DEVELOPMENT OF A SPECTRUM OCCUPANCY PREDICTION MODEL FOR COGNITIVE RADIO SYSTEMS

BY

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ABSTRACT

The two major users of a Cognitive Radio (CR) system are the Primary User (PU) and the Secondary User (SU). A secondary spectrum user cannot transmit in a channel before sensing and knowing the spectrum occupancy state as this may cause interference. This poses a major challenge because these operations ought to be performed in each time slot and thereby causing a substantial delay before the user gains access to the spectrum, leading to inefficient utilisation. Therefore, a channel predictive system will mitigate this problem. In this work, a machine learning model for spectrum occupancy prediction was developed. Power Spectrum Density (PSD) data were collected for 24 hours in Minna, Niger State and FCT Abuja both in Nigeria with 3 measurement sites per location within the VHF band (30-300 MHz). Exploratory Data Analysis (EDA) using power density plots was used to reduce the dimensionality of the dataset so that the data can be fit for machine learning. The power density plots reveal 12 distinct groupings or frequency sub-bands for the entire dataset. A Back-Propagation Neural Network (BPNN) model was developed to predict the spectrum occupancy using time-series data which was converted into a feature vector that was captured as time instances of the occupancy of all the frequency sub-bands. This serves as the input vector into the feedforward neural network. Twenty-four different input parameters, which capture hourly spectrum occupancy, were used with only one output that predicts the spectral occupancy. Comparison of the prediction results with the actual results obtained was done. The weight of the neural network initially generated randomly was improved using the Auto-Regressive (AR) model whose order is based on the time dimension of the feature vector. The coefficients of the AR model were obtained from the synaptic weights and adaptive coefficients of the nonlinear sigmoid activation function of one hidden layer with a ten-neuron Real-Valued Neural Network (RVNN). A linear activation function was used in the output layer. To obtain the AR coefficients, the training data and the corresponding expected occupancy (estimated from the raw data) are passed to the neural network alongside the number of neurons in the hidden layer. Based on the training data and the corresponding output data, the neural network model trains itself to come up with the best weights which can generally be used by the AR model for unseen data. After computing the weights, the performance is first tested on the entire training data, on the validation dataset, and the test dataset. Overall, the results for Minna dataset, in band 1 (30-47 MHz), reveal a highest actual spectral occupancy of 40.59% with a prediction accuracy of 99.06% while band 7 (137.05-144 MHz) has a lowest occupancy of 25.24% and a prediction accuracy of 99.31%. The corresponding results for the Abuja dataset, in band 1 (30-47 MHz), show a highest actual spectral occupancy of 39.11% with a prediction accuracy of 98.59% while band 11 (230.05-267 MHz) has a lowest occupancy of 22.13% in with a prediction accuracy of 99.40% were obtained for Abuja dataset. Clearly, band 1 had the highest spectral occupancy values in both locations and therefore should be avoided for Cognitive Radio (CR) deployment. The performance of the Neural Network prediction model reveals accuracy of 91.51% to an unseen test dataset, an accuracy of 99.02% on the training dataset and an accuracy 91.63% to the validation dataset.

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ABBREVIATIONS, GLOSSARIES AND SYMBOLS

AEDC	Abuja Electricity Distribution Company
AH	Ampere Hour
ALOHA	Additive Links On-line Hawaii Area
ANN	Artificial neural networks
AR	Auto Regression
ARM	Auto Regressive Model
ARNN	Auto-Regressive Neural Network
AWGN	Additive White Gaussian Noise
BP	Back Propagation
CSMA/CA	Carrier Sense Multiple Access/Collision Avoidance
CR	Cognitive Radio
CRN	Cognitive Radio Networks
DSA	Dynamic Spectrum Access
dB	Decibel
dBm	Decibel Milliwatts
EDA	Exploratory Data Analysis
EHF	Extremely High Frequency
EM	Electro Magnetic
EMA	Exponential Moving Average
EWMA	Exponentially Weighted Moving Average
FCT	Federal Capital Territory
FFT	Fast Fourier Transform

GHz	Giga Hertz
GIT	Georgia Institute of Technology
GK	Gidan Kwano
GSM	Global System for Mobile Communications
HD	High Definition Camera
Hz	Hertz
HF	High Frequency
HMM	Hidden Markov Model
IEEE	Institute of Electrical and Electronics Engineers
ITS	Institute of Telecommunication Sciences
ITU	International Telecommunication Union
LF	Low Frequency
LM	Levenberg Marquardt
LMR	Land Mobile Radio
MCPA	Markov-based channel-based prediction algorithm
MF	Medium Frequency
MFNN	Multilayered Feed Forward Neural Networks
MLP	Multilayer Perceptron
MPRG	Mobile Portable Radio Group
MSE	Mean Squared Error
NN	Neural Networks
NSHMM	Nonstationary Hidden Markov Process
NTIA	National Telecommunication Information and Administration

OFDM	Orthogonal Frequency Division Multiplexing
PCA	Principal Component Analysis
POMDP	Partially Observable Markov Decision Process
PSD	Power Spectral Density
PU	Primary User
QoS	Quality of Service
RAM	Random Access Memory
RF	Radio Frequency
RMS	Root Mean Squared
RNN	Real Valued Neural Network
SCG	Scaled Conjugate Gradient
SDR	Software Defined Radio
SHF	Super High Frequency
SMA	Sub Miniature Version
SPDT	Single Pole Double Throw
SS Co.	Shared Spectrum Company
SSDT	Spectrum Sensing and Data Transmission
SU	Secondary User
TDNN	Time Division Neural Network is a Feed-Forward
TV	Television
UHF	Ultra High Frequency
UK	United Kingdom
U-NII	Unlicensed National Information Infrastructure

USA	United States of America
USB	Universal Serial Bus
VA	Volt Amps
VHF	Very High Frequency
VLF	Very Low Frequency
VMM	Variable Length Markov Model
WiFi	Wireless Fidelity

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The demand for wireless equipment is high. Similarly, the usage of data and multimedia applications has resulted in a massive increase in demand for faster data rates. This has resulted in a greater need for radio spectrum (Oluwafemi *et al.,* 2021). The radio spectrum is the wheel on which wireless communication systems are driven. The high demand for radio spectrum can be observed in the auctions that have been conducted in nations where large sums have been paid for spectrum licenses (Kyeremateng-Boateng *et al.,* 2020; Anabi *et al.,* 2016; Mishra *et al.,* 2012; Doerr *et al.,* 2008; Dame, 2001). Due to the restricted natural frequency usage, there is a spectrum deficit. Because the entire radio spectrum has been assigned to various wireless services, some newly emerging wireless technologies are unable to operate (Gupta and Jha, 2015). The spectrum's opportunity cost rises as a result. Because of inefficient static spectrum distribution policies, spectrum scarcity is not real but artificial (Peha, 2009).

Early spectrum survey in the United States of America (USA) found a shocking result of spectrum underutilisation, corroborating the assertion of inefficient spectrum management (McHenry, 2005). According to the study, a considerable amount of the available spectrum is unused. Due to time, frequency, and geographic location, 15 percent to 85 percent of the allocated spectrum remains inactive (Seflek and Yaldiz 2019; Akyildiz *et al.,* 2006). These studies reveal that the existing spectrum allocation mechanism is faulty and incapable of meeting the increasing demand for spectrum for future cellular services. The present system of spectrum management is very rigid, with major licensed users having entire or absolute control over the radio frequency spectrum (Matheson and Morris, 2012).

1.1.1 The Radio Spectrum

Spectrum refers to the frequency range of Electromagnetic (EM) waves or radio frequencies utilised for communication. As shown in Equation 1.1, the frequency f of EM waves, measured in Hertz (Hz) or cycles per second, is inversely proportional to the wavelength.

$$f = \frac{c}{\lambda} \tag{1.1}$$

where

c is the speed of light in vacuum and

λ is wavelength in meters

EM waves have the capability of transporting energy through space at the speed of light. Frequency, wavelength and amplitude are the parameters for defining the EM waves. Wavelengths are shorter for high-frequency waves and longer for low-frequency waves. The wavelength also reflects the wave's ability to move through space. Waves with a lower frequency travel further than waves with a higher frequency. It is worth noting that radio waves are usually characterised in terms of frequency than wavelength. The radio frequency spectrum spans frequencies between 30 Hz and 300 GHz. It covers a range of radio waves, which are a subset of EM waves. Transmitters generate these waves which are received by the antennas or aerials.

Spectrum is a valuable finite resource that is becoming insufficient day by day because of the growth in deployment of newly emerging wireless systems. To support this growth, technology developers and regulators are examining and considering better techniques to increase spectrum efficiency to avoid spectrum crisis. Consequently, several investigations have been conducted around the world to assess and estimate the effectiveness of the fixed spectrum allocation technique currently in use. This involves conducting spectrum occupancy measurements in various locations with the aim of evaluating and selecting suitable spectrum bands for the application of Cognitive Radio (Martian *et al.,* 2013). Results obtained from such measurements reveal very low utilisation of the frequency spectrum. However, in Nigeria, the availability of such spectrum utilisation information remains limited (Ajiboye *et al.,* 2019) and this serves as the motivation for this research.

The radio spectrum is used by broadband services, radio and television transmission, mobile phones, radar, two-way radios, fixed lines, and satellite communications. As shown in Table 1.1, radio spectrum is divided into frequency bands based on frequency range.

Table 1.1: Radio Frequency Bands

Band	Frequency	Wavelength
Extremely High Frequency (EHF)	30-300 GHz	10 -1 mm
Super High Frequency (SHF)	3-30 GHz	10 -1 cm
Ultra High Frequency (UHF)	300-3000 MHz	100 -10 cm
Very High Frequency (VHF)	30-300 MHz	10 -1 m
High Frequency (HF)	3-30 MHz	100 -10 m
Medium Frequency (MF)	300-3000 kHz	1000 -100 m
Low Frequency (LF)	30 - 300 kHz	10 - 1 km
Very Low Frequency (VLF)	3 - 30 kHz	100 - 10 km

Ultra Low Frequency (ULF)	300 - 3000 Hz	1000-100 km
Extra Low Frequency (ELF)	30 - 300 Hz	10000 - 1000 km

Diverse telecommunication technologies might theoretically be found in any part of the radio spectrum. The size of the bandwidth required is determined by the amount of data carried by a signal. Simply said, bandwidth refers to the frequency range that a signal occupies in the spectrum. In the TV Band, the allocated bandwidth for the television transmission channel is 8 MHz. The bandwidth capacity of lower frequencies is less than that of higher frequencies. This means that communications with a lot of information, like mobile phones, television, and internet, need higher frequency bands, whereas basic audio radio signals can work with low-frequency waves. Radio signals have propagation features that are associated with the frequency during transmission.

1.1.2 Cognitive Radio Network

Cognitive Radio (CR) is a smart radio that is aware of its surroundings and can be used to implement Dynamic Spectrum Access (DSA) (Piran *et al.,* 2020; Ajiboye *et al.,* 2013). Figure 1.1 shows the network architecture of CR, consisting of two primary networks and a secondary CR network. A legitimate user that is licensed to operate in the primary network (or licensed network) within a specific band is referred to as a Primary User (PU). All PU activities are regulated through a base station if primary networks have infrastructure. In terms of functioning, PUs have precedence over unlicensed users. To be able to operate in the licensed spectrum band, it will need additional capabilities. The activities of secondary users are controlled by CR Networks (CRN), which have their own infrastructure. Finally, spectrum brokers may be used by CR networks to allocate spectrum resources among different CR networks (Ileri *et al.,* 2005).

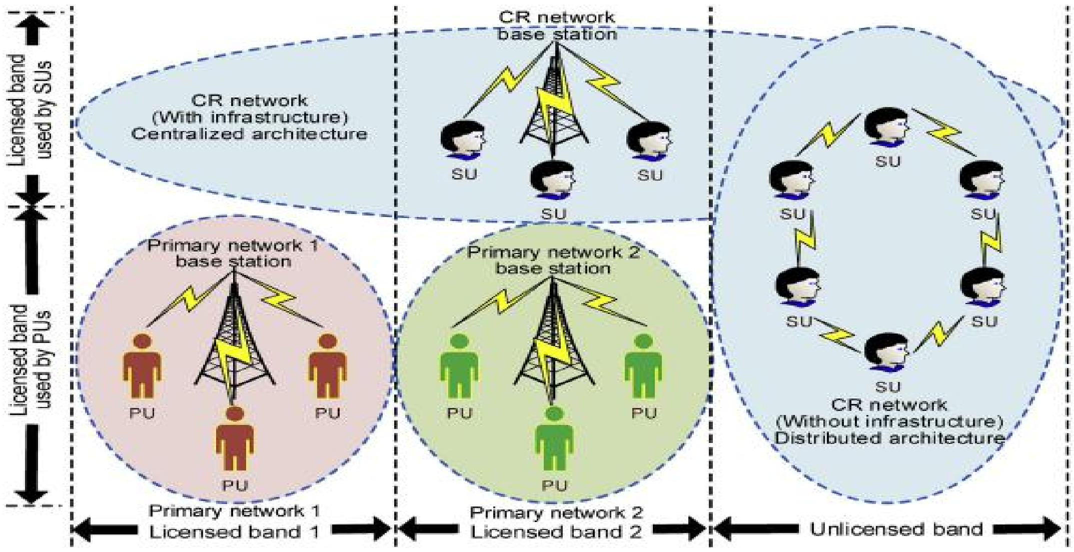


Figure 1.1: Cognitive Radio Architecture (Gupta and Kumar, 2019)

The heterogeneous wireless architecture enables CR Networks to provide unlicensed users large bandwidth through the technique of dynamic spectrum sharing. The CR users sense the channels and decide on the best channel that is free for secondary communication. While transmitting as Secondary User (SU), if a PU is detected, then the SU must vacate the channel for the PU since the PU is a priority user. Spectrum sensing, spectrum decision, spectrum sharing and spectrum mobility are all types of spectrum management activities and can all be used to create spectrum dynamics (Gupta and Kumar, 2019; Akyildiz *et al.,* 2008). CRN's spectrum management provides various services to solve difficulties such as avoiding harmful interference to authorised users, quality of service (QoS) provisioning, and smooth secondary communication (Fakhrudeen and Alani, 2017).

1.1.3 Spectrum Sensing

Transmitter detection, cooperative detection, and interference detection are the three types of spectrum sensing techniques (Nasser *et al.,* 2021). The transmitter detection technique is a frequently employed method used in the detection of PU. In order to detect primary transmitter signals, three procedures or strategies are used, which are are Energy detection, feature detection and match filter detection (Sivagurunathan *et al.,* 2021; Cabric *et al.,* 2004). An SU ensures that the channel is free by monitoring the bands that are not being utilised and thereby detecting spectrum holes for opportunistic use. In doing so the computational complexity of the network increases and this has an impact on the performance (Vartiainen *et al.,* 2016). To avoid severe interference to primary users, effective spectrum hole detection is a critical step in CR spectrum management.

1.1.4 Spectrum Decision

Spectrum decision is a critical feature of the Cognitive Radio Network (CRN). It is the ability to choose the best channel for the application out of all available channels in order to meet the QoS requirement (Joshi *et al.,* 2013). The choice of the spectrum is associated with channel features and the operation of the primary users. Policies made within and outside the country about channel allocation are very definite hence, spectrum decision is key. Two steps are involved in spectrum decision:

1. Each accessible spectrum band is characterised.

2. A suitable channel is selected based on characterisation.

The channel is characterised using statistical data from the primary network and the activity of CR users.

1.1.5 Spectrum Sharing

In the CRN, spectrum sharing comprises the coordination of transmission from CR users (Zareei *et al.,* 2017). Spectrum sharing can be achieved when functionality in Medium Access Control (MAC) protocol is engaged. Spectrum sharing in CRN is complicated by the coexistence of CR users and licensed users, as well as the large range of spectrum available for operation. The architecture, spectrum allocation behaviour and spectrum access technique are used to classify spectrum sharing and scope, as well as the related problems.

1.1.6 Spectrum Mobility

A CR user scans for the most vacant channel for signal transmission and immediately a PU appears, the CR user vacates to another channel ensuring noninterference (Oyewobi and Hancke, 2017; Ajiboye and Adediran, 2012). This phenomenon is called spectrum hand-off or spectrum mobility. To allow for faster switching without reducing connection performance, this frequency-agile operation necessitates a change to a network-protected parameter. The handoff time is an important factor in spectrum mobility management. The available channels for spectrum mobility change over time, making it difficult to maintain QoS. Furthermore, the migration of CR users causes a difficulty in which the same channel is continuously assigned to a new location.

1.2 Statement of the Research Problem

The majority of spectrum measurement campaigns done across the globe show that there is gross underutilisation of the radio spectrum temporally and spatially. However, since geographical locations are unique and have varied spectral activities, measurement results for a location cannot be directly applied to another geographical location. This is due to the impact of geographical and social characteristics on spectrum usage.

An opportunistic secondary usage of the spectrum requires repeated scanning of the bands and determining their occupancy in spectrum sensing. A secondary user therefore cannot transmit in a channel before sensing and knowing the occupancy state, as this may cause interference. This poses a major challenge because these operations ought to be performed in each time slot and thereby causing substantial delays before the user gains access to the spectrum, leading to inefficient utilisation. Therefore, a system that can intelligently forecast the state of the channel for future time slots can minimise the delay and also the energy consumed during spectrum sensing and the decision-making phase. The development of a prediction model for spectrum occupancy is what this study seeks to address.

1.3 Aim and Objectives of the Research

The research aims to develop a spectrum occupancy prediction model for Cognitive Radio (CR) systems. Towards achieving this aim, the following objectives are highlighted:

1. To Measure and Analyse spectrum data of TV bands with a view of quantifying the occupancy ratio.
2. To develop a Neural Network-based Model for Spectrum Occupancy Prediction.
3. To analyse and validate the performance of the developed Spectrum Occupancy Model.

1.4 Scope of the Study

This research focuses on TV bands. There are numerous reasons for focusing on the TV band for secondary usage. VHF sub-band (30-300 MHz) exists in some portions of the TV. The band has great potential in rural areas that are difficult to be reached due to remoteness. Optical fiber techniques and other types of technologies are not economically viable in such rural settings, therefore the TV band and its associated technology are most suitable (Kimani and Langat, 2017). Also, the VHF band has its relevance in developing countries where the telecommunications network is not yet deployed. This can serve as an economical way of making up for the unavailability of telecommunications infrastructure (Kimani and Langat, 2017).

Furthermore, the VHF band has a good propagation characteristics. According to Liang *et al.* (2008), the IEEE 802.22 standard is very popular for remote communication and employs CR technology. The standard ensures opportunistic use of the VHF in TV spectrum bands. The Institute of Electrical and Electronics Engineers (IEEE) 802.22 standard does not need a dedicated spectrum and this has led to a reduction in the expenses for its deployment. The advantage of network coverage makes IEEE 802.22 technology appropriate for use in rural and remote places. Finally, due to their relatively static network design, open standards, and public availability of information on TV transmitters, TV broadcast systems are extremely simple. A major advantage of Cognitive Radio is that it has potential of learning from past experiences. Therefore, models can be developed for the prediction of spectrum usage and the channel state accurately. Prediction-based spectrum sensing is a better alternative of spectrum sensing. The ability to predict spectrum holes will translate to a high-performance accuracy.

1.5 Significance of the Study

Primary User (PU) and Secondary User (SU) spectrum hole prediction should be done seamlessly and without creating interference by SU. Sensing the whole wideband spectrum each time a transmission is to be initiated is time-consuming and will ultimately lead to the draining of SU's power. Through a prediction mechanism, access to the spectrum that will help in restricting the sensing of channels to portions of the spectrum that are less busy through learning is desirable and this will greatly improve the ease of use and administration of the spectrum.

1.6 Thesis Layout

The introductory chapter, Chapter One, contains the following sections: Background to the Study, Statement of Problem, Aim, and Objectives, Scope, and Significance of the Study. Chapter Two contains Literature Review while Chapter Three highlights the proposed Research Methodology adopted. In Chapter Four, Results are presented and discussed while in Chapter Five Conclusions and Recommendations are drawn.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Review of Spectrum Occupancy Survey

The National Telecommunication Information and Administration (NTIA) in the USA conducted a large-scale spectrum survey in 1998. A related study conducted in New Zealand reveals the low utilisation in the band 806-2750 MHz to be 6.21% and 5.72% for outdoor and indoor locations respectively (Wellens *et al.,* 2007).

The Singapore spectrum measurement campaign result shows a low average spectrum occupancy of 4.54% (Islam *et al*., 2008). The bands allotted to aeronautical radio navigation, primary and secondary radar, and radiolocation are underutilised and suited for secondary use. The Radio Communications Group at Catalonia's Technical University conducted preliminary outdoor spectrum measurement in Barcelona and the average spectrum occupancy, according to the findings, is 22.72% for 75 MHz to 3 GHz frequency range (Lopez-Benítez *et al*., 2009a). TV bands were found to be are significantly occupied.

Another wide band campaign was carried out by López-Benítez and Casadevall (2009b) within a frequency band of 75 to 7075 MHz for twenty four hours. The impact of various locations on spectrum use was studied from the standpoint of

Cognitive Radio users. The results of a theoretical duty cycle model for the TV band were validated as well as the impact of various parameters on spectrum occupancy evaluation (López-Benítez and Casadevall, 2009b). In the spectrum measurement work of López-Benítez and Casadevall (2010), result reveal the inefficiency in static spectrum regulation. Kishor *et al*. (2011) provide an overview of global spectrum survey in the context of CR while a generic spectrum surveying framework was developed (Dinesh *et al.,* 2009). Most of these works were conducted in the USA and Europe and cannot be generalised to evaluate the occupancy situation in Nigeria.

2.2 Regional Spectrum Measurement Campaigns

To quantify spectrum utilisation, researchers have conducted spectrum measurements with narrow and wide bands of frequency. These measurements are location-bound. In this section, an overview of some campaigns conducted on country basis is documented.

2.2.1 Spectrum Measurement Campaigns in the USA

The primary goal of the 1998 spectrum occupancy survey was to quantify spectrum usage based on assigned spectrum in a variety of sites across the United States. Spectrum occupancy is higher in coastal cities due to the presence of naval radars than in Midwest cities. Another spectrum occupancy evaluation was carried out in order to determine the actual occupancy rate in a densely populated metropolitan setting and to discover spectral bands with low occupancy rates. In Chicago, the average spectrum occupancy rate over the two-day measurement was 17.4 percent (McHenry, 2005 and

McHenry *et al.,* 2006). Subramaniam *et al.* (2015) conducted a spectrum survey to determine spectrum utilisation. The frequency range covered is 824-5800 MHz band. Results for average occupancy rates for certain bands were presented. Das and Das (2015) did a worldwide study of spectrum occupancy models. Chen and Oh (2015) did similar work.

2.2.2 Spectrum Measurement Campaigns in Germany and Netherlands

Wellens *et al*. (2007) did a widespread measurement campaign in Aachen, Germany. A comparison was done for the results obtained for both indoor and outdoor measurements for spectrum band of 20-6000 MHz by using a highly sensitive spectrum analyser Agilent E4440A, having a capacity for up to 8192 measurement points. An antenna system that covered a wide spectrum band of 20 MHz to 6 GHz was designed and used for this work to avoid reconfiguring the setup. A large discone antenna, model AOR DA-5000, covers the 20 MHz to 1.52 GHz spectrum band, while a smaller discone antenna, model AOR DA-5000JA, covers the 1.5 GHz to 3 GHz spectrum band. The third antenna is a random antenna with the Antennentechnik Bad Blankenburg AG KS 1-10 version, which covers the frequency range of 3 to 6 GHz. The threshold was selected to be 3 dB above the noise floor level for the entire band of spectrum. The two parameters that influenced the results obtained are decision threshold and location. This work concluded that a high spectrum occupancy rate was obtained in outdoor measurement while a very low value was obtained for indoor measurement as a result of lower ambient noise.

An outdoor spectrum measurement was conducted by Wellens *et al.* (2007) in Aachen Germany with results showing that the spectrum for the Unlicensed National Information Infrastructure (U-NII) is mostly vacant because the commonly used home networks are within the frequency band of 2.4 GHz to 5 GHz WiFi. Mahonen and Wellens (2009) conducted a spectrum measurement campaign in three locations in Aachen, Germany, and the Netherlands, and developed a new duty cycle model. The findings of this study demonstrated that PU bandwidth has a considerable impact on the duty cycle's frequency domain correlation features.

2.2.3 Measurement Campaigns in Spain and Poland

A spectrum measurement campaign was carried out by López-Benitez *et al.* (2009a), covering a frequency range of 75 – 7000 MHz in Barcelona, Spain specifically for both suburban and urban areas for both indoors and outdoors settings. Analysis of the measurement was done with a view of determining the spectrum occupancy. A comparative analysis with the approved spectrum regulation of government agencies in Spain reveal the presence of a large amount of spectrum usable for future Cognitive Radio devices.

Lopez-Benitez and Casadevall (2010) did a measurement campaign that covered a wide spectrum band of a wide band of 75 to 7075 MHz for 24 hours. The impact of various locations on spectrum usage was investigated from the standpoint of CR in this study. The measurement setup includes a Single Pole Double Throw (SPDT) switch to select the desired antenna. Results revealed that the occupancy level strongly depends on its location. Also, the presentation and validation of a theoretical duty cycle model were achieved in this work.

Kliks *et al.,* (2013) also compared the measurement done in Spain and Poland to quantify spectral occupancy existing in various bands. Results show a large proportion of unused spectrum, with average spectrum occupancy of 22% in Barcelona and 27% in Poznan.

2.2.4 Measurement Campaign in Singapore

Islam *et al.* (2008) did a measurement campaign in Singapore and evaluated spectral occupancy of various services to discover potential bands for cognitive radio application. Results show average spectrum occupancy to be low with a value of 4.54% for the entire band studied while the highest occupancy occurred in broadcasting and GSM 900 bands. Very low occupancy was observed for the spectrum TV band of 614-790 MHz. Thus this band is ideal for cognitive radio use.

2.2.5 Measurement Campaign in New Zealand

Chiang *et al.* (2007) carried out the spectrum outdoor and indoor measurement campaign for the range of frequencies 806-2750 MHz in the metropolis of Auckland in New Zealand. The study set out to identify spectral holes for the usage of secondary devices. Statistical results in the form of an amplitude probability distribution, noise distribution and spectrum occupancy rate as a proportion of time were presented. The spectrum band was segmented into nineteen frequency sub-bands based on the services allocated for by the regulatory body. A dual antenna system was designed using a Rohde & Schwarz ESVN40 Test Receiver and a dipole antenna for the frequency range of 806-1000 MHz and a discone antenna for the frequency range of 1000-2750 MHz which was used for signal capture. To determine whether the channel is occupied or not, a threshold of 5 dB over the average noise power was applied. Any signal above the threshold is assumed to be occupied while below is not occupied. Estimation of the noise power was done by replacing the antenna with a matched load. Results show a low spectral occupancy of 6.21% and 5.72% for outdoor and indoor measurements respectively.

2.2.6 Measurement Campaign in Greece and Macedonia

Lazaridis *et al.* (2014) presented results for the measurement of TV spectrum UHF band and the level of field strength in Thessalonika, Greece as well as Skopje in Macedonia revealing the availability of opportunistic secondary spectrum access to a major part of the spectrum. Their work compared spectral occupancy results before the analog switch over and after the switch over and observed lots of unoccupied TV channels after the digital switchover.

2.2.7 Measurement Campaign in China

A two-day measurement survey was done in China covering a range of frequencies of 440-2700 MHz by Xue *et al.* (2013). The result indicates that the TV UHF band and the GSM900 bands were heavily used. Overall, the spectrum utilisation for the entire band is given as 15.2%. In Beijing, both fixed and mobile-based spectrum measurement has been performed with a focus on the whole TV band by analysing various parameters such as frequency, time, space domain and TV standards (Chen and Oh, 2015).

2.2.8 Measurement campaign in Japan and Finland

Spectrum occupancy measurement was done in three places of the Kanto area in Japan by Contreras *et al.* (2011). Analysis of data gathered was done aiming at identifying the white space in the TV band that is suitable for use by secondary users. The result shows that spectrum occupancy in TV bands is 13.9%. Hoyhtya *et al.* (2015) surveyed spectrum occupancy measurement by comparing metrics, measurement targets and equipment used. From their findings, focused and well-designed campaigns are better than universal ones. This is because a simple and generalised form of spectral occupancy value may lead to a false conclusion.

2.2.9 Measurement campaign in the United Kingdom

A multiple spectrum occupancy survey was performed by Palaios *et al.* (2012) in various locations in London for one week over a frequency range of 75-3000 MHz. Temporary measurement systems were established in areas like airports, streets and shopping centers. A correlation study was performed among the measurement points in the context of time, space and frequency domain.

2.2.10 Inter-Regional Measurement Campaigns

Results of spectrum measurement conducted in Chicago and Finland by Hoyhtya *et al.* (2014) reveal that the proportion of spectral occupancy in the UNII band is less than 5%. Biggs *et al.* (2004) and Ellingson (2005) also carried out measurements for a frequency range of 20-3000 MHz in four locations, for one week. Comparison of the results of the four locations was done and an investigation of the fitness of the occupancy statistics to the betta distribution was done. It was discovered that the frequency bands available can be used for CR. Spectrum measurement surveys were done in eleven European countries by Van de Beek *et al.* (2012) focusing on the UHF TV band (470-790 MHz). The survey aimed to discover TV white spaces and a comparative analysis of the results was done with those obtained from the USA.

Comparative studies have been undertaken for different locations and at different bands by Palaios *et al.* (2012). The studies include the synchronous spectrum occupancy measurement done in seven European cities for two days. The work aimed to harmonise measurement settings and equipment with a view of comparing data obtained. From the results, the effect of location is strong on the measured power spectral density. Palaios *et al.* (2012) surveyed seven different cities of Europe covering a frequency range of 110-3000 MHz for two days. Results were presented in the form of duty cycle tables for GSM 1800 and GSM 900 bands. Chen and Oh (2016) reported in detail the spectrum occupancy measurements on a statistical scale and the spectrum prediction models. The work also compared the spectrum occupancy in Nigeria with those of the UK and USA.

In South Africa, Barnes *et al.* (2013) proposed a measurement system with a measurement period lasting for six weeks. Results indicate occupancy rates of 20% for the UHF band, 40% for GSM 1800 uplink and 92% for GSM 900 downlink. Martian (2015) did a spectrum occupancy investigation in Romania. The range of frequency covered is 25 to 3400 MHz band. Results for spectral occupancy rates were presented for different threshold values. Spectrum occupancy rates were 14.19% and 21% in Maneciu village and Bucharest respectively.

2.2.11 Measurement Campaigns in Nigeria

Faruk *et al.* (2014) suggested a method of reuse of the TV frequency spectrum (that is, TV whitespace) by SU's band based on the results of field strength measurements carried out in Nigeria along six different routes. Furthermore, Faruk *et al.* (2015) developed a metric for estimation of reuse in the TV band. Babalola *et al.* (2015) conducted spectral occupancy measurement within the spectral band of 48.5-870 MHz in Nigeria for both rural and urban locations and results show that there is a great opportunity for CR deployment for maximum utilisation of the spectrum. Adediran *et al.* (2014) worked on estimation of the proportion of UHF TV band also in Kwara State.

Adeseko *et al.* (2016) carried out a spectrum occupancy measurement and analysis in the 2.4-2.7 GHz in an urban and rural environment within Kwara State. A global comparison of results was done which showed gross underutilisation. This work is only limited to the characterisation of the duty cycle of each location and estimation of the average duty cycle for the rural and urban areas. The average occupancy rates for both rural and urban areas were estimated. Faruk *et al.* (2016) further did a wide band spectrum occupancy measurement within the 50 MHz to 6 GHz frequency range. Also, Sikiru *et al.* (2017) investigated the effect that threshold is having on the duty cycle within the GSM band in Nigeria and concluded that a threshold of 5 dB above noise floor level is more appropriate against the 10 dB suggested by the ITU. Paulson *et al.* (2018) only scanned through the VHF band and presented results. Faruk *et al.* (2019) did a study on spatial variability of duty cycle within the cellular band. In this work, measurements were taken for nine locations with four out of the nine locations being in the city while the remaining five locations are in the remote areas and a comparison was made on measurements taken. The results concluded that there is a positive correlation between the occupancy results for GSM900 and GSM 1800.

2.3 Spectrum Data Characterisation

Spectrum occupancy measurement is necessary since spectrum behaviour cannot be predicted from licensing information data alone due to the fact that it fluctuates depending on a number of parameters. Capturing spectrum data for a specific location is essential to be able to characterise and evaluate the behaviour of the spectrum. Real-world live data when analysed will help to give information about the spectral activities in a specific place and time.

2.3.1 Applications of Spectrum Surveying

A summary of spectrum measurement surveys is shown in Table 2.1 for the Land Mobile Radio (LMR) frequency band and some selected bands. The Georgia Institute of Technology's (GIT) Radio Spectrum Engineering Lab, the Institute of Telecommunication Sciences (ITS) in the United States, Virginia Tech's Mobile

Portable Radio Group (MPRG), and the Shared Spectrum Company (SS Co.) Virginia, United States of America all did research on spectrum measurement surveys (Petrin and Steffes, 2005; Petrin and Steffes, 2004a; Hoffman and Matheson, 2005; Ellingson, 2005; McHenry, 2005).

Table 2.1 Spectrum Measurement Surveys

Location	Band	Reason for Spectrum Survey
1. ITS	LMR Bands	Enhanced utilisation of LMR bands, prediction
2. MPRG	30-300 MHz	Evaluation of spectrum for DSA purposes
3. SS Co.	54-3000 MHz	To determine spectral occupancy statistics
4. GIT	0.4-7.2 GHz	Determine spectrum occupancy and radiometric service interference

The spectrum data are essential in determining patterns of spectral transmission activities and also for interference analysis (Petrin and Steffes, 2004b). When the behaviour of spectrum is known with the interference issues, seamless access to spectrum by secondary users will enhance efficient use of the radio spectrum (Petrin and Steffes, 2004b; Hoffman and Matheson, 2005). Studies were done so that spectrum utilisation can be more efficient and to forecast usage of such bands in the future. The proportion of idle spectrum can be estimated, allowing for the consideration of broadband communication in spectrum white spaces via cognitive radio operation (Ellingson, 2005).

Resolving spectrum usage along all dimensions of the spectrum can provide insights that can help with spectrum efficiency (Petrin and Steffes, 2004a). In a real-world scenario, the data gathered from the spectrum measurement study could be incorporated into DSA networks to identify potential secondary access opportunities. Furthermore, three-dimensional spectrum data can disclose primary transmitter properties such as polarisation type and azimuth position (Petrin and Steffes, 2005).

Additionally, spectrum survey outcomes can help in preventing interference. Fixed microwave services are typically used in the 6.75-7.1 GHz frequency spectrum, although it is also open to radio astronomy studies and research (Petrin and Steffes, 2004b; Rogers *et al.,* 2005). The historical characteristics of the primary users can be observed with a view of identifying periodic spectrum users to develop methods of permitting passive services to exploit the spectrum when the primary user is not present. In summary, the study of the spectrum mainly has to do with processing the spectrum data to identify signal activity within the band, then evaluate the data to determine spectral occupancy.

2.3.2 Processing of Spectrum Survey Data

Effective spectrum data measurement and collection can be ensured by the sensitivity of the hardware, however, broadband impulse noise, intermodulation, and system noise introduce errors in measurement data, which can be easily rectified by subjecting the data to post-measurement data processing. (Hoffman and Matheson, 2005). The data can be processed in order to obtain signal features that can then be utilised to detect primary signals.

2.3.3 Refining of Spectrum Data

Principal Component Analysis (PCA) and Exploratory Data Analysis (EDA) can be used to refine spectrum data. When impulse noise occurs, it has an immediate effect on measurements. Sweeps of data with a higher average noise level can be detected and processed separately, or numerous sweeps of data can be averaged to reduce the average noise power (Hoffman and Matheson, 2005).

2.4 Dynamic Spectrum Access (DSA)

The term "Dynamic Spectrum Access" (DSA) refers to the ability to utilise parts of the spectrum opportunistically over time while taking regulatory and technical constraints into account (Ajiboye and Adediran, 2012). Secondary opportunistic usage of white spaces has significantly improved spectrum utilisation (Ellingson, 2005; Petrin and Steffes, 2005). Spectrum usage varies as a function of time, frequency, polarisation and geographical location (Petrin and Steffes, 2005). A cognitive radio is one that is adaptable and capable of adjusting to the present wireless environment in order to avoid interfering with communication of the primary users of the spectrum, whereas a frequency agile radio can dynamically identify spectrum opportunities and transmit in any spectrum hole (Adegbenjo *et al.,* 2020). In a dynamic context, cognitive radios can also make intelligent decisions about which transmit parameters to use to maximise the communication system's performance (Ellingson, 2005). DSA is being considered for multiband OFDM (Orthogonal Frequency Division Multiplexing) systems and Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) networks (Wylie-Green, 2005 and Jones *et al.,* 2005).

Although DSA has various advantages, implementing it is not simple. Dynamic sensing entails searching for spectrum holes in real time to minimise primary users' interference. Degraded channel settings, Real-time sensing addresses challenges such as detecting weak signals and the existence of intermodulation effects (Petrin and Steffes, 2005; Ghasemi and Sousa, 2005). Prior understanding of the spectrum occupancy and primary signal characteristics can substantially aid in the execution of DSA. Surveying the spectrum activity can provide this information.

2.4.1 Dynamic Spectrum Access in Cognitive Radio Network

The purpose of Dynamic Spectrum Access is to remove the secondary user barrier and provide secondary users access to licensed spectrum in order to maximise spectrum utilisation (Peha, 2009). Through the use of Software Defined Radio (SDR) and Cognitive Radio (CR), DSA enables flexible spectrum use which can considerably enhance spectrum utilisation (Sarijari *et al*., 2011). The primary requirement of DSA devices is frequency agility. Mitola is the first person that came up with the notion of CR and defines CR as the radio that evaluates the spectrum environment, find unused frequencies, and adjust to use them opportunistically without interfering with licensed users (Mitola, 1999). According to changes in the RF environment, the cognitive radio dynamically optimises operating parameters such as frequency and bandwidth (Kaniezhil and Chandrasekar, 2012). Industry, regulatory bodies, and academia are still working on CR definitions. The cognition interacts with the environment as shown in Figure 2.1.

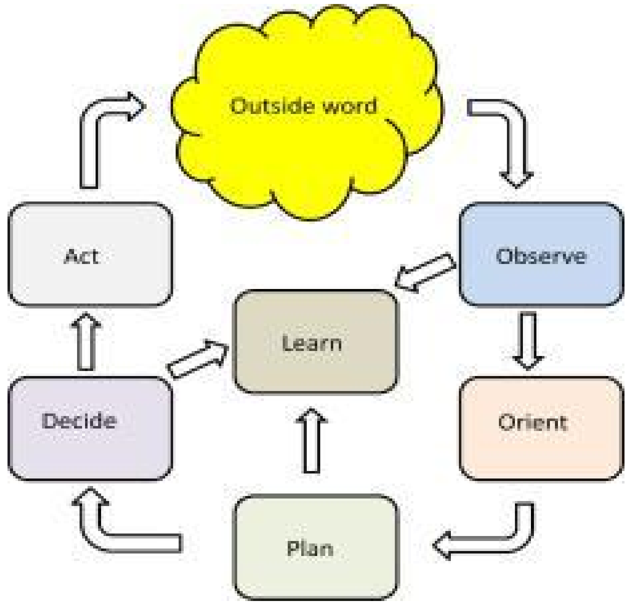


Figure 2.1: Cognition Cycle Source (Sowa, 2015)

During the cognitive cycle, a radio gains knowledge about its wireless communication environment or the outside world by direct observation or signaling. The relevance of this information is then assessed (Orient). The radio determines its options (Plan) and chooses one (Decide) that will most likely enhance the evaluation. If a change in waveform is required, the agile radio switches to the alternative (Act) by modifying its network resources and executing the relevant signals. The interference profile of the cognitive radio in the outside environment changes as a result of these adjustments. As part of this process, the radio uses these observations and decisions to improve its operation (Learn) by building new modeling states, producing new alternatives, or developing new valuations. The spectrum opportunities are depicted in Figure 2.2.

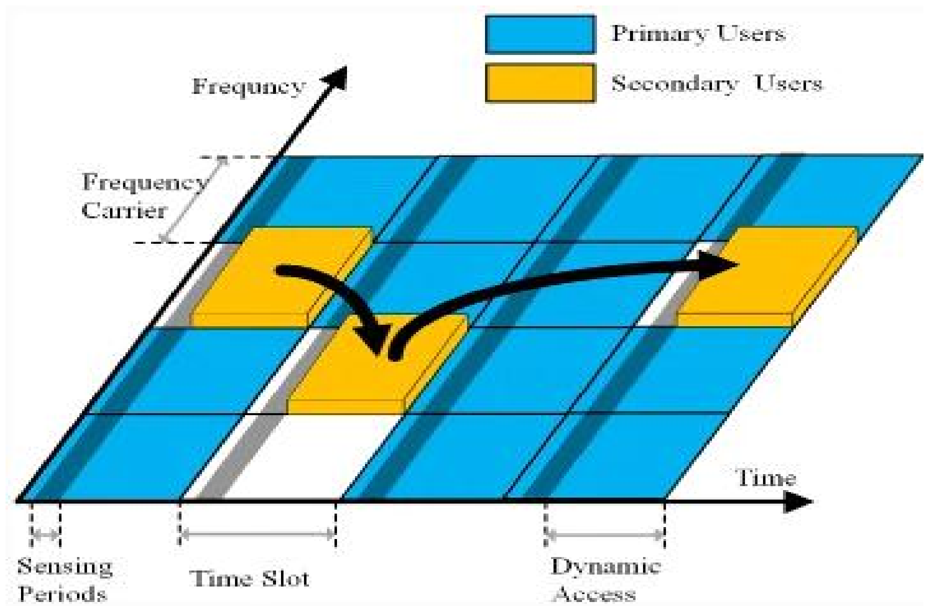


Figure 2.2: Spectrum Opportunity Source: Eltom *et al.* (2018)

In DSA, SUs form a CR network (CRN) and are allowed to opportunistically use the spectrum bands of PUs as long as the SUs do not interfere with the PUs. Spectrum opportunity, also known as spectrum whitespaces, is the period when SUs can utilise a licensed band (Ronoh *et al.,* 2021).

2.4.2 Energy Detector Spectrum Sensing Algorithm in Cognitive Radio

Spectrum detection is taking measurements across a portion of the spectrum and making decisions about spectrum usage based on the results. In a noisy environment, signal detection entails detecting the presence of a signal. The rapid growth of wireless communications has worsened the situation of spectrum utilisation. On the one hand, growing diversity (voice, short message, Web, and multimedia) and demand for high Quality of Service (QoS) applications have resulted in overcrowding of allocated spectrum bands, resulting in a considerable drop in user satisfaction. The service providers are in a predicament where they need more spectrum to meet the rising QoS demands. This has stimulated people's interest in unlicensed spectrum access, and spectrum detection is considered as critical. If a licensed user (primary user) is present, any unlicensed users (secondary users) must verify that the primary user is protected and that no secondary user is interfering with any primary user operation.

Spectrum sensing is the process of recognising unused spectrum, often known as spectrum holes, and sharing it with other secondary users in the network without causing harmful interference. Primary users in Cognitive Radio technology are those who have the highest priority for accessing a certain section of the spectrum, whereas secondary users have a lower priority and should not interfere with primary users in any manner when using the channel. In practice, unlicensed users, also known as cognitive users, continuously observe spectrum activities in order to identify a suitable spectrum band for possible use. SUs must avoid interfering with licensed users, also referred to as primary users. The above spectrum sensing by cognitive users involves detection of possible collision when a primary user becomes active, because main users have priority of service.

The field of spectrum sensing is still in its infancy. There are numerous methods for detecting the presence of a signal in transmissions that have been proposed. In some additional methods, characteristics of the identified transmission are detected in order to determine the signal transmission as well as the signal type. There are several spectrum sensing techniques used; Matched filter detection, Energy detection, Cyclo stationary detection, Covariance detection and Wavelet detection (Ohize *et al.,* 2017).

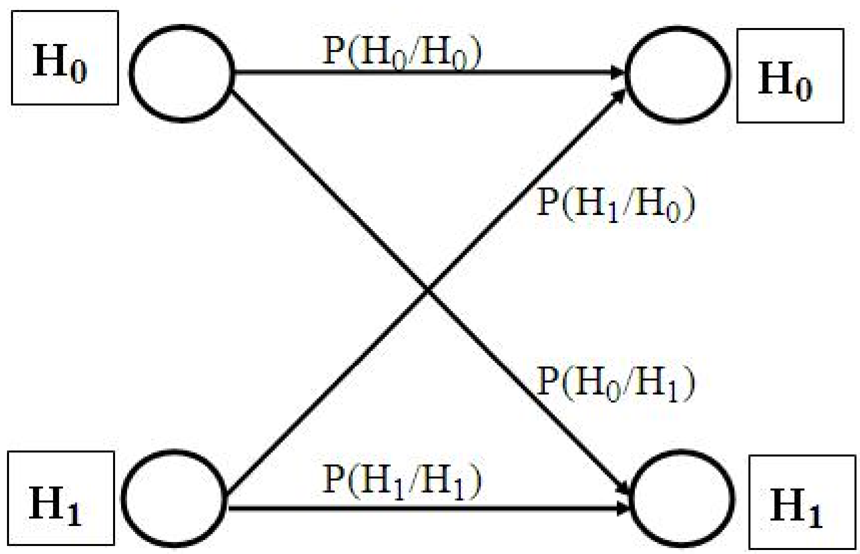
2.5 Spectrum Sensing Problem

Spectrum sensing is an important part of cognitive radio communications since it is required before unlicensed users can access an empty licensed band. Spectrum sensing discovers unused spectrum and communicates it with other licensed users without causing harmful interference. As demonstrated in Equation 2.1, spectrum sensing is essentially a binary hypothesis-testing problem.

$$\begin{aligned} &H_0\text{: Primary user is absent} \\ &H_1\text{: Primary user is present} \end{aligned} \tag{2.1}$$

When the channel is busy, the received signal has more energy than when it is idle. When an idle channel is identified as busy, false alarms occur, and missed detections occur when a busy channel is defined as idle. A false alarm results in a missed transmission opportunity for the SU, but a missed detection results in a collision with the PU, resulting in a wasted transmission for both the PU and the SU. Between protecting the PU's and providing service to the SU, there is a clear balance. By setting a threshold for the allowable probability of missed detection, a certain level of

PU protection is ensured. A good detector is an algorithm that decreases the likelihood of a false alarm while also minimising the likelihood of missed detection. As shown in Figure 2.3, spectrum sensing can be thought of as a binary hypothesis testing problem, with hypothesis H_0 indicating that the primary user (PU) is inactive



and hypothesis H_1 indicating that a PU is active.

Figure 2.3: Hypothesis Tests, Possible Outcomes and Corresponding Probabilities

As stated in Equation 2.2, a detector's performance is characterised by two parameters: the probability of detection P_d and the probability of false alarm P_f.

$$\begin{aligned} P_d &= \text{Prob}\{\text{Decision} = H_1/H_1\} \\ P_f &= \text{Prob}\{\text{Decision} = H_1/H_0\} \\ P_m &= \text{Prob}\{\text{Decision} = H_0/H_1\} \end{aligned} \tag{2.2}$$

Spectrum sensing is difficult to implement due to a number of reasons. To begin with, the required SNR for detection could be extremely low. Second, the spectrum sensing problem is complicated by multipath fading and time dispersion of wireless channels. Finally, noise levels might vary with time and place, resulting in a noise power uncertainty issue for detection. The spectrum sensor, as illustrated in Equation 2.3, effectively does a binary hypothesis test to determine whether or not a channel has primary users.

$$H_0 : x(n) = v(n)$$
$$H_1 : x(n) = s(n) + v(n), n = 1,2,3.........N \tag{2.3}$$

where H_0 indicates the absence of the primary signal. It implies the received signal $x(n)$ represents only the additive white Gaussian noise $v(n)$. Hypothesis H_1 denotes the presence of a primary signal. The received signal contains the primary signal $s(n)$ with additive noise $v(n)$ and the variable n denotes the number of signal samples. The noise is considered to be Additive White Gaussian Noise (AWGN) with a mean of zero and is generated randomly. As demonstrated in Equation 2.4, the signal to noise ratio is defined as the ratio of signal power to noise power.

$$\gamma = \frac{P_s}{N_o} \tag{2.4}$$

where P_s is the average power of the signal and N_o the average power of noise

2.6 Energy Detection

Due to its low computational and implementation complexity, the energy detector, also known as radiometry, is the most prevalent method of spectrum sensing. Furthermore, the receivers of the cognitive user do not need to be aware of the primary user's signal. The signal is identified by comparing the energy detector's output with the threshold, which is determined by the noise floor. As stated in Equation 2.5, the threshold is dependent on the noise floor and is compared to the test statistic T(x).

$$T = \frac{1}{N}\sum_{t=1}^{N}\left|x(t)\right|^2 \tag{2.5}$$

The detection statistics are compared to a specified threshold to determine whether the spectrum is occupied by the primary user. The probability of false alarm (Pf = P(H1|H0)), the probability of miss detection (Pd = P(H1|H1), and the probability of detection (Pd = P(H1|H1) can all be used to assess the performance of spectrum sensing. Equations 2.6 and 2.7 demonstrate this.

$$P_{\mathrm{f}} = \Pr(T > \lambda \left| H_0 \right.) \tag{2.6}$$

P_d denotes the probability that the test correctly decides H_1

$$P_{\mathrm{d}} = \Pr(T > \lambda \left| H_1 \right.) \tag{2.7}$$

A good detector should have a high detection probability and a low false alarm rate, or it should maximise spectrum efficiency (for example, QoS in a secondary user network) while ensuring primary user protection. It is desirable to reduce the false alarm rate for spectrum sensing as low as practicable so that the system can take advantage of all possible transmission possibilities.

Energy detection can be done in a variety of ways. To compute the signal energy, the received signal is filtered, translated to digital form, squared, and integrated over the observation interval. As shown in Figure 2.4, this energy is compared to a threshold to determine the presence of the signal of interest.

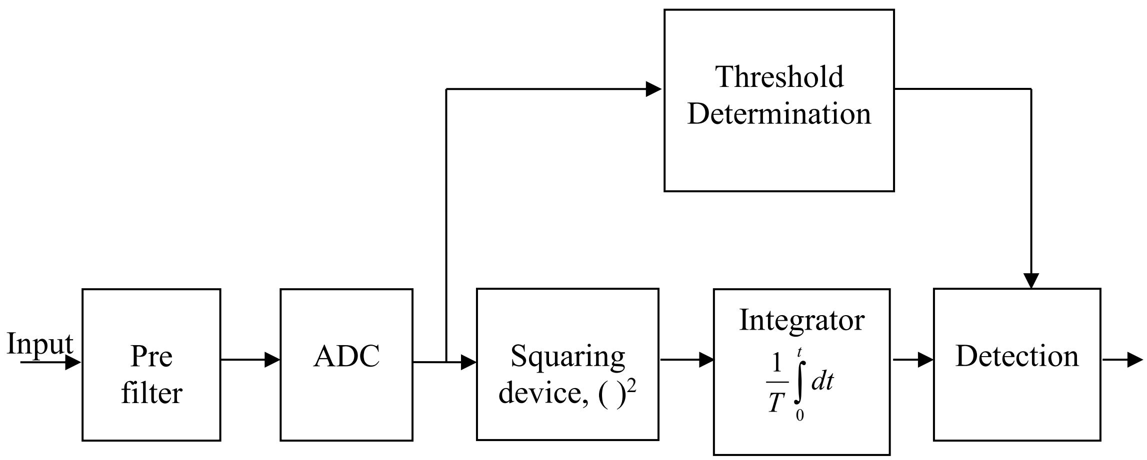


Figure 2.4: Energy detection in the time domain

The energy detection method is a standard spectrum sensing technique for determining whether or not unknown signals exist. The receiver (sensing node) does not need to be aware of the signal of the primary users. The energy E of signal x(t) can be measured using Rayleigh's energy theorem, as illustrated in Equation 2.8.

$$E = \int_{-\infty}^{\infty} |x(t)|^2 \, dt < \infty \tag{2.8}$$

If the signal's energy is equal to Equation 2.8 and the Fourier Transform X(f) of x(t) exists, then as indicated in Equation 2.9, a signal's energy is retained in both the time domain and the frequency domain, although the frequency domain representation is more flexible.

$$\int_{-\infty}^{\infty} |x(t)|^2 \, dt = \int_{-\infty}^{\infty} |X(f)|^2 \, df \qquad (2.9)$$

It makes no difference in whatever domain the signal analysis and processing is performed. Figure 2.5 shows a block diagram of the Energy Detection in the Frequency Domain.

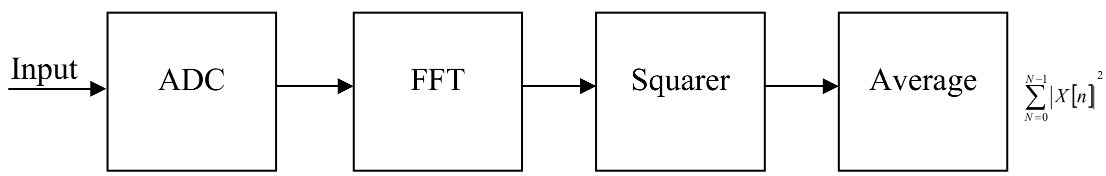


Figure 2.5 Energy detection in the frequency domain

The average magnitude squared is proportional to the overall signal strength (energy per unit time). A time-series' energy distribution in the frequency domain is described by a power spectrum.

2.7 Model Design for Energy Detection

It is assumed that no prior knowledge of the signal s(n) to be measured exists, and that just the signal's average power is known. As a result, the appropriate detector is an energy detector, also known as a radiometer, as illustrated in Equation 2.10.

$$K(Y) = \frac{1}{N}\sum_{n=0}^{N-1} y(n)s(n) > \gamma \quad :\mathrm{H}_1$$
$$< \gamma \quad :\mathrm{H}_0 \tag{2.10}$$

where K(Y) is the decision variable and hence the decision threshold, and N is the sample size. If the noise variance is entirely known, the following approximations can be obtained using the central limit theorem, as illustrated in Equation 2.11.

$$\begin{aligned} K(Y|H_0) &\sim N(\sigma_n{}^2, 2\sigma_n{}^4 / N) \\ K(Y|H_1) &\sim N(P+\sigma_n{}^2, 2(P+\sigma_n{}^2)^2 / N) \end{aligned} \tag{2.11}$$

where P is the average signal power and $\sigma_n{}^2$ is the noise variance. Using these approximations, the probability expressions are given as shown in Equations 2.12, 2.13 and 2.14.

$$\mathrm{P_f} = \Pr\,(K(Y) > \gamma | H_0) = Q\left(\frac{\gamma - \sigma_n{}^2}{\sqrt{2\sigma_n{}^4 / N}}\right) \tag{2.12}$$

$$\mathrm{P_d} = \Pr\,(K(Y) > \gamma | H_1) = Q\left(\frac{\gamma - (P+\sigma_n{}^2)}{\sqrt{2(P+\sigma_n{}^2)^2 / N}}\right) \tag{2.13}$$

$$\mathrm{P_m} = 1 - P_d = 1 - Q\left(\frac{\gamma - (P+\sigma_n{}^2)}{\sqrt{2(P+\sigma_n{}^2)^2 / N}}\right) \tag{2.14}$$

where Q (•) denotes the Gaussian complementary cumulative distribution function (CDF). Pd, Pf, and Pm denote the probability of detection, false alarm and missed detection, respectively. As a result, N, the number of samples, is given in Equation 2.15.

$$N = 2\left[Q^{-1}(P_f) - Q^{-1}(P_d)\right]^2 (SNR)^{-2} \tag{2.15}$$

where $SNR=P/\sigma_n^2$ and σ_n^2 is the normalised noise power.

2.8 Spectrum Prediction Techniques

In cognitive radio networks, primary user activity prediction, channel state prediction, transmission rate prediction, and radio environment prediction are all challenging issues to solve. Spectrum prediction provides benefits such as reduced sensing time, robust and flexible channel selection, and a proactive handover strategy to minimise collision with a licensed user (Jain and Goel, 2017). Spectrum prediction enhances bandwidth efficiency, dependability, and scalability while reducing spectrum sensing time.

2.8.1 Prediction based on Bayesian Inference

The Bayesian inference method is a statistical inference method based on Bayes' theorem. Bayes' theorem is used to update the probability of a hypothesis as more data becomes available. A method for predicting channel quality is proposed. The Nonstationary Hidden Markov Process (NSHMM) is used to model the spectrum sensing process while Bayesian inference with Gibbs sampling is used to estimate the model and model parameters (Xing *et al.,* 2013a). The secondary user can select a channel with good quality by modeling the channel status with NSHMM and proposing a channel quality evaluation scheme. This system also takes into account the secondary user's preferences. As a result of the method, each channel is assigned a predicted channel quality and ranked. As a result, ordered sequence can be applied to both spectrum sensing and decision-making (Wang *et al.,* 2009).

2.8.2 Prediction based on Hidden Markov Model (HMM)

The Hidden Markov Model is a statistical model for characterising generative sequences that can be regarded as the underlying mechanism that generates an observable sequence. HMM can be used to examine and model sequential data or time-series in any field. A Markov-based channel-based prediction algorithm (MCPA) has been developed for dynamic spectrum allocation (Benmammar *et al*., 2013). Because channel occupancy state (whether the channel is active or idle) cannot be monitored directly in cognitive radio networks, it is hidden. The sensed results of secondary users are observed channel states. Different HMMs train themselves based on spectrum usage patterns, and the spectrum manager then decides which channel to use based on the likelihood of spectrum holes in different channel bands. Spectrum usage patterns are assigned binary values, with 0 denoting that the spectrum is idle and 1 denoting that the channel is in use by the primary user. These binary vectors are used to train various HMMs, which subsequently predict when spectrum holes will appear. The statistics on spectrum usage are believed to be Poisson distributed.

HMM-based channel state prediction was proposed to reduce the adverse effect of response delays due by hardware platforms (Ding *et al.,* 2018). During spectrum sensing, time delays are imposed, reducing spectrum use. As a result of inaccuracy in real-time spectrum sensing, transmission collision between the primary and secondary users may occur. Spectrum decisions based on channel state prediction can be a suitable strategy to address this problem because secondary users receive the results of both spectrum prediction and spectrum sensing. Selecting a channel that is both predicted and sensed to be idle may improve spectrum use efficiency.

In spectrum sensing, a high-order HMM was developed for prediction based on the Spectrum Sensing and Data Transmission (SSDT) delay (Brahmi *et al*., 2012). The parameters of a high-order HMM are computed using statistical methods. During sensing, the Fast Fourier Transform (FFT) is utilised to transform incoming signals into the frequency domain. The observed value is then computed from a number of frequency points within a single frequency band and sent to a high-order HMM. The output is the predicted state of channels for sensing slots. It also predicts the chances of each of the probable outcomes. The five forms of Markov models that are often employed are the first-order Markov model, N-order Markov model, Hidden Markov Model (HMM), Partially Observable Markov Decision Process (POMDP), and Variable Length Markov Model (VMM).

The first-order Markov model has the advantage of having a simple structure and a small number of estimated parameters. Nevertheless, it has the disadvantage of being able to predict the next time using only the present channel state information, resulting in a limited prediction effect (Xing *et al*., 2013b). To address this shortcoming, the N-order Markov model was proposed, which incorporates more historical data and improves the prediction effect over the first-order Markov model. However, it was discovered that as order increases, complexity exponentially increases, resulting in an increase in the model's prediction delay (Song *et al*., 2010).

An HMM-based spectrum state prediction method was proposed, which is widely used in cognitive radio network research, due to the first-order Markov model's lack of historical information consideration and the N-order Markov model's exponential growth complexity. The effect of cognitive radio communication has been awesome to the use of an HMM-based prediction model. To improve spectrum consumption, a three-state HMM prediction model was proposed as a solution. All of these methods, however, require that channel occupancy and idle time follow an exponential distribution, meaning that channel a priori information is complete, although the reality of these environments is frequently imperfect or unknown, limiting the usefulness of the HMM prediction method.

The Partially Observable Markov Decision Process (POMDP) was used to predict the channel state, which is useful for enhancing spectral efficiency and selecting the best channel access. POMDP can forecast the spectrum under imperfect conditions, but it has the drawbacks of high computing cost and inability to anticipate large amounts of data.

The Variable-Length Markov Model (VMM) is a tradeoff between the first-order Markov model and the N-order Markov model, which can handle the N-order Markov model's problem of exponential complexity increase while overcoming the first-order Markov model's problem of limited memory. The requirement to set an upper constraint on the model's scope, however, is a disadvantage. The model's prediction ability is greatly affected by the upper limit of the selection, although the more appropriate limit is typically difficult to get.

2.8.3 Prediction-based Autoregressive Model

The Linear Autoregressive Model states that the output is linearly dependent on the prior value of a stochastic variable. AR(p) denotes an autoregressive model of order p. In a linear AR model, the secondary user estimates model parameters using Yule-Walker equations, maximum likelihood estimation, or other methods. The previous observations are then fed into the prediction rule, which forecasts the system's future state (Jain, 2017).

A channel prediction model for a fading channel was proposed using a second-order ARM process and a Kalman filter. For spectrum hole identification, a Bayes risk criterion was designed that takes channel idle probability and threshold into account. The second-order AutoRegressive (AR2) model is used to create the channel variation model. The parameters are determined using the Yule-Walker technique. The Kalman filter is then used to predict the channel's state. For randomly distributed primary and secondary users, a centralised ALOHA system is being proposed. The Poisson distribution is assumed to govern the arrival of messages to the primary user. When there is only one PU channel and channel idle times are exponentially distributed, a classical M/M/1 queue situation occurs.

2.8.4 Prediction based on Moving Average Model

Exponential Moving Moving Average (EMA) or Exponentially Weighted Moving Average (EWMA)-based prediction is another name for EMA-based prediction. This exploits exponentially decreasing weighting factors. Recent observations are given more weight as the weighing factor for past data points decreases exponentially, but previous values are not fully ignored. To forecast a trend in a data set, moving average-based predictors are widely utilised. A sequence of data is fed into an order-k moving average predictor, which predicts the next value in the sequence based on the average of the preceding k values.

A secondary user can disregard sensing channels whose estimated energy level exceeds a predetermined threshold value indicating the presence of the primary user. A constant smoothing factor "a" describes the degree of weighting reduction in an EMA-based technique. The smoothing factor is a number that ranges from 0 to 1. Older observations would be discounted more as the value of a increases.

2.8.5 Prediction based on Artificial Neural Networks

Artificial neural networks (ANN) emulate actual brain cells in that they are made up of several interconnected processors called neurons. An ANN's architecture is made up of many neurons and the connections between them, which are grouped into layers. Different learning techniques are utilised to train an ANN model depending on the desired output and the type of neural network being used. Throughout the training phase, the learning algorithms are used to adjust the weights. When we have a limited understanding of the network, such as with cognitive radio networks, ANN can be quite useful for prediction. Various ANNs have been used to forecast the spectrum over time.

For modeling the performance of Cognitive Radio functions, a Multilayered Feed Forward Neural Networks (MFNN) was developed (Salau *et al*., 2013). Even with a large number of inputs and outputs, CR radio networks can train efficiently with MFNN. The back propagation algorithm is used to train MFNN using a subset of the information obtained. Prior knowledge of the traffic characteristics of the main users' channel is not required for the deployment of a Multilayer Perceptron (MLP) predictor (Agarwal *et al*., 2016a). A binary series prediction problem is defined as the difficulty of predicting the state of a channel. A binary series is used to gather input and output for each channel by detecting the channel status for duration T in each slot. MLP is trained to forecast the channel state in the future slot using binary series based on the slot status history.

Secondary users are expected to split the PU channel into multiple time intervals as needed. PU traffic is assumed to follow the Poisson pattern on any channel. A Time Division Neural Network is a Feed-Forward (TDNN) network with a delay line as the network input. The RNN is a back propagation network having a feedback connection between its output and input. The sigmoid function is applied to the neurons in the hidden layer and output layer. The BP algorithm is used for learning, and the Mean Squared Error (MSE) is used as a performance metric.

The neural networks and support vector machines are the key components of the machine learning prediction model. The neural network prediction model has a great self-learning capability. When there is a high degree of non-linearity and excellent pattern categorisation abilities, the prediction effect is enhanced. However, the inherent weaknesses in the neural network prediction model lead to challenges like easy learning and generalisation in model training, as well as the need for a large amount of training data to attain high prediction accuracy.

2.9 Motivation for Artificial Neural Network (ANN)

A basic ANN consists of nodes, which are simple processing components that are connected together. The Feed Forward Neural Network (FFNN) is the most common technique of layout, in which nodes are arranged in layers and linked together by synaptic weight connections to construct structures.

The two kinds of layers are the hidden layer and the output layer that make up a standard ANN framework. The first interface is the input node, which is passive in nature. This is where data is fed into the network. The hidden layers are positioned between these two layers, and the output layer is another interface via which processed data is released from the network. Except for the input layer, each layer has one or more processing units. A processing unit is made up of an adder and an activation function. By adding the weighted input values, the adder computes the input to the activation function. Activation functions that transform the input to a new output range include sigmoid, tanh, linear, cubic, and radial. There are weights on either side of the processing unit in the hidden layer (left and right sides). These weights are changed during the training phase to ensure that the inputs produce an output that is near to the target value (Hu and Hwang, 2002). Weights between nodes in two successive layers are interconnected, but no nodes in the same layer are connected. ANN is an effective tool for estimating, categorising, and forecasting some nonlinear systems due to the large number of connection weights and nonlinear activation functions.

2.10 Ensemble Modeling

Ensemble modeling is a machine learning technique in which two or more different models are used to predict a result, either by employing a variety of modeling techniques or using a variety of training data sets the ensemble model integrates several base model's predictions to obtain a final forecast for unknown data. The basic goal of using ensemble models is to reduce the generalisation error of predictions. When using the ensemble approach, as long as the basic models are diverse and independent, the model's prediction error reduces (Re and Valentini, 2012). The integration of different models can be an effective approach of increasing their predictive accuracy, according to both theoretical and empirical studies, especially when the models in the ensemble are somewhat distinct.

2.11 Comparison of Measurement Campaigns

Table 2.2 shows a comparison of some work done in spectrum measurements showing the type of measurement, frequency range or band and the metrics used. These previous works have focused more on the cellular bands and higher frequencies. Only a few focused specifically on the TV band and hence, this research will focus specifically on TV band. There are various reasons why the TV spectrum should be used for secondary purposes. For example, the majority of the TV spectrum offers good propagation qualities for wireless communication over large distances. Second, television broadcast systems have a huge amount of spectrum dedicated to them. So secondary usage of this spectrum can provide significant additional capacity, particularly for rural dwellers. Finally, because of their generally static network design, open standards, and public access to information related to TV transmitters, TV broadcast systems are quite simple.

Table 2.2: Meta-Analysis

Location	Type	Frequency Range/Band	Metrics used	Reference
China	Outdoor	20 MHz to 3 GHz	Occupancy	Liang *et al.,* 2011
Europe	Outdoor	400 MHz to 3 GHz	Occupancy, Duty Cycle	Valenta *et al.,* 2010
	Outdoor	400 MHz to 7.2 GHz	Power	Petrin and Steffes, 2005
	Outdoor	Wi-Fi Band	Occupancy	Biggs *et al.,* 2004
	Outdoor	GSM Band	Occupancy	Blaschke *et al.,* 2007
Germany	Indoor/Outdoor	20 MHz to 6 GHz	Duty Cycle	Wellens *et al.,* 2007
India	Outdoor	TV/Cellular/ISM	Occupancy	Agarwal, *et al.,* 2016
Japan	Indoor/Outdoor	90 MHz to 3 GHz	Occupancy, Duty Cycle	Contreras *et al.,* 2011

Morocco	Outdoor	UHF/VHF	Duty Cycle	Btissam *et al.,* 2016
New Zealand	Indoor/Outdoor	806 MHz to 2.75 GHz	Duty Cycle	Chiang *et al.,* 2007
Nigeria	Outdoor	TV and Cellular	Duty Cycle	Babalola *et al.,* 2015
Nigeria	Outdoor	2.4-2.7 GHz	Duty Cycle	Adeseko *et al.,* 2016
Nigeria	Indoor	700 MHz- 2.4 GHz	Duty Cycle	Najashi *et al.,* 2015
Nigeria	Indoor	700 MHz- 2.5 GHz	Duty Cycle	Najashi *et al.,* 2013
Singapore	Outdoor	80 MHz to 5.85 GHz	Duty Cycle	Islam *et al.,* 2008
South Africa	Indoor	TV	Occupancy	Mauwa *et al.,* 2016
Spain	Outdoor	75 MHz to 3 GHz	Power, Occupancy, Duty Cycle	Lopez-Benitez *et al.,* 2009a
UK	Indoor/Outdoor	75 MHz to 3 GHz, Cellular, UMTS, ISM	Duty Cycle	Palaios *et al.,* 2012
UK	Outdoor	100 MHz to 2500 MHz	Time-series	Wang and Salous, 2009
USA	Outdoor	108 MHz to 19.3 GHz	Power	Sanders (1998)
USA	Outdoor	30 MHz to 3 GHz	Power, Occupancy, Duty Cycle	McHenry *et al.,* 2006, McHenry *et al.,* 2015, Roberson *et al.,* 2006, Bacchus *et al.,* 2008
	Indoor/Outdoor	20 MHz to 6 GHz	Power, Duty Cycle	Wellens *et al.,* 2007
USA	Outdoor	Public Safety Band	Occupancy	Bacchus *et al.,* 2010
	Outdoor	Public Safety Band	Occupancy	Jones *et al.,* 2007
	Outdoor	700 MHz to 3 GHz	Power	Qaraqe *et al.,* 2009
USA	Outdoor	100 MHz to 500 MHz	Power	Schiphorst and Slump, 2010
	Outdoor	300 MHz to 4.9	Occupancy,	Harrold *et*

		GHz	Duty Cycle	*al.,* 2011
USA	Outdoor	30 MHz to 6 GHz	Occupancy	Taher *et al.,* 2011

2.12 Dimensionality Reduction

The process of translating data from a high-dimensional space to a low-dimensional space while ensuring that the low-dimensional representation retains the majority of the original data's relevant features, ideally as close to its intrinsic dimension as possible is known as dimensionality reduction. It is a technique used to ensure data is fit for modeling. Working in high-dimensional spaces is not advisable and may result in a situation where analysing the data becomes computationally intractable. When the features in data are huge, it suffers from what is known as the "dimensionality curse". The curse of dimensionality usually makes learning for a model difficult. This presents a number of difficulties, including processing and data visualisation with large numbers of features; it also increases the feature space and causes issues with training models, memory, and space constraints. At instances when representations are redundant and the variables are correlated only a small subspace of the original representation space is populated by the sample and by the underlying process.

Each frequency is the feature in the data (which is the column). The problem of the curse of dimensionality in a dataset can be solved by gaining insight into the data using the technique of Exploratory Data Analysis (EDA). Python programming language can perform EDA on datasets because it has a wide array of machine learning routines with an enormous library. Also, it has a high range of mathematical, statistical and machine learning tools and is very close to machine language.

When EDA reveals that data features are highly correlated, it implies or suggests that much more reduced features prevail in comparison with what was contained in the original dataset. The technique of reducing the features of the research data to ensure that data is fit for model learning or training is essential.

2.13 Data Analysis using Principal Component Analysis (PCA)

One solution to the problem of the curse of dimensionality on a dataset is Principal Component Analysis (PCA) which is a method of analysing data. PCA is a dimensionality reduction technique in Feature Engineering. Feature Engineering is not just about feature reduction, it is also about creating, replacing, deleting, condensing, or combining features. Feature Engineering can reduce the dimensions of the features to a reasonable number. PCA is an unsupervised linear method and a lower-dimensional representation from the original data which describes a large proportion of the variance in the data. PCA is a procedure for reducing the dimensionality of the variable space by representing it with a few orthogonal (uncorrelated) variables that capture most of its variability.

PCA can identify data patterns by showing the similarities and differences between them. Patterns are difficult to identify in high-dimensional data, especially where the luxury of graphical representation is not available and as a result, PCA becomes a very effective data analysis tool in such situations. Once patterns are found in the data, the dimensions are reduced appropriately and there will be no much loss of information.

2.14 Correlation Analysis

The correlation coefficient is an estimate of how closely two features X and Y agree. Correlation analysis looks at each pair of variables to see if they tend to move in the same direction or not. Any value between -1 and 1 may be used for correlation coefficient. The term "positive correlation" refers to the relationship between two variables in which both variables move in the same direction. A positive correlation exists when one variable decreases as the other decreases or one variable increases while the other increases. A negative correlation coefficient is a relationship between two variables in which one variable increases as the other decreases whereas a correlation of zero indicates that the variables are unrelated. Equation 2.16 gives the bivariate correlation (Asuero *et al.*, 2006).

$$Cor(X,Y) = \frac{\left[\sum\left(x-\bar{x}\right)\left(y-\bar{y}\right)\right]}{\sqrt{\sum\left(x-\bar{x}\right)^2\sum\left(y-\bar{y}\right)^2}} \tag{2.16}$$

where

x is values for x-variable in a sample

$\bar{x}$ is the mean of values for the x-variable

y is values for x-variable in a sample

$\bar{y}$ is the mean of values for y-variable

The correlation matrix of a vector $X=(X_1, X_2,\ldots X_n)^T$ is a square matrix containing as elements the correlation of all pairs of elements of the random vector X and given as shown in Equation 2.17 (Pham-Gia and Choulakian, 2014).

$$R_{XX} = \begin{bmatrix} E[X_1X_1] & E[X_1X_2] & \ldots\ldots & E[X_1X_n] \\ E[X_2X_1] & E[X_2X_2] & \ldots\ldots. & E[X_2X_n] \\ . & & \ldots\ldots. & \\ . & & & \\ E[X_nX_1] & & \ldots\ldots. & E[X_nX_n] \end{bmatrix} \tag{2.17}$$

For time-series data $y_1, y_2,\ldots y_n$, the autocorrelation function at lag k is defined as shown in Equation 2.18 (Hasanni *et al*., 2012).

$$r_k = \frac{\left[\sum_{i=1}^{n-k}(y_i - \alpha)(y_{i+k} - \alpha)\right]}{\left[\sum_{i=1}^{n}(y_i - \alpha)^2\right]} \tag{2.18}$$

for a parameter $1 \leq \text{max lag} \leq n$.

Finding the projections that maximise the variance gives Principal Components. The direction in feature space along which projections have the most variance is the first principal component. The direction having the greatest variance across all orthogonal directions to the first is the second main component. PCA is a mathematical procedure that uses an orthogonal transformation to transform a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principle components. The number of primary components is less than or equal to the number of original variables. The first principal component has the offers the highest variance, and each succeeding component has the highest possible variance while remaining orthogonal to the previous components.

PCA decomposes multivariate attribute variation into non-correlated components, each of which is a linear composition of the original variables. The extracted non-correlated components are generated from the eigenvectors of the covariance matrix of the original variables, and are referred to as Principal Components (PC). The purpose of PCA is to achieve parsimony and reduce dimensionality by extracting the fewest number of components that account for the most of variation in the original multivariate data and summarizing it with minimal information loss.

If the original multivariate dataset is unavailable, PCA extractions can be performed using the covariance matrix. The correlation matrix can be used instead of the covariance matrix to compute PC when different variables in the data set are measured in different units or have different variances. Using the correlation matrix is the same as setting the variables' mean to zero and unit standard deviation. Equation 2.19 can be used to represent the PCA model.

$$Y_{mx1} = W_{mxd} X_{dx1} \qquad (2.19)$$

where Y is a projection of x and the original d-dimensional data vector (d>>m) and is an m-dimensional vector. W is a (mxd)-dimensional matrix. The eigenvectors $e_1, e_2, \ldots, e_m$ of the data set's covariance matrix K, which correspond to the m largest non-zero eigenvalues 1, 2,..., m, produce the m principal axes, which maximise the variance of Y. The covariance matrix is shown in Equation 2.20.

$$K = \frac{\sum_{i=1}^{n} (x - \mu)(x - \mu)^T}{n - 1} \quad (2.20)$$

where μ is the mean of vector x.

In matrix form the covariance matrix is as shown in Equation 2.21(Pham-Gia and Choulakian, 2014).

$$Cov = \begin{bmatrix} Cov[X_1 X_1] & Cov[X_1 X_2] & \ldots\ldots & Cov[X_1 X_n] \\ Cov[X_2 X_1] & Cov[X_2 X_2] & \ldots\ldots\ldots & Cov[X_2 X_n] \\ . & & & \\ & & \ldots\ldots\ldots & \\ . & & & \\ Cov[X_n X_1] & & \ldots\ldots\ldots & Cov[X_n X_n] \end{bmatrix} \quad (2.21)$$

The eigenvectors e_i can be found in Equation 2.22.

$$(K - \lambda_i I)e_i = 0 \quad (2.22)$$

where λ_i is the eigenvalues of matrix K.

The eigenvectors are ranked by the magnitude of the corresponding eigenvalues, and the m vectors with the highest eigenvalues are selected. Equation 2.23 shows how to compute the PCA projection matrix.

$$W = E^T \quad (2.23)$$

The m eigenvectors are the columns of E and W is a mxd matrix in this case.

2.15 Research Gap

In Nigeria, the TV band has not received enough attention in spectrum occupancy work and specifically the VHF sub-band. There is no specific work that focused on the VHF band despite the enormous attractive features of this band thereby, creating a gap for this work. There was no prediction model developed for the spectral occupancy usage specifically for the VHF band. This work, therefore, proposes to develop a spectrum occupancy prediction model for Cognitive Radio systems using the ensemble technique of Auto-Regressive Neural Network (ARNN).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Methodology Adopted

Modeling and prediction of wireless spectrum usage are essential and of great benefit to spectrum sensing procedures. Secondary Users can find the channel status prediction information useful in deciding the channels that are vacant and can be opportunistically used without causing collision to the Primary User. Furthermore, depending on the prediction status, the Secondary Users switches transmission to channels having a lower probability of occupancy. Accurate prediction of the activities of the PU can assist the SU in decision on its transmission and infact completely eliminate the spectrum sensing procedures.

Spectrum data measurement was done in this work. The experimental analysis and fieldwork were carried out using Aaronia Spectrum Analyser in three different sites each in Minna, Niger State and Abuja, FCT to determine spectrum occupancy statistics. For the sites in Minna, the minimum distance between these three sites is 5 kilometers while the three sites in Abuja have a minimum distance of 20 kilometers apart. The frequency measurement range is from 30-300 MHz (VHF Band) and measurement was done for 24 hours in each location.

The block diagram for the methodology adopted in this work is shown in Figure 3.1.

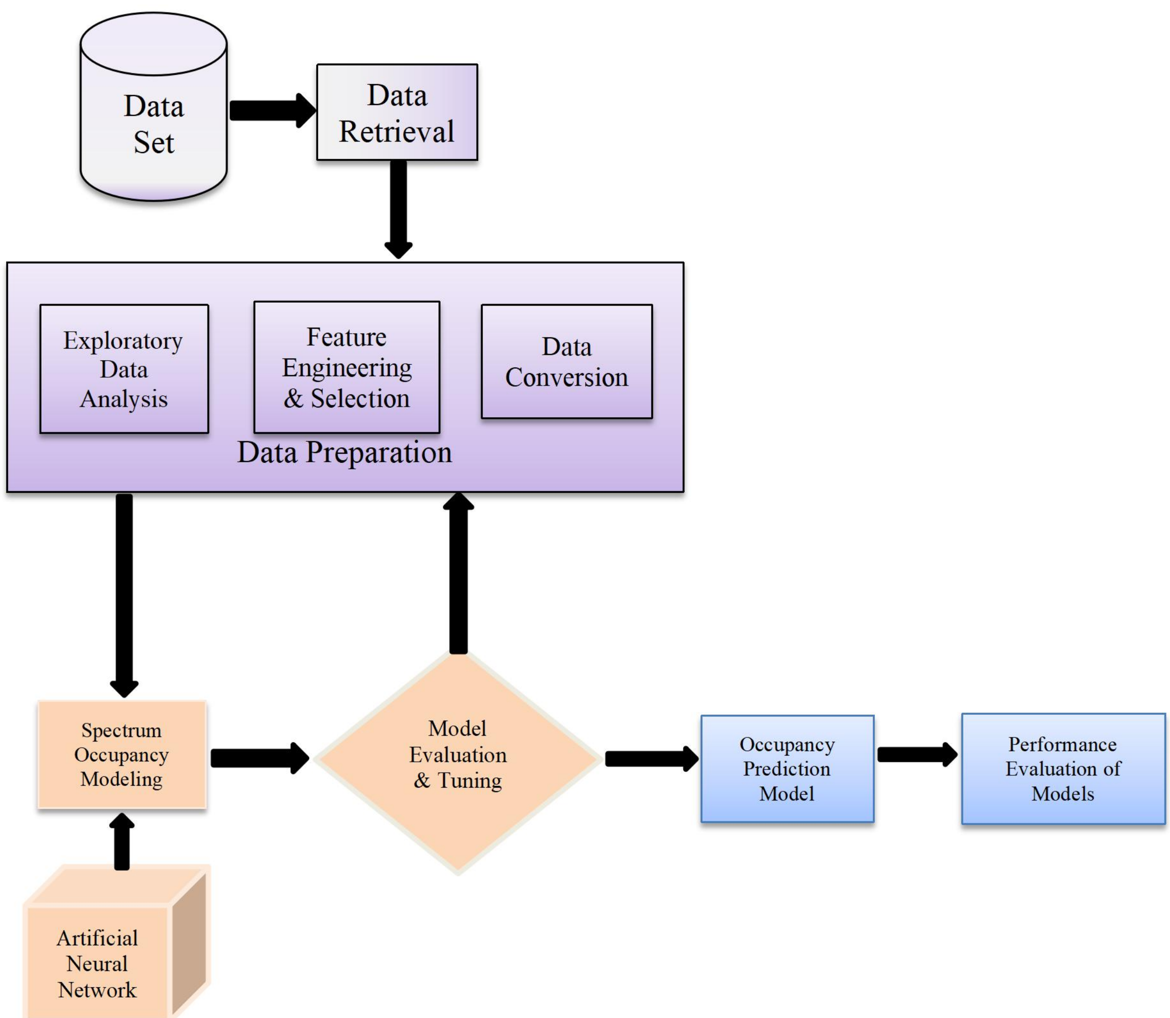


Figure 3.1: Block diagram of Methodology adopted

3.2 Measurement Locations and Sites

A careful choice of a measurement location is essential for a good spectrum measurement campaign. The location site chosen has an impact on the spectrum occupancy measurement. A site for spectrum measurement demands that:

1. Transmitters around the measurement location are minimal to avoid intermodulation and saturation challenges.
2. There should be minimal impulsive noise due to vehicular movements and electrical machines which can increase the signals received.

Bearing in mind these conditions, measurements were taken in six sites; three in Minna, Niger State, and three in Federal Capital Territory, Abuja as shown in Table 3.1.

Table 3.1: Measurement Sites and Locations

Sites	Location Code	Location	Geographic Coordinates	
			Latitude (°)	Longitude (°)
GK	1	Minna, Niger State, Nigeria	9.53469484 (9° 32′ 4.90′′N)	6.44827999 (6° 26′ 53.81′′E)
AEDC	2	Minna, Niger State, Nigeria	9.61195620 (9° 36′ 43.04′′N)	6.55071664 (6° 33′ 2.58′′E)
Tunga	3	Minna, Niger State, Nigeria	9.60074163 (9° 36′ 2.67′′N)	6.57261427 (6° 34′ 21.41′′E)
Kubwa	4	FCT, Abuja, Nigeria	9.00077653 (9° 0′ 2.80′′N)	7.46699567 (7° 28′ 1.18′′E)
Gudu	5	FCT, Abuja, Nigeria	9.16572750 (9° 9′ 56.62′′N)	7.32948389 (7° 19′ 46.14′′E)
Maitama	6	FCT, Abuja, Nigeria	9.07817990 (9° 4′ 41.45′′N)	7.50073397 (7° 30′ 2.64′′E)

The corresponding Google maps of these locations are shown in Plates I – VI.

Plate I: Google Map of Measurement Location (GK, Minna, Niger State)

Plate II: Google Map of Measurement Location (AEDC, Minna, Niger State)

Plate III: Google Map of Measurement Location (Tunga, Minna, Niger State)

Plate IV: Google Map of Measurement Location (Kubwa, FCT, Nigeria)

Plate V: Google Map of Measurement Location (Gudu, FCT, Nigeria)

Plate VI: Google Map of Measurement Location (Maitama, FCT, Nigeria.)

3.3 Measurement Equipment

The setup of equipment used for measurement in this work is an Aaronia spectrum analyser model HF-6065 V4 which has a frequency range between 10 MHz to 6 GHz, and Omnidirectional antenna with frequency range between 10 MHz to 3 GHz, a laptop that is connected via USB cable to the spectrum analyser and an MCS software which acts as an interface between the spectrum analyser and the laptop. The MCS software is used for adjusting and tuning of control knobs and is designed specifically to run on Aaronia Spectrum Analyser. The laptop is a Dell vPro laptop with 14-inch diagonal Intel (R) Core (TM) i7 – 6600U CPU and webcam TrueVision HD Camera @ 2.60 GHz 2.81 GHz processors with 8.0 GB (7.89 GB usable) RAM and runs on 64-bit windows 10 operating syetem, enterprise edition. The entire equipment was powered with an 850VA power inverter with a battery of 200AH. The setup is as shown in Plate 3.7 while the block diagram is shown in Figure 3.2.

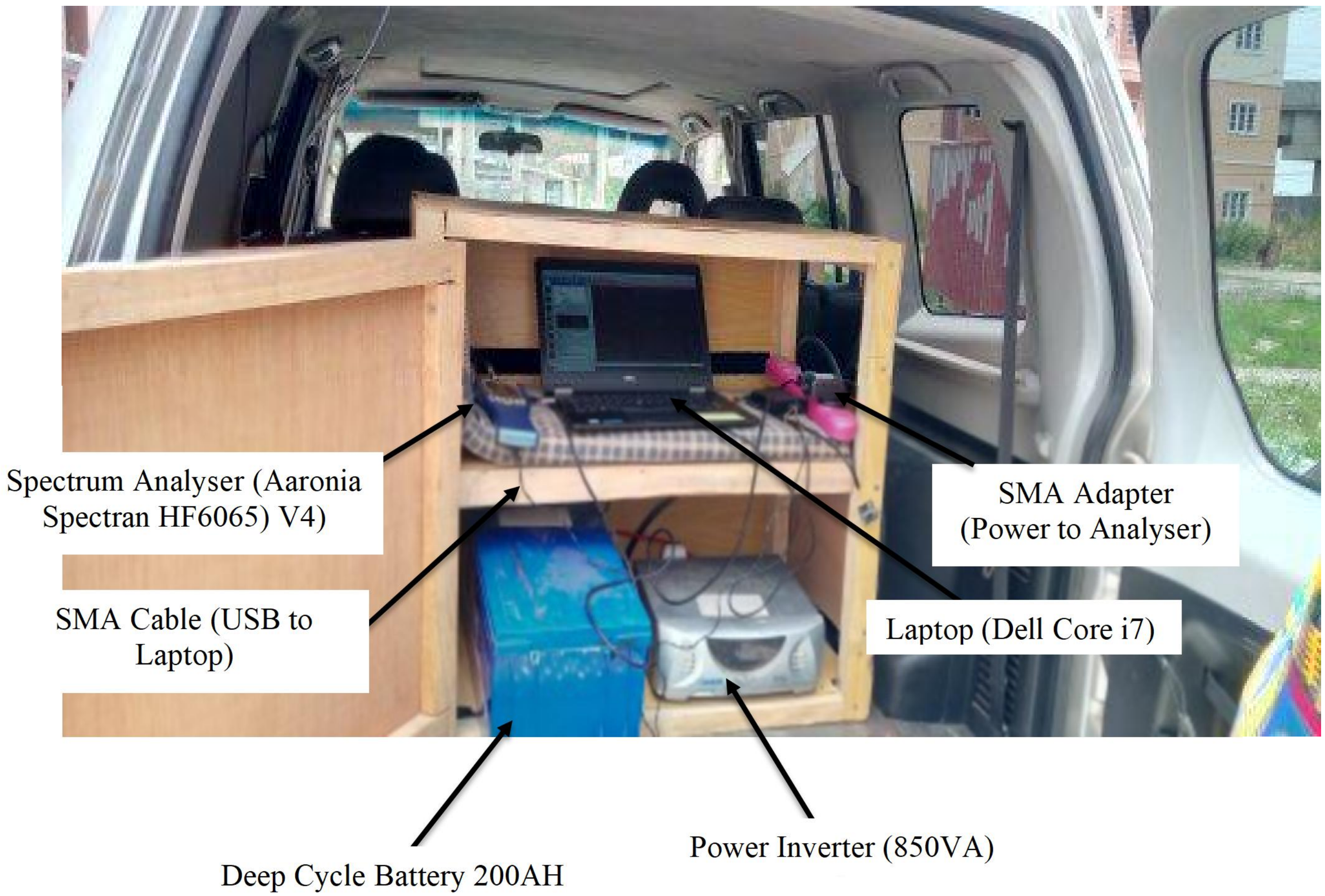


Plate VII: Measurement Setup

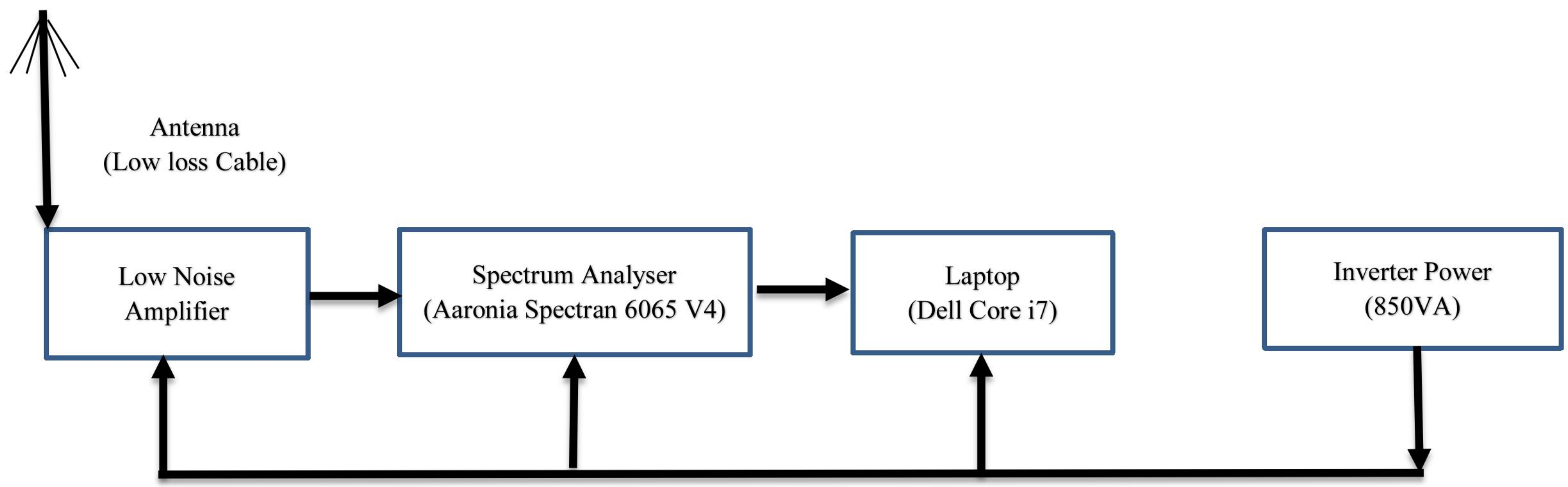


Figure 3.2: Block diagram of Measurement System

The frequency measurement range for this research is 30-300 MHz and data capture was done for 24 hours before spectrum data analysis was carried out. The spectrum analyser sweeps through the entire spectrum band and captures PSD signals which are captured and recorded by the MCS software and stored in the laptop in a matrix form. Finally, the captured data were processed using MATLAB version R2018a by computing the occupancy status of the frequency sub-bands. The parameter configuration of the spectrum analyser is shown in Table 3.2.

Table 3.2: Parameter Configuration of Spectrum Analyser

Parameter	Value
Frequency Range of the Analyser	10 MHz-6 GHz
Frequency Range of the Antennae	10 MHz-3 GHz
Frequency Range for the Study	30-300 MHz
Resolution Bandwidth (RBW)	100 kHz
Video Bandwidth (VBW)	100 kHz
Sweep Time	15.13 sec
Detection Type	RMS
Number of trace Points	5401
Attenuation Factor	Auto

Data gathered spanned a period T_{span} of 24hours with frequency span F_{span} of range 270 MHz. Given that N_{points} is the number of frequency points captured by the spectrum analyser, then the discrete frequency point f_n in the range of F_{span} is given by Equation 3.1.

$$f_n = f_{start} + (n-1).f_r \qquad n = 1,2,3..........,5401 \qquad (3.1)$$

where

F_{Start} is 30 MHz

f_r is the frequency resolution and is given by Equation 3.2

$$f_r = \frac{f_{span}}{N_{points}} \tag{3.2}$$

F_{span} is 270 MHz and N_{points} is the number of tracepoints which is fixed at 5401.

$$f_r = \frac{270 \times 10^6}{5401} = 49.990\,\text{kHz}$$

3.4 Spectrum Data Collection and Processing

The outdoor measurement was taken for 24 hours in each of the six sites. Spectrum Analyser was used to collect raw data as represented in a matrix form shown in Table 3.3 with $P_{i,j}$ being the elements of the received signal powers in dBm (decibel milliwatts) while time slots and frequency were stored in rows and columns respectively. A total of Thirty Million, Eight Hundred and Fifty Thousand, Five Hundred and Twelve (30,850,512) data elements were captured by the spectrum analyser for each site and saved into a file with a .csv extension. Processing of the measurement samples was done to get the necessary parameters for building a spectrum occupancy model. Appendix A shows some samples of Power Spectral Density (PSD) data captured for all six sites.

Table 3.3: Matrix for the Power Spectrum Data

$P(t_i,f_1)$	$P(t_i,f_2)$	…..	$P(t_i,f_j)$
$P(t_2,f_1)$	$P(t_2,f_2)$	…..	$P(t_2,f_j)$
…..	…..	…..	…..
$P(t_i,f_1)$	$P(t_i,f_2)$	…..	$P(t_i,f_j)$

3.5 Data Analysis with Power Density Plots

The research dataset has a huge dimension of features (columns) that will make learning for a model difficult. To solve the dimensionality challenge, power density plots of each frequency was done. A density plot is a smoothed, continuous form of a histogram computed from data that indicates how each frequency and power (measured in decibel milliwatts) are distributed. The x-axis represents the variable power in dBm, while the y-axis represents the density estimate of the probability density function. On the x-axis, the probability density is expressed as probability per unit. The probability density function of a normal distribution is given by Equation 3.3.

$$f(x) = \frac{1}{\sqrt{\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (3.3)$$

where

x is the value of a variable

μ is the mean and

σ is the variance

Appendix B shows a sample of the power density plots for each frequency. Visual observation was used to group the plots by combining plots with similar structures. After the groupings, 12 distinct sub-bands emerged as shown in Table 3.4.

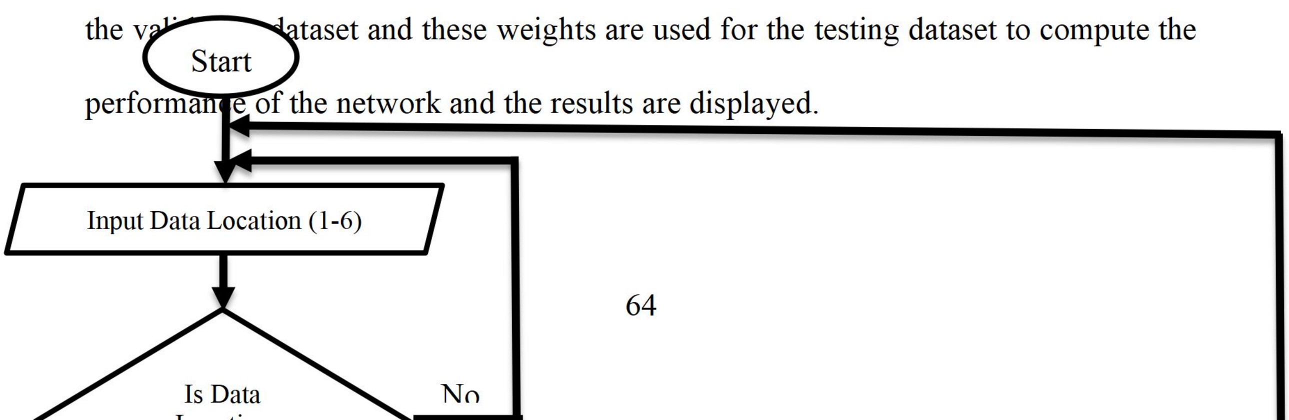
Table 3.4: Frequency Groupings based on Power Density Plots

Frequency Sub Band	Frequency Range (MHz)
Band 1	30 – 47
Band 2	47.05 – 68
Band 3	68.05 - 74.80
Band 4	74.85-87.45
Band 5	87.5-108
Band 6	108.05 – 137
Band 7	137.05 – 144
Band 8	144.05 – 174
Band 9	174.05 – 200
Band 10	200.05 – 230
Band 11	230.05 – 267
Band 12	267.05 – 300

3.6 Model Design and Development

The selection of the optimal network design, network topology, data format, training method, training parameters, and terminating criteria in order to achieve the network's maximum performance level is known as model development with neural networks. Without the need to define the relationship between inputs and outputs, ANNs can address highly nonlinear situations. They are a system of interconnected nodes and which act in a similar way as the human brain. An important benefit of ANN models over other types of nonlinear models is that they are universal approximators capable of approximating a large class of functions with excellent accuracy. The model building method does not necessitate any prior assumptions about the model structure.

The flowchart of the model developed is shown in Figure 3.3. Data location code with value between 1 to 6 is first inputed based on the sites where measurements were taken. Thereafter, the frequency code with a value between 1 to 12 is inputed based on the frequency groupings done. The k-means clustering algorithm computes the threshold and this is applied to the data so that the data can be separated into either noise or signal. A random sample of feature vector (70%) is extracted from data for the prediction of occupancy and passed to the neural network for the training of the developed model. 15% of the feature vector is for validation dataset and another 15% for testing dataset. Extraction of the AR weights is done when the MSE is lowest for the validation dataset and these weights are used for the testing dataset to compute the performance of the network and the results are displayed.



Yes

Figure 3.3: Flowchart of the ARNN Model

The time-series data is converted into a feature vector which is captured as time instances of the occupancy of all the frequency bands considered. This serves as the input vector into the feedforward neural network. The weight of the neural network is improved using an AR model whose order is based on the time dimension of the feature vector. Algorithm for the Autoregressive Neural Network (ARNN);

1. Gather PSD data for the frequency range 30-300 MHz (VHF band).
2. Split data based on the sub-bands groupings of the power density plots.
3. Apply K-means clustering algorithm to determine the threshold for spectrum occupancy.
4. Generate occupancy rates.
5. Feature Matrix Extraction.
6. Split Feature Matrix into Training (70%), Validation (15%), and Testing (15%) randomly.
7. ARNN Model Development using appropriate hyperparameters.
8. Train the Model.
9. Generate prediction results.

3.6.1 Data Conversion and Threshold Determination using K-Means Clustering Algorithm

The input signal data is a time-series data of signal strength obtained at different locations for frequency points ranging from 30 to 300 MHz at a frequency resolution of 0.05 MHz. Thus for each frequency point, 238 samples were obtained hourly. This was repeated for twenty-four hours in six different locations. To determine the occupancy level of the frequency bands, k-means clustering algorithm was initiated to segment the data into signal and noise. It automatically learns the data to determine a partitioning threshold which is used to detect the presence of a signal. The flowchart of the k-means clustering is as shown in Figure 3.4.

