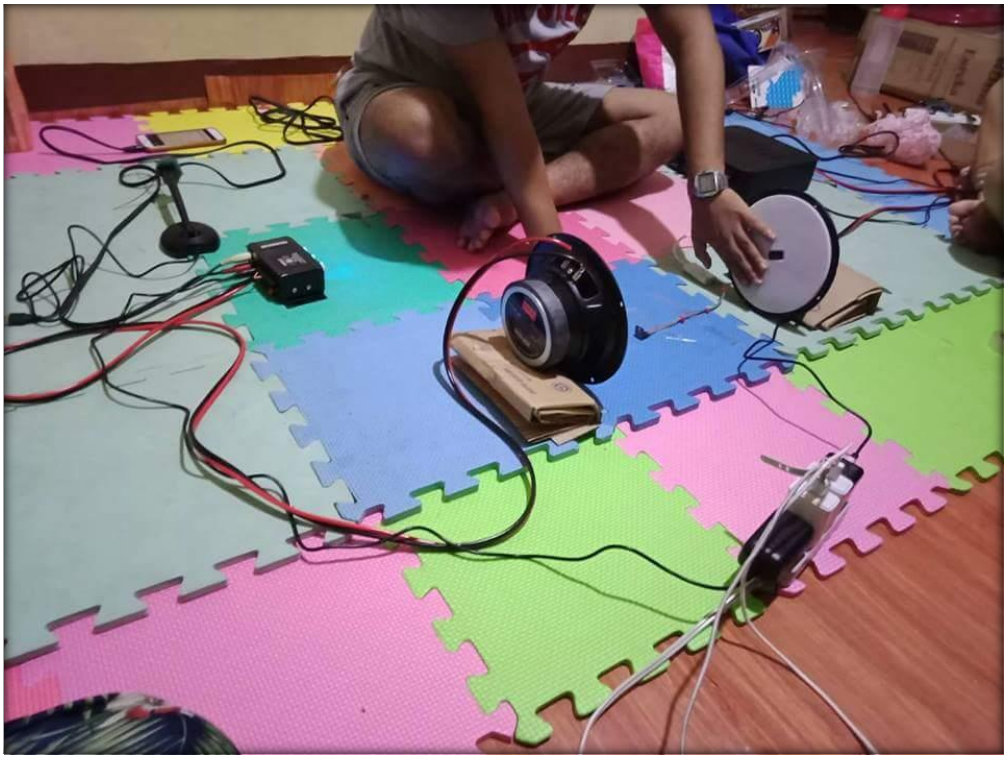
Topic Defense

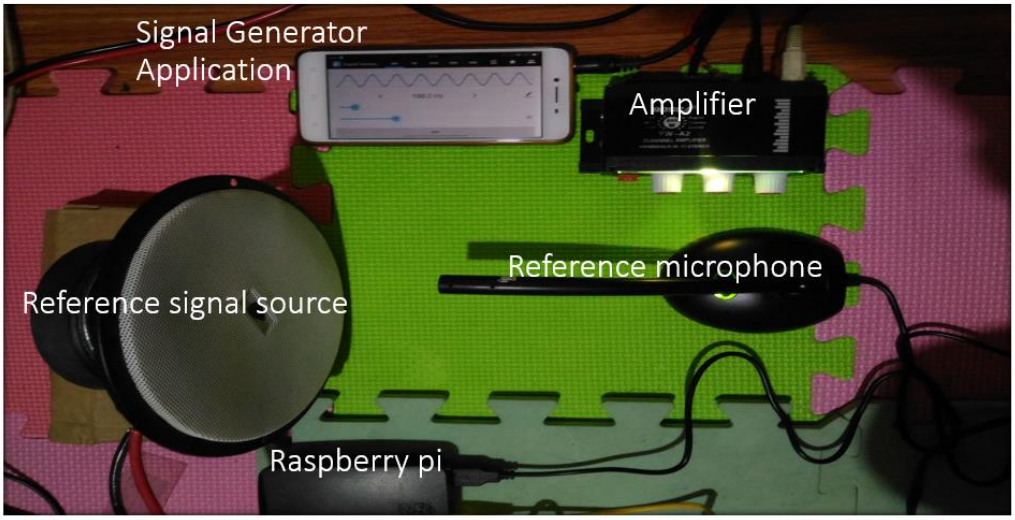
Title Defense

Adviser Consultation

Materials and Devices Purchased for Experimental Set-Up

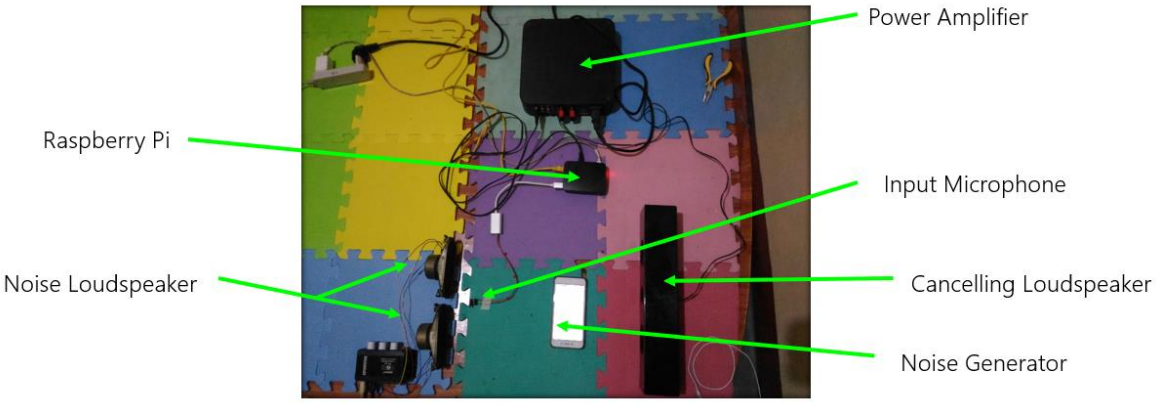