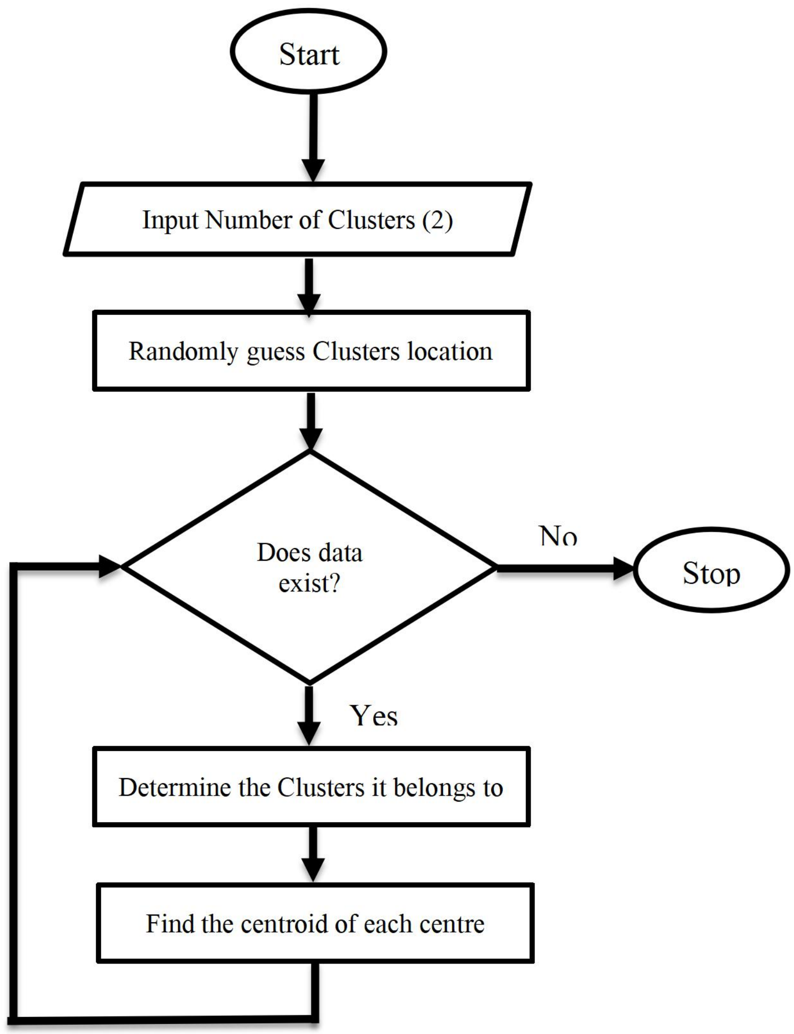


Figure 3.4: Flowchart for K-means Clustering

In finding the cluster each data point belongs to, the k-means algorithm minimises the Euclidean distance from the data point to each of the cluster centers.

3.6.2 Computation of Spectrum Occupancy

The acquired data matrix is shown as the received signal power in dBm at a particular time instance and frequency point as shown in Equation 3.12.

$$A = \left[A(t_i, f_j) \right] \tag{3.12}$$

where

i=1,2,…,I is the number of discrete-time instants (rows) and

j = 1,2…,J. is total number of frequency points (columns).

In this case, I = 5712 and J = 5401.

The frequency step is 0.05 MHz along with the columns while the steps for the time along the rows is 15secs. To compute the occupancy, each component of the matrix in Equation 3.12 is separated based on the threshold from the clustering algorithm. A new matrix Q is formed according to the obtained threshold as shown in Equation 3.13.

$$Q(t_i, f_j) = \begin{cases} 1, if A(t_i, f_j) \geq \lambda \\ 0, if A(t_i, f_j) < \lambda \end{cases} \tag{3.13}$$

The occupancy spectrum at the jth frequency point (along the column) is as shown in Equations 3.14.

$$Occupancy(t_i, f_j) = \frac{\sum_{i=1}^{I} Q(t_i, f_j)}{J} \tag{3.14}$$

3.6.3 Artificial Neural Network Model Design

The ANN is made up of three layers: input, hidden layers, and output. ANN models were used to estimate functions and parameters by training a large proportion of datasets known as the training dataset. Neural Networks have the ability of performing complex nonlinear modeling of relationships without having a prior understanding of the underlying structures. The topology of the ANN consists of fully interconnected processing nodes with no interconnections between the nodes within the same layer.

3.6.4 Model Design of Input Layer

The input layer is the time-series of the feature vector for the hourly spectral occupancy.

For a new data input A, (A is not part of the ANN training process), the percentage occupancy can be obtained using the following model:

The occupancy of the j^{th} frequency point in the data can be obtained from Equation 3.15.

$$Occupancy(j) = \left[\sum_{k=1}^{N} w_j(k)\phi_j(k) \right] \text{x}\, 100 \tag{3.15}$$

where w_j is the weight vector of the j^{th} frequency point, $k = 1,2,..N$ and $N = 24$ (24 hours). ϕ_j is the input vector of the j^{th} frequency point obtained from A given as Equation 3.16.

$$\phi_j = \frac{\sum_{i=1}^{I} Q(t_i, f_j)}{\text{I}} \tag{3.16}$$

where I is the number of samples obtained from the time-series data in an hour, t_i is the index of the time-series data. Similarly,

$$Q(t_i, f_j) = \begin{cases} 1, if A(t_i, f_j) \geq \lambda \\ 0, if A(t_i, f_j) < \lambda \end{cases} \tag{3.17}$$

3.6.5 Artificial Neural Network Structure Design

It is critical to determine the ideal value of the hidden layer neurons for a good ANN network topology since it has a significant impact on network performance. An excessively high amount of neurons will lead to overfitting. Neural networks are trained with distinct, progressively varying numbers of neurons in the hidden layer to achieve the optimal number of neurons. The network structure with the least value of neurons with reference to the validation dataset is therefore chosen. Two different learning algorithms were chosen and the performances observed as the number of hidden neurons were increased gradually from 3, 5, 10, 15 and 20 neurons. The two training algorithms are Levenberg Marquardt (LM) training function and Scaled Conjugated Gradient (SCG) backpropagation.

Figure 3.5 summarises the results of training the network using these two different training algorithms and shows that successively increasing the number of hidden neurons above ten impacts negatively on the network performance (that is, MSE). Above ten hidden neurons the MSE increases again. Therefore ten hidden neurons is the optimum number of neurons and was used in this work. Comparing the performance of the two training algorithms, the LM algorithm outperforms the SCG as it generally has a lower MSE value for both the training and validation data set.

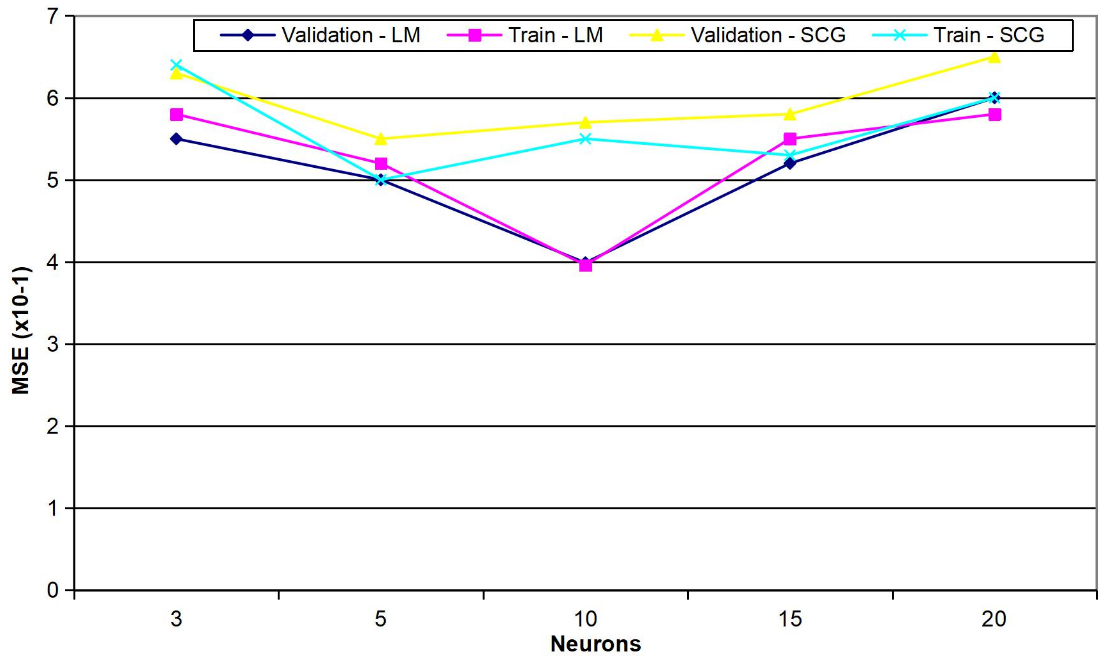


Figure 3.5: MSE results of Validation and Training dataset

The network with ten neurons and an LM-training process was chosen as the structure of the developed model based on the results of the initial architecture and the problem of overfitting. The model's network structure is shown in Figure 3.6.

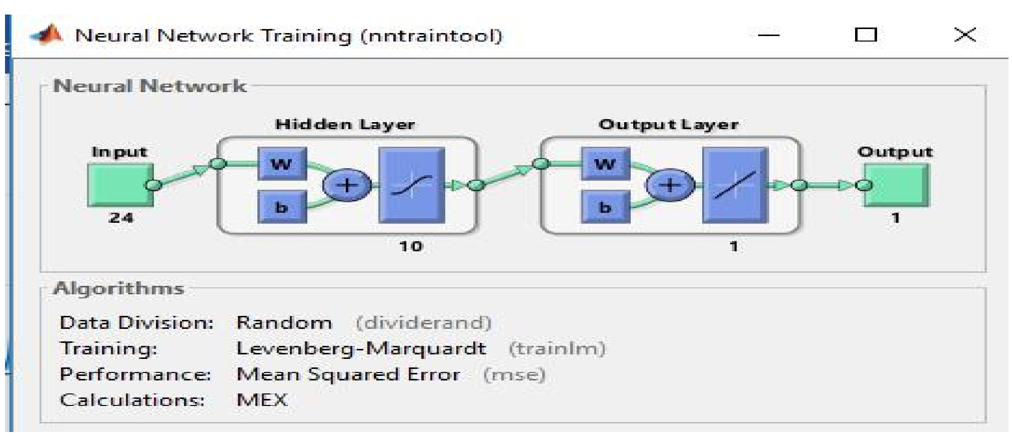


Figure 3.6: Network diagram in Neural Network Toolbox from MATLAB

The network architecture of the Neural Network consists of twenty four input samples and one target sample. The hidden layer has ten neurons while the output layer consists of only one node. For the algorithms, random data divisioning was used while for the training process, the Levenberg - Marquardt algorithm was used and MSE was chosen for the performance analysis.

The sigmoid activation with a scalar-valued bias in forecasting the current signal strength from the prior signal recorded was chosen as the activation function for the hidden layer node. The training data set has 119 patterns and the network is trained for 100 epochs. The network parameters of the ANN are shown in Table 3.5.

Table 3.5: Optimal Neural Network Parameters

Network Parameters	Value
Hidden layer	1
Input layer Neurons	24
Output layer Neuron	1
Hidden layer Neurons	10
Learning rate	0.001
Number of epochs	100
Adapt learning function	Trainln

The output is given by Equation 3.18.

$$y_t = g\left(\sum_i y_{t-1} w_{ij} + \beta_j\right) \tag{3.18}$$

where y_t is output from the j[th] node

y_{t-1} is the i[th] inputs

β_j is the bias of the j[th] node and

g(x) is the sigmoidal function given by Equation 3.19 (Jaiswal *et al.,* 2018).

$$g(x)=\frac{1}{1+e^{-x}} \tag{3.19}$$

The Autoregression model is a linear time-series model that predicts the value at a future time step using current and past observations as input to a regression equation. The weights of the hidden layer were tuned using Autoregression for faster convergence and model accuracy. Let autoregressive model, AR (*p*) of order *p* be given by Equation 3.20 (Aibinu *et al*., 2012).

$$x[n]=\sum_{t=1}^{p}\varphi_{i}x[n-i]+\varepsilon[n] \tag{3.20}$$

where,

φ_i = coefficients of each order of the model

p = model order

$\varepsilon[n]$ = white noise

$x[n]$ = output weights

$x[n-i]$ = input weights

In this case, model order, p is 24 and φ_i is derived from each unit weight of the weight matrix of the NN. Some samples of AR coefficients for the six sites are shown in Appendix C. The learning algorithm, using the training dataset (that is a sample of the entire dataset) trains the network based on the expected output for each received input. The weights are then modified by comparing the predicted output with the target output while minimising the loss function which is the Mean Squared Error (MSE) of the network. The MSE is given by Equation 3.21.

$$MSE = \frac{1}{n}\sum_{k=1}^{n}\left(y_t - y_p\right)^2 \tag{3.21}$$

where y_t and y_p are the target output and the predicted output vector of the k^{th} output node respectively. At the end of the training, the weights obtained are the best suited or the optimum for producing the best output.

Finally, an ANN model was used to estimate spectrum occupancy using an input vector of X and a hidden layer output vector of Y. The input layer to hidden layer weight matrix is V, and the hidden layer to output layer weight matrix is W. The output layer's output vector is O, the desired output vector is d, the input layer to hidden layer weight matrix is V, and the hidden layer to output layer weight matrix is W. Some samples of the input with 119 feature obtained from 238 samples of hourly spectrum occupancy rate are shown in Appendix D while some samples with weight matrix of the input layer connecting to the hidden layer are shown in Appendix E. The function of ANN is as shown in Equation 3.22.

$$Y_j = f\left(\sum_i w_{ij} x_{ij}\right) \tag{3.22}$$

If the predicted output is varied from the desired or expected output, the error E, is defined by Equation 3.23.

$$E = \frac{1}{2}(d - O)^2 = \frac{1}{2}\sum_{k=1}^{l}\left(d_k - O_k\right)^2 \tag{3.23}$$

When it is expanded to the input layer the result is as shown in Equation 3.24.

$$E = \frac{1}{2}\sum_{\mathrm{k}=1}^{1}\left\{\mathrm{d}_{\mathrm{k}} - f\left[\sum_{j=0}^{m} w_{jk} f\left(\sum_{i=0}^{n} v_{ij} x_i\right)\right]\right\}^2 \tag{3.24}$$

The error is determined by the weights w_{jk} and v_{ij} in the network input layers. The error E can be modified by adjusting the weights, and the purpose of weight change is to reduce error. As a result, the amount of weight should be proportional to the negative gradient of the error. As illustrated in Equations 3.25 and 3.25, different error signals should be defined for each hidden layer and output layer.

$$\partial_k^o = \frac{-\partial E}{\partial \mathrm{net}_{\mathrm{k}}} \tag{3.25}$$

$$\partial_j^y = \frac{-\partial E}{\partial \mathrm{net}_{\mathrm{j}}} \tag{3.26}$$

The weight adjustment of the BP neural network's learning process is determined after derivation, as illustrated in Equations 3.27 and 3.28.

$$\Delta W_{jk} = \eta \partial_k^o y_j = \eta(d_k - O_k)O_k(1 - O_k)y_j \tag{3.27}$$

$$\Delta V_{ij} = \eta \partial_j^y x_j = \eta \sum_{k}^{l}(\partial_k^o W_{jk}) y_i (1 - y_i) x_i \tag{3.28}$$

The Levenberg–Marquardt (LM) algorithm was utilised in this study and the LM algorithm is specifically developed to reduce sum-of-squares error functions, as demonstrated in Equations 3.29 and 3.30.

$$E = \frac{1}{2}\sum k(e_k)^2 = \frac{1}{2}\|e\|^2 \tag{3.29}$$

$$E = \frac{1}{2}\left\| e(j) + \frac{\partial e_k}{\partial w_i}\left(\mathrm{w}_{\,\mathrm{j+1}} - w_j\right)\right\|^2 \qquad (3.30)$$

To ensure the validity of the linear approximation, the LM algorithm minimises the error function while keeping the step size minimal. A modified error function of the form indicated in Equation 3.31 is used to achieve this.

$$E = \frac{1}{2}\left\| e(j) + \frac{\partial e_k}{\partial w_i}\left(w_{j+1} - w_j\right)\right\|^2 + \lambda \left\| w_{j+1} - w_j \right\|^2 \qquad (3.31)$$

where λ is a step-size-controlling parameter. Equation 3.32 is obtained by minimising the modified error with regard to w_{j+1}.

$$w_{j+1} = w_j - \left(Z^T Z + \lambda I\right)^{-1} Z^T e(j) \qquad (3.32)$$

Large values of λ correspond to ordinary gradient descent, while small values correspond to the Newton approach.The performance of the ANN model can be evaluated by Correlation Coefficient (R) as shown in Equation 3.33.

$$R = \frac{\sum_{i=1}^{n}\left(x_i - \overline{x}\right)\left(y_i - \overline{y}\right)}{\sqrt{\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2 . \sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2}} \qquad (3.33)$$

3.6.6 Auto-Regressive Neural Network Model

The Spectrum Occupancy Prediction Model has an autoregressive (AR) model, hence finding the AR model's coefficients is one of the most important tasks. Model selection, model parameter determination, and model validation are all part of the AR modeling process. The synaptic weights and adaptive coefficients of a feed-forward network's activation function are used to calculate the AR model's coefficients. Several methods have previously been proposed for finding the coefficient of an AR model. However, using a NN to estimate AR coefficients has several advantages over the traditional techniques such as the combining different models. The coefficients are derived via an approach that simulates the nonlinear relationship between the input vector and the goal output utilizing operations inspired by organic neural systems in the human body. The model order was derived using the feature vector obtained from the acquired data. Thus, the goal is to estimate the model coefficients from the neural network.

The training data and the appropriate actual occupancy (calculated from the raw data) are sent to a NN-based function, together with the number of neurons in the hidden layer, to obtain the AR coefficients. The order of the AR model is taken as the number of rows in the training data (dimension of the feature vector). Based on the training data and the corresponding output data, an NN model trains itself to come up with the best weights which can generally be used by the AR model for unseen data. After computing the weights, the performance is first tested on the entire training data, after which it is tested on the test set. Obtaining the output due to the obtained weights is done by simply multiplying the weights by the target data. ANN was used to model the generated data by AR model and to predict the future values of the time-series as shown in equation 3.34 and Figure 3.7.

$$y_t = w_o + \sum_{j=1}^{10} w_j . g\left(w_{o,j} + \sum_{i=1}^{24} w_{i,j} . y_{t-i} \right) \quad (3.34)$$

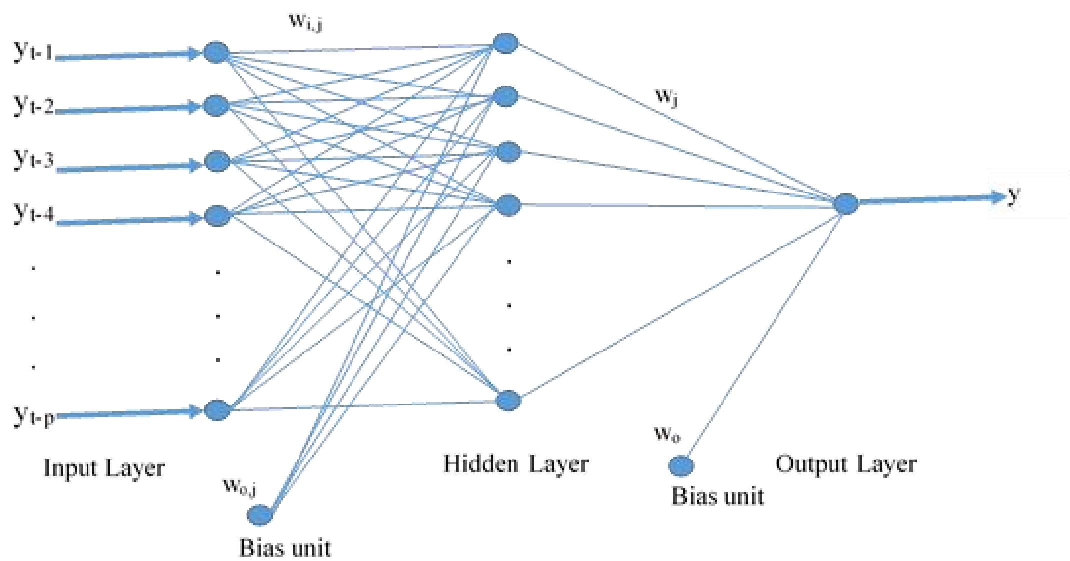


Figure 3.7: Autoregressive Neural Network Model Design

3.6.7 Neural Network Model Training, Validation and Testing

In order to train a neural network, necessary weights and biases are first chosen. The training dataset is composed of data sample that was utilised to fit the model. This is the dataset that the model is trained on. This data is seen and learned by the model. When training the network, the input and output values of the research data are randomly separated into three sets: a training set (70 percent of the data), a validation set (15 percent of the data), and a test set (15 percent of the data). This division is appropriate for a very large data set. The neural network is trained using the training data set. Various weights and biases are evaluated in order to find the set of values that will produce output values that are closest to the real output values. As a result, network training is the process of choosing the values for weights and biases in order to minimise error. In this work, back-propagation optimisation was used.

The test data set is not used at all during training. After training, the weights and biases of the final neural network model are applied to the test dataset only once to ensure accuracy. The developed model's accuracy on the test dataset provides an estimate of the model's accuracy when provided with unknown data. Model overfitting in neural networks is a common occurrence that develops when the training algorithm runs for an excessive amount of time and returns results for a set of weights and biases that produce outputs that are nearly identical to the training data. The longer the training process, the smaller the error on the training set and it is possible to produce values for the weights and biases such that the training set error is nearly zero. When those weights and bias values are utilised in predictions on new data that has not been seen before, the model performs badly. Therefore, the training, validation and testing process is designed in such a way as to identify when model overfitting starts occurring and the training stopped.

When the current weights and biases are applied to the validation data set, the error will start to rise at some point. Training should come to a halt at this time (at the specific Epoch), and the weight and bias values for that epoch should be recorded. After determining the model weights and bias values, they are applied to the unseen test data, and the resulting accuracy is an approximation of the neural network model's overall accuracy. The most important metric is the accuracy of the test data, which is an estimate of the accuracy to be expected if the model is supplied with new data with unknown output values. The validation data is utilised to identify when the training should be stopped, whereas the test data is used to estimate final model accuracy.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Spectrum Occupancy Results

Results of the measured samples are presented in this section. The actual Spectrum Occupancy of each band for all locations is presented and discussed.

4.1.1 Spectrum Occupancy Comparison at Different Frequency Bands

Figure 4.1 presents the actual comparative Spectrum Occupancy levels for the different bands at GK. Frequency Band 5 (87.45-108 MHz) shows the least occupancy level of 20.02%. This will be a good choice for CR deployment at this location. Frequency Band 1 (30-47 MHz) is the most occupied band in the location with a value of 38.42%. Deployment of CR at this band will be highly discouraged.

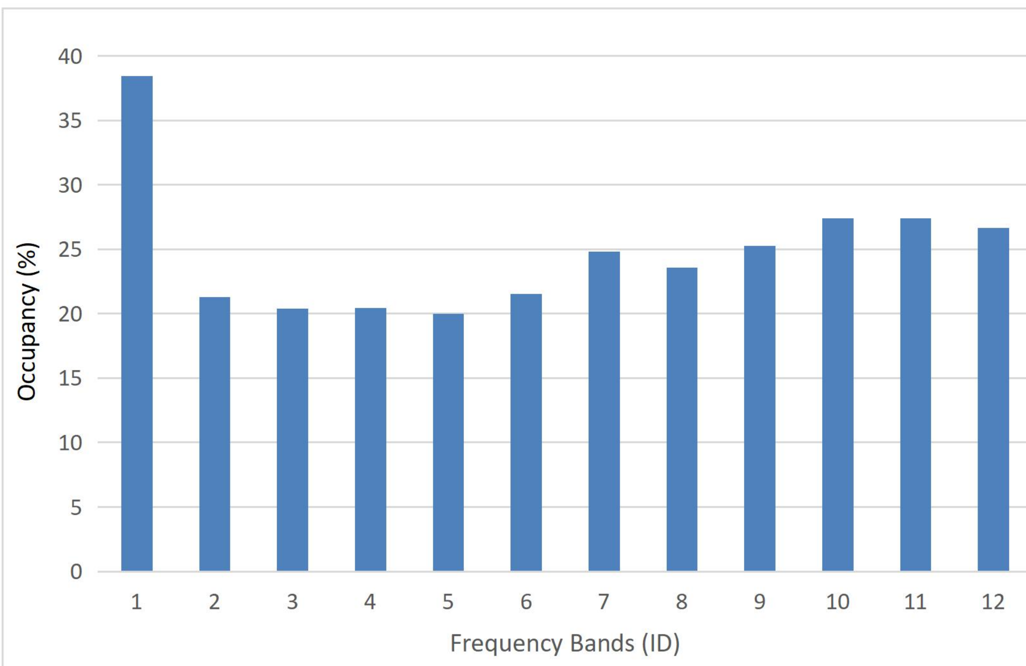


Figure 4.1: Spectrum Occupancy at various Frequency Bands for GK

Figure 4.2 shows that at AEDC, the least Spectrum Occupancy level of 22.26%

occurred at frequency Band 3 (68.05-74.80 MHz) while frequency Band 2 (47.05-68 MHz) followed closely with a value of 22.27%. These bands will be good choices for CR deployment at this location. Frequency Band 1 (30-47 MHz) is the most occupied band in the location with a value of 38.89%.

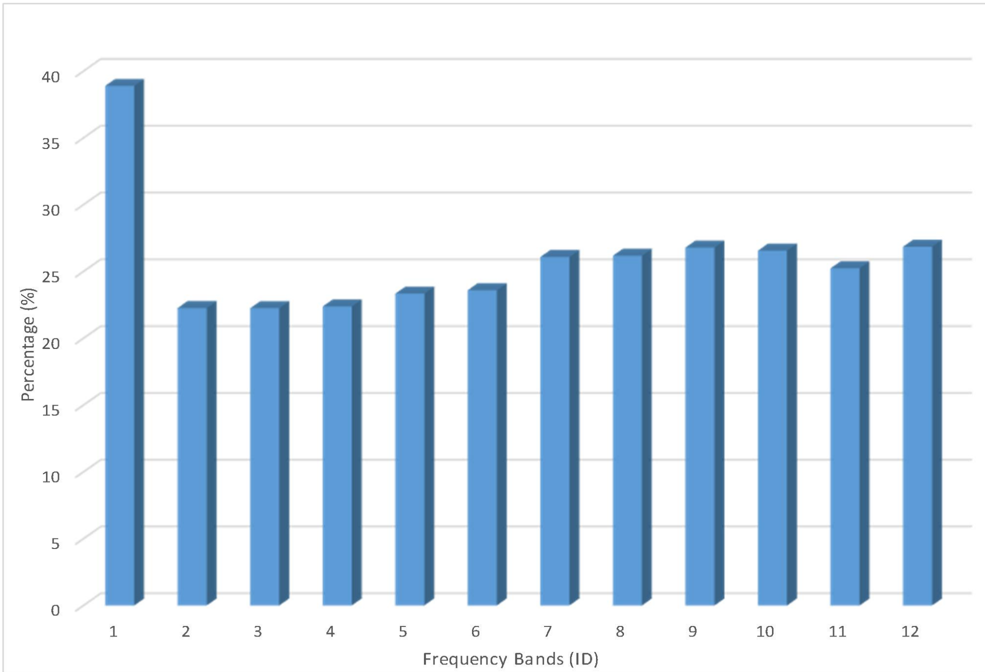


Figure 4.2: Spectrum Occupancy at various Frequency Bands for AEDC.

The results for TUNGA as shown in Figure 4.3 reveals the lowest Spectrum Occupancy level of 24.79% at frequency Band 7 (137.05-144 MHz). This band will be a good choice for CR deployment at this location. Frequency Band 1 (30-47 MHz) is the most occupied band in the location with a value of 44.46%.

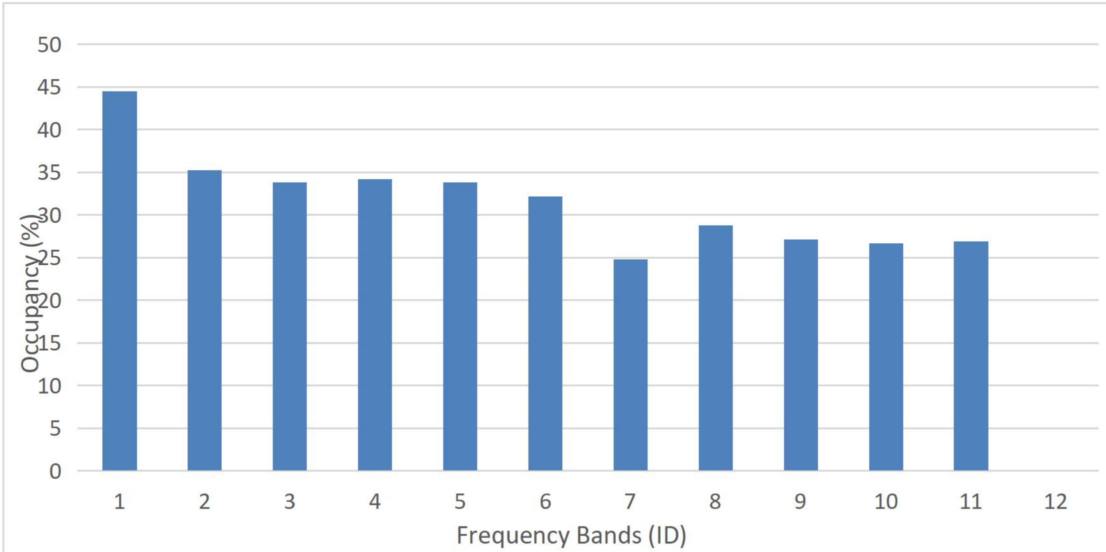


Figure 4.3: Spectrum Occupancy at various Frequency Bands for TUNGA

The results for KUBWA reveals the lowest Spectrum Occupancy level of 17.06% at frequency Band 10 (200.05-230 MHz). This band will be a good choice for CR deployment at this location. Frequency Band 1 (30-47 MHz) is the most occupied band in the location with a value of 37.18%.

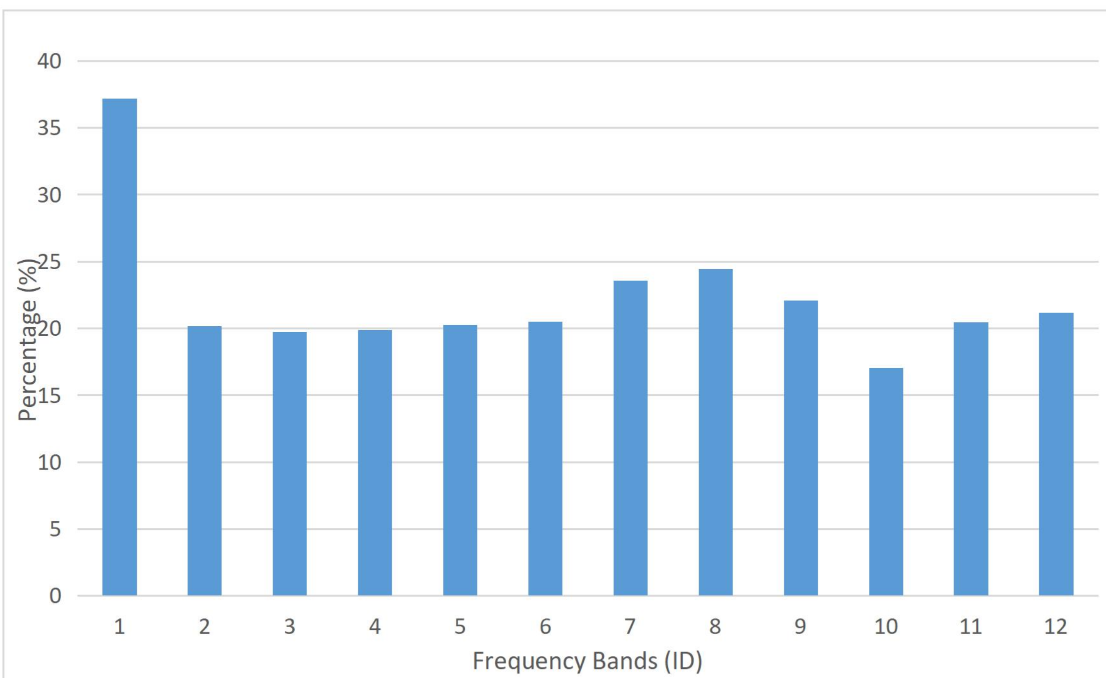


Figure 4.4: Spectrum Occupancy at various Frequency Bands for KUBWA

As seen in Figure 4.5, the lowest Spectrum Occupancy level of 19.98% is observed at frequency Band 2 (47.05-68 MHz) for GUDU. This band will be a good choice for CR deployment at this location. Frequency Band 1 (30-47 MHz) is the most occupied band in the location with a value of 37.10%.

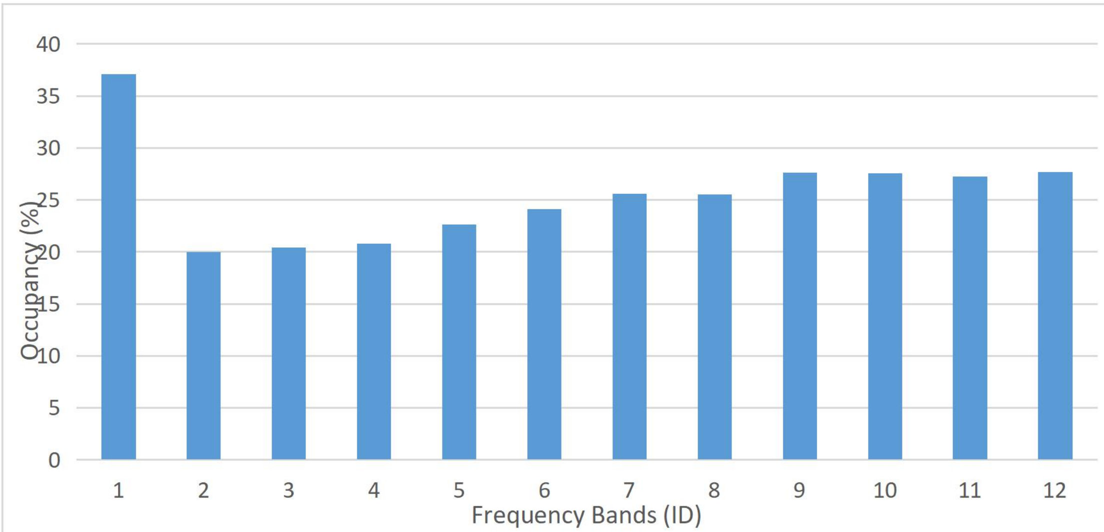


Figure 4.5: Spectrum Occupancy at various Frequency Bands for GUDU

Similarly, from Figure 4.6 the lowest Spectrum Occupancy levels of 18.19% and 18.66% at frequency bands 12 and 11 respectively, will make them a good candidate for CR deployment at MAITAMA. Frequency Band 1 (30-47 MHz) is the most occupied band in the location with a value of 42.94%.

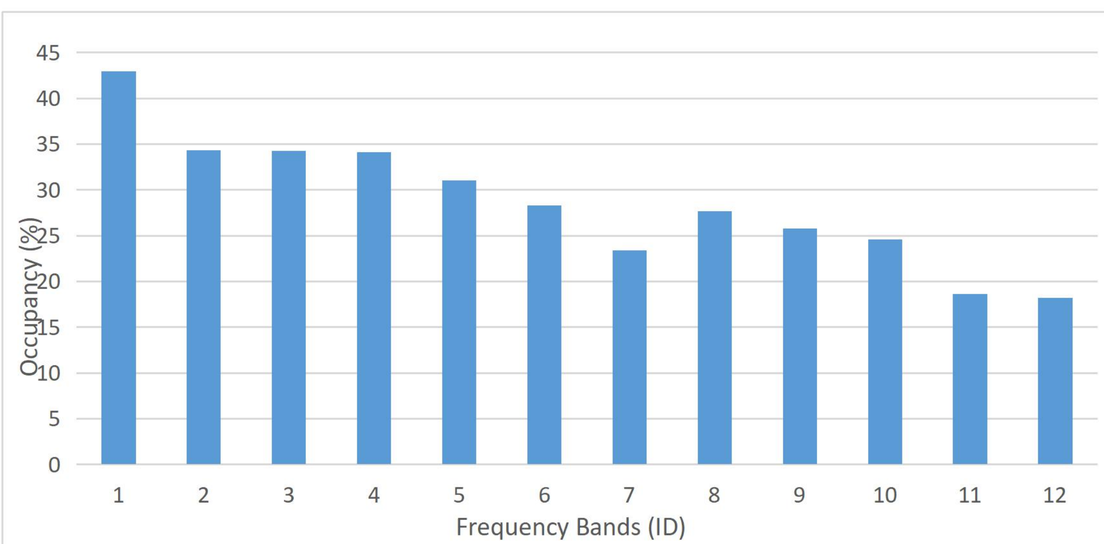


Figure 4.6: Spectrum Occupancy at various Frequency Bands for MAITAMA

4.1.2 Summary of Spectrum Occupancy Comparison

Table 4.1 shows the summary of the spectrum occupancies at each location revealing the highest and lowest proportions of occupancy at each location. Bands with lowest occupancy are the best bands for CR deployment.

Table 4.1: Actual Spectrum Occupancy Summary for all Sites

Location	Highest Occupancy (%)	Lowest Occupancy (%)
GK	38.42 (Band 1)	20.02 (Band 5)
AEDC	38.89 (Band 1)	22.24 (Band 4)
TUNGA	44.46 (Band 1)	24.79 (Band 7)
KUBWA	37.18 (Band 1)	17.04 (Band 10)
GUDU	37.11 (Band 1)	19.93 (Band 2)
MAITAMA	43.03 (Band 1)	18.15 (Band 12)

Overall, Band 10 (200.05-230 MHz) in KUBWA has the lowest Occupancy and therefore the most appropriate band that is suitable for CR. Band 1 (30-47 MHz) in all locations has the highest occupancy and should be avoided by CR devices.

4.2 Spectrum Occupancy Prediction for GK

Occupancy at different frequency bands predicted is compared with the measured values. Analysis of the results of spectrum occupancy prediction is presented in this section for GK.

4.2.1 Spectrum Occupancy Prediction for GK within Frequency Band of 30-47 MHz

On average, Figure 4.7 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of $5.37 \times 10^{-2}\%$ as compared with that of the measured values for the frequency band of 30-47 MHz.

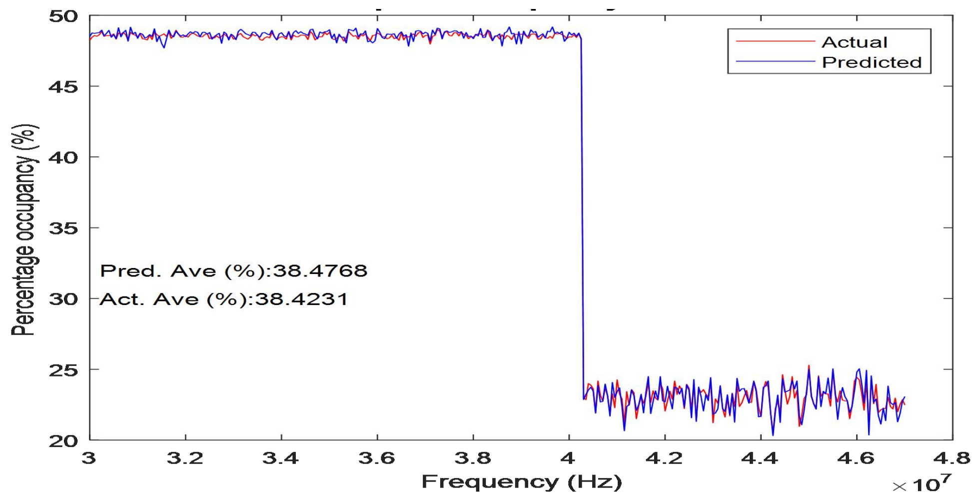


Figure 4.7: Performance Prediction for Spectrum Occupancy at Frequency Band of 30-47 MHz for GK

As seen in Figure 4.8, most of the percentage errors fall below 1%. The highest error of 1.5% occurred at 42.8 MHz.

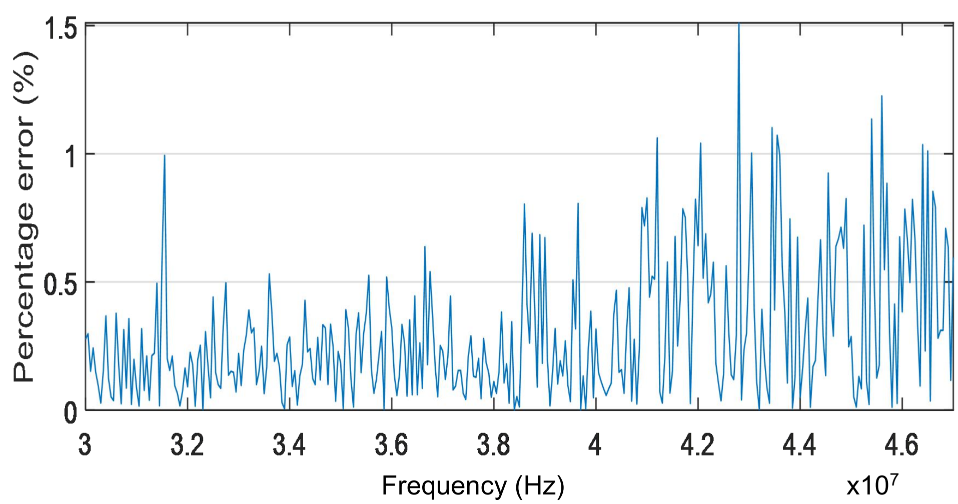


Figure 4.8: Percentage Error between Actual and Predicted Spectrum Occupancy values at 30-47 MHz for GK

4.2.2 Spectrum Occupancy Prediction Results for GK within Frequency Band of 47.05-68 MHz

Figure 4.9 shows the result of the Spectrum Occupancy prediction for GK with a

percentage difference of 3.90 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 47.05-68 MHz.

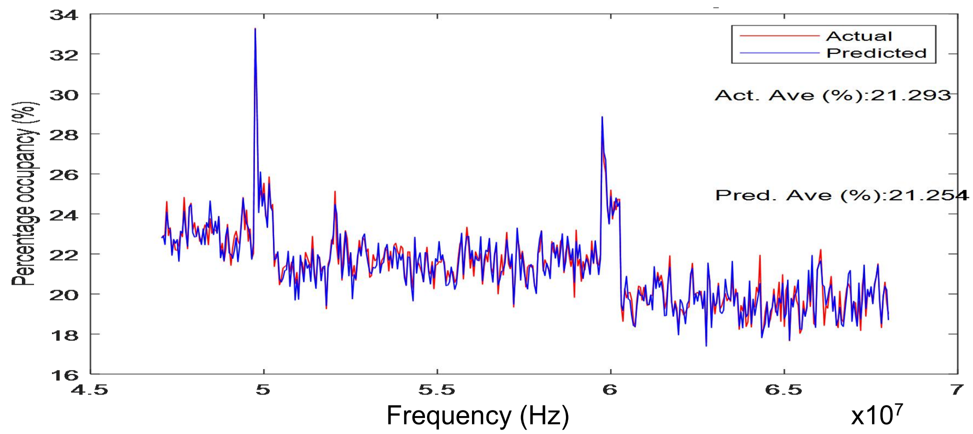


Figure 4.9: Performance Prediction for Spectrum Occupancy at Frequency Band of 47.05-68 MHz for GK

Figure 4.10 shows that most of the percentage errors fall below 1%. The highest error of 1.8% occurred at 6.1

MHz.

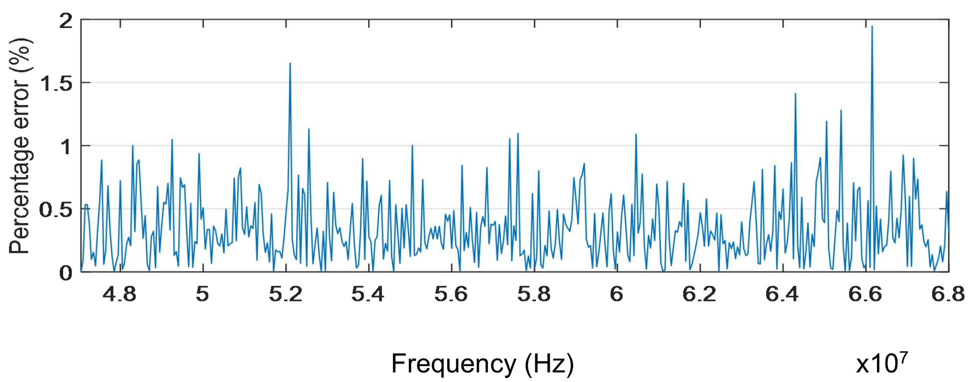


Figure 4.10: Percentage Error between Actual and Predicted Spectrum Occupancy values at 47-68 MHz for GK

4.2.3 Spectrum Occupancy Prediction for GK within Frequency Band of 68.05-74.8 MHz

Figure 4.11 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 9.07 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 68.05-74.8 MHz.

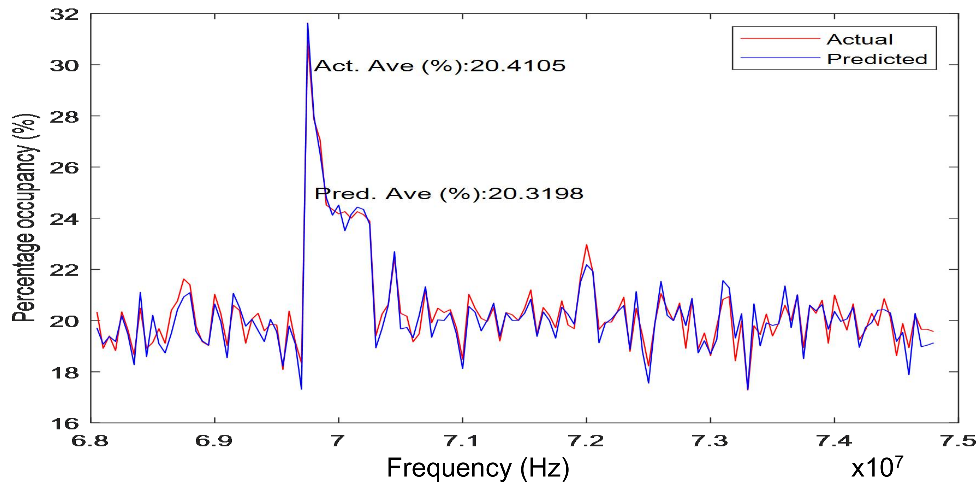


Figure 4.11: Performance Prediction for Spectrum Occupancy at Frequency Band of 68.05-74.8 MHz for GK

Figure 4.12 shows that most of the percentage errors fall below 1% while the highest error of 1.1% occurred at the frequencies of 68.5 MHz and 74.6 MHz.

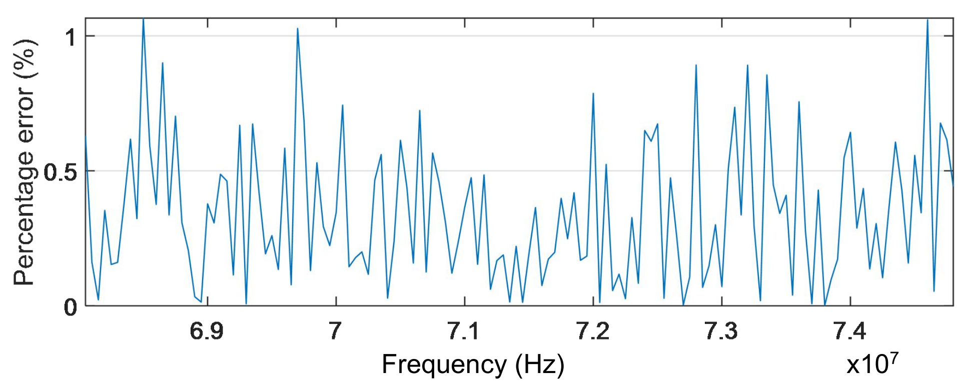


Figure 4.12: Percentage Error between Actual and Predicted Spectrum Occupancy values at 68.05-74.8 MHz for GK

4.2.4 Spectrum Occupancy Prediction for GK within Frequency Band of 74.85-87.45 MHz

Figure 4.13 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 2.34 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 74.85-87.45 MHz.

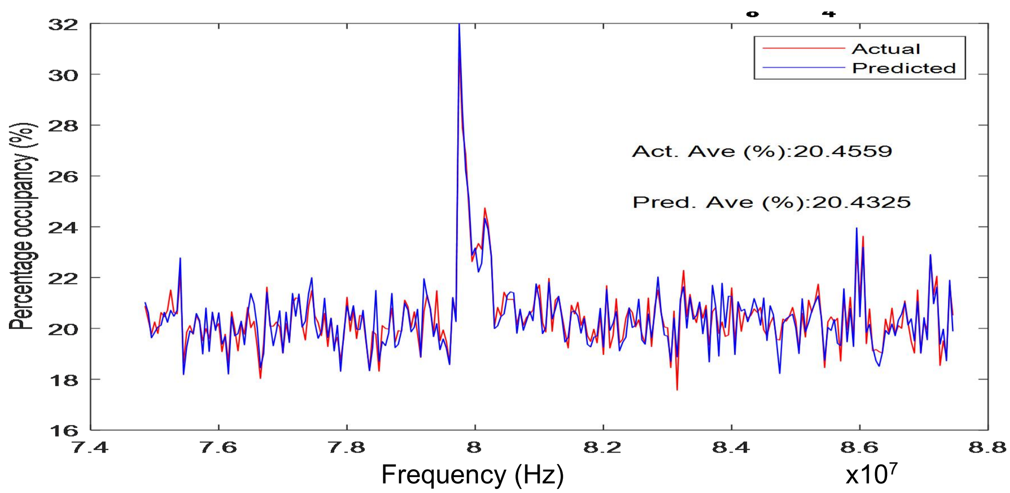


Figure 4.13: Performance Prediction for Spectrum Occupancy at Frequency Band of 74.85-87.45 MHz for GK

Figure 4.14 shows that most of the percentage errors fall below 1.5% while the highest error of 1.7% occurred at the frequency of 78.3 MHz.

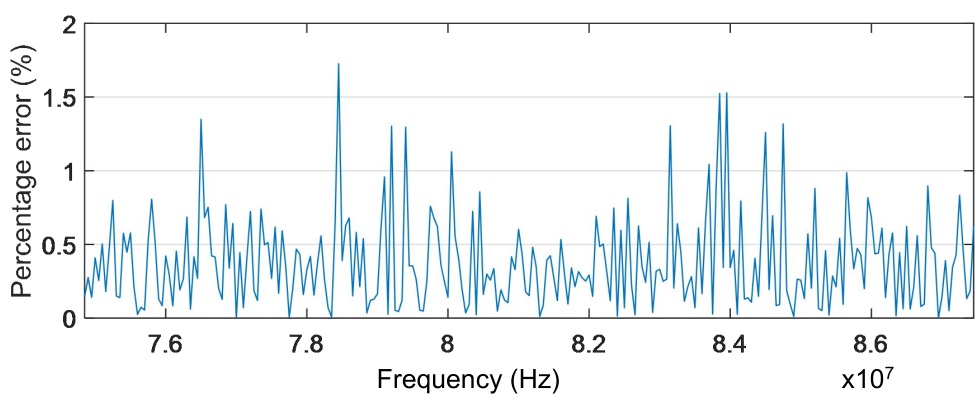


Figure 4.14: Percentage Error between Actual and Predicted Spectrum Occupancy values at 74.85-87.45 MHz for GK

4.2.5 Spectrum Occupancy Prediction for GK within Frequency Band of 87.50-108 MHz

Figure 4.15 shows the result of the Spectrum Occupancy prediction for GK with a

percentage difference of 5.28 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 87.50-108 MHz.

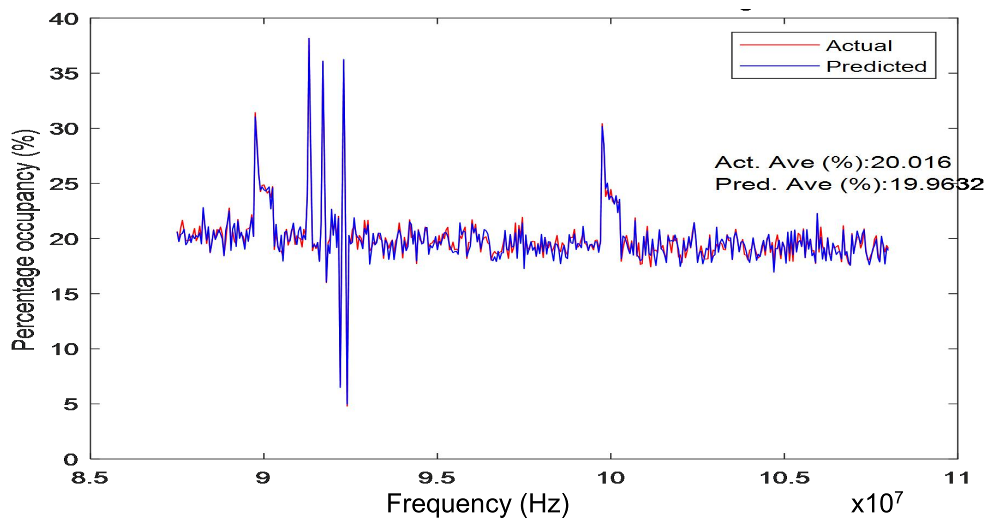


Figure 4.15: Performance Prediction for Spectrum Occupancy at Frequency Band of 87.50-108 MHz for GK

Figure 4.16 shows that most of the percentage errors fall below 1.5% while the highest error of 1.7% occurred at the frequency of 88.5 MHz.

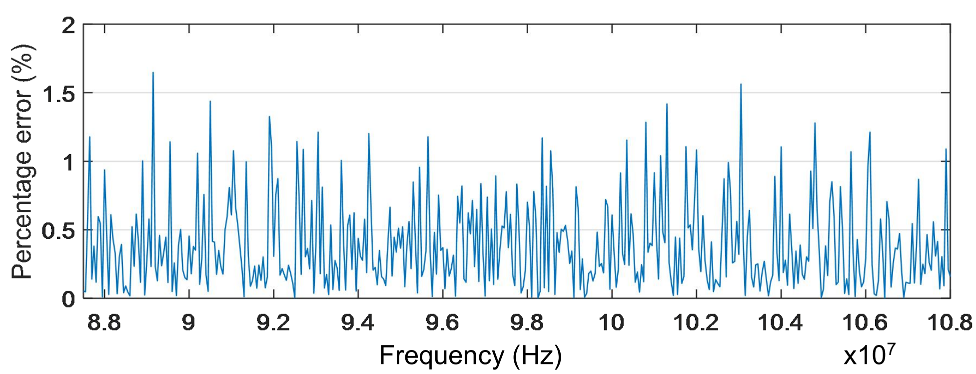


Figure 4.16: Percentage Error between Actual and Predicted Spectrum Occupancy values at 87.50-108 MHz for GK

4.2.6 Spectrum Occupancy Prediction for GK within Frequency Band of 108.05-137 MHz

Figure 4.17 shows the result of the Spectrum Occupancy prediction for GK with a

percentage difference of 0.45 x 10^{-2}% on the average as compared with that of the measured values for the frequency band 108.05-137 MHz.

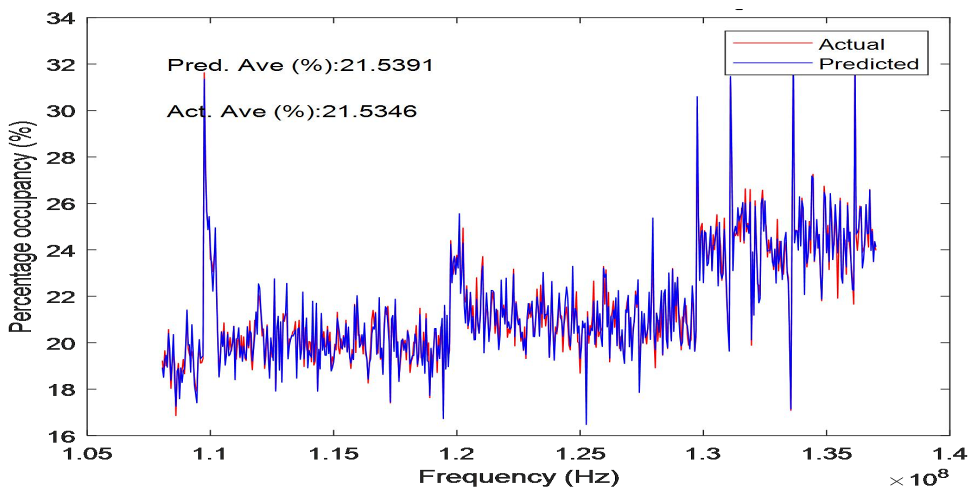


Figure 4.17: Performance Prediction for Spectrum Occupancy at Frequency Band of 108.05-137 MHz for GK

Figure 4.18 shows that most of the percentage errors fall below 1.5% while the highest error of 1.8% occurred at the frequency of 135.5 MHz.

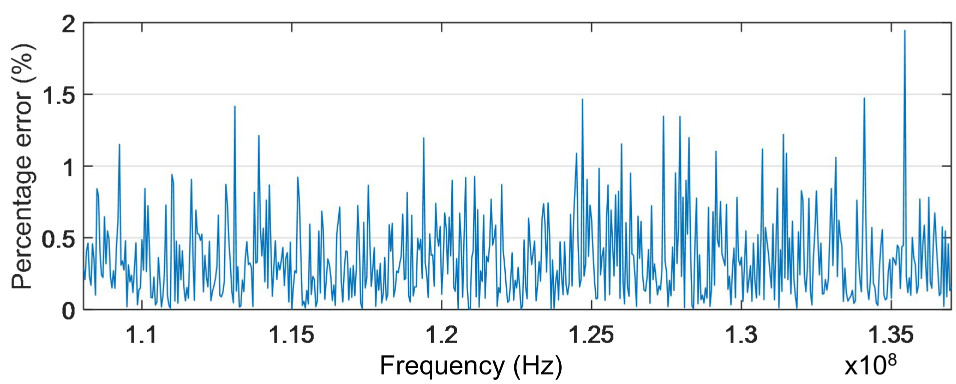


Figure 4.18: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 108.05-137 MHz for GK

4.2.7 Spectrum Occupancy Prediction for GK within Frequency Band of 137.05-144 MHz

Figure 4.19 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 1.19 x 10^{-2}% on the average when compared with that of the

measured values for the frequency band 137.05-144 MHz.

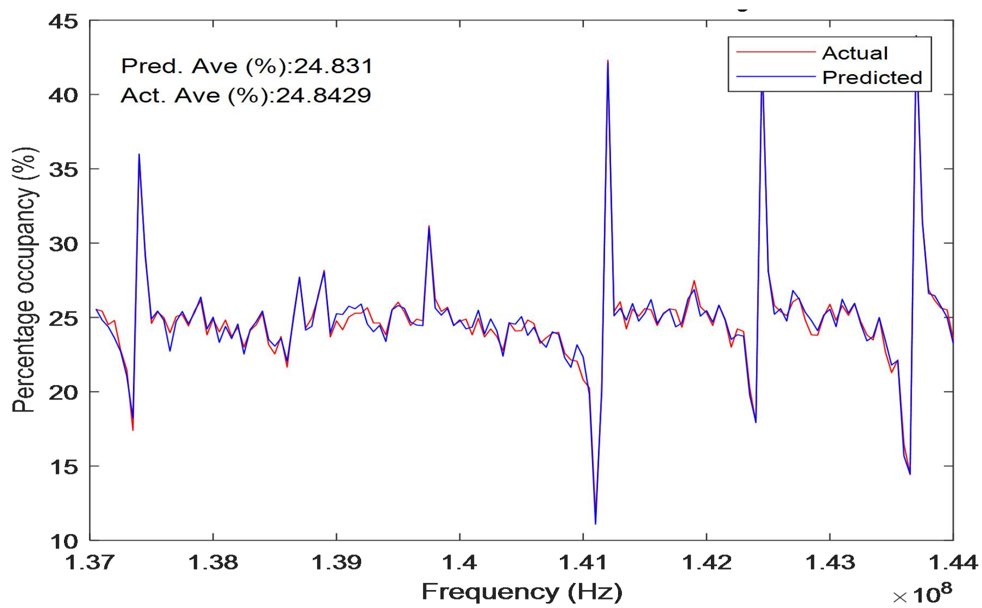


Figure 4.19: Performance Prediction for Spectrum Occupancy at Frequency Band of 137.05-144 MHz for GK

Figure 4.20 shows that most of the percentage errors fall below 1% while the highest error of 15.35 x 10^{-1}% occurred at the frequency of 141 MHz.

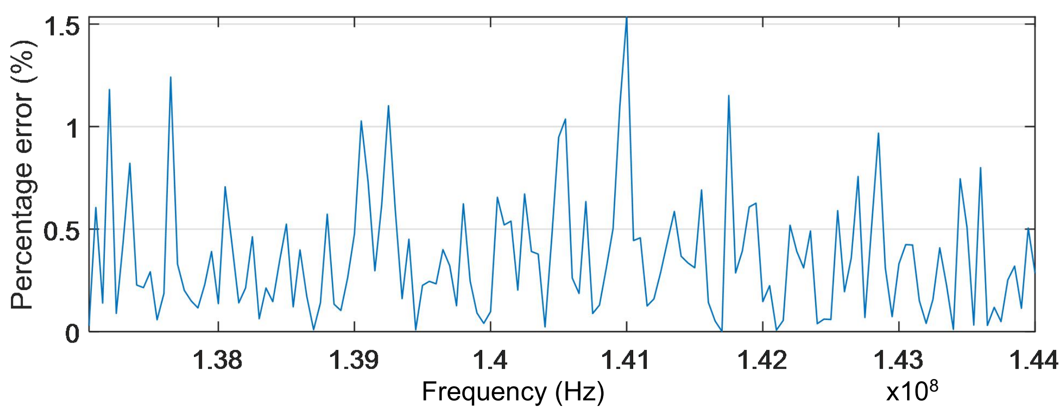


Figure 4.20: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 137.05-144 MHz for GK

4.2.8 Spectrum Occupancy Prediction for GK within Frequency Band of 144.05-174 MHz

Figure 4.21 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 2.29 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 144.05-174 MHz.

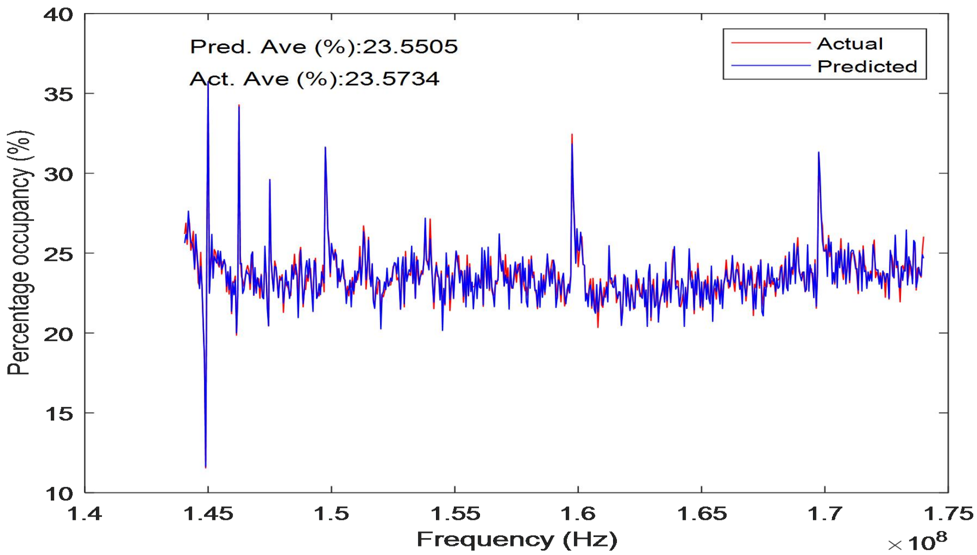


Figure 4.21 Performance Prediction for Spectrum Occupancy at Frequency Band of 144.05-174 MHz for GK

Figure 4.22 shows that most of the percentage errors fall below 1% while the highest error of 15.05 x 10^{-1}% occurred at the frequency of 154.5 MHz.

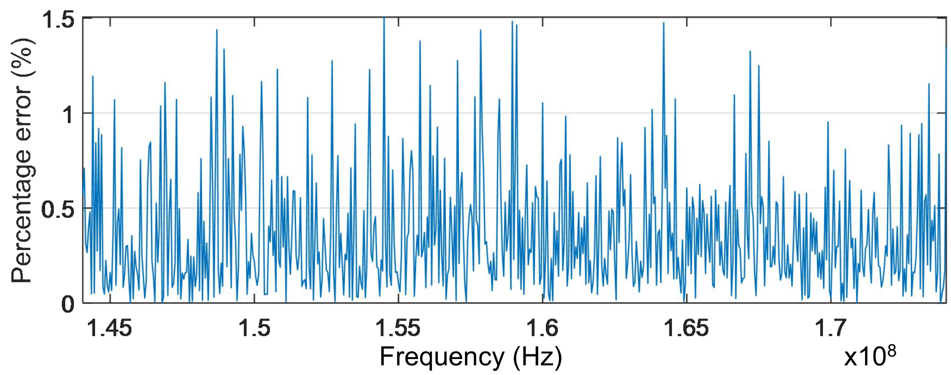


Figure 4.22: Percentage Error between Actual and Predicted Spectrum Occupancy values at 144.05-174 MHz for GK

4.2.9 Spectrum Occupancy Prediction for GK within Frequency Band of 174.05-200 MHz

Figure 4.23 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 0.13 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 174.05-200 MHz.

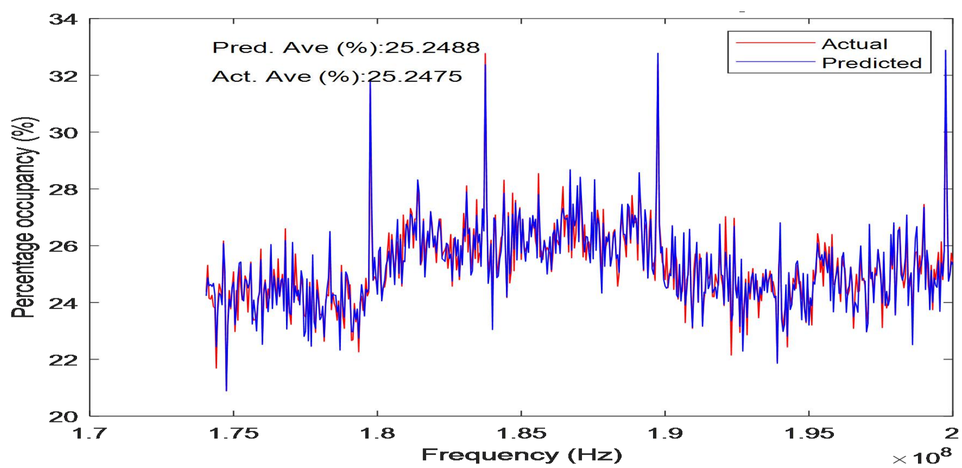


Figure 4.23 Performance Prediction for Spectrum Occupancy at Frequency Band of 174.05-200 MHz for GK

Figure 4.24 shows that most of the percentage errors fall below 1% while the highest error of 16.11 x 10^{-1}% occurred at the frequency of 180.9 MHz.

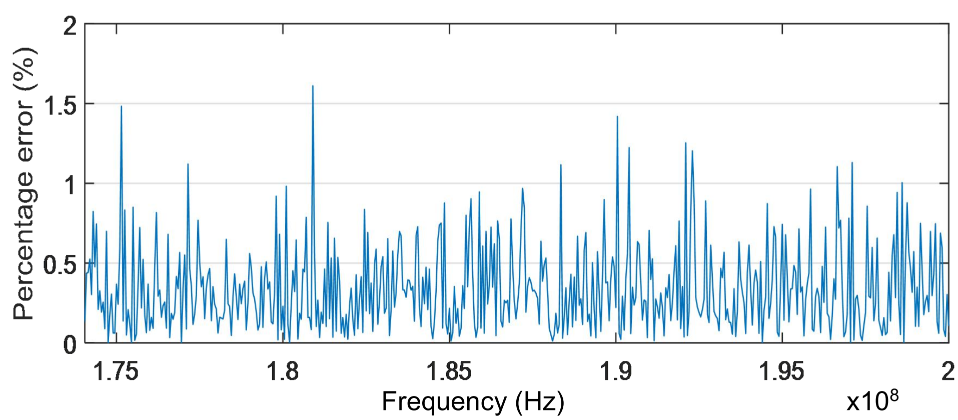


Figure 4.24: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 174.05-200 MHz for GK

4.2.10 Spectrum Occupancy Prediction for GK within Frequency Band of 200.05-230 MHz

Figure 4.25 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 1.37 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 200.05-230 MHz.

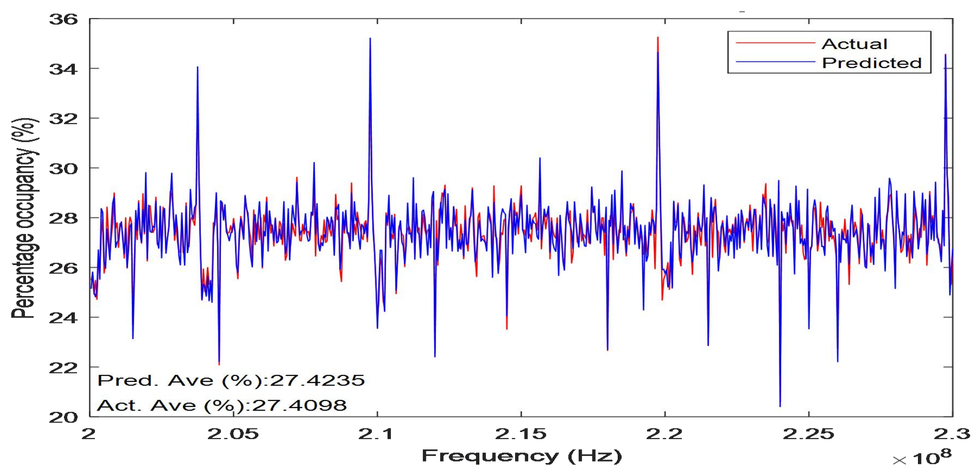


Figure 4.25: Performance Prediction for Spectrum Occupancy at Frequency Band of 200.05-230 MHz for GK

Figure 4.26 shows that most of the percentage errors fall below 1% while the highest error of 22.28 x 10^{-1}% occurred at the frequency of 219.3 MHz.

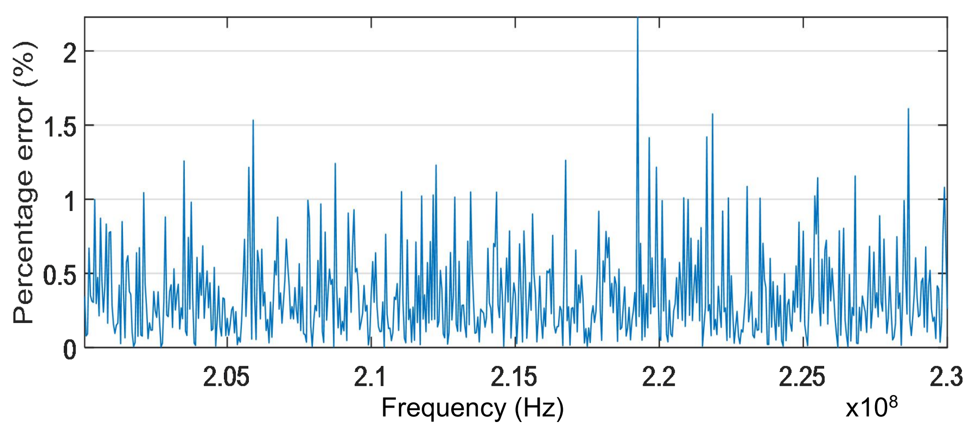


Figure 4.26: Percentage Error between Actual and Predicted Spectrum Occupancy values at 200.05-230 MHz for GK

4.2.11 Spectrum Occupancy Prediction for GK within Frequency Band of 230.05-267 MHz

Figure 4.27 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 2.74 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 230.05-267 MHz.

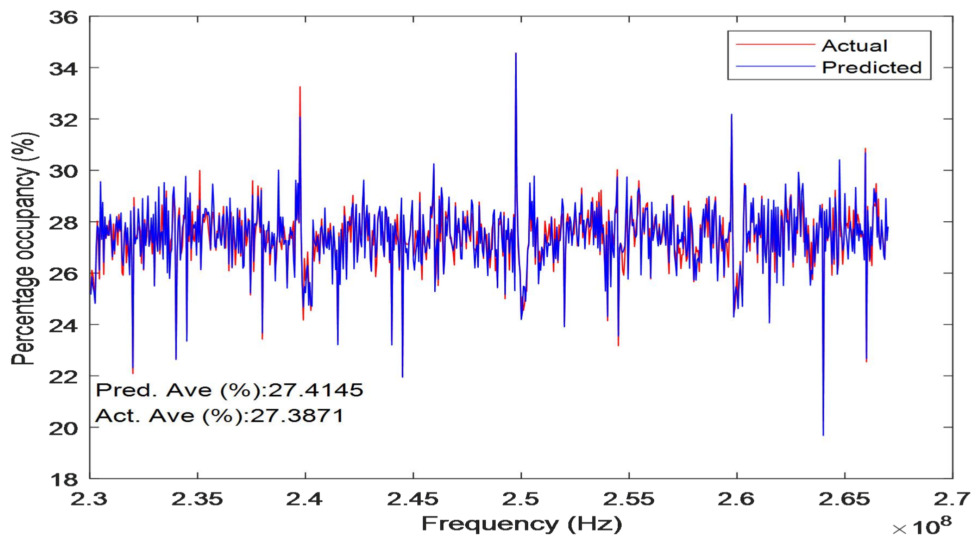
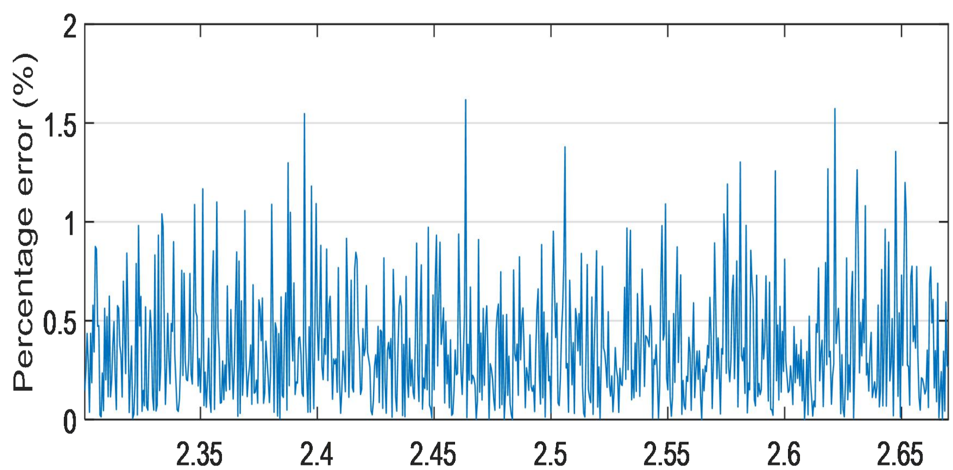


Figure 4.27: Performance Prediction for Spectrum Occupancy at Frequency Band of 230.05-267 MHz for GK

Figure 4.28 shows that most of the percentage errors fall below 1% while the highest



error of 16.17 x 10^{-1}% occurred at the frequency of 246.4 MHz.

Frequency (Hz) x10^8

Figure 4.28: Percentage Error between Actual and Predicted Spectrum Occupancy values at 230.05-267 MHz for GK

4.2.12 Spectrum Occupancy Prediction for GK within Frequency Band of 267.05-300 MHz

Figure 4.29 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 0.72 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 267.05-300 MHz.

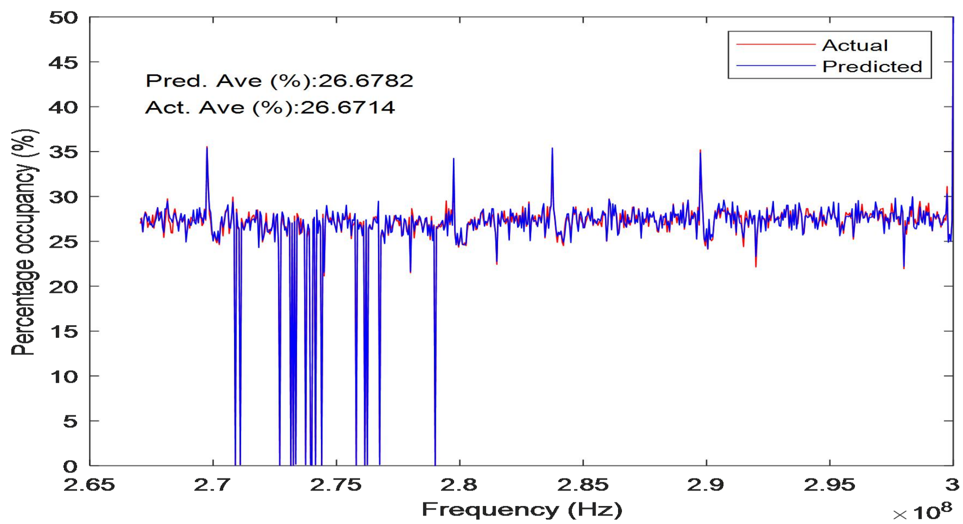


Figure 4.29: Performance Prediction for Spectrum Occupancy at Frequency Band of 267.05-300 MHz for GK

Figure 4.30 shows that most of the percentage errors fall below 1% while the highest error of 18.07 x 10^{-1}% occurred at the frequency of 298.6 MHz.

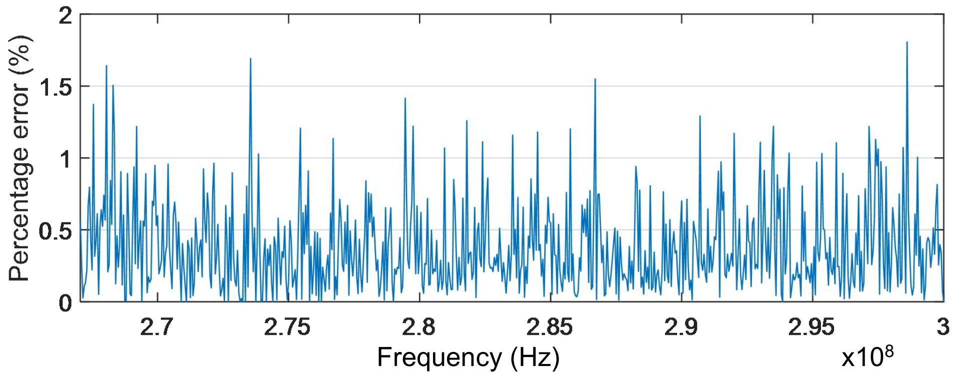


Figure 4.30: Percentage Error between Actual and Predicted Spectrum Occupancy values at 267.05-300 MHz for GK

4.2.13 Summary of Spectrum Occupancy Prediction for GK

Figure 4.31 shows that the maximum percentage difference between the actual and predicted values of 9 x 10^{-2}% occurred at the frequency band of 68.05-74.80 MHz while the lowest percentage difference of 0.13x10^{-2}% occurred at a frequency band of 174.05-200 MHz and 0.45x10^{-2}% at a frequency band of 267.05-300 MHz which shows the best predictions.

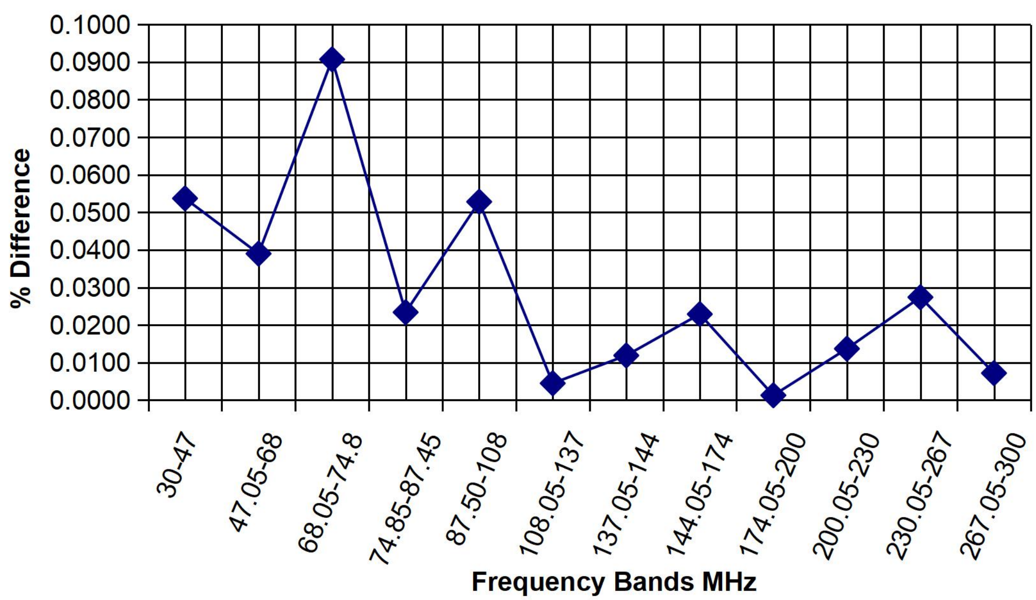


Figure 4:31: Percentage Spectrum Occupancy prediction difference at various Frequency bands in GK

4.3 Spectrum Occupancy Prediction for AEDC

Occupancy at different frequency bands predicted using ANN are compared with the measured values. Analysis of the results of spectrum occupancy prediction using ANN is presented in this section for AEDC.

4.3.1 Spectrum Occupancy Prediction for AEDC within Frequency Band of 30-47 MHz

On the average, Figure 4.32 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 3.19 x 10^{-2}% as compared with that of the measured values for the frequency band 30-47 MHz.

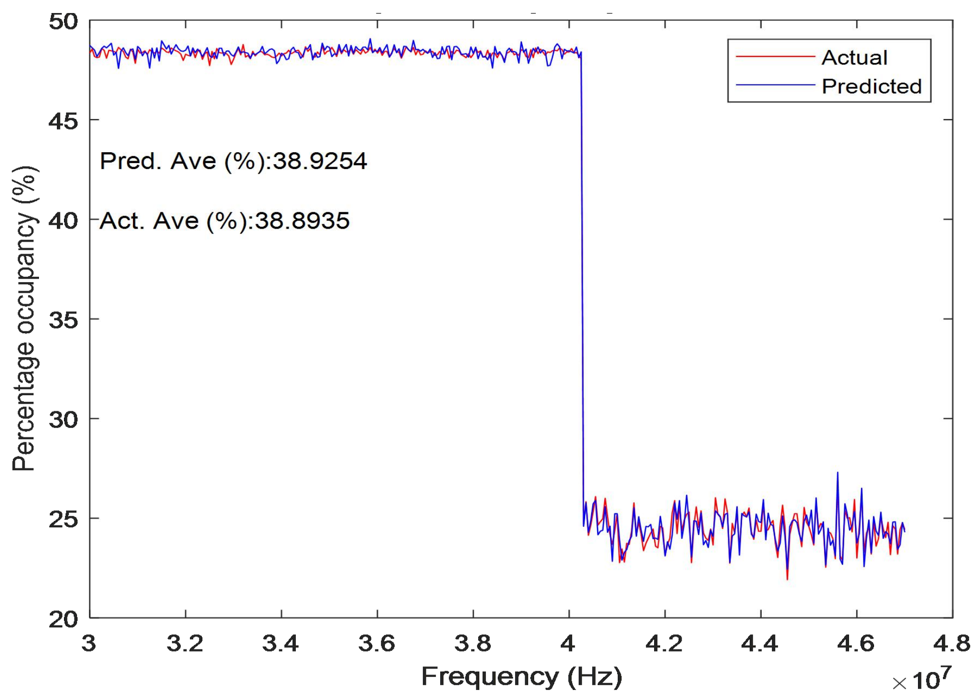


Figure 4.32: Performance Prediction for Spectrum Occupancy at Frequency Band of 30-47 MHz for AEDC

As see in Figure 4.33, most of the percentage errors fall below 1%. The highest error of 1.2% occurred at the frequency of 45.0 MHz.

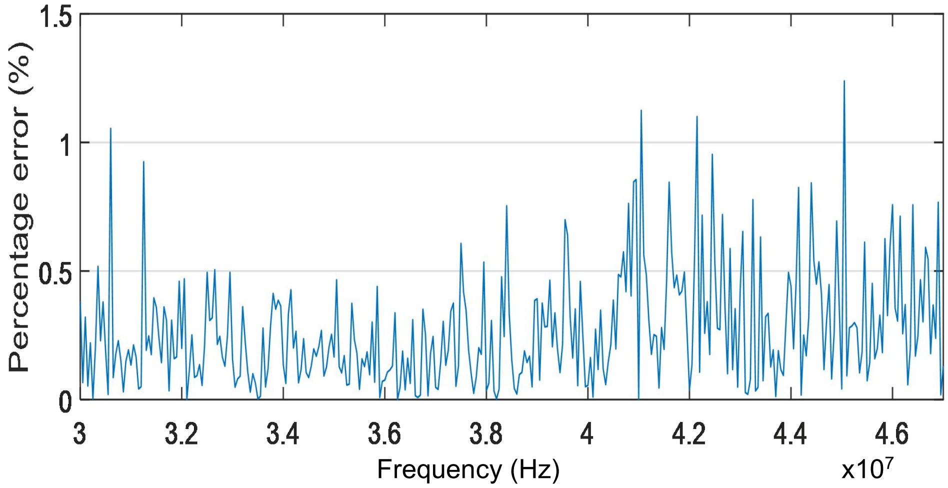


Figure 4.33: Percentage Error between Actual and Predicted Spectrum Occupancy values at 30-47 MHz for AEDC

4.3.2 Spectrum Occupancy Prediction for AEDC within Frequency Band of 47.05-68 MHz

Figure 4.34 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 0.06 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 47.05-68 MHz.

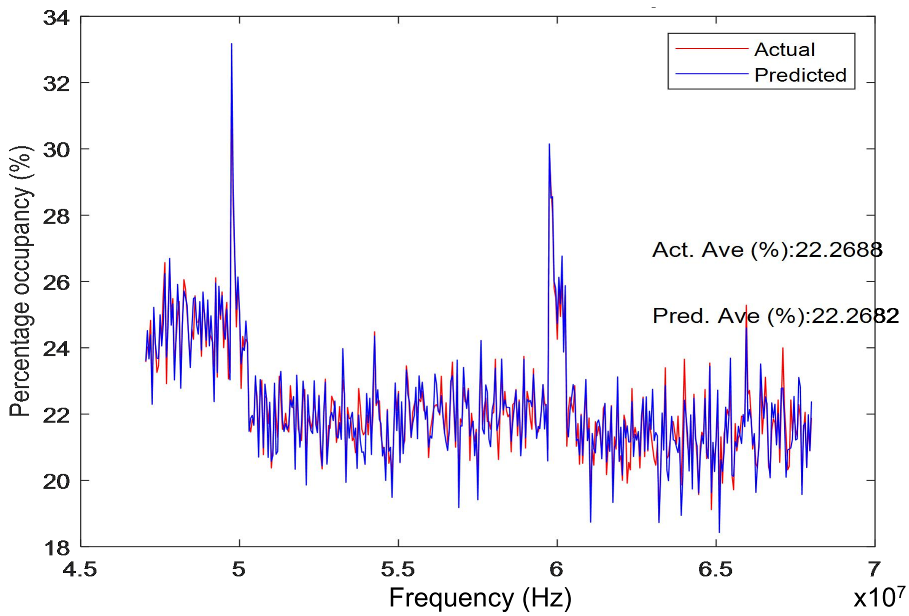


Figure 4.34: Performance Prediction for Spectrum Occupancy at Frequency Band of 47.05-68 MHz for AEDC

Figure 4.35 shows that most of the percentage errors fall below 1.5%. The highest error of 1.75% occurred at the frequency of 63 MHz.

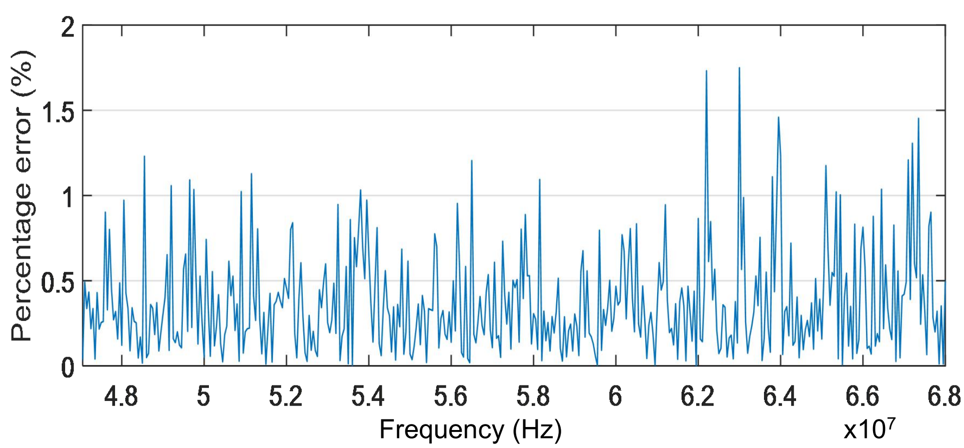


Figure 4.35: Percentage Error between Actual and Predicted Spectrum Occupancy values at 47.05-68 MHz for AEDC

4.3.3 Spectrum Occupancy Prediction for AEDC within Frequency Band of 68.05-74.8 MHz

Figure 4.36 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 2.06 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 68.05-74.8 MHz.

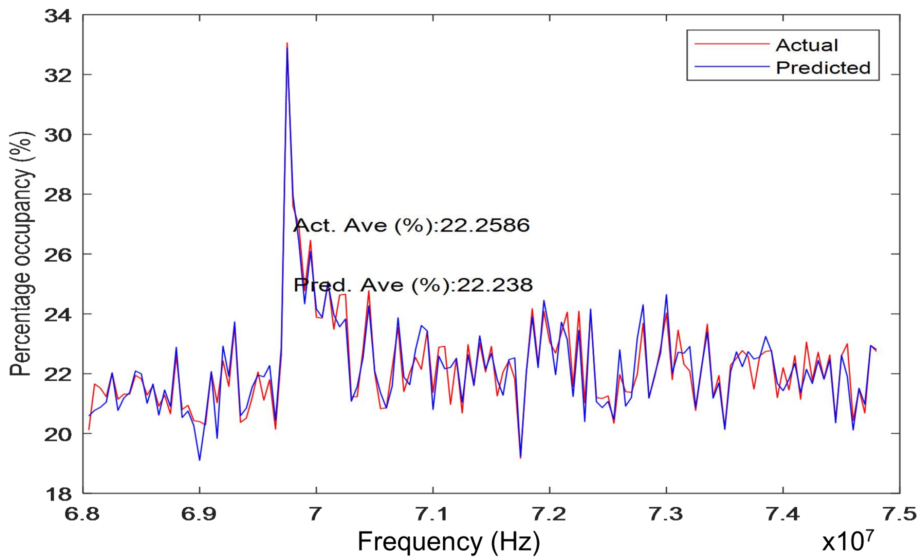


Figure 4.36: Performance Prediction for Spectrum Occupancy at Frequency Band of 68.05-74.8 MHz for AEDC

Figure 4.37 shows that most of the percentage errors fall below 1% while the highest error of 1.47% occurred at the frequency of 71 MHz.

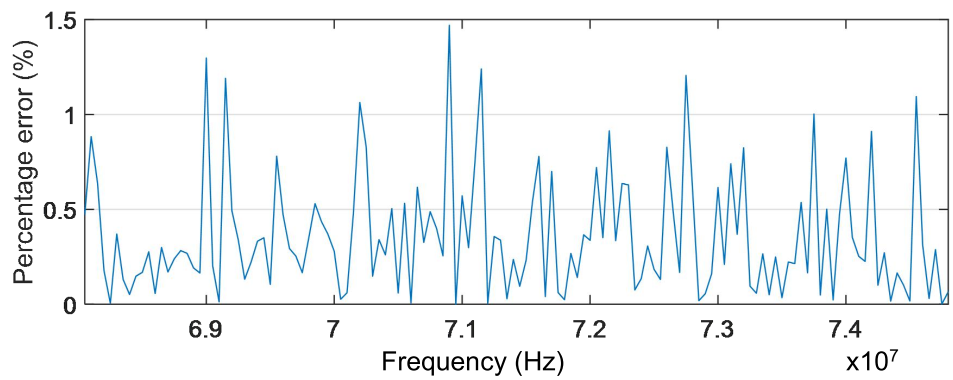


Figure 4.37: Percentage Error between Actual and Predicted Spectrum Occupancy values at 68.05-74.8 MHz for AEDC

4.3.4 Spectrum Occupancy Prediction for GK within Frequency Band of 74.85-87.45 MHz

Figure 4.38 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 5.89 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 74.85-87.45 MHz.

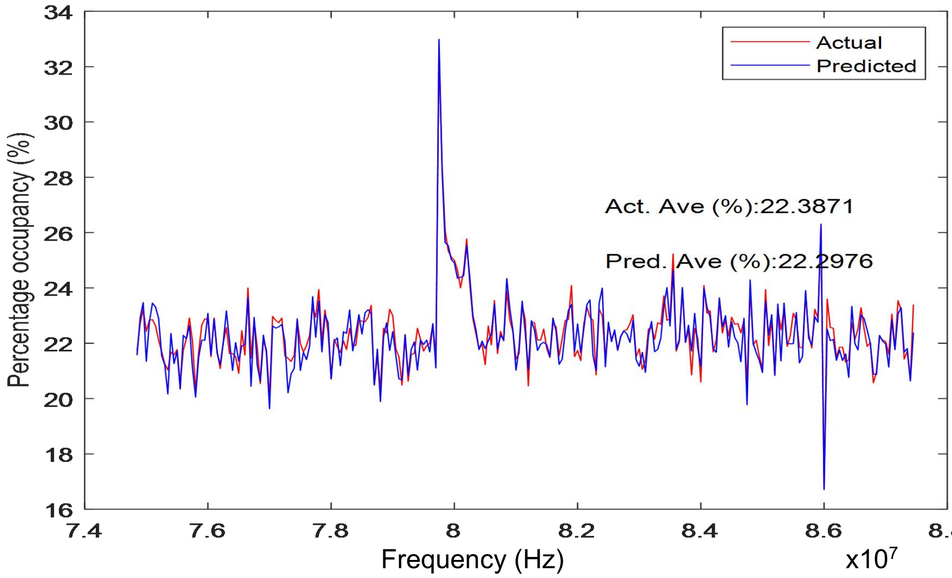


Figure 4.38: Performance Prediction for Spectrum Occupancy at Frequency Band of 74.85-87.45 MHz for AEDC

Figure 4.39 shows that most of the percentage errors fall below 1% while the highest error of 1.5% occurred at the frequency of 79.4 MHz.

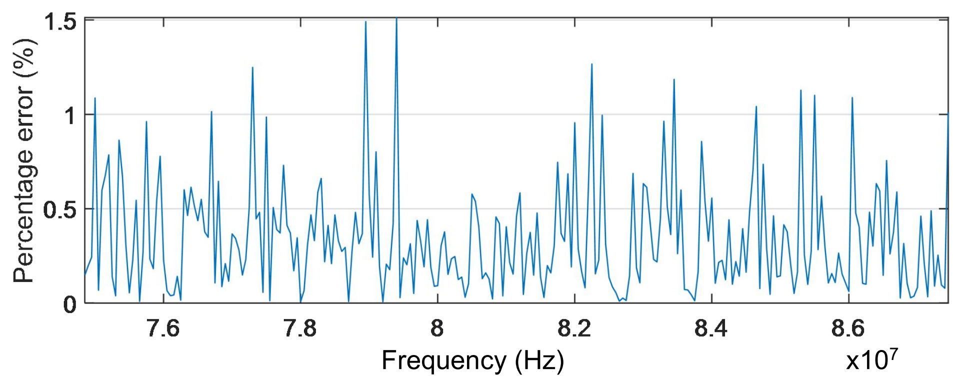


Figure 4.39: Percentage Error between Actual and Predicted Spectrum Occupancy values at 74.85-87.45 MHz for AEDC

4.3.5 Spectrum Occupancy Prediction for AEDC within Frequency Band of 87.50-108 MHz

Figure 4.40 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 1.14×10^{-2}% on the average as compared with that of the measured values for the frequency band of 87.50-108 MHz.

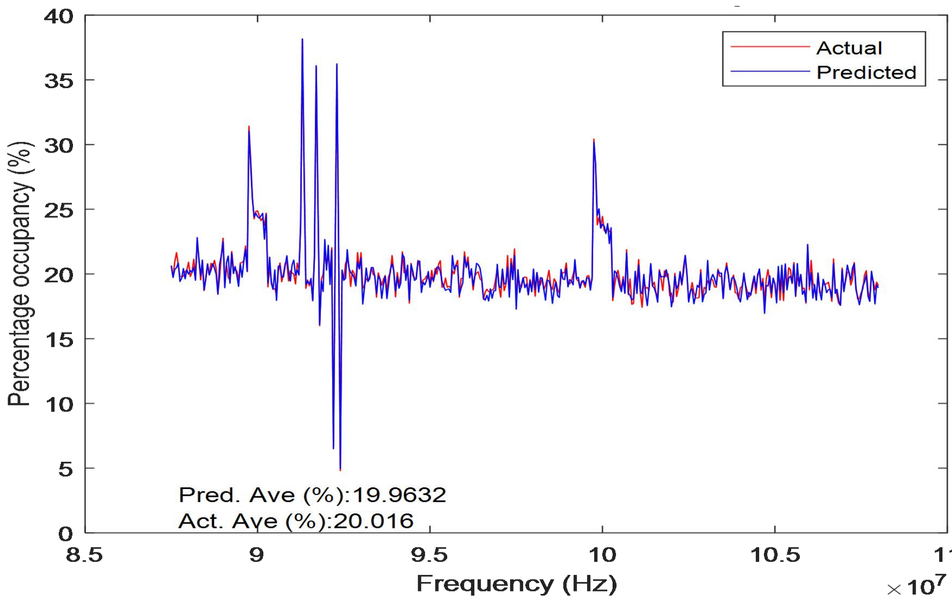


Figure 4.40: Performance Prediction for Spectrum Occupancy at Frequency Band of 87.50-108 MHz for AEDC

Figure 4.41 shows that most of the percentage errors fall below 1% while the highest error of 1.5% occurred at the frequencies of 104.2 MHz and 105.2 MHz.

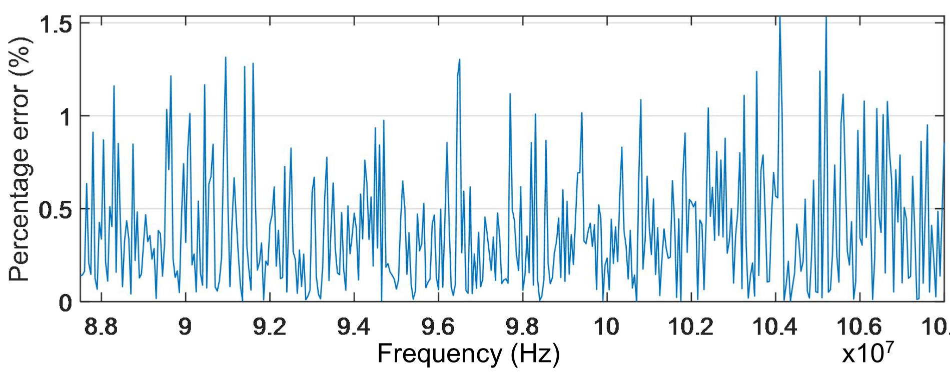


Figure 4.41: Percentage Error between Actual and Predicted Spectrum Occupancy values at 87.50-108 MHz for AEDC

4.3.6 Spectrum Occupancy Prediction for AEDC within Frequency Band of 108.05-137 MHz

Figure 4.42 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 0.45×10^{-2}% on the average as compared with that of the measured values for the frequency band 108.05-137 MHz.

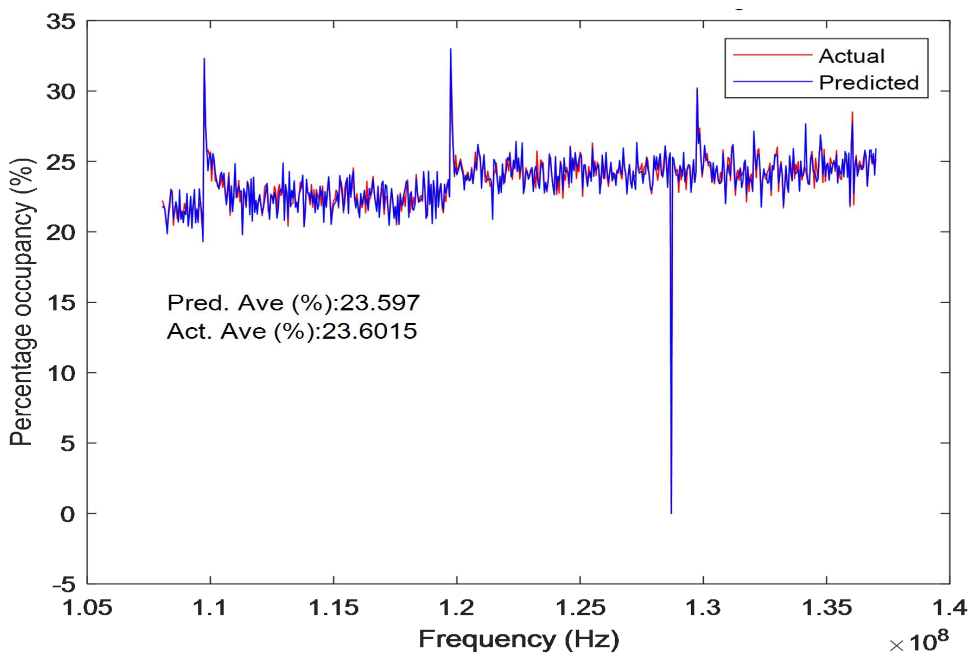


Figure 4.42: Performance Prediction for Spectrum Occupancy at Frequency Band of 108.05-137 MHz for AEDC

Figure 4.43 shows that most of the percentage errors fall below 3.4% while the highest error of 1.8% occurred at the frequency of 134.2 MHz.

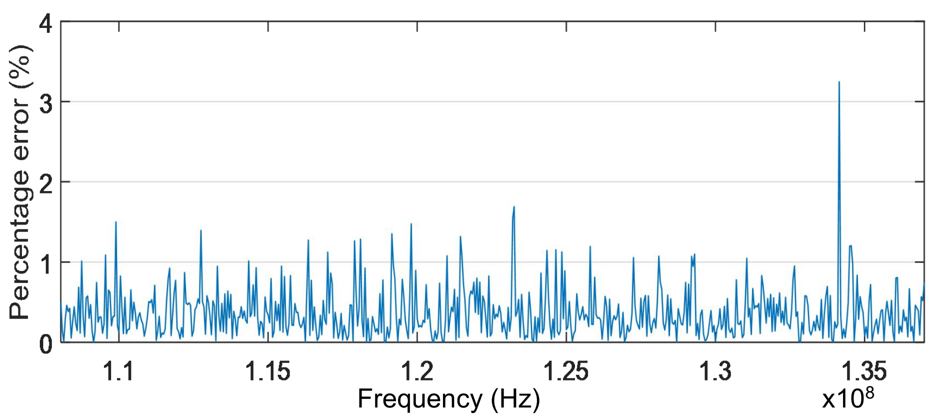


Figure 4.43 Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 108.05-137 MHz for AEDC

4.3.7 Spectrum Occupancy Prediction for AEDC within Frequency Band of 137.05-144 MHz

Figure 4.44 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 2.93 x 10^{-2}% on the average when compared with that of the

measured values for the frequency band 137.05-144 MHz.

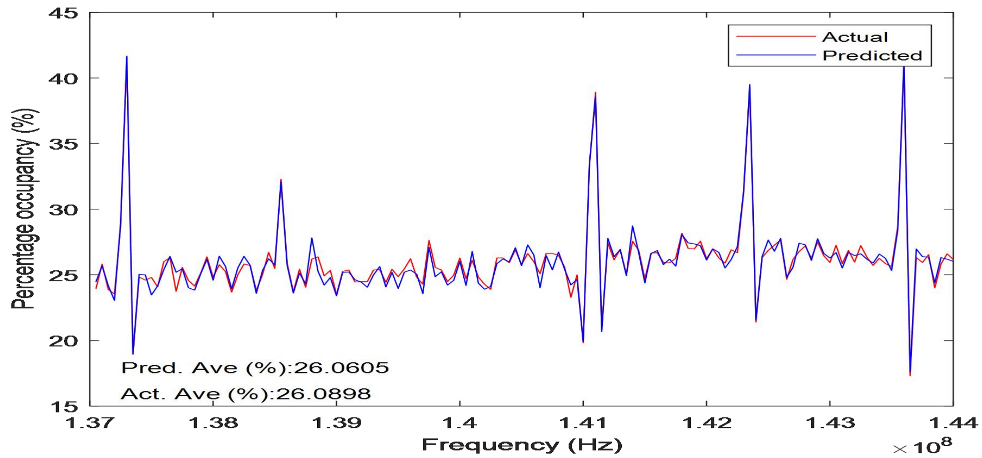


Figure 4.44: Performance Prediction for Spectrum Occupancy at Frequency Band of 137.05-144 MHz for AEDC

Figure 4.45 shows that most of the percentage errors fall below 1% while the highest error of 1.6% occurred at the frequency of 138.8 MHz.

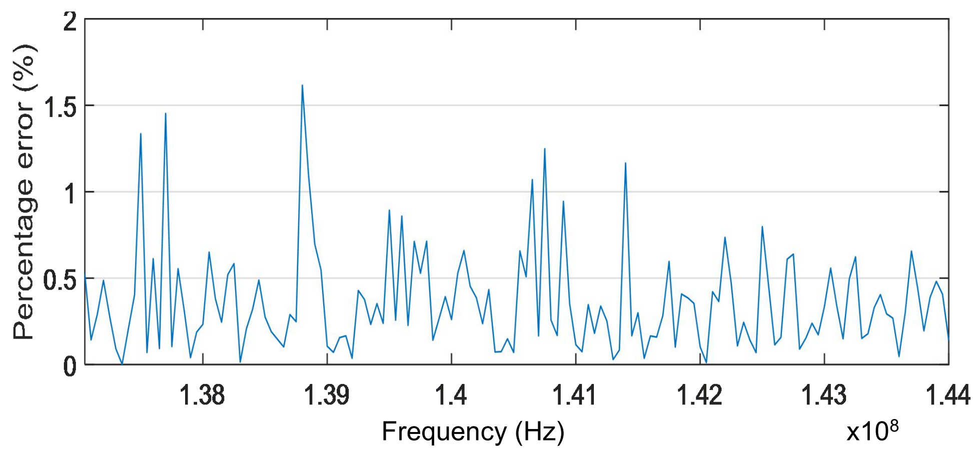


Figure 4.45: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 137.05-144 MHz for AEDC

4.3.8 Spectrum Occupancy Prediction for AEDC within Frequency Band of 144.05-174 MHz

Figure 4.46 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 1.44 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 144.05-174 MHz.

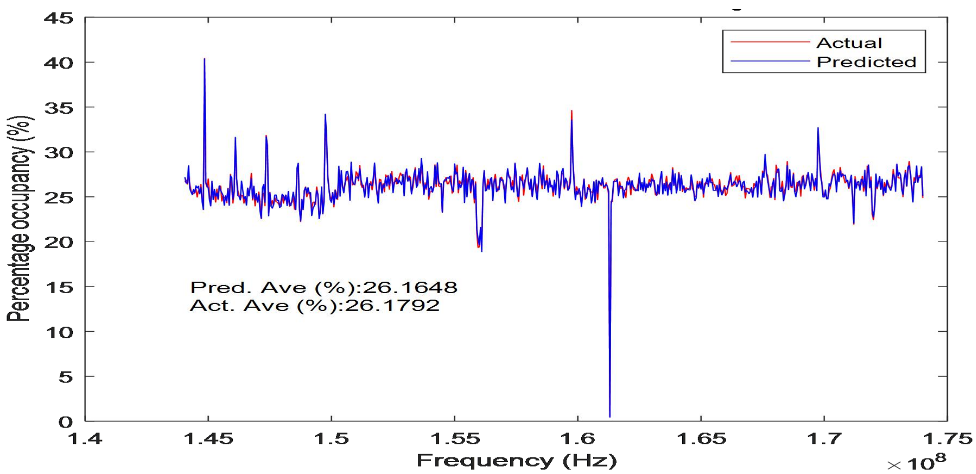


Figure 4.46 Performance Prediction for Spectrum Occupancy at Frequency Band of 144.05-174 MHz for AEDC

Figure 4.47 shows that most of the percentage errors fall below 1% while the highest error of 1.57% occurred at the frequency of 146.4 MHz.

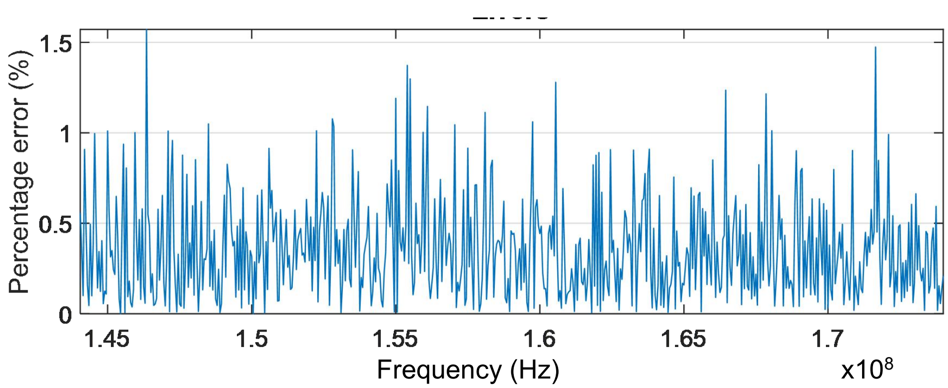


Figure 4.47: Percentage Error between Actual and Predicted Spectrum Occupancy values at 144.05-174 MHz for AEDC

4.3.9 Spectrum Occupancy Prediction for AEDC within Frequency Band of 174.05-200 MHz

Figure 4.48 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 8.42 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 174.05-200 MHz.

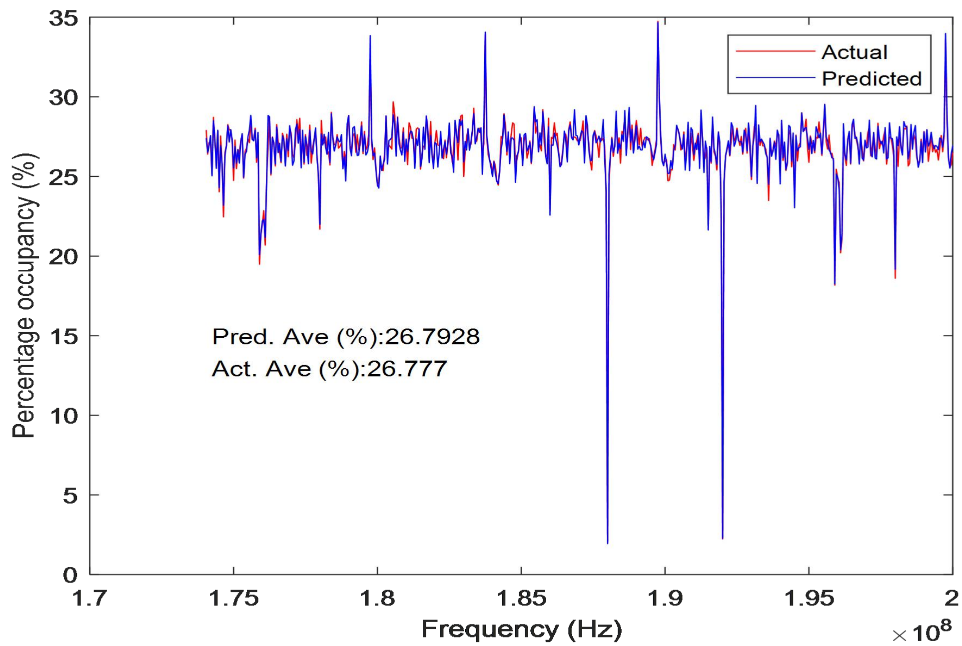


Figure 4.48 Performance Prediction for Spectrum Occupancy at Frequency Band of 174.05-200 MHz for AEDC

Figure 4.49 shows that most of the percentage errors fall below 1% while the highest error of 1.946% occurred at the frequency of 176.2 MHz.

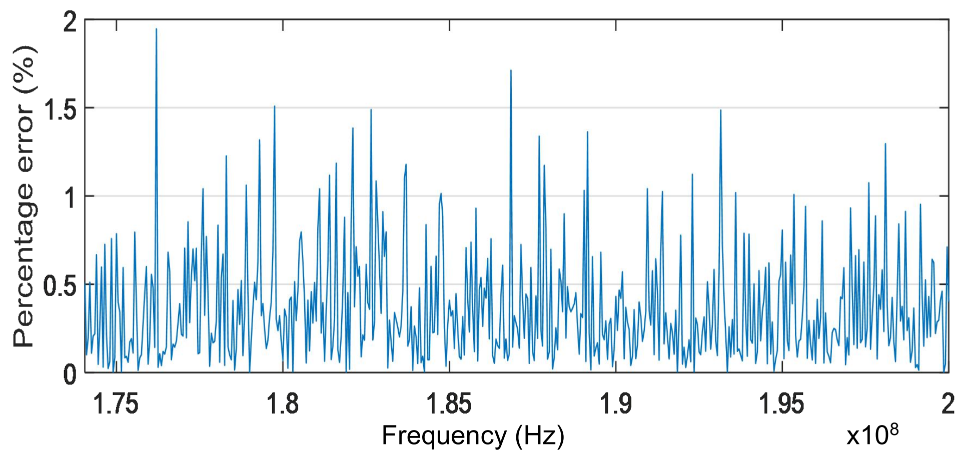


Figure 4.49: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 174.05-200 MHz for AEDC

4.3.10 Spectrum Occupancy Prediction for AEDC within Frequency Band of 200.05-230 MHz

Figure 4.50 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 2.19 x 10^{-2}% on the average when compared with that of the

measured values for the frequency band 200.05-230 MHz.

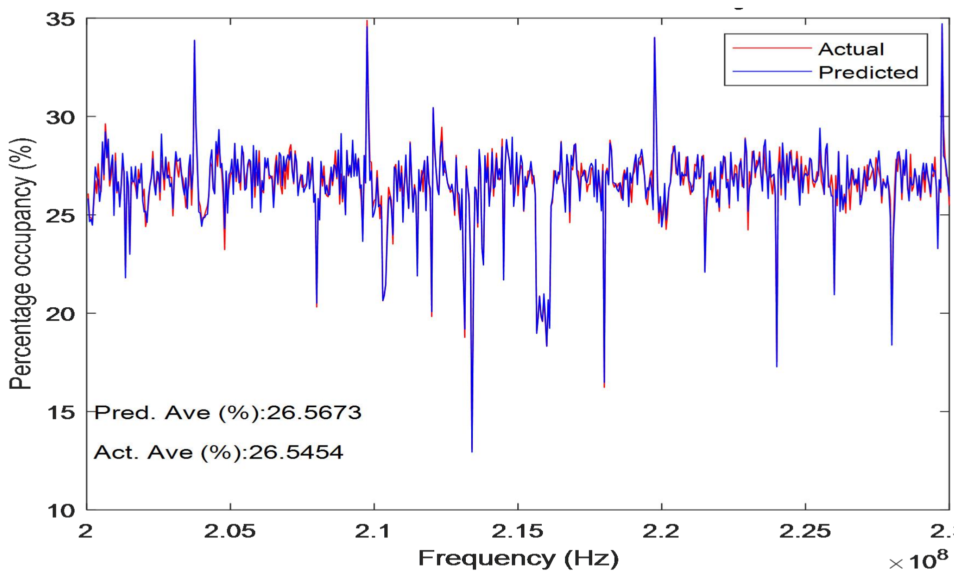


Figure 4.50: Performance Prediction for Spectrum Occupancy at Frequency Band of 200.05-230 MHz for AEDC

Figure 4.51 shows that most of the percentage errors fall below 1.5% while the highest error of 2.05% occurred at the frequency of 208.9 MHz.

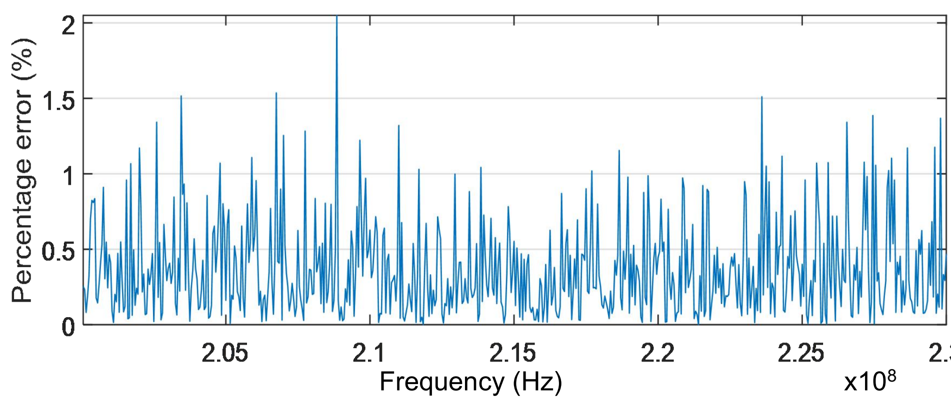


Figure 4.51: Percentage Error between Actual and Predicted Spectrum Occupancy values at 200.05-230 MHz for AEDC

4.3.11 Spectrum Occupancy Prediction for AEDC within Frequency Band of 230.05-267 MHz

Figure 4.52 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 0.07 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 230.05-267 MHz.

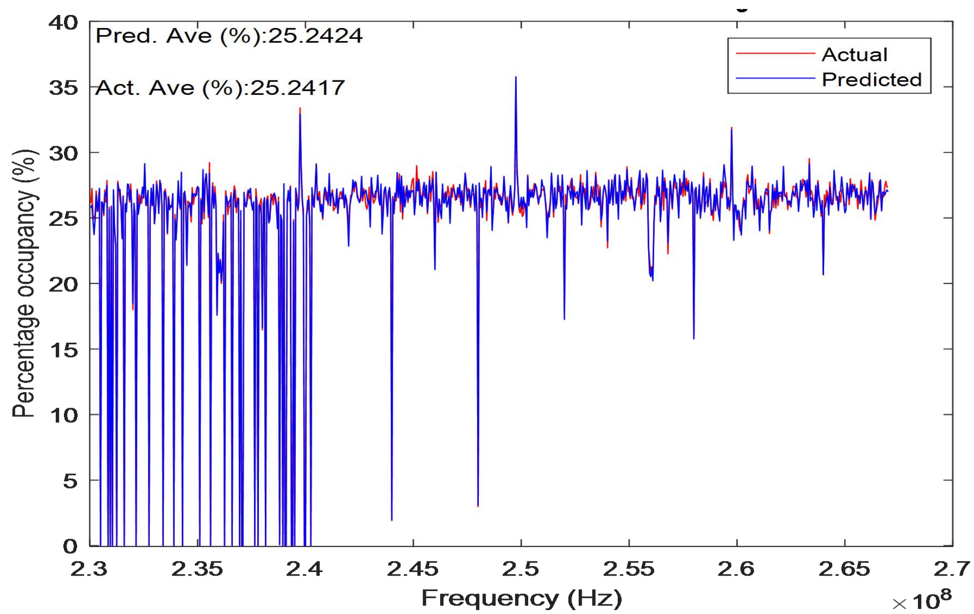


Figure 4.52: Performance Prediction for Spectrum Occupancy at Frequency Band of 230.05-267 MHz for AEDC

Figure 4.53 shows that most of the percentage errors fall below 1% while the highest error of 1.728% occurred at the frequency of 257.3 MHz.

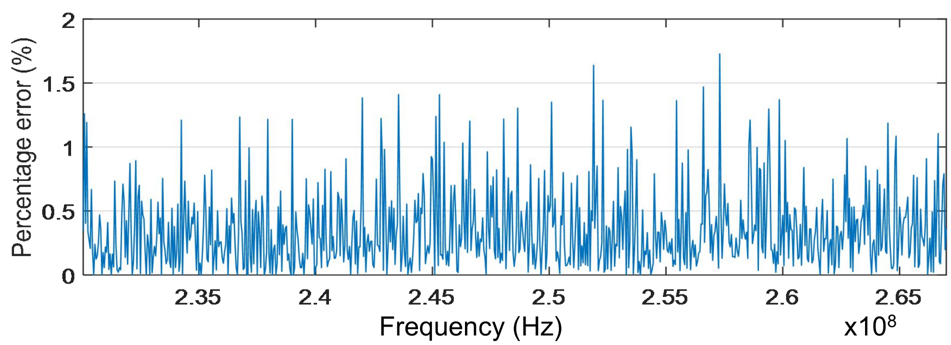


Figure 4.53: Percentage Error between Actual and Predicted Spectrum Occupancy values at 230.05-267 MHz for AEDC

4.3.12 Spectrum Occupancy Prediction for AEDC within Frequency Band of 267.05-300 MHz

Figure 4.54 shows the result of the Spectrum Occupancy prediction for AEDC with a percentage difference of 1.68×10^{-2}% on the average when compared with that of the measured values for the frequency band 267.05-300

MHz.

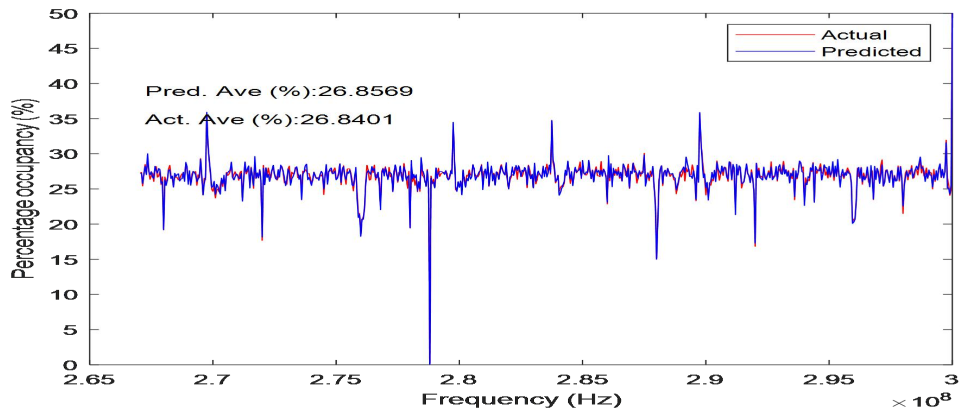


Figure 4.54: Performance Prediction for Spectrum Occupancy at Frequency Band of 267.05-300 MHz for AEDC

Figure 4.55 shows that most of the percentage errors fall below 1% while the highest error of 19.37 x 10^{-1}% occurred at the frequency of 289.5 MHz.

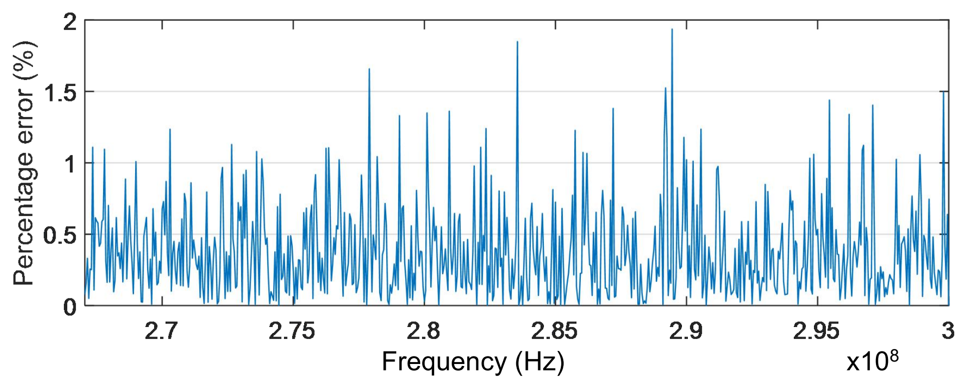


Figure 4.55: Percentage Error between Actual and Predicted Spectrum Occupancy values at 267.05-300 MHz for AEDC

4.3.13 Summary of Spectrum Occupancy Prediction for AEDC

Figure 4.56 shows that the maximum percentage difference between the actual and predicted values of 8.42 x 10^{-2}% occurred at the frequency band of 174.05-200 MHz while the lowest percentage differences of 0.06x10^{-2}% and 0.07x10^{-2}% at two frequency bands of 47.05-68 MHz and 230.05-267 MHz respectively.

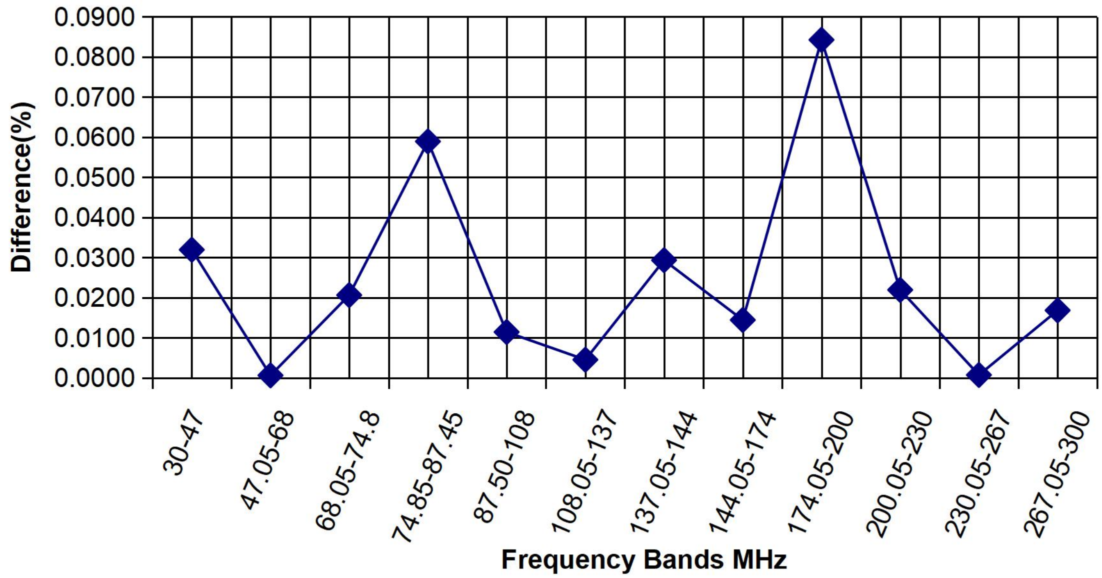


Figure 4.56: Percentage Difference Comparison of Performance Prediction for Spectrum Occupancy at various Frequency bands in AEDC

4.4 Spectrum Occupancy Prediction for TUNGA

The actual Spectrum Occupancy of each band for TUNGA is presented and discussed while performance at different frequency bands predicted using ANN are compared with the measured values.

4.4.1 Spectrum Occupancy Prediction for TUNGA within Frequency Band of 30-47 MHz

On the average, Figure 4.57 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 11.38 x 10^{-2}% as compared with that of the measured values for the frequency band 30-47 MHz.

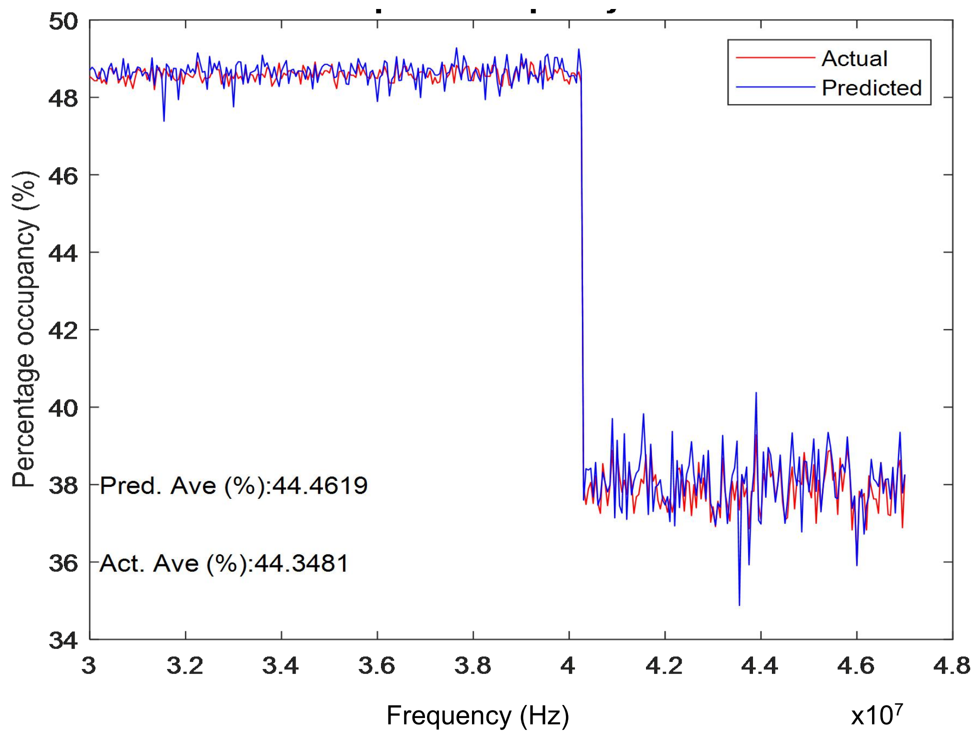


Figure 4.57: Performance Prediction for Spectrum Occupancy at Frequency Band of 30-47 MHz for TUNGA

As seen in Figure 4.58, most of the percentage errors fall below 1%. The highest error of 2.46 x 10^{-2}% occurred at the frequency of 43.55 MHz.

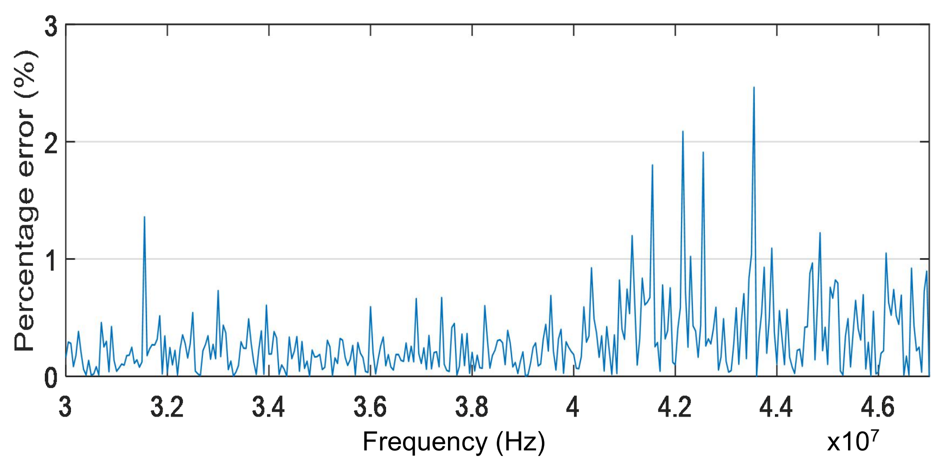


Figure 4.58: Percentage Error between Actual and Predicted Spectrum Occupancy values at 30-47 MHz for TUNGA

4.4.2 Spectrum Occupancy Prediction for TUNGA using within Frequency Band

of 47.05-68 MHz

Figure 4.59 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 8.71 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 47.05-68 MHz.

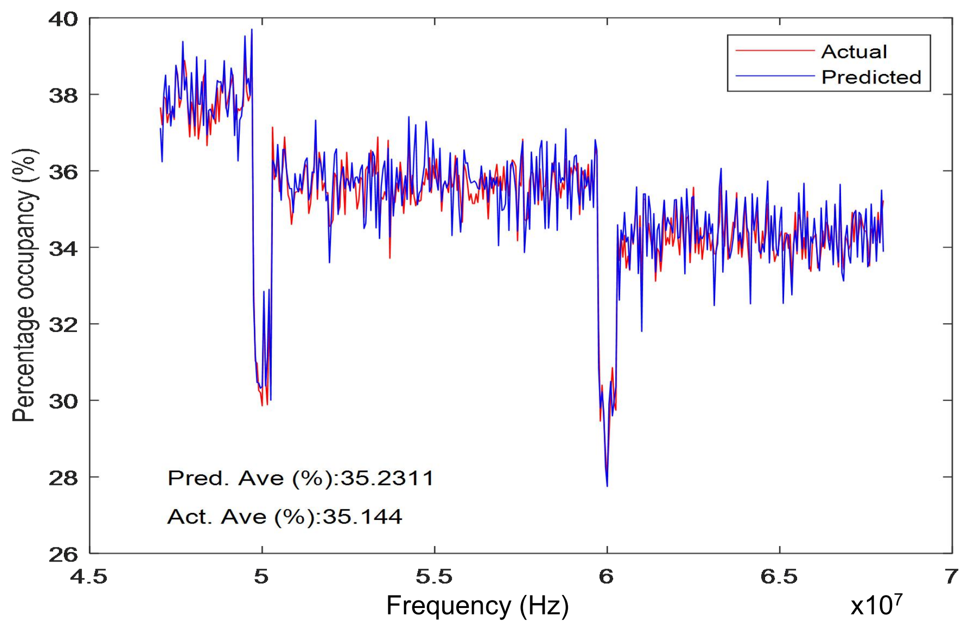


Figure 4.59: Performance Prediction for Spectrum Occupancy at Frequency Band of 47.05-68 MHz for TUNGA

Figure 4.60 shows that most of the percentage errors fall below 1.5%. The highest error of 2.12% occurred at the frequency of 54.45 MHz.

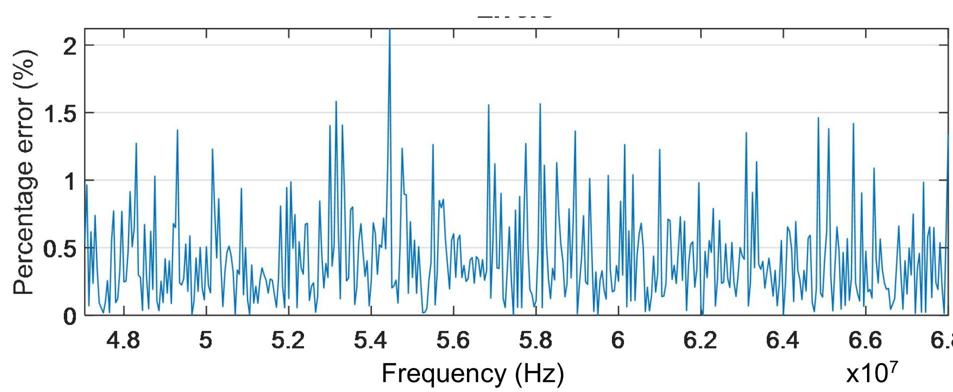


Figure 4.60: Percentage Error between Actual and Predicted Spectrum Occupancy values at 47-68 MHz for TUNGA

4.4.3 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

68.05-74.8 MHz

Figure 4.61 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 7.71 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 68.05-74.8 MHz.

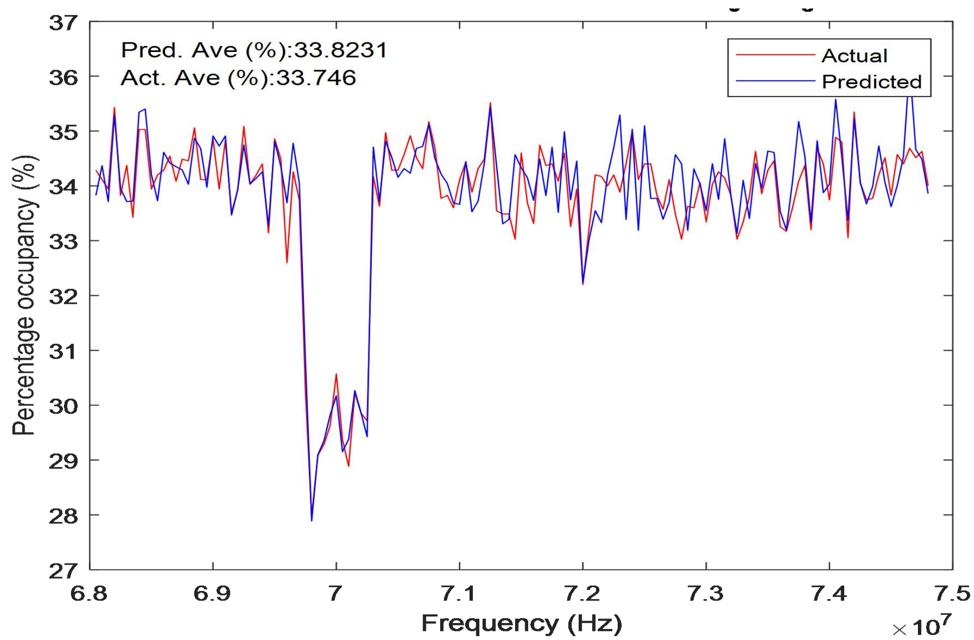


Figure 4.61: Performance Prediction for Spectrum Occupancy at Frequency Band of 68.05-74.8 MHz for TUNGA

Figure 4.62 shows that most of the percentage errors fall below 1% while the highest error of 1.54% occurred at the frequency of 71.45 MHz.

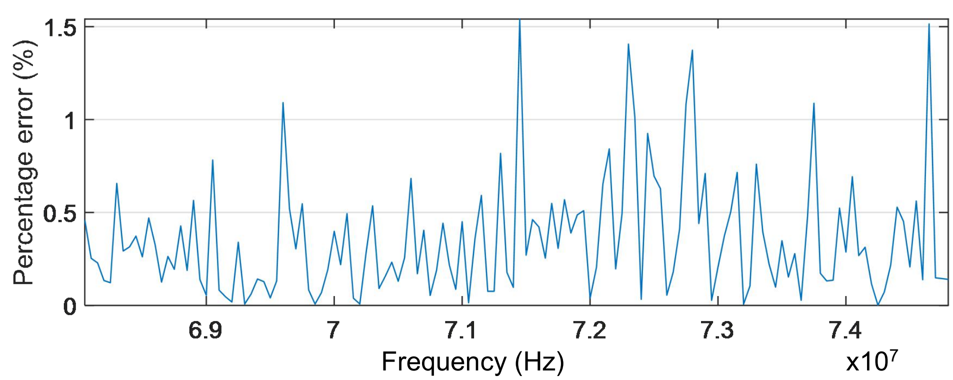


Figure 4.62: Percentage Error between Actual and Predicted Spectrum Occupancy values at 68.05-74.8 MHz for TUNGA

4.4.4 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

74.85-87.45 MHz

Figure 4.63 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 5.19 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 74.85-87.45 MHz.

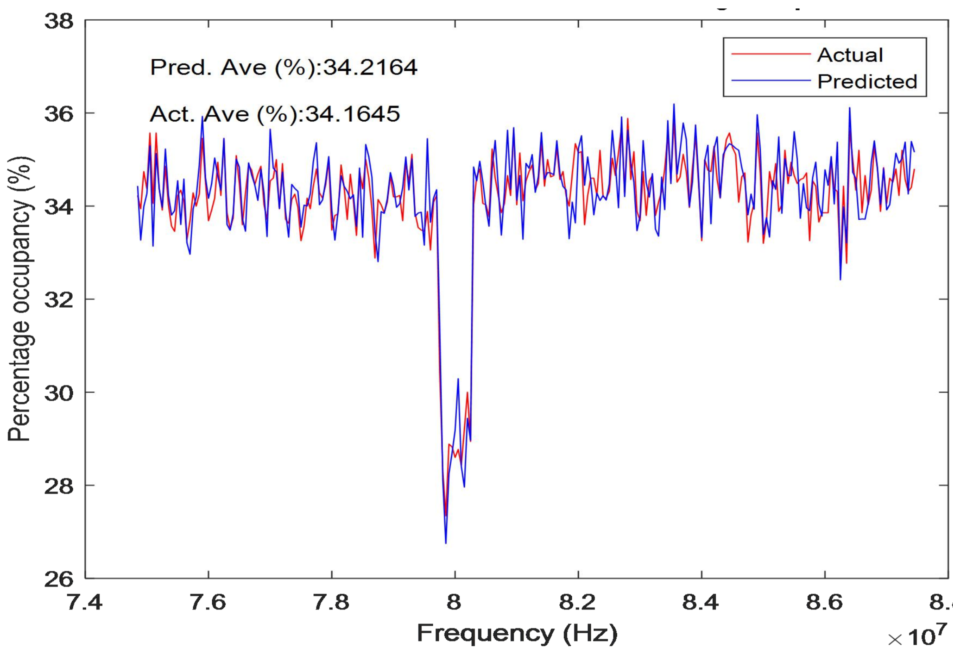


Figure 4.63: Performance Prediction for Spectrum Occupancy at Frequency Band of 74.85-87.45 MHz for TUNGA

Figure 4.64 shows that most of the percentage errors fall below 1% while the highest error of 1.71% occurred at the frequency of 81.95 MHz.

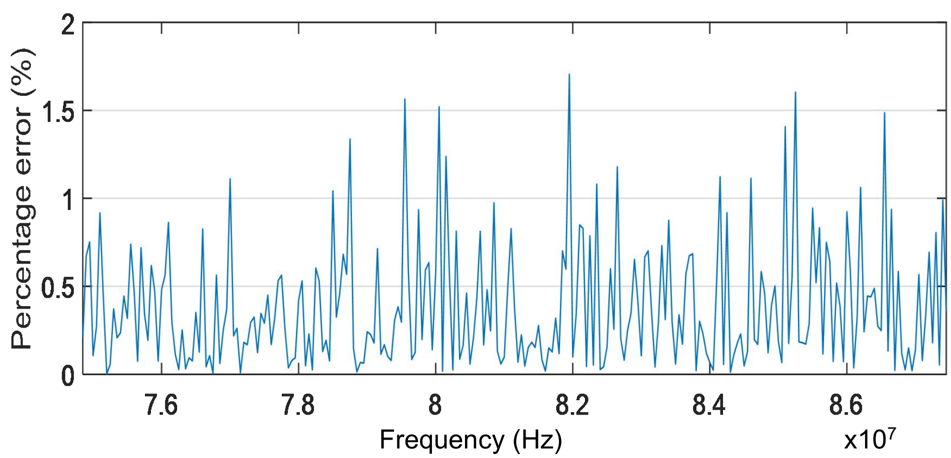


Figure 4.64: Percentage Error between Actual and Predicted Spectrum Occupancy values at 74.85-87.45 MHz for TUNGA

4.4.5 Spectrum Occupancy Prediction for TUNGA within Frequency Band of 87.50-108 MHz

Figure 4.65 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 5.62×10^{-2}% on the average as compared with that of the measured values for the frequency band of 87.50-108 MHz.

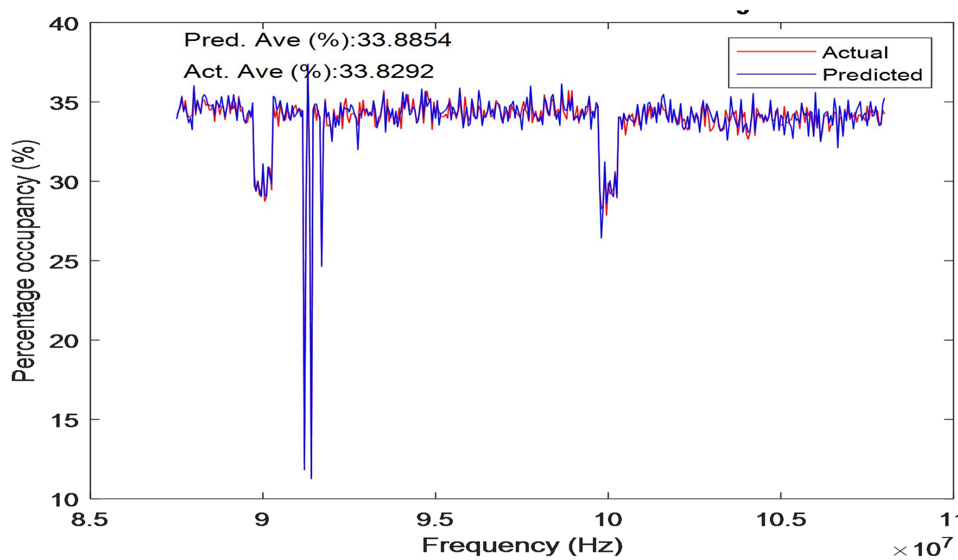


Figure 4.65: Performance Prediction for Spectrum Occupancy at Frequency Band of 87.50-108 MHz for TUNGA

Figure 4.66 shows that most of the percentage errors fall below 1% while the highest error of 1.83% occurred at the frequency of 99.8 MHz.

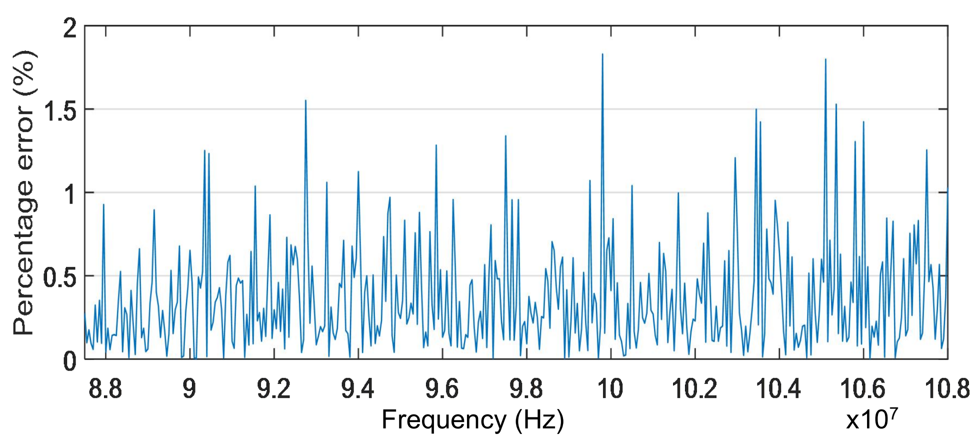


Figure 4.66: Percentage Error between Actual and Predicted Spectrum Occupancy values at 87.50-108 MHz for TUNGA

4.4.6 Spectrum Occupancy Prediction for TUNGA using within Frequency Band of 108.05-137 MHz

Figure 4.67 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 5.0 x 10^{-2}% on the average as compared with that of the measured values for the frequency band 108.05-137 MHz.

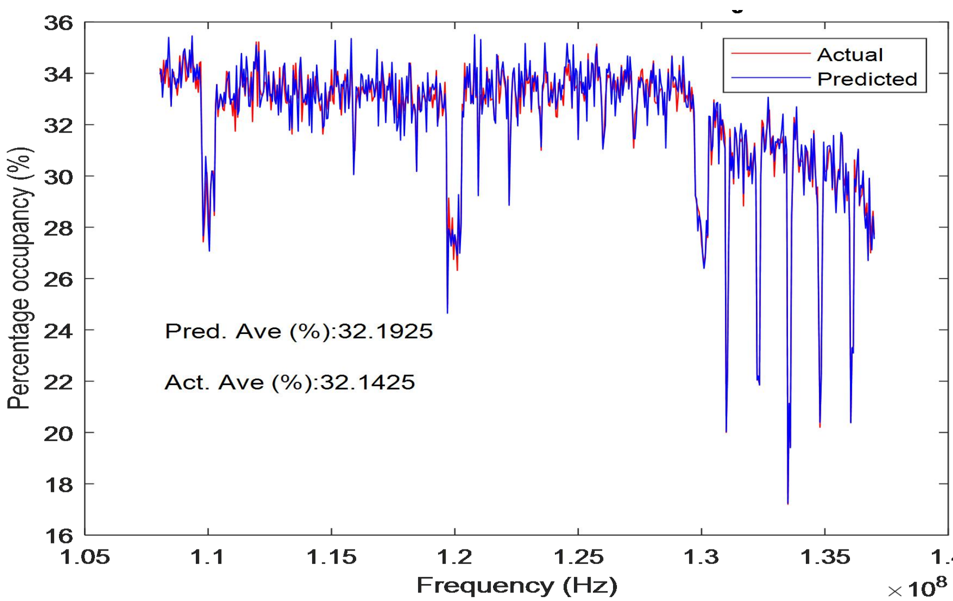


Figure 4.67 Performance Prediction for Spectrum Occupancy at Frequency Band of 108.05-137 MHz for TUNGA

Figure 4.68 shows that most of the percentage errors fall below 1.5% while the highest error of 2.1% occurred at the frequency of 121.1 MHz.

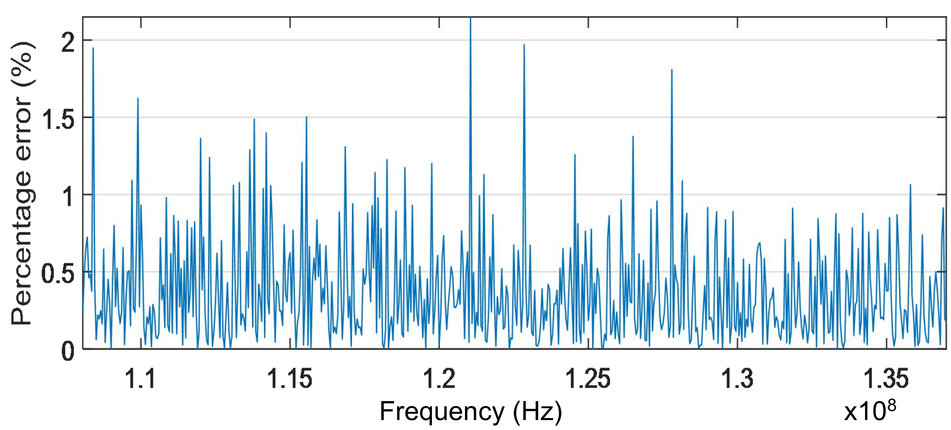


Figure 4.68 Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 108.05-137 MHz for TUNGA

4.4.7 Spectrum Occupancy Prediction for TUNGA within Frequency Band of 137.05-144 MHz

Figure 4.69 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 2.05 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 137.05-144 MHz.

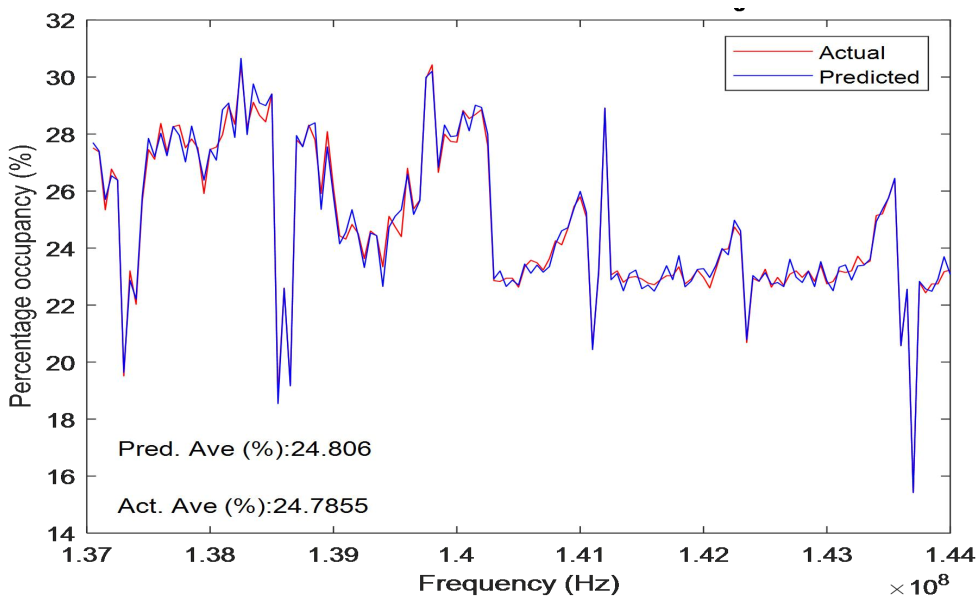


Figure 4.69: Performance Prediction for Spectrum Occupancy at Frequency Band of 137.05-144 MHz for TUNGA

Figure 4.70 shows that all of the percentage errors fall below 1% while the highest error of 94.45 x 10^{-2}% occurred at the frequency of 139.6 MHz.

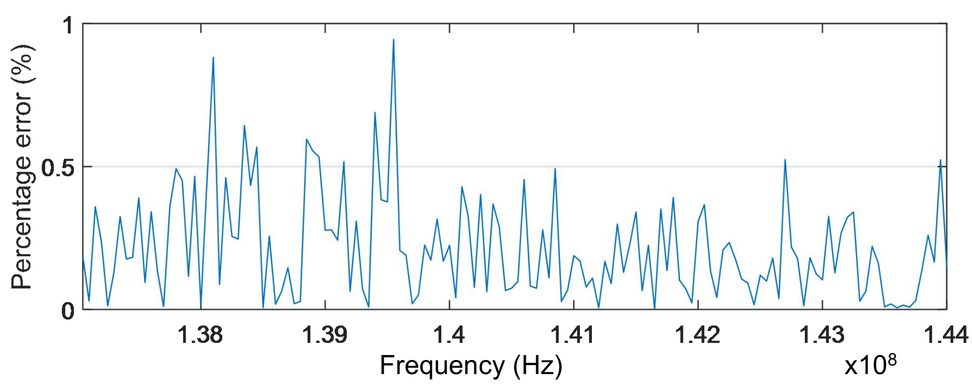


Figure 4.70: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 137.05-144 MHz for TUNGA

4.4.8 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

144.05-174 MHz

Figure 4.71 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 3.17 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 144.05-174 MHz.

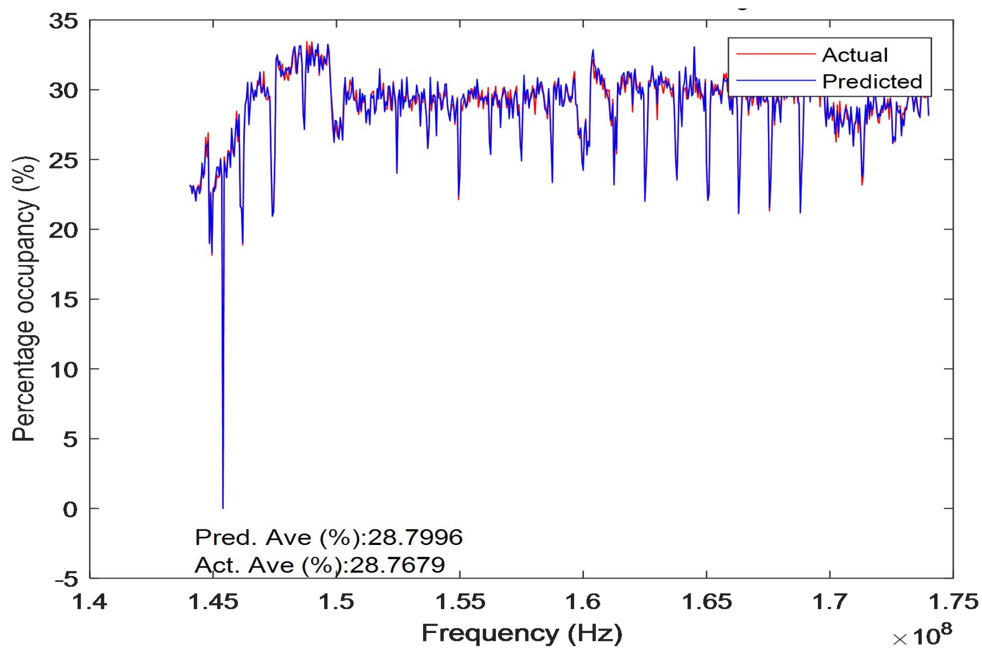


Figure 4.71 Performance Prediction for Spectrum Occupancy at Frequency Band of 144.05-174 MHz for TUNGA

Figure 4.72 shows that most of the percentage errors fall below 1% while the highest error of 1.46% occurred at the frequency of 164.2 MHz.

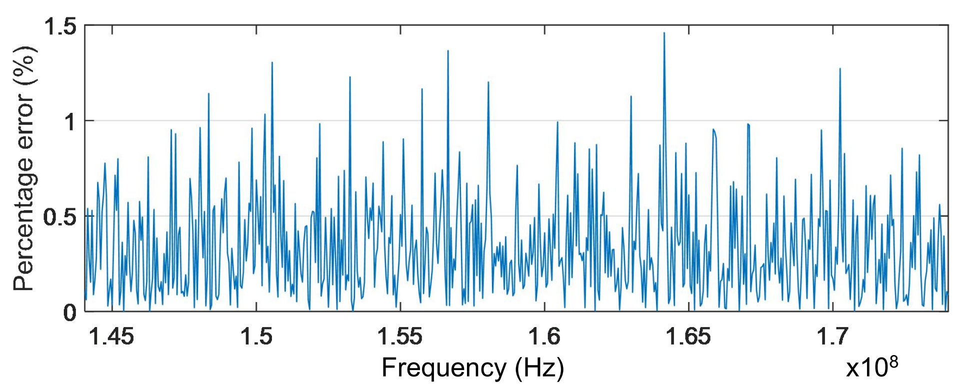


Figure 4.72: Percentage Error between Actual and Predicted Spectrum Occupancy values at 144.05-174 MHz for TUNGA

4.4.9 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

174.05-200 MHz

Figure 4.73 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 1.42 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 174.05-200 MHz.

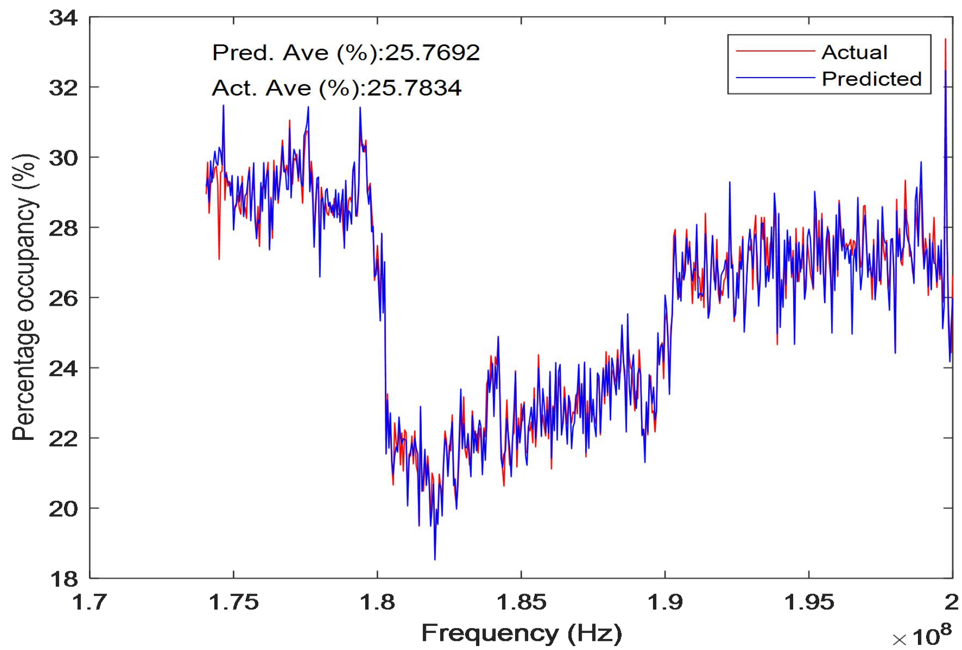


Figure 4.73 Performance Prediction for Spectrum Occupancy at Frequency Band of 174.05-200 MHz for TUNGA

Figure 4.74 shows that most of the percentage errors fall below 1% while the highest error of 31.97 x 10^{-1}% occurred at the frequency of 174.5 MHz.

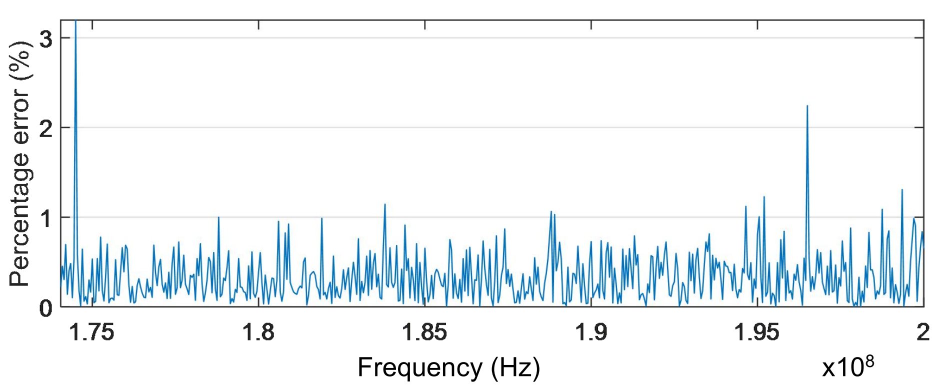


Figure 4.74: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 174.05-200 MHz for TUNGA

4.4.10 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

200.05-230 MHz

Figure 4.75 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 0.01 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 200.05-230 MHz.

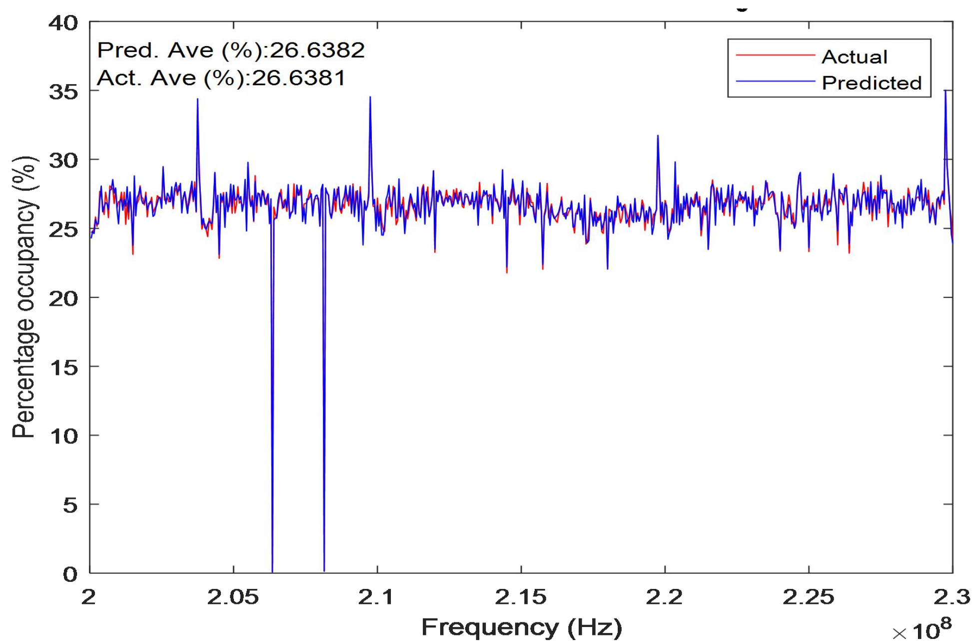


Figure 4.75: Performance Prediction for Spectrum Occupancy at Frequency Band of 200.05-230 MHz for TUNGA

Figure 4.76 shows that most of the percentage errors fall below 1.5% while the highest error of 1.7% occurred at the frequency of 223 MHz.

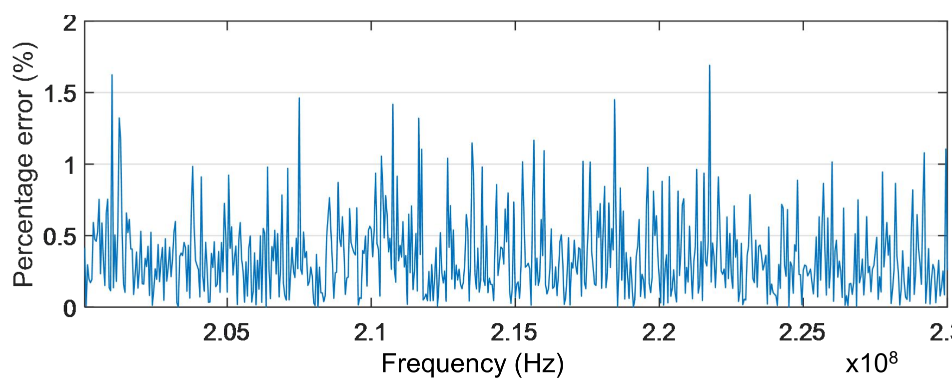


Figure 4.76: Percentage Error between Actual and Predicted Spectrum Occupancy values at 200.05-230 MHz for TUNGA

4.4.11 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

230.05-267 MHz

Figure 4.77 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 3.36 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 230.05-267 MHz.

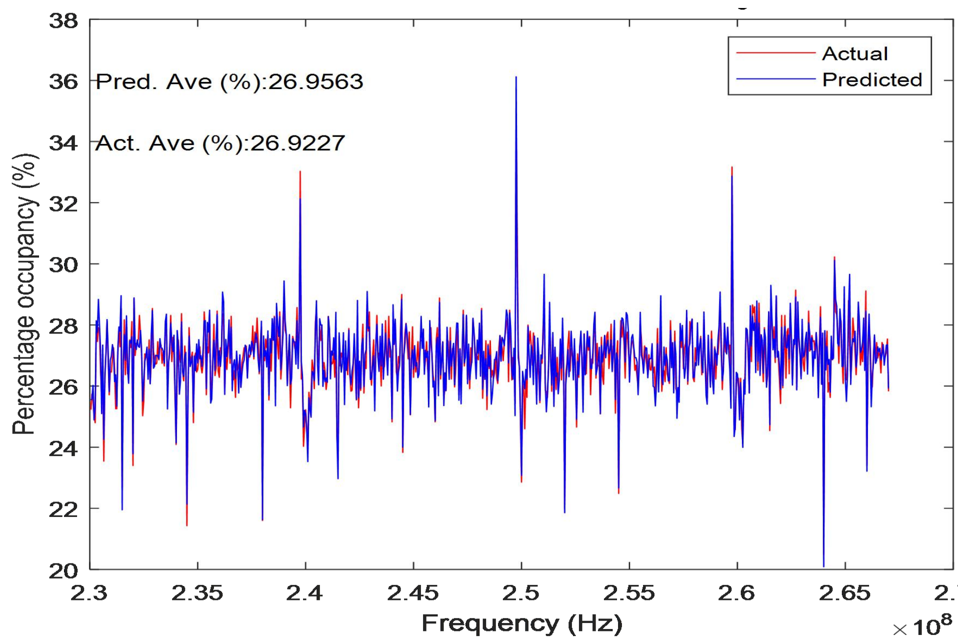


Figure 4.77: Performance Prediction for Spectrum Occupancy at Frequency Band of 230.05-267 MHz for TUNGA

Figure 4.78 shows that most of the percentage errors fall below 1.5% while the highest error of 2.34% occurred at the frequency of 265.2 MHz.

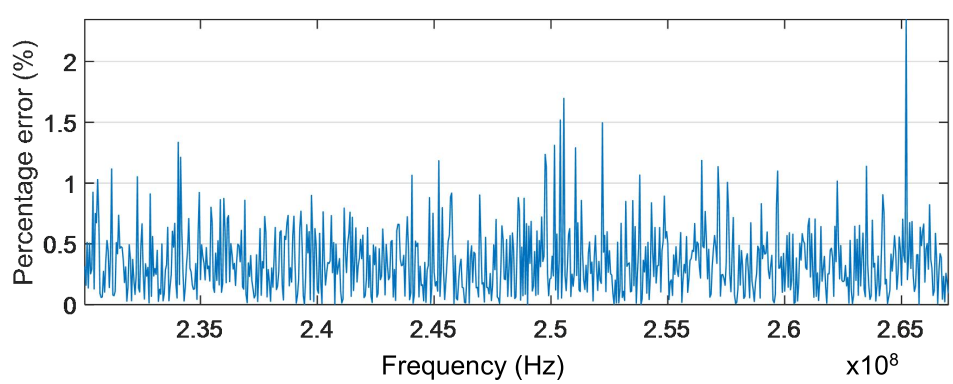


Figure 4.78: Percentage Error between Actual and Predicted Spectrum Occupancy values at 230.05-267 MHz for TUNGA

4.4.12 Spectrum Occupancy Prediction for TUNGA within Frequency Band of

267.05-300 MHz

Figure 4.79 shows the result of the Spectrum Occupancy prediction for TUNGA with a percentage difference of 3.80 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 267.05-300 MHz.

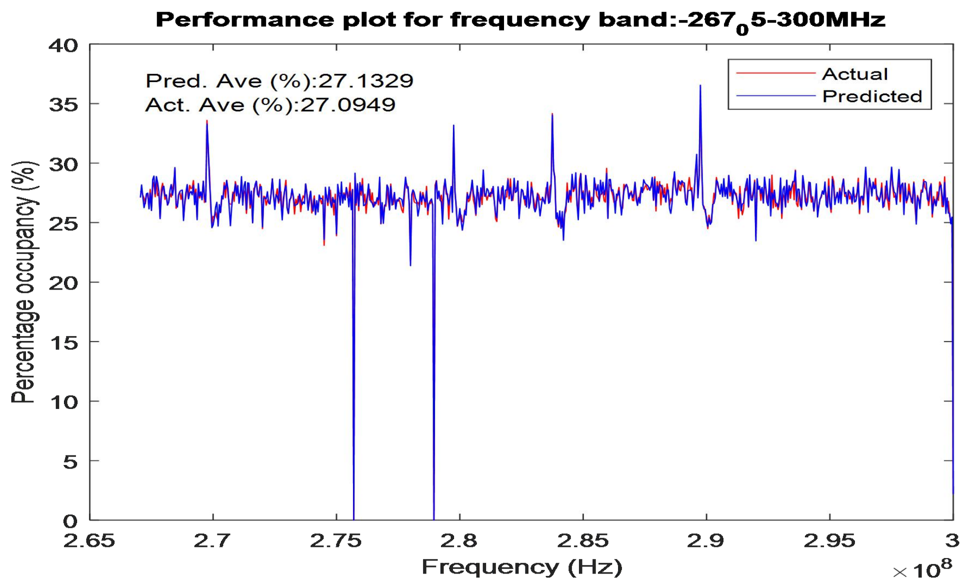


Figure 4.79: Performance Prediction for Spectrum Occupancy at Frequency Band of 267.05-300 MHz for TUNGA

Figure 4.80 shows that most of the percentage errors fall below 1.5% while the highest error of 1.81% occurred at the frequency of 270.7 MHz.

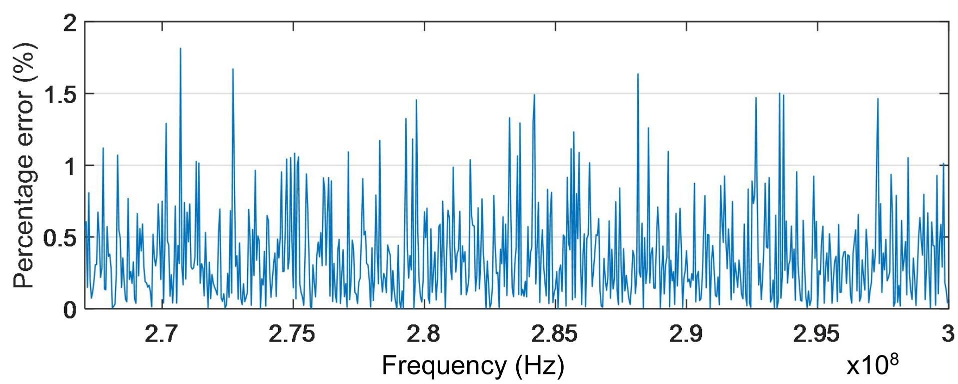


Figure 4.80: Percentage Error between Actual and Predicted Spectrum Occupancy values at 267.05-300 MHz for TUNGA

4.4.13 Summary of Spectrum Occupancy Prediction for TUNGA

Figure 4.81 shows that the maximum percentage difference between the actual and predicted values of 11.38 x 10^{-2}% occurred at the frequency band of 30-47 MHz while the lowest percentage difference approximated to 0.01 x 10^{-2}% occurred in a frequency band of 200.05-230 MHz.

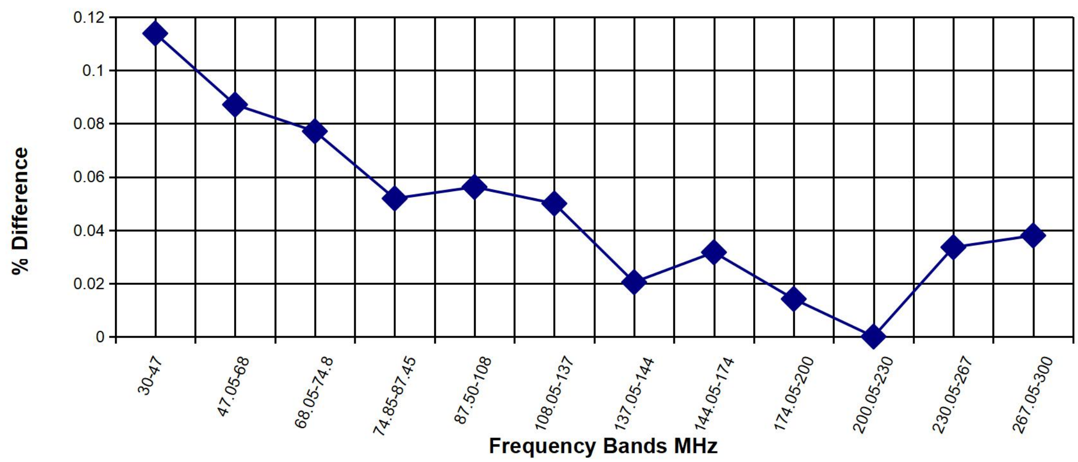


Figure 4.81: Percentage Difference Comparison of Performance Prediction for Spectrum Occupancy at various Frequency bands in TUNGA

4.5 Spectrum Occupancy Prediction for KUBWA

In this section, the actual Spectrum Occupancy of each band for KUBWA are presented and discussed. Performance at different frequency bands predicted using ANN are compared with the measured values.

4.5.1 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 30-47 MHz

On average, Figure 4.82 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 5.12 x 10^{-2}% as compared with that of the measured values for the frequency band 30-47 MHz.

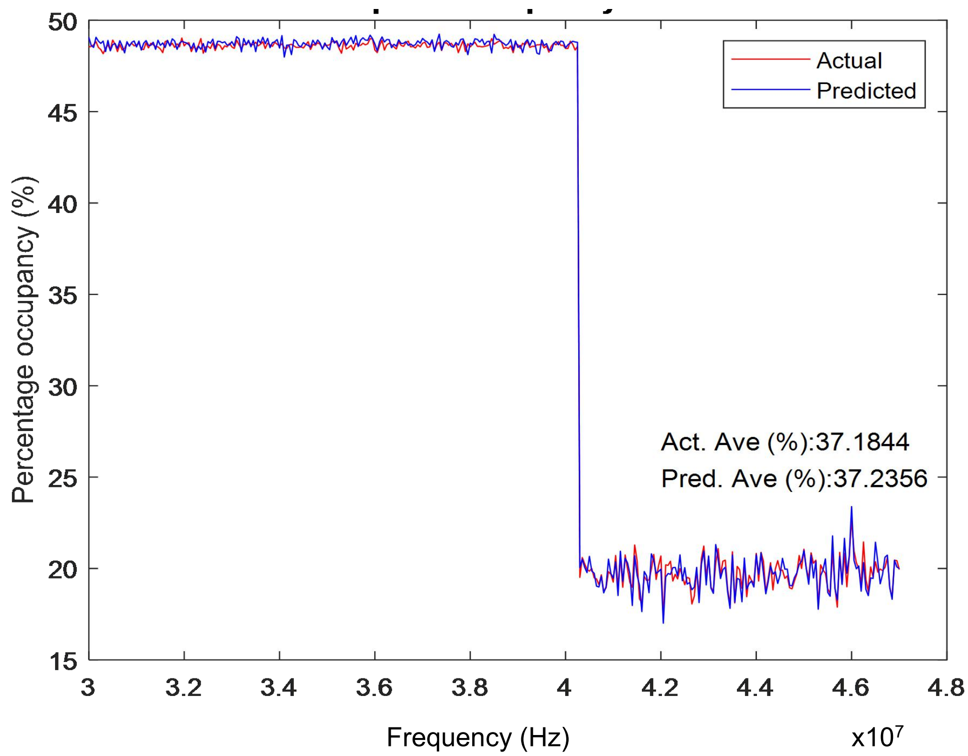


Figure 4.82: Performance Prediction for Spectrum Occupancy at Frequency Band of 30-47 MHz for KUBWA

As seen in Figure 4.83, most of the percentage errors fall below 1%. The highest error of 1.245% occurred at the frequency of 44.45 MHz.

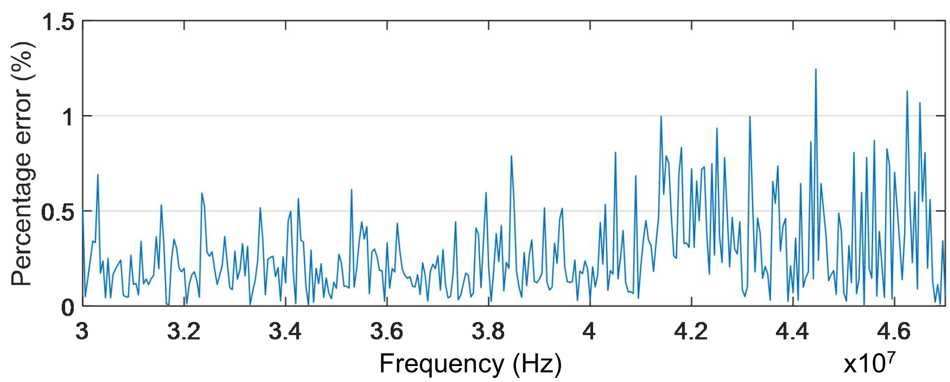


Figure 4.83: Percentage Error between Actual and Predicted Spectrum Occupancy values at 30-47 MHz for KUBWA

4.5.2 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 47.05-68 MHz

Figure 4.84 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 1.31 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 47.05-68 MHz.

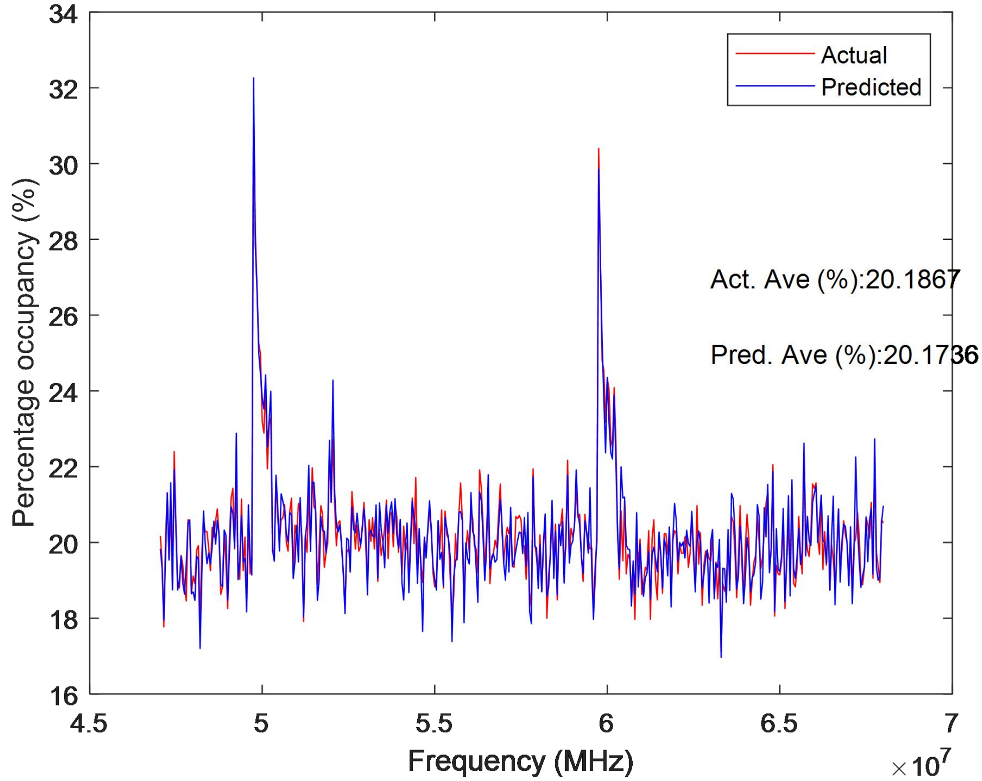


Figure 4.84: Performance Prediction for Spectrum Occupancy at Frequency Band of 47.05-68 MHz for KUBWA

Figure 4.85 shows that most of the percentage errors fall below 1.5%. The highest error of 21.41 x 10^{-1}% occurred at the frequency of 67.2 MHz.

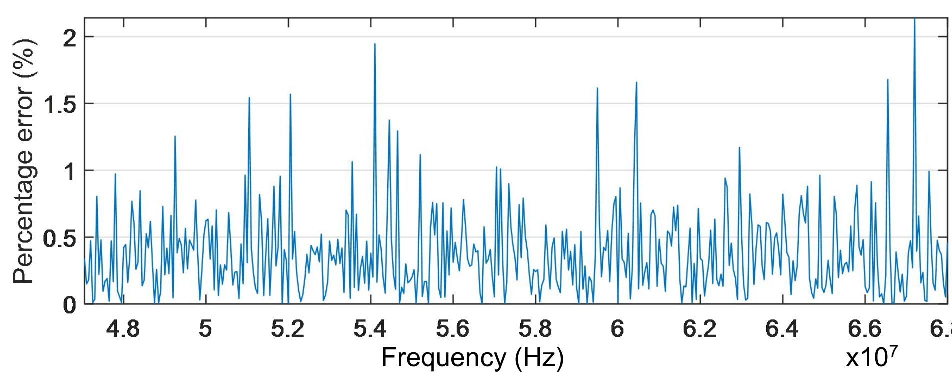


Figure 4.85: Percentage Error between Actual and Predicted Spectrum Occupancy values at 47-68 MHz for KUBWA

4.5.3 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 68.05-74.8 MHz

Figure 4.86 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 3.97 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 68.05-74.8 MHz.

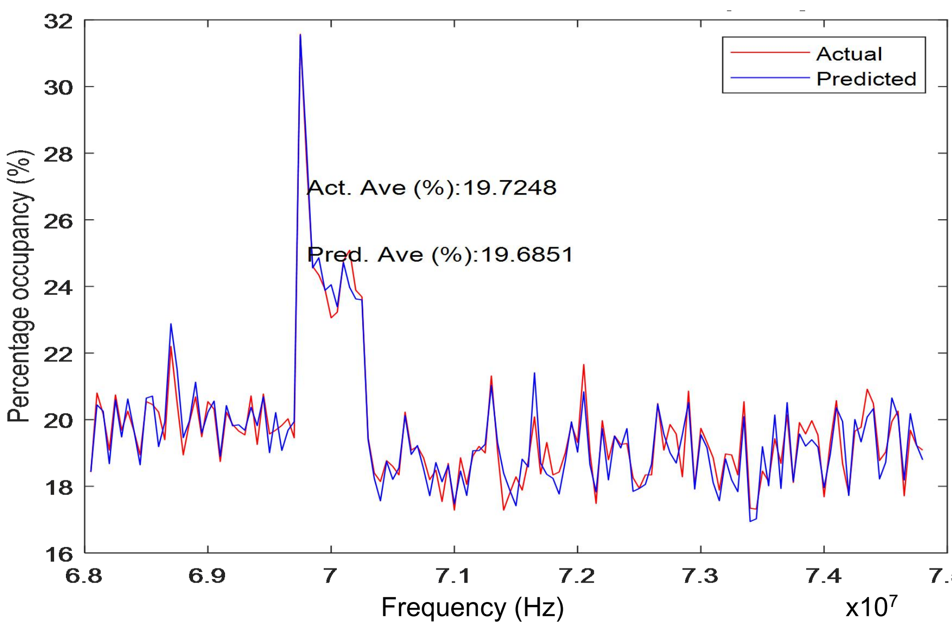


Figure 4.86: Performance Prediction for Spectrum Occupancy at Frequency Band of 68.05-74.8 MHz for KUBWA

Figure 4.87 shows that most of the percentage errors fall below 1% while the highest error of 13.23 x 10^{-1}% occurred at the frequency of 71.65 MHz.

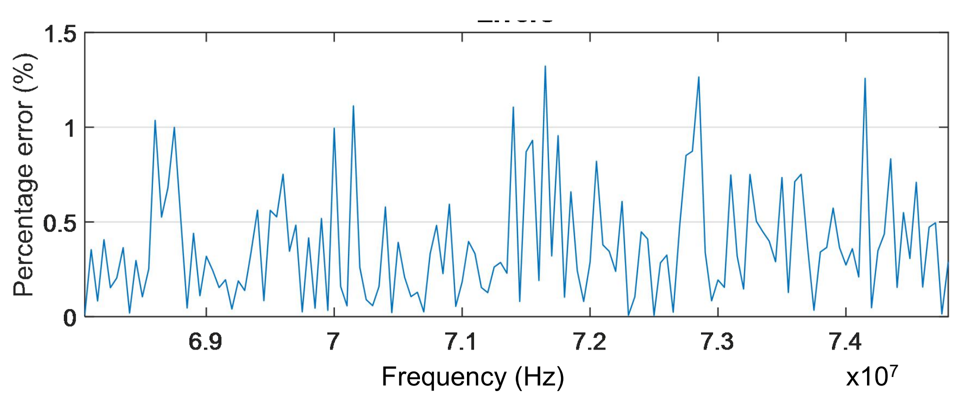


Figure 4.87: Percentage Error between Actual and Predicted Spectrum Occupancy values at 68.05-74.8 MHz for KUBWA

4.5.4 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 74.85-87.45 MHz

Figure 4.88 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 0.56×10^{-2}% on the average as compared with that of the measured values for the frequency band of 74.85-87.45 MHz.

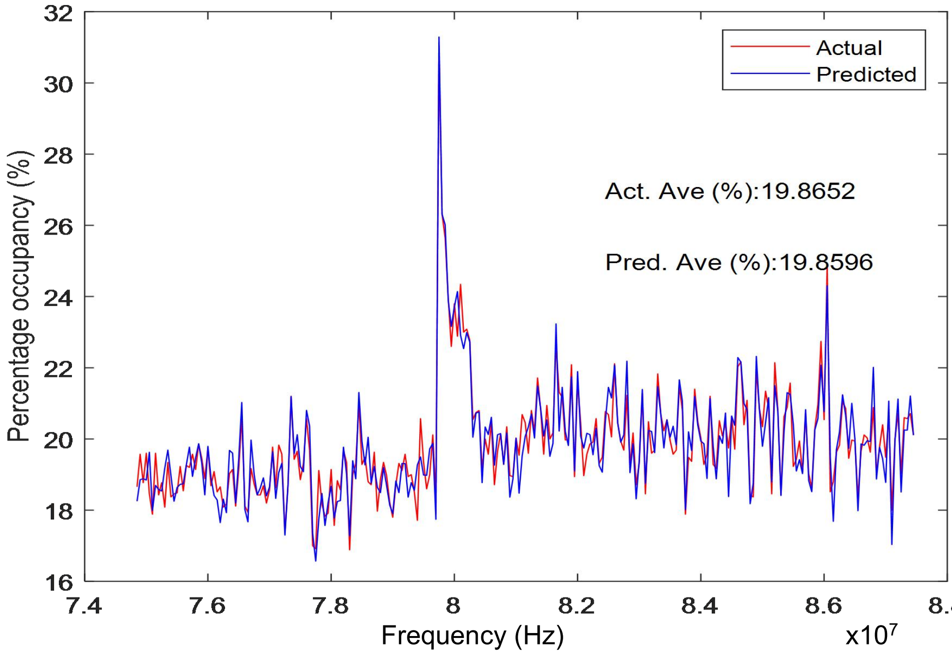


Figure 4.88: Performance Prediction for Spectrum Occupancy at Frequency Band of 74.85-87.45 MHz for KUBWA

Figure 4.89 shows that most of the percentage errors fall below 1% while the highest error of 1.56% occurred at the frequency of 79.4 MHz.

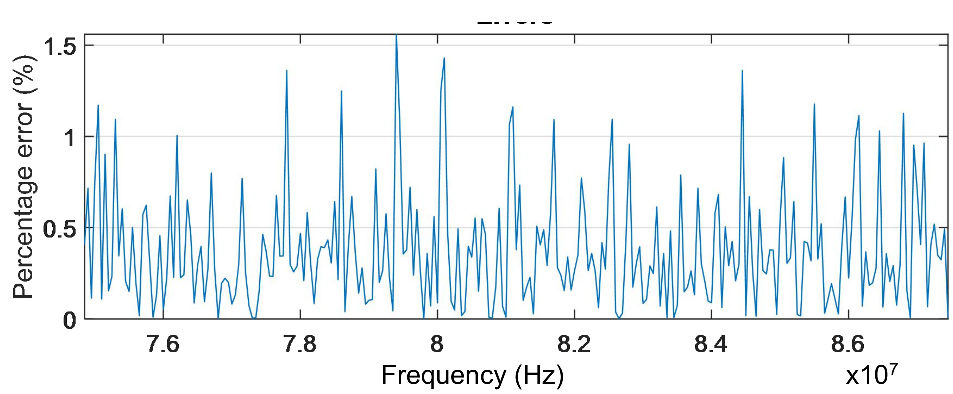


Figure 4.89: Percentage Error between Actual and Predicted Spectrum Occupancy values at 74.85-87.45 MHz for KUBWA

4.5.5 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 87.50-108 MHz

Figure 4.90 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of $4.76 \times 10^{-2}\%$ on the average as compared with that of the measured values for the frequency band of 87.50-108 MHz.

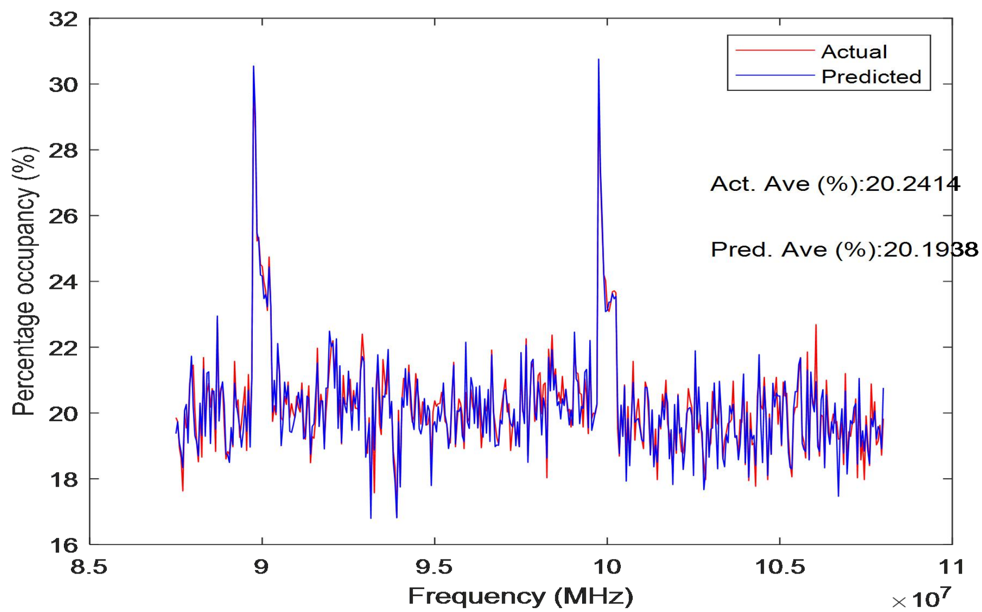


Figure 4.90: Performance Prediction for Spectrum Occupancy at Frequency Band of 87.50-108 MHz for KUBWA

Figure 4.91 shows that most of the percentage errors fall below 1% while the highest error of $17.31 \times 10^{-1}\%$ occurred at the frequency of 106.1 MHz.

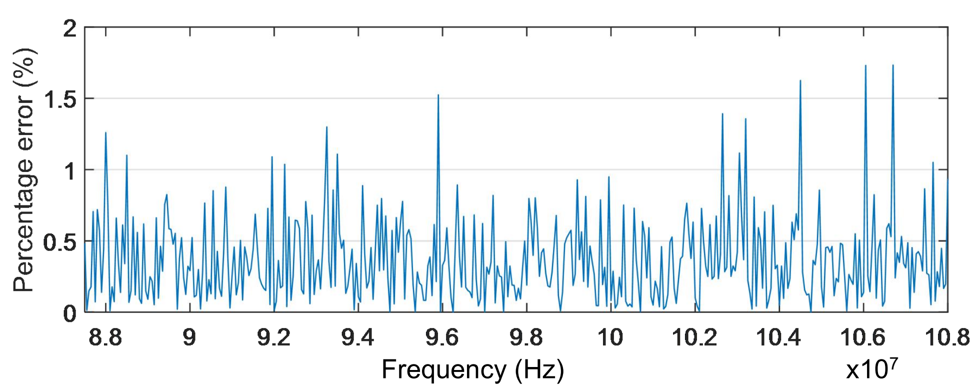


Figure 4.91: Percentage Error between Actual and Predicted Spectrum Occupancy values at 87.50-108 MHz for KUBWA

4.5.6 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 108.05-137 MHz

Figure 4.92 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 7.12 x 10^{-2}% on the average as compared with that of the measured values for the frequency band 108.05-137 MHz.

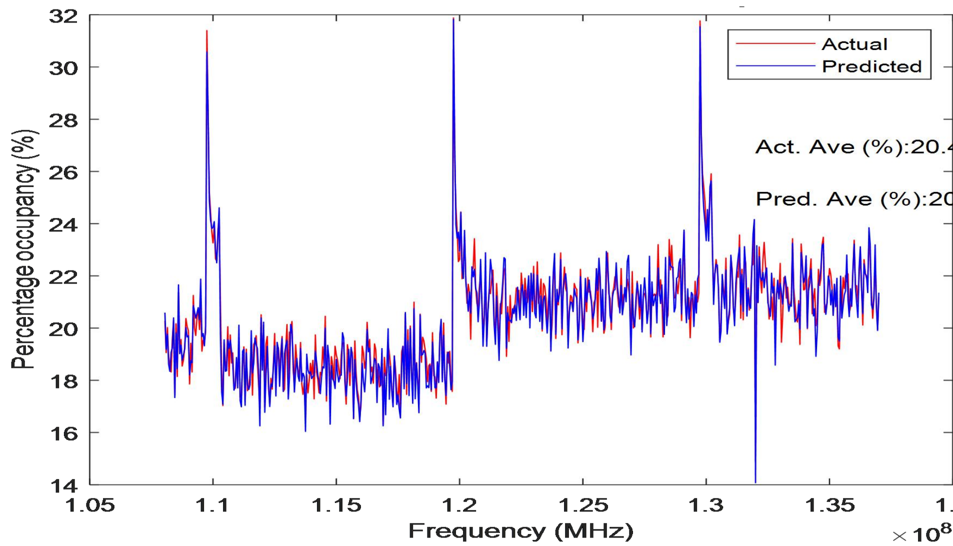


Figure 4.92: Performance Prediction for Spectrum Occupancy at Frequency Band of 108.05-137 MHz for KUBWA

Figure 4.93 shows that most of the percentage errors fall below 1.5% while the highest error of 19.52 x 10^{-1}% occurred at the frequency of 133.1 MHz.

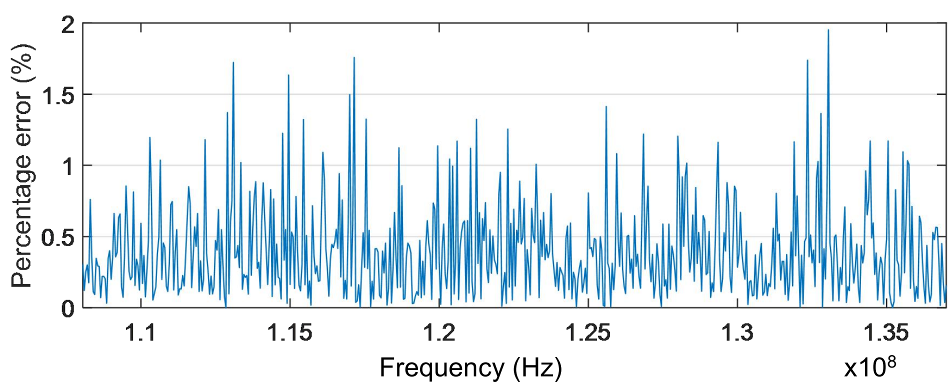


Figure 4.93 Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 108.05-137 MHz for KUBWA

4.5.7 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 137.05-144 MHz

Figure 4.94 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 0.34 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 137.05-144 MHz.

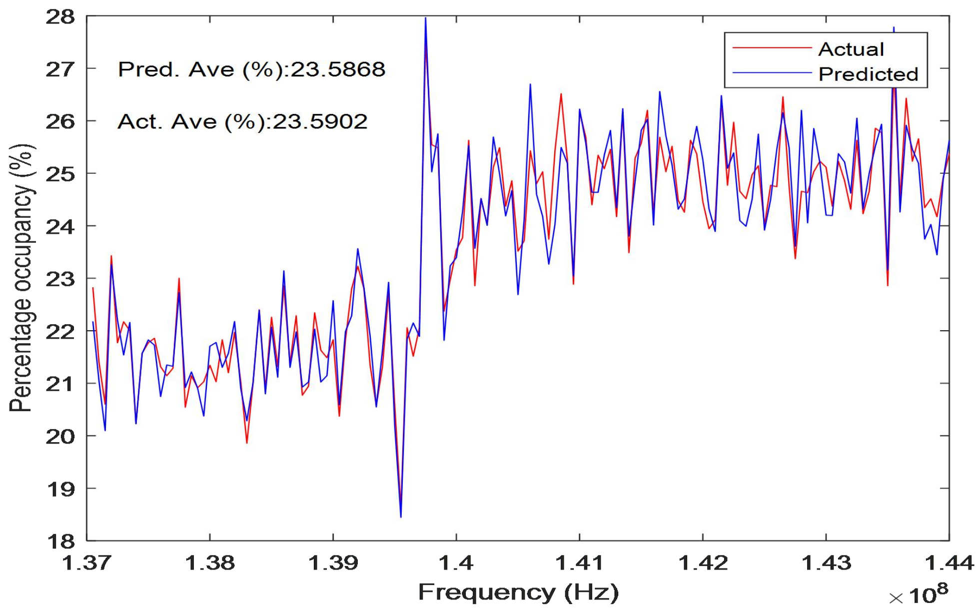


Figure 4.94: Performance Prediction for Spectrum Occupancy at Frequency Band of 137.05-144 MHz for KUBWA

Figure 4.95 shows that most of the percentage errors fall below 1% while the highest error of 1.51% occurred at the frequency of 142.7 MHz.

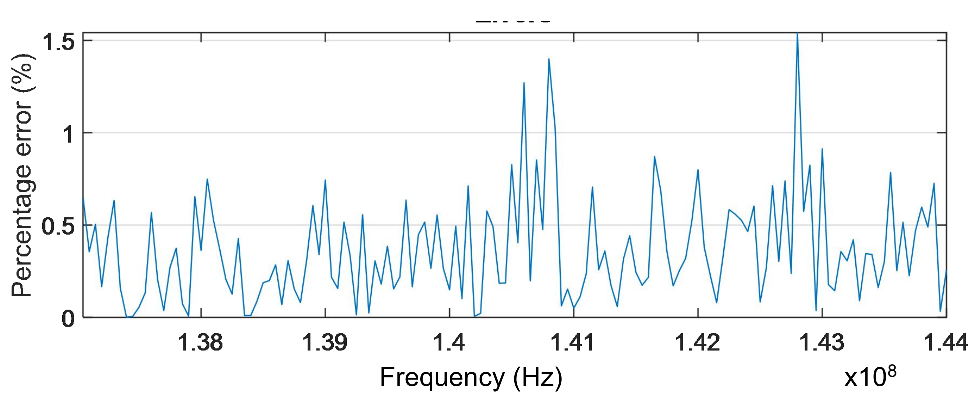


Figure 4.95: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 137.05-144 MHz for KUBWA

4.5.8 Spectrum Occupancy Prediction for KUBWA within Frequency Band of 144.05-174 MHz

Figure 4.96 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 2.07 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 144.05-174 MHz.

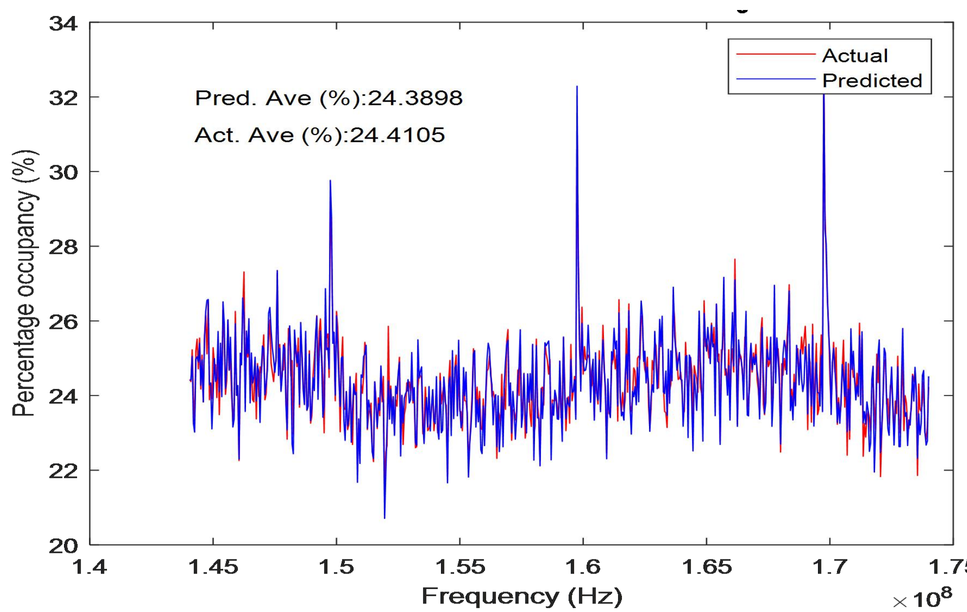


Figure 4.96 Performance Prediction for Spectrum Occupancy at Frequency Band of 144.05-174 MHz for KUBWA

Figure 4.97 shows that most of the percentage errors fall below 1% while the highest error of 22.47 x 10^{-1}% occurred at the frequency of 148.2 MHz.