Initial Simulation Set-Up

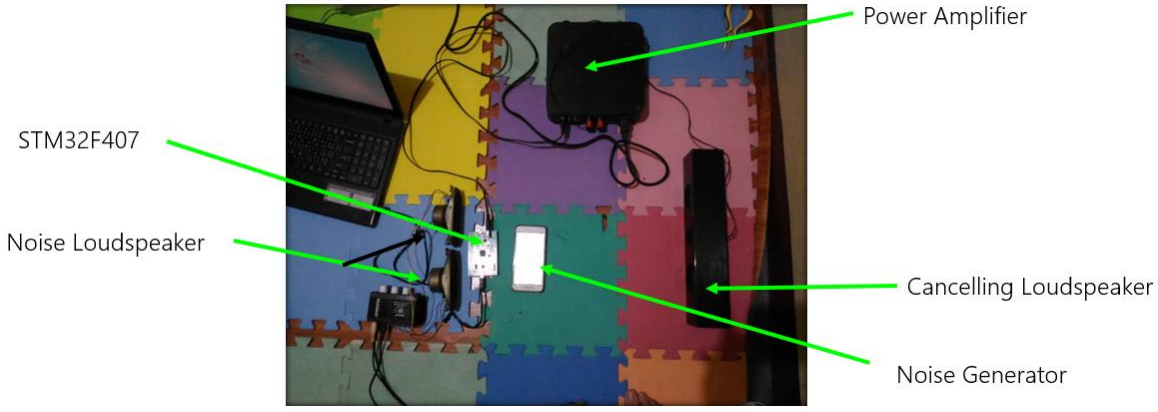




Initial Simulation and Testing of the System

Experimental Set-Up of the System





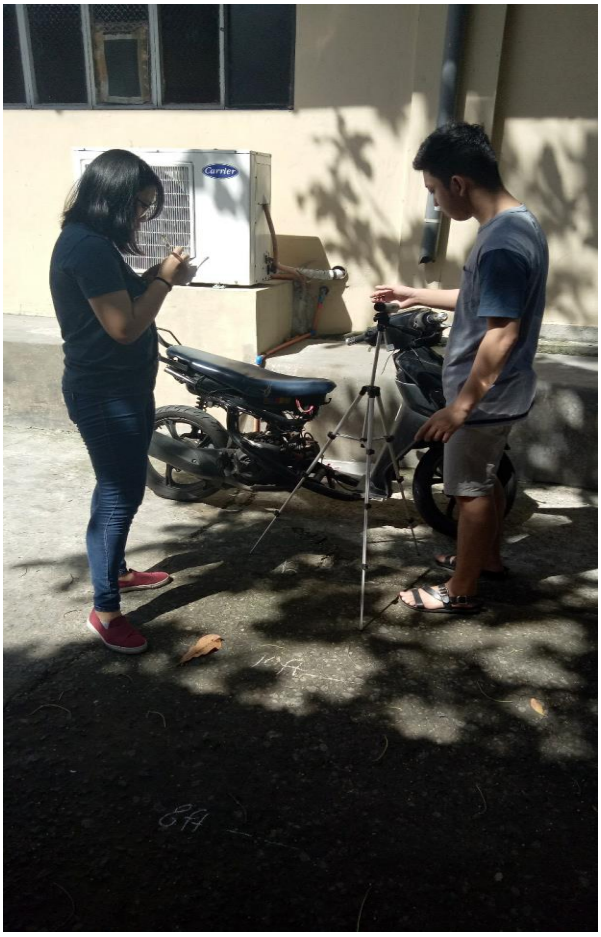
Improved Experimental Set-Up of the System