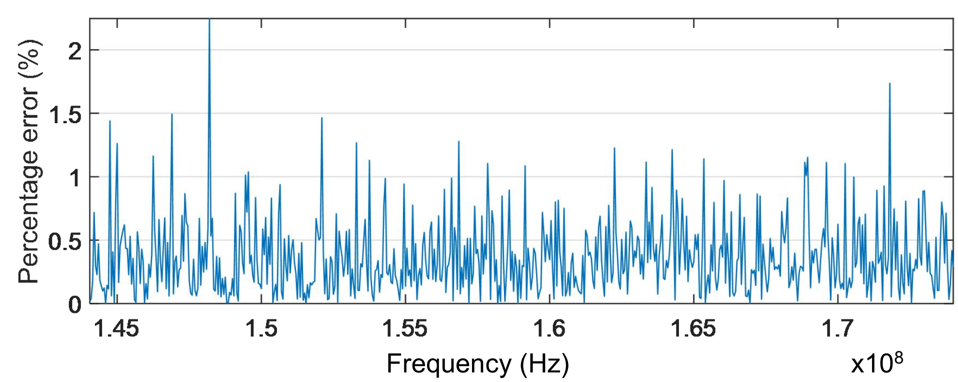


Figure 4.97: Percentage Error between Actual and Predicted Spectrum Occupancy values at 144.05-174 MHz for KUBWA

4.5.9 Spectrum Occupancy Prediction for KUBWA within Frequency Band of

174.05-200 MHz

Figure 4.98 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 4.20 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 174.05-200 MHz.

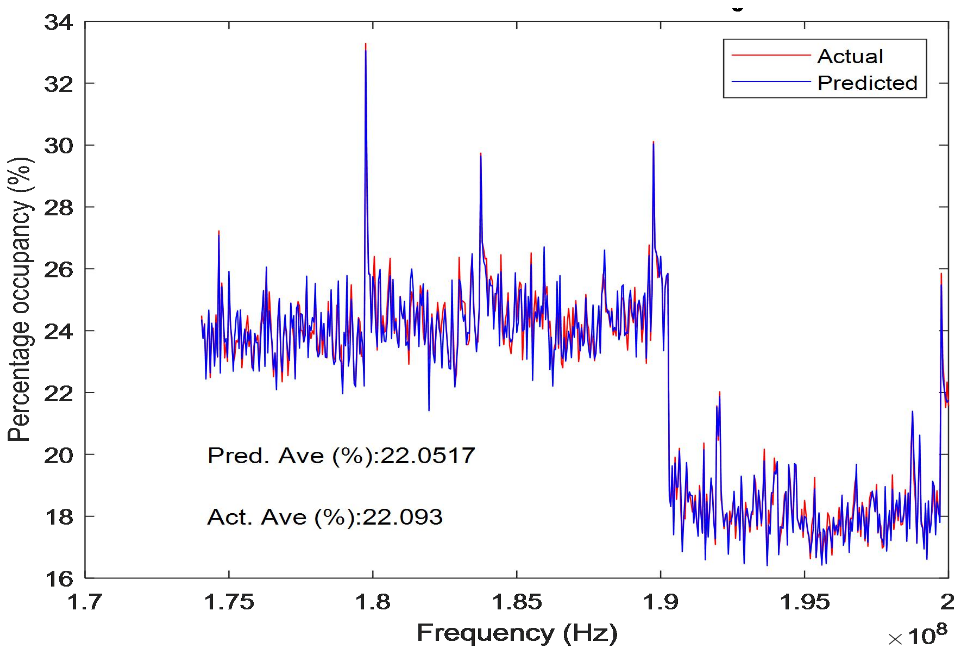


Figure 4.98: Performance Prediction for Spectrum Occupancy at Frequency Band of 174.05-200 MHz for KUBWA

Figure 4.99 shows that most of the percentage errors fall below 1% while the highest error of 16.74 x 10^{-1}% occurred at the frequency of 182 MHz.

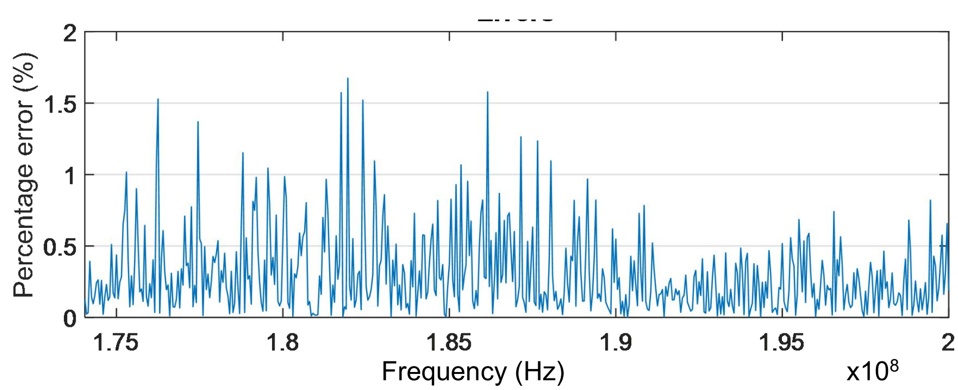


Figure 4.99: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 174.05-200 MHz for KUBWA

4.5.10 Spectrum Occupancy Prediction for KUBWA within Frequency Band of

200.05-230 MHz

Figure 4.100 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 2.34 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 200.05-230 MHz.

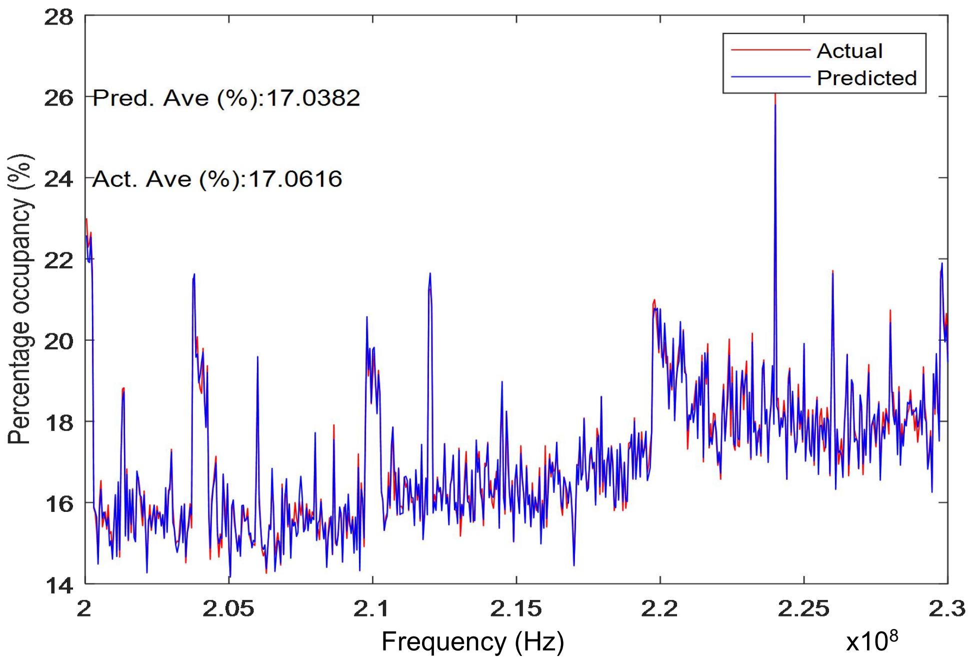


Figure 4.100: Performance Prediction for Spectrum Occupancy at Frequency Band of 200.05-230 MHz for KUBWA

Figure 4.101 shows that all of the percentage errors fall below 1% while the highest error of 96.34 x 10^{-2}% occurred at the frequency of 207.5 MHz.

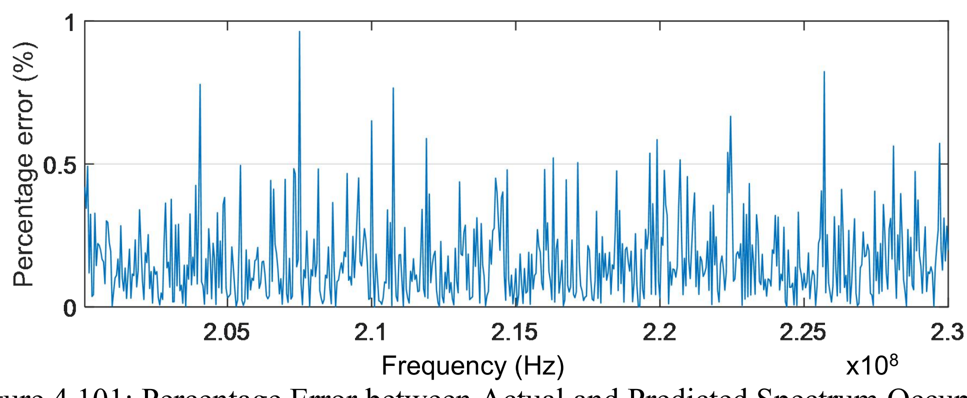


Figure 4.101: Percentage Error between Actual and Predicted Spectrum Occupancy values at 200.05-230 MHz for KUBWA

4.5.11 Spectrum Occupancy Prediction for KUBWA within Frequency Band of

230.05-267 MHz

Figure 4.102 shows the result of the Spectrum Occupancy prediction for Kubwa with a percentage difference of 2.29 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 230.05-267 MHz.

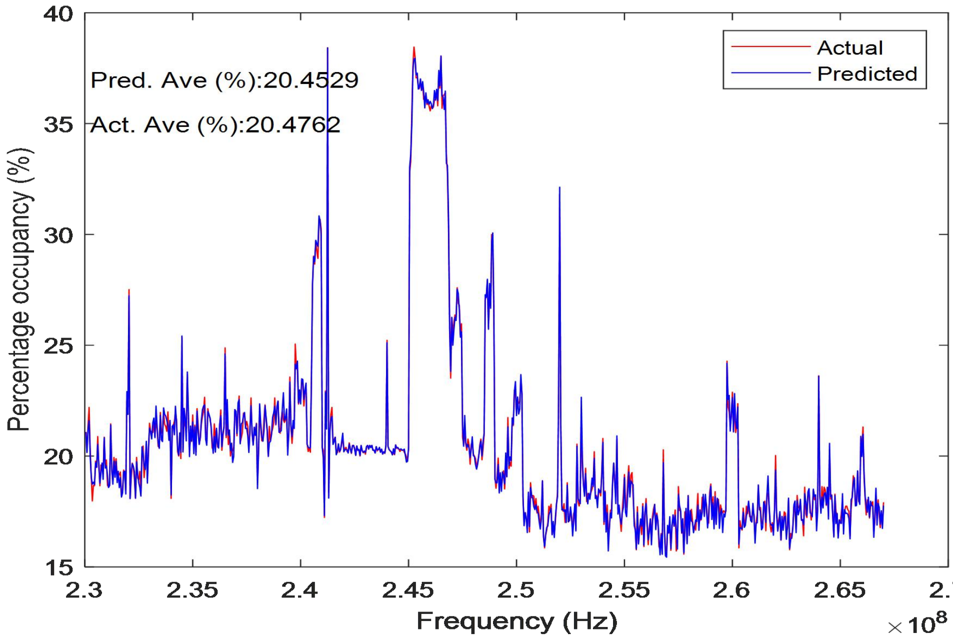


Figure 4.102: Performance Prediction for Spectrum Occupancy at Frequency Band of 230.05-267 MHz for KUBWA

Figure 4.103 shows that most of the percentage errors fall below 1% while the highest error of 12.35 x 10^{-1}% occurred at the frequency of 229.2 MHz.

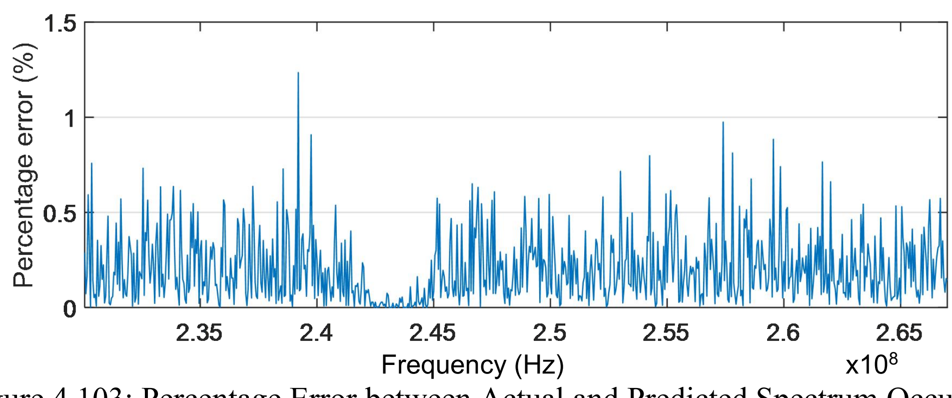


Figure 4.103: Percentage Error between Actual and Predicted Spectrum Occupancy values at 230.05-267 MHz for KUBWA

4.5.12 Spectrum Occupancy Prediction for KUBWA within Frequency Band of

267.05-300 MHz

Figure 4.104 shows the result of the Spectrum Occupancy prediction for KUBWA with a percentage difference of 4.79 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 267.05-300 MHz.

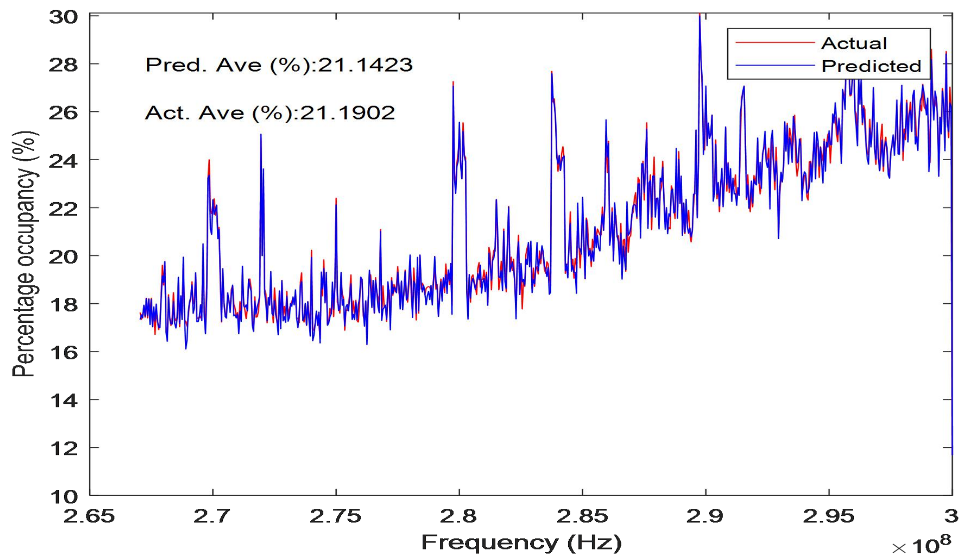


Figure 4.104: Performance Prediction for Spectrum Occupancy at Frequency Band of 267.05-300 MHz for KUBWA

Figure 4.105 shows that most of the percentage errors fall below 1% while the highest error of 15.92 x 10^{-1}% occurred at the frequency of 299.1 MHz.

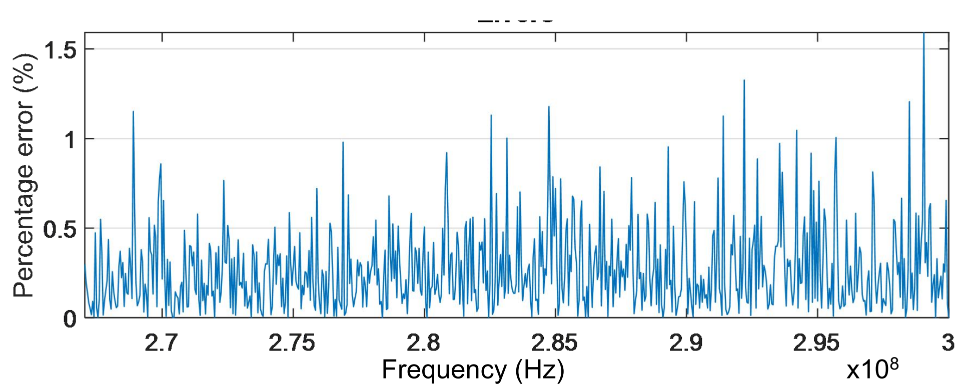


Figure 4.105: Percentage Error between Actual and Predicted Spectrum Occupancy values at 267.05-300 MHz for KUBWA

4.5.13 Summary of Spectrum Occupancy Prediction for KUBWA

Figure 4.106 shows that the maximum percentage difference between the actual and predicted values of 7.12×10^{-2}% occurred at the frequency band of 108.05-137 MHz while the lowest percentage difference of 0.34×10^{-2}% and 0.56×10^{-2}% occurred in two frequency bands of 137.05-144 MHz and 74.85-87.45 MHz respectively.

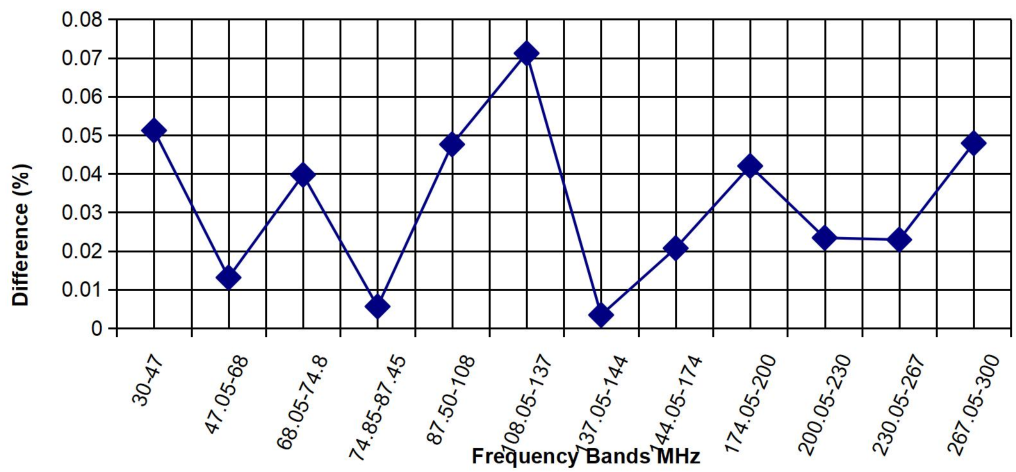


Figure 4.106: Percentage Difference Comparison of Performance Prediction for Spectrum Occupancy at various Frequency bands in KUBWA

4.6 Spectrum Occupancy Prediction for GUDU using ANN

In this section, performance at different frequency bands predicted using ANN are compared with the measured values.

4.6.1 Spectrum Occupancy Prediction for GUDU within Frequency Band of 30-47 MHz

On average, Figure 4.107 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 0.64×10^{-2}% as compared with that of the measured values for the frequency band 30-47 MHz.

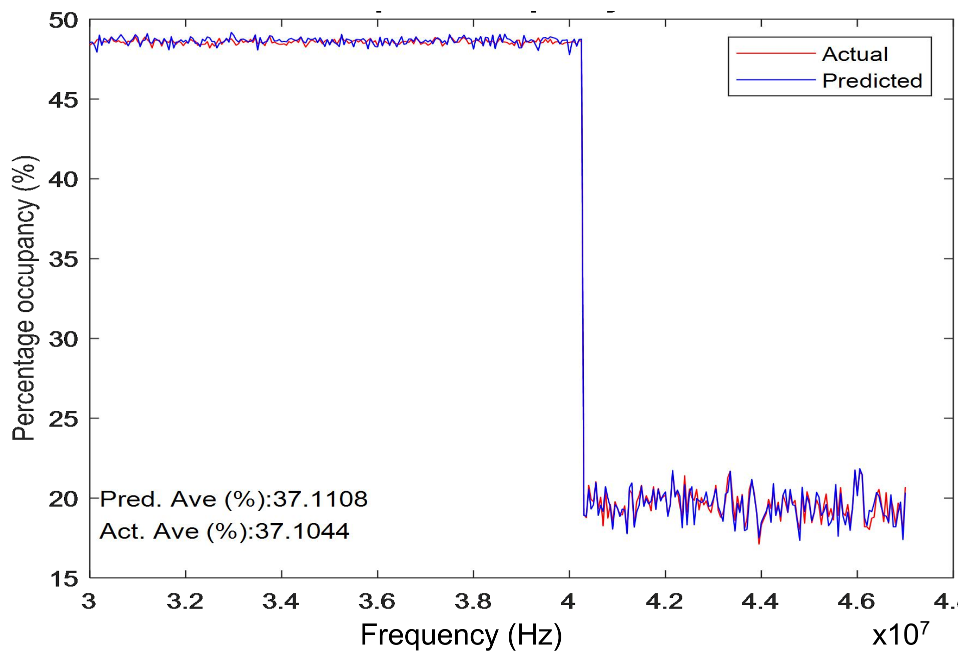


Figure 4.107: Performance Prediction for Spectrum Occupancy at Frequency Band of 30-47 MHz for GUDU

As seen in Figure 4.108, most of the percentage errors fall below 1%. The highest error of 15.31 x 10^{-1}% occurred at the frequency of 42 MHz.

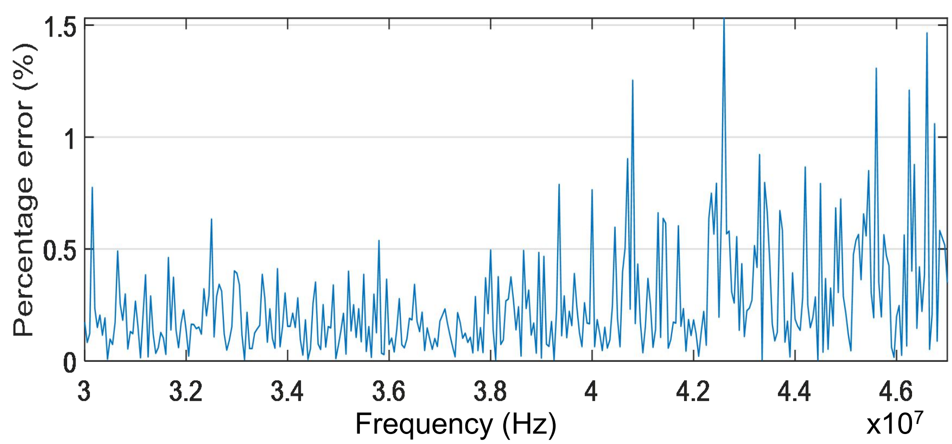


Figure 4.108: Percentage Error between Actual and Predicted Spectrum Occupancy values at 30-47 MHz for GUDU

4.6.2 Spectrum Occupancy Prediction for GUDU within Frequency Band of 47.05-68 MHz

Figure 4.109 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 4.61 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 47.05-68 MHz.

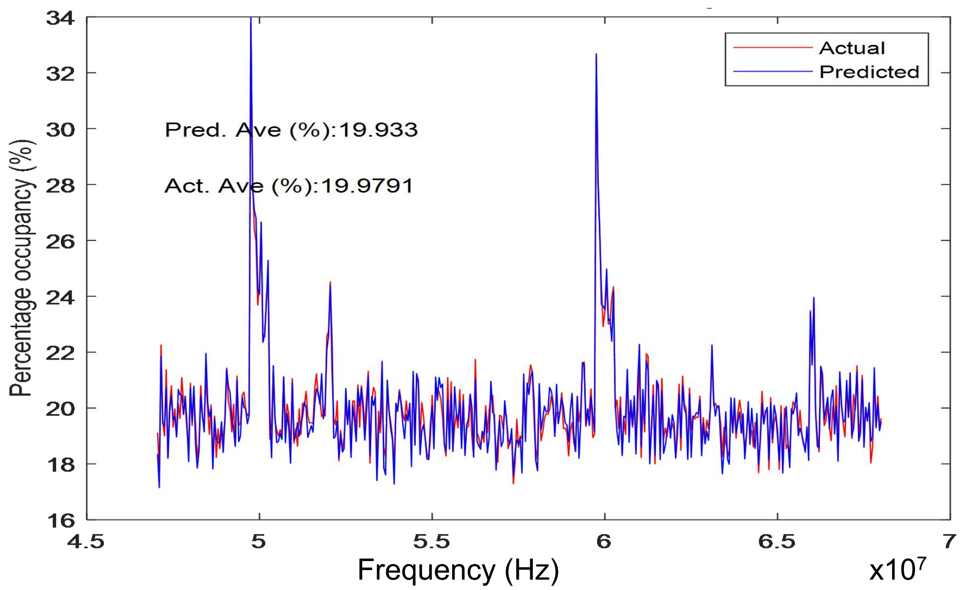


Figure 4.109: Performance Prediction for Spectrum Occupancy at Frequency Band of 47.05-68 MHz for GUDU

Figure 4.110 shows that most of the percentage errors fall below 1.5%. The highest error of 15.57 x 10^{-1}% occurred at the frequenies of 5.18 MHz and 60.2 MHz.

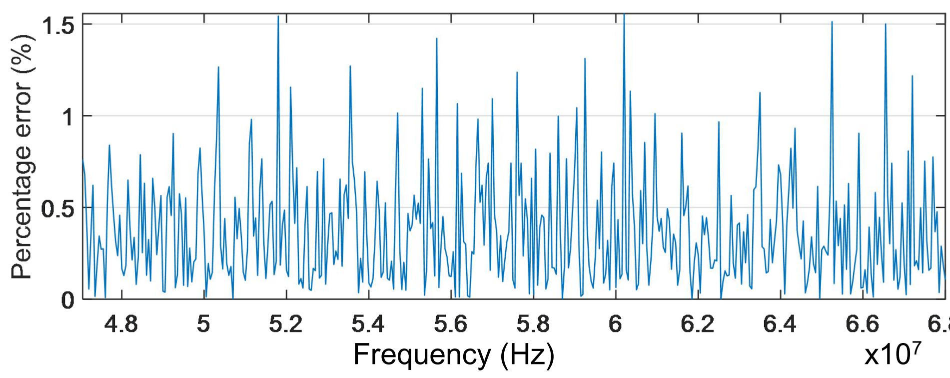


Figure 4.110: Percentage Error between Actual and Predicted Spectrum Occupancy values at 47-68 MHz for GUDU

4.6.3 Spectrum Occupancy Prediction for GUDU within Frequency Band of 68.05-74.8 MHz

Figure 4.111 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 1.38 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 68.05-74.8 MHz.

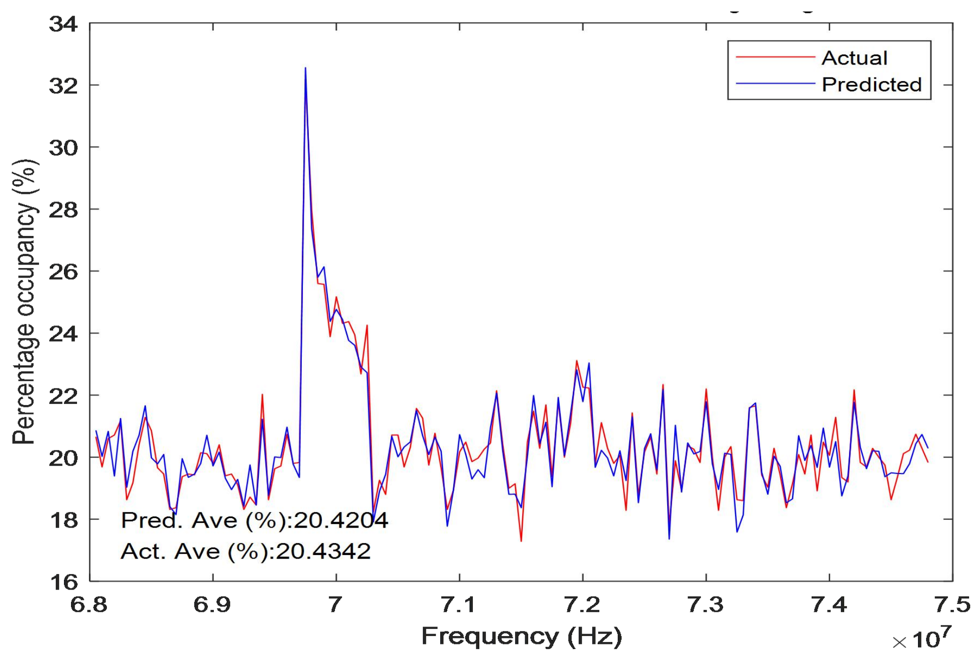


Figure 4.111: Performance Prediction for Spectrum Occupancy at Frequency Band of 68.05-74.8 MHz for GUDU

Figure 4.112 shows that most of the percentage errors fall below 1% while the highest error of 1.51% occurred at the frequency of 70.25 MHz.

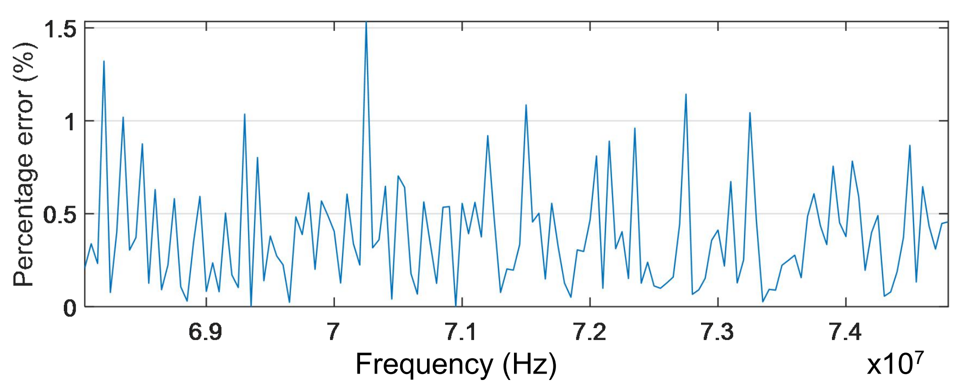


Figure 4.112: Percentage Error between Actual and Predicted Spectrum Occupancy values at 68.05-74.8 MHz for GUDU

4.6.4 Spectrum Occupancy Prediction for GUDU within Frequency Band of 74.85-87.45 MHz

Figure 4.113 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 6.57×10^{-2}% on the average as compared with that of the measured values for the frequency band of 74.85-87.45 MHz.

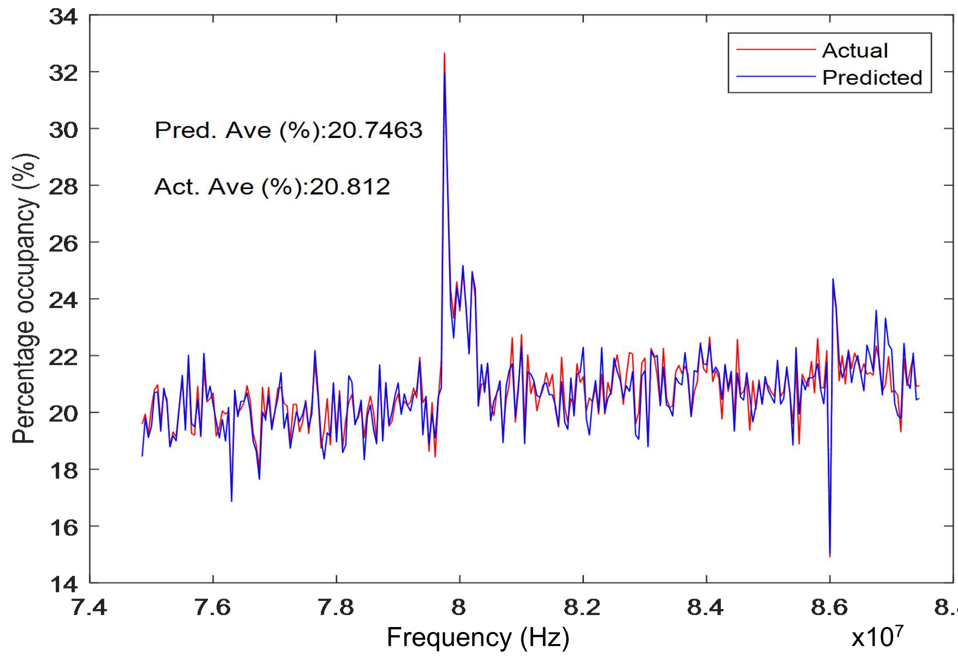


Figure 4.113: Performance Prediction for Spectrum Occupancy at Frequency Band of 74.85-87.45 MHz for GUDU

Figure 4.114 shows that most of the percentage errors fall below 1.5% while the highest error of 2.3% occurred at the frequency of 87 MHz.

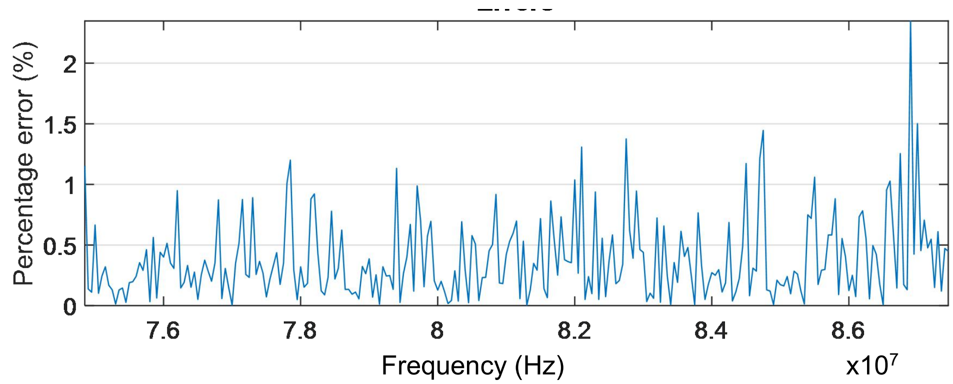


Figure 4.114: Percentage Error between Actual and Predicted Spectrum Occupancy values at 74.85-87.45 MHz for GUDU

4.6.5 Spectrum Occupancy Prediction for GUDU within Frequency Band of 87.50-108 MHz

Figure 4.115 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 0.41 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 87.50-108 MHz.

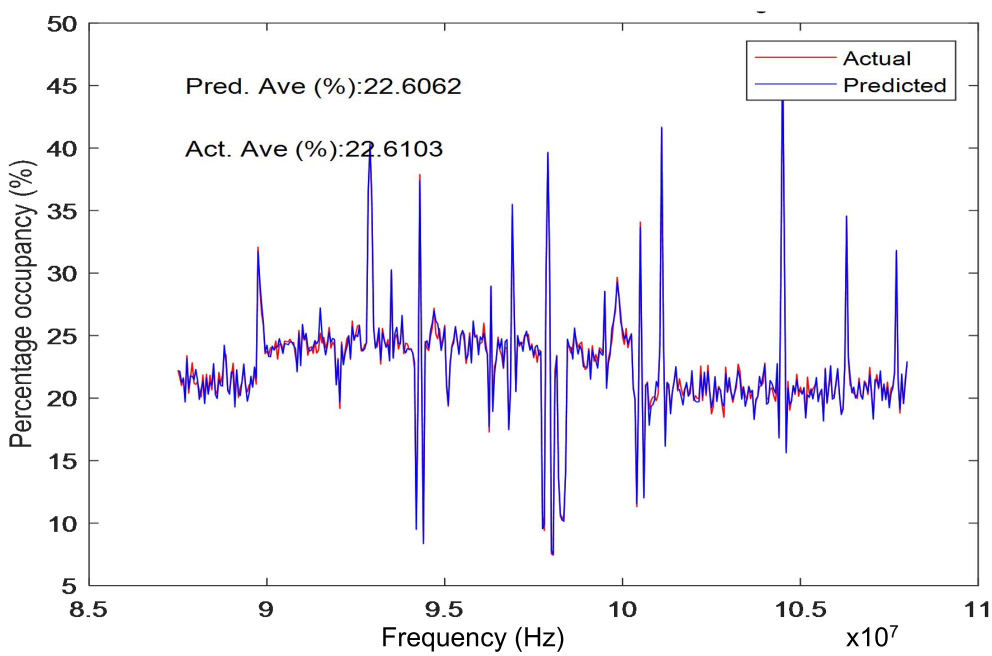


Figure 4.115: Performance Prediction for Spectrum Occupancy at Frequency Band of 87.50-108 MHz for GUDU

Figure 4.116 shows that most of the percentage errors fall below 1.5% while the highest error of 20.18 x 10^{-1}% occurred at the frequency of 91.5 MHz.

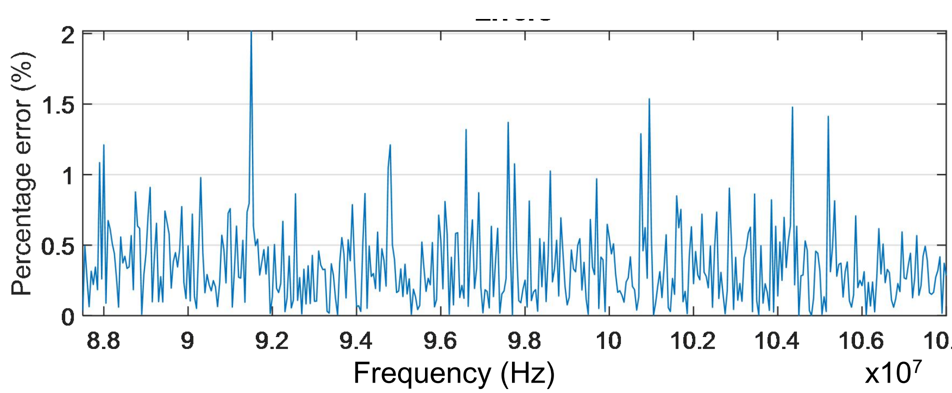


Figure 4.116: Percentage Error between Actual and Predicted Spectrum Occupancy values at 87.50-108 MHz for GUDU

4.6.6 Spectrum Occupancy Prediction for GUDU within Frequency Band of 108.05-137 MHz

Figure 4.117 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 0.45×10^{-2}% on the average as compared with that of the measured values for the frequency band 108.05-137 MHz.

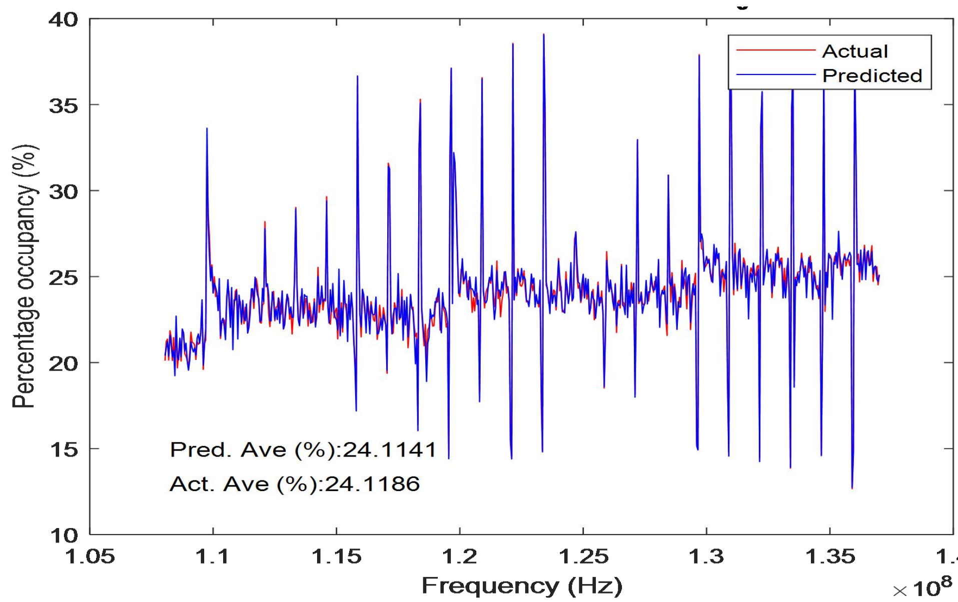


Figure 4.117: Performance Prediction for Spectrum Occupancy at Frequency Band of 108.05-137 MHz for GUDU

Figure 4.118 shows that most of the percentage errors fall below 1.5% while the highest error of 22.83×10^{-1}% occurred at the frequency of 115.1 MHz.

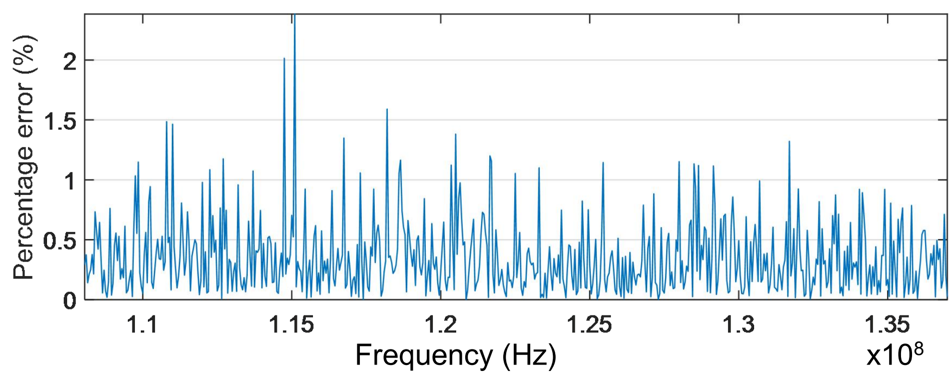


Figure 4.118 Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 108.05-137 MHz for GUDU

4.6.7 Spectrum Occupancy Prediction for GUDU within Frequency Band of 137.05-144 MHz

Figure 4.119 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 1.42 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 137.05-144 MHz.

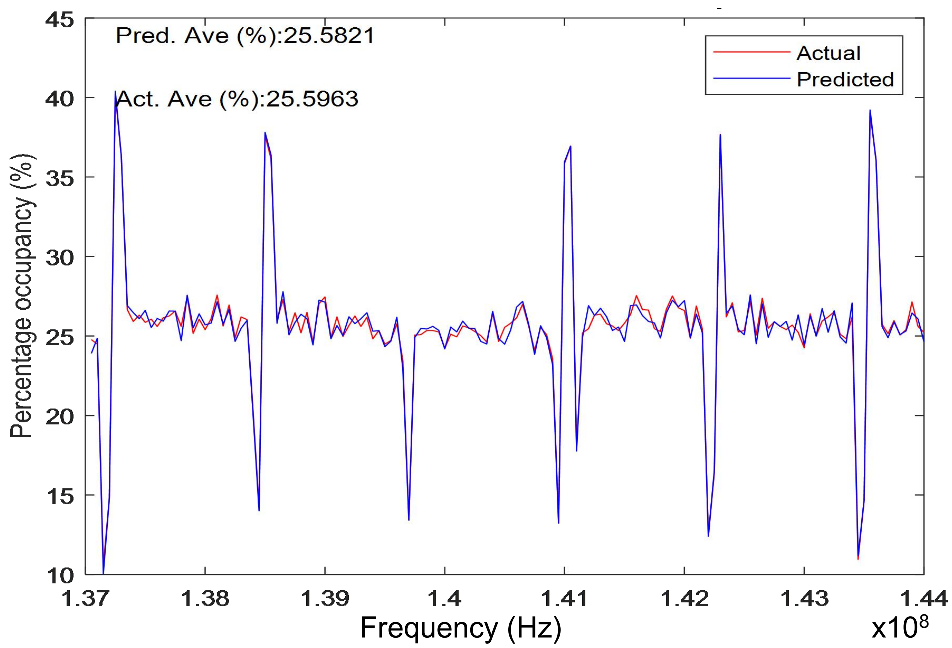


Figure 4.119: Performance Prediction for Spectrum Occupancy at Frequency Band of 137.05-144 MHz for GUDU

Figure 4.120 shows that all the percentage errors fall below 1.5% while the highest error of 14.52 x 10^{-1}% occurred at the frequency of 141.2 MHz.

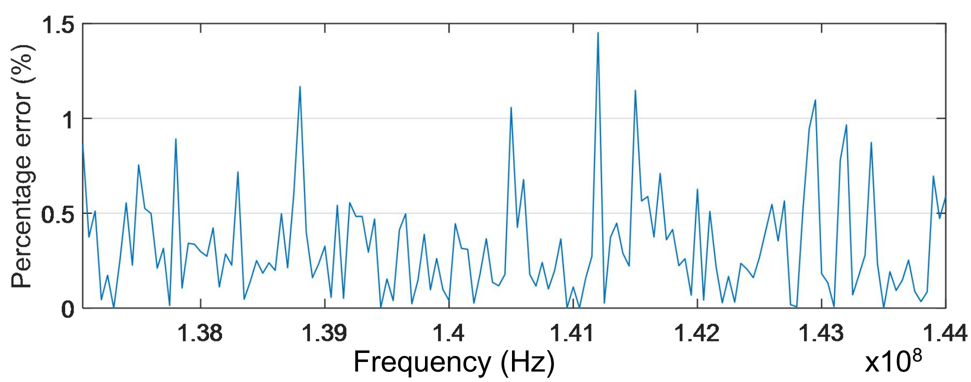


Figure 4.120: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 137.05-144 MHz for GUDU

4.6.8 Spectrum Occupancy Prediction for GUDU within Frequency Band of 144.05-174 MHz

Figure 4.121 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 0.9 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 144.05-174 MHz.

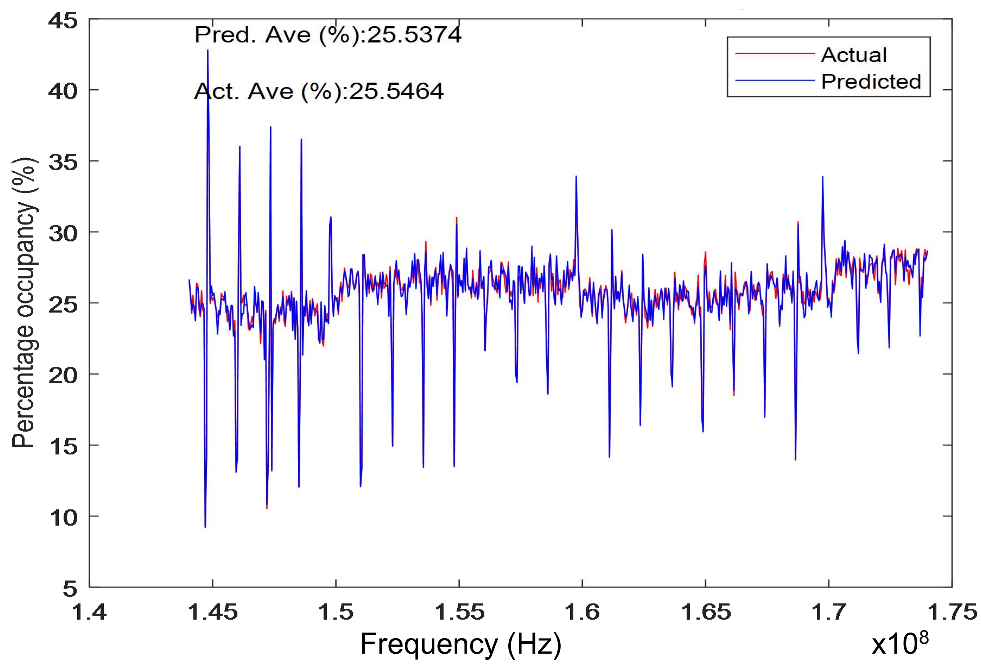


Figure 4.121 Performance Prediction for Spectrum Occupancy at Frequency Band of 144.05-174 MHz for GUDU

Figure 4.122 shows that most of the percentage errors fall below 1.5% while the highest error of 1.64% occurred at the frequency of 155.8 MHz.

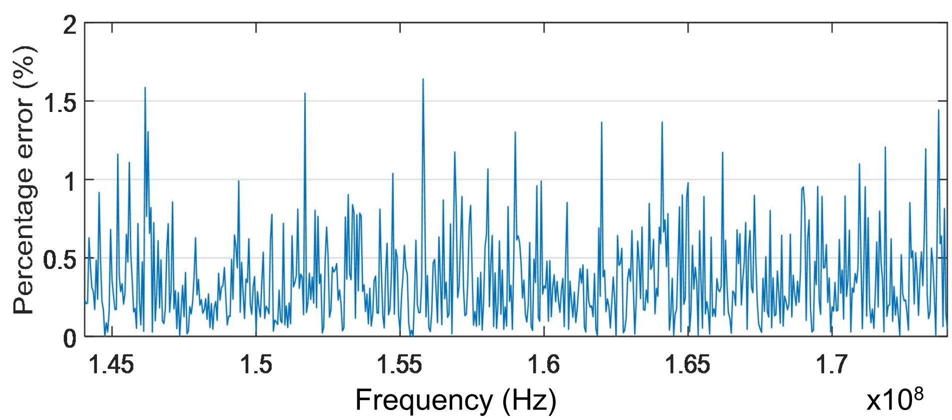


Figure 4.122: Percentage Error between Actual and Predicted Spectrum Occupancy values at 144.05-174 MHz for GUDU

4.6.9 Spectrum Occupancy Prediction for GUDU within Frequency Band of 174.05-200 MHz

Figure 4.123 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 2.77 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 174.05-200 MHz.

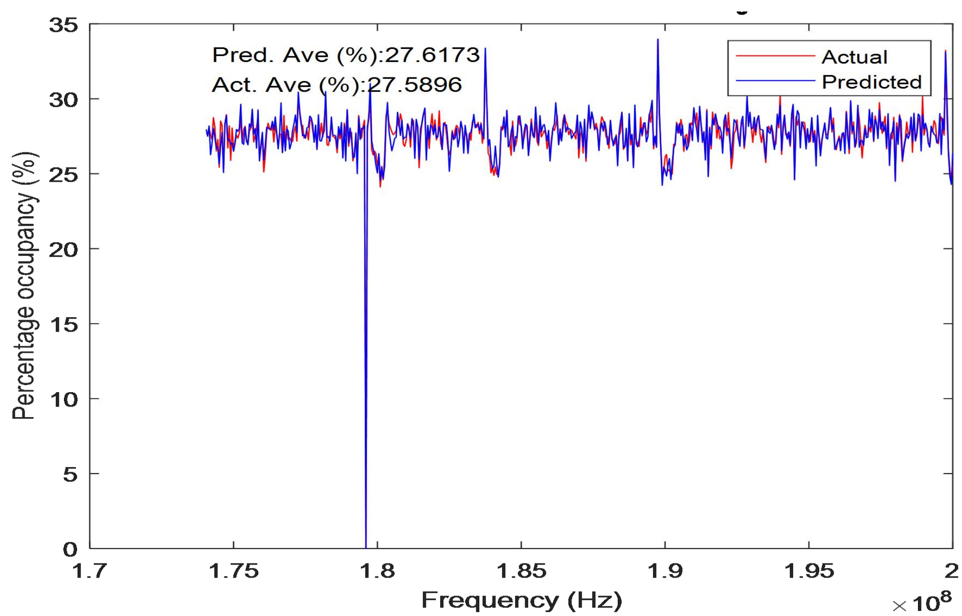


Figure 4.123 Performance Prediction for Spectrum Occupancy at Frequency Band of 174.05-200 MHz for GUDU

Figure 4.124 shows that most of the percentage errors fall below 1.5% while the highest error of 25.25 x 10^{-1}% occurred at the frequency of 199.6 MHz.

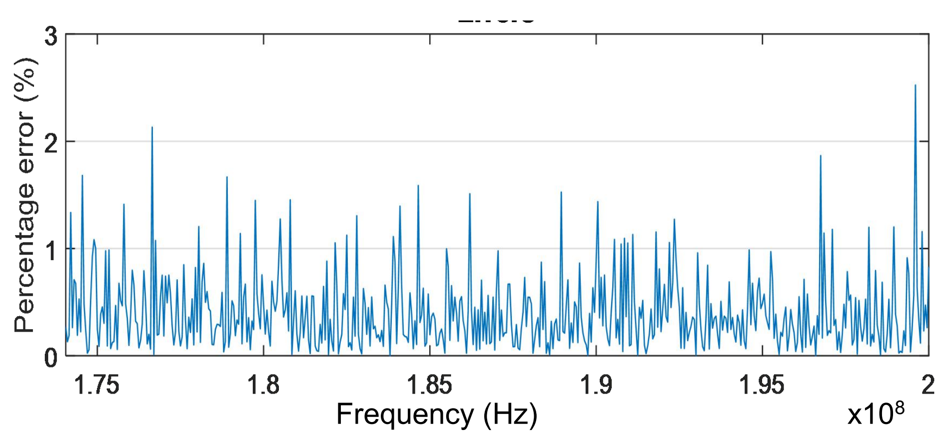


Figure 4.124: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 174.05-200 MHz for GUDU

4.6.10 Spectrum Occupancy Prediction for GUDU within Frequency Band of 200.05-230 MHz

Figure 4.125 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 4.43 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 200.05-230 MHz.

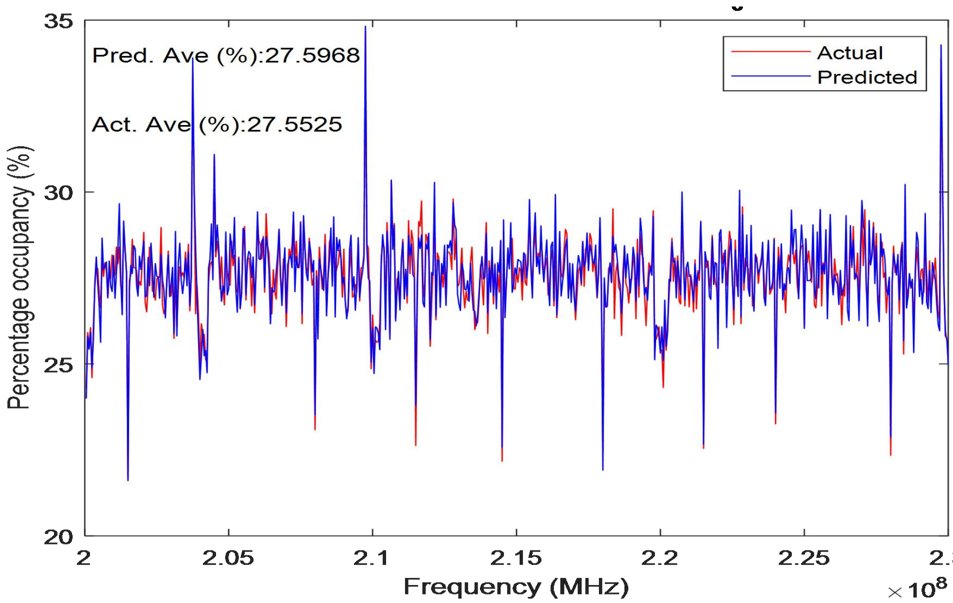


Figure 4.125: Performance Prediction for Spectrum Occupancy at Frequency Band of 200.05-230 MHz for GUDU

Figure 4.126 shows that all of the percentage errors fall below 1.5% while the highest error of 19.39 x 10^{-1}% occurred at the frequency of 203.9 MHz.

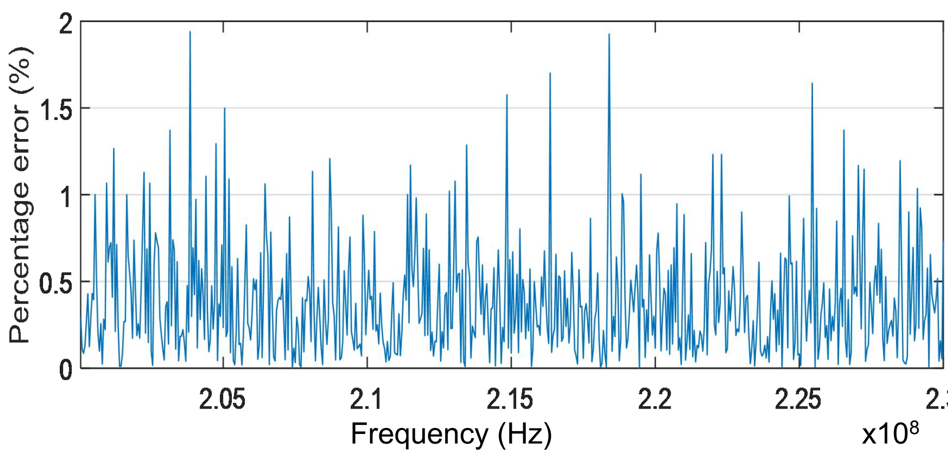


Figure 4.126: Percentage Error between Actual and Predicted Spectrum Occupancy values at 200.05-230 MHz for GUDU

4.6.11 Spectrum Occupancy Prediction for GUDU within Frequency Band of 230.05-267 MHz

Figure 4.127 shows the result of the Spectrum Occupancy prediction for GK with a percentage difference of 2.58 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 230.05-267 MHz.

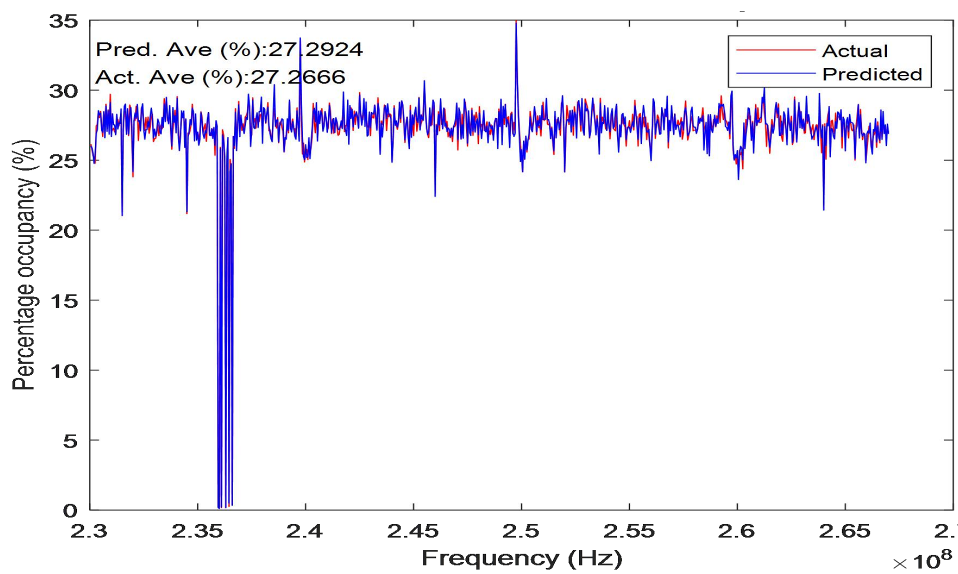


Figure 4.127: Performance Prediction for Spectrum Occupancy at Frequency Band of 230.05-267 MHz for GUDU

Figure 4.128 shows that most of the percentage errors fall below 1% while the highest error of 18.36 x 10^{-1}% occurred at the frequency of 258.5 MHz.

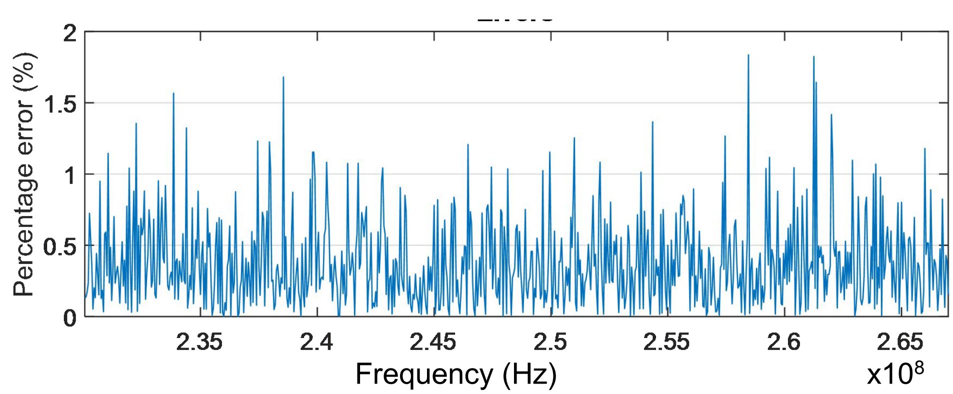


Figure 4.128: Percentage Error between Actual and Predicted Spectrum Occupancy values at 230.05-267 MHz for GUDU

4.6.12 Spectrum Occupancy Prediction for GUDU within Frequency Band of 267.05-300 MHz

Figure 4.129 shows the result of the Spectrum Occupancy prediction for GUDU with a percentage difference of 2.31 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 267.05-300 MHz.

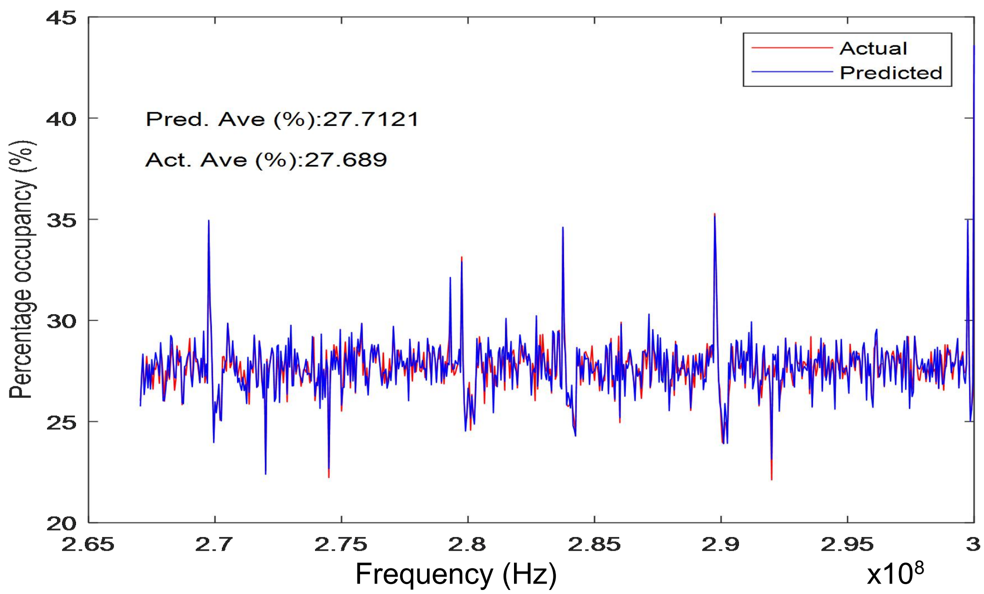


Figure 4.129: Performance Prediction for Spectrum Occupancy at Frequency Band of 267.05-300 MHz for GUDU

Figure 4.130 shows that most of the percentage errors fall below 1.5% while the highest error of 18.13 x 10^{-1}% occurred at the frequency of 281.8 MHz.

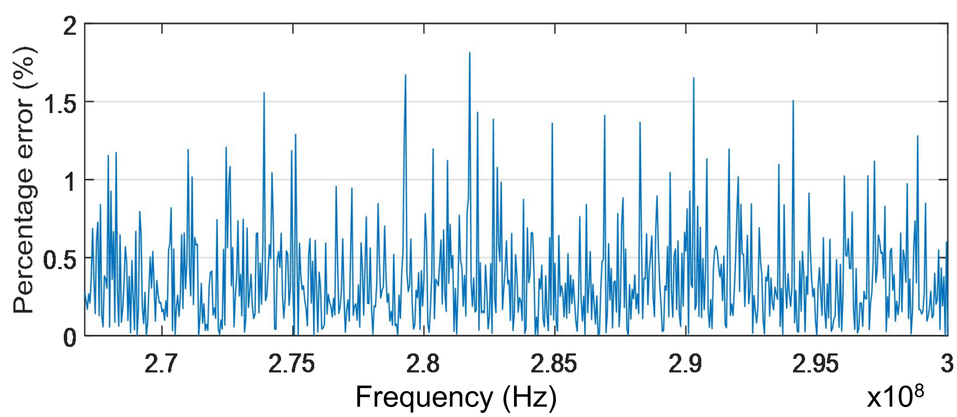


Figure 4.130: Percentage Error between Actual and Predicted Spectrum Occupancy values at 267.05-300 MHz for GUDU

4.6.13 Summary of Spectrum Occupancy Prediction for GUDU

Figure 4.131 shows that the maximum percentage difference between the actual and predicted values of 0.07% occurred at the frequency band of 74.80-87.45 MHz while the lowest percentage difference approximated to 0% occurred in two frequency bands of 87.50-108 MHz and 108.05-137 MHz.

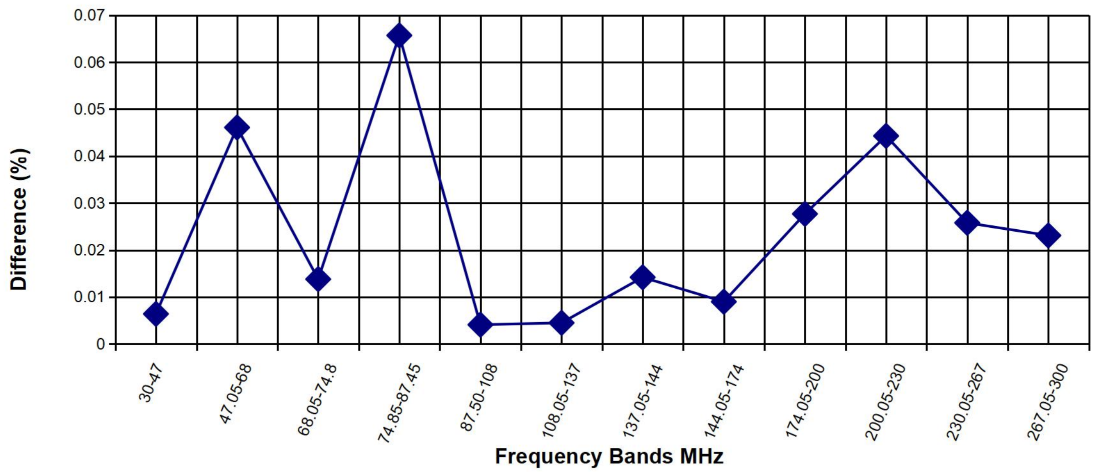


Figure 4.131: Percentage Difference Comparison of Performance Prediction for Spectrum Occupancy at various Frequency bands in GUDU

4.7 Spectrum Occupancy Prediction for MAITAMA

In this section, performance at different frequency bands predicted using ANN are compared with the measured values.

4.7.1 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 30-47 MHz

On the average, Figure 4.132 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 8.7×10^{-2}% as compared with that of the measured values for the frequency band 30-47 MHz.

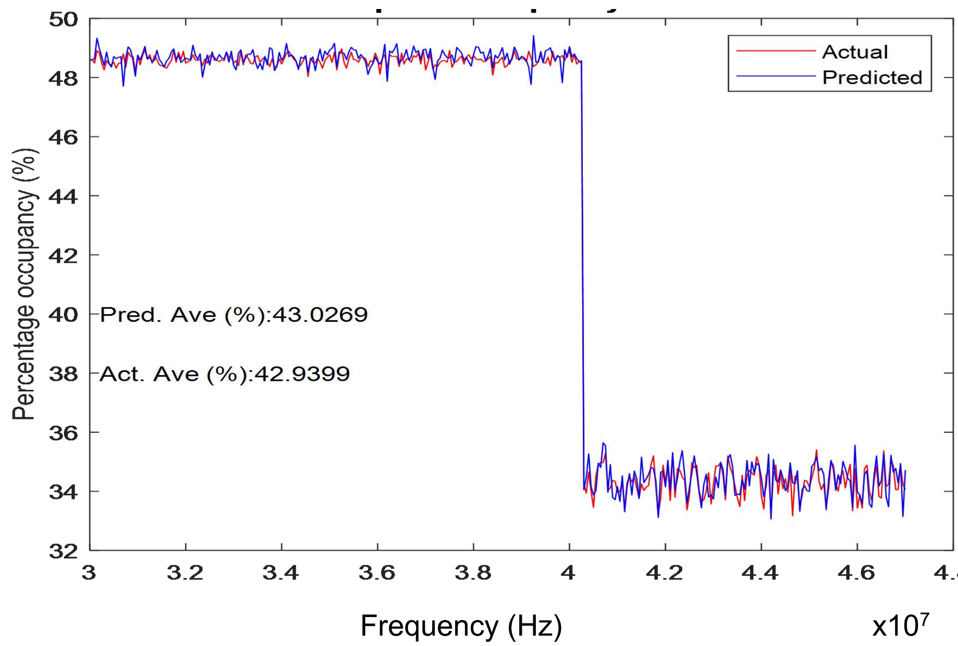


Figure 4.132: Performance Prediction for Spectrum Occupancy at Frequency Band of 30-47 MHz for MAITAMA

As see in Figure 4.133, most of the percentage errors fall below 1%. The highest error of 1.12% occurred at the frequency of 44.65 MHz.

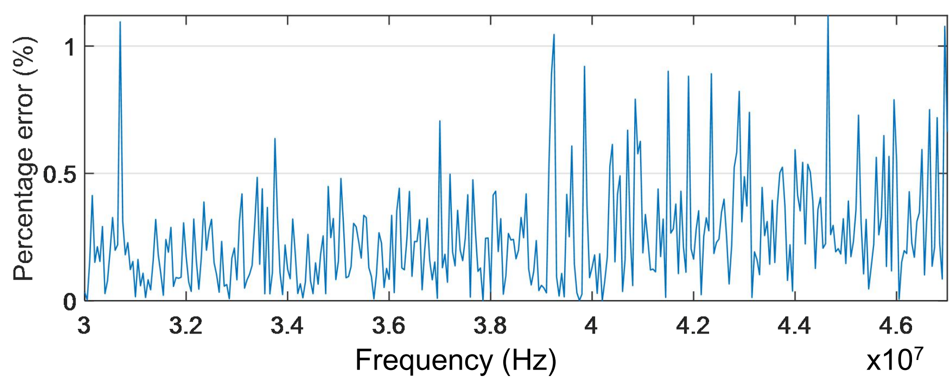


Figure 4.133: Percentage Error between Actual and Predicted Spectrum Occupancy values at 30-47 MHz for MAITAMA

4.7.2 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 47.05-68 MHz

Figure 4.134 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 10.61 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 47.05-68 MHz.

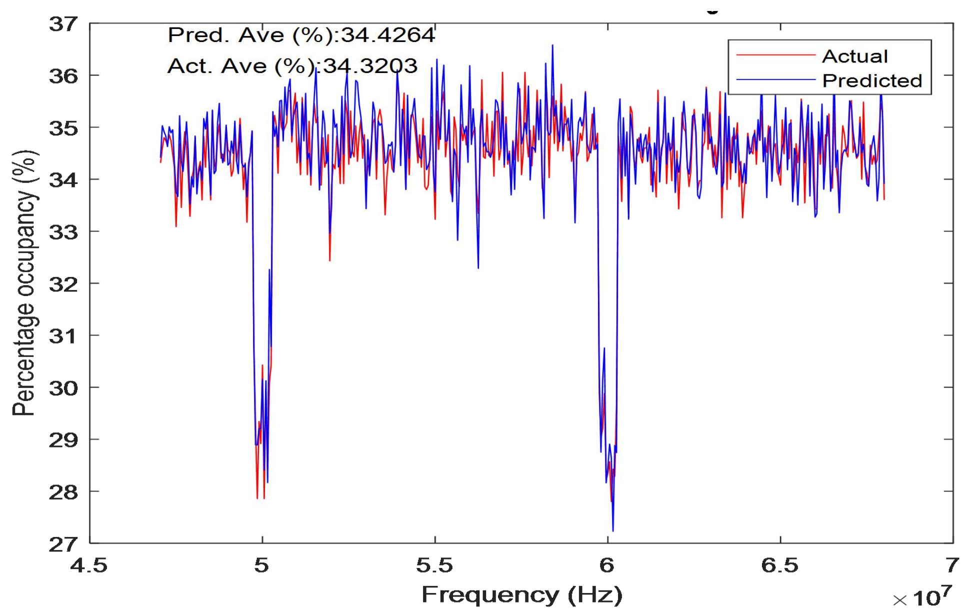


Figure 4.134: Performance Prediction for Spectrum Occupancy at Frequency Band of 47.05-68 MHz for MAITAMA

Figure 4.135 shows that most of the percentage errors fall below 1.5%. The highest error of 2.18% occurred at the frequency of 50.2 MHz.

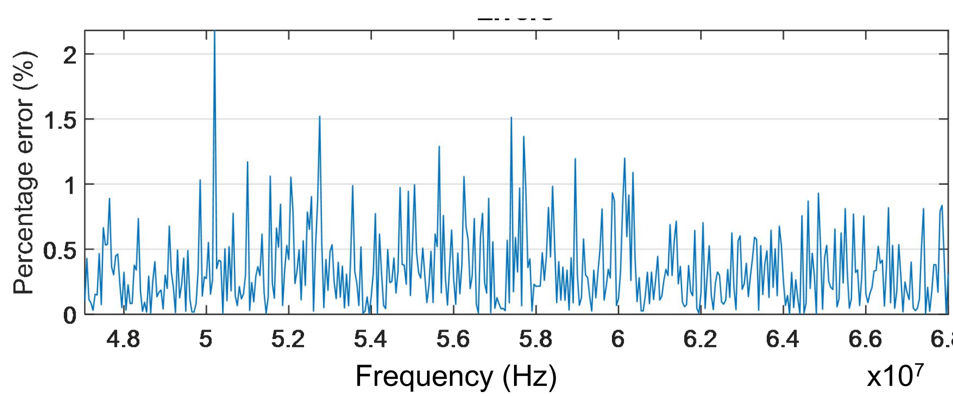


Figure 4.135: Percentage Error between Actual and Predicted Spectrum Occupancy values at 47.05-68 MHz for MAITAMA

4.7.3 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 68.05-74.8 MHz

Figure 4.136 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 3.99 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 68.05-74.8 MHz.

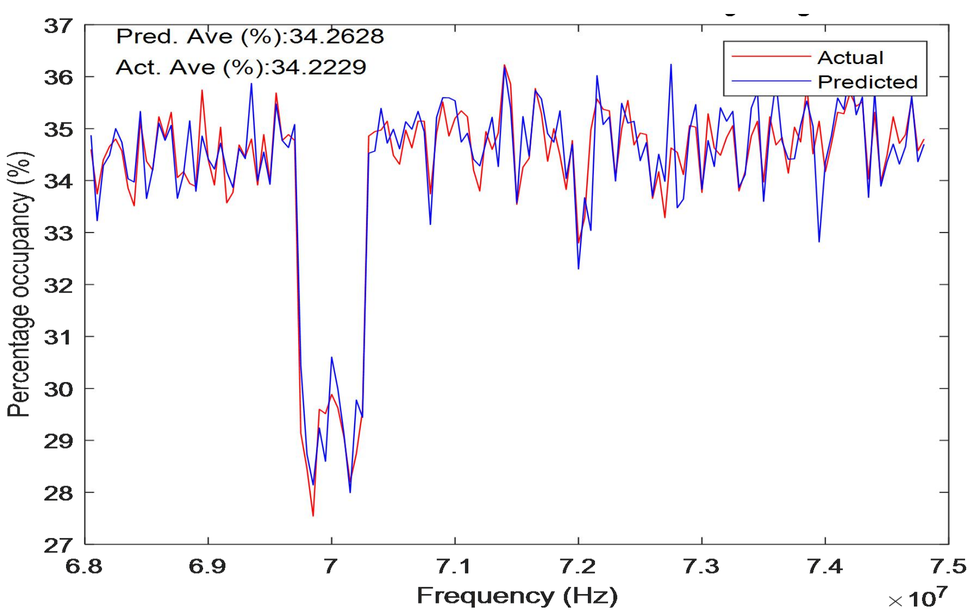


Figure 4.136: Performance Prediction for Spectrum Occupancy at Frequency Band of 68.05-74.8 MHz for MAITAMA

Figure 4.137 shows that most of the percentage errors fall below 1% while the highest error of 23.24 x 10^{-1}% occurred at the frequency of 73.95 MHz.

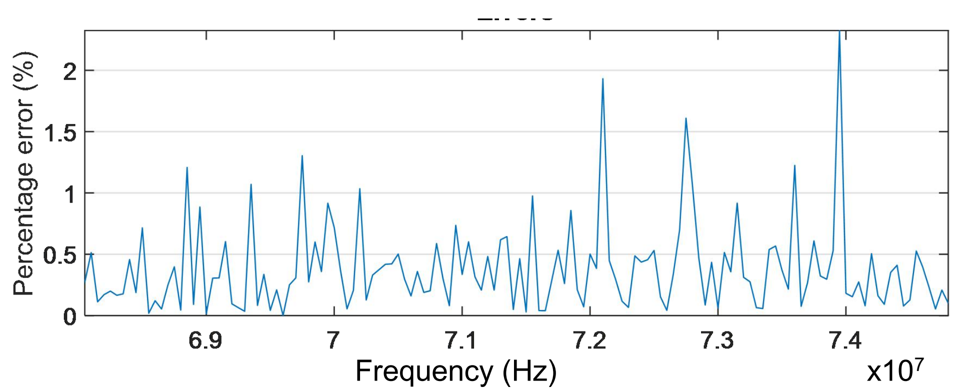


Figure 4.137: Percentage Error between Actual and Predicted Spectrum Occupancy values at 68.05-74.8 MHz for MAITAMA

4.7.4 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 74.85-87.45 MHz

Figure 4.138 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 0.99 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 74.85-87.45 MHz.

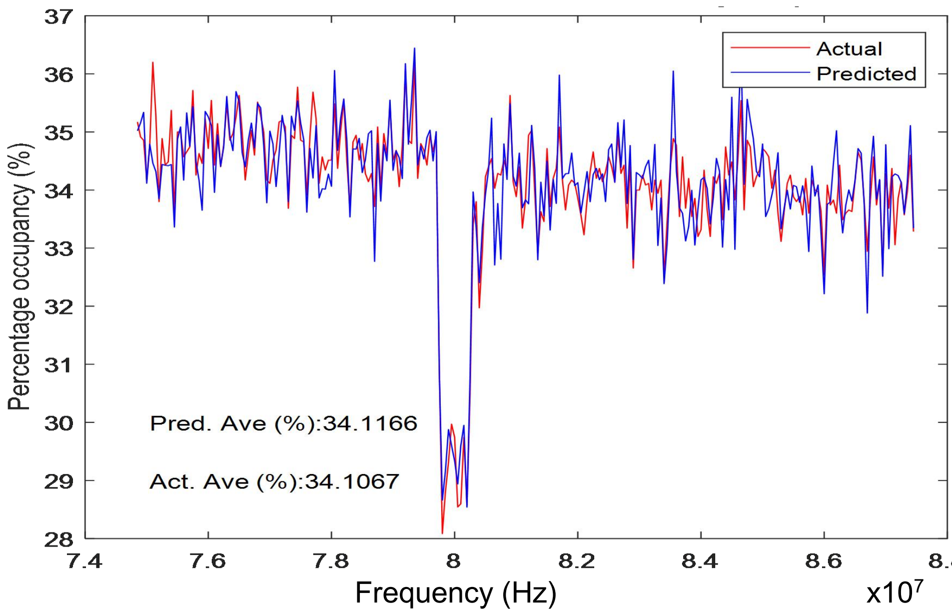


Figure 4.138: Performance Prediction for Spectrum Occupancy at Frequency Band of 74.85-87.45 MHz for MAITAMA

Figure 4.139 shows that most of the percentage errors fall below 1.5% while the highest error of 17.38 x 10^{-1}% occurred at the frequency of 75.1 MHz.

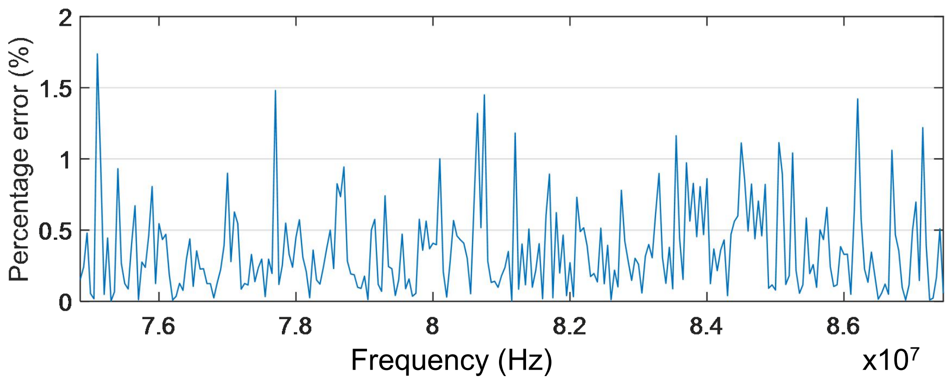


Figure 4.139: Percentage Error between Actual and Predicted Spectrum Occupancy values at 74.85-87.45 MHz for MAITAMA

4.7.5 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 87.50-108 MHz

Figure 4.140 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 6.03 x 10^{-2}% on the average as compared with that of the measured values for the frequency band of 87.50-108 MHz.

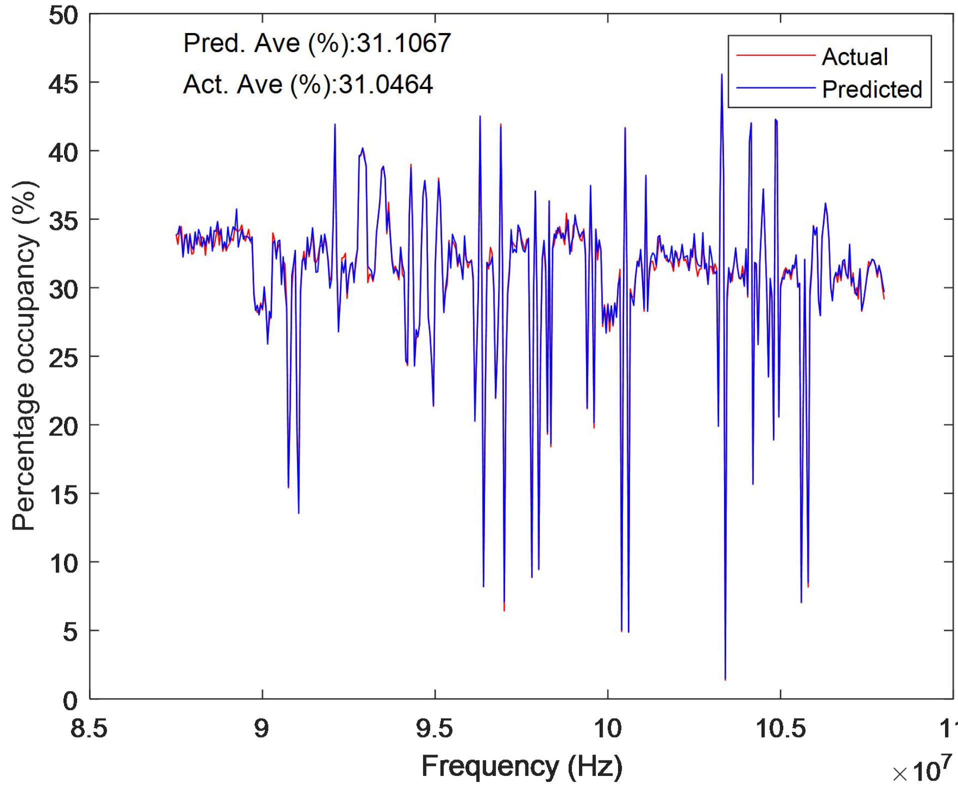


Figure 4.140: Performance Prediction for Spectrum Occupancy at Frequency Band of 87.50-108 MHz for MAITAMA

Figure 4.141 shows that most of the percentage errors fall below 1.5% while the highest error of 17.98 x 10^{-1}% occurred at the frequency of 90.65 MHz.

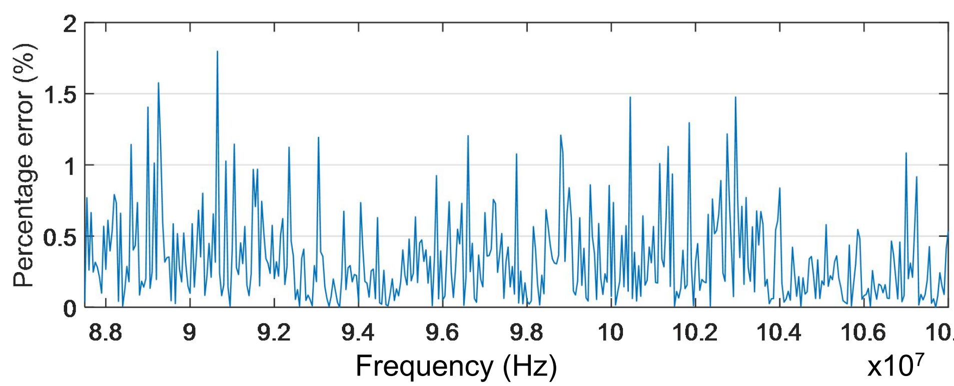


Figure 4.141: Percentage Error between Actual and Predicted Spectrum Occupancy values at 87.50-108 MHz for MAITAMA

4.7.6 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 108.05-137 MHz

Figure 4.142 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 1.23 x 10^{-2}% on the average as compared with that of the measured values for the frequency band 108.05-137 MHz.

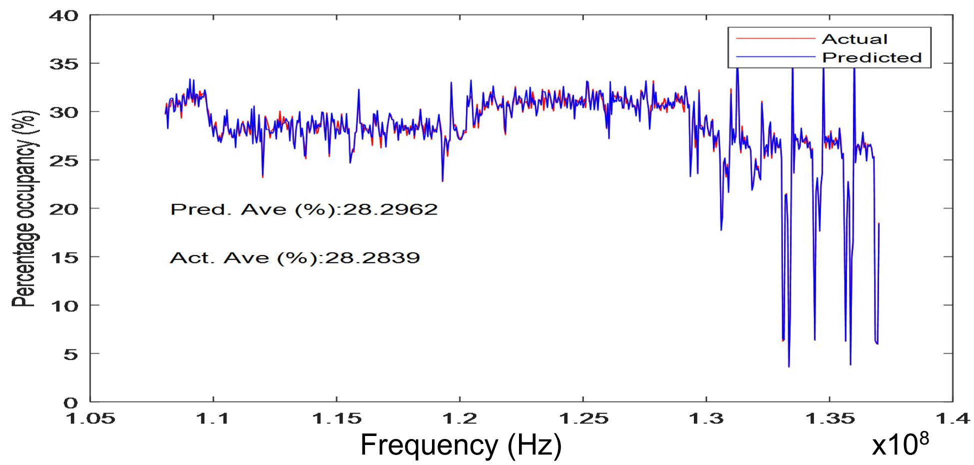


Figure 4.142: Performance Prediction for Spectrum Occupancy at Frequency Band of 108.05-137 MHz for MAITAMA

Figure 4.143 shows that most of the percentage errors fall below 1.5% while the highest error of 1.92% occurred at the frequency of 123.4 MHz.

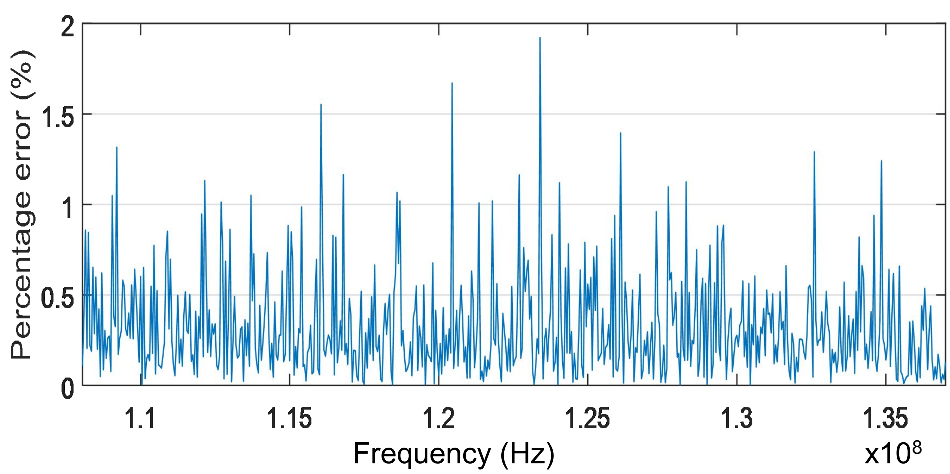


Figure 4.143 Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 108.05-137 MHz for MAITAMA

4.7.7 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 137.05-144 MHz

Figure 4.144 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 2.6 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 137.05-144 MHz.

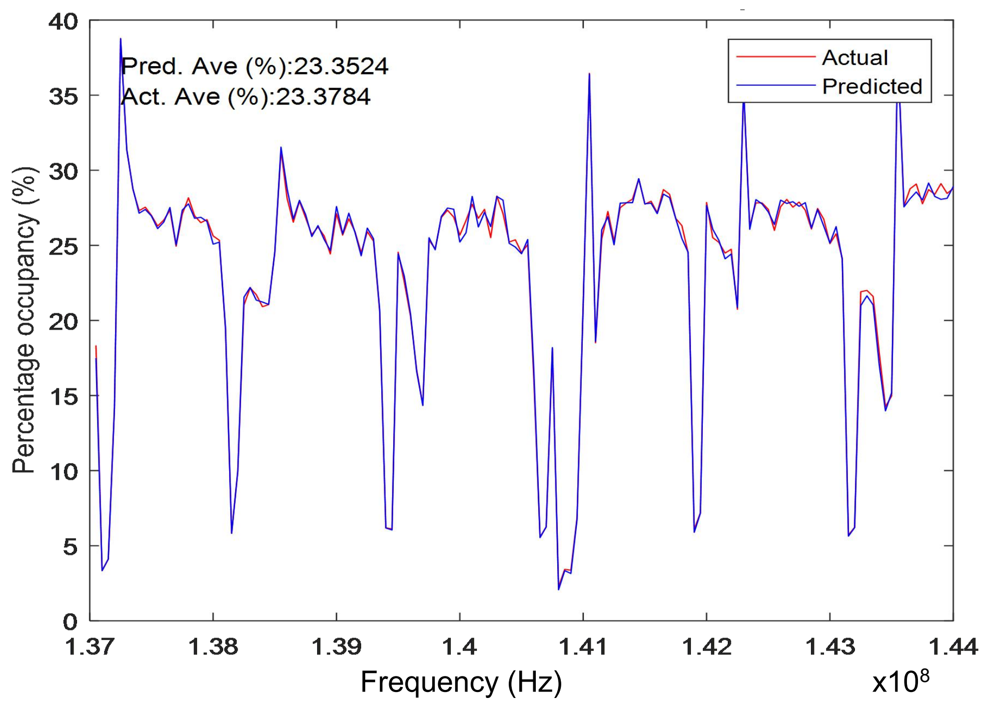


Figure 4.144: Performance Prediction for Spectrum Occupancy at Frequency Band of 137.05-144 MHz for MAITAMA

Figure 4.145 shows that all the percentage errors fall below 1% while the highest error of 10.49 x 10^{-1}% occurred at the frequency of 143.9 MHz.

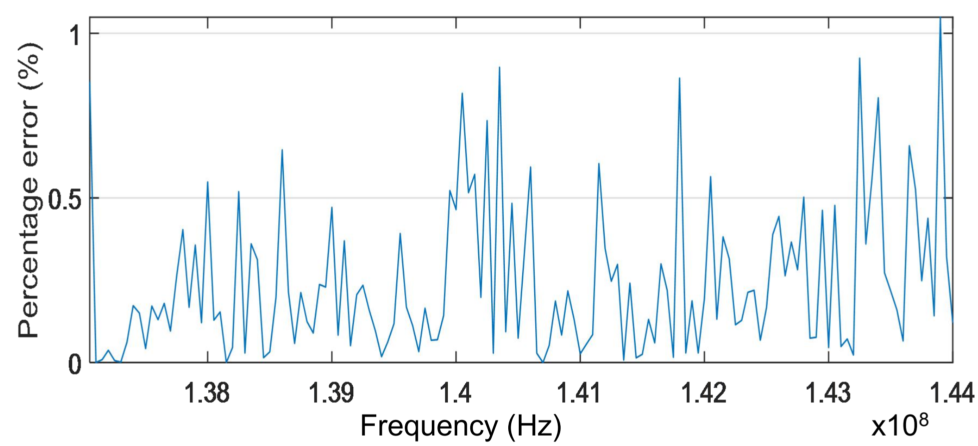


Figure 4.145: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 137.05-144 MHz for MAITAMA

4.7.8 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 144.05-174 MHz

Figure 4.146 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of $3.05 \times 10^{-2}\%$ on the average when compared with that of the measured values for the frequency band 144.05-174 MHz.

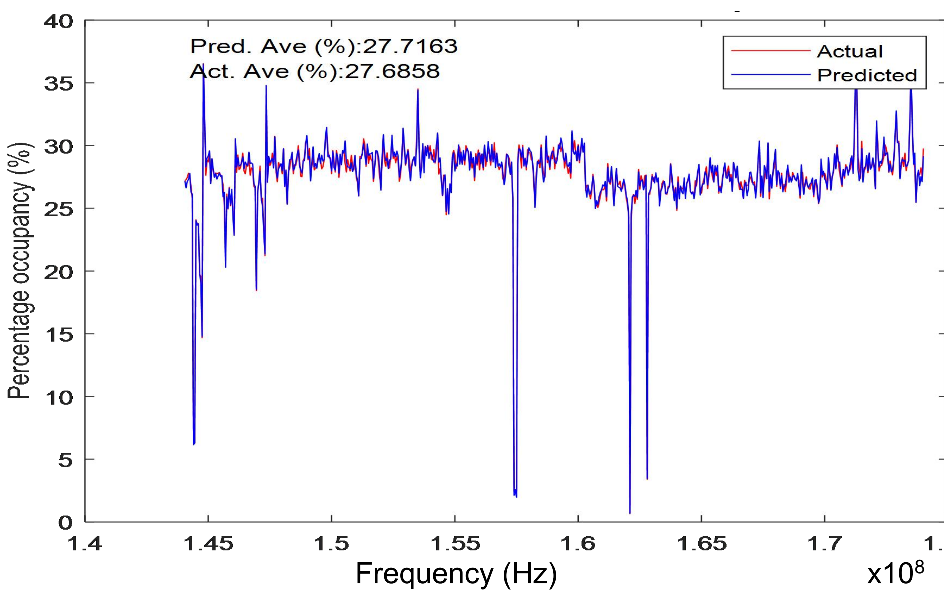


Figure 4.146 Performance Prediction for Spectrum Occupancy at Frequency Band of 144.05-174 MHz for MAITAMA

Figure 4.147 shows that most of the percentage errors fall below 1.5% while the highest error of 1.81% occurred at the frequency of 150.6 MHz.

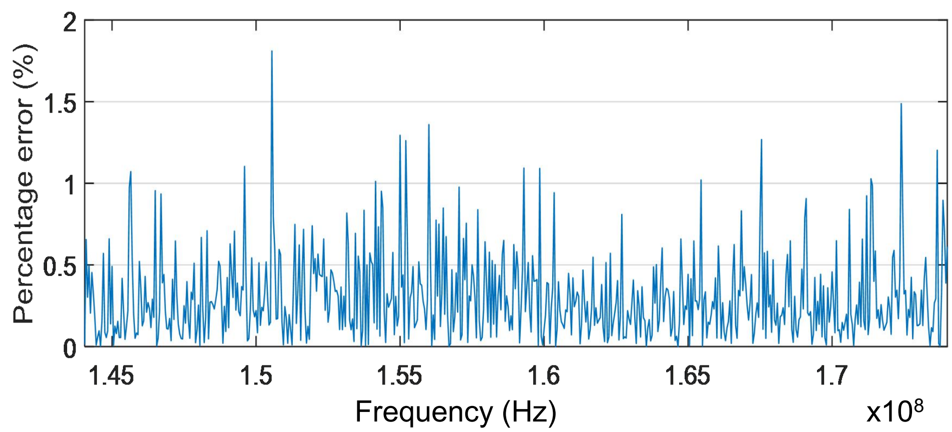


Figure 4.147: Percentage Error between Actual and Predicted Spectrum Occupancy values at 144.05-174 MHz for MAITAMA

4.7.9 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 174.05-200 MHz

Figure 4.148 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 2.05 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 174.05-200 MHz.

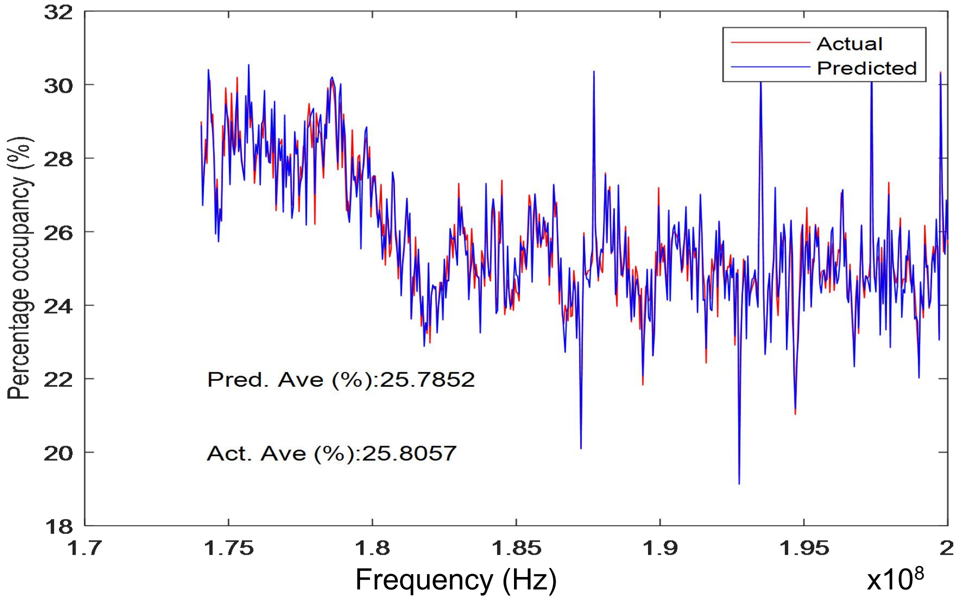


Figure 4.148 Performance Prediction for Spectrum Occupancy at Frequency Band of 174.05-200 MHz for MAITAMA

Figure 4.149 shows that most of the percentage errors fall below 1.5% while the highest error of 18.68 x 10^{-1}% occurred at the frequency of 179.6 MHz.

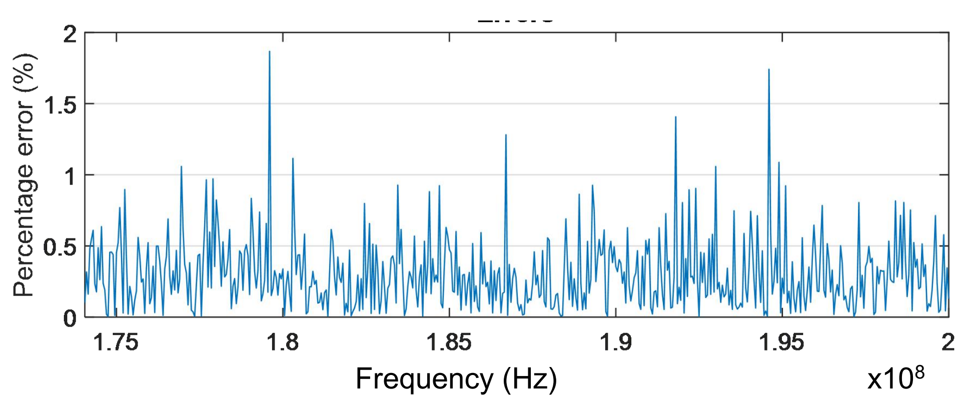


Figure 4.149: Percentage Error between Actual and Predicted Spectrum Occupancy values at Frequency Band of 174.05-200 MHz for MAITAMA

4.7.10 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 200.05-230 MHz

Figure 4.150 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 2.13×10^{-2}% on the average when compared with that of the measured values for the frequency band 200.05-230 MHz.

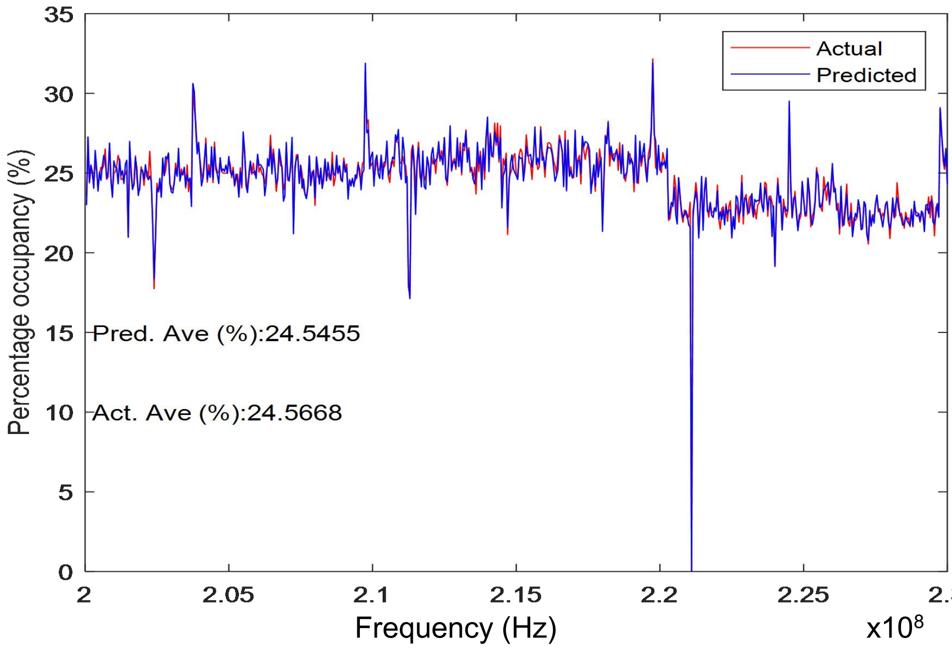


Figure 4.150: Performance Prediction for Spectrum Occupancy at Frequency Band of 200.05-230 MHz for MAITAMA

Figure 4.151 shows that all of the percentage errors fall below 1.5% while the highest error of 21.52×10^{-1}% occurred at the frequency of 223.9 MHz.

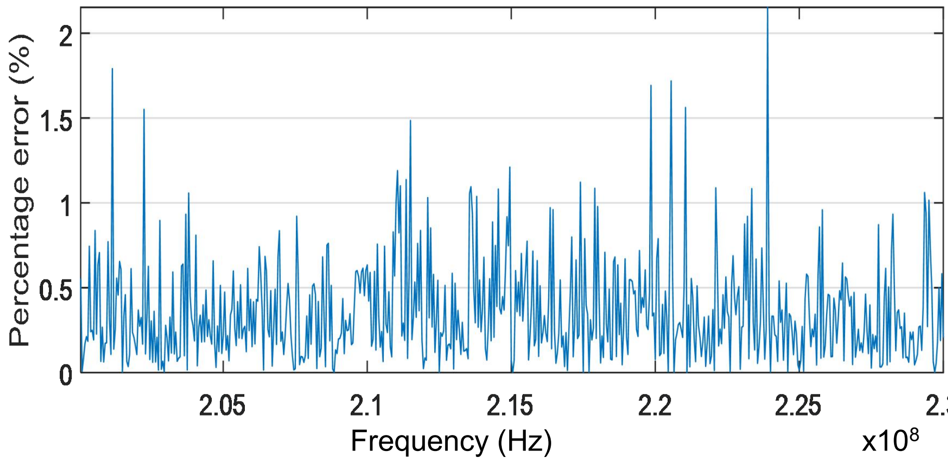


Figure 4.151: Percentage Error between Actual and Predicted Spectrum Occupancy values at 200.05-230 MHz for MAITAMA

4.7.11 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 230.05-267 MHz

Figure 4.152 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 3.07 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 230.05-267 MHz.

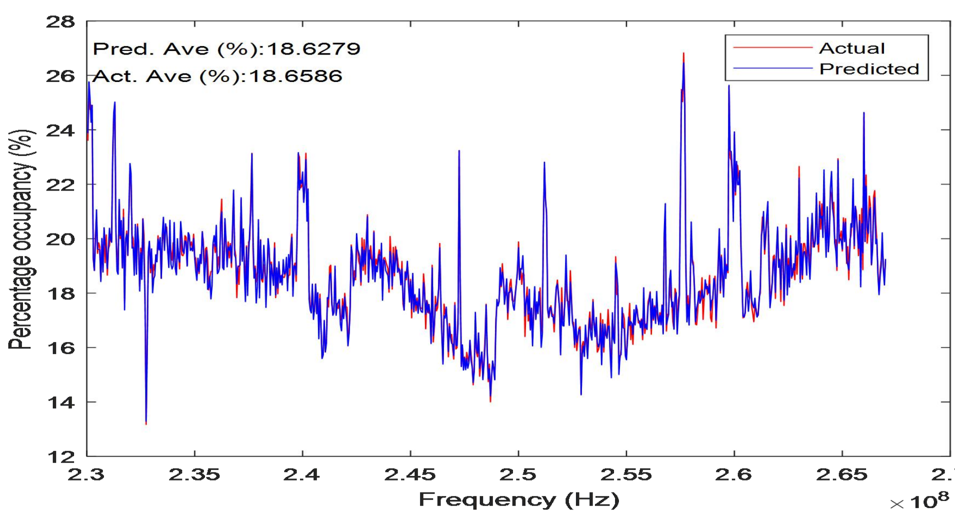


Figure 4.152: Performance Prediction for Spectrum Occupancy at Frequency Band of 230.05-267 MHz for MAITAMA

Figure 4.153 shows that most of the percentage errors fall below 1% while the highest error of 12.11 x 10^{-1}% occurred at the frequency of 239.9 MHz.

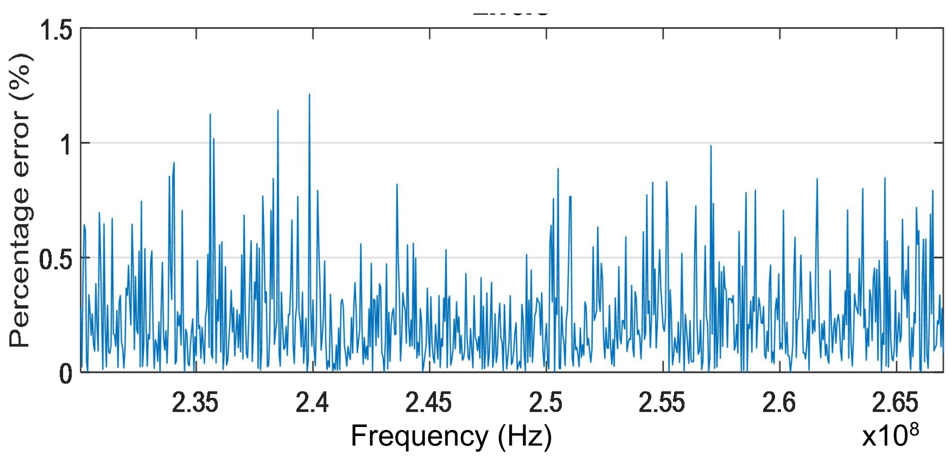


Figure 4.153: Percentage Error between Actual and Predicted Spectrum Occupancy values at 230.05-267 MHz for MAITAMA

4.7.12 Spectrum Occupancy Prediction for MAITAMA within Frequency Band of 267.05-300 MHz

Figure 4.154 shows the result of the Spectrum Occupancy prediction for MAITAMA with a percentage difference of 4.54 x 10^{-2}% on the average when compared with that of the measured values for the frequency band 267.05-300 MHz.

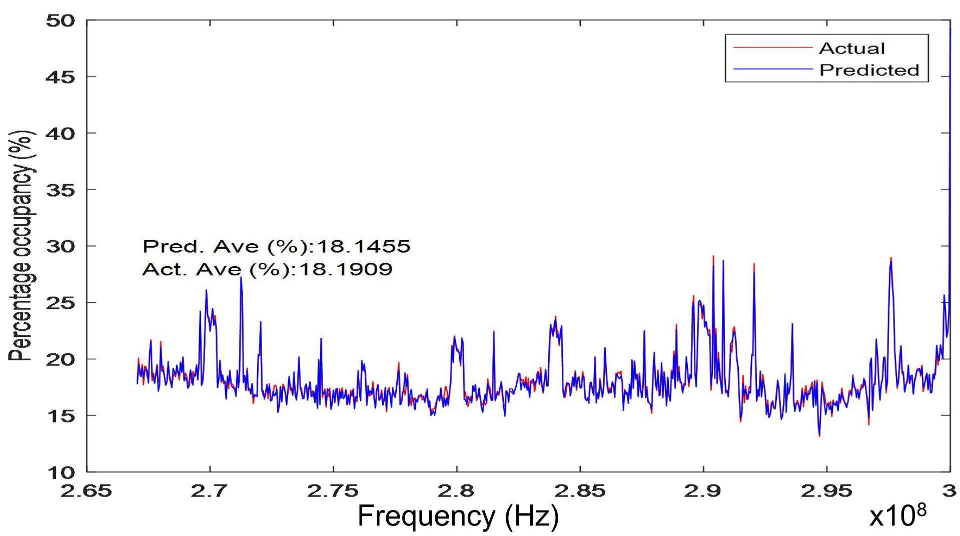


Figure 4.154: Performance Prediction for Spectrum Occupancy at Frequency Band of 267.05-300 MHz for MAITAMA

Figure 4.155 shows that most of the percentage errors fall below 1.5% while the highest error of 19.91 x 10^{-1}% occurred at the frequency of 277.9 MHz.

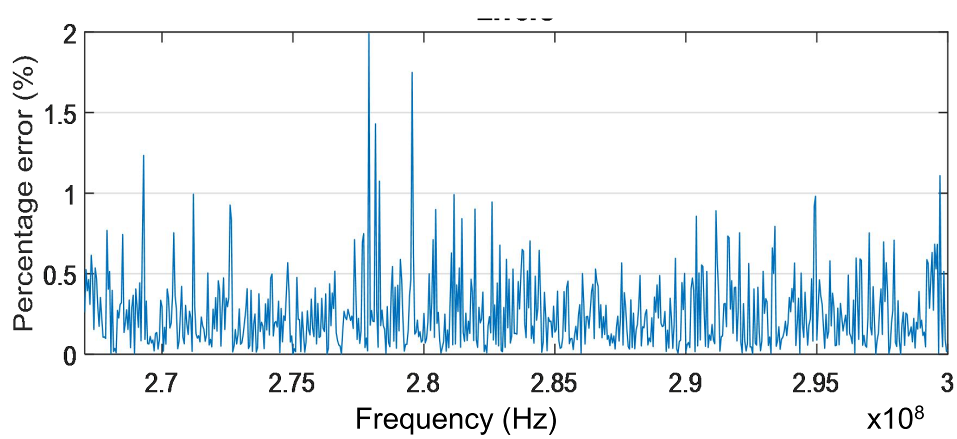


Figure 4.155: Percentage Error between Actual and Predicted Spectrum Occupancy values at 267.05-300 MHz for MAITAMA

4.7.13 Summary of Spectrum Occupancy Prediction for MAITAMA

Figure 4.156 shows that the maximum percentage difference between the actual and predicted values of 10.61×10^{-2}% occurred at the frequency band of 47.05-68 MHz while the lowest percentage difference of 0.99×10^{-2}% occurred at the frequency band of 74.85-87.45 MHz.

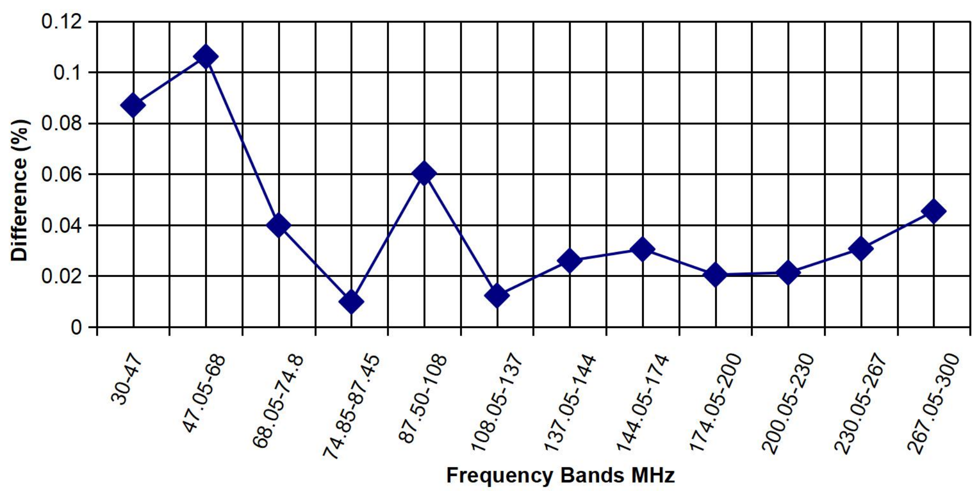


Figure 4.156: Percentage Difference Comparison of Performance Prediction for Spectrum Occupancy at various Frequency bands in MAITAMA

4.8 Summary of Spectrum Occupancy Predictions

Table 4.2 shows the summary of predicted spectrum occupancy values for all the sites particularly revealing the highest occupancy and the lowest occupancy. The highest values of prediction results occurred in Band 1 (30-47 MHz) in all the sites. Of all the six sites, Tunga Band 1 (30-47 MHz) has the highest occupancy of 44.35% and should be avoided for CR deployment while Kubwa Band 10 (200.05-230 MHz) has the lowest occupancy of 17.06% and may be considered for CR deployment. Appendix F shows the details of the actual values of the spectrum occupancy with their corresponding prediction values.

Table 4.2: Predicted Spectrum Occupancy Summary for all Sites

Location	Highest Occupancy (%)	Lowest Occupancy (%)
GK	38.48 (Band 1)	19.96 (Band 5)
AEDC	38.93 (Band 1)	22.30 (Band 4)
TUNGA	44.35 (Band 1)	24.81 (Band 7)
KUBWA	37.24 (Band 1)	17.06 (Band 10)
GUDU	37.10 (Band 1)	19.98 (Band 2)
MAITAMA	42.94 (Band 1)	18.19 (Band 12)

Table 4.3 and Table 4.4 presents the average percentage of actual and predicted spectrum occupancy for Minna and Abuja respectively for each of the 12 bands, and also the total average results for the two locations. The results show that the developed model performed well with very minimal prediction errors in both locations. For each location and in each of the bands, the predictions reveal that the errors are less than 1%. The model performed best in band 10 (200.05 – 230 MHz) both in Minna and Abuja with prediction accuracy of 99.73% and 99.99% respectively. Overall, the actual spectrum occupancy for the entire bands in Minna is 27.23% while the predicted value is 27.25% with a prediction accuracy of 97.45%. The actual spectrum occupancy for the entire bands in Abuja shows a slightly lower

value of 25.39% while the predicted value is 25.44% with a prediction accuracy of 95.21%.

Table 4.3: Average Spectrum Occupancy Prediction Summary for Minna per Band

Sub-Bands	Frequency Band (MHz)	Actual ($x10^{-2}$%)	Predicted ($x10^{-2}$%)	Difference ($x10^{-2}$%)	Accuracy (%)
Band 1	30 – 47	4059.28	4058.34	0.94	99.06
Band 2	47.05 – 68	2626.43	2622.21	4.22	95.78
Band 3	68.05 - 74.80	2549.74	2543.46	6.28	93.72
Band 4	74.85-87.45	2561.97	2564.88	2.91	97.09
Band 5	87.5-108	2573.07	2573.57	0.49	99.51
Band 6	108.05 – 137	2575.95	2577.62	1.67	98.33
Band 7	137.05 – 144	2523.94	2523.25	0.69	99.31
Band 8	144.05 – 174	2616.87	2617.64	0.77	99.23
Band 9	174.05 – 200	2590.32	2593.64	0.03	96.68
Band 10	200.05 – 230	2687.17	2686.90	0.27	99.73
Band 11	230.05 – 267	2651.72	2653.77	2.06	97.94
Band 12	267.05 – 300	2688.69	2687.11	1.59	98.41
AVERAGE TOTAL		**2725.43**	**2725.20**	**0.0023**	**97.45**

Table 4.4: Average Spectrum Occupancy Prediction Summary for Abuja per Band

Sub-Bands	Frequency Band (MHz)	Actual ($x10^{-2}$%)	Predicted ($x10^{-2}$%)	Difference ($x10^{-2}$%)	Accuracy (%)
Band 1	30 – 47	3910.74	3909.33	1.41	98.59
Band 2	47.05 – 68	2484.87	2482.43	2.44	97.56
Band 3	68.05 - 74.80	2480.27	2478.07	2.19	97.81
Band 4	74.85-87.45	2490.94	2492.61	1.67	98.33
Band 5	87.5-108	2465.14	2461.68	3.46	96.54
Band 6	108.05 – 137	2430.16	2427.52	2.63	97.37
Band 7	137.05 – 144	2417.49	2418.72	1.23	98.77
Band 8	144.05 – 174	25.8812	2588.09	0.0003	99.97
Band 9	174.05 – 200	2516.52	2514.88	01.64	98.36
Band 10	200.05 – 230	2306.02	2306.03	0.01	99.99
Band 11	230.05 – 267	2213.22	2212.62	0.60	99.40
Band 12	267.05 – 300	2233.33	2235.67	2.34	97.66
AVERAGE TOTAL		**2544.73**	**2543.97**	**4.79**	**95.21**

Summary of the actual spectrum occupancy for the two locations showing the highest and the lowest occupancy values and the equivalent bands is shown in Table 4.5. Band 1 (30 – 47 MHz) in both Minna and Abuja has the highest occupancy values of 40.60% and 39.10% respectively and should be avoided for CR deployment while Band 7 (137.05 – 144 MHz) and band 11 (230.05 – 267 MHz) have the lowest occupancy values of 25.24% and 22.13% respectively and are the ideal and best bands for CR deployment.

Table 4.5: Highest and Lowest Average Spectrum Occupancy Summary for the two Locations

Location	Highest Occupancy ($x10^{-2}$%)	Lowest Occupancy ($x10^{-2}$ %)
Minna	4059.28 (Band 1)	2523.94 (Band 7)
Abuja	3910.74 (Band 1)	2213.22 (Band 11)

4.9 Analysis of Model Performance

The datasets are split into 70:15:15, in which 70% is training data, 15% is validation data and another 15% is test data. In model development, ANN model validation is very important. Model validation is based upon some specified network performance measure of data that was not used in the model construction known as a test set. The performance measure is a metric that estimates the superiority of network architecture, learning algorithm, or application of a neural network. The two performance metrics used for the analysis of the developed model are Mean Square Error (MSE) and goodness of fit (R^2).

4.9.1 Performance metrics using MSE

Table 4.6 shows the values of the Mean Squared Error (MSE) of the ANN model for training, validation, and test steps while Appendix G shows samples of the plots for the best validation performance of the ANN model for the sub bands in all six sites where measurements were taken and the regression plots of ANN predicted spectrum occupancy against the actual occupancy results for the training, testing and validation sets, respectively. The metrics for all of the twelve bands and in all the six sites were obtained. From the results, the model had the lowest MSE of 0.42 in Tunga, band 7 (137.05-144 MHz), and the highest MSE of 13.53 in AEDC, band 10 (200.05-230 MHz). Overall the model had an MSE of 3.39. All the model predictions were in agreement with the actual results. It is worth mentioning that model training keeps going as long as the error of the network on the validation vector is reducing. An epoch refers to one cycle through the full training dataset.

Table 4.6: Mean Squared Error for Spectrum Occupancy Prediction

Sub-bands	Frequency Range (MHz)	GK	AEDC	TUNGA	KUBWA	GUDU	MAITAMA
Band 1	30 – 47	3.99	1.59	6.43	10.68	5.16	1.31
Band 2	47.05 – 68	3.03	4.65	3.48	2.93	3.22	10.28
Band 3	68.05 - 74.80	4.57	4.09	3.27	2.45	3.49	3.80
Band 4	74.85-87.45	2.06	2.90	4.82	1.25	2.46	3.70
Band 5	87.5-108	5.20	7.29	2.75	3.86	1.61	1.21
Band 6	108.05 – 137	1.27	3.99	2.65	3.53	2.46	1.61
Band 7	137.05 – 144	11.70	1.41	0.42	2.72	3.64	1.84
Band 8	144.05 – 174	0.64	4.52	6.31	3.40	1.45	4.12
Band 9	174.05 – 200	1.61	2.62	3.92	1.74	1.24	1.32
Band 10	200.05 – 230	4.20	13.53	8.58	0.92	3.57	3.70
Band 11	230.05 – 267	3.30	0.97	1.29	0.81	1.75	0.82
Band 12	267.05 – 300	2.22	3.12	1.10	1.92	1.52	2.99
	AVERAGE	3.65	4.22	3.75	3.02	2.63	3.06
	MINNA	3.88					
	ABUJA	2.90					
	AVERAGE	3.39					

4.9.2 Performance Analysis of the Network Architecture in terms of Training, Testing and Validation Efficiency

Prediction capability is the primary objective of the trained ANN model in this work. The performance of an ANN during testing with test data is the basis for selecting the best ANN architecture. For this ANN model, the training process was truncated at the epochs shown in Table 4.7 where the best validation to train the model occurred. The highest epoch of 7 occurred in Kubwa Band 11 (230.05-267 MHz)) with an MSE of 1.72 while the lowest value of 1 epoch occurred in Tunga Band 12 (267.05-300 MHz)) with an MSE of 3.38. The implication is that the model converges fastest in Tunga and in Band 12 (267.05-300 MHz). For all the six sites, the optimum number of epochs required to train the neural network ranges from 1 to 7 and shows how fast the model converged in all the sub-bands and over all the sites. On the average for the entire data, convergence occurred at 4 epoch.

Table 4.7: Epochs at which best validation occurred for the developed ANN Model

Sub-Bands	Frequency Range (MHz)	GK	AEDC	TUNGA	KUBWA	GUDU	MAITAMA
Band 1	30 – 47	3	2	5	2	6	2
Band 2	47.05 – 68	3	3	2	3	6	3
Band 3	68.05 - 74.80	5	5	2	3	6	4
Band 4	74.85-87.45	3	5	3	3	2	3
Band 5	87.5-108	6	2	5	2	4	4
Band 6	108.05 – 137	2	4	4	4	5	4
Band 7	137.05 – 144	4	4	5	3	5	5
Band 8	144.05 – 174	2	5	6	2	6	3
Band 9	174.05 – 200	6	3	3	5	3	5
Band 10	200.05 – 230	3	5	2	5	5	6
Band 11	230.05 – 267	5	6	3	7	4	4
Band 12	267.05 – 300	2	4	1	4	3	3
Average		4	4	3	4	5	4

An epoch in machine learning implies one pass over the complete training dataset. Weights are initialised at the beginning of training but undergo changes during the subsequent epochs. Epoch optimisation is important due to underfitting and overfitting. Overfitting occurs when a model is fed simultaneously with training data and noise in the training data in such a way that it poses a negative impact on the performance of the model on any data that the model has not seen earlier. The accuracy of the model is jeopardised when training data and noise are picked up by the model which leads to overfitting. However, underfitting occurs when a model is unable to learn the training data and also generalise new data given to it. The inability of the model to learn well on the training data will result in poor performance on any data given to it. Training the model using many epochs can lead to overfitting; there is therefore the need to determine the actual number of epochs to know the optimum iteration when the training process should stop.

Epochs play an important role in getting a good accuracy for the model. The ANN is trained using the training dataset only, computes the errors on both the training and validation set, and stops training when the validation error is at the lowest value. A validation set is employed to lower the overfitting as much as possible. The model is overfitted when the accuracy in the training data increases, while the validation accuracy in data remains the same or even decreases, and the training process should stop. The validation error is a measure of how well the learned model generalises and fits data that has not yet been trained on which is the validation data. The most important indicator for the quality of the network generalisation is its Mean Square

Error (MSE). Figure 4.157 shows the percentage of each epoch for the entire validation. Epoch 3 has the highest percentage, this implies majority of iteration converged at epoch 3.

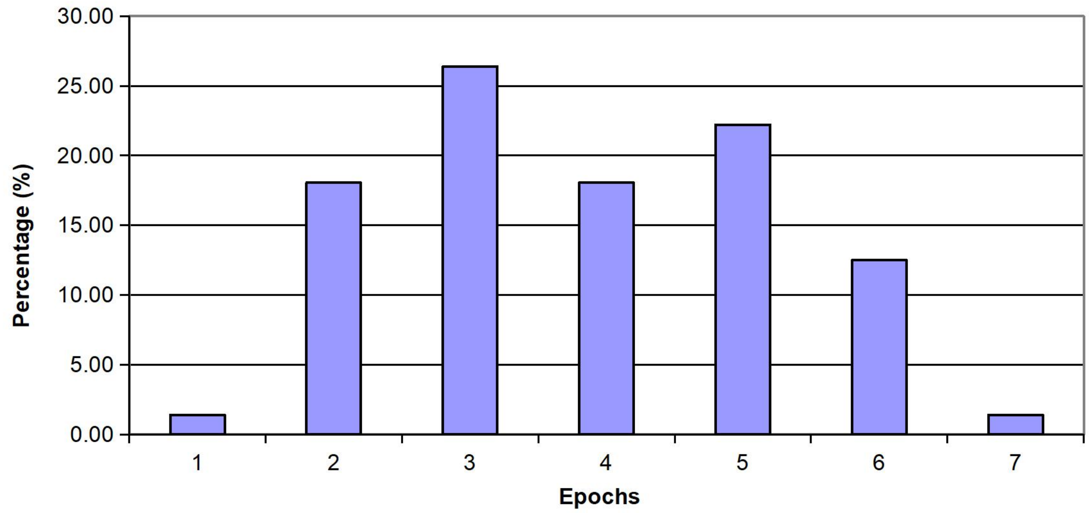


Figure 4.157: Percentage Epochs of the validation sets

Tables 4.8, 4.9 and 4.10 show that the predicted model fits so well to the actual values for both training, testing, and validation sets as can be seen in their correlation coefficients (R). The regression plots are also used to validate the network performance. Results show that the fit is reasonably good for all data sets, with regression (R) values of 99.02%, 91.51% and 91.63% for the training, testing, and validation data, respectively.

Table 4.8: Validation Performance for Spectrum Occupancy Prediction

Sub-Bands	Frequency Range (MHz)	Percentage Validation Performance for various sites GK (%)	AEDC (%)	TUNGA (%)	KUBWA (%)	GUDU (%)	MAITAMA (%)
Band 1	30 – 47	88.08	91.07	85.56	93.43	79.31	91.37
Band 2	47.05 – 68	90.89	83.45	90.81	91.82	85.97	95.34
Band 3	68.05 - 74.80	81.52	89.65	81.87	89.53	82.66	80.50
Band 4	74.85-87.45	89.18	93.48	81.22	94.03	92.35	83.29
Band 5	87.5-108	90.37	95.54	87.29	95.23	96.29	96.29
Band 6	108.05 – 137	94.54	81.15	93.23	90.45	94.59	90.00
Band 7	137.05 – 144	81.49	98.19	96.14	83.82	88.59	97.37
Band 8	144.05 – 174	97.74	87.83	94.55	97.56	93.83	96.65
Band 9	174.05 – 200	96.40	96.49	86.24	96.54	97.49	96.62
Band 10	200.05 – 230	95.69	93.34	95.54	94.98	92.64	90.55
Band 11	230.05 – 267	84.05	96.62	96.98	94.75	95.40	93.99
Band 12	267.05 – 300	98.40	95.25	96.77	94.46	97.65	95.45
	Average	90.69	91.84	90.52	93.05	91.40	92.29
	Total Average	91.63					

Table 4.9: Training Performance for Spectrum Occupancy Prediction

Sub-Bands	Frequency Range (MHz)	Percentage Training Performance for various sites GK (%)	AEDC (%)	TUNGA (%)	KUBWA (%)	GUDU (%)	MAITAMA (%)
Band 1	30 – 47	99.81	98.25	100.00	97.84	100.00	93.96
Band 2	47.05 – 68	99.97	99.78	94.20	99.99	100.00	99.88
Band 3	68.05 - 74.80	100.00	100.00	98.11	99.74	100.00	99.97
Band 4	74.85-87.45	97.81	100.00	99.22	99.09	98.03	99.92
Band 5	87.5-108	100.00	87.00	100.00	99.56	99.18	99.18
Band 6	108.05 – 137	89.93	99.91	100.00	100.00	100.00	99.76
Band 7	137.05 – 144	100.00	100.00	100.00	100.00	100.00	98.60
Band 8	144.05 – 174	95.66	100.00	100.00	98.43	100.00	99.99
Band 9	174.05 – 200	100.00	99.99	99.89	100.00	99.96	100.00
Band 10	200.05 – 230	99.98	100.00	98.67	99.78	100.00	100.00
Band 11	230.05 – 267	100.00	100.00	99.71	100.00	99.98	99.95
Band 12	267.05 – 300	98.71	99.57	100.00	97.99	96.87	95.45
	Average	98.49	98.71	99.15	99.37	99.50	98.89
	Total Average	99.02					

Table 4.10: Test Performance for Spectrum Occupancy Prediction

		Percentage Test Performance for various sites					
Sub-Bands	Frequency Range (MHz)	GK (%)	AEDC (%)	TUNGA (%)	KUBWA (%)	GUDU (%)	MAITAMA (%)
Band 1	30 – 47	89.98	86.67	88.75	81.74	85.79	84.27
Band 2	47.05 – 68	85.73	93.11	92.46	92.67	88.81	95.36
Band 3	68.05 - 74.80	89.96	88.98	96.43	91.72	95.42	95.75
Band 4	74.85-87.45	94.93	95.42	96.65	87.84	88.50	97.02
Band 5	87.5-108	88.98	97.79	87.22	93.05	94.87	94.87
Band 6	108.05 – 137	88.20	89.48	95.75	91.89	91.78	90.06
Band 7	137.05 – 144	93.43	90.72	96.64	88.18	96.91	97.67
Band 8	144.05 – 174	93.83	86.22	95.34	88.31	90.04	96.57
Band 9	174.05 – 200	97.88	79.92	90.34	93.25	93.97	90.36
Band 10	200.05 – 230	94.11	93.08	81.60	80.33	86.21	80.98
Band 11	230.05 – 267	90.30	92.43	92.21	93.75	88.76	96.66
Band 12	267.05 – 300	96.58	98.65	100.00	93.45	92.32	89.98
	Average	91.99	91.04	92.78	89.68	91.12	92.46
	Total Average	91.51					

4.10 Summary of Findings

Lowest Actual Occupancy value of 17.06% occurred in Kubwa in Band 10 (200.05-230 MHz), therefore this is the best band for CR. Highest Actual Occupancy rate of 44.46% occurred in Tunga in Band 1 (30-47 MHz) and this band is not suitable for CR.

In all the six sites, Band 1 had the highest Occupancy rate and should be avoided for CR applications. Minna had the highest occupancy rate of 40.59% in Band 1 (30-47 MHz) and lowest occupancy of 25.24% in Band 7 (137.05-144 MHz). Abuja had the highest occupancy rate of 39.11% in Band 1 (30-47 MHz) and lowest occupancy rate of 22.13% in Band 11 (230.05-267 MHz). In Minna, prediction model performed best with an accuracy of 99.73% in Band 10 (200.05-230 MHz) and a minimum accuracy of 93.72% in Band 3 (68.05-74.80 MHz). In Abuja, prediction model performed best with an accuracy of 99.99% in Band 10 (200.05-230 MHz) and a minimum accuracy of 96.54% in Band 5 (87.5-108 MHz).

CHAPTER FIVE

6.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

A secondary cognitive user is expected to know the channel status before opportunistic access to the channel is permitted to avoid collision or interference. This implies that spectrum sensing by the cognitive user is essential. Sensing of the spectrum before transmission causes delay and impacts on the utilisation performance. This challenge can be addressed by accurately predicting the status of the channel a priori. In this work, a machine learning model was developed and trained with spectrum occupancy data collected in two cities of Minna and Abuja with each location having 3 measurement sites, and analysis of this data was done using the EDA technique. Grouping of data into 12 frequency bands was done using the power density plots for the VHF band (30-300MHz). The dataset has huge features that are highly correlated. Modeling with huge features that are highly correlated leads to overfitting. In this work, redundancy was eliminated from the dataset and the best trainable features were selected for machine learning modeling. A sample of the dataset was used to train the model to understand the underlying structures of the dataset for prediction.

A new hybrid model for spectrum occupancy prediction was developed using ensembles of ANN and AR models comprising both nonlinear and linear models respectively. This is because real-world problems are complex and no single model can capture patterns equally well. A hybrid model is more robust with regards to possible structural change in the data. A feature vector was developed using the spectrum data to capture occupancy rate patterns per spectrum band across a 24-hour time interval. The feature vector was captured as time instances of the occupancy of all the frequency bands considered. This served as the input vector into the one feed-forward neural network. The weight of the feed-forward neural network is improved by using the AR model whose order is based on the time dimension of the feature vector. The generated coefficients are multiplied with the output of the feed-forward neural network to predict the occupancy of a particular frequency spectrum.

Performance analysis of the developed model was achieved and the accuracy documented. In Minna, the prediction model performed best with an accuracy of 99.73% in Band 10 (200.05 – 230 MHz) and a minimum accuracy of 93.72% in Band 3 (68.05 - 74.80 MHz). In Abuja, the prediction model performed best with an accuracy of 99.99% in Band 10 (200.05 – 230 MHz) and a minimum accuracy of 96.54% in Band 5 (87.5-108 MHz). Overall, the performance of the NN prediction model reveals the accuracy of 99.02% on the training dataset, 91.63% on the validation dataset and 91.51% on the Test dataset. Validation of the model was done by splitting the data into Training, Validation and Testing. Results for these show that the model performed well on unseen data.

5.2 Recommendations

Based on the findings in this work it is recommended that:

1. Synchronous measurement approach in all the sites be done. This will imply having a setup of equipment in each of the sites and commencing data capture simultaneously at the same time instance instead of moving the equipment around. Extensive data collection with dedicated servers containing several containers may be considered. Further research work can also consider automating the feature groupings for the power density plots.
2. Further spectrum occupancy investigation and analysis can be carried out in each of the frequency sub-bands. Other modeling techniques can also be considered with a view to comparing results with the developed model. To improve the prediction performance of the ANN model, more research experiments may be considered by varying other network parameters that are not studied in this work to produce better generalisation. Algorithms that can find appropriate parameters for the ANN model can be developed.
3. Different sample sizes of the training set, validation set, and testing set should be used to study the effect on performance.
4. Investigation of transmitters that are active in these bands and all the sites is recommended.
5. If the model is subjected to extensive training with data spanning a whole year, it could lead to more improved prediction accuracy.

5.4 Contribution to Knowledge

1. A novel frequency data grouping is done using power density plot techniques.

2. An ensemble of Autoregressive Neural Network (ARNN) prediction model with an accuracy of 91.51% to an unseen test data was developed.
3. Spectrum occupancy values for each band and in each of the sites were obtained with the highest actual occupancy of 40.59% and the lowest occupancy of 22.13%. The performance of the Neural Network prediction model reveals accuracy of 99.02% on the training dataset and 91.63% on the validation dataset.
4. Source codes for spectrum occupancy prediction was developed using Matlab.
5. Part of this work has been published in a journal and presented in a conference while some are undergoing review process.

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APPENDICES

APPENDIX A: SAMPLES OF POWER SPECTRUM DATA

SAMPLE DATA FOR GK

		Frequency (Hz)			
Timestamp	Measure Unit	30000000	30050000	30100000	30150000
2018-12-13T09:44:27.528	0	-33.098	-31.032	-29.456	-31.878
2018-12-13T09:44:42.332	0	-30.35	-31.41	-31.788	-30.684
2018-12-13T09:44:57.137	0	-31.047	-31.28	-31.806	-30.643
2018-12-13T09:45:11.941	0	-32.509	-31.233	-30.643	-31.248
2018-12-13T09:45:26.746	0	-31.735	-30.35	-30.712	-31.077
2018-12-13T09:45:41.566	0	-30.468	-33.347	-30.311	-30.148
2018-12-13T09:45:56.386	0	-31.032	-31.51	-31.527	-30.428
2018-12-13T09:46:11.174	0	-30.149	-31.139	-31.56	-32.931
2018-12-13T09:46:25.994	0	-30.561	-31.426	-31.77	-30.561
2018-12-13T09:46:40.799	0	-30.713	-31.002	-31.248	-32.487
2018-12-13T09:46:55.603	0	-30.261	-31.233	-31.108	-29.851
2018-12-13T09:47:10.423	0	-30.783	-31.578	-29.726	-30.826
2018-12-13T09:47:25.228	0	-30.548	-30.507	-31.56	-30.928
2018-12-13T09:47:40.032	0	-30.507	-30.898	-31.248	-30.52
2018-12-13T09:47:54.852	0	-31.735	-32.202	-32.027	-30.441
2018-12-13T09:48:09.672	0	-30.913	-31.077	-31.017	-31.123
2018-12-13T09:48:24.477	0	-30.063	-30.324	-31.077	-31.578
2018-12-13T09:48:39.297	0	-30.161	-29.749	-30.602	-31.248
2018-12-13T09:48:54.085	0	-30.468	-30.987	-32.261	-31.788
2018-12-13T09:49:08.906	0	-30.616	-31.328	-31.897	-31.426
2018-12-13T09:49:23.726	0	-31.249	-30.811	-31.664	-31.664
2018-12-13T09:49:38.530	0	-32.488	-31.915	-30.48	-31.527
2018-12-13T09:49:53.334	0	-31.682	-30.428	-31.646	-32.027

2018-12-13T09:50:08.154	0	-30.958	-32.182	-31.971	-30.428
2018-12-13T09:50:22.959	0	-31.155	-31.032	-31.185	-31.716
2018-12-13T09:50:37.904	0	-28.781	-27.494	-28.813	-29.323
2018-12-13T09:50:52.708	0	-28.211	-27.681	-27.421	-27.643
2018-12-13T09:51:07.653	0	-50.711	-50.737	-50.296	-52.374
2018-12-13T09:51:22.598	0	-29.97	-30.634	-30.412	-30.055
2018-12-13T09:51:37.402	0	-30.506	-32.579	-30.185	-29.764
2018-12-13T09:51:52.207	0	-30.87	-29.886	-31.117	-31.661
2018-12-13T09:52:07.027	0	-31.155	-30.818	-29.659	-30.274
2018-12-13T09:52:21.815	0	-30.23	-31.83	-30.602	-30.684
2018-12-13T09:52:36.635	0	-29.029	-29.272	-30.098	-31.117
2018-12-13T09:52:51.440	0	-31.136	-30.35	-30.396	-29.074
2018-12-13T09:53:06.260	0	-30.784	-29.914	-29.791	-29.443
2018-12-13T09:53:21.064	0	-29.712	-29.04	-29.9	-30.098
2018-12-13T09:53:35.884	0	-29.832	-29.751	-31.173	-29.764
2018-12-13T09:53:50.689	0	-30.26	-31.136	-31.285	-29.213
2018-12-13T09:54:05.509	0	-28.735	-30.667	-29.778	-31.342
2018-12-13T09:54:20.313	0	-29.285	-30.2	-30.069	-30.412
2018-12-13T09:54:35.118	0	-31.118	-30.956	-30.427	-30.57
2018-12-13T09:54:49.938	0	-30.335	-30.012	-30.7	-31.579
2018-12-13T09:55:04.742	0	-30.57	-29.53	-30.289	-29.646
2018-12-13T09:55:19.547	0	-31.641	-31.917	-30.215	-30.49
2018-12-13T09:55:34.367	0	-30.215	-30.956	-30.921	-29.818
2018-12-13T09:55:49.187	0	-30.29	-30.618	-30.244	-30.127
2018-12-13T09:56:03.991	0	-29.805	-30.069	-30.767	-29.19
2018-12-13T09:56:18.811	0	-29.052	-30.427	-31.081	-31.381
2018-12-13T09:56:33.600	0	-30.443	-30.602	-30.586	-29.393
2018-12-13T09:56:48.420	0	-29.19	-29.296	-29.725	-30.522
2018-12-13T09:57:03.302	0	-29.394	-29.074	-30.474	-29.381
2018-12-13T09:57:18.107	0	-30.443	-30.835	-31.599	-30.2
2018-12-13T09:57:32.927	0	-30.651	-30.012	-30.259	-29.646
2018-12-13T09:57:47.731	0	-29.381	-30.229	-29.9	-30.835
2018-12-13T09:58:02.551	0	-29.846	-30.522	-30.443	-29.886
2018-12-13T09:58:17.340	0	-29.792	-30.634	-29.886	-31.917
2018-12-13T09:58:32.160	0	-30.142	-30.904	-30.602	-30.141
2018-12-13T09:58:46.965	0	-30.35	-30.974	-30.458	-29.493
2018-12-13T09:59:01.785	0	-31.229	-29.344	-29.248	-29.873
2018-12-13T09:59:16.589	0	-30.055	-29.237	-29.406	-29.956
2018-12-13T09:59:31.409	0	-30.026	-31.808	-31.323	-30.427
2018-12-13T09:59:46.213	0	-30.522	-28.984	-30.474	-30.069
2018-12-13T10:00:01.018	0	-30.87	-30.684	-30.069	-28.488
2018-12-13T10:00:15.838	0	-31.559	-30.835	-29.9	-30.055

2018-12-13T10:00:30.642	0	-30.026	-30.35	-29.751	-30.458
2018-12-13T10:00:45.462	0	-30.335	-29.928	-31.361	-30.365
2018-12-13T10:01:00.251	0	-30.35	-29.9	-30.365	-31.599
2018-12-13T10:01:15.071	0	-29.942	-30.734	-29.097	-30.458
2018-12-13T10:01:29.876	0	-29.443	-29.418	-29.607	-30.602
2018-12-13T10:01:44.680	0	-30.602	-30.098	-30.602	-30.717
2018-12-13T10:01:59.500	0	-29.725	-30.229	-29.725	-30.112
2018-12-13T10:02:14.304	0	-29.345	-29.942	-30.304	-28.755
2018-12-13T10:02:29.109	0	-29.381	-30.055	-29.845	-30.921
2018-12-13T10:02:43.929	0	-29.97	-31.136	-29.443	-30.602
2018-12-13T10:02:58.733	0	-30.055	-31.961	-28.559	-32.404
2018-12-13T10:03:13.553	0	-28.984	-31.559	-31.045	-29.685
2018-12-13T10:03:28.358	0	-29.998	-31.21	-30.412	-30.506
2018-12-13T10:03:43.162	0	-31.479	-30.634	-30.554	-29.998
2018-12-13T10:03:57.982	0	-31.155	-30.055	-31.459	-31.154
2018-12-13T10:04:12.802	0	-31.155	-29.62	-30.381	-30.458
2018-12-13T10:04:27.747	0	-50.862	-51.658	-51.566	-51.612
2018-12-13T10:04:42.692	0	-48.258	-48.513	-48.176	-46.682
2018-12-13T10:04:57.637	0	-28.449	-29.557	-28.608	-28.17
2018-12-13T10:05:12.441	0	-28.098	-29.889	-30.409	-28.662
2018-12-13T10:05:27.246	0	-30.094	-28.358	-29.004	-29.019
2018-12-13T10:05:42.066	0	-29.625	-28.461	-29.853	-30.055
2018-12-13T10:05:56.870	0	-28.844	-28.989	-28.594	-29.248
2018-12-13T10:06:11.675	0	-28.96	-29.506	-28.858	-28.945
2018-12-13T10:06:26.495	0	-28.844	-27.852	-29.408	-28.527
2018-12-13T10:06:41.299	0	-28.026	-29.607	-30.908	-29.232
2018-12-13T10:06:56.103	0	-28.333	-28.703	-29.853	-28.435
2018-12-13T10:07:10.923	0	-29.004	-28.745	-29.557	-29.607
2018-12-13T10:07:25.728	0	-28.358	-30.018	-29.889	-28.384
2018-12-13T10:07:40.532	0	-29.799	-28.787	-29.424	-30.132
2018-12-13T10:07:55.352	0	-28.41	-28.038	-29.343	-29.034
2018-12-13T10:08:10.157	0	-28.844	-28.648	-28.014	-29.155
2018-12-13T10:08:24.977	0	-28.41	-28.931	-28.608	-29.034
2018-12-13T10:08:39.844	0	-29.14	-29.004	-29.17	-30.018
2018-12-13T10:08:54.664	0	-28.844	-29.264	-28.409	-29.14
2018-12-13T10:09:09.468	0	-29.54	-29.506	-28.801	-28.183
2018-12-13T10:09:24.272	0	-28.595	-28.448	-29.232	-28.873
2018-12-13T10:09:39.077	0	-28.32	-28.074	-29.232	-28.269
2018-12-13T10:09:53.897	0	-28.159	-28.759	-28.488	-29.49
2018-12-13T10:10:08.717	0	-29.711	-28.384	-30.954	-28.514
2018-12-13T10:10:23.521	0	-29.799	-28.858	-29.311	-28.717
2018-12-13T10:10:38.326	0	-28.514	-30.018	-27.852	-29.359

2018-12-13T10:10:53.146	0	-27.841	-29.607	-28.501	-29.064
2018-12-13T10:11:08.028	0	-28.649	-29.248	-29.264	-29.359
2018-12-13T10:11:22.895	0	-28.038	-28.873	-29.424	-29.557
2018-12-13T10:11:37.715	0	-28.788	-30.885	-28.759	-28.422
2018-12-13T10:11:52.644	0	-50.646	-49.135	-50.003	-52.315
2018-12-13T10:12:07.605	0	-30.105	-31.113	-31.576	-30.587
2018-12-13T10:12:22.409	0	-29.45	-31.509	-29.952	-29.906
2018-12-13T10:12:37.214	0	-30.765	-31.283	-31.559	-31.189
2018-12-13T10:12:52.018	0	-31.19	-30.377	-31.159	-32.836
2018-12-13T10:13:06.838	0	-30.339	-31.083	-31.492	-30.849
2018-12-13T10:13:21.658	0	-31.696	-30.863	-32.574	-29.975
2018-12-13T10:13:36.478	0	-31.252	-30.442	-29.532	-30.654
2018-12-13T10:13:51.283	0	-31.73	-30.681	-30.863	-31.053
2018-12-13T10:14:06.087	0	-30.574	-31.023	-29.998	-29.418
2018-12-13T10:14:20.891	0	-30.682	-31.33	-30.778	-30.709
2018-12-13T10:14:35.696	0	-31.61	-31.476	-31.981	-32.113
2018-12-13T10:14:50.516	0	-30.587	-31.765	-31.713	-30.892
2018-12-13T10:15:05.320	0	-31.252	-31.299	-30.326	-30.587
2018-12-13T10:15:20.140	0	-30.178	-30.264	-30.695	-30.792
2018-12-13T10:15:34.960	0	-31.175	-31.205	-29.952	-29.871
2018-12-13T10:15:49.765	0	-29.565	-30.835	-31.427	-31.411
2018-12-13T10:16:04.569	0	-29.565	-31.314	-31.713	-31.33
2018-12-13T10:16:19.374	0	-30.574	-31.378	-31.526	-31.159
2018-12-13T10:16:34.178	0	-31.098	-32.268	-30.289	-29.94
2018-12-13T10:16:48.998	0	-30.277	-31.509	-30.52	-31.576
2018-12-13T10:17:03.818	0	-30.093	-31.283	-30.668	-31.542
2018-12-13T10:17:18.763	0	-50.345	-50.755	-49.345	-49.654
2018-12-13T10:17:33.708	0	-32.48	-32.841	-30.671	-31.338
2018-12-13T10:17:48.512	0	-31.11	-31.354	-32.016	-31.45
2018-12-13T10:18:03.457	0	-51.003	-51.21	-51.805	-50.83
2018-12-13T10:18:18.402	0	-29.509	-30.148	-30.467	-30.198
2018-12-13T10:18:33.222	0	-29.727	-31.108	-30.84	-32.221
2018-12-13T10:18:48.026	0	-31.217	-30.84	-31.527	-31.296
2018-12-13T10:19:02.831	0	-31.093	-29.498	-30.957	-31.108
2018-12-13T10:19:17.651	0	-30.826	-30.84	-31.296	-31.952
2018-12-13T10:19:32.455	0	-30.972	-30.602	-30.273	-31.296
2018-12-13T10:19:47.260	0	-30.248	-29.944	-31.139	-32.816
2018-12-13T10:20:02.080	0	-29.806	-31.077	-29.771	-32.046
2018-12-13T10:20:16.884	0	-30.561	-31.093	-31.612	-29.76
2018-12-13T10:20:31.704	0	-30.629	-33.321	-31.629	-30.643
2018-12-13T10:20:46.508	0	-30.561	-29.932	-30.698	-30.698
2018-12-13T10:21:01.313	0	-30.441	-30.898	-30.574	-30.52

2018-12-13T10:21:16.133	0	-30.884	-30.428	-31.806	-31.264
2018-12-13T10:21:30.937	0	-30.913	-31.139	-30.855	-30.35
2018-12-13T10:21:45.742	0	-31.394	-30.124	-31.595	-32.342
2018-12-13T10:22:00.562	0	-30.324	-30.712	-30.21	-30.494
2018-12-13T10:22:15.366	0	-31.329	-31.002	-32.123	-31.28
2018-12-13T10:22:30.171	0	-30.616	-29.671	-31.716	-30.928
2018-12-13T10:22:44.975	0	-30.588	-32.046	-31.108	-32.182
2018-12-13T10:22:59.795	0	-30.415	-30.401	-31.612	-31.312
2018-12-13T10:23:14.615	0	-30.87	-30.869	-31.443	-30.615
2018-12-13T10:23:29.420	0	-31.139	-31.752	-31.716	-31.716
2018-12-13T10:23:44.224	0	-30.899	-31.345	-31.51	-31.017
2018-12-13T10:23:59.044	0	-31.612	-30.185	-30.467	-32.104
2018-12-13T10:24:13.848	0	-32.124	-31.201	-32.085	-31.824
2018-12-13T10:24:28.653	0	-31.093	-30.467	-30.67	-30.574
2018-12-13T10:24:43.473	0	-30.35	-29.541	-30.414	-30.148
2018-12-13T10:24:58.293	0	-29.991	-31.426	-31.077	-30.337
2018-12-13T10:25:13.097	0	-31.093	-30.898	-30.712	-29.771
2018-12-13T10:25:27.902	0	-31.595	-31.426	-31.217	-31.393
2018-12-13T10:25:42.706	0	-31.527	-30.84	-30.726	-30.401
2018-12-13T10:25:57.526	0	-31.934	-29.519	-31.629	-30.942
2018-12-13T10:26:12.346	0	-31.699	-30.48	-30.754	-31.595
2018-12-13T10:26:27.151	0	-30.161	-31.248	-30.898	-32.383
2018-12-13T10:26:41.955	0	-32.085	-30.84	-30.602	-31.629
2018-12-13T10:26:56.775	0	-31.578	-30.015	-31.56	-31.328
2018-12-13T10:27:11.580	0	-30.223	-31.312	-31.032	-31.806
2018-12-13T10:27:26.384	0	-29.617	-31.185	-30.574	-31.681
2018-12-13T10:27:41.204	0	-31.139	-31.264	-29.817	-30.26
2018-12-13T10:27:56.024	0	-32.839	-29.967	-30.855	-32.066
2018-12-13T10:28:10.828	0	-31.361	-30.754	-31.716	-30.987
2018-12-13T10:28:25.648	0	-30.899	-30.015	-29.53	-31.032
2018-12-13T10:28:40.437	0	-31.682	-31.971	-31.032	-30.643
2018-12-13T10:28:55.257	0	-31.313	-31.681	-29.301	-30.48
2018-12-13T10:29:10.062	0	-32.143	-30.783	-31.646	-30.375
2018-12-13T10:29:24.866	0	-30.507	-31.154	-30.588	-30.913
2018-12-13T10:29:39.686	0	-30.657	-30.602	-30.928	-31.752
2018-12-13T10:29:54.491	0	-30.534	-30.657	-29.477	-31.233
2018-12-13T10:30:09.295	0	-31.124	-30.754	-30.454	-30.884
2018-12-13T10:30:24.240	0	-49.319	-49.71	-48.823	-48.514
2018-12-13T10:30:39.185	0	-30.689	-29.649	-30.495	-31.511
2018-12-13T10:30:54.005	0	-30.689	-30.66	-31.529	-30.522
2018-12-13T10:31:08.809	0	-30.661	-31.942	-30.258	-30.322
2018-12-13T10:31:23.629	0	-30.661	-30.131	-30.847	-30.361

2018-12-13T10:31:38.434	0	-31.776	-30.789	-31.494	-30.59
2018-12-13T10:31:53.238	0	-31.23	-31.166	-31.057	-29.728
2018-12-13T10:32:08.042	0	-31.214	-30.258	-30.508	-30.789
2018-12-13T10:32:22.847	0	-30.107	-29.66	-31.214	-30.388
2018-12-13T10:32:37.667	0	-30.375	-31.088	-30.481	-30.981
2018-12-13T10:32:52.471	0	-31.529	-31.686	-31.999	-30.563
2018-12-13T10:33:07.291	0	-31.74	-31.722	-30.481	-30.033
2018-12-13T10:33:22.096	0	-29.728	-30.549	-30.283	-31.598
2018-12-13T10:33:36.900	0	-29.297	-30.774	-31.41	-28.98
2018-12-13T10:33:51.720	0	-30.509	-30.76	-32.116	-28.923
2018-12-13T10:34:06.525	0	-30.661	-30.891	-31.042	-29.819
2018-12-13T10:34:21.329	0	-29.878	-30.388	-31.704	-31.23
2018-12-13T10:34:36.149	0	-31.183	-29.997	-31.311	-31.722
2018-12-13T10:34:50.954	0	-30.847	-31.776	-30.832	-30.335
2018-12-13T10:35:05.758	0	-29.961	-30.283	-29.572	-31.278
2018-12-13T10:35:20.578	0	-30.675	-30.441	-31.511	-31.311
2018-12-13T10:35:35.382	0	-29.286	-31.151	-30.774	-30.508
2018-12-13T10:35:50.202	0	-29.949	-31.042	-31.74	-30.182
2018-12-13T10:36:05.007	0	-30.233	-31.246	-30.495	-31.073
2018-12-13T10:36:19.811	0	-30.996	-31.23	-30.033	-31.98
2018-12-13T10:36:34.772	0	-51.172	-50.901	-51.834	-52.444
2018-12-13T10:36:49.701	0	-30.336	-29.453	-30.832	-31.151
2018-12-13T10:37:04.521	0	-31.344	-30.717	-32.057	-30.375
2018-12-13T10:37:19.325	0	-30.563	-31.758	-31.246	-29.949
2018-12-13T10:37:34.130	0	-30.058	-29.866	-31.74	-30.717
2018-12-13T10:37:48.950	0	-32.572	-30.169	-31.166	-31.686
2018-12-13T10:38:03.770	0	-31.651	-31.477	-30.508	-31.214
2018-12-13T10:38:18.574	0	-30.336	-31.58	-30.454	-31.598
2018-12-13T10:38:33.394	0	-31.794	-30.508	-29.796	-31.961
2018-12-13T10:38:48.199	0	-31.073	-30.207	-29.762	-30.107
2018-12-13T10:39:03.144	0	-29.177	-28.387	-27.877	-27.824
2018-12-13T10:39:17.948	0	-28.541	-26.672	-27.694	-28.153
2018-12-13T10:39:32.893	0	-29.93	-30.631	-31.116	-31.266
2018-12-13T10:39:47.697	0	-30.113	-30.832	-32.174	-31.781
2018-12-13T10:40:02.502	0	-30.502	-30.464	-32.586	-31.564
2018-12-13T10:40:17.322	0	-29.269	-30.54	-30.916	-30.972
2018-12-13T10:40:32.126	0	-31.647	-30.29	-33.499	-31.5
2018-12-13T10:40:47.071	0	-51.62	-52.561	-52.219	-52.285
2018-12-13T10:41:02.016	0	-30.897	-31.006	-30.896	-30.583
2018-12-13T10:41:16.820	0	-30.673	-31.862	-31.119	-32.07
2018-12-13T10:41:31.640	0	-30.699	-32.781	-29.708	-30.339
2018-12-13T10:41:46.445	0	-31.931	-30.411	-30.856	-30.685

2018-12-13T10:42:01.265	0	-31.091	-31.521	-31.076	-31.845
2018-12-13T10:42:16.069	0	-31.353	-31.338	-32.214	-31.648
2018-12-13T10:42:30.874	0	-31.234	-30.75	-31.779	-29.607
2018-12-13T10:42:45.694	0	-31.569	-30.459	-31.506	-32.698
2018-12-13T10:43:00.498	0	-30.257	-31.034	-29.952	-31.948
2018-12-13T10:43:15.302	0	-30.712	-30.698	-31.234	-31.713
2018-12-13T10:43:30.122	0	-30.979	-31.034	-31.729	-31.205
2018-12-13T10:43:44.927	0	-30.938	-30.609	-31.19	-31.616
2018-12-13T10:43:59.872	0	-29.602	-28.682	-28.385	-28.967
2018-12-13T10:44:14.676	0	-27.911	-28.775	-28.531	-27.565
2018-12-13T10:44:29.637	0	-31.073	-30.147	-29.415	-31.131
2018-12-13T10:44:44.441	0	-30.944	-32.485	-30.93	-31.358
2018-12-13T10:44:59.245	0	-31.938	-31.175	-31.597	-31.205
2018-12-13T10:45:14.065	0	-31.297	-31.389	-30.194	-30.71
2018-12-13T10:45:28.870	0	-30.078	-30.791	-30.136	-31.452
2018-12-13T10:45:43.674	0	-31.358	-30.266	-31.815	-31.358
2018-12-13T10:45:58.479	0	-31.833	-30.54	-31.235	-33.065
2018-12-13T10:46:13.424	0	-29.297	-27.152	-29.206	-29.224
2018-12-13T10:46:28.228	0	-27.119	-28.484	-27.786	-27.647
2018-12-13T10:46:43.048	0	-28.576	-29.315	-26.882	-29.206
2018-12-13T10:46:57.852	0	-27.647	-27.404	-28.749	-27.709
2018-12-13T10:47:12.797	0	-27.723	-29.37	-27.634	-28.438
2018-12-13T10:47:27.742	0	-27.904	-29.37	-29.188	-28.438
2018-12-13T10:47:42.546	0	-27.799	-27.585	-28.56	-28.024
2018-12-13T10:47:57.367	0	-27.851	-28.394	-27.572	-28.335
2018-12-13T10:48:12.171	0	-28.484	-28.052	-28.205	-30.052
2018-12-13T10:48:26.975	0	-27.322	-27.38	-29.445	-28.191
2018-12-13T10:48:41.920	0	-30.552	-31.036	-30.698	-30.698
2018-12-13T10:48:56.725	0	-30.373	-31.354	-31.139	-30.335
2018-12-13T10:49:11.545	0	-33.695	-30.448	-31.925	-30.578
2018-12-13T10:49:26.365	0	-30.526	-31.466	-32.184	-31.386
2018-12-13T10:49:41.185	0	-30.385	-30.436	-31.498	-32.203
2018-12-13T10:49:55.989	0	-31.515	-31.647	-30.237	-32.184
2018-12-13T10:50:10.794	0	-30.726	-31.732	-31.498	-31.907
2018-12-13T10:50:25.598	0	-31.051	-30.864	-31.323	-31.036
2018-12-13T10:50:40.418	0	-29.7	-30.058	-31.124	-30.249
2018-12-13T10:50:55.222	0	-31.434	-30.261	-31.45	-31.997
2018-12-13T10:51:10.027	0	-31.021	-31.801	-30.685	-30.604
2018-12-13T10:51:24.847	0	-31.021	-29.897	-31.021	-30.836
2018-12-13T10:51:39.651	0	-31.597	-30.698	-31.292	-31.307
2018-12-13T10:51:54.456	0	-32.203	-30.739	-30.794	-30.436
2018-12-13T10:52:09.260	0	-30.141	-31.784	-30.992	-31.836

2018-12-13T10:52:24.080	0	-30.726	-31.402	-30.85	-29.689
2018-12-13T10:52:38.885	0	-29.389	-32.034	-30.36	-32.541
2018-12-13T10:52:53.689	0	-32.931	-30.273	-30.794	-32.09
2018-12-13T10:53:08.509	0	-30.808	-30.671	-30.31	-31.402
2018-12-13T10:53:23.313	0	-31.498	-30.934	-31.139	-31.109
2018-12-13T10:53:38.134	0	-30.261	-31.307	-30.285	-30.644
2018-12-13T10:53:52.938	0	-31.466	-31.63	-30.513	-30.698
2018-12-13T10:54:07.758	0	-29.646	-29.764	-29.469	-29.541
2018-12-13T10:54:22.562	0	-31.614	-30.2	-30.436	-30.36
2018-12-13T10:54:37.367	0	-31.482	-30.618	-31.021	-33.235
2018-12-13T10:54:52.171	0	-30.794	-31.292	-31.872	-33.186
2018-12-13T10:55:06.991	0	-30.836	-31.979	-32.261	-30.739
2018-12-13T10:55:21.936	0	-51.02	-49.941	-50.76	-50.791
2018-12-13T10:55:36.881	0	-30.182	-31.073	-30.348	-30.951
2018-12-13T10:55:51.701	0	-29.925	-30.966	-29.627	-29.453
2018-12-13T10:56:06.505	0	-31.012	-30.604	-32.593	-30.951
2018-12-13T10:56:21.310	0	-31.027	-30.296	-31.151	-30.832
2018-12-13T10:56:36.130	0	-30.401	-31.58	-31.546	-30.508
2018-12-13T10:56:50.950	0	-31.311	-30.495	-33.154	-31.246
2018-12-13T10:57:05.754	0	-31.199	-31.36	-32.096	-29.307
2018-12-13T10:57:20.574	0	-31.686	-32.136	-31.088	-33.056
2018-12-13T10:57:35.379	0	-29.878	-30.207	-31.151	-31.831
2018-12-13T10:57:50.199	0	-31.328	-30.996	-30.618	-30.508
2018-12-13T10:58:05.003	0	-31.279	-31.563	-30.891	-31.633
2018-12-13T10:58:19.808	0	-29.785	-30.996	-30.577	-31.278
2018-12-13T10:58:34.612	0	-30.803	-30.76	-31.529	-30.847
2018-12-13T10:58:49.432	0	-29.774	-29.913	-31.546	-31.686
2018-12-13T10:59:04.236	0	-30.144	-30.021	-30.632	-29.913
2018-12-13T10:59:19.041	0	-33.007	-31.104	-29.937	-31.849
2018-12-13T10:59:33.861	0	-30.182	-30.296	-29.517	-30.731
2018-12-13T10:59:48.665	0	-30.509	-30.577	-31.182	-30.454
2018-12-13T11:00:03.485	0	-30.862	-31.214	-30.789	-30.335
2018-12-13T11:00:18.290	0	-30.284	-30.921	-31.831	-31.344
2018-12-13T11:00:33.094	0	-31.776	-31.011	-30.936	-30.428
2018-12-13T11:00:47.899	0	-30.258	-31.182	-31.758	-30.549
2018-12-13T11:01:02.703	0	-31.651	-30.818	-31.295	-31.246
2018-12-13T11:01:17.523	0	-30.833	-30.454	-31.427	-31.494
2018-12-13T11:01:32.328	0	-31.135	-30.731	-31.027	-31.905
2018-12-13T11:01:47.148	0	-30.349	-30.454	-30.996	-31.377
2018-12-13T11:02:01.952	0	-29.774	-30.232	-32.358	-30.414
2018-12-13T11:02:16.756	0	-30.233	-30.401	-30.335	-31.246
2018-12-13T11:02:31.576	0	-29.797	-30.207	-31.214	-31.942

2018-12-13T11:02:46.381	0	-30.233	-31.042	-29.683	-30.745
2018-12-13T11:03:01.185	0	-31.461	-30.59	-29.866	-30.774
2018-12-13T11:03:16.005	0	-30.22	-31.027	-29.086	-31.393
2018-12-13T11:03:30.888	0	-29.762	-30.335	-31.427	-31.758
2018-12-13T11:03:45.786	0	-30.661	-30.401	-30.508	-30.604
2018-12-13T11:04:00.575	0	-30.774	-30.862	-31.135	-30.535
2018-12-13T11:04:15.395	0	-31.427	-30.818	-29.496	-29.937
2018-12-13T11:04:30.215	0	-31.849	-30.194	-31.722	-31.704
2018-12-13T11:04:45.035	0	-32.317	-31.278	-29.949	-29.925
2018-12-13T11:04:59.839	0	-31.831	-29.55	-31.758	-31.166
2018-12-13T11:05:14.659	0	-30.675	-30.232	-30.745	-31.073
2018-12-13T11:05:29.464	0	-30.388	-30.577	-31.104	-30.832
2018-12-13T11:05:44.268	0	-31.546	-30.774	-30.688	-30.119
2018-12-13T11:05:59.088	0	-31.905	-29.854	-30.401	-30.862
2018-12-13T11:06:13.892	0	-31.279	-29.096	-30.76	-29.694
2018-12-13T11:06:28.697	0	-30.661	-30.921	-30.632	-30.258
2018-12-13T11:06:43.517	0	-30.455	-30.296	-30.258	-31.393
2018-12-13T11:06:58.321	0	-32.058	-31.311	-31.74	-29.831
2018-12-13T11:07:13.126	0	-30.31	-31.758	-30.618	-29.831
2018-12-13T11:07:28.086	0	-50.95	-50.381	-52.704	-51.724
2018-12-13T11:07:43.093	0	-29.693	-28.416	-29.622	-29.353
2018-12-13T11:07:57.991	0	-28.578	-28.646	-29.536	-28.39
2018-12-13T11:08:12.921	0	-27.197	-29.13	-29.745	-29.038
2018-12-13T11:08:27.881	0	-28.313	-29.763	-29.984	-29.536
2018-12-13T11:08:42.670	0	-28.249	-29.502	-28.148	-29.208
2018-12-13T11:08:57.490	0	-29.162	-29.114	-29.469	-28.787
2018-12-13T11:09:12.310	0	-28.889	-29.502	-29.24	-30.769
2018-12-13T11:09:27.114	0	-29.369	-30.679	-29.008	-29.469
2018-12-13T11:09:41.919	0	-28.124	-29.288	-28.223	-29.605
2018-12-13T11:09:56.801	0	-29.537	-28.496	-27.991	-28.364
2018-12-13T11:10:11.621	0	-29.337	-30.701	-29.909	-28.55
2018-12-13T11:10:26.488	0	-28.161	-29.502	-30.08	-28.483
2018-12-13T11:10:41.308	0	-29.8	-29.177	-28.646	-28.111
2018-12-13T11:10:56.113	0	-28.674	-29.57	-29.402	-29.385
2018-12-13T11:11:10.933	0	-28.262	-28.325	-29.114	-29.818
2018-12-13T11:11:25.737	0	-29.657	-28.416	-29.469	-29.836
2018-12-13T11:11:40.682	0	-28.47	-28.55	-28.51	-28.801
2018-12-13T11:11:55.486	0	-28.889	-29.536	-29.891	-28.918
2018-12-13T11:12:10.431	0	-28.364	-29.485	-28.874	-28.744
2018-12-13T11:12:25.235	0	-28.249	-28.702	-29.068	-29.353
2018-12-13T11:12:40.040	0	-27.862	-28.325	-28.456	-27.463
2018-12-13T11:12:54.985	0	-28.963	-27.92	-27.955	-29.177

2018-12-13T11:13:09.805	0	-27.318	-29.272	-27.955	-28.773
2018-12-13T11:13:24.609	0	-29.657	-29.023	-30.338	-28.112
2018-12-13T11:13:39.414	0	-28.647	-28.211	-27.861	-28.43
2018-12-13T11:13:54.234	0	-28.443	-28.993	-29.519	-28.702
2018-12-13T11:14:09.038	0	-28.963	-28.744	-29.008	-28.075
2018-12-13T11:14:23.843	0	-28.55	-28.674	-28.716	-29.64
2018-12-13T11:14:38.663	0	-28.523	-29.485	-28.39	-28.948
2018-12-13T11:14:53.467	0	-30.339	-29.13	-28.903	-28.039
2018-12-13T11:15:08.271	0	-28.063	-28.063	-28.211	-28.716
2018-12-13T11:15:23.091	0	-28.326	-30.591	-28.43	-28.443
2018-12-13T11:15:37.896	0	-30.237	-30.505	-27.736	-29.469
2018-12-13T11:15:52.700	0	-28.633	-29.272	-28.859	-29.536
2018-12-13T11:16:07.520	0	-30.421	-28.536	-30.217	-29.13
2018-12-13T11:16:22.325	0	-29.304	-28.73	-28.148	-29.622
2018-12-13T11:16:37.145	0	-28.889	-30.022	-29.536	-28.702
2018-12-13T11:16:51.934	0	-27.827	-30.177	-28.161	-28.43
2018-12-13T11:17:06.754	0	-27.647	-29.836	-28.759	-28.859
2018-12-13T11:17:21.558	0	-27.68	-29.369	-30.237	-28.845
2018-12-13T11:17:36.362	0	-30.178	-29.588	-29.369	-28.416
2018-12-13T11:17:51.182	0	-30.099	-29.084	-29.336	-29.745
2018-12-13T11:18:06.065	0	-29.71	-28.716	-28.443	-28.39
2018-12-13T11:18:20.869	0	-28.378	-27.979	-28.002	-28.39
2018-12-13T11:18:35.674	0	-28.889	-28.039	-29.256	-28.632
2018-12-13T11:18:50.556	0	-29.053	-29.068	-28.124	-29.192
2018-12-13T11:19:05.376	0	-27.68	-29.114	-28.403	-28.646
2018-12-13T11:19:20.181	0	-29.928	-29.984	-29.553	-28.51
2018-12-13T11:19:34.985	0	-28.963	-30.041	-28.773	-31.122
2018-12-13T11:19:49.805	0	-28.816	-29.402	-28.43	-29.605
2018-12-13T11:20:04.609	0	-29.162	-27.421	-28.918	-28.773
2018-12-13T11:20:19.414	0	-27.158	-29.605	-28.918	-28.087
2018-12-13T11:20:34.234	0	-28.087	-29.947	-30.297	-29.161
2018-12-13T11:20:49.038	0	-27.967	-28.605	-29.304	-27.474
2018-12-13T11:21:03.858	0	-27.68	-28.416	-28.456	-28.377
2018-12-13T11:21:18.647	0	-30.548	-28.963	-28.918	-28.564
2018-12-13T11:21:33.467	0	-28.352	-27.702	-28.39	-28.377
2018-12-13T11:21:48.272	0	-28.605	-29.24	-28.274	-29.763
2018-12-13T11:22:03.076	0	-28.874	-28.39	-28.591	-28.377
2018-12-13T11:22:17.896	0	-28.47	-28.918	-28.087	-27.827
2018-12-13T11:22:32.701	0	-28.605	-27.432	-29.161	-28.456
2018-12-13T11:22:47.521	0	-28.287	-30.177	-29.099	-28.364
2018-12-13T11:23:02.325	0	-27.967	-28.773	-27.603	-29.038
2018-12-13T11:23:17.129	0	-28.674	-29.353	-29.208	-29.304

2018-12-13T11:23:31.934	0	-28.845	-29.32	-29.763	-28.889
2018-12-13T11:23:46.738	0	-27.747	-27.967	-27.861	-28.3
2018-12-13T11:24:01.558	0	-28.619	-30.442	-29.469	-29.519
2018-12-13T11:24:16.363	0	-29.419	-30.003	-29.728	-29.008
2018-12-13T11:24:31.167	0	-28.537	-29.336	-29.745	-28.646
2018-12-13T11:24:45.987	0	-28.313	-29.657	-29.177	-28.83
2018-12-13T11:25:00.792	0	-28.537	-30.883	-29.161	-29.799
2018-12-13T11:25:15.596	0	-29.64	-29.008	-27.967	-28.051
2018-12-13T11:25:30.416	0	-29.873	-29.13	-30.138	-28.66
2018-12-13T11:25:45.220	0	-28.963	-29.272	-27.827	-29.304
2018-12-13T11:26:00.181	0	-52.345	-52.586	-52.586	-51.006
2018-12-13T11:26:15.188	0	-30.273	-31.123	-31.595	-31.897
2018-12-13T11:26:29.993	0	-31.63	-30.235	-30.615	-30.124
2018-12-13T11:26:44.797	0	-29.98	-30.099	-30.928	-30.928
2018-12-13T11:26:59.742	0	-26.924	-26.266	-27.263	-28.317
2018-12-13T11:27:14.687	0	-31.279	-30.731	-29.649	-31.477
2018-12-13T11:27:29.491	0	-29.949	-31.46	-31.327	-31.563
2018-12-13T11:27:44.311	0	-31.135	-31.942	-32.571	-30.441
2018-12-13T11:27:59.116	0	-30.936	-29.086	-30.094	-31.942
2018-12-13T11:28:13.920	0	-31.394	-29.785	-31.344	-29.889
2018-12-13T11:28:28.740	0	-31.962	-30.441	-31.088	-30.401
2018-12-13T11:28:43.544	0	-30.981	-31.262	-30.618	-31.65
2018-12-13T11:28:58.349	0	-30.349	-31.98	-29.843	-30.717
2018-12-13T11:29:13.169	0	-29.507	-29.572	-29.901	-30.361
2018-12-13T11:29:27.973	0	-29.454	-32.077	-30.803	-32.549
2018-12-13T11:29:42.778	0	-29.297	-30.156	-30.495	-30.774
2018-12-13T11:29:57.801	0	-29.808	-30.522	-31.812	-30.996
2018-12-13T11:30:12.605	0	-31.183	-32.096	-30.688	-30.563
2018-12-13T11:30:27.409	0	-30.144	-31.011	-31.166	-31.999
2018-12-13T11:30:42.229	0	-29.913	-29.683	-31.36	-30.618
2018-12-13T11:30:57.034	0	-30.415	-31.615	-31.278	-31.151
2018-12-13T11:31:11.854	0	-29.785	-31.104	-31.042	-30.322
2018-12-13T11:31:26.674	0	-31.167	-31.166	-30.258	-31.46
2018-12-13T11:31:41.478	0	-32.359	-30.549	-29.913	-29.369
2018-12-13T11:31:56.283	0	-30.996	-30.847	-29.276	-31.23
2018-12-13T11:32:11.165	0	-29.694	-30.119	-31.042	-30.803
2018-12-13T11:32:25.970	0	-31.279	-30.76	-31.831	-29.901
2018-12-13T11:32:40.774	0	-29.913	-30.441	-31.511	-29.773
2018-12-13T11:32:55.672	0	-30.522	-30.646	-30.258	-30.862
2018-12-13T11:33:10.476	0	-29.762	-29.75	-30.59	-31.119
2018-12-13T11:33:25.281	0	-30.455	-30.082	-30.07	-30.428
2018-12-13T11:33:40.085	0	-31.279	-30.717	-30.107	-31.23

2018-12-13T11:33:54.905	0	-31.722	-32.659	-32.317	-31.119
2018-12-13T11:34:09.710	0	-30.082	-30.803	-31.198	-30.731
2018-12-13T11:34:24.514	0	-30.563	-30.876	-30.194	-30.522
2018-12-13T11:34:39.334	0	-30.774	-31.924	-30.688	-30.847
2018-12-13T11:34:54.139	0	-30.157	-30.182	-30.563	-29.496
2018-12-13T11:35:08.943	0	-29.246	-30.468	-30.441	-30.131
2018-12-13T11:35:23.763	0	-30.046	-31.704	-31.011	-31.073
2018-12-13T11:35:38.568	0	-30.818	-30.495	-30.774	-31.868
2018-12-13T11:35:53.372	0	-31.427	-30.522	-30.996	-30.789
2018-12-13T11:36:08.176	0	-30.468	-31.942	-31.088	-30.951
2018-12-13T11:36:22.996	0	-30.401	-31.36	-31.58	-30.495
2018-12-13T11:36:37.801	0	-29.422	-30.674	-30.832	-29.175
2018-12-13T11:36:52.605	0	-31.794	-30.632	-31.924	-30.522

SAMPLE DATA FOR AEDC

		Frequency (Hz)			
Timestamp	Measure Unit	30000000	30050000	30100000	30150000
2018-12-12T08:43:26.042	0	-61.444	-63.944	-62.553	-62.494
2018-12-12T08:43:40.987	0	-32.259	-34.273	-33.959	-33.889
2018-12-12T08:43:55.791	0	-33.618	-33.315	-34.273	-33.362
2018-12-12T08:44:10.674	0	-32.675	-32.307	-32.892	-33.751
2018-12-12T08:44:25.478	0	-33.347	-33.091	-32.948	-33.906
2018-12-12T08:44:40.298	0	-32.976	-32.081	-33.819	-32.57
2018-12-12T08:44:55.103	0	-32.418	-34.123	-32.878	-32.755
2018-12-12T08:45:09.907	0	-32.892	-33.785	-32.07	-33.393
2018-12-12T08:45:24.727	0	-32.948	-34.35	-32.557	-33.601
2018-12-12T08:45:39.547	0	-33.684	-33.854	-33.536	-33.019
2018-12-12T08:45:54.352	0	-33.785	-33.285	-33.568	-32.343
2018-12-12T08:46:09.156	0	-32.545	-32.741	-33.488	-33.552
2018-12-12T08:46:23.976	0	-33.889	-33.424	-34.104	-32.544
2018-12-12T08:46:38.781	0	-33.552	-32.741	-33.802	-34.509
2018-12-12T08:46:53.601	0	-32.934	-32.622	-33.44	-32.609
2018-12-12T08:47:08.421	0	-32.117	-33.44	-33.048	-35.606
2018-12-12T08:47:23.225	0	-33.718	-32.99	-32.675	-32.768
2018-12-12T08:47:38.029	0	-34.409	-32.27	-33.65	-33.568
2018-12-12T08:47:52.849	0	-35.659	-32.294	-33.456	-32.701
2018-12-12T08:48:07.654	0	-33.456	-33.667	-34.611	-34.37
2018-12-12T08:48:22.458	0	-33.106	-33.552	-33.12	-32.714
2018-12-12T08:48:37.278	0	-33.27	-32.99	-33.684	-34.141
2018-12-12T08:48:52.083	0	-32.702	-34.549	-33.785	-33.751
2018-12-12T08:49:06.887	0	-32.381	-33.536	-34.529	-33.924
2018-12-12T08:49:21.723	0	-32.782	-32.506	-33.019	-34.867
2018-12-12T08:49:36.668	0	-61.069	-61.423	-61.644	-61.912

2018-12-12T08:49:51.612	0	-32.099	-31.382	-31.313	-33.449
2018-12-12T08:50:06.557	0	-60.717	-61.513	-61.85	-61.79
2018-12-12T08:50:21.502	0	-33.314	-32.309	-31.845	-32.309
2018-12-12T08:50:36.322	0	-32.846	-32.845	-32.554	-32.352
2018-12-12T08:50:51.127	0	-31.697	-33.09	-32.281	-31.437
2018-12-12T08:51:05.931	0	-32.599	-33.023	-32.599	-33.261
2018-12-12T08:51:20.751	0	-31.66	-33.226	-33.439	-31.77
2018-12-12T08:51:35.555	0	-32.752	-33.314	-32.323	-31.985
2018-12-12T08:51:50.375	0	-31.203	-32.69	-32.254	-31.708
2018-12-12T08:52:05.320	0	-40.08	-39.262	-40.731	-40.326
2018-12-12T08:52:20.265	0	-31.743	-31.307	-32.381	-31.571
2018-12-12T08:52:35.085	0	-31.852	-31.964	-31.443	-32.152
2018-12-12T08:52:49.890	0	-31.175	-32.05	-32.396	-33.966
2018-12-12T08:53:04.710	0	-31.151	-32.671	-33.358	-32.807
2018-12-12T08:53:19.514	0	-32.094	-33.517	-32.212	-31.545
2018-12-12T08:53:34.334	0	-33.056	-33.725	-32.824	-31.61
2018-12-12T08:53:49.138	0	-31.571	-32.524	-32.381	-32.273
2018-12-12T08:54:03.943	0	-31.756	-33.768	-31.95	-33.338
2018-12-12T08:54:18.763	0	-33.129	-31.069	-34.416	-32.381
2018-12-12T08:54:33.567	0	-33.811	-32.35	-31.186	-33.074
2018-12-12T08:54:48.387	0	-31.65	-33.854	-32.428	-31.405
2018-12-12T08:55:03.192	0	-33.558	-31.922	-32.638	-31.729
2018-12-12T08:55:18.012	0	-32.273	-32.622	-33.11	-32.182
2018-12-12T08:55:32.972	0	-39.443	-41.017	-40.34	-39.945
2018-12-12T08:55:47.902	0	-34.469	-33.667	-34.241	-33.268
2018-12-12T08:56:02.722	0	-33.188	-34.074	-32.941	-33.187
2018-12-12T08:56:17.526	0	-34.074	-33.069	-33.977	-34.292
2018-12-12T08:56:32.346	0	-33.993	-32.189	-33.393	-35.002
2018-12-12T08:56:47.150	0	-34.652	-33.743	-34.19	-33.945
2018-12-12T08:57:01.970	0	-33.758	-33.743	-34.379	-33.393
2018-12-12T08:57:16.915	0	-39.216	-39.955	-38.596	-43.379
2018-12-12T08:57:31.860	0	-35.067	-34.305	-34.097	-34.669
2018-12-12T08:57:46.680	0	-34.122	-36.141	-35.571	-33.799
2018-12-12T08:58:01.485	0	-34.343	-36.457	-34.737	-34.779
2018-12-12T08:58:16.445	0	-40.112	-39.001	-40.042	-38.827
2018-12-12T08:58:31.374	0	-33.97	-33.435	-33.641	-33.449
2018-12-12T08:58:46.194	0	-34.17	-33.764	-34.343	-33.687
2018-12-12T08:59:01.014	0	-31.851	-33.552	-33.795	-34.656
2018-12-12T08:59:15.819	0	-33.407	-33.157	-32.381	-33.336
2018-12-12T08:59:30.623	0	-32.733	-34.397	-34.308	-33.921
2018-12-12T08:59:45.443	0	-33.826	-33.184	-33.596	-33.687
2018-12-12T09:00:00.248	0	-34.562	-32.171	-32.794	-33.378

2018-12-12T09:00:15.068	0	-33.642	-34.772	-33.81	-32.6
2018-12-12T09:00:29.888	0	-33.779	-34.019	-34.931	-34.58
2018-12-12T09:00:44.817	0	-40.77	-40.382	-41.415	-40.236
2018-12-12T09:00:59.762	0	-33.652	-33.412	-33.2	-32.192
2018-12-12T09:01:14.566	0	-34.496	-32.303	-34.172	-32.932
2018-12-12T09:01:29.386	0	-33.256	-33.823	-33.383	-33.823
2018-12-12T09:01:44.191	0	-34.571	-32.945	-32.452	-34.138
2018-12-12T09:01:59.011	0	-33.398	-34.138	-33.427	-34.019
2018-12-12T09:02:13.815	0	-33.214	-32.406	-33.76	-33.383
2018-12-12T09:02:28.635	0	-32.372	-32.475	-33.92	-34.277
2018-12-12T09:02:43.439	0	-33.545	-33.56	-31.844	-32.558
2018-12-12T09:02:58.259	0	-33.091	-33.214	-33.5	-32.829
2018-12-12T09:03:13.079	0	-33.355	-32.958	-33.904	-32.17
2018-12-12T09:03:27.884	0	-33.27	-33.697	-34.331	-32.906
2018-12-12T09:03:42.688	0	-32.073	-34.138	-32.655	-34.295
2018-12-12T09:03:57.493	0	-34.927	-34.053	-33.145	-34.036
2018-12-12T09:04:12.297	0	-33.242	-33.545	-33.05	-32.88
2018-12-12T09:04:27.117	0	-34.845	-32.642	-34.647	-33.2
2018-12-12T09:04:41.937	0	-33.064	-32.88	-33.158	-32.63
2018-12-12T09:04:56.742	0	-33.682	-32.511	-34.385	-32.667
2018-12-12T09:05:11.546	0	-33.76	-34.647	-33.871	-33.09
2018-12-12T09:05:26.366	0	-33.904	-34.331	-34.968	-33.104
2018-12-12T09:05:41.186	0	-32.394	-33.575	-33.807	-34.019
2018-12-12T09:05:55.991	0	-33.76	-34.036	-33.456	-33.823
2018-12-12T09:06:10.811	0	-33.56	-34.172	-34.571	-33.398
2018-12-12T09:06:25.631	0	-33.384	-32.326	-32.971	-33.823
2018-12-12T09:06:40.435	0	-33.355	-33.269	-33.326	-33.269
2018-12-12T09:06:55.239	0	-32.631	-33.34	-34.242	-31.978
2018-12-12T09:07:10.060	0	-34.989	-33.2	-33.05	-33.744
2018-12-12T09:07:24.880	0	-33.384	-33.904	-33.131	-34.019
2018-12-12T09:07:39.684	0	-33.442	-32.691	-34.628	-34.003
2018-12-12T09:07:54.488	0	-34.313	-34.385	-33.575	-32.753
2018-12-12T09:08:09.308	0	-33.745	-33.744	-32.854	-31.804
2018-12-12T09:08:24.113	0	-33.486	-34.087	-33.729	-33.823
2018-12-12T09:08:38.917	0	-32.971	-34.705	-32.314	-33.697
2018-12-12T09:08:53.737	0	-33.486	-33.888	-34.422	-33.605
2018-12-12T09:09:08.557	0	-32.766	-34.385	-33.34	-34.172
2018-12-12T09:09:23.377	0	-34.207	-32.214	-32.499	-33.104
2018-12-12T09:09:38.322	0	-37.976	-37.947	-38.927	-38.075
2018-12-12T09:09:53.267	0	-33.481	-35.152	-34.346	-33.729
2018-12-12T09:10:08.071	0	-35.64	-35.541	-33.178	-34.944
2018-12-12T09:10:22.891	0	-34.405	-34.944	-34.961	-34.201

2018-12-12T09:10:37.711	0	-34.861	-34.511	-34.682	-33.992
2018-12-12T09:10:52.516	0	-34.435	-35.047	-35.013	-34.698
2018-12-12T09:11:07.320	0	-34.962	-33.409	-34.273	-34.511
2018-12-12T09:11:22.140	0	-34.346	-34.557	-33.409	-35.679
2018-12-12T09:11:37.101	0	-39.56	-40.077	-40.412	-40.79
2018-12-12T09:11:52.030	0	-36.063	-35.942	-34.765	-35.993
2018-12-12T09:12:06.990	0	-33.227	-31.281	-31.221	-30.677
2018-12-12T09:12:21.920	0	-34.898	-34.433	-35.906	-36.632
2018-12-12T09:12:36.740	0	-35.569	-35.538	-35.314	-35.227
2018-12-12T09:12:51.560	0	-34.445	-35.477	-37.431	-35.299
2018-12-12T09:13:06.364	0	-34.858	-34.754	-36.008	-35.742
2018-12-12T09:13:21.184	0	-35.478	-36.345	-35.807	-35.285
2018-12-12T09:13:35.989	0	-35.991	-35.299	-35.432	-35.073
2018-12-12T09:13:50.793	0	-34.691	-35.616	-35.045	-34.793
2018-12-12T09:14:05.613	0	-34.281	-34.398	-35.242	-35.285
2018-12-12T09:14:20.433	0	-35.213	-35.807	-35.569	-35.101
2018-12-12T09:14:35.253	0	-35.256	-34.493	-36.2	-36.008
2018-12-12T09:14:50.058	0	-36.535	-34.615	-34.832	-35.432
2018-12-12T09:15:04.862	0	-35.185	-34.481	-35.256	-35.018
2018-12-12T09:15:19.682	0	-36.515	-35.156	-35.616	-34.977
2018-12-12T09:15:34.502	0	-35.791	-35.647	-35.242	-34.003
2018-12-12T09:15:49.306	0	-36.327	-34.398	-35.242	-34.409
2018-12-12T09:16:04.126	0	-33.929	-35.974	-34.433	-35.726
2018-12-12T09:16:18.946	0	-35.073	-34.591	-34.69	-35.101
2018-12-12T09:16:33.751	0	-35.616	-35.199	-34.421	-36.534
2018-12-12T09:16:48.555	0	-35.824	-35.631	-35.285	-35.631
2018-12-12T09:17:03.375	0	-35.974	-34.362	-36.691	-35.17
2018-12-12T09:17:18.180	0	-35.478	-34.517	-34.316	-36.111
2018-12-12T09:17:32.984	0	-34.754	-35.462	-34.505	-34.806
2018-12-12T09:17:47.804	0	-35.94	-36.094	-33.992	-35.432
2018-12-12T09:18:02.624	0	-35.373	-35.726	-36.42	-35.213
2018-12-12T09:18:17.429	0	-35.018	-36.111	-35.185	-35.631
2018-12-12T09:18:32.233	0	-34.845	-35.299	-35.199	-35.663
2018-12-12T09:18:47.053	0	-35.185	-35.807	-36.834	-34.578
2018-12-12T09:19:01.873	0	-34.742	-36.129	-36.752	-35.974
2018-12-12T09:19:16.678	0	-35.873	-35.032	-34.754	-35.477
2018-12-12T09:19:31.498	0	-35.6	-34.793	-35.84	-34.964
2018-12-12T09:19:46.302	0	-34.603	-34.035	-35.991	-34.937
2018-12-12T09:20:01.106	0	-35.242	-35.285	-36.671	-35.285
2018-12-12T09:20:15.926	0	-35.06	-34.628	-35.059	-34.937
2018-12-12T09:20:30.747	0	-35.679	-35.387	-35.492	-37.024
2018-12-12T09:20:45.551	0	-36.573	-36.327	-34.035	-36.477

2018-12-12T09:21:00.355	0	-35.032	-34.871	-35.906	-36.772
2018-12-12T09:21:15.175	0	-34.951	-35.477	-35.508	-35.373
2018-12-12T09:21:29.980	0	-35.447	-35.6	-36.008	-34.678
2018-12-12T09:21:44.800	0	-36.496	-36.458	-34.728	-35.018
2018-12-12T09:21:59.604	0	-35.329	-35.142	-35.538	-36.147
2018-12-12T09:22:14.424	0	-36.094	-37.156	-34.884	-34.578
2018-12-12T09:22:29.229	0	-34.703	-34.871	-36.554	-34.845
2018-12-12T09:22:44.049	0	-35.632	-35.923	-35.073	-36.129
2018-12-12T09:22:58.869	0	-35.508	-35.156	-35.432	-35.824
2018-12-12T09:23:13.673	0	-36.182	-35.358	-35.114	-35.242
2018-12-12T09:23:28.478	0	-34.871	-35.256	-36.309	-35.94
2018-12-12T09:23:43.298	0	-35.388	-33.939	-34.235	-35.142
2018-12-12T09:23:58.118	0	-35.873	-36.272	-35.142	-36.477
2018-12-12T09:24:12.922	0	-35.647	-36.592	-34.897	-34.858
2018-12-12T09:24:27.742	0	-35.663	-34.386	-34.529	-35.004
2018-12-12T09:24:42.547	0	-35.06	-35.569	-36.129	-35.824
2018-12-12T09:24:57.367	0	-35.228	-35.059	-35.678	-35.256
2018-12-12T09:25:12.171	0	-34.146	-36.327	-33.742	-35.101
2018-12-12T09:25:26.991	0	-37.003	-34.247	-35.045	-35.6
2018-12-12T09:25:41.795	0	-35.046	-35.256	-35.343	-34.224
2018-12-12T09:25:56.600	0	-35.808	-35.538	-34.754	-36.401
2018-12-12T09:26:11.420	0	-35.89	-35.957	-35.957	-35.343
2018-12-12T09:26:26.240	0	-36.42	-35.17	-36.42	-34.112
2018-12-12T09:26:41.044	0	-35.213	-35.432	-34.362	-34.493
2018-12-12T09:26:55.849	0	-34.991	-35.663	-34.046	-34.937
2018-12-12T09:27:10.669	0	-34.911	-34.653	-33.907	-35.694
2018-12-12T09:27:25.614	0	-31.758	-32.247	-31.307	-33.449
2018-12-12T09:27:40.558	0	-37.105	-35.644	-36.313	-35.772
2018-12-12T09:27:55.378	0	-35.371	-36.912	-35.92	-35.357
2018-12-12T09:28:10.183	0	-35.227	-36.248	-36.297	-34.286
2018-12-12T09:28:25.003	0	-35.831	-36.379	-34.663	-36.837
2018-12-12T09:28:39.807	0	-36.893	-35.615	-35.41	-36.874
2018-12-12T09:28:54.612	0	-35.686	-35.601	-35.37	-35.357
2018-12-12T09:29:09.432	0	-35.357	-36.413	-36.62	-35.305
2018-12-12T09:29:24.252	0	-35.588	-36.532	-36.089	-35.7
2018-12-12T09:29:39.056	0	-34.801	-35.996	-34.007	-35.686
2018-12-12T09:29:53.861	0	-34.391	-35.163	-35.875	-38.174
2018-12-12T09:30:08.681	0	-35.876	-35.816	-35.965	-36.313
2018-12-12T09:30:23.501	0	-34.641	-34.754	-36.28	-35.064
2018-12-12T09:30:38.305	0	-34.871	-34.307	-37.205	-36.673
2018-12-12T09:30:53.125	0	-36.089	-36.363	-35.686	-34.297
2018-12-12T09:31:07.930	0	-36.691	-35.397	-34.99	-35.846

2018-12-12T09:31:22.750	0	-35.686	-36.763	-37.046	-36.727
2018-12-12T09:31:37.554	0	-35.861	-36.763	-35.505	-35.201
2018-12-12T09:31:52.374	0	-34.871	-36.673	-35.138	-36.727
2018-12-12T09:32:07.194	0	-36.2	-35.7	-36.215	-37.205
2018-12-12T09:32:21.999	0	-36.95	-36.585	-36.104	-36.481
2018-12-12T09:32:36.803	0	-34.552	-34.871	-35.715	-36.12
2018-12-12T09:32:51.623	0	-36.396	-34.476	-35.715	-36.837
2018-12-12T09:33:06.427	0	-35.357	-34.124	-33.753	-35.113
2018-12-12T09:33:21.232	0	-36.184	-35.831	-36.363	-35.478
2018-12-12T09:33:36.067	0	-36.893	-37.411	-34.954	-34.835
2018-12-12T09:33:50.872	0	-36.216	-37.39	-36.027	-36.136
2018-12-12T09:34:05.676	0	-36.931	-35.772	-36.874	-35.574
2018-12-12T09:34:20.496	0	-35.266	-35.24	-36.089	-35.965
2018-12-12T09:34:35.316	0	-34.836	-35.644	-35.846	-34.812
2018-12-12T09:34:50.121	0	-34.789	-35.831	-36.152	-37.125
2018-12-12T09:35:04.941	0	-35.437	-35.45	-36.231	-34.918
2018-12-12T09:35:19.745	0	-35.588	-35.344	-35.935	-35.86
2018-12-12T09:35:34.690	0	-34.368	-32.833	-33.165	-33.636
2018-12-12T09:35:49.635	0	-35.668	-35.293	-35.668	-35.332
2018-12-12T09:36:04.595	0	-59.817	-60.87	-61.183	-61.476
2018-12-12T09:36:19.525	0	-36.625	-36.697	-35.291	-35.692
2018-12-12T09:36:34.345	0	-36.554	-36.165	-35.304	-36.085
2018-12-12T09:36:49.165	0	-35.93	-35.357	-35.278	-36.33
2018-12-12T09:37:03.969	0	-35.425	-35.899	-35.721	-36.214
2018-12-12T09:37:18.789	0	-34.924	-35.779	-36.643	-36.96
2018-12-12T09:37:33.609	0	-34.758	-35.62	-36.182	-35.225
2018-12-12T09:37:48.414	0	-36.166	-35.48	-36.085	-36.182
2018-12-12T09:38:03.234	0	-35.453	-36.07	-35.278	-36.449
2018-12-12T09:38:18.038	0	-37.22	-36.23	-35.225	-35.839
2018-12-12T09:38:32.858	0	-35.123	-34.665	-36.98	-35.135
2018-12-12T09:38:47.678	0	-35.239	-35.945	-36.247	-35.252
2018-12-12T09:39:02.482	0	-36.231	-35.839	-34.552	-34.711
2018-12-12T09:39:17.302	0	-35.252	-35.75	-35.809	-35.398
2018-12-12T09:39:32.107	0	-34.688	-37.345	-35.148	-35.549
2018-12-12T09:39:46.927	0	-35.78	-36.101	-35.869	-34.852
2018-12-12T09:40:01.731	0	-35.564	-35.265	-36.846	-35.148
2018-12-12T09:40:16.551	0	-35.073	-35.317	-36.347	-35.62
2018-12-12T09:40:31.356	0	-35.522	-37.91	-34.961	-35.212
2018-12-12T09:40:46.176	0	-35.073	-36.922	-35.425	-35.677
2018-12-12T09:41:00.996	0	-34.876	-35.991	-36.518	-36.117
2018-12-12T09:41:15.800	0	-35.508	-36.182	-35.75	-36.483
2018-12-12T09:41:30.761	0	-61.039	-60.85	-61.779	-64.232

2018-12-12T09:41:45.690	0	-35.774	-36.098	-36.335	-34.403
2018-12-12T09:42:00.510	0	-35.457	-35.007	-34.739	-35.79
2018-12-12T09:42:15.330	0	-34.415	-35.248	-35.472	-35.034
2018-12-12T09:42:30.134	0	-33.894	-34.871	-34.215	-35.565
2018-12-12T09:42:44.939	0	-34.488	-34.624	-34.549	-34.296
2018-12-12T09:42:59.759	0	-37.686	-36.449	-35.774	-36.242
2018-12-12T09:43:14.719	0	-31.697	-31.807	-32.323	-32.958
2018-12-12T09:43:29.664	0	-41.232	-40.602	-41.141	-41.018
2018-12-12T09:43:44.609	0	-34.907	-34.969	-35.879	-35.345
2018-12-12T09:43:59.429	0	-35.91	-35.12	-36.214	-36.099
2018-12-12T09:44:14.233	0	-35.972	-35.057	-35.972	-35.972
2018-12-12T09:44:29.038	0	-35.292	-36.953	-35.773	-35.758
2018-12-12T09:44:43.858	0	-35.359	-35.91	-35.728	-36.214
2018-12-12T09:44:58.818	0	-60.705	-62.393	-60.919	-60.997
2018-12-12T09:45:13.763	0	-34.873	-35.483	-34.058	-35.578
2018-12-12T09:45:28.583	0	-34.886	-34.982	-34.103	-35.708
2018-12-12T09:45:43.388	0	-35.659	-35.109	-35.875	-34.635
2018-12-12T09:45:58.192	0	-36.828	-35.893	-34.337	-34.483
2018-12-12T09:46:13.012	0	-35.3	-35.067	-36.032	-36.5
2018-12-12T09:46:27.832	0	-34.997	-34.583	-35.626	-35.515
2018-12-12T09:46:42.636	0	-34.927	-34.739	-34.571	-35.01
2018-12-12T09:46:57.441	0	-35.675	-35.109	-35.515	-34.508
2018-12-12T09:47:12.261	0	-33.991	-34.818	-34.596	-35.067
2018-12-12T09:47:27.065	0	-36.122	-35.081	-35.391	-35.626
2018-12-12T09:47:41.885	0	-34.819	-35.53	-34.765	-33.903
2018-12-12T09:47:56.705	0	-34.713	-34.325	-35.437	-35.858
2018-12-12T09:48:11.510	0	-33.702	-33.958	-36.539	-34.886
2018-12-12T09:48:26.314	0	-34.661	-35.109	-35.27	-34.913
2018-12-12T09:48:41.134	0	-35.211	-35.211	-34.361	-36.086
2018-12-12T09:48:55.954	0	-36.269	-34.941	-36.25	-34.471
2018-12-12T09:49:10.759	0	-36.422	-34.397	-35.024	-34.913
2018-12-12T09:49:25.563	0	-34.219	-36.702	-34.778	-35.285
2018-12-12T09:49:40.383	0	-34.648	-34.927	-35.067	-34.508
2018-12-12T09:49:55.188	0	-35.039	-36.158	-35.483	-35.962
2018-12-12T09:50:09.992	0	-34.941	-35.153	-35.052	-35.36
2018-12-12T09:50:24.812	0	-34.584	-35.33	-35.285	-35.91
2018-12-12T09:50:39.632	0	-35.484	-35.345	-34.859	-36.25
2018-12-12T09:50:54.437	0	-34.337	-34.172	-35.052	-35.211
2018-12-12T09:51:09.257	0	-34.832	-35.675	-33.882	-34.409
2018-12-12T09:51:24.061	0	-36.702	-35.226	-35.375	-35.196
2018-12-12T09:51:38.881	0	-35.255	-35.437	-35.345	-35.515
2018-12-12T09:51:53.685	0	-35.255	-36.87	-35.33	-34.385

2018-12-12T09:52:08.505	0	-35.025	-35.138	-34.725	-34.218
2018-12-12T09:52:23.325	0	-34.559	-34.52	-35.109	-34.558
2018-12-12T09:52:38.270	0	-61.326	-60.207	-61.227	-58.275
2018-12-12T09:52:53.215	0	-35.374	-35.865	-37.607	-36.334
2018-12-12T09:53:08.035	0	-36.522	-36.348	-35.752	-35.067
2018-12-12T09:53:22.840	0	-36.25	-37.209	-37.039	-36.86
2018-12-12T09:53:37.660	0	-36.734	-37.226	-37.039	-36.478
2018-12-12T09:53:52.464	0	-35.655	-36.507	-36.627	-35.853
2018-12-12T09:54:07.284	0	-35.753	-36.989	-36.278	-36.348
2018-12-12T09:54:22.104	0	-36.925	-37.296	-37.422	-36.14
2018-12-12T09:54:36.909	0	-36.765	-37.056	-36.552	-36.552
2018-12-12T09:54:51.729	0	-35.536	-36.522	-36.703	-37.476
2018-12-12T09:55:06.549	0	-36.264	-36.25	-35.454	-36.812
2018-12-12T09:55:21.353	0	-35.728	-36.749	-35.523	-35.802
2018-12-12T09:55:36.157	0	-36.391	-37.072	-36.734	-36.292
2018-12-12T09:55:50.977	0	-36.673	-36.405	-37.261	-36.391
2018-12-12T09:56:05.797	0	-38.088	-36.765	-37.14	-37.963
2018-12-12T09:56:20.602	0	-36.264	-36.672	-35.981	-36.434
2018-12-12T09:56:35.422	0	-36.237	-35.942	-37.123	-35.827
2018-12-12T09:56:50.367	0	-39.689	-41.137	-39.976	-41.287
2018-12-12T09:57:05.312	0	-34.481	-35.616	-35.142	-34.871
2018-12-12T09:57:20.116	0	-34.316	-34.386	-36.025	-37.002
2018-12-12T09:57:34.936	0	-35.432	-35.616	-34.754	-34.793
2018-12-12T09:57:49.896	0	-59.807	-60.411	-60.395	-59.162
2018-12-12T09:58:04.841	0	-35.429	-36.103	-35.455	-38.336
2018-12-12T09:58:19.802	0	-40.29	-39.676	-40.848	-39.573
2018-12-12T09:58:34.747	0	-34.543	-36.297	-36.577	-36.953
2018-12-12T09:58:49.551	0	-34.919	-35.626	-35.713	-35.251
2018-12-12T09:59:04.371	0	-34.611	-36.348	-34.786	-37.113
2018-12-12T09:59:19.175	0	-35.16	-36.4	-35.988	-34.622
2018-12-12T09:59:33.980	0	-37.134	-35.91	-35.133	-35.818
2018-12-12T09:59:48.800	0	-35.006	-36.452	-34.969	-35.554
2018-12-12T10:00:03.760	0	-59.374	-62.244	-60.793	-59.44
2018-12-12T10:00:18.705	0	-35.085	-35.976	-36.007	-35.706
2018-12-12T10:00:33.650	0	-61.196	-61.932	-61.563	-61.461
2018-12-12T10:00:48.610	0	-35.898	-36.252	-36.312	-35.634
2018-12-12T10:01:03.415	0	-35.858	-35.738	-35.57	-36.297
2018-12-12T10:01:18.219	0	-36.607	-35.764	-35.66	-35.434
2018-12-12T10:01:33.039	0	-35.725	-36.433	-35.884	-35.115
2018-12-12T10:01:47.859	0	-35.349	-36.036	-35.725	-35.458
2018-12-12T10:02:02.664	0	-34.188	-37.207	-35.409	-37.512
2018-12-12T10:02:17.484	0	-35.596	-36.327	-36.687	-36.357