Actual Testing of the Raspberry Pi

Inquiries for Possible Deployment Area

Trial System Deployment at Evangelical F.R.E.E. Church in G.M.A., Cavite

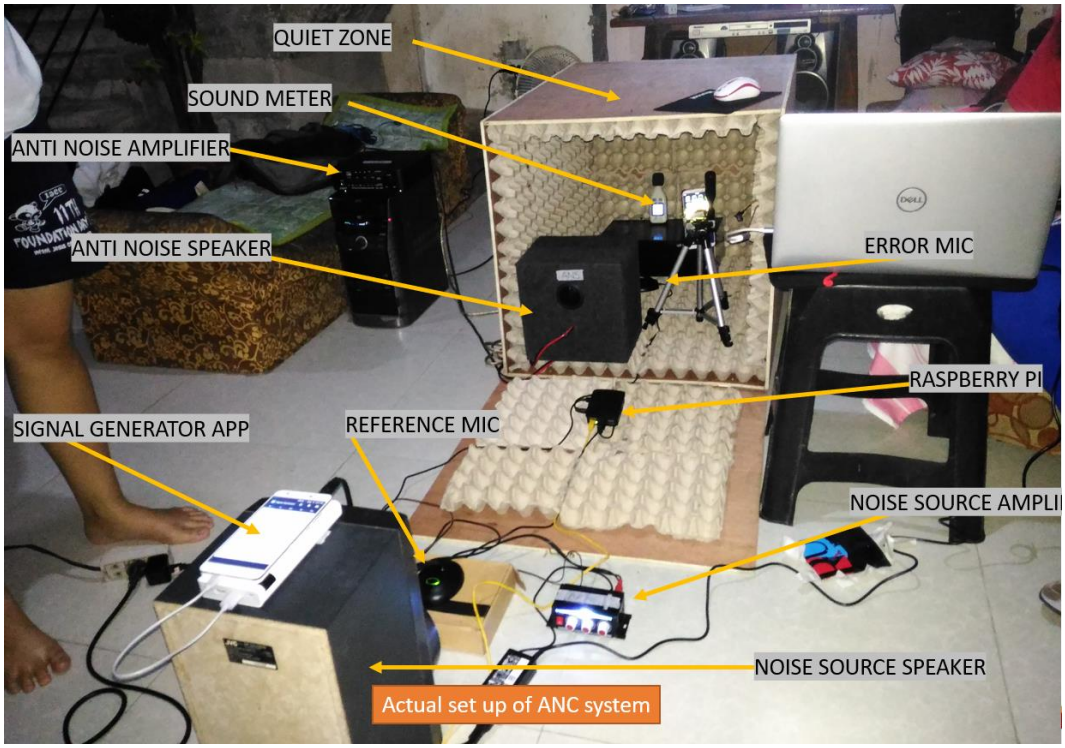
Trial System Testing in a Generator and Measuring of Sound Pressure Level



Progress Presentation (July 26, 2018)

Improved System Set-Up

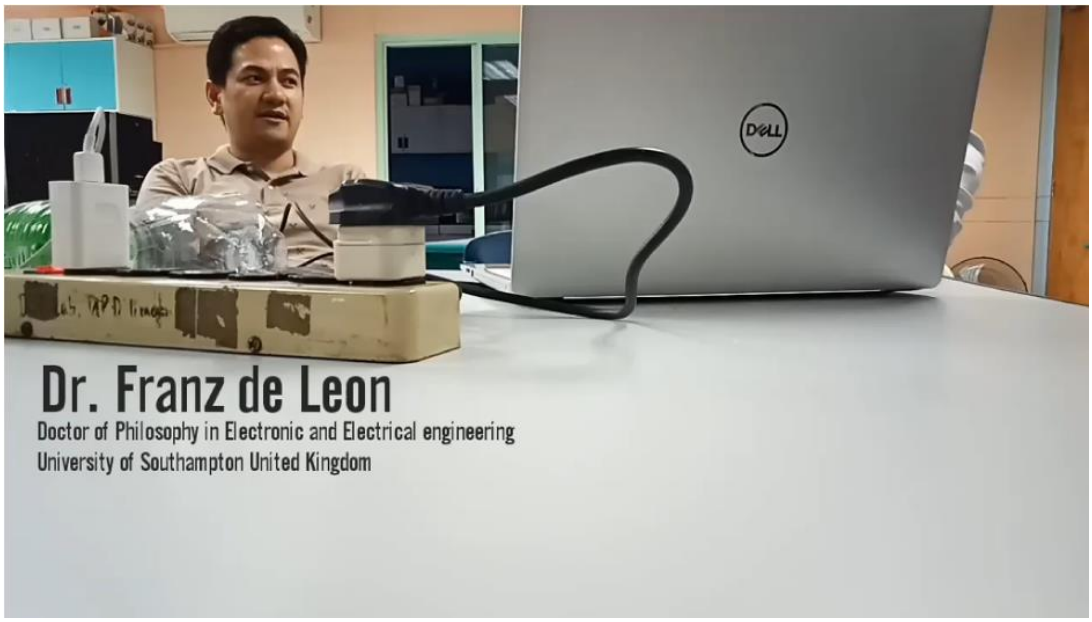
Controlled Environment



Real Environment

Pre-Final Defense

Project Validation



Final Project Deployment

Final Defense

APPRECIATE 2019

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Blvd., Ermita, Manila
COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT
electronics@tup.edu.ph

September 9, 2018

EVANGELICAL F.R.E.E. CHURCH
Nicolasa Virata, GMA, Cavite

Dear Maám/Sir:

We are **Electronics Engineering Students** from the **Technological University of the Philippines-Manila** currently enrolled in the subject **Project Study**. In partial fulfilment of our research study with the topic "**A Comparative Study of Arduino, Raspberry Pi, and STM32F407 Based Active Noise Cancellation System through Machine Noise Level Reduction using MATLAB for Adaptive Signal Processing**" under the **Broadcasting and Acoustics** specialization, we would like to request from your good office to please allow us to conduct a testing and evaluation of the system's efficiency and effectiveness in your equipment that needs noise reduction.

Thank you for your kind consideration and hoping for your positive response upon our request.

God bless and more power.

Very respectfully yours,

Angulo, Vench Learry

Iya, Christine Elysse

Jacinto, Niezamae

Quizon, Ezekiel

Ventura, Jacklyn Dennese

Noted by:

ENGR. ROMEO L. JORDA
Thesis Adviser

ENGR. NILO M. ARAGO
Subject Adviser

Recommending Approval:

Engr. LEAN KARLO S. TOLENTINO

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Blvd., Ermita, Manila
COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT
electronics@tup.edu.ph

August 23, 2018

MR. RODERICK PENOLLAR
Manufacturing Manager, Polyform-RGC International Corporation
Service Road, East Canumay, Valenzuela, Manila

Thru:
MS. ROVELYN SANTIAGO
Head, Human Resource Department

Dear Sir:

We are **Electronics Engineering Students** from the **Technological University of the Philippines-Manila** currently enrolled in the subject **Project Study**. In partial fulfilment of our research study with the topic "**A Comparative Study of Arduino, Raspberry Pi, and STM32F407 Based Active Noise Cancellation System through Machine Noise Level Reduction using MATLAB for Adaptive Signal Processing**" under the **Broadcasting and Acoustics** specialization, we would like to request from your good office to please allow us to conduct a testing and evaluation of the system's efficiency and effectiveness of out project in your equipment that needs noise reduction.

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Ventura, Jacklyn Dennese

Noted by:

ENGR. ROMEO L. JORDA JR.
Thesis Adviser

ENGR. NILO M. ARAGO
Subject Adviser

Recommending Approval:

Engr. LEAN KARLO S. TOLENTINO

College of Engineering

Electronics Engineering Department

APPROVAL SHEET

of

ECE PROJECT STUDY

(Final Defense)

Title: ***A Comparative Study of Arduino, Raspberry Pi, and STM32F407 Based Active Noise Control System through Noise Level Reduction using MATLAB for Adaptive Signal Processing***

Group Members:

1. Angulo, Vench Learry M.
2. Iya, Christine Elysse D.
3. Jacinto, Niezamae T.
4. Quizon, Ezekiel S.
5. Ventura, Jacklyn Dennese B.

Adviser:

Engr. Romeo L. Jorda Jr.

Action taken by the Advisory Committee:

Advisory Committee			Action Taken	
Name		Signature	Passed w/ Revisions	Failed
Panel Member	Engr. August C. Thio-ac		95	
Panel Member	Engr. Edmon O. Fernandez		85	
Panel Member	Engr. John Carlo V. Puno		95	

Comments and Suggestions:

1. IEEE format for citation in journal
2. see comments in journal paper for revisions
3.

Noted by:

Engr. Nilo M. Arago

PS 2L Professor

Approved by:

Engr. Lean Karlo S. Tolentino

Head, Electronics Engineering Department

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Blvd., cor San Marcelino St., Ermita, Manila
Telefax No. 522-3524; http://www.tup.edu.ph

COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT

SERVICE AGREEMENT

Title of Activity: **(Deployment)** "A COMPARATIVE STUDY OF ARDUINO, RASPBERRY PI, AND STM32F407 BASED ACTIVE NOISE CONTROL SYSTEM THROUGH NOISE LEVEL REDUCTION USING MATLAB FOR ADAPTIVE SIGNAL PROCESSING"

Description of Activity:

The "ANCious: A COMPARATIVE STUDY OF ARDUINO, RASPBERRY PI, AND STM32F407 BASED ACTIVE NOISE CONTROL SYSTEM THROUGH NOISE LEVEL REDUCTION USING MATLAB FOR ADAPTIVE SIGNAL PROCESSING" is a comparison of three modules: Arduino Due, Raspberry Pi 3, and STM32F407 respectively in terms of their maximum efficiency in reducing noise using MATLAB for adaptive signal processing, autonomy with regards to installation, self-adaptability, reliability, robustness, and simplification of the control electronics.

Responsibilities of the Client:

1. Regularly maintain and ensure its functionality.
2. Regarding for any potential development to the project study the client may suggest it to the researchers from TUP.
3. The parties hereto understand that during the technology adoption, the Transferor (TUP) shall give Transferee (Client) a gratis usage for four months. After four months, a rent-to-transfer scheme shall be employed. Payments shall be made payable by the Transferee to the Transferor under this agreement under the following scheme:
   a. Gratis usage for the first four (4) months.
   b. Rental fee of Php 500.00 of technology adoption stage.
4. Provide the necessary information in which the project is beneficial to its client.
5. Accommodate researchers from TUP if there are further studies that will be conducted related to the transferred technology/machine/prototype/project/study.

Responsibilities of TUP:

1. Provide the device, instruction manual and necessary training to operate the machine to ensure a satisfactory turn-over to the Client.
2. Give necessary information about the limitation of the device.
3. Provide technical support in case of device malfunction.

The parties hereto agree to keep any information identified as confidential by the disclosing party confidential using methods at least as stringent as each party uses to protect its own confidential information. "Confidential Information" shall include the Proprietor's development plan, the Option Technology and all information concerning it and any other information marked confidential or accompanied by correspondence indicating such information is confidential exchanged between the parties hereto prior to or during the Option Period.

This agreement has been signed by authorized representatives of the Parties and shall enter effect upon signature by the parties.

Conforme:

Project Proponents/Researchers from TUP:

ENGR. ROMEO L. JORDA JR.
Adviser

ANGULO, VENCH LEARRY M.
ECE 5TH Year Student

IYA, CHRISTINE ELYSSE D.
ECE 5TH Year Student

JACINTO, NIEZAMAE T.
ECE 5TH Year Student

QUIZON, EZERIEL S.
ECE 5TH Year Student

VENTURA, JACKLYN DENNESE B.
ECE 5TH Year Student

Client:

MS. ANA MICHELE A. ISANAN
Owner, Chelesea Water Refilling Station
177 Fernandez St., Brgy. San Antonio,
San Francisco Del Monte, Quezon City
09750951791

Witnesses:

MS. ROSEANNE A. ISANAN
Co-Owner, Chelesea Water Refilling Station
177 Fernandez St., Brgy. San Antonio,
San Francisco Del Monte, Quezon City
09350165811

MS. HELEN A. ISANAN
Co-Owner, Chelesea Water Refilling Station
177 Fernandez St., Brgy. San Antonio,
San Francisco Del Monte, Quezon City

Witnesses:

ENGR. NILO M. ARAGO
College Secretary, College of Engineering
Technological University of the Philippines
Ayala Blvd., cor San Marcelino St., Ermita, Manila

ENGR. LEAN KARLO S. TOLENTINO
Head, Electronics Engineering Department
Technological University of the Philippines
Ayala Blvd., cor San Marcelino St., Ermita, Manila

ENGR. BENEDICTO N. FORTALEZA
Dean, College of Engineering

Date Signed: February 19, 2019

Appendix I – Curriculum Vitae

To be placed in a company in which I can use my technical skills and leadership qualities to the upliftment of the company and personal growth.

PERSONAL PARTICULARS

Date of Birth : August 30, 1996
Age : 22
Gender : Male
Civil Status : Single
Religion : Catholic

SKILLS

WORK

1.Proficient in Microsoft Office Application (Word, Excel, PowerPoint)

2. Knowledgeable in electronics circuits design and applications
3.Skilled in Bench Work, Soldering and circuit designs

PERSONAL

1. Can work under pressure with minimum supervision
2.Fluent in Writing and Speaking English
3.Written and verbal communications skills
4.Proactive and willing to take on new challenges

CHARACTER REFERENCES

GINA NAPOLES
Section Manager
Integrated Microelectronics Inc.