2018-12-12T10:02:32.304	0	-35.764	-35.925	-36.036	-36.238
2018-12-12T10:02:47.124	0	-34.97	-35.673	-35.421	-35.458
2018-12-12T10:03:01.928	0	-36.122	-35.583	-36.433	-35.698
2018-12-12T10:03:16.733	0	-36.787	-37.591	-36.671	-36.922
2018-12-12T10:03:31.553	0	-35.898	-37.357	-37.861	-37.319
2018-12-12T10:03:46.373	0	-36.905	-35.967	-36.671	-35.98
2018-12-12T10:04:01.177	0	-36.465	-35.66	-35.409	-35.337
2018-12-12T10:04:15.997	0	-36.48	-36.974	-36.786	-36.495
2018-12-12T10:04:30.802	0	-35.571	-35.685	-36.252	-36.065
2018-12-12T10:04:45.622	0	-36.82	-36.574	-36.194	-35.83
2018-12-12T10:05:00.426	0	-35.791	-36.342	-36.974	-37.632
2018-12-12T10:05:15.246	0	-36.623	-36.208	-37.152	-35.994
2018-12-12T10:05:30.066	0	-36.704	-35.925	-35.925	-36.888
2018-12-12T10:05:45.011	0	-40.208	-40.705	-39.585	-41.02
2018-12-12T10:05:59.971	0	-33.662	-33.48	-32.661	-33.228
2018-12-12T10:06:14.776	0	-34.457	-33.426	-34.096	-34.757
2018-12-12T10:06:29.736	0	-36.306	-36.221	-35.476	-36.151
2018-12-12T10:06:44.556	0	-35.536	-35.858	-36.616	-36.571
2018-12-12T10:06:59.361	0	-36.466	-36.525	-37.225	-36.918
2018-12-12T10:07:14.165	0	-36.496	-37.387	-36.421	-35.781
2018-12-12T10:07:28.985	0	-38.168	-37.103	-37.612	-37.26
2018-12-12T10:07:43.805	0	-35.95	-35.706	-35.936	-36.11
2018-12-12T10:07:58.610	0	-36.511	-36.741	-35.257	-36.207
2018-12-12T10:08:13.414	0	-36.221	-36.902	-36.306	-37.225
2018-12-12T10:08:28.234	0	-35.429	-35.62	-37.278	-36.137
2018-12-12T10:08:43.054	0	-37.79	-35.82	-35.884	-37.278
2018-12-12T10:08:57.858	0	-38.558	-36.306	-36.741	-35.632
2018-12-12T10:09:12.678	0	-35.5	-37.79	-35.359	-36.725
2018-12-12T10:09:27.483	0	-37.002	-36.616	-35.949	-36.885
2018-12-12T10:09:42.303	0	-36.152	-36.805	-36.221	-37.593
2018-12-12T10:09:57.123	0	-37.48	-35.644	-37.555	-37.052
2018-12-12T10:10:11.927	0	-36.436	-38.256	-35.744	-36.601
2018-12-12T10:10:26.747	0	-36.663	-36.334	-37.612	-36.935
2018-12-12T10:10:41.552	0	-36.821	-36.51	-34.573	-36.029
2018-12-12T10:10:56.372	0	-35.976	-36.694	-35.989	-36.029
2018-12-12T10:11:11.176	0	-36.016	-37.12	-36.821	-37.536
2018-12-12T10:11:25.996	0	-35.923	-35.571	-35.923	-35.359
2018-12-12T10:11:40.816	0	-35.82	-35.845	-35.571	-36.069
2018-12-12T10:11:55.621	0	-36.694	-36.32	-35.535	-35.923
2018-12-12T10:12:10.425	0	-36.436	-37.81	-36.869	-37.12
2018-12-12T10:12:25.245	0	-36.837	-36.235	-36.678	-37.001
2018-12-12T10:12:40.065	0	-36.481	-36.918	-37.35	-37.387

2018-12-12T10:12:55.026	0	-40.114	-39.231	-40.899	-40.245
2018-12-12T10:13:09.955	0	-36.649	-35.23	-36.241	-37.92
2018-12-12T10:13:24.775	0	-34.801	-35.84	-37.987	-36.05
2018-12-12T10:13:39.595	0	-35.667	-35.895	-36.938	-35.254
2018-12-12T10:13:54.540	0	-32.563	-33.137	-33.717	-34.255
2018-12-12T10:14:09.500	0	-61.117	-60.88	-61.144	-63.228
2018-12-12T10:14:24.429	0	-36.169	-35.218	-36.184	-36.583
2018-12-12T10:14:39.249	0	-35.861	-35.875	-35.405	-36.859
2018-12-12T10:14:54.069	0	-34.573	-35.304	-35.443	-34.9
2018-12-12T10:15:08.889	0	-35.791	-36.23	-36.65	-35.218
2018-12-12T10:15:23.694	0	-35.722	-34.669	-36.199	-35.722
2018-12-12T10:15:38.514	0	-35.182	-35.6	-35.05	-37.368
2018-12-12T10:15:53.318	0	-35.904	-35.11	-36.684	-35.763
2018-12-12T10:16:08.138	0	-36.55	-35.242	-35.708	-36.049
2018-12-12T10:16:23.083	0	-33.937	-34.778	-33.161	-34.176
2018-12-12T10:16:38.028	0	-37.21	-37.193	-35.623	-37
2018-12-12T10:16:52.848	0	-35.919	-36.8	-38.125	-36.303
2018-12-12T10:17:07.652	0	-36.496	-37.482	-37.625	-37.906
2018-12-12T10:17:22.473	0	-37.736	-36.33	-35.87	-37.735
2018-12-12T10:17:37.293	0	-36.624	-36.968	-36.453	-36.667
2018-12-12T10:17:52.097	0	-36.44	-36.523	-37.031	-37.754
2018-12-12T10:18:06.901	0	-36.159	-36.523	-38.044	-36.953
2018-12-12T10:18:21.721	0	-36.938	-35.034	-36.495	-37.811
2018-12-12T10:18:36.526	0	-36.581	-36.83	-37.378	-37.754
2018-12-12T10:18:51.471	0	-35.583	-32.634	-33.7	-33.96
2018-12-12T10:19:06.291	0	-34.581	-35.343	-34.729	-34.58
2018-12-12T10:19:21.095	0	-33.687	-33.442	-34.089	-34.162
2018-12-12T10:19:35.915	0	-34.548	-34.358	-33.808	-34.883
2018-12-12T10:19:50.735	0	-34.884	-34.452	-35.007	-33.876
2018-12-12T10:20:05.540	0	-34.148	-33.767	-33.794	-34.282
2018-12-12T10:20:20.500	0	-40.347	-40.915	-38.915	-38.623
2018-12-12T10:20:35.445	0	-35.895	-36.019	-35.879	-36.035
2018-12-12T10:20:50.265	0	-35.879	-35.291	-35.956	-37.452
2018-12-12T10:21:05.069	0	-35.684	-35.669	-35.159	-35.655
2018-12-12T10:21:19.874	0	-37.992	-36.115	-35.4	-35.956
2018-12-12T10:21:34.694	0	-34.727	-36.973	-35.554	-35.251
2018-12-12T10:21:49.514	0	-35.64	-35.669	-34.822	-36.115
2018-12-12T10:22:04.318	0	-35.788	-36.197	-35.251	-35.305
2018-12-12T10:22:19.138	0	-36.315	-35.455	-34.969	-35.728
2018-12-12T10:22:33.958	0	-35.265	-36.992	-35.655	-35.988
2018-12-12T10:22:48.778	0	-36.541	-34.475	-36.099	-35.788
2018-12-12T10:23:03.583	0	-35.4	-36.132	-37.012	-34.42

2018-12-12T10:23:18.403	0	-36.4	-36.47	-36.019	-34.542
2018-12-12T10:23:33.223	0	-34.599	-36.914	-35.386	-34.846
2018-12-12T10:23:48.027	0	-35.988	-36.281	-35.359	-35.345
2018-12-12T10:24:02.847	0	-35.988	-35.069	-37.113	-35.582
2018-12-12T10:24:17.652	0	-35.199	-37.012	-35.345	-36.761
2018-12-12T10:24:32.472	0	-35.895	-37.113	-36.281	-35.146
2018-12-12T10:24:47.292	0	-35.512	-35.525	-36.505	-35.848
2018-12-12T10:25:02.096	0	-35.225	-36.003	-35.225	-36.148
2018-12-12T10:25:16.916	0	-35.568	-35.095	-36.003	-37.154
2018-12-12T10:25:31.721	0	-34.227	-35.788	-36.779	-35.069
2018-12-12T10:25:46.541	0	-35.057	-35.483	-35.972	-36.523
2018-12-12T10:26:01.345	0	-34.727	-35.265	-35.803	-35.359
2018-12-12T10:26:16.165	0	-36.051	-35.12	-36.314	-35.803
2018-12-12T10:26:30.985	0	-34.475	-36.649	-35.006	-35.669
2018-12-12T10:26:45.789	0	-35.67	-35.427	-35.441	-36.181
2018-12-12T10:27:00.610	0	-34.333	-34.981	-35.879	-35.386
2018-12-12T10:27:15.554	0	-60.366	-62.22	-60.354	-61.024
2018-12-12T10:27:30.515	0	-36.438	-36.689	-37.292	-37.478
2018-12-12T10:27:45.319	0	-36.733	-36.356	-36.911	-37.035
2018-12-12T10:28:00.264	0	-33.766	-32.284	-33.282	-32.689
2018-12-12T10:28:15.209	0	-34.445	-36.242	-35.895	-36.042
2018-12-12T10:28:30.029	0	-35.201	-34.961	-36.567	-35.852
2018-12-12T10:28:44.849	0	-35.39	-35.881	-35.669	-35.008
2018-12-12T10:28:59.653	0	-37.106	-36.057	-36.289	-35.91
2018-12-12T10:29:14.473	0	-35.925	-36.722	-36.828	-35.39
2018-12-12T10:29:29.278	0	-37.424	-36.882	-35.781	-35.494
2018-12-12T10:29:44.098	0	-36.088	-37.125	-34.834	-36.103
2018-12-12T10:29:59.058	0	-39.428	-40.769	-40.657	-40.518
2018-12-12T10:30:13.987	0	-35.82	-35.146	-38.463	-37.612
2018-12-12T10:30:28.807	0	-36.306	-36.741	-35.559	-35.644
2018-12-12T10:30:43.628	0	-36.526	-36.392	-36.363	-35.744
2018-12-12T10:30:58.432	0	-37.086	-37.225	-36.179	-37.069
2018-12-12T10:31:13.236	0	-36.757	-36.495	-36.918	-36.235
2018-12-12T10:31:28.056	0	-36.393	-36.678	-36.363	-35.559
2018-12-12T10:31:42.861	0	-35.017	-36.179	-37.035	-36.378
2018-12-12T10:31:57.681	0	-37.831	-36.725	-36.853	-36.069
2018-12-12T10:32:12.641	0	-62.382	-61.315	-60.789	-61.611
2018-12-12T10:32:27.586	0	-36.912	-37.05	-36.661	-36.022
2018-12-12T10:32:42.391	0	-36.123	-39.3	-35.84	-36.212
2018-12-12T10:32:57.211	0	-35.998	-36.022	-37.461	-36.303
2018-12-12T10:33:12.031	0	-38.111	-35.936	-36.851	-37.41
2018-12-12T10:33:26.835	0	-36.41	-36.927	-36.173	-35.7

2018-12-12T10:33:41.639	0	-37.839	-36.356	-36.464	-35.654
2018-12-12T10:33:56.459	0	-37.098	-38.212	-36.303	-39.02
2018-12-12T10:34:11.264	0	-37.098	-36.604	-35.9	-37.41
2018-12-12T10:34:26.084	0	-36.988	-36.689	-37.548	-36.478
2018-12-12T10:34:41.029	0	-60.296	-61.366	-61.512	-61.468
2018-12-12T10:34:55.989	0	-37.286	-36.6	-35.653	-35.979
2018-12-12T10:35:10.794	0	-35.746	-36.583	-35.733	-36.567
2018-12-12T10:35:25.598	0	-35.474	-35.033	-35.338	-35.01
2018-12-12T10:35:40.418	0	-36.851	-35.854	-35.773	-36.211
2018-12-12T10:35:55.238	0	-35.242	-35.563	-36.271	-36.551
2018-12-12T10:36:10.042	0	-36.152	-37.643	-36.123	-36.332
2018-12-12T10:36:24.863	0	-36.766	-36.123	-35.399	-37.726
2018-12-12T10:36:39.823	0	-59.447	-59.815	-59.342	-58.936
2018-12-12T10:36:54.768	0	-36.828	-37.881	-36.567	-36.264
2018-12-12T10:37:09.572	0	-36.306	-37.174	-35.968	-36.908
2018-12-12T10:37:24.392	0	-35.363	-36.876	-37.056	-37.191
2018-12-12T10:37:39.212	0	-36.334	-35.63	-35.715	-35.078
2018-12-12T10:37:54.017	0	-37.039	-36.168	-36.989	-36.222
2018-12-12T10:38:08.821	0	-37.881	-37.174	-35.547	-36.007
2018-12-12T10:38:23.641	0	-37.006	-35.955	-35.981	-36.86
2018-12-12T10:38:38.461	0	-37.332	-36.007	-36.672	-36.02
2018-12-12T10:38:53.281	0	-36.688	-37.821	-36.391	-35.715
2018-12-12T10:39:08.086	0	-36.087	-36.362	-36.597	-36.1
2018-12-12T10:39:22.906	0	-37.514	-36.989	-36.127	-37.039
2018-12-12T10:39:37.726	0	-36.828	-37.664	-36.567	-36.718
2018-12-12T10:39:52.546	0	-35.5	-37.243	-38.195	-37.072
2018-12-12T10:40:07.350	0	-36.892	-37.476	-35.703	-36.348
2018-12-12T10:40:22.155	0	-36.99	-37.209	-36.073	-35.994
2018-12-12T10:40:36.975	0	-37.984	-36.94	-35.362	-37.513
2018-12-12T10:40:51.795	0	-35.955	-35.765	-35.317	-35.34
2018-12-12T10:41:06.739	0	-60.648	-60.635	-61.206	-61.357
2018-12-12T10:41:21.684	0	-36.056	-33.94	-34.648	-34.429
2018-12-12T10:41:36.504	0	-34.648	-34.384	-33.343	-34.414
2018-12-12T10:41:51.309	0	-33.296	-33.331	-34.354	-35.694
2018-12-12T10:42:06.113	0	-33.537	-33.953	-34.036	-33.65
2018-12-12T10:42:20.933	0	-33.488	-33.886	-34.036	-33.562
2018-12-12T10:42:35.753	0	-34.522	-34.036	-35.553	-33.034
2018-12-12T10:42:50.558	0	-36.354	-33.157	-34.811	-33.319
2018-12-12T10:43:05.378	0	-34.207	-33.296	-33.549	-34.135
2018-12-12T10:43:20.198	0	-33.012	-35.176	-35.379	-34.149
2018-12-12T10:43:35.002	0	-34.964	-34.46	-34.135	-34.475
2018-12-12T10:43:49.822	0	-35.158	-33.574	-34.632	-34.828

2018-12-12T10:44:04.767	0	-60.073	-60.394	-62.806	-60.469
2018-12-12T10:44:19.727	0	-36.096	-35.2	-35.27	-36.253
2018-12-12T10:44:34.672	0	-61.264	-60.381	-61.235	-59.853
2018-12-12T10:44:49.742	0	-35.942	-35.738	-34.542	-34.564
2018-12-12T10:45:04.687	0	-34.332	-35.503	-36.202	-36.462
2018-12-12T10:45:19.507	0	-35.957	-36.282	-36.903	-35.809
2018-12-12T10:45:34.327	0	-36.202	-36.496	-35.255	-35.204
2018-12-12T10:45:49.131	0	-35.294	-34.499	-35.436	-36.686
2018-12-12T10:46:03.936	0	-35.668	-35.056	-36.547	-36.564
2018-12-12T10:46:18.756	0	-35.571	-35.682	-35.956	-35.167
2018-12-12T10:46:33.576	0	-36.347	-36.155	-37.311	-37.373
2018-12-12T10:46:48.380	0	-35.192	-34.607	-35.204	-36.922
2018-12-12T10:47:03.200	0	-35.424	-35.49	-36.001	-35.941
2018-12-12T10:47:18.020	0	-34.597	-37.112	-34.972	-35.371
2018-12-12T10:47:32.824	0	-35.069	-35.668	-36.282	-35.557
2018-12-12T10:47:47.645	0	-36.793	-36.429	-35.612	-36.186
2018-12-12T10:48:02.465	0	-35.217	-35.682	-34.843	-35.986
2018-12-12T10:48:17.409	0	-40.412	-40.266	-39.887	-39.946
2018-12-12T10:48:32.370	0	-35.844	-36.755	-35.69	-36.113
2018-12-12T10:48:47.174	0	-36.49	-36.628	-36.986	-36.738
2018-12-12T10:49:01.979	0	-36.644	-36.819	-36.058	-38.036
2018-12-12T10:49:16.799	0	-34.92	-35.99	-36.819	-37.605
2018-12-12T10:49:31.619	0	-36.141	-37.339	-37.071	-35.481
2018-12-12T10:49:46.423	0	-36.183	-36.169	-36.55	-36.003
2018-12-12T10:50:01.228	0	-36.82	-35.135	-36.803	-35.923
2018-12-12T10:50:16.048	0	-35.844	-36.885	-34.614	-36.535
2018-12-12T10:50:30.868	0	-37.625	-36.225	-36.297	-36.03
2018-12-12T10:50:45.672	0	-35.469	-36.628	-35.282	-36.771
2018-12-12T10:51:00.492	0	-37.339	-35.936	-36.254	-36.489
2018-12-12T10:51:15.312	0	-36.43	-36.597	-35.779	-37.432
2018-12-12T10:51:30.132	0	-36.535	-35.64	-35.818	-37.23
2018-12-12T10:51:44.937	0	-36.385	-37.266	-37.825	-35.949
2018-12-12T10:51:59.741	0	-36.505	-35.529	-36.504	-36.044
2018-12-12T10:52:14.701	0	-33.805	-33.415	-33.597	-32.741
2018-12-12T10:52:29.646	0	-35.168	-34.542	-34.945	-35.035
2018-12-12T10:52:44.451	0	-35.263	-36.211	-35.835	-35.532
2018-12-12T10:52:59.271	0	-36.757	-35.591	-34.45	-35.101
2018-12-12T10:53:14.091	0	-37.142	-34.831	-35.235	-35.318
2018-12-12T10:53:29.036	0	-60.919	-60.855	-63.34	-61.144
2018-12-12T10:53:43.980	0	-36.535	-36.036	-38.009	-37.402
2018-12-12T10:53:58.800	0	-36.898	-36.407	-36.828	-37.481
2018-12-12T10:54:13.605	0	-37.546	-36.036	-37.529	-37.386

2018-12-12T10:54:28.409	0	-35.683	-36.612	-36.883	-36.679
2018-12-12T10:54:43.229	0	-36.272	-36.586	-37.217	-37.644
2018-12-12T10:54:58.049	0	-37.481	-37.711	-35.856	-37.04
2018-12-12T10:55:12.854	0	-37.661	-37.083	-38.175	-37.465
2018-12-12T10:55:27.674	0	-37.418	-38.027	-35.202	-37.37
2018-12-12T10:55:42.494	0	-37.202	-37.172	-35.694	-36.869
2018-12-12T10:55:57.298	0	-36.236	-35.911	-37.04	-37.142
2018-12-12T10:56:12.118	0	-37.187	-36.534	-37.481	-38.406
2018-12-12T10:56:26.923	0	-36.164	-36.855	-36.176	-37.402
2018-12-12T10:56:41.743	0	-36.484	-37.695	-37.324	-37.069
2018-12-12T10:56:56.563	0	-37.232	-37.661	-36.897	-38.009
2018-12-12T10:57:11.367	0	-37.34	-38.045	-37.728	-37.083
2018-12-12T10:57:26.172	0	-37.902	-37.402	-38.193	-37.278

SAMPLE DATA FOR TUNGA

		Frequency (Hz)			
Timestamp	Measure Unit	30000000	30050000	30100000	30150000
2018-12-11T07:47:36.106	0	-32.216	-33.371	-32.559	-33.895
2018-12-11T07:47:50.926	0	-33.758	-34.756	-31.181	-32.663
2018-12-11T07:48:05.731	0	-33.311	-33.191	-33.625	-33.625
2018-12-11T07:48:20.551	0	-32.676	-34.072	-32.299	-33.544
2018-12-11T07:48:35.356	0	-33.046	-31.459	-35.726	-32.702
2018-12-11T07:48:50.176	0	-34.799	-33.103	-34.693	-33.003
2018-12-11T07:49:04.980	0	-32.384	-34.072	-34.182	-33.528
2018-12-11T07:49:19.800	0	-34.09	-33.609	-33.418	-33.809
2018-12-11T07:49:34.620	0	-33.965	-33.576	-32.508	-33.465
2018-12-11T07:49:49.425	0	-34.127	-33.341	-33.117	-32.85
2018-12-11T07:50:04.229	0	-32.989	-33.205	-34.257	-33.176
2018-12-11T07:50:19.049	0	-31.919	-31.832	-33.146	-32.421
2018-12-11T07:50:33.869	0	-32.192	-33.843	-33.372	-33.929
2018-12-11T07:50:48.814	0	-55.062	-55.347	-54.703	-55.437
2018-12-11T07:51:03.759	0	-31.683	-32.701	-33.88	-31.964
2018-12-11T07:51:18.563	0	-32.784	-32.619	-33.241	-32.279
2018-12-11T07:51:33.368	0	-32.62	-33.45	-32.54	-32.22
2018-12-11T07:51:48.188	0	-32.54	-32.783	-32.048	-32.508
2018-12-11T07:52:02.992	0	-33.65	-32.264	-32.817	-31.991
2018-12-11T07:52:17.812	0	-32.148	-31.58	-31.239	-33.113
2018-12-11T07:52:32.632	0	-31.568	-32.324	-32.684	-33.629
2018-12-11T07:52:47.437	0	-32.509	-32.868	-32.493	-32.294
2018-12-11T07:53:02.241	0	-32.462	-33.392	-32.294	-33.67
2018-12-11T07:53:17.061	0	-31.311	-32.119	-32.603	-32.508
2018-12-11T07:53:31.881	0	-31.068	-32.062	-31.709	-33.431
2018-12-11T07:53:46.686	0	-31.709	-32.902	-31.468	-32.22

2018-12-11T07:54:01.506	0	-31.619	-31.95	-32.636	-31.492
2018-12-11T07:54:16.310	0	-32.989	-32.817	-32.4	-31.868
2018-12-11T07:54:31.130	0	-32.509	-30.858	-31.618	-31.828
2018-12-11T07:54:45.950	0	-31.193	-32.048	-32.415	-32.684
2018-12-11T07:55:00.755	0	-31.48	-32.033	-31.882	-30.659
2018-12-11T07:55:15.575	0	-34.1	-32.264	-31.696	-31.978
2018-12-11T07:55:30.395	0	-31.868	-32.385	-32.062	-32.119
2018-12-11T07:55:45.199	0	-31.456	-30.805	-32.954	-31.286
2018-12-11T07:56:00.003	0	-31.868	-32.733	-32.119	-32.048
2018-12-11T07:56:14.824	0	-32.37	-32.415	-32.062	-32.048
2018-12-11T07:56:29.628	0	-31.683	-32.652	-31.605	-33.489
2018-12-11T07:56:44.432	0	-32.006	-31.841	-32.279	-30.923
2018-12-11T07:56:59.252	0	-31.937	-32.868	-31.882	-32.076
2018-12-11T07:57:14.072	0	-31.593	-31.58	-33.259	-31.431
2018-12-11T07:57:28.939	0	-31.193	-33.548	-31.618	-32.019
2018-12-11T07:57:43.900	0	-31.395	-31.882	-31.517	-31.801
2018-12-11T07:57:58.845	0	-35.138	-36.488	-34.894	-36.08
2018-12-11T07:58:13.665	0	-34.135	-35.446	-35.298	-35.201
2018-12-11T07:58:28.469	0	-35.481	-36.382	-35.964	-34.939
2018-12-11T07:58:43.273	0	-34.525	-34.159	-33.674	-36.488
2018-12-11T07:58:58.234	0	-35.927	-34.806	-34.511	-34.748
2018-12-11T07:59:13.241	0	-54.647	-52.873	-53.966	-53.997
2018-12-11T07:59:28.264	0	-32.491	-33.142	-31.776	-33.007
2018-12-11T07:59:43.084	0	-32.504	-31.866	-33.662	-33.559
2018-12-11T07:59:57.888	0	-32.652	-34.537	-33.749	-32.186
2018-12-11T08:00:12.693	0	-33.82	-33.037	-32.977	-32.504
2018-12-11T08:00:27.638	0	-32.611	-33.427	-33.576	-33.082
2018-12-11T08:00:42.520	0	-32.876	-31.935	-34.412	-32.706
2018-12-11T08:00:57.465	0	-31.341	-32.992	-33.346	-33.593
2018-12-11T08:01:12.347	0	-33.628	-32.323	-33.874	-34.173
2018-12-11T08:01:27.292	0	-32.323	-34.077	-32.804	-32.504
2018-12-11T08:01:42.252	0	-32.707	-32.21	-33.282	-32.557
2018-12-11T08:01:57.057	0	-32.993	-33.067	-34.077	-33.037
2018-12-11T08:02:11.877	0	-32.89	-33.037	-32.79	-32.818
2018-12-11T08:02:26.697	0	-32.557	-33.037	-32.818	-31.924
2018-12-11T08:02:41.501	0	-33.346	-33.22	-32.323	-32.933
2018-12-11T08:02:56.321	0	-33.112	-31.935	-33.022	-33.112
2018-12-11T08:03:11.266	0	-55.109	-53.416	-53.627	-54.451
2018-12-11T08:03:26.211	0	-33.14	-32.855	-33.209	-32.904
2018-12-11T08:03:41.016	0	-33.752	-32.696	-31.925	-32.987
2018-12-11T08:03:55.976	0	-32.045	-33.673	-31.912	-33.28
2018-12-11T08:04:10.905	0	-33.596	-31.237	-31.733	-32.251

2018-12-11T08:04:25.725	0	-31.237	-32.68	-31.622	-32.775
2018-12-11T08:04:40.545	0	-32.468	-32.181	-32.68	-33.263
2018-12-11T08:04:55.365	0	-33.071	-33.389	-33.812	-31.646
2018-12-11T08:05:10.310	0	-54.912	-55.23	-55.621	-55.559
2018-12-11T08:05:25.255	0	-32.736	-33.053	-32.987	-32.097
2018-12-11T08:05:40.075	0	-31.791	-34.005	-33.431	-32.299
2018-12-11T08:05:54.879	0	-32.66	-32.397	-33.786	-31.517
2018-12-11T08:06:09.699	0	-31.954	-32.44	-32.355	-32.15
2018-12-11T08:06:24.504	0	-32.097	-32.828	-32.498	-33.965
2018-12-11T08:06:39.324	0	-33.221	-31.528	-32.875	-32.939
2018-12-11T08:06:54.144	0	-34.459	-32.123	-32.844	-33.02
2018-12-11T08:07:09.089	0	-34.661	-36.569	-35.784	-34.221
2018-12-11T08:07:23.909	0	-35.076	-34.727	-35.583	-37.137
2018-12-11T08:07:38.713	0	-35.503	-35.09	-34.174	-35.149
2018-12-11T08:07:53.658	0	-32.759	-33.693	-31.847	-33.14
2018-12-11T08:08:08.540	0	-33.558	-33.576	-32.336	-31.758
2018-12-11T08:08:23.563	0	-34.612	-35.933	-34.612	-35.355
2018-12-11T08:08:38.368	0	-34.524	-36.58	-36.481	-35.603
2018-12-11T08:08:53.312	0	-32.938	-31.824	-31.451	-33.07
2018-12-11T08:09:08.132	0	-31.725	-33.223	-32.303	-33.086
2018-12-11T08:09:22.937	0	-31.023	-33.364	-32.261	-32.762
2018-12-11T08:09:37.757	0	-31.689	-34.236	-33.171	-32.317
2018-12-11T08:09:52.577	0	-34.022	-33.223	-32.624	-31.544
2018-12-11T08:10:07.459	0	-33.94	-32.857	-32.36	-33.12
2018-12-11T08:10:22.342	0	-32.747	-32.289	-33.662	-32.921
2018-12-11T08:10:37.146	0	-31.837	-33.036	-31.991	-31.725
2018-12-11T08:10:52.107	0	-34.754	-35.455	-35.075	-35.519
2018-12-11T08:11:06.911	0	-34.7	-35.269	-35.519	-36.672
2018-12-11T08:11:21.872	0	-32.4	-32.477	-32.354	-30.956
2018-12-11T08:11:36.738	0	-32.221	-32.556	-31.895	-32.733
2018-12-11T08:11:51.558	0	-31.568	-31.868	-34.578	-33.649
2018-12-11T08:12:06.378	0	-31.722	-32.076	-31.735	-31.801
2018-12-11T08:12:21.261	0	-32.355	-32.22	-32.162	-32.587
2018-12-11T08:12:36.065	0	-31.964	-32.415	-35.172	-33.431
2018-12-11T08:12:50.885	0	-31.855	-32.636	-32.75	-33.649
2018-12-11T08:13:05.690	0	-33.077	-32.09	-33.392	-32.019
2018-12-11T08:13:20.510	0	-31.855	-32.571	-32.294	-32.571
2018-12-11T08:13:35.314	0	-31.828	-31.868	-32.191	-34.077
2018-12-11T08:13:50.134	0	-32.902	-31.841	-32.4	-32.885
2018-12-11T08:14:04.939	0	-31.543	-31.17	-33.489	-32.652
2018-12-11T08:14:19.759	0	-32.09	-31.657	-32.8	-31.936
2018-12-11T08:14:34.781	0	-31.882	-32.75	-32.279	-33.204

2018-12-11T08:14:49.789	0	-31.53	-31.895	-33.45	-32.133
2018-12-11T08:15:04.609	0	-31.801	-33.411	-34.1	-32.8
2018-12-11T08:15:19.413	0	-32.572	-32.508	-31.67	-32.235
2018-12-11T08:15:34.358	0	-34.147	-35.411	-35.601	-35.142
2018-12-11T08:15:49.162	0	-35.29	-34.674	-34.396	-34.82
2018-12-11T08:16:03.982	0	-34.82	-34.915	-36.888	-34.508
2018-12-11T08:16:18.787	0	-34.193	-35.427	-35.474	-35.185
2018-12-11T08:16:33.732	0	-32.939	-34.172	-33.825	-32.286
2018-12-11T08:16:48.552	0	-32.955	-34.067	-32.483	-32.527
2018-12-11T08:17:03.356	0	-34.068	-31.67	-33.449	-32.813
2018-12-11T08:17:18.161	0	-31.816	-32.797	-31.742	-33.577
2018-12-11T08:17:32.981	0	-33.17	-33.102	-33.053	-32.527
2018-12-11T08:17:47.801	0	-33.36	-32.66	-32.355	-32.272
2018-12-11T08:18:02.605	0	-32.15	-33.67	-33.904	-32.454
2018-12-11T08:18:17.425	0	-32.342	-32.426	-32.72	-33.449
2018-12-11T08:18:32.229	0	-33.17	-31.67	-31.903	-33.102
2018-12-11T08:18:47.049	0	-31.767	-32.258	-31.803	-31.891
2018-12-11T08:19:01.994	0	-32.586	-31.437	-34.13	-31.779
2018-12-11T08:19:16.939	0	-33.845	-32.891	-33.786	-32.527
2018-12-11T08:19:31.759	0	-32.286	-31.992	-32.615	-33.503
2018-12-11T08:19:46.704	0	-53.757	-53.543	-53.966	-53.069
2018-12-11T08:20:01.664	0	-32.15	-32.813	-32.955	-32.797
2018-12-11T08:20:16.469	0	-32.3	-31.84	-33.153	-32.585
2018-12-11T08:20:31.273	0	-33.053	-32.469	-31.141	-32.585
2018-12-11T08:20:46.218	0	-34.006	-32.675	-31.865	-31.803
2018-12-11T08:21:01.163	0	-32.571	-32.454	-31.292	-32.675
2018-12-11T08:21:16.123	0	-35.079	-34.574	-34.178	-35.037
2018-12-11T08:21:30.928	0	-33.701	-34.144	-35.296	-35.023
2018-12-11T08:21:45.873	0	-33.767	-32.258	-32.15	-32.44
2018-12-11T08:22:00.693	0	-31.54	-32.031	-32.57	-32.11
2018-12-11T08:22:15.497	0	-31.587	-32.705	-32.005	-32.204
2018-12-11T08:22:30.317	0	-32.6	-32.19	-31.928	-32.412
2018-12-11T08:22:45.137	0	-32.798	-31.992	-32.07	-33.359
2018-12-11T08:22:59.957	0	-33.633	-31.992	-32.57	-32.766
2018-12-11T08:23:14.762	0	-32.876	-33.844	-32.057	-32.987
2018-12-11T08:23:29.566	0	-32.356	-31.73	-32.813	-32.66
2018-12-11T08:23:44.386	0	-32.006	-33.805	-33.395	-32.469
2018-12-11T08:23:59.190	0	-32.259	-32.483	-32.123	-33.651
2018-12-11T08:24:14.010	0	-32.045	-31.816	-33.904	-32.66
2018-12-11T08:24:28.815	0	-32.86	-31.73	-32.813	-32.44
2018-12-11T08:24:43.775	0	-32.556	-32.782	-31.078	-31.682
2018-12-11T08:24:58.580	0	-32.892	-32.939	-32.971	-32.397

2018-12-11T08:25:13.384	0	-32.084	-32.341	-33.521	-31.967
2018-12-11T08:25:28.204	0	-32.218	-32.204	-33.467	-33.449
2018-12-11T08:25:43.149	0	-31.646	-32.813	-32.412	-31.226
2018-12-11T08:25:57.953	0	-33.119	-32.736	-32.844	-32.231
2018-12-11T08:26:12.898	0	-32.259	-32.19	-31.437	-31.482
2018-12-11T08:26:27.718	0	-31.841	-33.053	-32.313	-32.797
2018-12-11T08:26:42.663	0	-33.54	-32.341	-33.004	-33.708
2018-12-11T08:26:57.468	0	-32.908	-31.658	-31.766	-32.585
2018-12-11T08:27:12.288	0	-31.967	-32.397	-32.084	-32.69
2018-12-11T08:27:27.108	0	-32.813	-31.967	-32.939	-33.54
2018-12-11T08:27:41.912	0	-31.292	-32.766	-33.102	-33.985
2018-12-11T08:27:56.857	0	-55.786	-56.075	-56.484	-56.427
2018-12-11T08:28:11.802	0	-32.535	-33.532	-33.358	-34.102
2018-12-11T08:28:26.622	0	-31.343	-32.104	-34.267	-31.843
2018-12-11T08:28:41.426	0	-32.288	-33.141	-33.55	-33.109
2018-12-11T08:28:56.371	0	-33.029	-31.418	-33.714	-33.884
2018-12-11T08:29:11.316	0	-32.248	-31.643	-32.247	-32.919
2018-12-11T08:29:26.120	0	-31.795	-31.385	-31.953	-32.091
2018-12-11T08:29:40.940	0	-33.029	-33.223	-33.392	-33.125
2018-12-11T08:29:55.885	0	-35.899	-37.154	-34.981	-35.222
2018-12-11T08:30:10.830	0	-33.943	-33.174	-32.577	-32.577
2018-12-11T08:30:25.634	0	-32.904	-33.206	-33.141	-32.577
2018-12-11T08:30:40.454	0	-34.268	-32.592	-33.64	-32.904
2018-12-11T08:30:55.259	0	-33.846	-31.759	-32.13	-33.223
2018-12-11T08:31:10.079	0	-32.694	-31.289	-32.521	-32.919
2018-12-11T08:31:24.899	0	-32.694	-34.002	-33.013	-32.423
2018-12-11T08:31:39.703	0	-32.079	-33.622	-33.341	-32.858
2018-12-11T08:31:54.523	0	-32.535	-33.846	-32.563	-32.827
2018-12-11T08:32:09.328	0	-33.207	-31.843	-32.091	-32.873
2018-12-11T08:32:24.148	0	-32.355	-32.635	-31.001	-32.066
2018-12-11T08:32:39.093	0	-52.777	-53.771	-53.119	-54.88
2018-12-11T08:32:54.037	0	-33.125	-32.678	-32.066	-32.535
2018-12-11T08:33:08.857	0	-32.235	-32.261	-32.314	-33.324
2018-12-11T08:33:23.802	0	-52.928	-54.502	-53.972	-54.126
2018-12-11T08:33:38.763	0	-33.379	-32.041	-33.33	-33.526
2018-12-11T08:33:53.567	0	-32.273	-33.526	-33.173	-32.638
2018-12-11T08:34:08.372	0	-33.189	-31.271	-33.082	-32.584
2018-12-11T08:34:23.394	0	-31.444	-33.052	-33.251	-32.919
2018-12-11T08:34:38.199	0	-33.097	-34.843	-34.82	-32.597
2018-12-11T08:34:53.222	0	-32.517	-32.762	-32.977	-32.348
2018-12-11T08:35:08.042	0	-32.089	-31.912	-33.082	-32.693
2018-12-11T08:35:22.862	0	-33.037	-32.977	-32.005	-32.477

2018-12-11T08:35:37.682	0	-31.634	-32.904	-33.346	-32.665
2018-12-11T08:35:52.486	0	-33.158	-34.665	-31.732	-33.158
2018-12-11T08:36:07.291	0	-33.236	-33.543	-32.992	-32.464
2018-12-11T08:36:22.111	0	-32.517	-34.002	-33.947	-33.543
2018-12-11T08:36:36.931	0	-32.584	-32.818	-33.476	-33.251
2018-12-11T08:36:51.875	0	-36.076	-35.637	-35.828	-34.395
2018-12-11T08:37:06.820	0	-33.141	-32.577	-33.125	-32.327
2018-12-11T08:37:21.640	0	-31.529	-31.608	-33.532	-33.77
2018-12-11T08:37:36.445	0	-32.396	-32.395	-32.287	-32.423
2018-12-11T08:37:51.327	0	-33.808	-32.981	-33.358	-32.737
2018-12-11T08:38:06.132	0	-33.714	-33.677	-32.091	-33.64
2018-12-11T08:38:21.045	0	-32.369	-35.051	-34.205	-33.044
2018-12-11T08:38:35.850	0	-32.723	-32.395	-32.079	-32.182
2018-12-11T08:38:50.654	0	-31.953	-32.104	-32.873	-33.409
2018-12-11T08:39:05.474	0	-32.679	-31.867	-33.444	-33.109
2018-12-11T08:39:20.294	0	-33.444	-32.368	-33.174	-31.783
2018-12-11T08:39:35.098	0	-32.549	-32.858	-33.273	-31.771
2018-12-11T08:39:49.903	0	-33.061	-32.409	-32.015	-32.812
2018-12-11T08:40:04.801	0	-32.274	-33.341	-32.395	-33.013
2018-12-11T08:40:19.746	0	-32.507	-32.858	-33.789	-32.395
2018-12-11T08:40:34.691	0	-32.003	-32.368	-32.723	-32.919
2018-12-11T08:40:49.573	0	-32.768	-32.478	-33.532	-32.842
2018-12-11T08:41:04.393	0	-33.714	-33.109	-32.649	-32.169
2018-12-11T08:41:19.197	0	-31.43	-32.723	-32.919	-33.962
2018-12-11T08:41:34.017	0	-31.529	-31.518	-32.919	-33.962
2018-12-11T08:41:48.822	0	-32.843	-32.549	-33.827	-32.708
2018-12-11T08:42:03.626	0	-32.169	-33.307	-34.041	-33.076
2018-12-11T08:42:18.446	0	-31.856	-33.125	-32.606	-33.695
2018-12-11T08:42:33.266	0	-33.604	-31.473	-32.079	-33.307
2018-12-11T08:42:48.133	0	-33.207	-32.521	-32.169	-32.966
2018-12-11T08:43:02.953	0	-33.013	-32.966	-31.748	-32.015
2018-12-11T08:43:17.773	0	-33.714	-31.429	-32.221	-31.748
2018-12-11T08:43:32.578	0	-32.355	-32.423	-34.246	-34.041
2018-12-11T08:43:47.398	0	-32.738	-33.427	-32.465	-31.916
2018-12-11T08:44:02.202	0	-31.632	-32.287	-33.732	-33.125
2018-12-11T08:44:17.147	0	-33.273	-34.267	-33.141	-33.029
2018-12-11T08:44:32.107	0	-33.41	-33.109	-33.732	-31.855
2018-12-11T08:44:46.990	0	-33.462	-33.223	-33.256	-32.723
2018-12-11T08:45:01.810	0	-32.997	-32.492	-33.141	-32.261
2018-12-11T08:45:16.614	0	-31.247	-33.604	-33.174	-32.314
2018-12-11T08:45:31.434	0	-32.889	-34.353	-32.888	-32.451
2018-12-11T08:45:46.239	0	-32.003	-32.549	-33.884	-32.287

2018-12-11T08:46:01.059	0	-32.195	-32.234	-34.878	-31.724
2018-12-11T08:46:16.019	0	-34.644	-36.377	-36.798	-34.654
2018-12-11T08:46:30.964	0	-32.145	-32.601	-31.945	-32.448
2018-12-11T08:46:45.909	0	-32.34	-33.095	-33.095	-33.273
2018-12-11T08:47:00.854	0	-33.207	-32.774	-32.745	-32.804
2018-12-11T08:47:15.658	0	-32.476	-32.545	-32.196	-32.367
2018-12-11T08:47:30.478	0	-32.819	-33.493	-32.545	-34.108
2018-12-11T08:47:45.283	0	-32.394	-32.715	-32.489	-33.339
2018-12-11T08:48:00.103	0	-32.716	-32.462	-33.356	-34.639
2018-12-11T08:48:15.001	0	-33.652	-32.985	-31.897	-32.545
2018-12-11T08:48:29.867	0	-33.207	-32.909	-32.367	-33.424
2018-12-11T08:48:44.828	0	-32.909	-32.367	-33.545	-32.587
2018-12-11T08:48:59.773	0	-32.057	-33.142	-33.001	-32.421
2018-12-11T08:49:14.718	0	-32.274	-34.8	-31.408	-33.356
2018-12-11T08:49:29.522	0	-32.879	-32.531	-32.545	-33.191
2018-12-11T08:49:44.342	0	-34.148	-32.573	-31.517	-34.312
2018-12-11T08:49:59.162	0	-33.599	-33.598	-31.994	-32.658
2018-12-11T08:50:14.232	0	-55.156	-55.858	-55.649	-55.993
2018-12-11T08:50:29.176	0	-31.678	-32.919	-32.301	-32.664
2018-12-11T08:50:43.996	0	-33.462	-33.808	-33.962	-32.888
2018-12-11T08:50:58.801	0	-32.664	-33.358	-33.808	-32.827
2018-12-11T08:51:13.746	0	-32.592	-32.966	-32.693	-33.808
2018-12-11T08:51:28.691	0	-33.375	-32.535	-33.29	-34.122
2018-12-11T08:51:43.713	0	-34.831	-36.378	-36.45	-33.731
2018-12-11T08:51:58.658	0	-33.77	-32.919	-32.028	-32.812
2018-12-11T08:52:13.541	0	-32.828	-32.981	-32.678	-33.044
2018-12-11T08:52:28.361	0	-31.966	-33.568	-33.462	-34.002
2018-12-11T08:52:43.165	0	-33.963	-31.495	-33.256	-33.029
2018-12-11T08:52:57.970	0	-32.328	-32.182	-32.028	-32.301
2018-12-11T08:53:12.914	0	-34.524	-35.447	-35.462	-35.447
2018-12-11T08:53:27.734	0	-33.481	-36.144	-35.252	-35.009
2018-12-11T08:53:42.757	0	-31.944	-31.76	-32.366	-33.152
2018-12-11T08:53:57.702	0	-55.41	-54.689	-54.621	-54.521
2018-12-11T08:54:12.662	0	-32.797	-33.389	-31.605	-32.99
2018-12-11T08:54:27.545	0	-32.354	-31.752	-32.366	-32.353
2018-12-11T08:54:42.349	0	-32.447	-34.938	-32.796	-33.809
2018-12-11T08:54:57.169	0	-32.173	-32.667	-31.856	-31.903
2018-12-11T08:55:11.974	0	-31.432	-32.46	-32.99	-32.314
2018-12-11T08:55:26.794	0	-32.012	-33.129	-33.098	-31.798
2018-12-11T08:55:41.739	0	-34.593	-34.996	-36.532	-35.116
2018-12-11T08:55:56.543	0	-34.094	-35.426	-35.727	-36.844
2018-12-11T08:56:11.363	0	-35.354	-34.393	-35.397	-35.144

2018-12-11T08:56:26.183	0	-35.559	-36.069	-35.382	-36.171
2018-12-11T08:56:40.987	0	-34.581	-34.777	-36.966	-34.996
2018-12-11T08:56:55.792	0	-35.5	-34.917	-36.241	-35.952
2018-12-11T08:57:10.752	0	-34.44	-32.274	-32.327	-32.079
2018-12-11T08:57:25.572	0	-32.694	-34.374	-32.382	-33.677
2018-12-11T08:57:40.517	0	-53.987	-53.651	-55.029	-54.952
2018-12-11T08:57:55.462	0	-32.066	-33.076	-33.29	-33.497
2018-12-11T08:58:10.282	0	-33.109	-31.332	-32.028	-34.461
2018-12-11T08:58:25.227	0	-34.919	-36.188	-36.155	-35.416
2018-12-11T08:58:40.172	0	-32.261	-33.78	-32.909	-32.157
2018-12-11T08:58:54.992	0	-33.652	-33.273	-32.353	-32.804
2018-12-11T08:59:09.796	0	-33.407	-32.132	-32.007	-32.687
2018-12-11T08:59:24.757	0	-31.814	-32.287	-33.095	-34.068
2018-12-11T08:59:39.686	0	-33.546	-33.441	-32.774	-32.909
2018-12-11T08:59:54.506	0	-34.168	-32.517	-32.774	-33.273
2018-12-11T09:00:09.326	0	-33.111	-32.503	-32.462	-33.407
2018-12-11T09:00:24.255	0	-54.337	-54.881	-53.381	-53.577
2018-12-11T09:00:39.216	0	-32.667	-32.639	-32.148	-32.796
2018-12-11T09:00:54.020	0	-32.667	-32.959	-32.639	-33.129
2018-12-11T09:01:08.824	0	-32.148	-31.963	-32.71	-32.724
2018-12-11T09:01:23.644	0	-35.234	-33.067	-32.611	-31.306
2018-12-11T09:01:38.449	0	-32.96	-32.782	-31.963	-33.067
2018-12-11T09:01:53.269	0	-34.134	-33.611	-32.87	-34.442
2018-12-11T09:02:08.073	0	-33.612	-33.355	-33.289	-33.273
2018-12-11T09:02:22.893	0	-32.474	-32.38	-33.177	-31.672
2018-12-11T09:02:37.698	0	-32.597	-33.542	-32.738	-32.224
2018-12-11T09:02:52.518	0	-32.38	-32.899	-32.314	-32.583
2018-12-11T09:03:07.338	0	-33.067	-33.49	-32.288	-33.241
2018-12-11T09:03:22.142	0	-31.868	-33.791	-32.796	-33.773
2018-12-11T09:03:36.947	0	-31.833	-33.339	-32.767	-33.273
2018-12-11T09:03:51.907	0	-35.791	-35.97	-35.604	-36.354
2018-12-11T09:04:06.852	0	-33.372	-32.974	-32.496	-35.041
2018-12-11T09:04:21.656	0	-32.397	-32.689	-32.663	-33.792
2018-12-11T09:04:36.601	0	-33.434	-33.625	-33.176	-32.689
2018-12-11T09:04:51.686	0	-34.59	-37.015	-37.851	-35.06
2018-12-11T09:05:06.647	0	-32.881	-34.191	-33.352	-33.777
2018-12-11T09:05:21.451	0	-33.245	-32.596	-33.066	-32.596
2018-12-11T09:05:36.334	0	-31.403	-33.008	-32.138	-32.033
2018-12-11T09:05:51.216	0	-32.584	-33.43	-32.493	-33.446
2018-12-11T09:06:06.036	0	-31.92	-32.951	-32.583	-33.008
2018-12-11T09:06:20.841	0	-31.887	-32.88	-33.828	-33.184
2018-12-11T09:06:35.661	0	-34.042	-33.846	-32.839	-32.293

2018-12-11T09:06:50.465	0	-33.777	-32.61	-33.494	-34.21
2018-12-11T09:07:05.269	0	-33.527	-32.293	-34.483	-33.229
2018-12-11T09:07:20.167	0	-33.199	-33.478	-31.875	-34.21
2018-12-11T09:07:35.050	0	-33.609	-31.942	-31.766	-33.022
2018-12-11T09:07:49.995	0	-32.623	-33.022	-33.777	-31.787
2018-12-11T09:08:04.939	0	-33.846	-34.325	-34.669	-32.532
2018-12-11T09:08:19.760	0	-32.663	-34.975	-32.318	-33.229
2018-12-11T09:08:34.564	0	-33.214	-34.191	-32.596	-33.229
2018-12-11T09:08:49.384	0	-31.864	-32.519	-33.415	-32.825
2018-12-11T09:09:04.188	0	-33.337	-34.648	-33.214	-32.811
2018-12-11T09:09:19.149	0	-32.392	-32.965	-33.051	-32.506
2018-12-11T09:09:34.094	0	-34.098	-34.153	-32.442	-33.608
2018-12-11T09:09:49.038	0	-34.69	-34.993	-35.416	-34.297
2018-12-11T09:10:03.983	0	-31.799	-33.82	-31.677	-32.477
2018-12-11T09:10:18.803	0	-32.361	-33.142	-31.947	-33.067
2018-12-11T09:10:33.608	0	-33.112	-32.557	-31.97	-32.57
2018-12-11T09:10:48.428	0	-33.493	-32.065	-33.022	-32.077
2018-12-11T09:11:03.232	0	-33.33	-32.348	-31.516	-33.314
2018-12-11T09:11:18.130	0	-31.331	-32.762	-32.173	-32.804
2018-12-11T09:11:32.935	0	-32.721	-32.477	-32.477	-33.007
2018-12-11T09:11:47.755	0	-34.193	-32.101	-32.464	-34.232
2018-12-11T09:12:02.762	0	-35.71	-34.984	-35.695	-34.483
2018-12-11T09:12:17.707	0	-34.182	-34.162	-33	-32.704
2018-12-11T09:12:32.527	0	-33.163	-31.853	-34.499	-33.014
2018-12-11T09:12:47.331	0	-33.015	-34.162	-33.239	-33.193
2018-12-11T09:13:02.151	0	-32.942	-33.609	-33.477	-33.333
2018-12-11T09:13:16.956	0	-32.013	-32.65	-32.87	-33.27
2018-12-11T09:13:31.978	0	-32.913	-32.364	-33.073	-32.313
2018-12-11T09:13:46.861	0	-32.453	-33.78	-32.06	-32.401
2018-12-11T09:14:01.806	0	-32.677	-32.814	-33.94	-34.068
2018-12-11T09:14:16.626	0	-33.073	-33.255	-33.058	-33.317
2018-12-11T09:14:31.508	0	-32.131	-32.001	-32.465	-33.904
2018-12-11T09:14:46.391	0	-32.518	-31.297	-34.688	-33.444
2018-12-11T09:15:01.273	0	-33.029	-33.301	-32.913	-33.797
2018-12-11T09:15:16.155	0	-33.103	-32.389	-33.014	-33.477
2018-12-11T09:15:30.975	0	-32.857	-31.809	-33.255	-33.348
2018-12-11T09:15:45.780	0	-33.643	-32.504	-33.94	-33.255
2018-12-11T09:16:00.600	0	-33.015	-33.868	-31.458	-32.048
2018-12-11T09:16:15.404	0	-32.57	-32.583	-33.148	-32.814
2018-12-11T09:16:30.287	0	-33.677	-32.44	-32.095	-33.38
2018-12-11T09:16:45.107	0	-34.378	-31.614	-35.165	-32.828
2018-12-11T09:16:59.989	0	-34.646	-33.728	-35.567	-33.904

2018-12-11T09:17:14.934	0	-33.286	-33.745	-33.509	-33.994
2018-12-11T09:17:29.894	0	-32.691	-34.357	-31.268	-33.575
2018-12-11T09:17:44.699	0	-32.843	-34.031	-32.927	-32.453
2018-12-11T09:17:59.644	0	-32.277	-33.676	-32.557	-32.786
2018-12-11T09:18:14.448	0	-34.087	-31.944	-33.239	-33.224
2018-12-11T09:18:29.409	0	-31.689	-32.57	-31.798	-32.239
2018-12-11T09:18:44.213	0	-33.592	-32.453	-33.693	-32.465
2018-12-11T09:18:59.033	0	-31.99	-32.636	-33.693	-32.517
2018-12-11T09:19:13.837	0	-32.143	-33.994	-32.842	-32.453
2018-12-11T09:19:28.657	0	-32.557	-33.224	-32.167	-33.728
2018-12-11T09:19:43.478	0	-33.694	-32.985	-33.659	-33.088
2018-12-11T09:19:58.298	0	-32.351	-32.745	-33.163	-32.465
2018-12-11T09:20:13.305	0	-33.302	-32.985	-32.491	-33.396
2018-12-11T09:20:28.390	0	-35.427	-37.053	-35.386	-34.767
2018-12-11T09:20:43.335	0	-34.036	-32.681	-34.214	-32.301
2018-12-11T09:20:58.217	0	-32.061	-32.419	-33.389	-34.255
2018-12-11T09:21:13.037	0	-33.036	-33.647	-32.555	-33.507
2018-12-11T09:21:27.857	0	-33.241	-33.322	-32.275	-33.611
2018-12-11T09:21:42.662	0	-33.577	-32.34	-32.514	-33.257
2018-12-11T09:21:57.466	0	-31.507	-32.914	-33.524	-33.664
2018-12-11T09:22:12.286	0	-33.865	-32.528	-32.914	-33.036
2018-12-11T09:22:27.091	0	-31.976	-33.559	-32.975	-31.892
2018-12-11T09:22:42.051	0	-53.392	-54.704	-55.853	-53.15
2018-12-11T09:22:56.871	0	-54.637	-54.928	-53.318	-54.841
2018-12-11T09:23:11.878	0	-32.966	-34.933	-33.356	-33.731
2018-12-11T09:23:26.776	0	-32.834	-33.695	-31.705	-31.922
2018-12-11T09:23:41.659	0	-32.719	-33.356	-32.649	-33.438
2018-12-11T09:23:56.541	0	-32.354	-32.776	-33.026	-32.733
2018-12-11T09:24:11.361	0	-32.115	-32.38	-33.471	-32.139
2018-12-11T09:24:26.306	0	-33.803	-33.731	-32.848	-34.638
2018-12-11T09:24:41.110	0	-33.149	-32.539	-31.595	-31.649
2018-12-11T09:24:56.071	0	-31.994	-33.66	-33.164	-32.446
2018-12-11T09:25:10.875	0	-32.691	-33.388	-32.776	-32.804
2018-12-11T09:25:25.680	0	-33.678	-33.102	-34.749	-32.892
2018-12-11T09:25:40.578	0	-33.422	-33.802	-32.761	-32.733
2018-12-11T09:25:55.460	0	-32.513	-32.29	-31.958	-31.75
2018-12-11T09:26:10.280	0	-32.433	-32.367	-33.148	-33.505
2018-12-11T09:26:25.085	0	-32.677	-33.748	-32.833	-33.66
2018-12-11T09:26:39.889	0	-32.733	-32.79	-32.264	-33.243
2018-12-11T09:26:54.849	0	-32.252	-33.026	-32.315	-33.01
2018-12-11T09:27:09.872	0	-34.362	-32.79	-33.766	-32.499
2018-12-11T09:27:24.677	0	-32.705	-33.227	-32.58	-31.23

2018-12-11T09:27:39.559	0	-34.362	-33.102	-32.608	-33.372
2018-12-11T09:27:54.582	0	-33.275	-32.189	-34.121	-34.616
2018-12-11T09:28:09.511	0	-32.006	-33.117	-33.608	-32.995
2018-12-11T09:28:24.394	0	-32.677	-33.026	-33.259	-32.819
2018-12-11T09:28:39.214	0	-32.719	-32.862	-32.906	-32.877
2018-12-11T09:28:54.018	0	-32.09	-32.406	-32.98	-31.864
2018-12-11T09:29:09.041	0	-33.713	-32.354	-33.356	-34.445
2018-12-11T09:29:23.970	0	-34.509	-32.58	-31.617	-32.264
2018-12-11T09:29:38.868	0	-31.488	-34.006	-32.921	-34.121
2018-12-11T09:29:53.673	0	-34.616	-32.472	-33.471	-32.877
2018-12-11T09:30:08.555	0	-32.367	-32.239	-32.58	-32.459
2018-12-11T09:30:23.453	0	-33.455	-31.694	-33.323	-32.341
2018-12-11T09:30:38.257	0	-31.52	-33.421	-33.968	-33.117
2018-12-11T09:30:53.202	0	-32.459	-32.921	-33.372	-32.621
2018-12-11T09:31:08.225	0	-34.383	-33.117	-32.264	-33.026
2018-12-11T09:31:23.310	0	-55.752	-57.284	-56.711	-56.86
2018-12-11T09:31:38.333	0	-33.212	-33.117	-33.323	-33.522
2018-12-11T09:31:53.138	0	-33.489	-32.29	-33.339	-31.27
2018-12-11T09:32:07.958	0	-32.54	-33.195	-34.771	-33.211
2018-12-11T09:32:22.778	0	-33.011	-33.087	-33.372	-32.251
2018-12-11T09:32:37.582	0	-32.227	-33.66	-33.041	-33.522
2018-12-11T09:32:52.387	0	-32.54	-32.189	-33.339	-31.672
2018-12-11T09:33:07.207	0	-32.677	-33.227	-33.573	-34.321
2018-12-11T09:33:22.027	0	-33.164	-32.446	-32.819	-32.151
2018-12-11T09:33:36.831	0	-32.433	-34.121	-32.354	-33.01
2018-12-11T09:33:51.635	0	-32.29	-32.553	-31.83	-32.733
2018-12-11T09:34:06.518	0	-33.118	-32.719	-33.59	-32.38
2018-12-11T09:34:21.400	0	-32.499	-33.307	-33.339	-32.936
2018-12-11T09:34:36.283	0	-32.164	-31.672	-32.432	-32.649
2018-12-11T09:34:51.228	0	-32.622	-32.553	-32.354	-32.367
2018-12-11T09:35:06.110	0	-32.486	-32.776	-31.784	-33.839
2018-12-11T09:35:20.930	0	-32.29	-33.259	-32.164	-32.833
2018-12-11T09:35:35.734	0	-33.118	-34.2	-32.649	-33.259
2018-12-11T09:35:50.554	0	-32.367	-33.438	-33.372	-32.526
2018-12-11T09:36:05.359	0	-32.066	-32.459	-33.82	-32.833
2018-12-11T09:36:20.304	0	-33.133	-31.638	-33.372	-33.857
2018-12-11T09:36:35.124	0	-32.354	-33.102	-32.176	-33.275
2018-12-11T09:36:49.944	0	-32.608	-32.567	-32.315	-33.987
2018-12-11T09:37:04.889	0	-32.748	-32.406	-32.277	-33.339
2018-12-11T09:37:19.693	0	-32.407	-32.09	-32.862	-31.331
2018-12-11T09:37:34.497	0	-33.713	-34.886	-32.98	-32.921
2018-12-11T09:37:49.317	0	-33.196	-32.164	-32.226	-32.608

2018-12-11T09:38:04.325	0	-33.087	-32.776	-32.608	-33.087
2018-12-11T09:38:19.223	0	-31.982	-31.672	-32.691	-32.512
2018-12-11T09:38:34.168	0	-32.663	-33.323	-33.471	-33.556
2018-12-11T09:38:49.050	0	-33.149	-33.405	-33.164	-33.421
2018-12-11T09:39:03.870	0	-32.892	-32.594	-33.291	-33.421
2018-12-11T09:39:18.752	0	-32.733	-33.164	-32.98	-32.621
2018-12-11T09:39:33.635	0	-32.719	-32.677	-31.66	-32.214
2018-12-11T09:39:48.439	0	-33.041	-32.526	-32.264	-33.66
2018-12-11T09:40:03.259	0	-33.372	-32.608	-32.776	-33.505
2018-12-11T09:40:18.079	0	-31.21	-33.01	-32.176	-32.804
2018-12-11T09:40:32.946	0	-33.323	-32.733	-32.201	-33.323
2018-12-11T09:40:47.766	0	-33.18	-32.446	-32.315	-31.694
2018-12-11T09:41:02.711	0	-33.678	-32.719	-32.965	-32.393

SAMPLE DATA FOR KUBWA

		Frequency (Hz)			
Timestamp	Measure Unit	30000000	30050000	30100000	30150000
2019-05-10T12:40:09.754	0	-28.112	-28.112	-27.789	-28.351
2019-05-10T12:40:24.885	0	-26.44	-30.021	-29.07	-28.823
2019-05-10T12:40:40.005	0	-28.275	-27.816	-27.843	-29.106
2019-05-10T12:40:55.133	0	-27.552	-27.137	-29.694	-28.2
2019-05-10T12:41:10.262	0	-28.509	-29.43	-28.275	-28.2
2019-05-10T12:41:25.375	0	-27.722	-28.654	-27.816	-28.589
2019-05-10T12:41:40.510	0	-27.451	-29.088	-28.589	-28.738
2019-05-10T12:41:55.638	0	-28.557	-27.102	-28.26	-28.771
2019-05-10T12:42:10.771	0	-28.23	-28.039	-28.29	-27.695
2019-05-10T12:42:25.901	0	-29.144	-27.789	-28.755	-28.573
2019-05-10T12:42:41.029	0	-29.737	-27.762	-28.589	-27.816
2019-05-10T12:42:56.155	0	-27.426	-29.55	-28.2	-27.762
2019-05-10T12:43:11.275	0	-28.026	-28.445	-28.382	-29.034
2019-05-10T12:43:26.413	0	-27.219	-28.556	-29.255	-29.469
2019-05-10T12:43:41.541	0	-29.275	-28.305	-27.997	-27.488
2019-05-10T12:43:56.669	0	-27.669	-27.451	-29.18	-27.898
2019-05-10T12:44:11.824	0	-50.587	-50.118	-49.188	-48.357
2019-05-10T12:44:26.994	0	-29.447	-28.504	-29.156	-29.299
2019-05-10T12:44:42.156	0	-49.64	-49.687	-48.827	-49.687
2019-05-10T12:44:57.318	0	-27.172	-27.488	-25.907	-26.977
2019-05-10T12:45:12.449	0	-26.89	-26.962	-28.826	-27.391
2019-05-10T12:45:27.576	0	-27.296	-26.847	-26.833	-26.314
2019-05-10T12:45:42.699	0	-27.296	-26.653	-25.738	-28.3
2019-05-10T12:45:57.834	0	-27.375	-26.351	-27.656	-28.012
2019-05-10T12:46:12.965	0	-27.343	-26.519	-27.423	-27.538
2019-05-10T12:46:28.085	0	-26.13	-27.795	-26.326	-27.725

2019-05-10T12:46:43.245	0	-29.459	-30.575	-29.638	-31.357
2019-05-10T12:46:58.374	0	-28.939	-29.352	-30.92	-29.839
2019-05-10T12:47:13.499	0	-29.81	-29.824	-29.248	-29.928
2019-05-10T12:47:28.630	0	-29.486	-31.113	-29.723	-30.305
2019-05-10T12:47:43.760	0	-30.224	-28.855	-28.683	-29.781
2019-05-10T12:47:58.876	0	-29.473	-30.558	-29.541	-31.074
2019-05-10T12:48:14.010	0	-30.628	-30.338	-29.248	-29.445
2019-05-10T12:48:29.136	0	-30.79	-30.628	-30.523	-30.404
2019-05-10T12:48:44.277	0	-27.91	-30.864	-29.197	-29.839
2019-05-10T12:48:59.385	0	-29.652	-30.92	-30.717	-30.506
2019-05-10T12:49:14.520	0	-30.455	-29.752	-29.898	-29.047
2019-05-10T12:49:29.693	0	-49.512	-49.742	-50.692	-49.742
2019-05-10T12:49:44.852	0	-28.735	-29.563	-29.145	-28.209
2019-05-10T12:50:00.013	0	-27.185	-27.167	-26.053	-26.183
2019-05-10T12:50:15.168	0	-28.645	-28.462	-28.673	-28.926
2019-05-10T12:50:30.306	0	-28.574	-30.649	-28.532	-28.988
2019-05-10T12:50:45.420	0	-29.31	-28.248	-28.235	-28.394
2019-05-10T12:51:00.544	0	-29.003	-28.462	-28.865	-29.129
2019-05-10T12:51:15.665	0	-30.016	-28.274	-29.034	-27.969
2019-05-10T12:51:30.806	0	-28.821	-28.941	-29.428	-29.019
2019-05-10T12:51:45.933	0	-29.327	-27.824	-30.055	-29.996
2019-05-10T12:52:01.065	0	-29.498	-28.602	-29.842	-29.567
2019-05-10T12:52:16.188	0	-29.36	-29.36	-28.031	-27.896
2019-05-10T12:52:31.317	0	-29.178	-28.043	-28.367	-30.196
2019-05-10T12:52:46.439	0	-28.476	-28.476	-28.274	-27.684
2019-05-10T12:53:01.577	0	-29.621	-30.278	-27.605	-28.79
2019-05-10T12:53:16.700	0	-28.056	-29.394	-28.79	-29.36
2019-05-10T12:53:31.840	0	-28.044	-28.34	-29.748	-29.532
2019-05-10T12:53:46.968	0	-28.56	-29.88	-28.183	-27.684
2019-05-10T12:54:02.075	0	-28.972	-29.497	-29.034	-28.988
2019-05-10T12:54:17.219	0	-28.821	-27.673	-28.532	-27.548
2019-05-10T12:54:32.343	0	-28.791	-28.449	-28.835	-28.659
2019-05-10T12:54:47.466	0	-29.899	-28.776	-28.408	-29.034
2019-05-10T12:55:02.588	0	-28.806	-28.63	-29.326	-29.21
2019-05-10T12:55:17.725	0	-28.235	-28.354	-29.26	-29.693
2019-05-10T12:55:32.850	0	-28.435	-28.132	-27.884	-28.327
2019-05-10T12:55:47.988	0	-28.942	-27.994	-28.56	-27.824
2019-05-10T12:56:03.141	0	-50.391	-49.313	-50.092	-49.313
2019-05-10T12:56:18.296	0	-28.201	-29.201	-28.301	-27.73
2019-05-10T12:56:33.435	0	-26.733	-29.516	-27.912	-28.494
2019-05-10T12:56:48.557	0	-29.983	-27.73	-28.257	-27.872
2019-05-10T12:57:03.696	0	-27.926	-29.713	-29.44	-28.033

2019-05-10T12:57:18.820	0	-28.374	-28.728	-28.891	-30.025
2019-05-10T12:57:33.942	0	-27.846	-28.808	-29.653	-28.315
2019-05-10T12:57:49.079	0	-28.571	-27.305	-28.374	-27.567
2019-05-10T12:58:04.201	0	-29.329	-27.494	-28.359	-27.617
2019-05-10T12:58:19.339	0	-28.571	-28.633	-28.539	-26.866
2019-05-10T12:58:34.463	0	-28.36	-28.2	-28.433	-28.286
2019-05-10T12:58:49.603	0	-28.54	-28.463	-28.524	-29.713
2019-05-10T12:59:04.727	0	-28.586	-28.019	-28.214	-27.271
2019-05-10T12:59:19.849	0	-27.471	-28.908	-28.116	-29.148
2019-05-10T12:59:34.973	0	-29.329	-29.44	-28.744	-27.692
2019-05-10T12:59:50.101	0	-28.404	-28.712	-28.478	-27.859
2019-05-10T13:00:05.241	0	-28.76	-29.347	-28.403	-28.315
2019-05-10T13:00:20.363	0	-29.459	-28.825	-28.728	-28.68
2019-05-10T13:00:35.489	0	-29.078	-28.617	-29.814	-27.781
2019-05-10T13:00:50.611	0	-28.891	-28.448	-29.148	-27.885
2019-05-10T13:01:05.751	0	-29.384	-28.792	-27.58	-27.82
2019-05-10T13:01:20.858	0	-27.979	-28.524	-29.516	-27.768
2019-05-10T13:01:35.996	0	-29.096	-28.257	-28.617	-27.717
2019-05-10T13:01:51.122	0	-27.756	-28.019	-28.586	-28.033
2019-05-10T13:02:06.245	0	-29.113	-27.717	-29.183	-27.833
2019-05-10T13:02:21.382	0	-27.605	-27.47	-28.403	-28.186
2019-05-10T13:02:36.520	0	-27.979	-28.344	-28.2	-27.58
2019-05-10T13:02:51.643	0	-27.952	-29.095	-27.925	-27.422
2019-05-10T13:03:06.762	0	-27.341	-28.418	-28.958	-28.509
2019-05-10T13:03:21.900	0	-28.102	-28.033	-27.73	-29.594
2019-05-10T13:03:37.023	0	-26.703	-28.728	-27.952	-29.733
2019-05-10T13:03:52.161	0	-27.629	-27.617	-29.594	-29.594
2019-05-10T13:04:07.283	0	-28.172	-27.885	-29.574	-28.006
2019-05-10T13:04:22.405	0	-30.247	-27.717	-27.717	-27.859
2019-05-10T13:04:37.543	0	-28.494	-28.186	-27.305	-28.257
2019-05-10T13:04:52.711	0	-49.875	-48.753	-48.992	-48.705
2019-05-10T13:05:07.864	0	-29.457	-30.211	-28.103	-28.828
2019-05-10T13:05:22.987	0	-29.65	-29.302	-29.364	-28.279
2019-05-10T13:05:38.124	0	-28.291	-27.856	-28.577	-28.5
2019-05-10T13:05:53.264	0	-29.303	-29.023	-30.306	-28.551
2019-05-10T13:06:08.373	0	-28.801	-29.634	-28.577	-28.747
2019-05-10T13:06:23.511	0	-29.198	-28.291	-28.126	-30.422
2019-05-10T13:06:38.635	0	-29.767	-30.192	-29.095	-29.921
2019-05-10T13:06:53.774	0	-27.277	-29.257	-28.388	-29.318
2019-05-10T13:07:08.913	0	-28.995	-28.303	-29.457	-29.095
2019-05-10T13:07:24.036	0	-30.046	-29.52	-28.734	-28.401
2019-05-10T13:07:39.158	0	-29.273	-29.138	-29.869	-29.784

2019-05-10T13:07:54.280	0	-30.046	-30.211	-28.255	-28.774
2019-05-10T13:08:09.417	0	-29.066	-30.287	-29.7	-29.585
2019-05-10T13:08:24.540	0	-29.473	-28.327	-28.149	-28.966
2019-05-10T13:08:39.664	0	-28.616	-29.197	-29.41	-29.41
2019-05-10T13:08:54.818	0	-28.196	-29.41	-28.869	-29.257
2019-05-10T13:09:09.942	0	-31.148	-30.287	-29.939	-30.812
2019-05-10T13:09:25.063	0	-27.857	-29.227	-29.869	-28.551
2019-05-10T13:09:40.201	0	-29.634	-28.815	-28.842	-29.212
2019-05-10T13:09:55.321	0	-29.733	-28.488	-28.279	-28.966
2019-05-10T13:10:10.445	0	-27.634	-28.315	-28.815	-28.721
2019-05-10T13:10:25.569	0	-29.168	-29.666	-28.855	-29.138
2019-05-10T13:10:40.692	0	-29.066	-28.721	-28.267	-30.623
2019-05-10T13:10:55.829	0	-28.925	-30.644	-29.52	-30.364
2019-05-10T13:11:10.952	0	-30.583	-28.924	-29.287	-29.023
2019-05-10T13:11:26.090	0	-30.01	-29.552	-29.095	-28.924
2019-05-10T13:11:41.214	0	-30.064	-30.306	-30.383	-28.655
2019-05-10T13:11:56.351	0	-29.395	-28.352	-29.441	-29.869
2019-05-10T13:12:11.473	0	-29.784	-29.212	-28.303	-29.183
2019-05-10T13:12:26.597	0	-29.081	-28.774	-29.504	-30.028
2019-05-10T13:12:41.720	0	-28.501	-28.538	-28.911	-28.564
2019-05-10T13:12:56.843	0	-28.149	-29.52	-29.767	-29.287
2019-05-10T13:13:11.981	0	-28.539	-28.45	-29.536	-29.394
2019-05-10T13:13:27.103	0	-28.564	-28.938	-28.219	-29.887
2019-05-10T13:13:42.241	0	-29.198	-28.883	-28.564	-29.767
2019-05-10T13:13:57.363	0	-29.242	-29.634	-29.41	-29.197
2019-05-10T13:14:12.485	0	-28.513	-30.344	-28.924	-30.501
2019-05-10T13:14:27.609	0	-28.87	-30.119	-29.08	-29.869
2019-05-10T13:14:42.748	0	-28.513	-29.504	-29.227	-28.577
2019-05-10T13:14:57.872	0	-29.124	-28.883	-29.212	-28.869
2019-05-10T13:15:12.996	0	-28.939	-28.538	-29.394	-29.887
2019-05-10T13:15:28.117	0	-28.352	-30.01	-28.425	-28.401
2019-05-10T13:15:43.244	0	-29.139	-28.603	-29.197	-29.716
2019-05-10T13:15:58.381	0	-29.257	-29.257	-30.249	-29.939
2019-05-10T13:16:13.505	0	-29.426	-29.683	-30.603	-29.227
2019-05-10T13:16:28.643	0	-28.801	-28.303	-29.666	-29.08
2019-05-10T13:16:43.766	0	-28.364	-28.761	-29.052	-29.302
2019-05-10T13:16:58.903	0	-28.315	-28.787	-29.109	-30.306
2019-05-10T13:17:14.025	0	-29.505	-28.126	-29.904	-30.064
2019-05-10T13:17:29.165	0	-29.303	-29.318	-29.41	-28.721
2019-05-10T13:17:44.287	0	-29.11	-29.095	-29.536	-29.379
2019-05-10T13:17:59.410	0	-28.413	-28.513	-29.801	-30.064
2019-05-10T13:18:14.532	0	-29.009	-29.109	-28.774	-28.721

2019-05-10T13:18:29.669	0	-29.442	-29.037	-29.348	-29.348
2019-05-10T13:18:44.792	0	-28.59	-29.835	-30.422	-28.352
2019-05-10T13:18:59.932	0	-28.883	-30.155	-29.767	-28.438
2019-05-10T13:19:15.055	0	-29.585	-29.767	-29.601	-28.966
2019-05-10T13:19:30.177	0	-28.315	-28.364	-30.082	-29.666
2019-05-10T13:19:45.315	0	-29.11	-29.227	-29.168	-28.828
2019-05-10T13:20:00.437	0	-29.288	-28.629	-28.938	-29.272
2019-05-10T13:20:15.575	0	-29.717	-29.052	-29.257	-31.078
2019-05-10T13:20:30.699	0	-29.349	-29.197	-29.666	-28.551
2019-05-10T13:20:45.821	0	-29.154	-29.333	-28.721	-30.921
2019-05-10T13:21:00.942	0	-30.082	-29.552	-29.426	-30.268
2019-05-10T13:21:16.079	0	-29.426	-29.818	-29.08	-28.681
2019-05-10T13:21:31.203	0	-30.442	-30.402	-28.5	-28.911
2019-05-10T13:21:46.325	0	-30.119	-28.721	-28.488	-29.333
2019-05-10T13:22:01.465	0	-30.749	-29.52	-29.65	-28.513
2019-05-10T13:22:16.587	0	-28.328	-28.475	-28.376	-29.394
2019-05-10T13:22:31.711	0	-28.939	-30.623	-28.172	-28.59
2019-05-10T13:22:46.835	0	-29.198	-29.109	-29.536	-29.257
2019-05-10T13:23:01.957	0	-29.228	-28.208	-28.327	-28.279
2019-05-10T13:23:17.096	0	-28.401	-28.966	-30.028	-29.009
2019-05-10T13:23:32.219	0	-28.829	-29.852	-28.774	-29.272
2019-05-10T13:23:47.356	0	-29.038	-29.7	-28.938	-28.924
2019-05-10T13:24:02.478	0	-29.521	-28.774	-29.153	-29.552
2019-05-10T13:24:17.616	0	-28.161	-29.183	-28.303	-29.257
2019-05-10T13:24:32.739	0	-29.634	-28.883	-28.801	-30.344
2019-05-10T13:24:47.877	0	-29.473	-29.287	-29.426	-29.318
2019-05-10T13:25:02.999	0	-29.333	-29.009	-29.066	-29.41
2019-05-10T13:25:18.128	0	-28.681	-29.568	-29.08	-29.052
2019-05-10T13:25:33.281	0	-26.394	-26.199	-25.45	-25.999
2019-05-10T13:25:48.451	0	-29.024	-29.546	-29.993	-30.312
2019-05-10T13:26:03.589	0	-29.993	-29.292	-30.235	-29.292
2019-05-10T13:26:18.713	0	-29.127	-29.679	-30.763	-28.784
2019-05-10T13:26:33.835	0	-28.342	-30.41	-29.628	-28.839
2019-05-10T13:26:48.958	0	-31.054	-29.712	-28.48	-28.757
2019-05-10T13:27:04.097	0	-29.308	-29.957	-29.053	-29.815
2019-05-10T13:27:19.205	0	-30.159	-29.449	-29.156	-30.511
2019-05-10T13:27:34.343	0	-28.981	-29.903	-28.73	-29.433
2019-05-10T13:27:49.466	0	-30.615	-29.579	-28.544	-29.386
2019-05-10T13:28:04.605	0	-31.491	-28.442	-29.216	-28.066
2019-05-10T13:28:19.728	0	-29.339	-28.043	-27.731	-28.557
2019-05-10T13:28:34.866	0	-30.371	-29.009	-28.16	-28.73
2019-05-10T13:28:49.988	0	-30.14	-29.645	-28.649	-27.646

2019-05-10T13:29:05.110	0	-29.262	-28.48	-30.273	-30.552
2019-05-10T13:29:20.278	0	-26.952	-26.067	-26.153	-25.492
2019-05-10T13:29:35.400	0	-26.198	-25.858	-26.813	-27.551
2019-05-10T13:29:50.556	0	-29.054	-29.463	-29.054	-29.736
2019-05-10T13:30:05.680	0	-29.099	-27.379	-28.491	-29.084
2019-05-10T13:30:20.820	0	-30.379	-28.863	-28.92	-29.207
2019-05-10T13:30:35.943	0	-29.48	-29.191	-29.43	-30.18
2019-05-10T13:30:51.065	0	-28.849	-28.735	-28.544	-29.381
2019-05-10T13:31:06.187	0	-30.763	-29.024	-27.853	-28.222
2019-05-10T13:31:21.327	0	-29.382	-28.877	-28.361	-29.397
2019-05-10T13:31:36.450	0	-29.916	-30.121	-28.322	-28.373
2019-05-10T13:31:51.573	0	-28.95	-28.95	-27.599	-28.791
2019-05-10T13:32:06.697	0	-28.198	-29.114	-27.945	-29.563
2019-05-10T13:32:21.821	0	-27.993	-28.425	-28.451	-28.438
2019-05-10T13:32:36.945	0	-28.777	-28.848	-28.016	-28.028
2019-05-10T13:32:52.076	0	-29.861	-27.708	-28.935	-29.285
2019-05-10T13:33:07.199	0	-28.735	-29.631	-28.598	-30.74
2019-05-10T13:33:22.337	0	-28.005	-30.762	-28.625	-28.544
2019-05-10T13:33:37.460	0	-28.694	-29.842	-29.447	-30.42
2019-05-10T13:33:52.599	0	-29.207	-28.666	-29.915	-29.753
2019-05-10T13:34:07.738	0	-29.333	-28.185	-28.544	-29.753
2019-05-10T13:34:22.861	0	-28.721	-28.517	-29.915	-28.666
2019-05-10T13:34:38.000	0	-30.161	-29.43	-30.524	-30.318
2019-05-10T13:34:53.154	0	-26.818	-26.171	-25.646	-28.475
2019-05-10T13:35:08.292	0	-26.257	-28.154	-26.328	-27.172
2019-05-10T13:35:23.414	0	-27.017	-26.612	-25.94	-26.627
2019-05-10T13:35:38.570	0	-30.305	-30.288	-28.86	-29.938
2019-05-10T13:35:53.693	0	-29.489	-30.761	-29.406	-29.586
2019-05-10T13:36:08.834	0	-29.273	-29.461	-30.816	-29.195
2019-05-10T13:36:23.958	0	-30.207	-29.006	-30.046	-28.932
2019-05-10T13:36:39.079	0	-29.544	-29.671	-30.816	-30.158
2019-05-10T13:36:54.204	0	-30.19	-29.42	-30.239	-30.798
2019-05-10T13:37:09.343	0	-29.516	-29.862	-30.078	-30.255
2019-05-10T13:37:24.466	0	-30.289	-28.945	-29.156	-30.126
2019-05-10T13:37:39.588	0	-30.562	-29.558	-30.322	-30.816
2019-05-10T13:37:54.711	0	-28.72	-30.031	-29.299	-29.433
2019-05-10T13:38:09.850	0	-31.107	-29.379	-29.433	-29.544
2019-05-10T13:38:24.973	0	-28.801	-29.461	-30.816	-29.984
2019-05-10T13:38:40.095	0	-29.759	-29.643	-29.558	-30.255
2019-05-10T13:38:55.220	0	-30.95	-32.653	-29.299	-30.11
2019-05-10T13:39:10.341	0	-30.094	-30.527	-30.015	-31.992
2019-05-10T13:39:25.481	0	-29.195	-29.803	-29.299	-29.544

2019-05-10T13:39:40.605	0	-28.628	-29.247	-28.994	-31.27
2019-05-10T13:39:55.728	0	-30.207	-29.474	-29.847	-29.068
2019-05-10T13:40:10.866	0	-30.094	-28.662	-30.338	-29.326
2019-05-10T13:40:25.989	0	-30.19	-31.107	-30.669	-29.516
2019-05-10T13:40:41.128	0	-29.848	-29.892	-30.669	-29.953
2019-05-10T13:40:56.250	0	-29.17	-30.389	-31.894	-30.11
2019-05-10T13:41:11.387	0	-30.706	-30.835	-29.393	-27.988
2019-05-10T13:41:26.539	0	-26.361	-26.531	-27.07	-26.306
2019-05-10T13:41:41.662	0	-27.137	-25.493	-25.8	-26.649
2019-05-10T13:41:56.785	0	-25.875	-26.375	-27.153	-25.727
2019-05-10T13:42:11.922	0	-26.634	-27.22	-26.634	-28.06
2019-05-10T13:42:27.045	0	-26.941	-27.958	-26.694	-27.666
2019-05-10T13:42:42.168	0	-27.187	-27.12	-26.091	-28.947
2019-05-10T13:42:57.307	0	-26.432	-27.704	-27.086	-25.597
2019-05-10T13:43:12.415	0	-26.04	-25.924	-27.323	-26.184
2019-05-10T13:43:27.552	0	-25.85	-26.846	-27.878	-27.12
2019-05-10T13:43:42.676	0	-26.59	-26.319	-26.941	-26.709
2019-05-10T13:43:57.807	0	-27.555	-26.8	-26.265	-27.086
2019-05-10T13:44:12.947	0	-27.038	-26.909	-26.925	-24.998
2019-05-10T13:44:28.069	0	-27.341	-27.037	-28.38	-25.962
2019-05-10T13:44:43.193	0	-26.59	-26.878	-26.251	-26.973
2019-05-10T13:44:58.315	0	-26.694	-26.361	-26.333	-26.739
2019-05-10T13:45:13.484	0	-30.325	-28.813	-29.558	-28.933
2019-05-10T13:45:28.606	0	-28.988	-29.815	-28.96	-30.476
2019-05-10T13:45:43.731	0	-30.756	-28.235	-29.933	-29.184
2019-05-10T13:45:58.853	0	-28.697	-28.709	-29.33	-30.178
2019-05-10T13:46:13.993	0	-28.376	-29.029	-29.511	-29.33
2019-05-10T13:46:29.116	0	-28.893	-28.508	-28.533	-29.001
2019-05-10T13:46:44.253	0	-28.436	-28.906	-30.797	-30.054
2019-05-10T13:46:59.375	0	-31.234	-29.967	-27.892	-28.235
2019-05-10T13:47:14.499	0	-28.961	-30.16	-29.984	-29.573
2019-05-10T13:47:29.636	0	-30.516	-29.637	-29.766	-28.947
2019-05-10T13:47:44.759	0	-29.574	-30.839	-30.054	-29.511
2019-05-10T13:47:59.884	0	-29.967	-29.45	-31.188	-29.48
2019-05-10T13:48:15.006	0	-29.899	-28.906	-30.107	-28.099
2019-05-10T13:48:30.145	0	-30.019	-29.33	-29.573	-29.419
2019-05-10T13:48:45.261	0	-30.86	-28.328	-30.178	-28.281
2019-05-10T13:49:00.398	0	-28.364	-29.389	-29.184	-29.3
2019-05-10T13:49:15.553	0	-26.087	-26.526	-25.7	-26.772
2019-05-10T13:49:30.708	0	-30.305	-28.773	-29.513	-29.529
2019-05-10T13:49:45.847	0	-30.345	-30.093	-29.242	-28.871
2019-05-10T13:50:00.971	0	-28.943	-28.288	-28.597	-28.664

2019-05-10T13:50:16.110	0	-28.402	-28.214	-30.074	-28.35
2019-05-10T13:50:31.233	0	-28.57	-28.732	-29.06	-29.045
2019-05-10T13:50:46.355	0	-29.336	-28.19	-28.871	-28.023
2019-05-10T13:51:01.478	0	-28.364	-29.288	-30.465	-28.929
2019-05-10T13:51:16.616	0	-28.801	-29.546	-29.165	-28.801
2019-05-10T13:51:31.738	0	-28.61	-29.257	-28.597	-28.623
2019-05-10T13:51:46.876	0	-29.016	-28.178	-29.06	-29.06
2019-05-10T13:52:01.998	0	-29.242	-27.58	-29.802	-29.001
2019-05-10T13:52:17.122	0	-29.681	-29.415	-28.178	-29.715
2019-05-10T13:52:32.245	0	-28.915	-29.335	-29.32	-29.873
2019-05-10T13:52:47.368	0	-29.647	-28.677	-29.211	-29.399
2019-05-10T13:53:02.505	0	-31.057	-29.06	-28.57	-29.399
2019-05-10T13:53:17.628	0	-29.579	-29.415	-28.478	-29.18
2019-05-10T13:53:32.766	0	-29.767	-27.527	-29.383	-28.637
2019-05-10T13:53:47.888	0	-28.943	-28.597	-29.767	-28.815
2019-05-10T13:54:03.028	0	-29.513	-29.48	-29.15	-27.548
2019-05-10T13:54:18.149	0	-29.873	-28.491	-29.909	-29.105
2019-05-10T13:54:33.288	0	-29.002	-29.715	-29.03	-29.612
2019-05-10T13:54:48.410	0	-28.972	-29.304	-28.857	-29.09
2019-05-10T13:55:03.532	0	-28.815	-29.001	-27.908	-30.207
2019-05-10T13:55:18.670	0	-29.563	-28.843	-29.715	-30.675
2019-05-10T13:55:33.794	0	-28.505	-29.629	-29.579	-28.106
2019-05-10T13:55:48.918	0	-28.518	-29.513	-28.35	-28.517
2019-05-10T13:56:04.041	0	-30.018	-30.188	-29.749	-29.464
2019-05-10T13:56:19.180	0	-29.596	-28.929	-29.837	-27.84
2019-05-10T13:56:34.339	0	-49.882	-48.724	-50.137	-48.143
2019-05-10T13:56:49.493	0	-28.91	-28.73	-29.246	-29.323
2019-05-10T13:57:04.619	0	-28.812	-27.997	-27.963	-29.595
2019-05-10T13:57:19.755	0	-29.339	-28.98	-29.513	-30.763
2019-05-10T13:57:34.894	0	-28.785	-28.649	-28.966	-30.45
2019-05-10T13:57:50.000	0	-28.101	-29.201	-29.038	-30.084
2019-05-10T13:58:05.139	0	-27.646	-29.067	-29.993	-29.354
2019-05-10T13:58:20.277	0	-28.84	-29.679	-29.993	-27.84
2019-05-10T13:58:35.400	0	-28.545	-30.312	-29.292	-30.047
2019-05-10T13:58:50.523	0	-29.957	-29.024	-29.323	-28.342
2019-05-10T13:59:05.662	0	-29.53	-28.467	-31.194	-29.053
2019-05-10T13:59:20.786	0	-28.952	-29.067	-28.649	-29.401
2019-05-10T13:59:35.924	0	-28.785	-28.689	-30.784	-28.089
2019-05-10T13:59:51.030	0	-28.113	-28.305	-29.595	-29.262
2019-05-10T14:00:06.169	0	-28.149	-28.519	-28.244	-28.597
2019-05-10T14:00:21.291	0	-29.466	-29.126	-29.231	-28.839
2019-05-10T14:00:36.415	0	-28.493	-30.159	-29.246	-29.595

2019-05-10T14:00:51.539	0	-29.262	-29.009	-28.48	-28.853
2019-05-10T14:01:06.679	0	-28.966	-30.047	-30.215	-28.417
2019-05-10T14:01:21.801	0	-28.232	-28.467	-28.557	-29.082
2019-05-10T14:01:36.971	0	-48.442	-48.791	-48.605	-47.669
2019-05-10T14:01:52.124	0	-28.381	-29.842	-27.777	-28.094
2019-05-10T14:02:07.261	0	-30.835	-28.732	-29.675	-28.081
2019-05-10T14:02:22.384	0	-28.209	-28.645	-27.504	-28.805
2019-05-10T14:02:37.522	0	-28.261	-29.88	-28.006	-28.746
2019-05-10T14:02:52.677	0	-48.072	-49.194	-50.226	-48.561
2019-05-10T14:03:07.846	0	-29.25	-29.193	-30.137	-29.898
2019-05-10T14:03:22.984	0	-29.8	-29.396	-29.562	-28.587
2019-05-10T14:03:38.106	0	-29.426	-28.098	-29.396	-29.193
2019-05-10T14:03:53.228	0	-30.085	-30.428	-30.905	-29.455
2019-05-10T14:04:08.355	0	-28.906	-30.601	-29.322	-29.026
2019-05-10T14:04:23.493	0	-30.12	-28.827	-28.513	-29.081
2019-05-10T14:04:38.618	0	-29.64	-30.173	-28.919	-29.137
2019-05-10T14:04:53.741	0	-29.532	-30.262	-29.425	-29.44
2019-05-10T14:05:08.881	0	-29.593	-29.109	-29.308	-28.788
2019-05-10T14:05:24.006	0	-29.932	-28.775	-30.581	-27.863
2019-05-10T14:05:39.161	0	-26.979	-27.153	-26.019	-26.197
2019-05-10T14:05:54.299	0	-27.203	-26.664	-26.62	-26.841
2019-05-10T14:06:09.413	0	-26.343	-25.513	-26.664	-27.041
2019-05-10T14:06:24.551	0	-25.8	-26.356	-27.579	-25.86
2019-05-10T14:06:39.673	0	-26.276	-26.811	-27.404	-26.707
2019-05-10T14:06:54.797	0	-28.071	-26.356	-27.105	-26.424
2019-05-10T14:07:09.921	0	-26.185	-25.233	-27.525	-27.057
2019-05-10T14:07:25.060	0	-26.564	-26.781	-27.073	-26.21
2019-05-10T14:07:40.182	0	-26.425	-27.252	-26.592	-26.722
2019-05-10T14:07:55.322	0	-26.564	-26.963	-25.513	-26.902
2019-05-10T14:08:10.446	0	-26.007	-26.549	-27.971	-27.186
2019-05-10T14:08:25.569	0	-26.508	-27.089	-26.146	-26.811
2019-05-10T14:08:40.691	0	-27.991	-26.343	-25.569	-25.872
2019-05-10T14:08:55.830	0	-25.436	-27.335	-26.932	-27.268
2019-05-10T14:09:10.967	0	-27.353	-27.137	-27.186	-27.17
2019-05-10T14:09:26.092	0	-28.602	-26.146	-26.796	-26.082
2019-05-10T14:09:41.216	0	-27.09	-27.743	-25.957	-26.057
2019-05-10T14:09:56.339	0	-26.933	-25.884	-27.651	-27.319
2019-05-10T14:10:11.462	0	-26.172	-27.633	-28.787	-25.671
2019-05-10T14:10:26.585	0	-27.09	-26.549	-26.811	-25.872
2019-05-10T14:10:41.723	0	-26.995	-26.871	-26.438	-27.252
2019-05-10T14:10:56.846	0	-27.387	-26.25	-27.202	-26.737
2019-05-10T14:11:12.002	0	-28.986	-29.915	-28.932	-28.853

2019-05-10T14:11:27.141	0	-30.191	-29.965	-30.173	-29.655
2019-05-10T14:11:42.295	0	-49.446	-49.109	-49.134	-51.274
2019-05-10T14:11:57.465	0	-28.84	-29.331	-28.669	-28.451
2019-05-10T14:12:12.587	0	-28.372	-30.948	-29.156	-30.521
2019-05-10T14:12:27.724	0	-29.033	-28.372	-28.398	-29.548
2019-05-10T14:12:42.846	0	-28.641	-28.683	-29.219	-29.299
2019-05-10T14:12:57.984	0	-28.869	-27.437	-29.497	-27.856
2019-05-10T14:13:13.106	0	-29.414	-29.463	-30.521	-29.634
2019-05-10T14:13:28.228	0	-28.559	-29.203	-30.786	-28.438
2019-05-10T14:13:43.368	0	-28.855	-28.683	-30.153	-28.869
2019-05-10T14:13:58.490	0	-28.022	-29.283	-28.613	-27.914
2019-05-10T14:14:13.645	0	-48.352	-49.65	-49.109	-49.733
2019-05-10T14:14:28.815	0	-28.544	-28.557	-28.746	-29.579
2019-05-10T14:14:43.939	0	-28.788	-29.784	-29.767	-29.03
2019-05-10T14:14:59.076	0	-29.53	-30.784	-29.226	-29.596
2019-05-10T14:15:14.191	0	-29.647	-28.414	-29.18	-28.504
2019-05-10T14:15:29.328	0	-31.011	-29.165	-29.273	-28.691
2019-05-10T14:15:44.468	0	-30.188	-30.149	-29.546	-29.195
2019-05-10T14:15:59.575	0	-28.691	-29.383	-29.016	-29.135
2019-05-10T14:16:14.714	0	-28.9	-29.981	-28.452	-29.562
2019-05-10T14:16:29.835	0	-29.181	-29.367	-28.691	-28.972
2019-05-10T14:16:44.957	0	-28.958	-30.384	-28.583	-29.399
2019-05-10T14:17:00.095	0	-28.801	-29.629	-28.718	-30.226
2019-05-10T14:17:15.217	0	-29.596	-27.054	-28.13	-29.18
2019-05-10T14:17:30.387	0	-50.525	-49.904	-50.361	-50.909
2019-05-10T14:17:45.557	0	-28.973	-29.776	-30.5	-29.652
2019-05-10T14:18:00.683	0	-29.6	-29.705	-28.811	-28.613
2019-05-10T14:18:15.806	0	-29.11	-28.218	-28.572	-29.96
2019-05-10T14:18:30.944	0	-30.114	-28.753	-29.531	-28.411
2019-05-10T14:18:46.067	0	-28.943	-29.776	-28.531	-28.613
2019-05-10T14:19:01.225	0	-49.766	-49.476	-50.106	-51.345
2019-05-10T14:19:16.397	0	-26.887	-28.232	-28.165	-27.196
2019-05-10T14:19:31.528	0	-28.931	-27.953	-28.033	-28.851
2019-05-10T14:19:46.681	0	-49.333	-49.869	-48.938	-48.734
2019-05-10T14:20:01.837	0	-28.064	-29.58	-28.964	-29.649
2019-05-10T14:20:16.977	0	-29.684	-28.284	-27.853	-28.571
2019-05-10T14:20:32.085	0	-28.584	-28.504	-28.906	-29.099
2019-05-10T14:20:47.224	0	-30.853	-29.317	-28.666	-29.58
2019-05-10T14:21:02.346	0	-30.567	-29.191	-28.136	-30.219
2019-05-10T14:21:17.483	0	-27.981	-30.696	-29.207	-28.906
2019-05-10T14:21:32.606	0	-29.431	-29.381	-28.148	-29.365
2019-05-10T14:21:47.731	0	-29.754	-30.258	-28.964	-29.989

2019-05-10T14:22:02.870	0	-28.413	-30.141	-28.571	-29.253
2019-05-10T14:22:17.992	0	-28.763	-30.083	-28.412	-28.517
2019-05-10T14:22:33.115	0	-27.73	-29.099	-29.546	-29.789
2019-05-10T14:22:48.237	0	-28.272	-28.666	-28.148	-29.084
2019-05-10T14:23:03.376	0	-27.686	-29.546	-29.238	-28.625
2019-05-10T14:23:18.498	0	-29.238	-28.906	-28.087	-29.789
2019-05-10T14:23:33.636	0	-28.921	-29.207	-28.834	-28.052
2019-05-10T14:23:48.760	0	-29.099	-29.349	-28.438	-29.614
2019-05-10T14:24:03.884	0	-29.431	-28.04	-28.412	-27.62
2019-05-10T14:24:19.008	0	-28.584	-28.464	-28.425	-28.92
2019-05-10T14:24:34.146	0	-28.335	-28.707	-29.933	-28.964
2019-05-10T14:24:49.299	0	-25.269	-24.843	-26.226	-26.304
2019-05-10T14:25:04.468	0	-30.041	-28.935	-29.263	-27.773
2019-05-10T14:25:19.592	0	-28.37	-28.516	-28.8	-29.507
2019-05-10T14:25:34.716	0	-28.695	-28.43	-30.296	-29.278
2019-05-10T14:25:49.838	0	-29.867	-29.445	-30.023	-28.345
2019-05-10T14:26:04.976	0	-27.847	-28.695	-29.445	-29.399
2019-05-10T14:26:20.098	0	-29.369	-28.867	-28.708	-29.555
2019-05-10T14:26:35.269	0	-26.196	-25.848	-26.254	-26.558
2019-05-10T14:26:50.391	0	-25.957	-26.589	-26.095	-25.356
2019-05-10T14:27:05.559	0	-29.891	-29.083	-28.035	-29.735
2019-05-10T14:27:20.681	0	-29.203	-28.528	-29.57	-30.118
2019-05-10T14:27:35.819	0	-28.979	-29.017	-30.594	-29.796
2019-05-10T14:27:50.941	0	-28.622	-30.844	-28.827	-30.135
2019-05-10T14:28:06.081	0	-28.766	-29.396	-28.902	-30.101
2019-05-10T14:28:21.203	0	-29.285	-28.645	-29.354	-29.482
2019-05-10T14:28:36.327	0	-29.383	-29.468	-30.185	-28.966
2019-05-10T14:28:51.449	0	-29.659	-29.257	-31.025	-29.326
2019-05-10T14:29:06.572	0	-28.903	-29.659	-29.453	-30.484
2019-05-10T14:29:21.708	0	-28.575	-28.852	-30.502	-28.693
2019-05-10T14:29:36.885	0	-49.23	-50.052	-49.411	-49.326
2019-05-10T14:29:52.040	0	-27.528	-27.37	-27.544	-27.464
2019-05-10T14:30:07.163	0	-28.703	-26.327	-27.915	-27.203
2019-05-10T14:30:22.300	0	-26.579	-27.48	-27.48	-27.692
2019-05-10T14:30:37.425	0	-27.028	-26.021	-27.085	-27.293
2019-05-10T14:30:52.549	0	-27.34	-27.417	-27.725	-28.517
2019-05-10T14:31:07.672	0	-26.804	-26.763	-27.433	-28.517
2019-05-10T14:31:22.810	0	-27.203	-26.984	-26.463	-27.776
2019-05-10T14:31:37.932	0	-27.085	-26.777	-26.501	-27.386
2019-05-10T14:31:53.055	0	-25.92	-26.67	-26.231	-27.355
2019-05-10T14:32:08.195	0	-26.464	-26.886	-26.303	-29.054
2019-05-10T14:32:23.319	0	-26.605	-27.675	-26.79	-26.101