ENGR. LEAN KARLO S. TOLENTINO
Department Head, ECE Department
College of Engineering, TUP Manila
+639958925845

VENCH LEARRY M. ANGULO

Blk 1 Lot 8 Brgy.Gregoria De Jesus Gma, Cavite
+639093918033
angulovench@gmail.com

EXPERIENCE

(April 2018)

ON-THE-JOB TRAINING
PLDT Inc.
Tondo, Manila

(June 2015 – October 2015)

ON-THE-JOB TRAINING
MAXIM INTEGRATED PHILIPPINES
Gateway Business Park, Barangay Javalera, General Trias, Cavite

AWARDS

March 2013 SECOND HONORABLE MENTION
BEST IN MATHEMATICS
(San Jose Community High School)
March 2009 FIRST HONORABLE MENTION
(San Jose Elementary School)

EDUCATION

BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING
Technological University of the Philippines-Manila
A.Y. 2016 – Present

BACHELOR OF TECHNOLOGY IN ELECTRONICS ENGINEERING TECHNOLOGY
Technological University of the Philippines-Cavite
A.Y. 2013 – A.Y. 2016 (Class of 2016)

SECONDARY LEVEL
San Jose Community High School
A.Y. 2009 – A.Y. 2013 (Class of 2013)

PRIMARY LEVEL
San Jose Elementary School
A.Y. 2003 – A. Y. 2009 (Class of 2009)

ORGANIZATIONS

A.Y. 2016-Present *Member* at Organization of Electronics Engineering Students
A.Y. 2018-Present *Member* at Institute of Electronics and Communications Engineers of the Philippines-Manila Student Chapter

To gain an entry into a progressive company to gain further experience and life skills. This will allow me to become a more effective individual, permitting me a greater contribution to a company's services and success.

PERSONAL PARTICULARS

Date of Birth	:	August 6, 1996
Age	:	22
Gender	:	Female
Civil Status	:	Single
Religion	:	Catholic

SKILLS

WORK

1. Proficient in Microsoft Office Application (Word, Excel, PowerPoint)
2. Strong clerical skills (Detailed, Focused, Communication, Organization)
3. Competent in English Language Proficiency

PERSONAL

1. Excellent grip over verbal and written communication
2. Pressure Handling
3. Team Player
4. Ability to do the repetitive task in an optimized manner
5. Quick learner of advance technologies

CHARACTER REFERENCES

ENGR. LEAN KARLO S. TOLENTINO
Department Head, ECE Department
College of Engineering, TUP-Manila
09958925845

ENGR. ORLANDO R. LUYUN JR.
Building Engineer, Rockwell Property Management Corporation
Contact details will be provided upon request

MR. ANTHONY I. HERNANDEZ
Managing Director, Caballo Negro Industriya Corp.
Contact details will be provided upon request

MR. RALPH ANDREW A. BASINANG
Supervisor, Task Us Lizzy's Nook
Contact details will be provided upon request

CHRISTINE ELYSSE D. IYA

B 19 L 15 3rd Street, Alfonso Village, Alapan 1-B, Imus, Cavite
09952718485
christineelysseiya.cei@gmail.com

EXPERIENCE

(Nov 2018 – Present)

TEAMMATE
TASK US LIZZY'S NOOK
2F-4F Lumina Point Mall, Emilio Aguinaldo Highway, Imus, Cavite
- Engaged in placing outbound calls to provide world-class service to clients.

(April 2018 – May 2018)

COMMUNICATION SYSTEMS STAFF
CABALLO NEGRO INDUSTRIYA CORP.
5th Floor, South Gate Bldg., Finance Drive, Madrigal Business Park, Ayala Alabang, Muntinlupa City, Metro Manila
- Engaged in office-related works like sorting and filing of company's documents.

(Oct 2015 – April 2016)

STUDENT ASSISTANT
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Boulevard, Ermita, Manila
- Engaged in instructor-related works like checking of students' examinations and activities and encoding of their grades.

(May 2014 – Dec 2015)

SERVICE CREW (COUNTER)
MCDONALD'S
Robinsons Place, Ermita, Manila
- Engaged in process of customer payments and customer service.

AWARDS

July 2018	PARTICIPANT – YMCA's 111th Anniversary: Extemporaneous Speaking (English Category)
Dec 2017	FIRST RUNNER-UP – Tagis Talino 2017: Extemporaneous Speech Category (English)
Mar 2013	FIRST HONORABLE MENTION – Del Pilar Academy
Mar 2009	SALUTATORIAN – Imus Pilot Elementary School

EDUCATION

BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING
Technological University of the Philippines-Manila
A.Y. 2016 – Present

BACHELOR OF TECHNOLOGY IN ELECTRONICS ENGINEERING TECHNOLOGY
Technological University of the Philippines-Manila
A.Y. 2013 – A.Y. 2016 (Class of 2016)

SECONDARY LEVEL
Imus, Cavite
A.Y. 2009 – A.Y. 2013 (Class of 2013)

PRIMARY LEVEL
Imus, Cavite
A.Y. 2003 – A. Y. 2009 (Class of 2009)

ORGANIZATIONS

A.Y. 2017-2018	*Secretary* at Organization of Electronics Engineering Students
A.Y. 2016-Present	*Member* at Institute of Electronics and Communications Engineers of the Philippines-Manila Student Chapter
A.Y. 2013-Present	*Executive Officer* at TUP-M ROTCU Corps of Lady Sponsors

To be able to work where I can appy all the knowledge and skills I have gained from the course I've taken.

PERSONAL PARTICULARS

Date of Birth	:	April 12, 1997
Age	:	21
Gender	:	Female
Civil Status	:	Single
Religion	:	INC

SKILLS

WORK

1.Proficient in Microsoft Office Application (Word, Excel, PowerPoint)

2. Skillled in Soldering, Circuit Designs and Troubleshooting
3.Computer Literate

PERSONAL

1.Written and verbal communications skills
2.Independent and can work with minimum supervision
3.Highly trainable and a team player
4.Trustworthy and honest

CHARACTER REFERENCES

MARCONI RAMIREZ
Supervisor
Maxim Integrated Philippines
+639155618930

ENGR. LEAN KARLO S. TOLENTINO
Department Head, ECE Department
College of Engineering, TUP Manila
+639958925845

ENGR. KATRINA CHEZKA VIDEÑA
Equipment Engineer
Telford Services Phils. Inc.
+639771810422

NIEZAMAE T. JACINTO

Block 13 Lot 52 Phase 4, Family Village Resources,
Barangay Poblacion 5, General Mariano Alvarez, Cavite
+639177354044
niezamae.jacinto@tup.edu.ph

EXPERIENCE

(December 2018 – March 2019)

ON-THE-JOB TRAINING
TELFORD SERVICES PHILS. INC.
Gateway Business Park, Barangay Javalera, General Trias, Cavite

(June 2015 – October 2015)

ON-THE-JOB TRAINING
MAXIM INTEGRATED PHILIPPINES
Gateway Business Park, Barangay Javalera, General Trias, Cavite

EDUCATION

BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING
Technological University of the Philippines-Manila
A.Y. 2016 – Present

BACHELOR OF TECHNOLOGY IN ELECTRONICS ENGINEERING TECHNOLOGY
Technological University of the Philippines-Cavite
A.Y. 2013 – A.Y. 2016 (Class of 2016)

SECONDARY LEVEL
General Mariano Alvarez Technical High School
A.Y. 2009 – A.Y. 2013 (Class of 2013)

PRIMARY LEVEL
Area J Elementary School
A.Y. 2003 – A. Y. 2009 (Class of 2009)

ORGANIZATIONS

A.Y. 2016-Present	*Member* at Organization of Electronics Engineering Students
A.Y. 2018-Present	*Member* at Institute of Electronics and Communications Engineers of the Philippines-Manila Student Chapter

To be able to acquire and enhance my knowledge in a company where I could practice and develop my personality as an individual while utilizing my skills in electronics processes and applications such as designing, testing, troubleshooting and modifying electronics equipment.

PERSONAL PARTICULARS

Date of Birth	:	July 7, 1997
Age	:	21
Gender	:	Male
Civil Status	:	Single
Religion	:	Born Again

SKILLS

WORK

1.Skilled in electronics design and circuits
2.Skilled in Bench Work, Soldering and circuit designs
3.Well verse in using Microsoft Office (Word, Excel, Outlook, and PowerPoint)

PERSONAL

1.Fluent in Writing and Speaking English
2.Written and verbal communications skills
3.Proactive and willing to take on new challenges

CHARACTER REFERENCES

MAJOR CHRISTOPHER QUILANG
Police Senior Inspector
Camp Crame, Quezon City

ENGR. LEAN KARLO S. TOLENTINO
Department Head, ECE Department
College of Engineering, TUP Manila
+639958925845

EZEKIEL S. QUIZON

Blk 32 Lot 10 Phase 3 Villa Luisa Homes
Dasmariñas City, Cavite
+639058976500
ezekiel.quizon@tup.edu.ph

EXPERIENCE

(December 2018 – March 2019)

ON-THE-JOB TRAINING
TELFORD SERVICES PHILS. INC.
Gateway Business Park, Barangay Javalera, General Trias, Cavite

(April 2015)