2019-05-10T14:32:38.443	0	-28.32	-26.914	-26.578	-28.206
2019-05-10T14:32:53.581	0	-27.528	-27.188	-26.696	-27.158
2019-05-10T14:33:08.704	0	-27.34	-26.75	-27.828	-27.278
2019-05-10T14:33:23.845	0	-27.676	-27.027	-27.248	-26.591
2019-05-10T14:33:38.969	0	-27.071	-26.845	-26.723	-27.433
2019-05-10T14:33:54.092	0	-28.206	-27.114	-27.609	-26.54
2019-05-10T14:34:09.217	0	-27.968	-28.021	-27.129	-27.793
2019-05-10T14:34:24.355	0	-27.071	-27.577	-26.339	-27.278
2019-05-10T14:34:39.479	0	-29.101	-27.512	-28.517	-26.055
2019-05-10T14:34:54.601	0	-27.159	-26.67	-27.528	-26.219
2019-05-10T14:35:09.727	0	-27.968	-26.872	-26.845	-26.999
2019-05-10T14:35:24.851	0	-26.377	-26.136	-27.626	-26.243
2019-05-10T14:35:39.988	0	-26.489	-27.188	-28.15	-27.203

SAMPLE DATA FOR GUDU

		Frequency (Hz)			
Timestamp	Measure Unit	30000000	30050000	30100000	30150000
2019-05-06T16:19:30.273	0	-37.994	-37.302	-37.968	-38.293
2019-05-06T16:19:45.420	0	-39.366	-38.415	-39.63	-40.059
2019-05-06T16:20:00.544	0	-38.021	-38.185	-38.227	-38.007
2019-05-06T16:20:15.693	0	-38.242	-36.943	-38.327	-38.672
2019-05-06T16:20:30.822	0	-38.595	-39.533	-39.257	-38.284
2019-05-06T16:20:45.938	0	-37.735	-38.415	-38.72	-39.047
2019-05-06T16:21:01.065	0	-38.611	-38.157	-38.534	-38.241
2019-05-06T16:21:16.197	0	-38.58	-37.478	-39.151	-38.199
2019-05-06T16:21:31.354	0	-35.273	-34.325	-35.314	-35.122
2019-05-06T16:21:46.511	0	-37.981	-39.829	-38.595	-38.342
2019-05-06T16:22:01.653	0	-37.039	-38.474	-38.997	-38.549
2019-05-06T16:22:16.763	0	-38.657	-38.864	-38.429	-36.87
2019-05-06T16:22:31.905	0	-38.103	-38.27	-38.385	-38.997
2019-05-06T16:22:47.030	0	-37.214	-37.672	-37.824	-38.256
2019-05-06T16:23:02.152	0	-38.228	-38.88	-37.66	-38.227
2019-05-06T16:23:17.283	0	-38.43	-38.429	-38.848	-39.553
2019-05-06T16:23:32.404	0	-40.125	-37.798	-38.034	-38.048
2019-05-06T16:23:47.532	0	-37.889	-39.496	-38.595	-39.553
2019-05-06T16:24:02.665	0	-37.104	-37.407	-37.538	-39.221
2019-05-06T16:24:17.780	0	-37.837	-38.688	-37.862	-35.953
2019-05-06T16:24:32.889	0	-37.722	-37.431	-38.27	-37.685
2019-05-06T16:24:48.035	0	-38.415	-38.688	-37.888	-37.685
2019-05-06T16:25:03.156	0	-37.55	-38.241	-38.4	-37.954
2019-05-06T16:25:18.282	0	-38.768	-38.429	-38.284	-37.773
2019-05-06T16:25:33.417	0	-37.599	-37.967	-39.533	-37.773
2019-05-06T16:25:48.544	0	-37.735	-38.342	-38.626	-39.116

2019-05-06T16:26:03.671	0	-37.994	-39.151	-40.235	-38.657
2019-05-06T16:26:18.788	0	-37.902	-37.837	-39.384	-38.534
2019-05-06T16:26:33.915	0	-37.786	-38.444	-39.365	-38.327
2019-05-06T16:26:49.043	0	-38.103	-37.954	-38.831	-38.342
2019-05-06T16:27:04.174	0	-37.685	-37.006	-38.519	-38.549
2019-05-06T16:27:19.326	0	-36.028	-34.884	-35.445	-35.432
2019-05-06T16:27:34.452	0	-34.885	-35.105	-34.848	-35.272
2019-05-06T16:27:49.611	0	-37.092	-38.847	-38.363	-38.438
2019-05-06T16:28:04.747	0	-38.848	-37.995	-38.022	-37.915
2019-05-06T16:28:19.879	0	-37.249	-39.825	-38.606	-39.506
2019-05-06T16:28:34.997	0	-39.138	-38.077	-38.438	-38.591
2019-05-06T16:28:50.123	0	-37.888	-38.363	-38.733	-38.423
2019-05-06T16:29:05.266	0	-37.644	-38.147	-38.276	-37.581
2019-05-06T16:29:20.372	0	-38.453	-38.204	-36.652	-38.814
2019-05-06T16:29:35.542	0	-35.969	-36.332	-35.937	-36.71
2019-05-06T16:29:50.708	0	-38.659	-39.208	-38.686	-39.068
2019-05-06T16:30:05.823	0	-38.297	-40.103	-38.348	-40.364
2019-05-06T16:30:20.959	0	-38.362	-38.829	-38.888	-37.533
2019-05-06T16:30:36.097	0	-38.133	-38.348	-37.653	-37.788
2019-05-06T16:30:51.215	0	-38.631	-37.709	-38.195	-38.388
2019-05-06T16:31:06.371	0	-36.2	-36.231	-35.974	-36.2
2019-05-06T16:31:21.502	0	-36.69	-36.537	-36.293	-36.958
2019-05-06T16:31:36.628	0	-36.154	-35.649	-35.974	-35.773
2019-05-06T16:31:51.747	0	-36.488	-35.398	-35.872	-35.787
2019-05-06T16:32:06.873	0	-36.656	-35.676	-35.475	-35.959
2019-05-06T16:32:22.008	0	-36.94	-35.221	-36.921	-35.581
2019-05-06T16:32:37.139	0	-36.294	-36.231	-37.204	-35.988
2019-05-06T16:32:52.263	0	-35.622	-36.587	-34.855	-36.154
2019-05-06T16:33:07.430	0	-60.306	-61.845	-62.148	-59.973
2019-05-06T16:33:22.577	0	-38.489	-37.522	-38.09	-38.996
2019-05-06T16:33:37.716	0	-37.247	-37.83	-38.458	-37.951
2019-05-06T16:33:52.826	0	-38.979	-38.09	-38.458	-37.132
2019-05-06T16:34:07.960	0	-37.938	-37.843	-38.678	-37.777
2019-05-06T16:34:23.096	0	-38.292	-36.1	-37.485	-38.535
2019-05-06T16:34:38.219	0	-37.83	-39.155	-38.322	-37.247
2019-05-06T16:34:53.373	0	-34.426	-34.388	-34.703	-34.676
2019-05-06T16:35:08.539	0	-37.979	-38.097	-38.157	-38.157
2019-05-06T16:35:23.654	0	-39.302	-38.234	-38.188	-37.92
2019-05-06T16:35:38.800	0	-38.886	-37.614	-37.468	-37.949
2019-05-06T16:35:53.917	0	-38.235	-36.707	-37.993	-38.344
2019-05-06T16:36:09.044	0	-37.328	-36.599	-38.052	-37.521
2019-05-06T16:36:24.169	0	-38.54	-37.835	-39.873	-39.07

2019-05-06T16:36:39.285	0	-37.095	-38.097	-38.082	-38.173
2019-05-06T16:36:54.419	0	-37.107	-36.989	-37.378	-37.095
2019-05-06T16:37:09.548	0	-38.393	-38.658	-38.127	-37.723
2019-05-06T16:37:24.676	0	-38.458	-37.654	-37.56	-38.408
2019-05-06T16:37:39.796	0	-38.507	-37.764	-37.764	-36.897
2019-05-06T16:37:54.919	0	-38.441	-37.468	-37.253	-37.641
2019-05-06T16:38:10.062	0	-37.614	-37.993	-38.641	-37.241
2019-05-06T16:38:25.184	0	-38.112	-37.682	-37.534	-37.241
2019-05-06T16:38:40.307	0	-37.548	-37.534	-37.366	-39.301
2019-05-06T16:38:55.429	0	-36.382	-36.773	-38.188	-38.523
2019-05-06T16:39:10.560	0	-36.84	-37.468	-38.904	-38.203
2019-05-06T16:39:25.688	0	-37.001	-37.654	-38.376	-37.92
2019-05-06T16:39:40.812	0	-36.74	-38.49	-37.978	-38.281
2019-05-06T16:39:55.937	0	-36.897	-37.353	-38.425	-38.49
2019-05-06T16:40:11.059	0	-37.366	-38.173	-37.216	-36.412
2019-05-06T16:40:26.296	0	-37.072	-38.067	-38.112	-37.641
2019-05-06T16:40:41.320	0	-37.696	-38.188	-38.037	-37.949
2019-05-06T16:40:56.441	0	-38.762	-36.806	-36.331	-38.556
2019-05-06T16:41:11.573	0	-37.723	-37.906	-37.764	-36.06
2019-05-06T16:41:26.694	0	-37.849	-37.417	-38.127	-37.764
2019-05-06T16:41:41.809	0	-37.641	-37.378	-37.495	-36.718
2019-05-06T16:41:56.947	0	-36.852	-37.378	-38.675	-37.191
2019-05-06T16:42:12.076	0	-37.131	-37.737	-40.081	-37.682
2019-05-06T16:42:27.195	0	-37.001	-38.392	-37.978	-37.481
2019-05-06T16:42:42.327	0	-36.464	-36.653	-37.627	-38.85
2019-05-06T16:42:57.450	0	-38.393	-38.922	-37.216	-37.682
2019-05-06T16:43:12.577	0	-37.303	-38.624	-38.641	-38.234
2019-05-06T16:43:27.704	0	-37.107	-36.291	-37.6	-37.353
2019-05-06T16:43:42.831	0	-37.119	-36.484	-37.179	-39.422
2019-05-06T16:43:57.947	0	-37.614	-37.641	-37.167	-37.778
2019-05-06T16:44:13.073	0	-36.536	-37.521	-38.142	-38.658
2019-05-06T16:44:28.196	0	-38.158	-38.573	-38.59	-38.142
2019-05-06T16:44:43.330	0	-38.675	-36.863	-38.313	-37.131
2019-05-06T16:44:58.449	0	-37.807	-38.082	-38.573	-38.658
2019-05-06T16:45:13.581	0	-37.291	-37.191	-37.43	-37.071
2019-05-06T16:45:28.699	0	-38.297	-38.344	-36.863	-37.82
2019-05-06T16:45:43.857	0	-33.957	-35.239	-35.157	-34.53
2019-05-06T16:45:59.017	0	-38.408	-39.431	-39.834	-38.481
2019-05-06T16:46:14.134	0	-38.996	-38.224	-38.033	-38.437
2019-05-06T16:46:29.267	0	-37.052	-39.287	-38.898	-39.735
2019-05-06T16:46:44.392	0	-39.581	-38.393	-38.451	-38.251
2019-05-06T16:46:59.783	0	-38.061	-39.029	-38.279	-38.168

2019-05-06T16:47:14.639	0	-38.963	-37.677	-38.754	-39.977
2019-05-06T16:47:29.805	0	-61.418	-61.479	-60.974	-61.981
2019-05-06T16:47:45.292	0	-39.116	-38.185	-36.708	-38.72
2019-05-06T16:48:00.133	0	-35.678	-35.662	-36.508	-35.363
2019-05-06T16:48:15.260	0	-37.698	-34.844	-34.955	-35.349
2019-05-06T16:48:30.375	0	-35.752	-35.737	-36	-35.363
2019-05-06T16:48:45.503	0	-35.937	-34.807	-36.384	-35.517
2019-05-06T16:49:00.631	0	-35.006	-37.042	-36.384	-35.89
2019-05-06T16:49:15.765	0	-36.147	-36.016	-34.314	-34.856
2019-05-06T16:49:30.904	0	-35.044	-35.692	-35.418	-35.108
2019-05-06T16:49:46.048	0	-41.078	-40.206	-39.632	-41.114
2019-05-06T16:50:01.185	0	-39.937	-41.007	-40.604	-40.416
2019-05-06T16:50:16.341	0	-38.038	-37.885	-38.398	-38.143
2019-05-06T16:50:31.485	0	-36.657	-37.852	-37.107	-35.928
2019-05-06T16:50:46.593	0	-37.61	-37.051	-37.121	-37.902
2019-05-06T16:51:01.732	0	-36.772	-36.889	-37.336	-37.038
2019-05-06T16:51:16.841	0	-36.249	-36.81	-38.161	-36.606
2019-05-06T16:51:31.985	0	-37.093	-37.366	-37.441	-36.956
2019-05-06T16:51:47.105	0	-37.178	-38.196	-37.657	-36.435
2019-05-06T16:52:02.232	0	-36.903	-36.997	-37.051	-37.426
2019-05-06T16:52:17.359	0	-38.552	-37.532	-38.361	-36.619
2019-05-06T16:52:32.494	0	-37.563	-37.563	-36.364	-36.669
2019-05-06T16:52:47.613	0	-36.657	-39.579	-37.471	-37.737
2019-05-06T16:53:02.734	0	-37.502	-37.579	-35.74	-36.52
2019-05-06T16:53:17.868	0	-36.069	-36.771	-36.594	-36.81
2019-05-06T16:53:33.001	0	-35.436	-37.673	-36.745	-36.771
2019-05-06T16:53:48.125	0	-36.695	-37.441	-37.902	-37.641
2019-05-06T16:54:03.255	0	-36.746	-37.249	-36.72	-37.426
2019-05-06T16:54:18.383	0	-38.021	-37.038	-36.376	-37.441
2019-05-06T16:54:33.515	0	-36.772	-36.823	-37.547	-37.517
2019-05-06T16:54:48.638	0	-37.471	-37.22	-38.055	-37.456
2019-05-06T16:55:03.764	0	-37.411	-38.361	-39.068	-36.771
2019-05-06T16:55:18.885	0	-38.591	-37.411	-37.322	-38.571
2019-05-06T16:55:34.026	0	-37.987	-37.819	-36.557	-35.992
2019-05-06T16:55:49.189	0	-61.111	-60.809	-62.474	-61.548
2019-05-06T16:56:04.344	0	-38.28	-36.559	-37.606	-38.372
2019-05-06T16:56:19.475	0	-38.988	-39.419	-37.986	-38.562
2019-05-06T16:56:34.606	0	-38.372	-37.503	-38.387	-37.711
2019-05-06T16:56:49.734	0	-39.4	-37.091	-38.387	-38.744
2019-05-06T16:57:04.860	0	-38.546	-37.86	-38.418	-38.899
2019-05-06T16:57:19.997	0	-38.466	-38.015	-37.138	-37.86
2019-05-06T16:57:35.125	0	-37	-38.899	-36.844	-36.844

2019-05-06T16:57:50.248	0	-38.265	-38.969	-39.059	-38.864
2019-05-06T16:58:05.374	0	-39.17	-37.751	-37.658	-36.652
2019-05-06T16:58:20.508	0	-37.645	-38.881	-39.023	-38.31
2019-05-06T16:58:35.638	0	-37.619	-38.175	-39.283	-38.029
2019-05-06T16:58:50.757	0	-39.499	-38.45	-37.685	-38.341
2019-05-06T16:59:05.881	0	-38.644	-39.264	-38.934	-39.096
2019-05-06T16:59:21.014	0	-37.012	-38.847	-39.114	-38.727
2019-05-06T16:59:36.148	0	-38.546	-38.175	-38.498	-37.724
2019-05-06T16:59:51.307	0	-61.815	-60.561	-62.034	-60.713
2019-05-06T17:00:06.466	0	-38.7	-37.389	-37.536	-38.087
2019-05-06T17:00:21.597	0	-37.774	-37.285	-37.208	-39.31
2019-05-06T17:00:36.727	0	-38.118	-38.041	-38.196	-38.7
2019-05-06T17:00:51.856	0	-37.876	-37.802	-37.98	-37.618
2019-05-06T17:01:06.981	0	-38.63	-38.18	-38.149	-37.121
2019-05-06T17:01:22.118	0	-37.221	-37.536	-37.509	-38.919
2019-05-06T17:01:37.248	0	-36.951	-38.525	-37.935	-37.759
2019-05-06T17:01:52.370	0	-38.492	-38.79	-36.868	-38.882
2019-05-06T17:02:07.498	0	-38.665	-37.158	-37.549	-37.632
2019-05-06T17:02:22.612	0	-37.935	-38.341	-36.81	-37.577
2019-05-06T17:02:37.735	0	-38.543	-37.702	-37.084	-37.832
2019-05-06T17:02:52.877	0	-38.665	-38.629	-38.102	-36.915
2019-05-06T17:03:08.000	0	-37.92	-38.228	-38.01	-37.935
2019-05-06T17:03:23.128	0	-38.293	-38.358	-37.688	-37.536
2019-05-06T17:03:38.245	0	-38.118	-38.01	-37.563	-37.95
2019-05-06T17:03:53.375	0	-37.95	-37.702	-38.994	-37.716
2019-05-06T17:04:08.505	0	-38.665	-36.81	-36.478	-36.022
2019-05-06T17:04:23.640	0	-37.935	-37.336	-38.087	-38.718
2019-05-06T17:04:38.761	0	-37.95	-37.522	-39.855	-37.875
2019-05-06T17:04:53.898	0	-40.426	-38.994	-37.442	-37.108
2019-05-06T17:05:09.032	0	-37.285	-37.158	-39.052	-37.31
2019-05-06T17:05:24.151	0	-37.133	-37.66	-37.233	-38.994
2019-05-06T17:05:39.280	0	-37.389	-37.674	-37.788	-38.577
2019-05-06T17:05:54.405	0	-37.234	-38.341	-37.442	-36.209
2019-05-06T17:06:09.532	0	-37.109	-38.244	-38.424	-37.108
2019-05-06T17:06:24.692	0	-33.616	-35.046	-33.149	-34.601
2019-05-06T17:06:39.861	0	-38.169	-36.524	-39.048	-38.833
2019-05-06T17:06:54.978	0	-37.794	-38.644	-38.244	-37.386
2019-05-06T17:07:10.120	0	-36.867	-38.02	-37.19	-37.864
2019-05-06T17:07:25.245	0	-39.681	-37.672	-37.892	-37.991
2019-05-06T17:07:40.373	0	-38.353	-37.605	-38.496	-37.475
2019-05-06T17:07:55.501	0	-38.109	-39.048	-38.763	-37.553
2019-05-06T17:08:10.627	0	-37.85	-37.287	-37.934	-37.991

2019-05-06T17:08:25.765	0	-38.781	-37.808	-36.968	-37.906
2019-05-06T17:08:40.900	0	-37.037	-38.833	-38.094	-37.822
2019-05-06T17:08:56.017	0	-38.021	-38.183	-37.878	-38.094
2019-05-06T17:09:11.192	0	-36.665	-34.633	-34.923	-36.704
2019-05-06T17:09:26.310	0	-35.755	-36.364	-33.713	-35.192
2019-05-06T17:09:41.436	0	-36.704	-33.833	-35.676	-37.547
2019-05-06T17:09:56.623	0	-36.151	-35.882	-34.949	-35.818
2019-05-06T17:10:11.688	0	-35.818	-35.22	-33.539	-35.66
2019-05-06T17:10:26.862	0	-38.45	-38.234	-38.611	-38.795
2019-05-06T17:10:42.009	0	-34.166	-35.162	-34.178	-35.162
2019-05-06T17:10:57.174	0	-37.135	-37.68	-38.953	-38.388
2019-05-06T17:11:12.298	0	-37.412	-39.319	-38.915	-38.287
2019-05-06T17:11:27.423	0	-37.199	-40.081	-37.797	-37.134
2019-05-06T17:11:42.556	0	-38.388	-37.858	-37.783	-37.358
2019-05-06T17:11:57.683	0	-37.873	-36.861	-38.838	-38.027
2019-05-06T17:12:12.810	0	-36.696	-37.134	-37.888	-37.622
2019-05-06T17:12:27.927	0	-38.527	-39.361	-38.545	-37.238
2019-05-06T17:12:43.060	0	-37.651	-37.537	-36.65	-38.744
2019-05-06T17:12:58.189	0	-37.199	-37.186	-38.58	-37.68
2019-05-06T17:13:13.310	0	-39.052	-37.033	-37.842	-37.694
2019-05-06T17:13:28.430	0	-37.551	-38.527	-36.802	-37.827
2019-05-06T17:13:43.567	0	-37.481	-36.492	-37.426	-37.412
2019-05-06T17:13:58.680	0	-37.173	-38.22	-37.096	-38.763
2019-05-06T17:14:13.816	0	-36.898	-38.744	-38.509	-36.696
2019-05-06T17:14:28.952	0	-36.947	-38.107	-37.291	-37.071
2019-05-06T17:14:44.078	0	-38.689	-38.091	-37.537	-38.22
2019-05-06T17:14:59.197	0	-36.922	-36.639	-38.253	-37.291
2019-05-06T17:15:14.324	0	-38.304	-37.481	-38.562	-37.147
2019-05-06T17:15:29.463	0	-38.254	-37.858	-37.903	-37.398
2019-05-06T17:15:44.571	0	-37.965	-37.371	-37.996	-36.708
2019-05-06T17:15:59.709	0	-36.708	-37.842	-37.083	-37.509
2019-05-06T17:16:14.842	0	-37.238	-38.8	-37.827	-37.238
2019-05-06T17:16:29.964	0	-36.204	-36.754	-39.361	-37.812
2019-05-06T17:16:45.082	0	-38.091	-36.885	-38.527	-36.071
2019-05-06T17:17:00.223	0	-37.467	-38.075	-37.858	-37.467
2019-05-06T17:17:15.341	0	-36.471	-37.98	-37.212	-37.768
2019-05-06T17:17:30.469	0	-38.188	-37.965	-39.277	-37.783
2019-05-06T17:17:45.581	0	-37.828	-37.453	-39.404	-38.337
2019-05-06T17:18:00.718	0	-38.993	-38.405	-37.709	-38.545
2019-05-06T17:18:15.856	0	-37.009	-38.545	-38.337	-39.052
2019-05-06T17:18:30.966	0	-39.112	-38.707	-37.694	-37.723
2019-05-06T17:18:46.094	0	-38.726	-38.509	-37.199	-38.059

2019-05-06T17:19:01.220	0	-38.254	-38.027	-36.885	-38.838
2019-05-06T17:19:16.357	0	-37.278	-36.959	-39.032	-37.412
2019-05-06T17:19:31.484	0	-38.123	-38.58	-38.253	-38.652
2019-05-06T17:19:46.603	0	-38.321	-37.651	-37.495	-37.858
2019-05-06T17:20:01.742	0	-36.766	-36.861	-38.44	-38.707
2019-05-06T17:20:16.863	0	-36.685	-37.827	-38.354	-36.885
2019-05-06T17:20:31.999	0	-37.695	-37.827	-37.278	-39.012
2019-05-06T17:20:47.123	0	-37.651	-37.122	-36.922	-37.16
2019-05-06T17:21:02.251	0	-37.426	-37.903	-37.753	-37.873
2019-05-06T17:21:17.385	0	-37.345	-37.439	-37.278	-37.723
2019-05-06T17:21:32.498	0	-37.828	-37.109	-38.27	-37.579
2019-05-06T17:21:47.639	0	-38.954	-36.754	-39.032	-37.934
2019-05-06T17:22:02.766	0	-37.58	-38.634	-37.071	-38.139
2019-05-06T17:22:17.888	0	-37.551	-36.971	-38.171	-37.16
2019-05-06T17:22:33.018	0	-39.86	-38.107	-37.495	-37.965
2019-05-06T17:22:48.145	0	-37.084	-38.155	-38.043	-36.47
2019-05-06T17:23:03.279	0	-38.107	-37.723	-37.291	-38.726
2019-05-06T17:23:18.392	0	-37.135	-37.694	-38.012	-36.861
2019-05-06T17:23:33.525	0	-37.059	-38.091	-37.212	-39.194
2019-05-06T17:23:48.651	0	-39.173	-37.071	-37.278	-38.598
2019-05-06T17:24:03.778	0	-37.798	-37.636	-37.173	-36.298
2019-05-06T17:24:18.894	0	-38.237	-37.134	-37.608	-36.673
2019-05-06T17:24:34.038	0	-36.85	-38.915	-37.467	-37.565
2019-05-06T17:24:49.150	0	-37.399	-36.802	-36.825	-38.139
2019-05-06T17:25:04.274	0	-38.337	-37.147	-37.965	-37.385
2019-05-06T17:25:19.403	0	-38.27	-37.186	-39.47	-38.545
2019-05-06T17:25:34.537	0	-37.594	-37.918	-37.238	-38.237
2019-05-06T17:25:49.666	0	-37.934	-38.671	-36.743	-36.885
2019-05-06T17:26:04.782	0	-37.318	-38.171	-36.743	-38.188
2019-05-06T17:26:19.919	0	-38.801	-37.593	-37.738	-38.652
2019-05-06T17:26:35.047	0	-37.695	-38.895	-37.439	-38.107
2019-05-06T17:26:50.175	0	-38.763	-37.278	-36.959	-37.439
2019-05-06T17:27:05.295	0	-37.68	-36.983	-36.235	-37.812
2019-05-06T17:27:20.422	0	-38.671	-36.051	-37.371	-38.27
2019-05-06T17:27:35.547	0	-37.709	-37.225	-37.467	-37.412
2019-05-06T17:27:50.681	0	-38.934	-37.186	-38.171	-37.058
2019-05-06T17:28:05.809	0	-37.16	-36.983	-36.861	-37.903
2019-05-06T17:28:20.930	0	-37.594	-38.819	-37.622	-38.027
2019-05-06T17:28:36.062	0	-38.838	-37.873	-37.173	-37.439
2019-05-06T17:28:51.193	0	-36.504	-36.885	-38.616	-37.622
2019-05-06T17:29:06.317	0	-36.984	-36.582	-36.754	-37.495
2019-05-06T17:29:21.440	0	-36.996	-38.091	-37.008	-38.474

2019-05-06T17:29:36.561	0	-38.254	-38.287	-37.665	-38.545
2019-05-06T17:29:51.701	0	-39.133	-38.895	-38.043	-37.919
2019-05-06T17:30:06.830	0	-37.44	-37.304	-37.371	-37.412
2019-05-06T17:30:21.962	0	-37.828	-37.398	-38.934	-38.652
2019-05-06T17:30:37.073	0	-37.495	-37.565	-36.873	-37.058
2019-05-06T17:30:52.203	0	-37.009	-36.319	-36.309	-37.358
2019-05-06T17:31:07.339	0	-37.934	-38.107	-37.783	-37.919
2019-05-06T17:31:22.464	0	-37.622	-37.738	-38.838	-40.288
2019-05-06T17:31:37.579	0	-37.096	-38.107	-37.509	-36.983
2019-05-06T17:31:52.706	0	-38.44	-38.075	-37.453	-38.075
2019-05-06T17:32:07.830	0	-39.013	-39.981	-37.996	-38.043
2019-05-06T17:32:22.963	0	-37.238	-37.122	-38.155	-36.861
2019-05-06T17:32:38.097	0	-37.021	-37.918	-39.032	-38.237
2019-05-06T17:32:53.218	0	-38.123	-37.651	-37.398	-38.934
2019-05-06T17:33:08.350	0	-37.537	-38.689	-37.426	-37.753
2019-05-06T17:33:23.479	0	-37.412	-38.188	-37.98	-36.319
2019-05-06T17:33:38.605	0	-37.238	-38.422	-38.838	-36.548
2019-05-06T17:33:53.732	0	-36.766	-37.371	-36.57	-38.598
2019-05-06T17:34:08.852	0	-38.012	-38.598	-39.932	-37.636
2019-05-06T17:34:23.991	0	-37.059	-37.033	-37.495	-38.616
2019-05-06T17:34:39.108	0	-36.802	-37.021	-36.983	-38.509
2019-05-06T17:34:54.248	0	-38.091	-37.238	-38.303	-37.551
2019-05-06T17:35:09.357	0	-37.68	-38.091	-38.895	-37.738
2019-05-06T17:35:24.498	0	-37.68	-37.304	-38.819	-38.405
2019-05-06T17:35:39.619	0	-37.919	-37.68	-38.043	-36.194
2019-05-06T17:35:54.750	0	-36.755	-37.033	-38.634	-38.22
2019-05-06T17:36:09.869	0	-37.68	-37.551	-36.983	-37.873
2019-05-06T17:36:25.005	0	-37.904	-38.303	-36.873	-38.474
2019-05-06T17:36:40.138	0	-38.012	-38.123	-37.965	-37.934
2019-05-06T17:36:55.248	0	-37.768	-38.58	-37.467	-36.873
2019-05-06T17:37:10.389	0	-37.345	-38.155	-38.139	-36.849
2019-05-06T17:37:25.508	0	-37.843	-37.812	-37.651	-39.361
2019-05-06T17:37:40.635	0	-37.454	-38.188	-37.738	-37.636
2019-05-06T17:37:55.764	0	-37.58	-36.813	-37.147	-38.253
2019-05-06T17:38:10.885	0	-37.495	-36.91	-38.915	-37.509
2019-05-06T17:38:26.025	0	-38.406	-38.012	-38.726	-37.304
2019-05-06T17:38:41.154	0	-37.58	-37.753	-37.996	-37.385
2019-05-06T17:38:56.282	0	-37.981	-37.509	-38.337	-38.253
2019-05-06T17:39:11.413	0	-37.173	-37.251	-37.083	-37.888
2019-05-06T17:39:26.528	0	-37.739	-36.33	-38.107	-38.457
2019-05-06T17:39:41.656	0	-36.947	-37.238	-36.731	-37.331
2019-05-06T17:39:56.786	0	-37.021	-37.723	-37.453	-37.636

2019-05-06T17:40:11.912	0	-39.86	-38.337	-38.371	-37.371
2019-05-06T17:40:27.042	0	-35.895	-36.627	-37.467	-37.812
2019-05-06T17:40:42.153	0	-38.028	-37.651	-36.802	-38.107
2019-05-06T17:40:57.292	0	-37.981	-37.495	-38.545	-38.354
2019-05-06T17:41:12.408	0	-36.743	-36.898	-38.616	-38.107
2019-05-06T17:41:27.556	0	-37.467	-37.453	-38.155	-37.723
2019-05-06T17:41:42.701	0	-39.829	-39.738	-39.65	-40.472
2019-05-06T17:41:57.843	0	-40.867	-41.337	-39.842	-40.353
2019-05-06T17:42:12.964	0	-40.503	-40.266	-41.337	-40.237
2019-05-06T17:42:28.128	0	-37.495	-37.304	-38.123	-37.636
2019-05-06T17:42:43.258	0	-37.695	-37.651	-38.634	-38.973
2019-05-06T17:42:58.385	0	-37.637	-36.813	-37.651	-39.404
2019-05-06T17:43:13.500	0	-36.341	-36.849	-37.565	-37.291
2019-05-06T17:43:28.637	0	-36.56	-38.075	-37.371	-37.738
2019-05-06T17:43:43.772	0	-38.527	-38.091	-37.537	-38.527
2019-05-06T17:43:58.895	0	-36.639	-38.075	-37.398	-38.155
2019-05-06T17:44:14.025	0	-39.559	-37.579	-36.383	-38.139
2019-05-06T17:44:29.149	0	-38.204	-37.398	-38.58	-38.562
2019-05-06T17:44:44.283	0	-37.934	-38.388	-37.812	-37.412
2019-05-06T17:44:59.438	0	-35.476	-34.312	-33.943	-33.55
2019-05-06T17:45:14.591	0	-37.817	-38.612	-37.133	-38.919
2019-05-06T17:45:29.723	0	-39.15	-37.221	-38.441	-38.325
2019-05-06T17:45:44.861	0	-37.55	-37.272	-37.442	-37.89
2019-05-06T17:45:59.984	0	-37.121	-37.774	-38.424	-39.11
2019-05-06T17:46:15.165	0	-60.069	-61.56	-60.057	-60.663
2019-05-06T17:46:30.310	0	-38.696	-37.521	-36.911	-38.199
2019-05-06T17:46:45.437	0	-37.2	-38.643	-38.524	-38.342
2019-05-06T17:47:00.576	0	-39.853	-36.587	-38.44	-37.077
2019-05-06T17:47:15.699	0	-37.927	-38.358	-39.255	-36.619
2019-05-06T17:47:30.814	0	-37.249	-37.224	-37.643	-37.754
2019-05-06T17:47:45.940	0	-38.874	-37.494	-37.869	-40.793
2019-05-06T17:48:01.070	0	-37.883	-39.586	-37.629	-38.929
2019-05-06T17:48:16.184	0	-37.364	-38.199	-38.73	-37.869
2019-05-06T17:48:31.317	0	-37.053	-38.122	-37.927	-38.407
2019-05-06T17:48:46.448	0	-39.256	-37.224	-38.153	-37.629
2019-05-06T17:49:01.570	0	-37.575	-38.391	-38.184	-37.768
2019-05-06T17:49:16.702	0	-37.053	-38.424	-39.522	-37.74
2019-05-06T17:49:31.837	0	-37.15	-37.548	-36.356	-37.797
2019-05-06T17:49:46.966	0	-38.802	-37.508	-39.255	-36.523
2019-05-06T17:50:02.081	0	-37.562	-37.643	-37.84	-40.111
2019-05-06T17:50:17.253	0	-36.356	-35.86	-34.838	-35
2019-05-06T17:50:32.372	0	-35.762	-34.945	-35.356	-34.57

2019-05-06T17:50:47.532	0	-38.181	-36.81	-36.531	-37.145
2019-05-06T17:51:02.665	0	-36.742	-36.719	-37.846	-38.956
2019-05-06T17:51:17.779	0	-36.904	-38.165	-37.428	-38.133
2019-05-06T17:51:32.916	0	-38.277	-37.522	-38.118	-39.071
2019-05-06T17:51:48.037	0	-37.469	-37.285	-38.441	-38.087
2019-05-06T17:52:03.179	0	-37.674	-37.92	-37.023	-38.26
2019-05-06T17:52:18.310	0	-37.298	-38.228	-37.389	-36.939
2019-05-06T17:52:33.429	0	-37.402	-37.861	-37.17	-38.196
2019-05-06T17:52:48.549	0	-38.087	-37.011	-36.927	-36.531
2019-05-06T17:53:03.684	0	-37.536	-37.935	-38.808	-37.442
2019-05-06T17:53:18.827	0	-35.928	-37.495	-38.612	-37.196
2019-05-06T17:53:33.949	0	-39.014	-38.309	-37.95	-37.688
2019-05-06T17:53:49.064	0	-37.121	-39.249	-37.688	-37.495
2019-05-06T17:54:04.202	0	-35.78	-37.702	-36.404	-37.415
2019-05-06T17:54:19.339	0	-36.834	-37.618	-36.542	-37.745
2019-05-06T17:54:34.452	0	-38.01	-37.965	-38.647	-38.276
2019-05-06T17:54:49.580	0	-37.272	-40.143	-39.629	-37.442
2019-05-06T17:55:04.719	0	-37.905	-38.133	-38.149	-37.965
2019-05-06T17:55:19.843	0	-36.597	-38.26	-37.618	-37.745
2019-05-06T17:55:34.961	0	-37.817	-37.158	-38.542	-39.052
2019-05-06T17:55:50.088	0	-37.376	-38.491	-36.575	-38.087
2019-05-06T17:56:05.217	0	-37.861	-37.716	-38.736	-36.927
2019-05-06T17:56:20.336	0	-38.118	-36.799	-38.938	-36.674
2019-05-06T17:56:35.478	0	-39.719	-38.612	-38.01	-37.536
2019-05-06T17:56:50.603	0	-37.442	-37.935	-39.31	-38.26
2019-05-06T17:57:05.730	0	-39.072	-37.183	-38.056	-38.682
2019-05-06T17:57:20.871	0	-37.95	-37.402	-36.189	-38.165
2019-05-06T17:57:36.000	0	-37.745	-37.905	-37.774	-38.244
2019-05-06T17:57:51.131	0	-36.927	-37.323	-37.745	-39.809
2019-05-06T17:58:06.250	0	-37.455	-37.285	-37.336	-36.963
2019-05-06T17:58:21.370	0	-37.847	-38.041	-38.441	-37.121
2019-05-06T17:58:36.500	0	-39.014	-40.218	-39.149	-37.522
2019-05-06T17:58:51.628	0	-38.134	-38.882	-37.31	-37.563
2019-05-06T17:59:06.749	0	-37.259	-37.195	-38.358	-37.455
2019-05-06T17:59:21.890	0	-38.458	-37.259	-37.362	-36.352
2019-05-06T17:59:37.020	0	-36.834	-38.664	-37.035	-36.435
2019-05-06T17:59:52.132	0	-39.997	-37.233	-36.521	-38.612
2019-05-06T18:00:07.263	0	-37.646	-37.285	-38.424	-36.915
2019-05-06T18:00:22.400	0	-37.98	-36.915	-39.229	-37.731
2019-05-06T18:00:37.530	0	-38.197	-36.999	-38.118	-38.056
2019-05-06T18:00:52.639	0	-38.228	-38.26	-36.331	-36.209
2019-05-06T18:01:07.770	0	-37.221	-38.341	-38.374	-37.759

2019-05-06T18:01:22.899	0	-37.06	-38.26	-37.731	-37.802
2019-05-06T18:01:38.022	0	-37.861	-37.196	-38.025	-37.716
2019-05-06T18:01:53.151	0	-36.975	-38.228	-38.391	-38.826
2019-05-06T18:02:08.281	0	-39.014	-37.788	-37.375	-36.383
2019-05-06T18:02:23.415	0	-38.391	-36.575	-37.468	-38.525
2019-05-06T18:02:38.539	0	-37.591	-37.362	-38.118	-37.817
2019-05-06T18:02:53.663	0	-37.208	-37.549	-38.629	-38.041
2019-05-06T18:03:08.781	0	-37.247	-36.1	-37.145	-36.975
2019-05-06T18:03:23.924	0	-36.811	-38.863	-37.875	-38.808
2019-05-06T18:03:39.040	0	-38.938	-37.158	-37.832	-37.604
2019-05-06T18:03:54.171	0	-36.88	-37.591	-39.033	-37.233
2019-05-06T18:04:09.293	0	-36.869	-38.474	-37.702	-38.244
2019-05-06T18:04:24.431	0	-37.011	-38.56	-38.845	-37.259
2019-05-06T18:04:39.557	0	-37.084	-37.121	-39.27	-37.495
2019-05-06T18:04:54.674	0	-37.429	-37.495	-37.285	-38.391
2019-05-06T18:05:09.803	0	-37.832	-37.428	-37.646	-37.495
2019-05-06T18:05:24.925	0	-38.682	-37.415	-38.056	-39.229
2019-05-06T18:05:40.055	0	-37.591	-38.133	-36.975	-38.391
2019-05-06T18:05:55.224	0	-34.305	-34.95	-35.915	-34.595
2019-05-06T18:06:10.356	0	-35.168	-36.189	-34.304	-33.852
2019-05-06T18:06:25.508	0	-38.287	-38.353	-37.2	-38.015
2019-05-06T18:06:40.645	0	-37.465	-38.904	-39.926	-37.397
2019-05-06T18:06:55.772	0	-38.848	-38.173	-38.719	-38.237
2019-05-06T18:07:10.895	0	-37.924	-37.025	-38.629	-37.049
2019-05-06T18:07:26.055	0	-40.205	-40.721	-39.993	-40.66
2019-05-06T18:07:41.211	0	-37.519	-37.895	-36.851	-37.015
2019-05-06T18:07:56.358	0	-36.729	-36.863	-39.426	-39.165
2019-05-06T18:08:11.478	0	-37.726	-37.635	-37.321	-37.335
2019-05-06T18:08:26.610	0	-37.848	-38.841	-38.557	-37.817
2019-05-06T18:08:41.736	0	-36.082	-37.28	-36.901	-37.405
2019-05-06T18:08:56.862	0	-36.901	-37.119	-37.054	-36.284
2019-05-06T18:09:11.992	0	-36.439	-38.52	-38.744	-36.863
2019-05-06T18:09:27.113	0	-37.239	-37.695	-36.427	-37.942
2019-05-06T18:09:42.230	0	-36.622	-37.028	-37.974	-37.433
2019-05-06T18:09:57.373	0	-38.725	-36.483	-38.256	-36.461
2019-05-06T18:10:12.484	0	-36.977	-37.547	-37.606	-38.072
2019-05-06T18:10:27.611	0	-37.959	-37.895	-37.28	-37.927
2019-05-06T18:10:42.736	0	-37.239	-38.706	-38.256	-36.741
2019-05-06T18:10:57.870	0	-38.007	-39.337	-38.557	-37.621
2019-05-06T18:11:12.997	0	-36.219	-39.103	-37.377	-36.461
2019-05-06T18:11:28.124	0	-38.413	-36.587	-37.756	-38.706
2019-05-06T18:11:43.246	0	-36.814	-37.266	-38.239	-38.725

2019-05-06T18:11:58.377	0	-38.36	-38.593	-36.876	-36.03
2019-05-06T18:12:13.497	0	-37.651	-37.864	-36.669	-37.591
2019-05-06T18:12:28.635	0	-37.462	-37.145	-38.466	-37.518
2019-05-06T18:12:43.765	0	-37.787	-37.533	-36.61	-36.646
2019-05-06T18:12:58.895	0	-37.462	-37.879	-37.093	-37.577
2019-05-06T18:13:14.008	0	-37.681	-36.901	-38.154	-37.266
2019-05-06T18:13:29.135	0	-37.621	-36.989	-37.911	-37.802
2019-05-06T18:13:44.268	0	-37.548	-37.99	-37.802	-38.188
2019-05-06T18:13:59.395	0	-39.273	-38.92	-38.188	-37.756
2019-05-06T18:14:14.519	0	-39.082	-37.377	-37.266	-37.145
2019-05-06T18:14:29.655	0	-39.426	-37.974	-37.99	-37.433
2019-05-06T18:14:44.765	0	-37.577	-36.729	-38.205	-36.349
2019-05-06T18:14:59.904	0	-37.172	-36.989	-37.145	-37.942

SAMPLE DATA FOR MAITAMA

		Frequency (Hz)			
Timestamp	Measure Unit	30000000	30050000	30100000	30150000
2019-05-08T08:27:19.306	0	-36.002	-37.266	-37.327	-36.394
2019-05-08T08:27:34.432	0	-37.389	-35.912	-35.825	-35.854
2019-05-08T08:27:49.559	0	-36.17	-36.123	-35.572	-34.905
2019-05-08T08:28:04.689	0	-35.133	-37.514	-36.001	-37.186
2019-05-08T08:28:19.808	0	-37.031	-36.683	-36.427	-36.201
2019-05-08T08:28:34.938	0	-36.124	-35.753	-36.772	-35.545
2019-05-08T08:28:50.058	0	-34.088	-36.701	-35.412	-35.27
2019-05-08T08:29:05.198	0	-35.825	-35.545	-36.545	-34.612
2019-05-08T08:29:20.324	0	-35.883	-37.327	-37.127	-35.452
2019-05-08T08:29:35.445	0	-36.108	-35.912	-36.186	-35.425
2019-05-08T08:29:50.585	0	-35.6	-35.532	-36.772	-37.347
2019-05-08T08:30:05.722	0	-36.078	-36.579	-36.918	-35.854
2019-05-08T08:30:20.845	0	-36.124	-36.17	-35.739	-35.157
2019-05-08T08:30:35.981	0	-35.782	-36.154	-36.918	-36.511
2019-05-08T08:30:51.116	0	-35.768	-36.201	-36.937	-36.494
2019-05-08T08:31:06.256	0	-36.428	-35.81	-36.281	-36.477
2019-05-08T08:31:21.380	0	-35.22	-35.883	-36.845	-36.528
2019-05-08T08:31:36.512	0	-36.186	-35.257	-35.697	-35.711
2019-05-08T08:31:51.638	0	-36.773	-35.614	-35.81	-34.964
2019-05-08T08:32:06.782	0	-34.317	-35.711	-35.145	-36.297
2019-05-08T08:32:21.940	0	-57.672	-56.368	-57.635	-56.274
2019-05-08T08:32:37.102	0	-35.695	-35.275	-35.499	-34.971
2019-05-08T08:32:52.222	0	-37.826	-36.057	-35.735	-36.342
2019-05-08T08:33:07.354	0	-35.324	-36.765	-35.776	-36.086
2019-05-08T08:33:22.490	0	-35.971	-37.35	-35.324	-36.631
2019-05-08T08:33:37.611	0	-36.501	-36.13	-35.9	-37.449

2019-05-08T08:33:52.734	0	-35.551	-35.461	-36.13	-36.631
2019-05-08T08:34:07.874	0	-35.538	-35.602	-35.776	-36.358
2019-05-08T08:34:22.995	0	-35.179	-36.647	-37.739	-36.852
2019-05-08T08:34:38.133	0	-36.835	-36.205	-35.957	-36.175
2019-05-08T08:34:53.255	0	-35.551	-35.629	-36.101	-35.9
2019-05-08T08:35:08.379	0	-36.146	-36.043	-35.928	-36.631
2019-05-08T08:35:23.503	0	-36.101	-37.39	-37.048	-35.655
2019-05-08T08:35:38.641	0	-36.766	-35.942	-36.452	-36.698
2019-05-08T08:35:53.765	0	-35.324	-36.175	-36.311	-36.296
2019-05-08T08:36:08.887	0	-34.881	-36.175	-35.12	-36.715
2019-05-08T08:36:24.010	0	-35.776	-35.722	-36.922	-34.196
2019-05-08T08:36:39.147	0	-35.986	-35.589	-36.783	-36.296
2019-05-08T08:36:54.293	0	-36.533	-35.942	-35.629	-35.499
2019-05-08T08:37:09.415	0	-36.631	-35.361	-38.142	-35.275
2019-05-08T08:37:24.549	0	-36.582	-36.043	-36.681	-36.311
2019-05-08T08:37:39.678	0	-36.681	-35.845	-37.311	-35.971
2019-05-08T08:37:54.808	0	-36.405	-35.858	-37.39	-36.484
2019-05-08T08:38:09.931	0	-36.146	-36.817	-36.869	-37.936
2019-05-08T08:38:25.052	0	-36.958	-36.8	-37.847	-37.654
2019-05-08T08:38:40.192	0	-37.141	-35.682	-37.03	-35.589
2019-05-08T08:38:55.316	0	-35.156	-36.698	-36.468	-36.614
2019-05-08T08:39:10.439	0	-35.749	-36.014	-36.175	-36.389
2019-05-08T08:39:25.560	0	-35.386	-35.914	-35.845	-37.103
2019-05-08T08:39:40.685	0	-35.629	-34.815	-35.263	-36.014
2019-05-08T08:39:55.823	0	-35.804	-35.942	-37.085	-35.858
2019-05-08T08:40:10.947	0	-35.474	-35.776	-36.436	-35.817
2019-05-08T08:40:26.075	0	-35.986	-34.914	-35.858	-37.048
2019-05-08T08:40:41.205	0	-35.074	-36.436	-35.957	-36.817
2019-05-08T08:40:56.332	0	-36.698	-37.804	-36.25	-36.698
2019-05-08T08:41:11.475	0	-34.52	-35.629	-36.421	-36.8
2019-05-08T08:41:26.605	0	-35.971	-35.803	-38.142	-35.299
2019-05-08T08:41:41.721	0	-36.058	-36.421	-35.928	-36.421
2019-05-08T08:41:56.854	0	-35.79	-35.215	-36.311	-35.629
2019-05-08T08:42:11.976	0	-36.732	-35.803	-35.538	-36.205
2019-05-08T08:42:27.099	0	-36.296	-37.254	-35.803	-36.631
2019-05-08T08:42:42.252	0	-35.873	-35.776	-37.085	-36.028
2019-05-08T08:42:57.374	0	-37.292	-36.817	-35.668	-36.532
2019-05-08T08:43:12.513	0	-36.598	-36.631	-35.474	-35.655
2019-05-08T08:43:27.637	0	-34.634	-35.062	-35.762	-35.05
2019-05-08T08:43:42.761	0	-34.87	-36.389	-36.057	-37.612
2019-05-08T08:43:57.900	0	-35.695	-35.275	-34.848	-36.549
2019-05-08T08:44:13.021	0	-35.577	-36.731	-36.565	-36.057

2019-05-08T08:44:28.159	0	-35.873	-37.14	-37.159	-36.405
2019-05-08T08:44:43.284	0	-36.374	-35.525	-36.327	-37.178
2019-05-08T08:44:58.424	0	-35.629	-36.19	-36.5	-35.227
2019-05-08T08:45:13.546	0	-36.681	-36.516	-36.887	-35.576
2019-05-08T08:45:28.670	0	-36.501	-35.655	-37.122	-36.373
2019-05-08T08:45:43.794	0	-36.389	-36.086	-35.886	-36.405
2019-05-08T08:45:58.930	0	-36.665	-37.409	-36.565	-35.474
2019-05-08T08:46:14.053	0	-35.487	-35.735	-34.959	-39.478
2019-05-08T08:46:29.191	0	-35.487	-35.999	-35.132	-35.263
2019-05-08T08:46:44.313	0	-36.251	-37.489	-36.028	-35.275
2019-05-08T08:46:59.439	0	-37.51	-36.389	-36.715	-36.25
2019-05-08T08:47:14.576	0	-35.957	-36.421	-35.682	-35.324
2019-05-08T08:47:29.699	0	-35.499	-36.664	-36.13	-37.066
2019-05-08T08:47:44.837	0	-36.631	-35.776	-37.76	-35.132
2019-05-08T08:47:59.960	0	-37.012	-35.999	-35.914	-36.358
2019-05-08T08:48:15.084	0	-37.676	-36.817	-36.731	-35.942
2019-05-08T08:48:30.207	0	-36.501	-35.942	-35.312	-35.886
2019-05-08T08:48:45.346	0	-37.067	-36.664	-36.101	-35.735
2019-05-08T08:49:00.470	0	-34.87	-36.014	-36.25	-35.872
2019-05-08T08:49:15.594	0	-35.736	-35.722	-35.914	-35.373
2019-05-08T08:49:30.719	0	-37.273	-35.312	-37.197	-35.602
2019-05-08T08:49:45.854	0	-35.564	-37.739	-36.043	-35.263
2019-05-08T08:50:00.978	0	-34.971	-36.205	-36.614	-35.695
2019-05-08T08:50:16.100	0	-35.499	-35.474	-37.53	-36.698
2019-05-08T08:50:31.224	0	-35.051	-37.273	-35.858	-36.101
2019-05-08T08:50:46.364	0	-35.499	-35.398	-35.682	-35.538
2019-05-08T08:51:01.502	0	-36.205	-35.461	-35.668	-36.766
2019-05-08T08:51:16.636	0	-35.656	-38.072	-36.175	-37.804
2019-05-08T08:51:31.791	0	-56.15	-57.688	-57.67	-56.763
2019-05-08T08:51:46.963	0	-35.774	-35.233	-35.311	-34.434
2019-05-08T08:52:02.126	0	-37.565	-38.843	-36.924	-38.052
2019-05-08T08:52:17.257	0	-37.051	-38.052	-36.887	-38.421
2019-05-08T08:52:32.386	0	-37.508	-36.216	-37.508	-36.133
2019-05-08T08:52:47.510	0	-37.988	-37.594	-37.756	-37.536
2019-05-08T08:53:02.636	0	-37.013	-37.025	-37.623	-38.843
2019-05-08T08:53:17.796	0	-34.59	-34.698	-35.569	-35.536
2019-05-08T08:53:32.934	0	-35.504	-35.406	-33.87	-35.988
2019-05-08T08:53:48.056	0	-35.654	-35.653	-35.67	-36.431
2019-05-08T08:54:03.191	0	-34.258	-35.952	-35.933	-35.39
2019-05-08T08:54:18.316	0	-36.044	-34.357	-34.822	-35.295
2019-05-08T08:54:33.493	0	-57.508	-56.054	-56.546	-56.254
2019-05-08T08:54:48.650	0	-35.845	-33.679	-35.776	-33.422

2019-05-08T08:55:03.793	0	-35.124	-34.403	-36.171	-34.635
2019-05-08T08:55:18.916	0	-36.152	-35.915	-34.935	-36.71
2019-05-08T08:55:34.056	0	-35.274	-35.429	-36.818	-35.674
2019-05-08T08:55:49.177	0	-33.797	-35.304	-34.742	-35.969
2019-05-08T08:56:04.304	0	-35.494	-34.329	-35.88	-34.935
2019-05-08T08:56:19.432	0	-34.244	-33.907	-34.701	-35.123
2019-05-08T08:56:34.574	0	-34.021	-35.493	-34.783	-35.065
2019-05-08T08:56:49.697	0	-34.81	-34.403	-35.674	-34.379
2019-05-08T08:57:04.815	0	-34.391	-34.556	-35.183	-35.138
2019-05-08T08:57:19.960	0	-34.544	-35.493	-35.274	-34.043
2019-05-08T08:57:35.087	0	-36.209	-36.005	-34.964	-35.413
2019-05-08T08:57:50.213	0	-35.05	-36.152	-35.827	-35.036
2019-05-08T08:58:05.341	0	-34.993	-34.715	-36.152	-35.079
2019-05-08T08:58:20.467	0	-34.442	-35.558	-35.198	-36.523
2019-05-08T08:58:35.606	0	-35.446	-34.728	-35.168	-34.582
2019-05-08T08:58:50.728	0	-35.305	-35.007	-35.382	-35.198
2019-05-08T08:59:05.866	0	-33.787	-35.657	-35.109	-35.094
2019-05-08T08:59:20.997	0	-36.668	-34.865	-34.661	-35.109
2019-05-08T08:59:36.136	0	-34.032	-35.987	-35.477	-35.183
2019-05-08T08:59:51.260	0	-35.138	-34.742	-35.243	-34.742
2019-05-08T09:00:06.394	0	-35.558	-34.742	-35.228	-34.824
2019-05-08T09:00:21.518	0	-35.898	-35.413	-35.213	-33.732
2019-05-08T09:00:36.659	0	-34.329	-36.383	-34.783	-35.366
2019-05-08T09:00:51.789	0	-34.993	-35.065	-35.707	-37.766
2019-05-08T09:01:06.918	0	-35.183	-35.461	-34.232	-36.152
2019-05-08T09:01:22.055	0	-34.978	-34.992	-35.657	-34.416
2019-05-08T09:01:37.178	0	-35.367	-34.113	-34.796	-35.591
2019-05-08T09:01:52.301	0	-35.414	-33.492	-35.525	-35.366
2019-05-08T09:02:07.423	0	-35.987	-35.493	-36.422	-34.879
2019-05-08T09:02:22.547	0	-33.998	-34.608	-34.492	-35.64
2019-05-08T09:02:37.685	0	-34.454	-35.021	-35.243	-35.707
2019-05-08T09:02:52.808	0	-34.783	-35.915	-34.009	-35.691
2019-05-08T09:03:07.978	0	-57.242	-55.434	-56.988	-56.508
2019-05-08T09:03:23.134	0	-34.615	-35.691	-35.411	-35.234
2019-05-08T09:03:38.271	0	-35.906	-35.036	-34.69	-36.503
2019-05-08T09:03:53.395	0	-36.825	-35.756	-34.627	-35.366
2019-05-08T09:04:08.517	0	-35.293	-36.561	-36.503	-35.12
2019-05-08T09:04:23.655	0	-35.457	-36.149	-35.708	-35.487
2019-05-08T09:04:38.777	0	-35.12	-35.396	-35.773	-35.991
2019-05-08T09:04:53.900	0	-34.418	-35.219	-34.678	-34.886
2019-05-08T09:05:09.039	0	-34.64	-35.078	-34.454	-35.628
2019-05-08T09:05:24.163	0	-36.026	-36.483	-34.755	-36.503

2019-05-08T09:05:39.300	0	-34.242	-36.294	-35.092	-37.357
2019-05-08T09:05:54.408	0	-34.807	-35.756	-35.503	-34.335
2019-05-08T09:06:09.547	0	-36.641	-35.94	-34.873	-35.092
2019-05-08T09:06:24.670	0	-35.472	-33.941	-32.837	-35.472
2019-05-08T09:06:39.810	0	-35.873	-34.729	-35.036	-34.82
2019-05-08T09:06:54.934	0	-35.992	-35.906	-36.061	-35.518
2019-05-08T09:07:10.071	0	-37.429	-37.017	-35.991	-36.952
2019-05-08T09:07:25.194	0	-36.079	-35.351	-33.814	-35.855
2019-05-08T09:07:40.331	0	-34.82	-37.525	-35.503	-35.756
2019-05-08T09:07:55.453	0	-34.834	-35.596	-35.806	-35.092
2019-05-08T09:08:10.591	0	-34.185	-35.205	-35.58	-34.703
2019-05-08T09:08:25.714	0	-35.036	-36.464	-35.248	-35.441
2019-05-08T09:08:40.853	0	-34.954	-34.981	-35.518	-35.773
2019-05-08T09:08:55.961	0	-34.873	-36.601	-36.113	-35.487
2019-05-08T09:09:11.101	0	-37.039	-34.358	-34.927	-36.167
2019-05-08T09:09:26.217	0	-35.322	-33.931	-34.288	-35.644
2019-05-08T09:09:41.355	0	-34.029	-35.426	-35.191	-35.691
2019-05-08T09:09:56.477	0	-34.288	-35.078	-36.721	-35.336
2019-05-08T09:10:11.616	0	-34.185	-36.701	-35.457	-34.335
2019-05-08T09:10:26.738	0	-34.847	-35.441	-35.675	-35.148
2019-05-08T09:10:41.862	0	-36.562	-35.806	-35.134	-34.716
2019-05-08T09:10:57.000	0	-34.653	-35.596	-34.347	-35.534
2019-05-08T09:11:12.171	0	-57.106	-57.897	-55.966	-56.59
2019-05-08T09:11:27.342	0	-35.564	-35.976	-35.686	-36.322
2019-05-08T09:11:42.450	0	-35.943	-35.504	-35.749	-35.781
2019-05-08T09:11:57.590	0	-33.828	-34.567	-35.894	-34.496
2019-05-08T09:12:12.714	0	-35.489	-36.18	-34.944	-36.163
2019-05-08T09:12:27.836	0	-35.174	-35.024	-35.943	-35.271
2019-05-08T09:12:42.973	0	-35.132	-34.802	-35.504	-36.198
2019-05-08T09:12:58.097	0	-34.334	-34.414	-36.45	-35.474
2019-05-08T09:13:13.235	0	-36.01	-35.894	-34.853	-36.738
2019-05-08T09:13:28.390	0	-38.804	-38.577	-38.317	-37.049
2019-05-08T09:13:43.560	0	-35.08	-35.845	-35.574	-34.755
2019-05-08T09:13:58.682	0	-35.477	-34.256	-34.196	-35.674
2019-05-08T09:14:13.853	0	-37.638	-38.386	-37.084	-37.503
2019-05-08T09:14:28.991	0	-39.172	-38.435	-38.321	-38.117
2019-05-08T09:14:44.114	0	-36.625	-38.502	-36.78	-36.86
2019-05-08T09:14:59.284	0	-34.687	-35.673	-35.587	-34.728
2019-05-08T09:15:14.455	0	-56.828	-55.168	-55.792	-55.957
2019-05-08T09:15:29.610	0	-36.259	-36.571	-35.055	-35.163
2019-05-08T09:15:44.732	0	-35.82	-34.593	-34.353	-35.322
2019-05-08T09:15:59.856	0	-35.179	-34.634	-34.818	-35.306

2019-05-08T09:16:14.993	0	-34.458	-33.615	-35.747	-34.593
2019-05-08T09:16:30.117	0	-35.488	-34.301	-35.132	-34.634
2019-05-08T09:16:45.240	0	-35.73	-34.935	-35.676	-36.444
2019-05-08T09:17:00.377	0	-34.621	-34.718	-34.789	-33.76
2019-05-08T09:17:15.533	0	-36.964	-39.306	-38.131	-37.22
2019-05-08T09:17:30.672	0	-37.913	-37.434	-37.03	-38.544
2019-05-08T09:17:45.824	0	-35.322	-34.694	-36.015	-35.735
2019-05-08T09:18:00.961	0	-34.236	-34.883	-35.404	-33.762
2019-05-08T09:18:16.114	0	-37.75	-37.253	-38.671	-36.977
2019-05-08T09:18:31.252	0	-37.154	-38.257	-38.403	-37.182
2019-05-08T09:18:46.376	0	-37.457	-36.95	-36.884	-37.929
2019-05-08T09:19:01.514	0	-38.048	-37.578	-37.457	-38.134
2019-05-08T09:19:16.652	0	-36.449	-37.578	-38.652	-37.502
2019-05-08T09:19:31.781	0	-36.264	-38.204	-37.044	-36.806
2019-05-08T09:19:46.904	0	-37.687	-37.21	-37.847	-37.126
2019-05-08T09:20:02.076	0	-57.85	-58.269	-58.315	-60.28
2019-05-08T09:20:17.231	0	-35.112	-34.893	-35.406	-34.511
2019-05-08T09:20:32.415	0	-55.712	-57.407	-57.539	-55.254
2019-05-08T09:20:47.569	0	-36.379	-35.546	-36.36	-35.096
2019-05-08T09:21:02.693	0	-35.226	-34.78	-34.847	-34.997
2019-05-08T09:21:17.825	0	-35.674	-36.265	-36.929	-35.53
2019-05-08T09:21:32.964	0	-35.773	-34.281	-34.715	-34.328
2019-05-08T09:21:48.087	0	-36.192	-34.928	-35.84	-35.3
2019-05-08T09:22:03.225	0	-34.794	-34.561	-35.315	-35.139
2019-05-08T09:22:18.365	0	-35.111	-34.956	-35.891	-36.417
2019-05-08T09:22:33.518	0	-38.25	-36.3	-38.431	-37.123
2019-05-08T09:22:48.657	0	-38.061	-36.846	-37.553	-37.664
2019-05-08T09:23:03.826	0	-34.767	-34.176	-35.241	-35.84
2019-05-08T09:23:18.951	0	-35.61	-35.562	-34.807	-33.995
2019-05-08T09:23:34.106	0	-38.011	-37.683	-37.325	-37.964
2019-05-08T09:23:49.261	0	-35.951	-35.81	-36.096	-36.152
2019-05-08T09:24:04.384	0	-37.254	-33.907	-34.317	-36.059
2019-05-08T09:24:19.522	0	-35.793	-35.607	-34.391	-35.036
2019-05-08T09:24:34.645	0	-34.454	-34.755	-35.897	-34.391
2019-05-08T09:24:49.785	0	-34.557	-34.043	-34.688	-34.22
2019-05-08T09:25:04.908	0	-35.708	-34.467	-34.317	-34.113
2019-05-08T09:25:20.046	0	-34.756	-35.64	-35.198	-35.274
2019-05-08T09:25:35.169	0	-36.627	-35.138	-35.243	-35.304
2019-05-08T09:25:50.308	0	-35.558	-34.232	-34.479	-35.258
2019-05-08T09:26:05.432	0	-36.023	-35.674	-35.183	-34.769
2019-05-08T09:26:20.603	0	-55.958	-56.918	-57.407	-57.718
2019-05-08T09:26:35.756	0	-35.327	-34.907	-34.893	-34.197

2019-05-08T09:26:50.894	0	-33.859	-34.537	-34.979	-35.187
2019-05-08T09:27:06.049	0	-37.537	-38.035	-38.149	-36.59
2019-05-08T09:27:21.220	0	-34.965	-35.142	-34.766	-34.836
2019-05-08T09:27:36.344	0	-33.262	-34.822	-34.173	-35.97
2019-05-08T09:27:51.466	0	-34.753	-34.979	-34.472	-34.282
2019-05-08T09:28:06.635	0	-39.251	-37.38	-37.733	-38.666
2019-05-08T09:28:21.774	0	-37.181	-36.714	-37.091	-37.104
2019-05-08T09:28:36.927	0	-56.691	-56.025	-57.546	-55.832
2019-05-08T09:28:52.097	0	-34.831	-36.745	-34.377	-33.935
2019-05-08T09:29:07.237	0	-34.366	-36.042	-34.527	-36.591
2019-05-08T09:29:22.345	0	-35.496	-36.177	-35.863	-36.726
2019-05-08T09:29:37.498	0	-35.254	-35.993	-36.335	-36.61
2019-05-08T09:29:52.652	0	-58.703	-59.383	-59.699	-58.568
2019-05-08T09:30:07.822	0	-35.74	-34.328	-35.11	-36.155
2019-05-08T09:30:22.945	0	-35.012	-35.499	-35.625	-34.997
2019-05-08T09:30:38.069	0	-35.806	-34.328	-35.977	-36.515
2019-05-08T09:30:53.207	0	-35.53	-36.065	-35.593	-34.888
2019-05-08T09:31:08.329	0	-36.101	-36.173	-35.641	-35.241
2019-05-08T09:31:23.468	0	-34.511	-35.11	-34.498	-35.773
2019-05-08T09:31:38.590	0	-35.125	-35.375	-35.609	-36.047
2019-05-08T09:31:53.730	0	-35.376	-34.928	-35.739	-34.586
2019-05-08T09:32:08.852	0	-34.281	-35.226	-35.483	-36.21
2019-05-08T09:32:23.977	0	-35.674	-34.624	-35.707	-33.854
2019-05-08T09:32:39.114	0	-34.874	-34.928	-34.561	-33.886
2019-05-08T09:32:54.237	0	-35.361	-35.27	-35.3	-35.315
2019-05-08T09:33:09.408	0	-56.577	-56.385	-56.062	-56.763
2019-05-08T09:33:24.579	0	-36.798	-35.281	-37.535	-35.604
2019-05-08T09:33:39.701	0	-35.566	-36.226	-36.832	-35.938
2019-05-08T09:33:54.839	0	-34.827	-36.256	-36.123	-36.316
2019-05-08T09:34:09.962	0	-35.14	-36.764	-37.244	-38.024
2019-05-08T09:34:25.139	0	-57.177	-55.502	-58.437	-56.719
2019-05-08T09:34:40.294	0	-34.334	-34.597	-35.928	-34.064
2019-05-08T09:34:55.425	0	-35.433	-35.016	-36.125	-34.931
2019-05-08T09:35:10.558	0	-35.964	-36.125	-35.264	-34.622
2019-05-08T09:35:25.677	0	-34.121	-36.906	-34.781	-34.89
2019-05-08T09:35:40.837	0	-57.241	-60.08	-58.498	-59.623
2019-05-08T09:35:55.999	0	-35.498	-36.258	-36.275	-35.823
2019-05-08T09:36:11.138	0	-34.79	-35.289	-36.344	-35.963
2019-05-08T09:36:26.267	0	-36.762	-35.441	-36.667	-35.932
2019-05-08T09:36:41.401	0	-35.823	-34.802	-35.555	-36.503
2019-05-08T09:36:56.529	0	-37.119	-34.601	-35.732	-36.686
2019-05-08T09:37:11.667	0	-35.222	-35.732	-36.8	-35.262

2019-05-08T09:37:26.796	0	-36.575	-35.762	-36.241	-35.541
2019-05-08T09:37:41.932	0	-35.317	-36.485	-37.016	-35.599
2019-05-08T09:37:57.046	0	-34.888	-34.192	-36.208	-35.916
2019-05-08T09:38:12.181	0	-34.888	-35.09	-36.781	-35.823
2019-05-08T09:38:27.315	0	-35.916	-35.399	-36.396	-36.225
2019-05-08T09:38:42.451	0	-36.028	-36.503	-35.869	-36.076
2019-05-08T09:38:57.573	0	-34.408	-35.916	-34.802	-35.57
2019-05-08T09:39:12.697	0	-35.47	-34.589	-36.108	-35.885
2019-05-08T09:39:27.820	0	-35.628	-36.043	-35.687	-34.95
2019-05-08T09:39:42.959	0	-34.453	-36.467	-35.235	-35.441
2019-05-08T09:39:58.089	0	-36.208	-35.9	-36.092	-36.158
2019-05-08T09:40:13.218	0	-36.242	-36.125	-35.195	-35.932
2019-05-08T09:40:28.338	0	-35.541	-36.225	-34.554	-35.303
2019-05-08T09:40:43.481	0	-35.263	-35.317	-35.599	-35.484
2019-05-08T09:40:58.631	0	-57.39	-57.116	-56.947	-55.514
2019-05-08T09:41:13.804	0	-34.981	-34.742	-35.148	-35.12
2019-05-08T09:41:28.925	0	-35.644	-35.426	-35.292	-35.822
2019-05-08T09:41:44.053	0	-35.518	-34.454	-34.665	-37.287
2019-05-08T09:41:59.193	0	-35.974	-35.534	-35.426	-34.627
2019-05-08T09:42:14.299	0	-33.359	-36.131	-36.93	-34.083
2019-05-08T09:42:29.443	0	-36.276	-33.846	-35.036	-35.708
2019-05-08T09:42:44.558	0	-36.522	-34.781	-35.839	-35.839
2019-05-08T09:42:59.694	0	-35.628	-37.06	-35.12	-35.336
2019-05-08T09:43:14.835	0	-35.307	-34.995	-35.176	-35.351
2019-05-08T09:43:29.952	0	-34.873	-35.855	-37.452	-34.466
2019-05-08T09:43:45.090	0	-35.612	-35.191	-34.577	-35.756
2019-05-08T09:44:00.200	0	-35.992	-35.855	-35.806	-35.675
2019-05-08T09:44:15.342	0	-36.149	-35.596	-36.35	-33.92
2019-05-08T09:44:30.495	0	-38.153	-38.017	-36.961	-38.568
2019-05-08T09:44:45.673	0	-35.036	-34.53	-35.274	-35.607
2019-05-08T09:45:00.796	0	-34.518	-35.32	-36.363	-34.608
2019-05-08T09:45:15.933	0	-33.392	-35.243	-35.776	-35.591
2019-05-08T09:45:31.055	0	-36.285	-34.879	-35.021	-34.429
2019-05-08T09:45:46.183	0	-34.404	-35.558	-35.138	-35.094
2019-05-08T09:46:01.313	0	-35.542	-35.109	-34.992	-34.824
2019-05-08T09:46:16.440	0	-34.783	-35.094	-35.987	-34.454
2019-05-08T09:46:31.567	0	-35.153	-35.509	-35.413	-35.429
2019-05-08T09:46:46.695	0	-34.81	-34.354	-35.674	-35.228
2019-05-08T09:47:01.829	0	-35.674	-35.741	-35.525	-34.066
2019-05-08T09:47:16.955	0	-35.575	-35.351	-33.819	-36.171
2019-05-08T09:47:32.082	0	-35.81	-34.595	-35.289	-36.906
2019-05-08T09:47:47.221	0	-34.416	-34.95	-34.688	-38.223

2019-05-08T09:48:02.339	0	-35.845	-34.543	-34.416	-35.461
2019-05-08T09:48:17.464	0	-36.228	-35.741	-34.256	-36.503
2019-05-08T09:48:32.602	0	-34.149	-34.837	-34.992	-36.096
2019-05-08T09:48:47.726	0	-36.606	-35.05	-34.648	-35.624
2019-05-08T09:49:02.865	0	-35.828	-35.351	-35.951	-35.827
2019-05-08T09:49:17.971	0	-35.08	-36.343	-34.101	-34.556
2019-05-08T09:49:33.110	0	-35.51	-34.441	-34.661	-36.605
2019-05-08T09:49:48.248	0	-33.808	-33.595	-35.591	-34.907
2019-05-08T09:50:03.370	0	-34.838	-35.827	-33.918	-34.329
2019-05-08T09:50:18.493	0	-35.124	-34.978	-34.341	-34.479
2019-05-08T09:50:33.614	0	-33.711	-35.32	-35.021	-34.661
2019-05-08T09:50:48.752	0	-35.08	-35.036	-34.964	-34.742
2019-05-08T09:51:03.875	0	-35.021	-35.897	-35.88	-35.657
2019-05-08T09:51:19.046	0	-38.55	-37.746	-38.205	-37.923
2019-05-08T09:51:34.217	0	-34.755	-34.589	-35.503	-35.381
2019-05-08T09:51:49.338	0	-36.484	-35.708	-35.366	-35.078
2019-05-08T09:52:04.476	0	-36.351	-36.167	-35.534	-35.708
2019-05-08T09:52:19.583	0	-36.167	-35.58	-36.078	-35.708
2019-05-08T09:52:34.949	0	-36.464	-34.652	-35.092	-34.981
2019-05-08T09:52:49.854	0	-35.565	-33.856	-35.336	-35.644
2019-05-08T09:53:04.976	0	-34.954	-35.518	-35.162	-36.185
2019-05-08T09:53:20.114	0	-35.106	-35.74	-34.678	-34.913
2019-05-08T09:53:35.250	0	-35.518	-34.602	-34.466	-35.351
2019-05-08T09:53:50.372	0	-36.313	-36.203	-36.096	-35.457
2019-05-08T09:54:05.509	0	-34.807	-35.906	-36.581	-36.742
2019-05-08T09:54:20.631	0	-34.615	-34.335	-35.549	-35.756
2019-05-08T09:54:35.770	0	-34.335	-34.478	-35.219	-36.601
2019-05-08T09:54:50.882	0	-34.86	-36.445	-35.923	-34.886
2019-05-08T09:55:06.021	0	-34.231	-34.564	-35.12	-34.527
2019-05-08T09:55:21.159	0	-36.079	-35.278	-34.873	-35.219
2019-05-08T09:55:36.283	0	-35.839	-35.518	-37.017	-35.628
2019-05-08T09:55:51.420	0	-35.191	-36.239	-35.756	-34.794
2019-05-08T09:56:06.541	0	-35.724	-35.708	-35.351	-34.967
2019-05-08T09:56:21.678	0	-34.847	-35.806	-36.681	-34.37
2019-05-08T09:56:36.802	0	-35.322	-35.022	-34.794	-36.258
2019-05-08T09:56:51.924	0	-33.825	-35.472	-35.991	-34.466
2019-05-08T09:57:07.062	0	-36.114	-35.872	-35.396	-36.952
2019-05-08T09:57:22.186	0	-35.009	-35.381	-33.995	-34.94
2019-05-08T09:57:37.324	0	-35.708	-36.581	-35.307	-35.134
2019-05-08T09:57:52.452	0	-34.768	-35.322	-35.549	-36.167
2019-05-08T09:58:07.574	0	-34.82	-35.659	-35.822	-34.781
2019-05-08T09:58:22.695	0	-34.265	-35.708	-35.248	-35.078

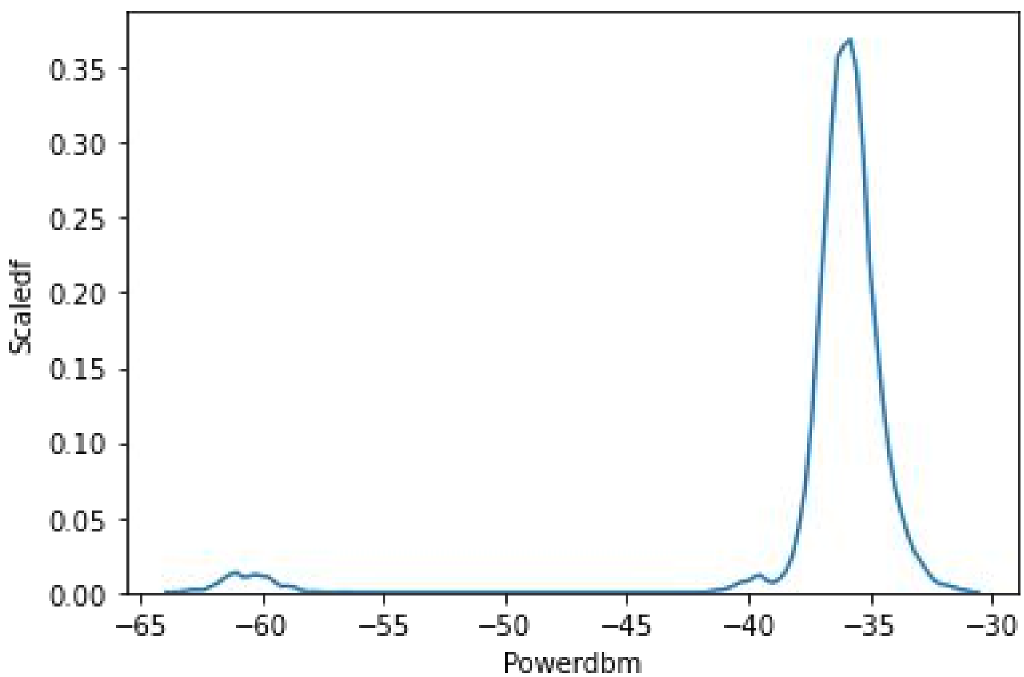
2019-05-08T09:58:37.826	0	-35.191	-35.351	-37.428	-36.131
2019-05-08T09:58:52.952	0	-35.022	-36.026	-36.043	-35.106
2019-05-08T09:59:08.081	0	-34.64	-34.418	-36.131	-35.503
2019-05-08T09:59:23.214	0	-34.383	-34.995	-35.064	-35.366
2019-05-08T09:59:38.376	0	-55.578	-57.497	-55.624	-56.975
2019-05-08T09:59:53.532	0	-33.715	-35.167	-35.69	-34.841
2019-05-08T10:00:08.653	0	-35.503	-34.192	-34.714	-34.058
2019-05-08T10:00:23.792	0	-34.368	-34.756	-35.182	-35.091
2019-05-08T10:00:38.925	0	-35.152	-35.292	-37.141	-34.432
2019-05-08T10:00:54.057	0	-35.604	-34.756	-34.406	-35.182
2019-05-08T10:01:09.187	0	-35.245	-35.587	-35.031	-36.226
2019-05-08T10:01:24.314	0	-34.913	-35.356	-34.355	-35.121
2019-05-08T10:01:39.431	0	-35.656	-35.404	-34.329	-34.756
2019-05-08T10:01:54.565	0	-35.245	-35.778	-34.551	-34.564
2019-05-08T10:02:09.688	0	-33.964	-34.524	-35.621	-33.849
2019-05-08T10:02:24.818	0	-35.214	-35.69	-35.922	-36.345
2019-05-08T10:02:39.958	0	-35.046	-34.686	-36.814	-35.276
2019-05-08T10:02:55.083	0	-35.832	-35.553	-34.714	-34.714
2019-05-08T10:03:10.240	0	-38.522	-38.006	-38.07	-36.577
2019-05-08T10:03:25.370	0	-38.833	-38.134	-38.282	-39.356
2019-05-08T10:03:40.487	0	-37.66	-36.773	-38.349	-37.194
2019-05-08T10:03:55.667	0	-35.203	-34.657	-34.95	-34.864
2019-05-08T10:04:10.794	0	-35.233	-34.979	-35.172	-34.498
2019-05-08T10:04:25.924	0	-34.631	-34.511	-35.722	-34.446
2019-05-08T10:04:41.042	0	-36.432	-34.03	-35.342	-33.704
2019-05-08T10:04:56.181	0	-35.97	-35.052	-34.921	-34.85
2019-05-08T10:05:11.310	0	-34.965	-36.431	-34.485	-35.536
2019-05-08T10:05:26.431	0	-34.564	-36.371	-34.836	-35.406
2019-05-08T10:05:41.570	0	-34.149	-34.78	-34.964	-37.017
2019-05-08T10:05:56.691	0	-35.311	-34.113	-35.157	-34.671
2019-05-08T10:06:11.830	0	-35.023	-34.657	-34.345	-34.808
2019-05-08T10:06:26.953	0	-34.808	-35.988	-34.042	-35.809
2019-05-08T10:06:42.091	0	-35.536	-34.383	-35.082	-35.422
2019-05-08T10:06:57.220	0	-34.644	-35.933	-35.653	-35.112
2019-05-08T10:07:12.341	0	-35.203	-34.993	-35.52	-34.822
2019-05-08T10:07:27.471	0	-35.688	-34.864	-34.511	-35.636
2019-05-08T10:07:42.610	0	-35.438	-35.112	-33.493	-33.904
2019-05-08T10:07:57.718	0	-36.176	-35.454	-34.209	-35.879
2019-05-08T10:08:12.851	0	-34.486	-35.933	-34.808	-35.157
2019-05-08T10:08:27.993	0	-33.927	-35.067	-35.358	-35.536
2019-05-08T10:08:43.098	0	-34.907	-34.78	-34.63	-34.511
2019-05-08T10:08:58.229	0	-34.234	-34.993	-36.272	-34.808

2019-05-08T10:09:13.374	0	-35.374	-35.157	-35.127	-35.248
2019-05-08T10:09:28.495	0	-34.054	-36.194	-35.487	-34.258
2019-05-08T10:09:43.614	0	-34.936	-34.979	-35.603	-34.684
2019-05-08T10:09:58.745	0	-35.654	-35.438	-34.332	-35.311
2019-05-08T10:10:13.877	0	-35.471	-34.752	-34.007	-35.67
2019-05-08T10:10:29.009	0	-34.32	-35.264	-35.739	-33.661
2019-05-08T10:10:44.166	0	-38.311	-38.655	-37.991	-39.682
2019-05-08T10:10:59.326	0	-35.699	-34.78	-34.869	-35.977
2019-05-08T10:11:14.449	0	-33.463	-35.16	-33.399	-35.827
2019-05-08T10:11:29.579	0	-34.097	-34.134	-35.035	-35.864
2019-05-08T10:11:44.732	0	-37.649	-36.617	-37.544	-37.163
2019-05-08T10:11:59.873	0	-38.944	-37.122	-37.259	-36.977
2019-05-08T10:12:15.001	0	-37.947	-37.882	-38.687	-38.301
2019-05-08T10:12:30.122	0	-38.029	-36.499	-37.328	-37.428
2019-05-08T10:12:45.241	0	-38.481	-38.061	-36.787	-36.593
2019-05-08T10:13:00.386	0	-36.641	-37.385	-37.442	-38.197
2019-05-08T10:13:15.551	0	-57.405	-56.505	-57.917	-56.436
2019-05-08T10:13:30.704	0	-39.121	-39.506	-38.845	-38.792
2019-05-08T10:13:45.870	0	-33.888	-34.967	-36.008	-36.294
2019-05-08T10:14:00.996	0	-34.678	-34.768	-35.773	-34.716
2019-05-08T10:14:16.162	0	-37.456	-37.383	-38.854	-37.681
2019-05-08T10:14:31.331	0	-35.74	-34.64	-34.442	-35.092
2019-05-08T10:14:46.455	0	-34.914	-34.394	-34.967	-37.83
2019-05-08T10:15:01.594	0	-35.05	-36.824	-35.336	-36.185
2019-05-08T10:15:16.749	0	-57.71	-57.851	-56.86	-57.125
2019-05-08T10:15:31.918	0	-34.874	-34.915	-36.047	-35.891
2019-05-08T10:15:47.040	0	-35.468	-34.807	-35.994	-35.11
2019-05-08T10:16:02.163	0	-35.499	-34.292	-35.36	-35.33
2019-05-08T10:16:17.302	0	-35.139	-36.173	-34.164	-34.97
2019-05-08T10:16:32.425	0	-36.266	-36.475	-35.421	-36.676
2019-05-08T10:16:47.547	0	-35.546	-36.155	-35.068	-36.047
2019-05-08T10:17:02.686	0	-35.271	-36.475	-35.593	-34.915
2019-05-08T10:17:17.810	0	-35.33	-35.068	-36.228	-35.84
2019-05-08T10:17:32.933	0	-35.452	-34.767	-34.915	-35.96
2019-05-08T10:17:48.067	0	-35.806	-35.806	-34.715	-35.773
2019-05-08T10:18:03.191	0	-34.998	-36.155	-33.227	-35.011
2019-05-08T10:18:18.315	0	-37.106	-34.997	-33.311	-34.874
2019-05-08T10:18:33.440	0	-33.738	-35.315	-36.574	-35.942
2019-05-08T10:18:48.577	0	-34.888	-35.562	-34.292	-34.794
2019-05-08T10:19:03.701	0	-35.33	-35.168	-35.375	-35.096
2019-05-08T10:19:18.839	0	-34.984	-34.834	-34.942	-33.274
2019-05-08T10:19:33.962	0	-35.499	-35.33	-35.994	-35.375

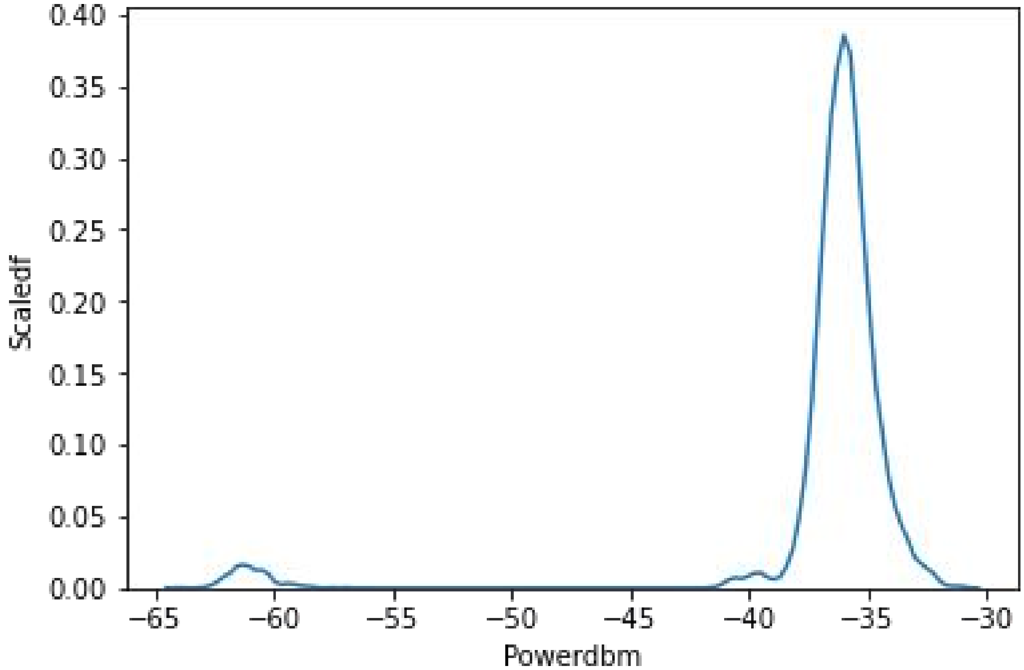
2019-05-08T10:19:49.086	0	-34.807	-34.689	-35.437	-34.82
2019-05-08T10:20:04.211	0	-33.93	-36.341	-34.794	-34.611
2019-05-08T10:20:19.348	0	-34.847	-36.655	-36.03	-34.234
2019-05-08T10:20:34.472	0	-35.483	-35.84	-34.073	-37.267
2019-05-08T10:20:49.595	0	-35.286	-34.741	-35.593	-36.8
2019-05-08T10:21:04.718	0	-36.137	-34.611	-36.03	-35.609
2019-05-08T10:21:19.843	0	-34.728	-33.368	-36.417	-35.241
2019-05-08T10:21:34.980	0	-34.943	-35.707	-35.153	-36.265
2019-05-08T10:21:50.118	0	-34.165	-34.13	-36.21	-35.125
2019-05-08T10:22:05.242	0	-35.773	-34.176	-35.69	-34.586
2019-05-08T10:22:20.380	0	-37.106	-34.984	-34.141	-34.511
2019-05-08T10:22:35.549	0	-57.202	-56.846	-56.706	-58.344
2019-05-08T10:22:50.709	0	-34.767	-37.305	-35.374	-34.808

APPENDIX B: SAMPLES OF POWER DENSITY PLOTS

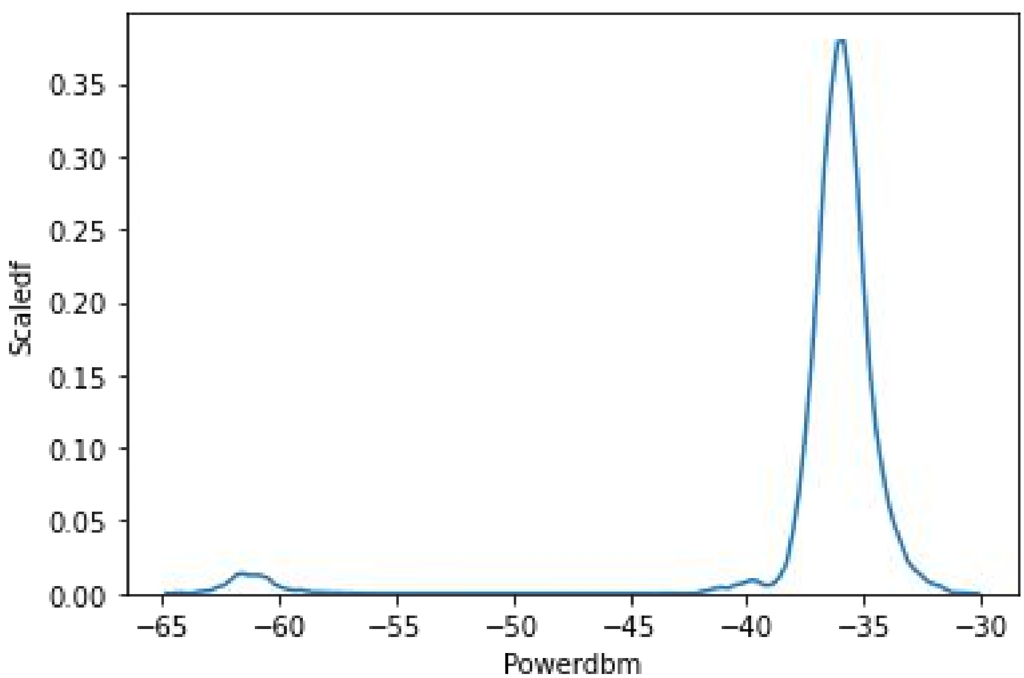
SAMPLE OF POWER DISTRIBUTION PLOTS FOR 30-47 MHz