ON-THE-JOB TRAINING
SHARP SERVICE CENTER
Dasmariñas City, Cavite

EDUCATION

BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING
Technological University of the Philippines-Manila
A.Y. 2016 – Present

BACHELOR OF TECHNOLOGY IN ELECTRONICS ENGINEERING TECHNOLOGY
Technological University of the Philippines-Cavite
A.Y. 2013 – A.Y. 2016 (Class of 2016)

SECONDARY LEVEL
Jesus Christ King of kings and Lord of lords Academy
A.Y. 2009 – A.Y. 2013 (Class of 2013)

PRIMARY LEVEL
Holy Child Jesus Montesorri
A.Y. 2003 – A. Y. 2009 (Class of 2009)

ORGANIZATIONS

A.Y. 2016-Present	*Member* at Organization of Electronics Engineering Students
A.Y. 2016-Present	*Member* at Institute of Electronics and Communications Engineers of the Philippines-Manila Student Chapter

To enhance my knowledge and skills in a different environment which will help to develop my personality and self-reliance.

PERSONAL PARTICULARS

Date of Birth : January 2, 1998
Age : 21
Gender : Female
Civil Status : Single
Religion : Catholic

SKILLS

WORK

1. Proficient in Microsoft Office Application (Word, Excel, PowerPoint)
2. Knowledge to electronics circuits and components
3. Knowledge to circuit designing and soldering

PERSONAL

1. Strong written and verbal communication, and interpersonal skills
2. Good organizational and time management
3. Ability to exercise flexibility, initiative, good judgment and discretion
4. Ability to work effectively as a member of team and establish and maintain cooperative working relationships with diverse groups and the public.

CHARACTER REFERENCES

Mr. Roalfred Nazareth Abelar
Email Support Representative
TaskUs - Philippines
0926-822-9156

Mrs.Emelita D. Umbao
School Principal
Infant Jesus Colleges Cavite. Inc
0929-724-3884

Rev. Fr. Windylle Macaranas
Asst. Parish Priest
Mary Immaculate Parish - Salawag
0917-246-6230

JACKLYN DENNESE B. VENTURA

Block 46 Lot 19 Phase 4 Mabuhay Homes 2000,
Brgy. Paliparan II, Dasmariñas City, Cavite 4114
+639161216743
jacklydennese.ventura@tup.edu.ph

EXPERIENCE

(December 2018 – March 2019)

ON-THE-JOB TRAINING
TELFORD SERVICES PHILS. INC.
Gateway Business Park, Barangay Javalera, General Trias, Cavite

(April 2015)

ON-THE-JOB TRAINING
SHARP SERVICE CENTER
Dasmariñas City, Cavite

EDUCATION

BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING
Technological University of the Philippines-Manila
A.Y. 2016 – Present

BACHELOR OF TECHNOLOGY IN ELECTRONICS ENGINEERING TECHNOLOGY
Technological University of the Philippines-Cavite
A.Y. 2013 – A.Y. 2016 (Class of 2016)

SECONDARY LEVEL
Infant Jesus Colleges Cavite
A.Y. 2009 – A.Y. 2013 (Class of 2013)

PRIMARY LEVEL
Infant Jesus Colleges Cavite
A.Y. 2003 – A. Y. 2009 (Class of 2009)

ORGANIZATIONS

A.Y. 2016-Present	*Member* at Organization of Electronics Engineering Students
A.Y. 2016-Present	*Member* at Institute of Electronics and Communications Engineers of the Philippines-Manila Student Chapter

Appendix J – Certification

Order Details

Your order has been processed

MathWorks Order Number: 11519259
Purchase Order:
Invoice Number: 29915413
Terms: Prepaid

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Burbank CA
PH

Deliver To:
Ayala Boulevard
Manila1000
PH

Order Processed: 22-Mar-2019

Master License 31411006

License 40801275
Student | Individual | Perpetual

Part No.	Product	Service Period	Qty	Unit Price	Discount	Extended Price
SV	MATLAB and Simulink Student Suite	22-Mar-2019 - 31-Mar-2020	1	USD 55.00	USD 0.00	USD 55.00
AUSV	Audio Toolbox	22-Mar-2019 - 31-Mar-2020	1	USD 16.00	USD 10.00	USD 6.00
MESV	MATLAB Coder	22-Mar-2019 - 31-Mar-2020	1	USD 16.00	USD 10.00	USD 6.00
RTSV	Simulink Coder	22-Mar-2019 - 31-Mar-2020	1	USD 16.00	USD 10.00	USD 6.00
					Subtotal:	USD 73.00

Subtotal:	USD 73.00
Tax:	USD 0.00
Total:	USD 73.00

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for speech in noise", International Journal of Industrial Ergonomics, 2012.
Publication

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