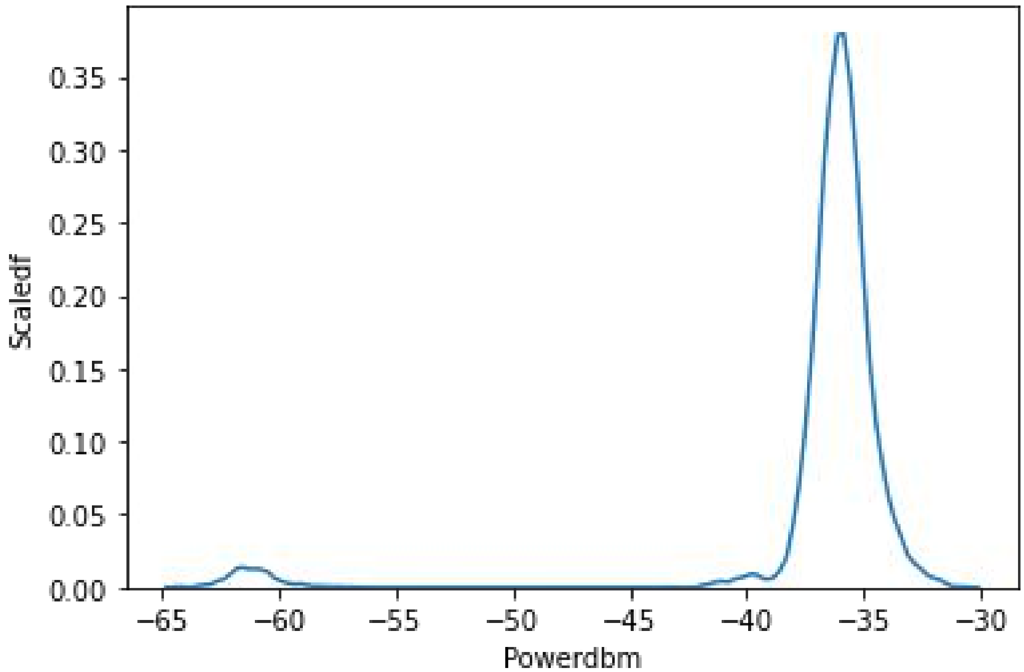
Power distribution plot for 30 MHz



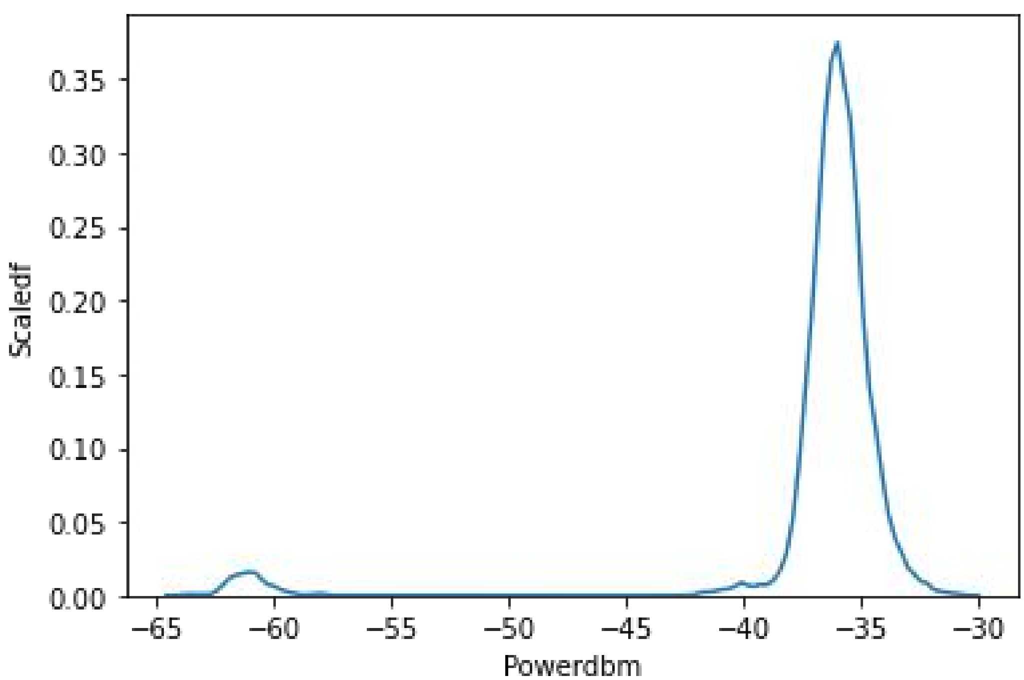
Power distribution plot for 30.05 MHz



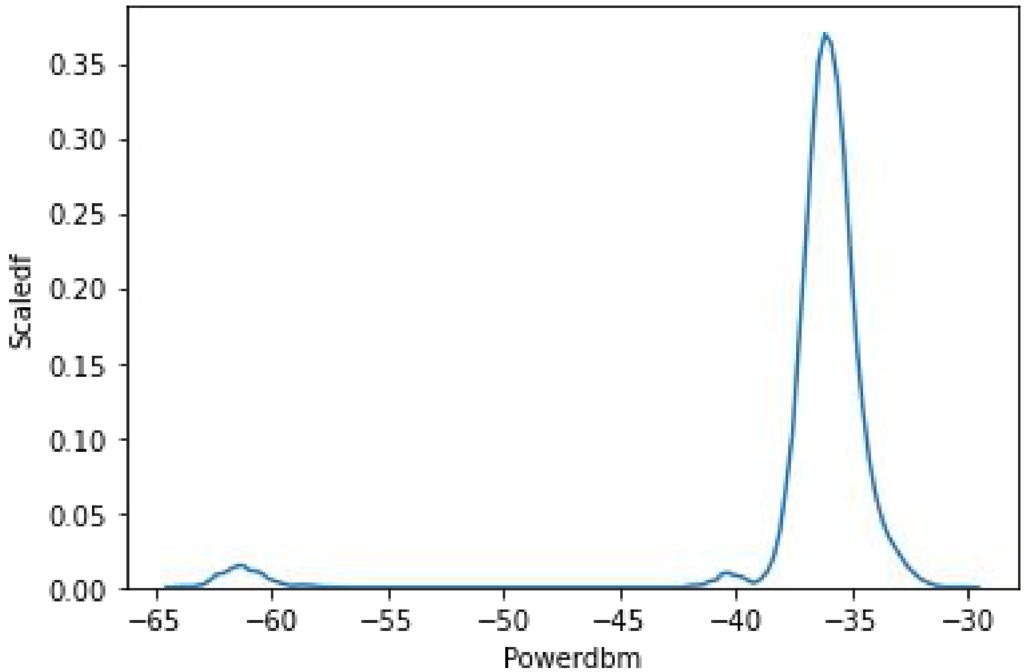
Power distribution plot for 30.10 MHz



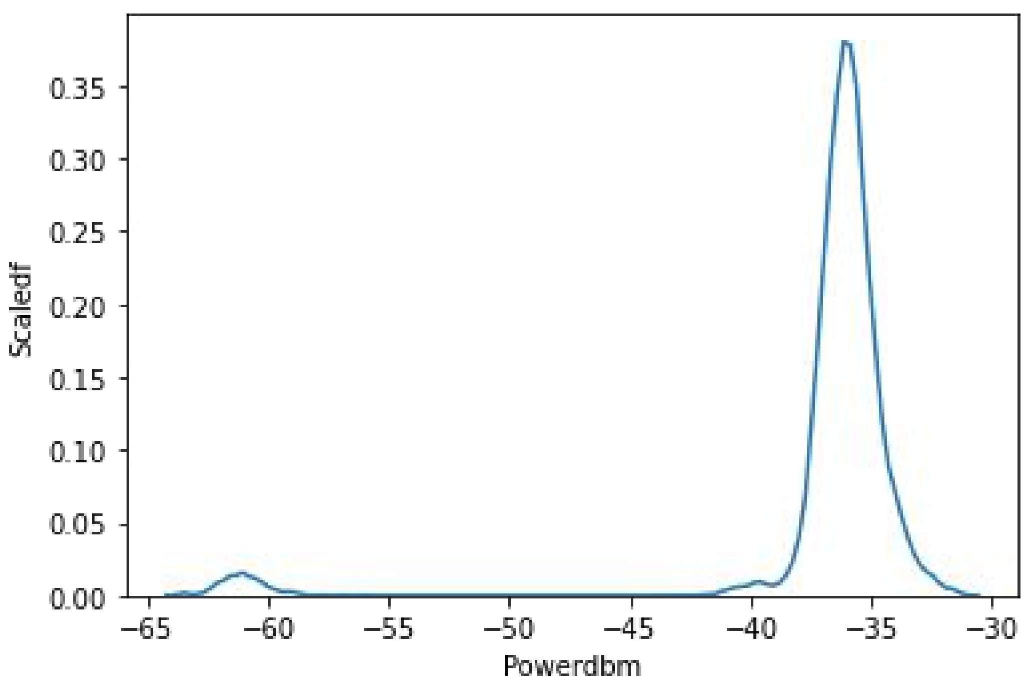
Power distribution plot for 30.15 MHz



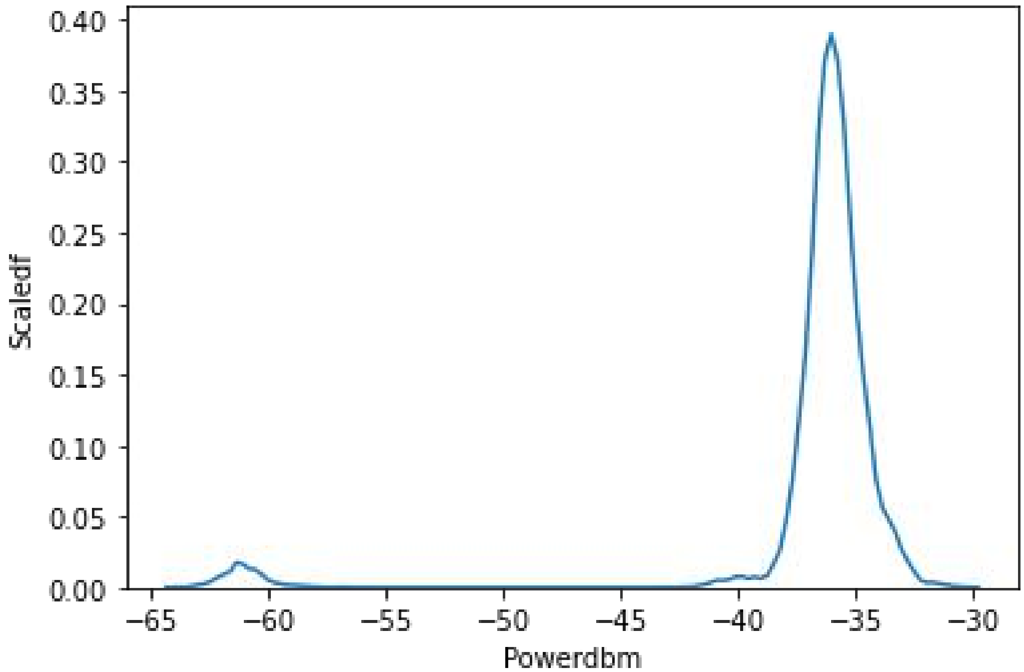
Power distribution plot for 30.20 MHz



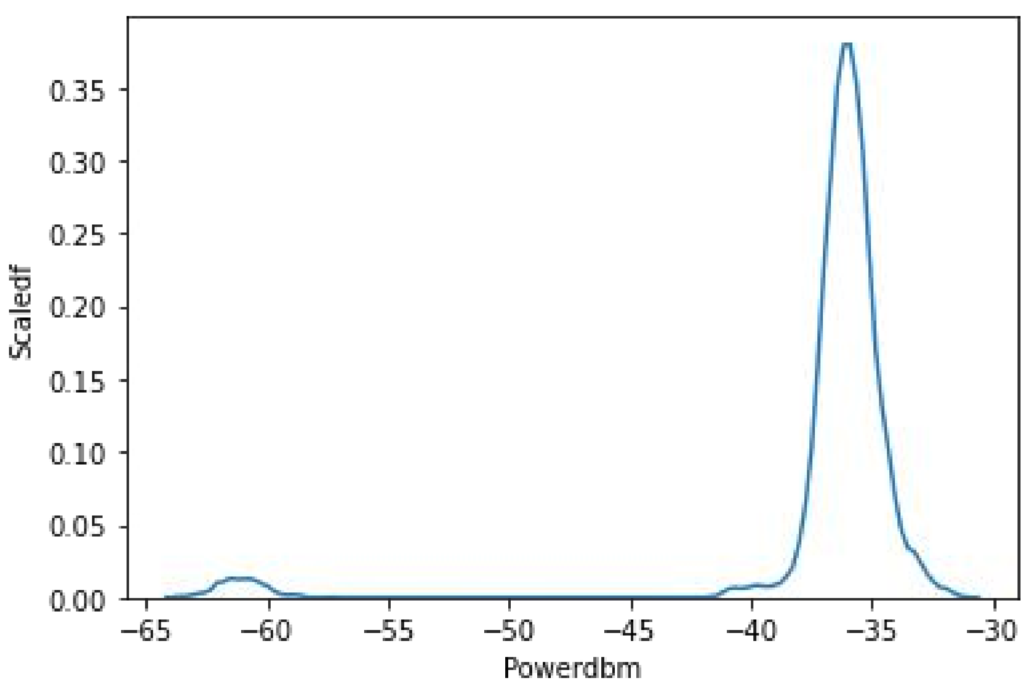
Power distribution plot for 30.25 MHz



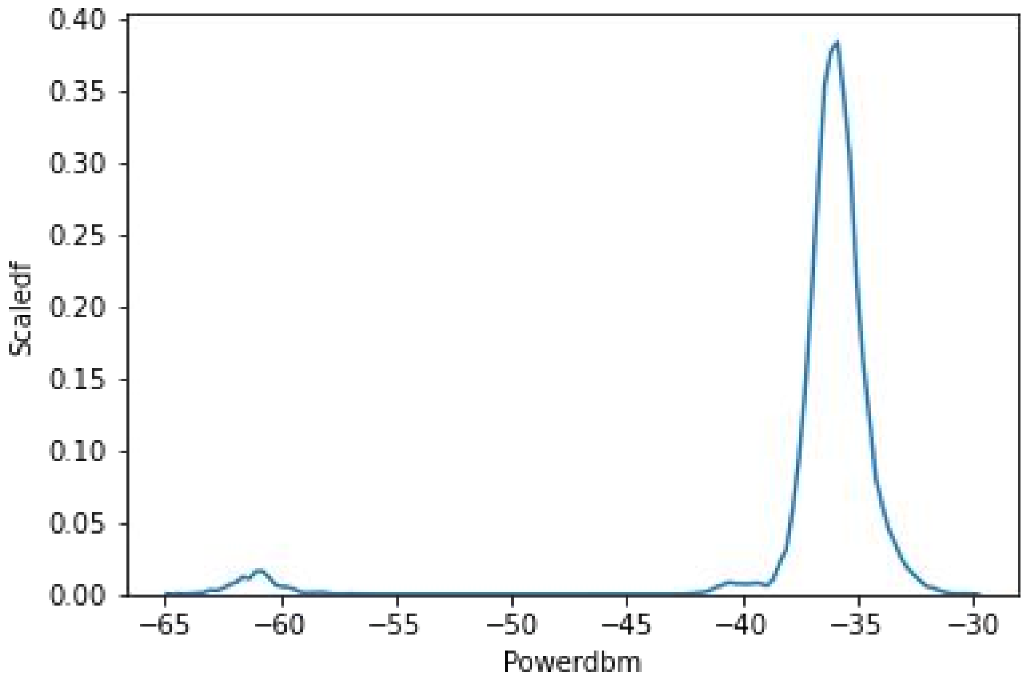
Power distribution plot for 30.25 MHz



Power distribution plot for 30.30 MHz

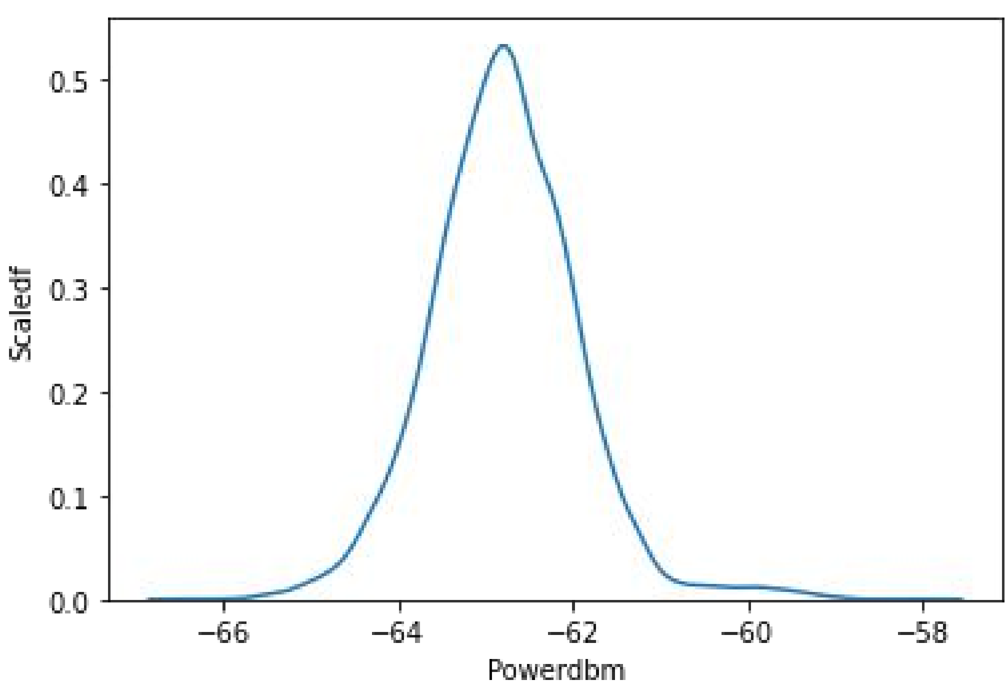


Power distribution plot for 30.35 MHz

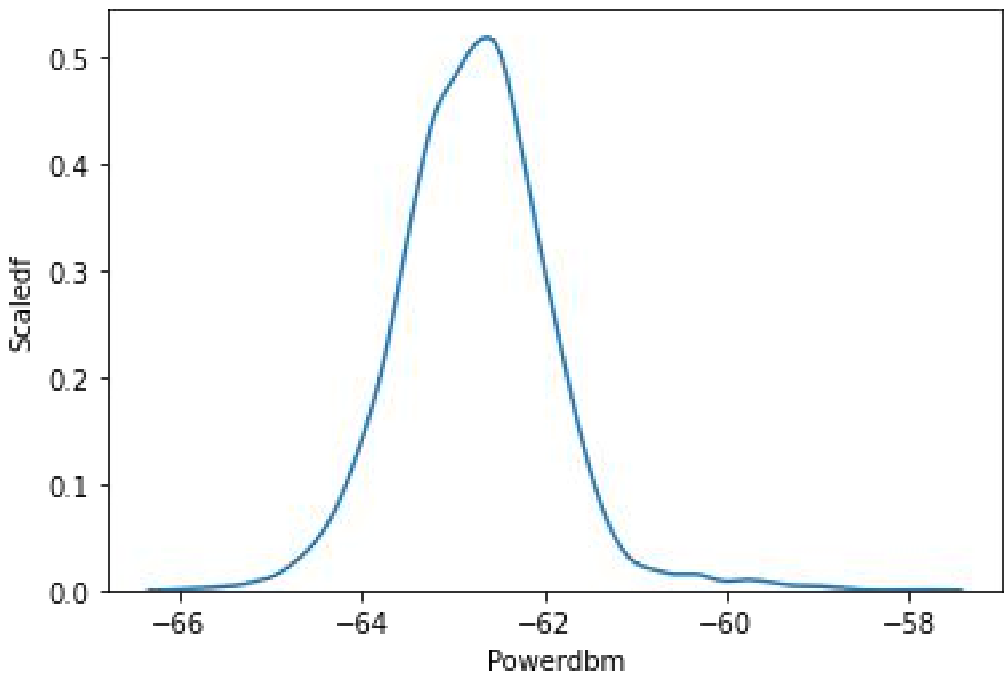


Power distribution plot for 30.40 MHz

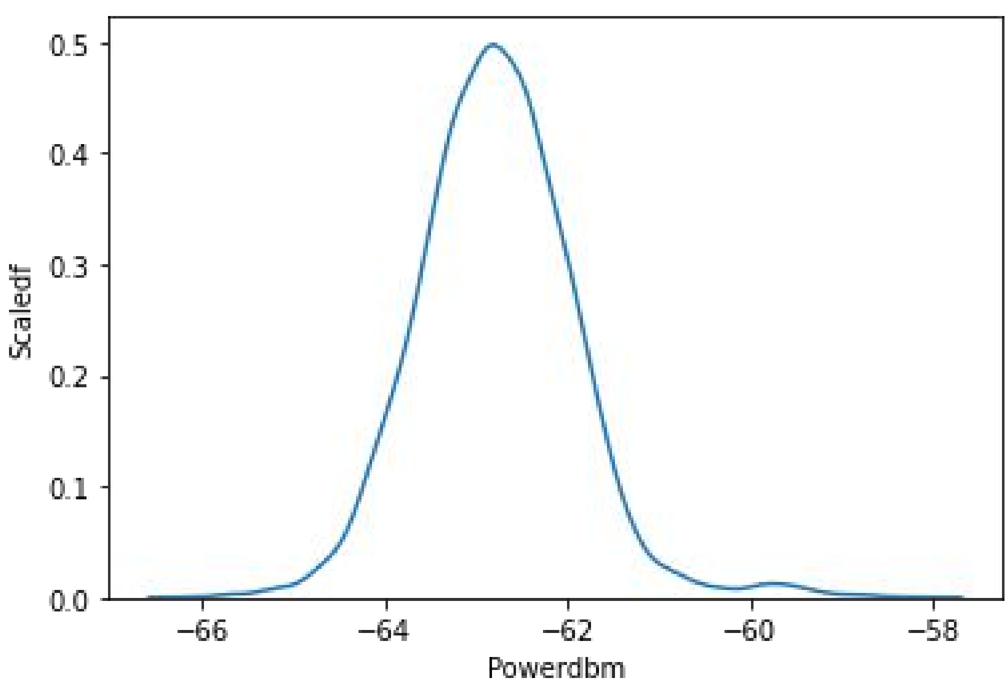
SAMPLE OF POWER DISTRIBUTION PLOTS FOR 47.05-68 MHz



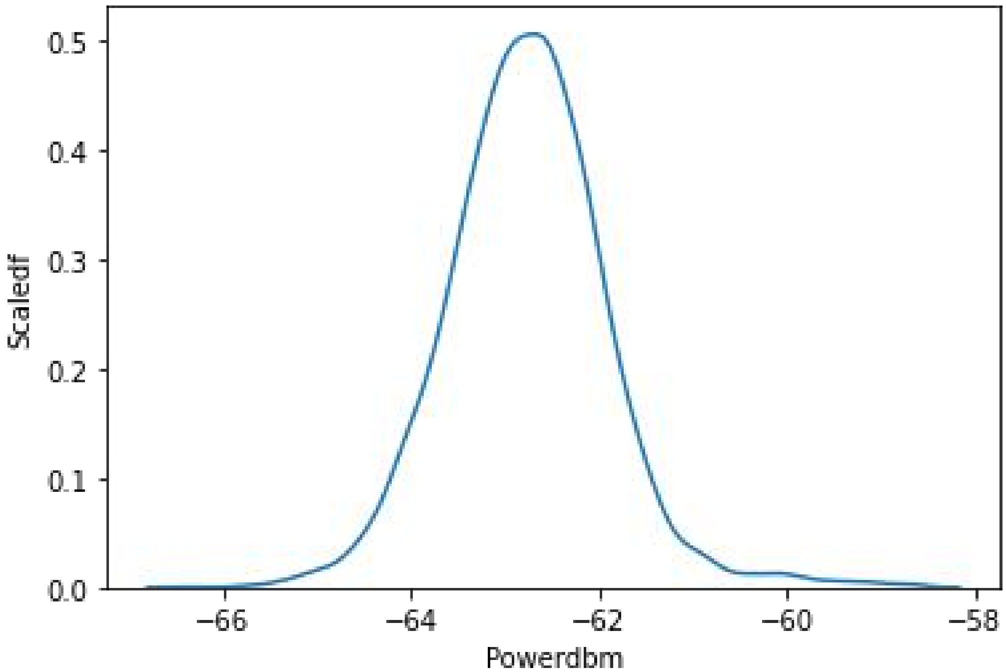
Power distribution plot for 47.05 MHz



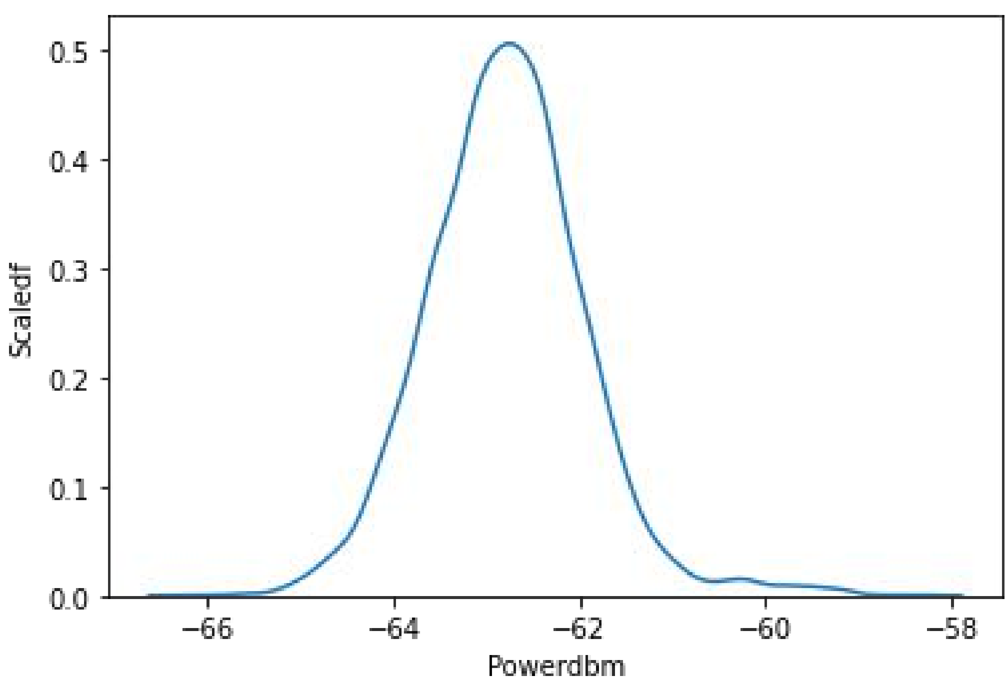
Power distribution plot for 47.10 MHz



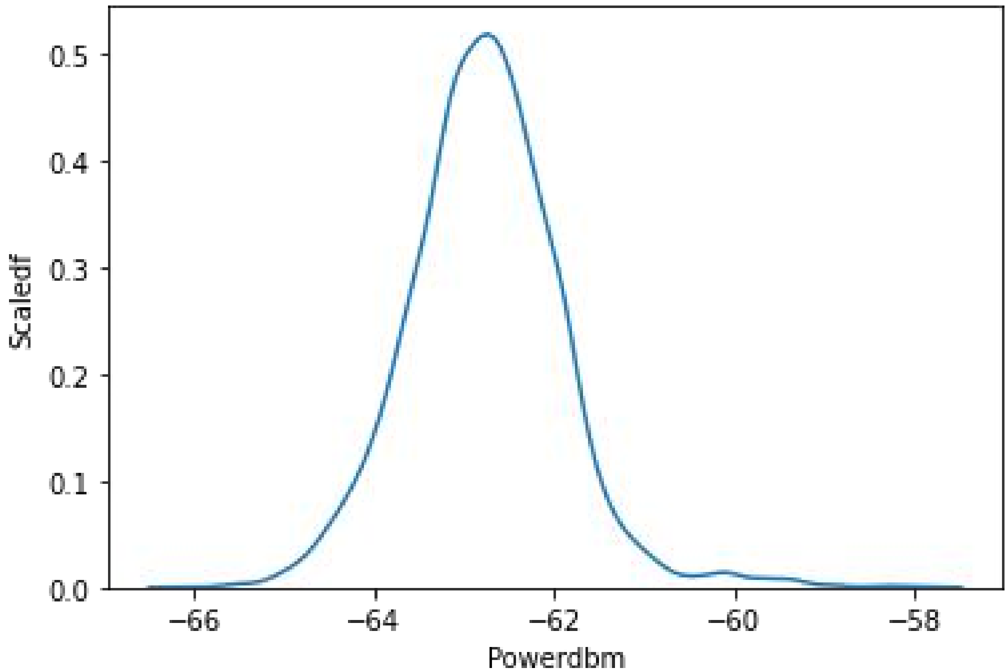
Power distribution plot for 47.15 MHz



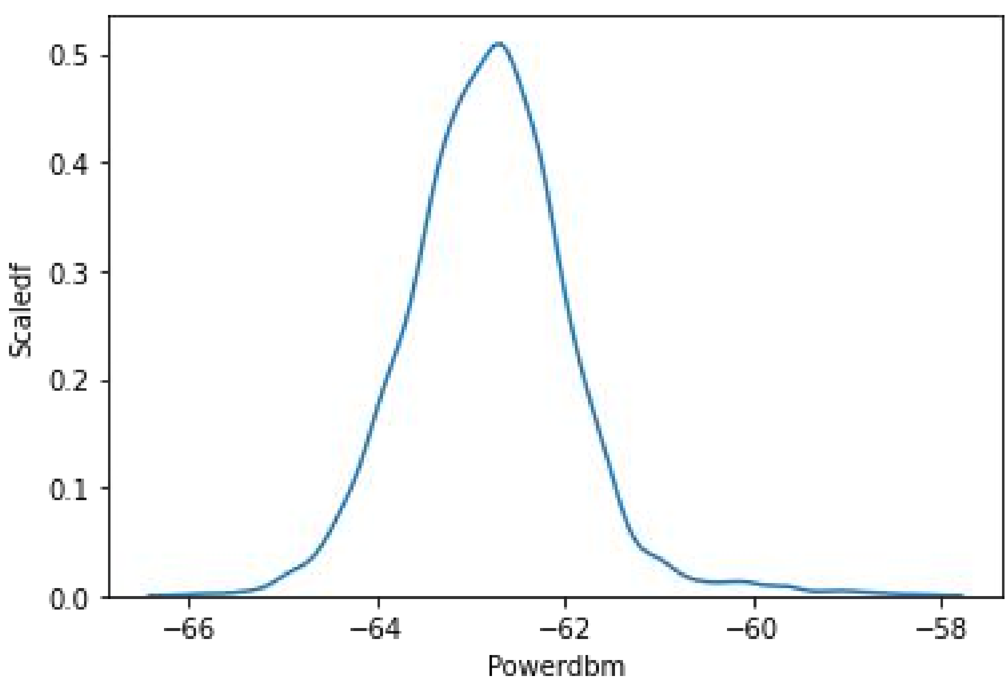
Power distribution plot for 47.20 MHz



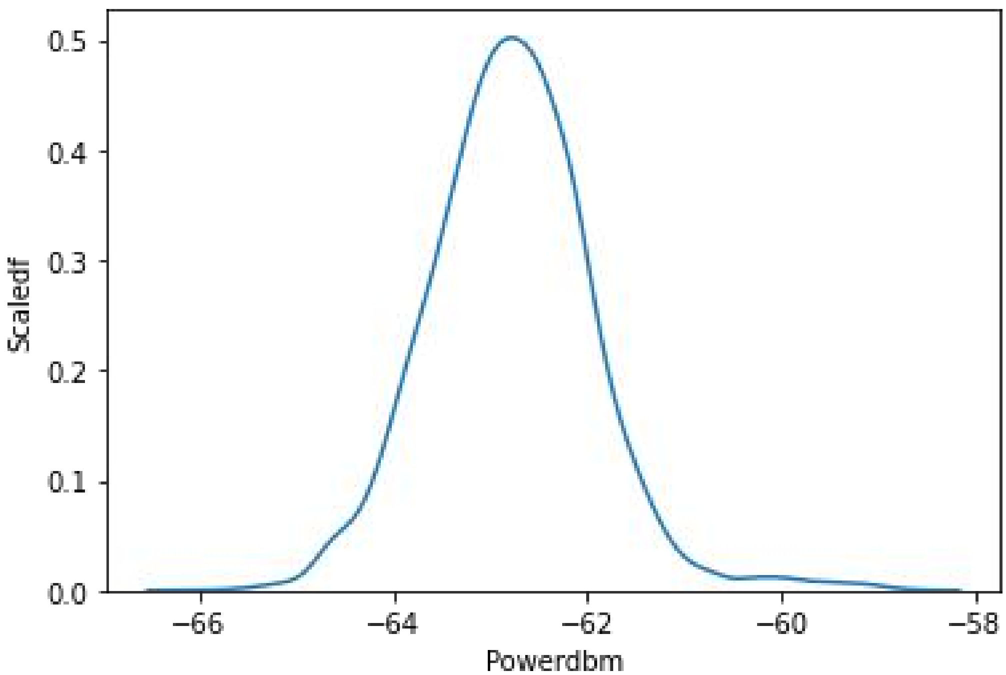
Power distribution plot for 47.25 MHz



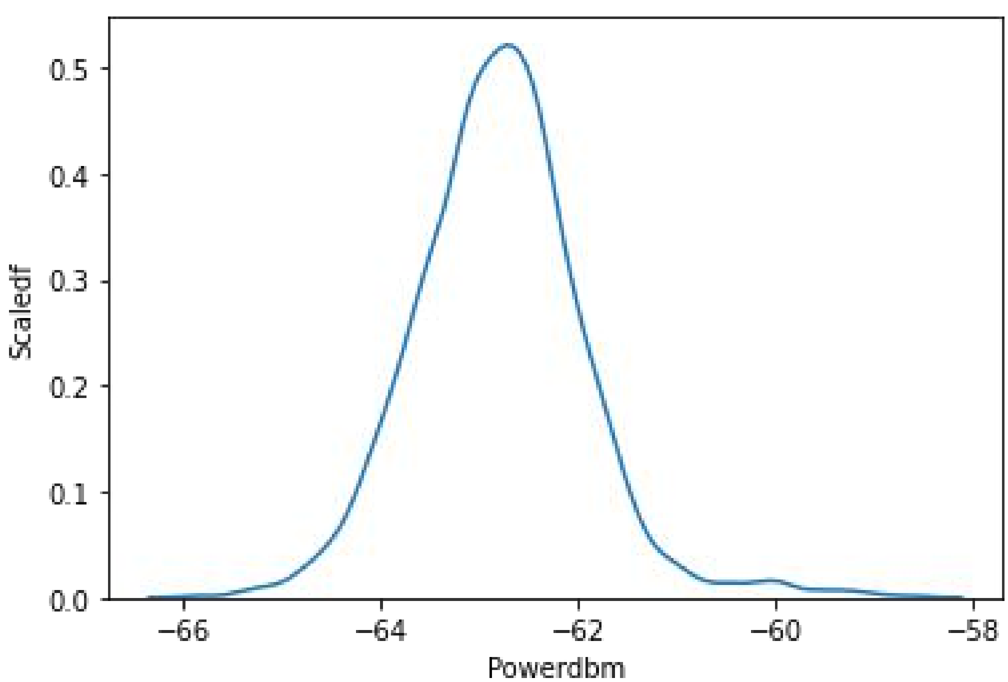
Power distribution plot for 47.30 MHz



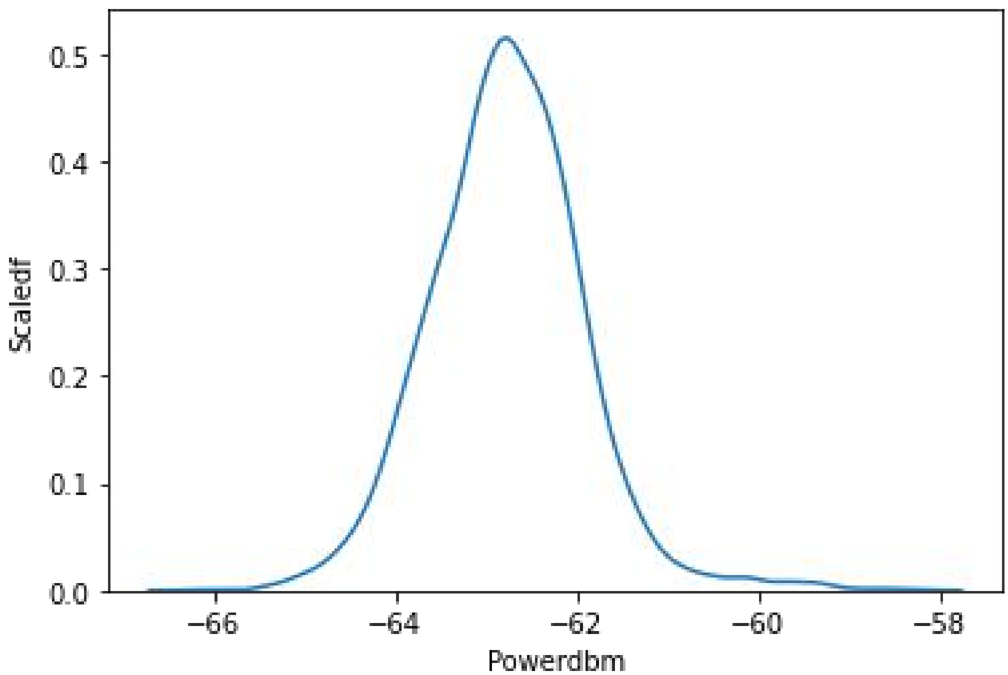
Power distribution plot for 47.35 MHz



Power distribution plot for 47.40 MHz



Power distribution plot for 47.45 MHz



Power distribution plot for 47.50 MHz

APPENDIX C: SAMPLES OF AUTOREGRESSIVE (AR) COEFFICIENTS

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

	Frequency (Hz)						
	30000000	30050000	30100000	30150000	30200000	30250000	30300000
1	0.485451	0.009914	-0.37993	0.495588	0.300936	0.349167	0.495044
2	-0.04029	0.463966	-0.53531	0.003513	-0.03981	0.657137	-0.33871
3	-0.47772	-0.68858	-0.71206	-0.10397	0.288517	-0.12679	0.312696
4	0.01541	-0.06223	0.203709	0.47508	0.009971	-0.02622	-0.10342
5	-0.35026	0.124234	-0.36926	0.316308	0.084494	0.697356	-0.04524
6	-0.36438	0.41457	-0.08557	0.175202	0.363298	0.562541	0.341545
7	0.117124	0.275014	-0.03642	-0.88967	-0.06254	0.200362	0.131248
8	0.10569	0.276019	-0.4417	0.124854	0.214635	-0.33959	0.174884
9	0.269036	-0.15212	-0.41289	-0.05376	0.195666	0.252812	0.564584
10	-0.34093	-0.28758	-0.3811	0.304647	-0.15237	0.652057	-0.39526
11	0.303834	-0.10178	-0.12546	0.015786	0.282342	-0.61174	-0.28793
12	-0.05868	0.528375	-0.64987	0.309157	0.016799	-0.04924	0.421658
13	-0.22926	0.081775	0.063624	-0.201	0.17305	0.27454	-0.22047

14	0.075703	-0.40146	0.153254	-0.08946	0.339094	-0.01957	-0.26165
15	0.094846	0.208814	0.248063	-0.85142	0.265299	0.313195	-0.27129
16	-0.09802	0.086617	-0.21094	0.104744	0.100055	0.033177	0.186455
17	0.419752	-0.53065	0.074768	0.376478	0.315041	-0.06534	0.039684
18	-0.3392	0.209451	-0.46313	-0.09444	-0.13818	-0.92502	0.250101
19	-0.11786	-0.10645	0.195351	-0.15672	0.234941	0.394273	-0.46923
20	-0.13856	0.465529	-0.21571	-0.23824	0.043136	0.110968	-0.11214
21	0.114106	0.012146	0.074555	-0.51249	0.336578	-0.27719	0.342257
22	-0.02832	0.689521	-0.27493	-0.51934	-0.18136	0.142099	-0.01367
23	0.835035	-0.04579	0.758511	0.455413	0.609222	0.415501	0.72844
24	-0.06952	-0.06952	0.682114	0.918259	0.312455	-0.01846	0.032706

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

			Frequency (Hz)			
30350000	30400000	30450000	30500000	30550000	30600000	30650000
-0.01269	0.123524	-0.01114	0.529977	-0.72428	0.276353	0.022639
-0.31103	0.063475	0.093354	-0.33073	-0.528	0.15987	0.145224
-0.12326	0.020964	0.566503	-0.36707	-0.47608	0.024924	0.539002
0.773873	0.209329	-0.13289	0.638541	-0.56017	0.262316	0.169355
-0.02115	-0.27718	-0.84703	-0.53312	0.230427	-1.12173	0.466346
-0.2934	0.364332	-0.01697	-0.3946	-0.4606	-0.20142	0.446766
-0.19843	-0.20638	-0.43981	-0.3413	-0.49121	0.051924	-0.26581
0.151442	0.005082	-0.19414	0.058521	0.438186	0.085325	0.219415
-0.07602	0.067459	-0.5533	-0.11407	0.534901	0.210412	0.125682
0.181591	0.383623	-0.21644	-0.64342	-0.32856	0.135446	-0.36824
-0.02806	0.544006	-0.01166	-0.87904	-0.40196	0.172276	-0.53462
0.048577	0.262604	0.824021	-0.16939	-0.58743	0.03982	0.533907
0.991208	0.158182	0.776996	0.962977	-0.74092	0.165786	-0.53668
-0.36503	-0.72727	-0.80287	-0.1968	0.507237	0.101447	-0.14818
0.437856	0.337926	0.21802	0.122771	0.374237	0.137496	0.312975

0.388457	0.471517	-0.31926	-0.15205	0.263683	0.221357	0.383819
-0.3156	0.308097	0.206587	-0.29638	-1.06983	0.198743	-0.62773
-0.05932	0.301177	-0.58762	0.575575	0.269553	0.058786	-0.17356
-0.18091	0.013275	0.346504	-0.13826	-0.30433	0.224499	0.534349
0.755867	0.085668	0.135118	-0.8116	-0.07204	0.107749	-0.5597
0.018856	0.349732	0.685219	0.562562	-0.9118	0.183326	0.027059
0.095008	-0.23829	-0.38036	-0.18379	-0.19493	0.095129	0.158913
0.74185	0.421516	1.294263	0.44711	1.150644	0.569796	0.286035
0.000962	0.454279	0.889528	-1.21629	0.140409	0.147645	0.196632

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

Frequency (Hz)						
30700000	30750000	30800000	30850000	30900000	30950000	31000000
0.181619	0.003026	0.114502	0.328002	0.465973	-0.05048	-0.03931
-0.77237	-1.53123	-1.25634	-0.36017	-0.15773	-0.15721	-0.03581
0.713618	0.114583	0.276289	-0.29484	-0.23211	-0.45199	-0.24244
-0.11878	-0.24635	0.002824	0.390997	0.041325	-0.42109	-0.36057
-0.06311	0.47511	0.492854	-0.07461	-0.03207	-0.47906	-0.08922
-0.01351	0.21373	0.200487	0.07824	0.093746	0.013814	0.051629
-0.16306	-0.36081	0.639195	-0.97258	0.125311	-1.19115	0.061345
0.343632	0.426032	-0.25824	0.299817	-0.26444	0.333292	-0.27673
0.239204	-0.0267	0.594743	0.193505	0.307352	0.07242	0.126018
-0.23588	0.088376	0.199537	-0.16244	0.43454	-0.38775	0.236173
0.113183	-0.12421	0.443131	-0.27617	0.368301	0.01574	-0.62289
0.41063	0.062281	0.765217	-0.21717	0.392243	-0.0473	0.056238
0.011752	0.146493	-0.18293	0.282355	-0.30397	0.108462	0.173438
-0.4321	0.882017	0.212531	0.120982	0.112148	-0.02239	-0.45382

-0.19056	-0.38445	0.737401	-0.11994	0.33081	-0.31317	-0.96496
0.394652	-0.29944	-0.79961	0.493752	-0.20503	-0.04785	-0.14286
0.024996	-0.42508	0.197267	-0.31634	0.206101	0.463356	0.100656
-0.3693	0.682109	-0.76254	0.118866	-0.29251	0.514187	-0.48058
0.240632	-0.91143	-0.37623	-0.01467	0.206829	-0.08607	0.407471
0.411785	-0.08436	-0.38803	-0.23557	0.071142	0.283727	0.138515
-0.02842	-0.01123	-0.62464	0.612574	-0.08673	0.48152	0.096391
0.113117	0.013679	0.727201	0.119163	-0.66838	0.212495	-0.19048
0.93471	0.491734	0.628905	0.249705	0.801194	0.754147	0.787681
-0.12786	0.244954	-0.0242	0.553931	0.678068	0.440243	0.401526

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

Frequency (Hz)						
31050000	31100000	31150000	31200000	31250000	31300000	31350000
0.382858	-0.24343	-0.42149	0.243388	-0.19144	-0.08088	-1.42071
0.072975	-0.15651	-0.06115	0.158036	-0.73835	0.092094	-0.47548
0.84323	-0.6932	0.814246	0.33121	-0.12283	0.698141	1.355821
0.021831	0.455327	0.456982	0.589993	0.087149	-0.01666	0.17961
-0.03048	-0.51707	0.041659	-0.22022	-0.08165	0.061308	0.427384
-0.34206	-0.46668	-0.19943	-0.11797	-0.26793	-0.03529	-0.44845
0.085789	-0.52418	-0.98778	0.207349	-0.01709	-0.70446	-0.16959
0.418657	0.330271	0.468952	0.238139	-0.23966	0.721541	0.394929
-0.10242	-0.57556	-0.99766	0.184152	0.371845	-0.15273	-0.12943
0.240106	-1.32553	-0.22022	0.593233	-1.74565	0.183352	0.362333
0.298103	-0.51828	-0.29585	-0.42206	0.203707	-0.04001	0.012653
-0.23906	-0.11217	0.056129	-0.20431	0.288462	-0.00381	0.259886
0.091021	0.44669	-0.77168	0.521395	-0.5865	0.271099	0.405337
0.369667	0.192567	-1.06951	-0.11415	0.189173	0.059085	0.505634

-0.41614	-0.2245	-0.95349	0.090363	-0.06723	0.89371	-0.2178
0.29047	-0.10025	-1.2485	0.491626	-0.3833	0.410365	-0.05867
0.014279	0.175326	-0.32817	-0.79398	0.212209	0.389743	-0.16979
-0.05229	-0.35406	0.705785	0.294976	0.156758	0.036094	-0.09885
0.085204	0.25645	-0.16006	0.197582	-0.07926	0.87114	-0.02252
0.333509	0.276767	-1.33339	0.129535	0.00522	-0.14037	0.087214
0.596398	0.061818	0.032559	0.738546	-0.17086	-0.58023	0.042952
0.011903	0.017748	0.689912	0.050531	0.679009	-0.33692	-1.53963
0.280162	0.472853	0.77485	0.453876	-0.24908	0.22205	0.050355
0.426608	0.10007	0.10007	1.097287	1.097287	0.43132	-0.6363

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

Frequency (Hz)						
31400000	31450000	31500000	31550000	31600000	31650000	31700000
-0.31049	-0.33859	0.429527	-0.3363	0.258826	0.501485	0.208556
0.571982	-0.393	-0.23574	-0.66131	0.241704	0.384528	0.817789
-0.10706	0.129718	0.675599	0.311469	0.280079	0.416771	0.213182
-0.02375	-0.43378	0.228997	0.454312	-0.30149	-0.28311	-0.12469
-0.0911	0.636099	-0.15345	0.007736	0.067766	0.363236	0.004937
0.449276	-0.05784	0.356391	-0.02816	0.26548	-0.15586	0.112844
0.138846	-1.27013	-0.67181	0.077968	-0.18117	0.013084	-0.29843
0.412147	-0.14969	0.330154	-0.25022	0.406328	-0.12228	0.63093
0.399422	-0.08474	0.136787	0.082375	0.215586	0.346521	-0.32957
0.112392	0.879034	-0.22448	-0.27103	0.043908	-0.27774	0.086598
0.369209	-0.30527	-1.24384	-0.2733	0.318035	0.108476	-0.18767
0.323489	-0.19211	-0.12327	0.15609	-0.08604	0.155806	0.306525
0.131066	-0.04209	0.282129	-0.56226	0.076014	-0.03777	0.426202

-0.09526	-0.85973	-0.01963	-0.00841	-0.28899	-0.64329	0.115699
-0.20285	0.13712	-0.194	0.205343	0.327848	-0.20462	-0.02234
0.247702	-0.48111	0.172984	-0.01078	-0.00136	0.204774	0.007068
-0.14535	0.241299	-0.19328	-0.49088	0.063785	-0.35546	0.311341
0.202693	0.15022	-0.68418	0.061297	0.191993	0.296696	0.305454
0.519917	-0.24653	0.828091	-0.23646	0.844876	0.306361	0.225332
0.007375	-0.42664	0.335007	-0.22376	0.111449	0.06512	-0.03846
0.417039	-0.74792	-0.07151	-0.09635	0.191303	0.452356	0.139408
0.299897	-0.90722	-0.51076	-0.39681	-1.10125	0.309284	0.160733
0.312955	0.786797	0.599152	0.366561	0.737706	0.995341	0.266982
-0.6363	0.821473	0.281951	0.534435	0.093295	-0.17237	0.595655

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

Frequency (Hz)						
31750000	31800000	31850000	31900000	31950000	32000000	32050000
0.491395	0.678413	0.234545	-1.01887	-0.17812	0.461294	-0.31576
-0.392	-0.73213	0.702878	-0.25355	-0.33432	-0.41594	-0.85328
-0.23193	0.173076	0.231952	0.119377	-0.15581	0.38488	0.894804
-0.61541	-0.05815	-0.29958	0.003428	-0.42266	0.065995	-0.1975
0.293509	-0.14355	-0.11252	-0.75873	-0.90091	-0.10068	-0.45915
-0.03824	-0.32353	0.236647	0.090365	0.217295	-0.28786	0.160142
0.610031	0.18352	-0.02454	-0.28813	-0.63226	-0.01892	-0.81144
-0.39198	0.271448	0.366266	-0.02737	-0.42886	0.010007	-0.05248
0.478101	0.35394	-0.13855	0.137427	-0.77104	0.157368	-0.13528
0.481904	0.757042	-0.61014	0.523967	-0.27732	-0.3672	0.076459
-0.32141	-0.01818	-1.29692	0.221406	-0.12668	0.34263	0.48441
-0.21106	-0.33294	0.159057	-1.54187	0.647696	0.361578	-0.39081

0.243965	-0.08265	-0.09473	0.424383	-0.30386	0.155064	-0.5415
0.477716	-0.13275	-1.14066	-0.1531	0.219454	-0.60689	-0.05934
0.178878	-0.84676	0.613847	0.851552	0.195602	0.242721	0.342772
0.769895	0.077472	0.056368	-0.51668	0.666271	0.100501	-0.2952
-0.23397	0.283911	-0.38455	0.011112	0.624234	-0.20782	-0.03299
-0.51763	-0.5493	-0.28617	-1.30796	0.121979	-0.11588	-0.08341
-0.3684	0.434156	0.109288	-0.6574	-0.42865	0.429222	0.137813
0.099843	-0.37597	-0.32312	1.230484	-0.74031	0.164966	0.14644
-0.31662	0.144724	0.213497	-0.78558	0.270895	0.175701	0.087865
-0.23831	-0.17473	-0.79656	-0.06909	-0.19713	-1.02661	0.871718
0.286217	1.05664	0.659616	0.73122	0.48186	0.517096	0.232153
-0.11312	-0.24773	0.004913	-0.69084	0.910867	0.435377	0.435377

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

Frequency (Hz)						
32100000	32150000	32200000	32250000	32300000	32350000	32400000
-0.3815	0.151406	0.106112	0.31626	0.122699	-0.39011	0.079026
-0.56517	0.007025	0.227626	-0.79814	-0.37217	-0.56556	-0.55319
-0.22791	0.194813	0.316411	-0.16189	-0.00511	-0.37204	-0.36399
-0.02724	-0.39196	0.289994	-0.18662	0.130493	-0.64944	0.251693
-0.32079	-1.06434	-0.35503	-0.46841	-0.0868	-0.41126	-1.20174
0.724875	-0.00356	-0.06698	0.482528	-0.60352	0.145534	-0.45522
-0.66968	0.222586	-0.52654	0.396935	0.01227	-1.02384	-0.46777
-0.49971	0.087747	-0.40574	-0.13223	0.232476	0.245964	-0.11328
0.371982	0.578344	0.205598	0.135035	0.222607	0.383294	0.010091
0.011322	0.082695	-0.07139	0.303881	-0.18523	-0.41488	0.694273
-0.20667	-0.41057	0.092649	-0.00603	0.126488	0.835521	-0.07603

-0.51828	-0.63734	-0.52638	-0.34042	0.079151	-0.16096	0.731816
-0.10678	0.669874	-0.07431	0.575293	0.160639	0.338046	-0.33016
-0.44665	-0.71059	0.101822	0.061695	0.246623	-0.41409	-0.48973
-0.18444	-0.46709	0.382483	0.710624	0.337109	-0.15956	0.082087
-0.08581	-0.45273	-0.13672	-0.11889	0.200323	0.619896	0.51926
0.169083	0.307301	0.039664	-0.43008	-0.491	-0.53086	-0.04374
0.379071	-1.19805	0.318762	0.15056	-0.03777	-0.18184	-0.28877
-0.22126	0.841479	-0.3612	-0.05484	0.037167	0.210618	-0.02941
-0.52699	0.228093	0.779335	-0.71799	0.255911	0.059821	-0.01484
0.467883	-1.18952	0.554557	-2.01306	-0.40596	0.424169	-0.23195
0.641531	-1.60774	0.027033	-0.00377	0.200701	0.404852	-0.10251
0.137326	1.115949	0.898617	0.110676	0.651468	0.390917	0.169243
0.003179	0.246808	0.415358	0.315976	0.167373	0.755473	0.265427

SAMPLE OF AR COEFFICIENTS FOR GK (BAND 1)

Frequency (Hz)						
32450000	32500000	32550000	32600000	32650000	32700000	32750000
0.077795	0.207669	0.351366	0.561791	0.207413	0.047333	-0.17751
0.376974	-0.40436	-0.42993	0.193092	0.127574	-0.32456	0.021096
0.348177	-0.6001	-0.05139	-0.11034	-0.10164	0.20734	-0.02442
-0.16978	0.478267	0.072592	-0.37204	0.320068	0.410564	0.784844
-0.5673	-0.37122	-0.35644	0.356536	0.177603	0.032407	0.028037
0.044903	-1.05229	0.039581	-0.79687	0.380404	0.142969	0.30999
-0.56018	0.185289	0.060862	-0.6329	0.132531	-0.12771	-0.48816
0.084126	-0.52415	-0.10978	-0.25436	0.093998	0.474088	-0.06255
-0.07565	-0.03122	0.037117	-1.15747	-0.02722	0.383652	-0.12218
0.382496	0.630432	0.588984	0.368983	-0.16442	-0.57658	0.180678

0.661724	0.059101	0.004058	-0.75268	0.073361	-0.69977	-0.27245
0.157977	0.254049	0.007809	-0.36666	-0.71309	0.222209	0.810841
0.395155	-0.19389	0.102149	-0.1709	0.836024	0.276348	0.155904
0.180323	-0.21966	-0.34311	0.326328	0.088184	0.484859	-0.18185
0.397909	0.555905	0.694116	-0.03671	0.146781	-0.00251	-0.29381
0.518616	0.308954	-0.01511	-0.27442	-0.26565	-0.02143	0.02464
-0.54396	-0.83032	-0.17036	0.076752	-0.04293	0.060958	-0.33861
0.064223	0.498509	0.131406	-0.44358	0.009124	0.1415	0.335013
0.489721	0.342353	0.126331	-0.51382	0.469661	0.404604	-0.35673
-0.0505	-0.43938	-0.09682	0.728419	0.165222	0.078607	-0.40619
-0.1828	-0.88853	-0.12946	0.047562	0.769118	0.383116	-1.05453
-1.40955	0.346104	0.019267	-0.0851	0.016292	-0.38585	-0.16341
0.696619	1.227139	0.124328	0.628076	0.907875	0.593288	0.783178
0.667067	0.313179	-0.13529	-0.20661	0.605085	0.288145	1.018348

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

	Frequency						
	47050000	47100000	47150000	47200000	47250000	47300000	47350000
1	0.142082	0.142854	0.161302	0.21118	0.142981	0.137319	0.092333
2	0.327202	0.373812	0.316963	0.194136	0.132453	0.101847	0.042412
3	0.454381	0.167989	0.17302	0.249151	0.234787	0.267966	0.142745
4	0.140027	0.270385	0.363605	0.32279	0.074365	0.292491	-0.01411
5	0.522173	0.312971	0.173534	0.177438	0.108956	0.214388	0.146981
6	0.44874	0.211417	0.099387	0.324615	0.133016	0.352732	0.124719
7	0.33887	0.269968	0.2373	0.155681	0.416226	0.102995	0.117596
8	0.157132	0.306358	-0.00141	0.272535	0.208197	0.149202	0.000427
9	0.162024	0.282532	-0.02315	0.132821	0.360085	0.324602	0.170727

10	0.865904	0.194295	0.26583	0.231205	0.258112	0.203318	0.07668
11	0.186506	0.253247	0.143088	0.260109	0.165268	0.239198	0.232936
12	0.189718	0.34354	0.324506	0.241545	0.295583	0.19041	0.324238
13	0.341102	0.264191	0.208441	0.120399	0.35972	0.226627	0.247537
14	0.195521	0.312405	0.147051	0.22366	0.356598	0.189614	-0.00936
15	0.359257	0.222688	0.201197	0.128564	0.30404	0.301991	-0.01251
16	0.082627	0.40479	-0.01724	0.101498	0.286102	0.122072	0.151119
17	0.156976	0.164462	-0.03283	0.232648	0.322013	0.273275	0.358765
18	0.3636	0.359227	0.266467	0.263827	0.295614	0.142958	0.356196
19	0.246285	0.322666	0.092883	0.107118	0.467496	0.279867	0.191872
20	0.188093	0.261917	0.223381	0.162498	0.122183	0.310879	0.268874
21	0.20837	0.38382	0.263768	0.118315	0.201843	0.299611	0.307794
22	0.180388	0.243748	0.294233	0.141246	0.439085	0.241694	-0.05643
23	0.25279	0.32624	0.114348	0.247479	0.188274	0.222941	0.379945
24	0.152943	0.22427	0.174014	0.231672	0.336958	0.301555	0.189629

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
47400000	47450000	47500000	47550000	47600000	47650000	47700000
0.337013	0.257961	0.148321	0.504029	0.351936	0.13665	0.325231
0.241823	0.340692	0.229975	0.181242	0.084694	0.244065	0.381632
0.30991	0.425245	0.182202	0.469512	0.146848	0.173356	0.070811
0.136191	0.374542	0.345709	0.16381	0.15822	0.19734	0.279928
0.263841	0.331457	0.325712	0.067713	0.153447	0.260228	0.367471
0.234977	0.292713	0.15655	0.163228	0.157566	0.269924	0.070188
0.390016	0.493589	0.170876	0.235913	0.267487	0.224139	0.233451
0.351621	0.332806	0.241562	0.52053	0.28966	0.245585	0.290074

0.308746	0.405164	0.120629	0.218973	0.128817	0.198991	-0.02549
0.417823	0.08652	0.362445	-0.07269	0.355855	0.171482	0.253525
0.110315	0.2504	0.349451	0.31039	0.085504	0.178283	0.203773
0.275696	0.398615	0.224358	0.388456	0.297876	0.292691	0.312448
0.391891	0.350471	0.30673	0.259152	0.441148	0.164841	0.249304
0.20972	0.217953	0.330677	0.137359	0.072023	0.108454	0.229369
0.204995	0.231337	0.158989	0.122768	0.053345	0.232638	0.178473
0.267808	0.363397	0.234377	0.429685	0.333232	0.181952	0.208415
-0.04904	0.342199	0.119368	0.268175	0.162682	0.234477	0.398328
0.123791	0.345921	0.257598	0.168701	0.1811	0.119054	0.332416
0.131913	0.175202	0.071928	0.23005	0.011562	0.214631	0.198515
0.302737	0.36121	0.320767	0.435699	0.280087	0.256949	0.154217
0.342511	0.321887	0.159922	0.217751	0.183264	0.135628	0.320376
0.160859	0.25168	0.311087	0.23299	0.188603	0.127516	0.104859
-0.02191	0.194027	0.307757	0.109909	0.222518	0.20504	0.129523
0.209052	0.118723	0.233558	0.362968	0.108629	0.135453	0.318264

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
47750000	47800000	47850000	47900000	47950000	48000000	48050000
0.208414	0.415822	0.253451	0.275091	0.283419	0.259392	0.262838
0.270987	0.455098	0.098208	0.164782	0.453851	0.274283	0.511712
0.299677	0.252523	0.257369	0.017839	0.061665	0.14789	0.312461
0.16251	0.339231	0.376726	0.143708	0.179055	0.171234	-0.06163
0.12616	0.248513	0.267665	0.28489	0.145653	-0.00352	0.226639
0.278262	0.213103	-0.05055	0.316637	0.165385	0.298382	0.484458
0.204479	0.308146	0.297131	0.138159	0.209555	0.486183	0.139977

0.221502	0.30554	0.257665	0.320246	0.227374	0.051078	-0.10021
0.149475	0.205949	0.44265	0.218669	0.113691	0.098264	-0.02542
0.281541	0.346909	0.35466	0.34979	0.237741	0.14159	0.250645
0.311996	0.227585	0.135473	0.199916	0.085742	-0.04394	0.195642
0.25957	0.222922	0.492637	0.026013	0.270691	0.178791	0.411776
0.297521	0.104825	0.499944	0.401248	0.304677	0.230909	0.406657
0.262243	0.226533	0.348202	0.112542	0.154454	0.171675	0.125855
0.228118	0.345123	0.310307	0.045113	0.262738	0.30655	0.244172
0.1231	0.396964	0.293406	0.128631	0.432909	0.380231	0.198818
0.184435	0.27367	0.171446	0.089946	0.417461	-0.0007	0.465911
0.313835	0.293458	0.34622	0.144393	0.369475	0.560524	0.27424
0.186746	0.165543	0.212462	0.337106	0.43562	0.464282	0.35088
0.204629	0.11503	0.310016	0.089355	0.346507	0.223741	0.316487
0.258907	0.384655	0.165855	0.261361	0.421759	0.142666	0.280727
0.245068	0.352029	0.277845	0.103736	0.152909	0.332586	0.479093
0.252298	0.428831	0.275396	0.086884	0.362612	0.339902	0.375988
0.245735	0.168654	0.176836	0.115023	0.217304	0.300426	0.120559

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
48100000	48150000	48200000	48250000	48300000	48350000	48400000
0.233611	0.091637	0.207375	0.10452	0.237439	0.15432	0.2766
0.073136	0.17808	0.372996	0.018461	0.382509	0.117874	0.389545
0.266576	0.142668	0.343166	0.161766	0.380585	0.163614	0.20038
0.146032	0.055395	0.150459	0.55289	0.38204	0.187048	0.26508
0.328001	0.174281	0.282295	0.388147	0.226968	0.203737	0.188635
0.135022	0.241786	0.426777	0.257959	0.268359	0.362997	0.158014

0.390102	0.213254	0.105862	-0.02518	0.300015	0.293687	0.027017
0.18745	0.183531	0.21246	0.258165	0.433287	0.168339	0.107382
0.170437	0.250073	0.246218	0.020934	0.087469	0.178582	0.062651
0.178887	0.292619	0.334553	0.087883	0.123467	0.277605	0.347895
0.156487	0.319731	0.157008	0.365369	0.299606	0.243444	0.122708
0.179044	0.238436	0.028189	0.384852	0.253357	0.246134	0.14831
0.21086	0.111517	0.171589	0.141548	0.16525	0.142692	0.13477
0.253191	0.282757	0.285392	0.047891	0.218281	0.423015	0.172768
0.35955	0.251784	0.242235	-0.09944	0.289077	0.22912	0.175964
0.325842	0.233677	0.407275	0.563987	0.181636	0.208841	0.22489
0.351211	0.367084	0.176109	0.464469	0.302239	0.181771	0.155867
0.26602	0.341132	0.308777	0.095619	0.159797	-0.03129	0.232671
0.235862	0.1365	0.211655	0.713786	0.386664	0.136725	0.133121
0.166626	0.221256	0.245635	0.435581	0.101802	0.169356	0.16829
0.211609	0.236858	0.279045	-0.22909	0.186326	0.122804	0.111231
0.121041	0.275425	0.274835	0.105201	0.178035	0.349799	0.351463
0.168918	0.235957	0.26182	0.483031	0.139901	-0.06586	0.319013
0.252284	0.232677	0.333119	0.454803	0.175974	0.189124	0.126258

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
48450000	48500000	48550000	48600000	48650000	48700000	48750000
0.316208	0.256668	0.182821	0.260913	0.36851	0.204869	0.21019
0.364456	0.129315	0.394649	0.170254	0.028897	0.349819	0.050156
0.372902	0.227924	0.201272	0.201927	0.330086	0.137272	0.176853
0.269113	0.222474	0.293732	0.311815	0.286803	0.43043	0.233077
0.178678	0.170728	0.381263	0.348145	0.172282	0.310271	0.212585

0.318944	0.192483	0.356951	0.234392	0.190185	0.241849	0.120147
0.302158	0.297017	0.330925	0.343692	0.099856	0.316964	0.184198
0.288502	0.261097	0.121479	0.331464	0.309612	0.224747	0.171575
0.132795	0.168068	0.292363	0.251559	0.106779	0.424352	0.16706
0.341831	0.136129	0.228663	0.220786	0.176031	0.200057	0.113948
0.403695	0.038945	0.217631	0.24785	0.253403	0.291708	0.200786
0.341597	0.259007	0.339743	0.293324	0.209661	0.254479	0.199696
0.130744	0.273113	0.008968	0.186712	0.31986	0.355682	0.16706
0.217406	0.215912	0.348826	0.228773	0.392322	0.361627	0.042844
0.186536	0.205498	0.145181	0.232522	0.252266	0.121872	0.300535
0.258092	0.360698	0.157352	0.261762	0.16563	0.347764	0.239462
0.351409	0.163955	0.373451	0.226512	0.191468	0.338671	0.271876
0.171041	0.276761	0.265984	0.131493	0.300954	0.065248	0.154403
0.294182	0.148963	0.214007	0.177686	0.103745	0.11362	0.127121
0.288367	0.275811	0.148927	0.2841	0.207193	0.150056	0.168313
0.240269	0.164417	0.424467	0.313289	0.20493	0.189592	0.178362
0.336005	0.138485	0.240721	0.295213	0.229691	0.255487	0.283993
0.313776	0.171315	0.230326	0.230718	0.189924	0.223231	0.247631
0.133097	0.272881	0.248582	0.312766	0.237941	0.269279	0.177161

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
48800000	48850000	48900000	48950000	49000000	49050000	49100000
0.220418	0.178624	0.17493	0.127058	0.26837	0.284217	0.290151
0.273313	0.096873	0.209886	0.127025	0.572193	0.296818	0.140677
0.195969	0.033055	0.267641	0.221883	0.159512	0.101725	0.329583
0.360634	0.203055	0.37153	0.270604	0.303819	-0.02062	0.255751

0.295154	0.283461	0.282901	0.245444	0.012422	0.214401	0.284091
0.305973	0.253305	0.277705	0.22996	0.294681	0.105063	0.275897
0.05734	0.199246	0.365443	0.122511	0.305901	0.143611	0.149056
0.532126	0.445472	0.31587	0.280475	0.037907	0.172914	0.330688
0.221716	0.293054	0.257298	0.250145	0.360106	0.389816	0.323806
0.213462	0.158361	0.495893	0.116277	0.510553	0.277396	0.250947
0.298859	0.106968	0.409082	0.241321	0.025582	0.435656	0.272873
0.147998	0.243548	0.480399	0.214417	0.236868	0.165438	0.321397
0.267597	0.318107	0.322243	0.364651	0.186717	0.339006	0.450064
0.010227	0.157487	0.43532	0.190726	0.333089	0.266979	0.307184
0.275374	0.178433	0.44115	0.228167	0.018649	0.475746	0.292891
0.11179	0.277212	0.242517	0.332228	0.412817	0.298131	0.286035
0.141028	0.128287	0.242302	0.310205	0.132382	0.374067	0.367804
0.296018	0.288418	0.299254	0.236123	0.224512	0.566937	0.169724
0.004348	0.288007	0.292359	0.265595	0.02642	0.135697	0.219735
0.186249	0.163293	0.376219	0.149254	0.276062	0.380962	0.316931
0.240453	0.052947	0.260555	0.344692	0.293209	0.176577	0.251985

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
49150000	49200000	49250000	49300000	49350000	49400000	49450000
0.150694	0.07449	0.199529	0.10077	0.60707	0.276936	0.002516
0.186703	0.117901	0.334891	0.208155	0.43559	0.334669	0.03085
0.172582	0.272309	0.191464	0.032014	0.265421	0.287165	0.378088
0.089728	0.364489	0.263601	0.198765	0.186398	0.149714	0.418405

0.196771	0.420627	0.176774	0.185799	0.309628	0.341771	-0.04362
0.266223	0.353034	0.197323	0.365867	0.22763	0.167261	-0.15076
0.360096	0.180219	0.501324	0.174817	-0.07555	0.24713	0.123102
0.239748	0.249503	0.126257	0.386937	-0.05208	0.170659	0.522475
0.328973	0.1397	0.152417	0.250133	0.510233	0.281816	0.101543
0.365059	0.441587	0.261599	0.469072	-0.03759	0.139361	0.409593
0.284061	0.226627	0.222543	0.435221	-0.0711	0.281494	0.126863
0.172732	0.25573	0.291383	0.202873	0.083185	0.112751	-0.03788
0.308739	0.061004	0.119967	0.268775	0.297974	0.282008	0.291838
0.196121	0.332714	0.201282	0.4053	0.062975	0.294393	0.398234
0.245764	0.247839	0.245118	0.067182	0.180181	0.230011	-0.03923
0.253137	0.131752	0.137548	0.137658	-0.0729	0.283906	0.310728
0.391317	0.401431	0.205504	0.330109	0.070826	0.26413	0.352229
0.09616	-0.01178	0.211082	0.12915	0.435807	0.3218	0.129584
0.122596	0.127742	0.232206	0.27059	0.394458	0.305486	0.150521
0.203807	0.301213	0.214462	0.577386	0.214477	0.231788	0.215651
0.151417	0.141155	0.162724	-0.08292	0.223532	0.147915	-0.06628

SAMPLE OF AR COEFFICIENTS FOR AEDC (BAND 2)

Frequency (Hz)						
49500000	49550000	49600000	49650000	49700000	49750000	49800000
0.152428	0.317012	0.133759	0.351	0.304292	0.289555	0.170872
0.472016	0.127387	0.184255	0.286011	0.05056	0.257615	0.206386
0.136591	0.115435	0.3483	0.354284	0.124356	0.020405	0.136383
0.084461	0.263474	0.09413	0.083406	0.382042	0.159282	0.134395

0.367255	0.070509	0.455573	0.117028	0.350791	-0.02685	0.2589
0.359287	0.147931	0.166719	0.109382	0.090664	0.351345	0.33198
0.114238	0.204703	0.247238	0.560906	0.284617	0.314482	0.34179
0.358648	0.154283	0.188283	0.222989	0.083553	-0.02366	0.228865
0.32879	0.217686	0.234085	0.276362	0.29892	0.377248	0.367441
0.165998	0.236599	0.243114	0.260268	0.26259	0.438269	0.296904
0.221119	0.133484	0.335715	0.184714	0.180902	0.67812	0.111484
0.224878	0.239832	0.25763	0.134111	0.212425	0.141777	0.140596
0.218633	0.26102	0.194624	0.249436	0.369421	-0.13565	-0.03233
0.254584	0.249711	0.287063	0.290687	0.107871	0.300756	0.048615
0.154923	0.136573	0.326936	0.296616	0.354326	0.198648	0.176694
0.01954	0.186015	0.08122	0.243902	0.208821	0.686849	0.176515
0.280947	0.195516	0.183516	0.209594	0.199586	-0.1151	0.363151
0.159258	0.173548	0.006348	0.215089	0.302256	0.244986	0.09645
0.360275	0.239163	0.104727	-0.07528	0.270732	0.448811	0.124433
0.292862	0.168278	0.183284	0.126264	0.23287	0.510952	0.000391
0.301088	0.180433	0.088751	0.34187	0.369022	0.158931	0.282206
0.190081	0.111038	0.024505	0.230749	0.220229	-0.10008	0.325077
0.211242	0.212104	0.340155	0.086536	0.137223	-0.03606	0.419405
0.29178	0.260513	0.238387	0.076961	0.344003	0.121317	0.364957

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

	Frequency						
	68050000	68100000	68150000	68200000	68250000	68300000	68350000
1	0.321241	0.10897	-0.13146	0.369122	0.289017	0.22697	-0.10787
2	0.15433	0.372653	0.395381	0.26844	0.19061	0.292839	-0.0067
3	0.102924	0.073226	0.328379	-0.05429	0.330065	0.203718	-0.01782

4	0.042768	0.410961	0.273561	0.245344	0.244701	0.006036	-0.41429
5	0.226134	0.158648	0.253916	0.343017	0.240003	0.177558	-0.12758
6	0.089094	0.334099	0.141509	0.475823	0.216215	0.39633	0.127646
7	0.395831	0.357886	0.199003	0.125405	0.248634	0.152199	-0.36164
8	0.211866	0.477532	0.113892	0.368822	0.213184	0.086122	-0.47873
9	0.326936	0.479356	0.211078	0.20212	0.207943	0.226933	-0.02957
10	0.168075	0.262234	0.400041	0.06643	0.410644	0.16552	0.247574
11	0.153512	0.083299	0.35675	0.018726	0.180527	0.378967	0.23818
12	0.225493	0.178633	0.221654	0.239792	0.302162	0.084015	0.349846
13	0.02181	0.08178	0.180301	0.228437	0.309539	0.257109	0.00934
14	0.178074	0.311401	0.148314	-0.1635	0.27652	0.336986	-0.05698
15	0.372826	0.736652	0.019312	0.235799	0.341816	0.031335	-0.05342
16	0.313482	0.442924	0.178198	-0.09891	0.122481	0.084673	0.13376
17	0.260323	0.036132	0.11865	0.248277	0.138346	0.347486	0.270551
18	0.151742	0.412322	0.156344	0.118394	0.243946	0.206263	0.652353
19	0.391826	0.103967	-0.10332	-0.01629	0.176867	0.168748	0.106284
20	0.121139	-0.01267	0.231847	0.064706	0.169213	0.3131	0.211616
21	0.157327	0.018124	0.352179	0.137374	0.098356	0.261459	-0.03465
22	0.073897	0.127757	0.280163	0.185145	0.307065	0.103796	-0.11211
23	0.23936	0.175518	0.008859	0.068934	0.089552	0.189063	0.194486
24	0.072628	0.120501	0.080419	0.103966	0.178382	0.207954	-0.07779

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)						
68400000	68450000	68500000	68550000	68600000	68650000	68700000
0.221235	0.179234	0.161863	0.475272	0.247436	0.1271	0.199574
0.271969	0.165442	0.142437	0.146623	-0.21308	0.28671	0.249645

0.078687	0.31056	0.115189	-0.03065	0.360202	0.070151	0.212271
-0.03851	-0.01546	0.030724	0.2156	0.322086	0.123131	0.414555
0.210952	0.230413	0.017411	0.325641	0.060434	0.263753	0.356746
0.338174	0.374432	0.133954	0.331736	-0.02813	0.103258	0.468344
0.312253	0.156955	0.156457	0.707404	0.573846	0.428838	0.140313
0.176562	0.230466	0.01115	0.490707	0.000836	0.111194	0.334235
0.623309	0.324611	0.221931	0.066414	0.19491	0.182807	0.096247
-0.00548	0.391699	0.3167	0.313066	0.330409	0.307324	0.275833
0.458112	0.438617	0.432702	0.502103	0.281606	0.12233	0.330763
0.313614	0.342393	0.142697	0.432462	0.25277	0.141158	0.261813
0.229995	0.205969	0.23214	0.383464	0.506774	0.192477	0.13214
0.277871	0.278502	0.1857	-0.03785	0.388486	0.226482	0.267013
0.170413	0.283763	0.047964	0.434863	-0.33382	0.116689	0.226816
0.281301	0.296423	0.163339	0.260115	0.346641	-0.03474	0.252282
0.001952	0.384084	-0.03863	0.327506	-0.05382	0.204076	0.341955
0.133349	0.342275	0.187294	0.279523	0.370426	0.193062	0.39117
0.047277	0.000314	0.134764	0.62147	0.400297	0.153222	0.382101
0.357916	0.025041	0.146608	0.115062	-0.11215	0.402588	0.110151
0.198048	0.201856	0.116073	0.497607	-0.40099	0.17135	0.323549
-0.04945	0.191546	0.17872	-0.29669	0.334304	0.200612	0.310608
-0.05443	0.141786	0.218759	0.414138	0.225844	0.090281	0.144072
0.401907	0.272183	0.393874	0.726372	0.463637	0.116888	0.272298

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)						
68750000	68800000	68850000	68900000	68950000	69000000	69050000
0.060842	0.267183	0.153526	0.007454	0.063861	0.326728	-0.06065

0.217494	0.110043	0.176987	-0.01165	0.398621	0.248253	0.338006
0.184928	0.22873	0.14662	0.351326	0.358205	0.314052	0.27216
0.208478	0.259792	0.220341	0.086143	0.316917	0.611418	-0.10855
0.135254	0.272872	0.227737	0.163418	0.062017	0.163402	-0.00724
0.266415	0.228054	0.13015	0.382712	0.273259	0.081347	0.304989
0.221723	0.055265	0.273058	0.105413	0.150019	0.247896	0.097335
0.068157	0.095141	0.13282	0.393868	0.201347	0.394158	0.094206
0.258802	0.095997	0.15999	0.299358	0.261263	0.191829	-0.01562
0.25059	0.262702	0.232437	-0.12541	0.254341	0.298559	0.12504
0.24825	0.113818	0.214903	0.187366	0.306456	0.488978	0.412722
0.391954	0.146046	-0.01802	0.222064	0.303573	0.048891	0.377561
0.210515	0.14014	0.130932	0.140243	0.480888	0.506979	0.210322
0.195968	0.210336	0.092689	0.373108	-0.01522	0.201031	0.168377
0.225734	0.121354	0.371565	0.211833	0.556885	0.096195	0.145149
0.198952	0.017032	0.235568	0.216823	0.41434	0.61108	0.046803
0.072652	0.322273	0.320919	0.168574	0.251081	0.108475	0.214156
0.261671	0.322687	0.129853	0.394665	0.494456	0.292745	-0.08225
0.328459	0.274765	0.136121	0.054619	-0.08562	0.435359	0.092839
0.128302	0.013309	0.26481	0.444514	-0.02005	0.335381	0.151341
0.255432	0.27477	0.265058	-0.01778	0.135641	0.057236	-0.04744
0.110558	0.266029	0.07902	0.255477	0.198974	-0.08309	0.405445
0.327765	0.285567	0.143751	0.258199	0.203955	0.470864	0.436017
0.20436	0.080756	0.115844	0.395478	0.052573	0.574601	-0.02949

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)						
69100000	69150000	69200000	69250000	69300000	69350000	69400000

0.303628	0.2141	0.109927	0.272062	0.147196	0.271175	0.379952
0.228441	0.247503	0.488949	0.168968	0.283515	0.432464	0.181465
0.189092	0.196728	0.651233	0.284392	0.051146	0.513276	0.206259
0.190329	0.105899	0.290592	0.217904	0.293954	0.265983	0.229588
0.08744	0.230667	0.339643	0.352341	0.31078	0.091083	0.061835
0.202382	0.278358	0.042218	0.197482	-0.04639	0.481104	0.253793
0.241868	0.236732	0.510599	0.265396	0.191392	0.243518	0.202904
0.11767	0.124299	-0.21563	0.205393	0.22978	0.22561	-0.03132
0.095278	0.228668	0.099747	0.014861	-0.11652	0.042227	0.006186
0.151628	0.208369	0.196041	0.17101	0.153271	0.156174	0.455421
0.180544	0.292455	0.410601	0.151896	0.31204	0.683653	0.221997
0.165566	0.316808	0.194842	0.320571	0.145038	0.47903	0.30987
0.179132	0.147481	-0.16269	0.089705	0.139982	0.449511	0.185045
0.184704	0.193759	-0.0424	0.206489	0.190591	0.410576	0.018634
0.191033	0.191476	-0.15849	0.297287	0.278421	0.318996	0.046681
0.152305	0.335595	-0.11352	0.279976	0.012452	0.406232	0.136594
0.169534	0.192047	0.24582	0.227219	0.247787	0.138078	0.471958
0.190338	0.178365	0.292818	0.110152	0.347235	0.146363	0.32871
0.172213	0.241031	0.111538	0.253232	0.142509	0.307084	0.280816
0.162723	0.208821	0.111394	0.346413	0.190018	0.2535	-0.01084
0.195803	0.180558	0.349274	-0.08654	-0.06398	0.149557	0.211246
0.167534	0.188336	0.590481	0.277249	0.056686	0.251407	0.215526
0.058497	0.193398	0.594477	0.348645	0.194156	0.140844	0.42911
0.122852	0.171183	0.163196	0.312844	0.19401	0.416304	0.239115

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)

69450000	69500000	69550000	69600000	69650000	69700000	69750000
0.238469	0.220925	0.181153	0.071529	0.172672	-0.17235	0.141419
-0.01702	0.015417	0.340889	0.163484	0.104183	0.488664	0.005595
0.273163	0.294762	0.064137	0.206138	0.175102	0.186054	0.293008
0.139151	-0.01968	0.039104	0.011154	0.093598	0.343061	0.323236
0.216611	-0.04482	0.36725	0.149889	0.172754	0.188304	0.286986
0.161967	0.105686	0.245038	0.213209	0.16946	0.459276	0.128332
0.116479	0.042521	0.080817	0.209144	0.2491	0.262107	0.070801
0.100138	0.296261	-0.03938	0.198308	-0.00262	0.197969	0.2594
0.060628	-0.02453	0.186682	0.216701	0.278144	0.390068	0.116056
-0.10688	0.008674	0.067781	0.13731	0.210077	0.206607	0.098496
0.234944	-0.0064	0.30555	0.199017	0.218192	0.423754	0.350122
0.109927	0.117433	0.139816	0.12162	0.336955	-0.12318	0.206696
-0.09304	0.137393	-0.0121	0.035558	0.167737	0.502112	0.201268
0.072903	0.315272	0.260499	0.072047	0.060076	0.047556	0.221822
0.14771	0.358193	0.16879	0.205564	0.215832	0.25198	0.140697
0.188775	0.329806	0.126486	0.19437	0.130382	0.178551	0.170679
0.016809	0.029657	0.22112	0.127584	0.21691	0.340457	0.142878
0.294081	0.275621	0.273352	0.107496	0.048658	0.071644	0.13162
0.019532	0.12025	0.029074	0.163987	0.124634	-0.10986	0.272571
0.04431	0.192198	0.213447	0.137852	0.31983	0.124718	0.156528
0.243572	0.057058	0.359659	0.121423	0.185187	-0.2476	0.027707
0.144076	0.14342	0.267962	0.158076	0.216891	0.269136	0.180377
0.029379	0.058191	-0.0867	0.149039	0.046331	0.389955	0.093359
0.197527	-0.12338	0.038574	0.127308	0.20537	-0.2387	0.178417

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)						
69800000	69850000	69900000	69950000	70000000	70050000	70100000
0.333623	0.292139	0.14177	0.259658	0.198844	0.382266	0.308133
0.202312	-0.00026	0.348708	0.151081	0.409796	0.295286	0.037599
0.291359	0.207801	0.308702	0.204519	0.31565	0.183999	0.343498
0.254839	0.33603	0.134379	0.233244	0.37773	0.240225	0.209071
0.22253	0.35434	0.093995	0.264617	0.048874	0.187971	0.312331
0.254149	0.630806	0.304079	0.287208	0.187204	0.233428	0.373372
0.200791	0.404918	0.249283	0.339782	0.357521	0.156435	-0.00337
0.177197	0.342962	0.223172	0.341365	0.12082	0.123771	0.145582
0.283437	0.495456	0.132947	0.25036	0.067694	0.116481	0.330321
0.294807	0.316093	0.210164	0.227048	0.549844	0.464233	0.229536
0.313034	0.161632	0.390178	0.160962	0.053523	0.353662	0.222632
0.197732	0.323735	0.360144	0.184772	0.062464	0.278196	0.191102
0.305579	0.351576	0.30298	0.256289	0.331287	0.263597	0.153651
0.420877	0.26982	0.215399	0.103358	0.393151	0.055869	0.236633
0.30772	0.296189	0.242059	0.134479	0.352231	0.178366	0.350399
0.413414	0.300215	0.115531	0.274654	0.376799	0.137183	0.237207
0.355883	0.23183	0.264414	0.234718	0.167475	0.221068	0.179889
0.37594	0.34613	0.399688	0.173543	0.246126	0.117168	0.325204
0.27973	0.31976	0.030406	0.140449	0.158525	0.292308	0.324824
0.331956	0.225792	0.037051	0.263618	0.185966	0.225225	0.274461
0.341288	0.245147	0.205187	0.174829	0.167847	0.281341	0.170489

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)						
70150000	70200000	70250000	70300000	70350000	70400000	70450000
-0.03053	0.092694	-0.04722	0.189541	0.176861	0.196502	0.21075
0.111326	0.376641	0.35604	0.387853	0.15418	0.198079	0.342603
0.153641	0.315637	0.40919	0.265344	0.180363	0.287922	0.112651
0.237896	0.36931	0.290754	0.285828	0.141768	0.347689	0.363788
-0.00957	0.15263	0.225493	0.153019	0.166634	0.342109	0.206703
0.069501	-0.04015	0.044321	0.297321	0.130413	0.221855	0.333269
0.183167	0.112804	0.122467	0.204895	0.167538	0.216676	0.450628
0.104362	0.426436	0.477532	0.253212	0.165228	0.270476	0.310585
0.327839	0.055482	0.124528	0.094677	0.230896	0.21081	0.23592
0.267673	0.259083	0.21692	0.231651	0.20065	0.166594	0.259341
0.27342	0.227052	0.026126	0.038955	0.154559	0.246422	0.443857
0.10253	0.066702	0.310356	0.290581	0.209725	0.291402	0.552133
0.335218	0.280545	0.554917	0.065224	0.180736	0.342994	0.197107
0.197707	0.479314	0.363024	0.295442	0.225762	0.234975	0.033642
0.227538	0.132264	0.114392	0.161352	0.09478	0.262581	0.36132
0.265475	0.207321	0.062291	0.36975	0.191221	0.073532	0.337604
0.296856	0.064456	0.326247	0.28949	0.191754	0.312838	0.400956
0.003427	0.26419	0.431772	0.2648	0.121227	0.261984	0.226917
0.043921	0.327879	0.204451	0.217225	0.183579	0.381787	0.24296
0.010372	0.30051	-0.07525	0.185159	0.177584	0.143845	0.365173
0.220305	0.303568	0.104181	0.140231	0.138326	0.481042	0.195888

SAMPLE OF AR COEFFICIENTS FOR TUNGA (BAND 3)

Frequency (Hz)

70500000	70550000	70600000	70650000	70700000	70750000	70800000
-0.04481	0.182949	0.220415	0.391017	0.159552	0.310938	0.278784
0.135213	0.275089	0.33466	0.127379	0.198603	0.061121	0.415781
0.238331	0.27417	0.418302	0.238902	0.154726	0.153758	0.292643
0.332233	0.348262	0.338857	0.450582	0.20445	0.141009	0.01959
0.15711	0.045395	0.208108	0.01847	0.232361	0.304055	0.365875
0.16571	0.180123	0.000922	-0.02471	0.183809	0.223193	0.210577
0.053694	0.19391	0.108281	0.481527	0.275334	0.225676	0.334024
0.061084	0.014029	0.208483	0.259987	0.132196	-0.26926	0.24793
0.181601	0.073484	0.090549	0.425791	0.204426	0.323619	0.183783
0.144363	0.162357	0.407705	0.461187	0.203692	0.169226	0.194917
0.176169	0.173611	0.132933	-0.04804	0.275976	0.326135	0.019754
0.108109	0.127694	0.313942	0.380985	0.200403	0.16228	0.392315
0.314755	0.334169	0.285515	0.40501	0.127061	0.056427	0.143568
0.251634	0.057662	0.540136	0.175277	0.225873	0.388771	0.311694
0.140433	0.289914	0.248001	0.402404	0.131421	0.286098	0.130495
0.118504	0.302998	0.271428	0.173526	0.245525	0.166594	-0.02323
0.202691	0.333401	0.198652	0.156823	0.221807	0.152387	0.367448
0.116155	0.075024	0.101961	0.198924	0.187277	0.473423	0.035797
0.119397	0.272693	0.128364	0.300858	0.176365	0.448394	0.321884
0.191739	-0.04991	0.271861	0.302596	0.182134	0.351432	0.102162
0.142582	0.072289	0.221697	0.194573	0.282097	0.191233	0.330811

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

	Frequency						
	74850000	74900000	74950000	75000000	75050000	75100000	75150000
1	0.412299	0.131394	0.122548	0.267964	0.012732	-0.01165	0.026221
2	0.437116	0.112495	0.263785	0.322352	0.161751	0.201856	0.187336
3	0.382413	0.113711	0.171069	0.134117	0.096099	0.054867	0.334717
4	0.066917	0.137265	0.329828	-0.04803	0.050614	0.048027	0.021856
5	-0.06143	0.115372	0.205911	0.208631	0.174423	0.136258	-0.06266
6	0.247751	0.27152	0.199478	0.164184	0.120373	0.051598	0.200847
7	0.201046	0.065664	0.201459	0.154756	0.077923	0.21072	0.13822
8	-0.15757	0.158377	0.147377	0.322162	0.103581	0.253926	-0.09613
9	0.170878	0.137457	0.224595	0.117899	0.059717	0.130934	0.058245
10	0.332395	0.117515	0.131685	0.251023	0.159907	0.082311	0.390946
11	0.003642	0.212299	0.160312	0.084944	0.08775	0.283345	0.019607
12	0.071884	0.222199	0.299635	0.298508	0.158219	0.2484	0.212966
13	0.132875	0.186666	0.177944	0.16969	0.186165	0.23671	0.24604
14	-0.0283	0.274589	0.197933	0.301396	0.095274	-0.02693	0.152502
15	0.153938	0.196531	0.070818	0.182547	0.155642	0.445534	0.190764
16	0.200278	0.392292	0.140158	0.145397	0.128804	0.133478	0.252625
17	-0.06379	0.08231	0.168155	0.243672	0.083248	0.016145	0.110798
18	0.40626	0.165555	0.111574	0.27644	0.11125	0.149177	0.501302
19	0.373339	0.332856	0.171922	0.192802	-0.00236	0.176756	0.309813
20	0.04963	0.189074	0.135935	0.065652	0.146312	0.111459	0.092135
21	0.25805	0.13251	0.218717	-0.02333	0.153265	0.057964	0.304519
22	0.241951	0.19466	0.347895	0.326371	0.110444	0.174149	0.099438
23	0.499112	0.185447	0.265822	0.344197	0.022094	0.222911	0.084614
24	0.046493	0.182982	0.203939	0.140223	0.123009	0.157543	0.195471

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)						
75200000	75250000	75300000	75350000	75400000	75450000	75500000
0.29605	0.125513	0.62325	0.118095	0.093811	0.156508	0.138005
0.240921	0.195592	0.643801	0.276527	0.113291	0.168011	-0.16617
0.195777	0.174234	0.083368	0.478228	0.20093	0.280935	-0.22458
0.073171	0.200695	0.460269	0.336039	0.287531	0.067408	-0.02011
0.105738	0.120171	0.289019	0.033144	0.001288	0.309236	-0.12655
0.229644	0.140491	0.170796	0.274274	0.196637	0.111448	-0.01853
0.416587	0.187053	-0.00498	0.243377	0.164557	0.08079	0.279386
0.261782	0.129831	0.083447	0.464448	0.084926	0.136515	-0.12906
0.332312	0.142414	0.331606	0.282495	0.00093	0.027904	-0.22011
0.442388	0.015056	-0.07874	0.013106	0.143714	0.307893	0.447773
0.052704	0.127982	0.352027	0.369375	0.188411	0.242244	0.106035
0.162169	0.172251	0.465524	0.216849	0.157138	0.164819	0.322223
0.259758	0.165197	0.370824	0.172182	0.07532	0.16067	-0.02337
0.221778	0.113806	0.459962	-0.03828	0.159785	0.132631	0.089185
0.212116	0.186878	-0.13283	0.073631	0.088355	0.196891	0.00094
0.268397	0.201971	0.37403	0.22332	0.139282	0.121535	0.18969
0.083937	0.251723	0.347846	0.426242	0.133183	0.13268	0.099254
0.17871	0.088965	0.467801	0.096393	0.11487	0.229405	0.13313
0.298969	0.132114	0.434043	0.299031	0.154738	0.044788	0.209448
0.339355	0.221449	0.031604	0.433504	0.115057	0.159521	0.037562
0.220675	0.145476	0.378628	0.287505	0.079079	0.157879	0.506376
0.388707	0.255468	0.172926	0.083196	0.09941	0.133222	-0.01215
0.190004	0.168592	0.125988	0.34888	0.085822	0.111594	0.038055
0.060841	0.166116	0.234273	0.627756	0.168769	0.185835	-0.10689

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)						
75550000	75600000	75650000	75700000	75750000	75800000	75850000
0.230776	0.273774	0.260189	0.133041	0.588201	0.174593	0.116155
0.343695	0.356202	0.215015	0.15181	0.30667	0.36536	0.345248
0.059976	0.292659	0.16114	0.266371	0.357888	0.258764	0.233547
0.121383	0.272224	0.200293	0.087514	0.193005	0.319385	0.161924
0.154514	0.195214	0.270817	0.244087	0.24138	0.260317	0.20807
0.118247	0.23812	0.185486	0.270682	0.090267	0.407396	0.192981
0.255429	0.410923	0.198666	0.25525	-0.13516	0.142948	0.357865
0.073392	-0.02321	0.326172	0.169682	0.198865	0.117655	0.048748
0.276017	0.056933	0.30923	0.162939	0.545393	0.013105	0.245222
0.369519	0.317278	0.209465	0.057453	0.161768	0.286927	0.176761
0.145513	0.35183	0.202566	0.207421	-0.0375	0.157903	0.184989
0.269123	0.333179	0.368898	-0.05893	-0.02917	0.053075	0.309989
0.003984	0.149519	0.325851	0.269045	0.021783	0.269416	0.370648
0.021732	0.184023	0.412882	0.161067	0.192084	0.206692	0.105911
0.448146	0.504674	0.159957	0.108452	0.474578	0.159817	0.23111
0.037776	0.306855	0.274093	0.082891	0.289822	0.294697	0.177354
0.135697	0.321941	0.098703	0.18273	0.177277	0.04603	0.347012
0.248898	0.317338	0.232267	0.262378	0.774	0.40783	0.196153
0.375693	0.40463	0.279587	0.08105	0.02741	0.085806	0.25207
0.032505	0.460011	0.174246	0.097727	-0.01687	0.33055	0.228347
0.240624	0.199225	0.209123	0.100878	-0.09752	0.069431	0.188848
0.12792	0.158406	0.229888	0.169075	-0.02227	0.230707	0.187995
0.235378	0.423065	0.156873	0.284402	0.220644	0.077454	0.3207
0.09398	0.331169	0.100424	0.20546	0.212889	0.144914	0.158216

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)						
75900000	75950000	76000000	76050000	76100000	76150000	76200000
0.391956	0.194446	0.244825	0.044067	0.47545	-0.00144	0.247549
0.334708	0.290938	0.429807	-0.00184	0.058766	0.383032	0.190861
0.133636	0.246188	0.336321	0.127132	0.224072	0.195202	0.100654
0.268641	0.136159	0.185189	0.576739	0.403758	0.074183	0.439921
0.189448	0.331484	-0.02009	0.378139	0.096103	0.062904	0.111902
0.124495	0.359722	0.390637	0.326936	-0.06659	0.332219	0.06447
0.29115	0.145572	0.393184	0.212698	0.509443	0.225079	0.267152
0.011824	0.261775	0.326842	0.263887	0.346609	0.266645	0.201883
0.115734	0.322686	-0.05282	0.025032	0.3551	0.133688	0.099689
0.017491	0.218072	0.17176	0.248198	0.284961	0.090566	0.167152
0.16376	0.190271	0.314704	0.350403	0.29879	0.154394	0.158842
0.125553	0.191734	0.288127	0.268826	0.185183	0.272122	0.238806
0.28377	0.060246	0.145885	0.132666	0.129562	0.200338	0.13314
0.224919	0.265397	0.314008	0.158156	0.065029	0.291112	0.110008
0.16236	0.324724	0.468784	0.021146	0.081407	0.281942	0.16743
0.184157	0.241527	0.299231	0.294066	-0.16925	0.336021	0.237924
0.184727	0.444219	0.235601	0.367399	0.496469	0.15778	0.220879
0.123389	0.342068	0.257424	0.120113	0.162916	0.176772	0.297483
0.202997	0.196409	0.350708	0.535404	0.304731	0.16788	0.122195
0.137492	0.266467	0.1718	0.290444	0.001237	0.063044	0.159071
0.068706	0.336213	0.169636	-0.07137	0.312891	0.243421	0.299227
0.028496	0.310916	0.002168	0.167477	0.104251	0.163318	0.194189
0.290251	0.340333	0.157465	0.331238	-0.04102	0.158495	0.35861
0.274186	0.322849	0.232668	0.291438	0.2133	0.050127	0.10301

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)						
76250000	76300000	76350000	76400000	76450000	76500000	76550000
0.208131	0.137641	0.386634	0.346641	0.301953	0.186506	0.336139
0.204667	0.140085	0.63101	0.125427	0.197675	0.348481	0.212417
0.140487	0.226294	0.514547	0.15772	0.278411	0.181023	0.157524
0.397969	0.117927	0.348673	0.475324	0.148507	0.283498	0.045852
0.179743	0.198013	0.350455	0.314788	0.182597	0.210468	0.098995
0.211356	0.082686	0.511524	0.295801	0.182495	0.624049	0.260949
0.298434	0.153578	0.114823	0.065523	0.259008	0.408852	0.171136
0.264896	0.051646	0.33765	0.256898	0.234222	0.448703	0.234913
0.349229	0.30395	0.398046	0.32064	0.121088	0.139452	0.190171
0.363819	0.076535	0.356587	0.228503	0.040201	0.150874	0.203119
0.41299	0.219072	0.213606	0.367772	0.231522	0.150115	0.253292
0.462932	0.18557	0.184989	0.341623	0.166091	-0.18742	0.121141
0.232152	0.223296	0.083277	0.229768	0.228829	0.380545	0.28081
0.135156	0.120336	0.421115	0.160377	0.506723	0.336531	0.302568
0.205861	0.184615	0.233733	0.28179	0.425202	0.374079	0.371949
0.211525	0.313883	0.183223	0.09424	0.42561	0.385445	0.212031
0.409776	0.173107	0.255094	0.2128	0.198521	0.270041	0.107437
0.283242	0.287093	0.325785	0.310247	0.309903	0.28264	0.092236
0.321804	0.154015	0.18791	0.394471	0.207444	0.288995	0.128297
0.163181	0.099456	0.074556	0.174056	-0.04839	0.427461	0.164655
0.174509	0.123401	0.326632	0.233233	-0.01057	0.110044	0.417686
0.372038	0.1437	0.31422	0.289016	0.309035	0.229617	0.048185
0.204196	0.111568	0.117145	0.240864	0.329185	0.145682	0.19049
0.302195	0.015332	0.030798	0.289816	0.268496	-0.00214	0.218924

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)						
76600000	76650000	76700000	76750000	76800000	76850000	76900000
0.222335	0.299335	0.040841	0.252807	0.275923	0.248115	0.185304
0.206062	0.392533	0.091838	-0.01157	0.389074	0.073098	0.182271
0.234328	0.08997	0.115358	0.271321	0.423235	0.21641	0.068444
0.36572	0.198151	0.377621	0.200807	0.315485	0.179388	0.11564
0.126908	0.24363	0.449803	0.158046	-0.30354	0.3041	0.143285
0.034595	0.166813	0.626053	0.344158	0.46876	0.260673	0.123349
0.030381	0.22145	0.318059	0.312703	0.183568	0.233002	0.046381
0.218248	0.350732	0.375599	0.147755	-0.03465	0.256701	0.069131
0.162801	0.322454	0.132554	0.231502	0.199019	0.14045	0.187281
0.240493	0.273111	0.319912	0.279161	0.464464	0.111242	-0.03502
0.151123	0.128303	0.325328	0.399787	0.258365	0.259952	0.114383
0.367604	0.287058	-0.13816	0.096275	-0.02661	0.403923	0.26014
0.279031	0.307152	0.572259	0.298181	0.214377	0.072692	0.114379
0.256755	0.127802	0.295738	0.101627	0.434134	0.074746	0.350847
-0.03515	0.042769	0.287028	0.020885	0.096295	0.311742	0.202693
0.163838	0.243818	0.420547	0.360307	0.049538	0.066571	0.273997
0.04666	0.121887	0.526324	0.056154	0.213643	0.259902	0.250654
0.198542	0.23799	0.212328	0.272687	0.159209	0.013096	0.124845
-0.032	0.18323	0.156564	0.250137	-0.01521	0.202692	0.247276
0.150034	0.077877	0.412905	0.274015	0.059491	0.11822	0.238933
0.132965	0.098345	0.329295	0.444466	0.136776	0.173026	0.233234

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)						
76950000	77000000	77050000	77100000	77150000	77200000	77250000
0.05977	-0.01793	0.136189	0.327394	0.296001	0.232789	-0.03951
0.137748	0.32741	0.144969	0.322054	0.296915	0.193592	0.1579
-0.0144	0.273905	0.187955	0.078322	-0.04261	0.238711	0.416965
0.309996	-0.12371	0.096151	0.031763	0.335309	0.163598	0.298734
0.195433	0.212821	0.023723	0.134842	0.144433	0.18761	0.135703
0.073742	0.189089	0.191981	0.346621	0.195037	0.213659	0.11853
0.140551	0.315788	0.423337	-0.12365	-0.29498	0.165353	0.160327
-0.08099	0.369808	0.129695	0.35689	0.020495	0.273162	0.323499
0.352026	-0.03779	0.133571	0.343507	0.686166	0.205493	0.095765
0.088947	0.219338	0.133482	0.350647	0.138939	0.156773	0.18025
0.227378	0.24583	-0.01865	0.254744	-0.17154	0.213445	0.177977
0.217471	0.034862	0.168986	0.108747	0.372527	0.193963	0.121919
0.335587	0.211213	0.219916	0.26476	0.343902	0.270155	0.053005
0.578004	0.230078	0.03438	0.175163	0.392994	0.262061	0.31329
0.300825	0.41515	0.294133	0.126608	0.0887	0.38461	0.073651
0.18249	0.256173	0.122228	0.307946	-0.04873	0.170973	0.380239
0.174098	0.202188	0.077859	0.186101	0.038381	0.126831	0.274961
-0.05349	-0.05158	0.137925	-0.02548	0.178639	0.356244	0.073816
0.244148	0.453338	0.187512	0.427085	0.263727	0.211461	0.07917
0.102166	0.489057	0.271444	0.336814	0.036357	0.302075	0.006342
0.281104	0.416727	-0.02358	0.173776	0.384907	0.102942	0.144352

SAMPLE OF AR COEFFICIENTS FOR KUBWA (BAND 4)

Frequency (Hz)

77300000	77350000	77400000	77450000	77500000	77550000	77600000
0.174811	0.304755	0.109258	0.210652	0.256689	0.182107	0.01006
0.146084	0.303272	0.122334	0.30482	0.144896	0.435738	0.236042
0.131383	0.130867	0.216218	-0.02284	0.224416	0.285548	0.011539
0.143872	0.044186	0.02219	0.260202	0.245091	0.246093	0.135409
0.263222	0.174815	0.188967	0.010635	0.210486	0.1288	0.256948
0.260224	0.311522	-0.26682	0.232581	0.154834	0.102736	0.183514
0.202828	0.203825	0.182229	0.537147	0.201424	0.218942	0.180387
0.141637	0.110055	0.262709	0.44548	0.184049	0.245267	0.142221
0.244753	0.16227	0.37574	0.323655	0.189955	0.334851	0.138883
0.300448	0.195627	0.229029	0.041488	-0.00718	0.37451	0.270267
0.288136	0.179443	0.157744	0.114589	0.176706	0.013059	0.158044
0.075088	0.085514	0.223187	0.157984	0.093921	0.080087	0.081364
0.231179	0.277167	0.323841	0.25398	0.231516	0.038723	0.231772
0.232312	0.289879	0.321866	0.352901	0.188134	0.201792	0.349763
0.294642	0.294451	0.323599	0.323841	0.397965	0.195877	0.269152
0.108024	0.255356	0.181863	0.174712	0.270289	0.266965	0.315591
0.016263	0.280304	0.285896	0.030389	0.362613	-0.0186	0.258055
0.093774	0.219768	0.113478	0.280175	0.105325	0.36771	0.235071
0.241052	0.211487	0.247282	0.204089	0.237345	0.156103	0.303375
0.330318	0.263672	0.044506	0.251161	0.076422	0.245009	0.145484
0.212133	0.227323	0.12846	0.095735	0.485184	0.180312	0.282426

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

	Frequency						
	87500000	87550000	87600000	87650000	87700000	87750000	87800000
1	-0.07877	0.224776	0.184034	0.137961	0.192728	0.154994	0.19774
2	0.053554	0.315563	0.338777	0.165851	0.373001	0.320717	0.199068
3	0.211907	0.094825	0.235149	0.294662	0.258463	0.11474	0.342534
4	0.219213	0.256188	0.301653	0.079251	0.200922	0.205431	0.190225
5	0.284086	0.217582	0.284141	0.194836	0.194926	0.072578	0.25902
6	0.278445	0.266223	0.183648	0.229078	0.272672	0.281287	0.076935
7	0.208002	0.27104	0.388348	0.141222	0.335052	0.305274	0.223916
8	0.247385	0.299188	0.10396	0.18293	0.276244	0.223678	0.095698
9	0.417145	0.228928	0.179757	0.233846	0.211785	0.228797	0.315236
10	0.329636	0.209756	0.071455	0.14511	0.230612	0.209489	0.361118
11	0.033607	0.281886	0.216163	0.071223	0.255458	0.26141	0.203284
12	0.222778	0.413648	0.200957	0.253557	0.144028	0.305479	0.27231
13	0.355609	0.198264	0.23094	0.172044	0.276657	0.319335	0.198373
14	0.050771	0.180397	0.228816	0.261776	0.259635	0.172444	0.384327
15	0.355327	0.229627	0.120966	0.182025	0.166244	0.290296	0.206655
16	0.107288	0.254627	0.201387	0.061881	0.223251	0.113614	0.31343
17	0.005949	0.181955	0.277694	0.168914	0.34976	0.226685	0.216065
18	0.270916	0.273207	0.1383	0.235537	0.217683	0.240512	0.35171
19	0.341071	0.345775	0.138784	0.107988	0.245073	0.211126	0.14845
20	-0.18037	0.317776	0.241395	0.317582	0.059611	0.24773	0.193438
21	0.165575	0.169467	0.349094	0.267315	0.184573	0.177901	0.232238
22	0.099761	0.213457	0.199964	0.24337	0.228797	0.233683	0.203175
23	0.217185	0.126961	0.15846	0.313789	0.321758	0.278655	0.292155
24	0.028694	0.137579	0.235928	0.028166	0.216461	0.226384	0.1031

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
87850000	87900000	87950000	88000000	88050000	88100000	88150000
0.121349	0.156369	0.616429	0.067944	0.101918	0.195849	0.228323
0.284427	0.248297	0.432852	-0.1639	0.167684	0.07745	0.229958
0.121447	0.152967	0.174548	0.263627	0.174692	0.134773	0.345334
0.06201	0.215787	0.462798	0.359673	0.292428	0.387602	0.337855
0.166192	0.166963	0.102689	-0.08551	0.043276	0.43721	0.246878
-0.04259	0.079966	0.184431	0.150394	0.354913	0.251998	0.406049
0.477002	0.113151	0.121044	0.246209	0.420118	0.25868	0.571271
0.27475	0.184676	0.288822	0.597676	0.253043	0.314366	0.481881
0.336685	0.253787	0.343248	0.46215	0.118353	0.100077	0.590877
0.276942	0.106698	0.117278	-0.07042	0.277134	0.261795	0.510522
-0.01576	0.170493	0.279881	0.388654	0.272367	0.293406	0.415275
0.245343	0.345546	0.286203	0.20318	0.086932	0.22014	0.562395
0.281485	0.197732	0.373378	0.312599	0.264473	0.161304	0.192187
0.236021	0.261481	0.121576	-0.1433	0.247664	0.333547	0.514311
-0.0149	0.201591	0.074002	0.204974	0.147287	0.132514	0.438422
0.262737	0.32192	0.121739	-0.102	0.089891	0.352429	0.310532
0.091079	0.165054	0.135737	0.245795	0.279743	0.281838	0.377228
0.212981	0.193693	0.29326	0.144322	0.099222	0.232062	0.52671
0.160626	0.157533	0.509171	0.343684	0.220855	0.215216	0.461124
0.337047	0.22204	0.123636	0.475344	0.044997	0.24754	0.366116
0.33048	0.158952	0.13894	0.221769	0.234128	-0.04328	0.666946
0.461263	0.2229	0.246684	-0.18897	0.197944	0.044683	0.310773
0.160176	0.131047	-0.11143	0.268575	-0.02367	0.128933	0.199059
0.216584	0.151949	0.222388	0.5585	0.313095	0.279706	0.307755

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
88200000	88250000	88300000	88350000	88400000	88450000	88500000
0.136775	0.210251	0.108396	0.189834	0.479564	0.192387	0.109377
0.236943	0.133879	0.124436	0.101708	0.236251	0.464898	0.317311
0.199008	0.262203	0.112965	0.174433	0.456064	0.273276	0.533245
0.095791	0.211583	0.146405	0.300124	0.468338	0.420659	-0.017
0.202144	0.13624	-0.00699	0.080709	0.280955	0.182685	0.168695
0.170984	0.19066	0.090312	0.316954	0.26495	0.473215	0.157646
0.28098	0.254221	0.095526	0.050876	-0.01882	0.294372	0.224968
0.131798	0.09997	0.210766	0.336378	0.243407	0.128159	-0.05298
0.044598	0.046325	0.094058	0.124007	0.434714	0.25944	0.057184
0.187378	0.043348	0.143121	-0.0194	-0.00579	0.353509	0.18767
0.307872	0.322823	0.202964	0.230958	0.159857	0.221482	0.199995
0.206818	0.253941	0.252203	0.160622	0.170676	0.201686	0.31996
-0.02944	0.153234	0.120543	0.081678	-0.03573	0.058582	0.493369
-0.03678	0.14303	0.093079	0.118366	0.123642	0.386475	0.379835
0.228673	0.185605	0.102872	0.124059	0.39925	0.087971	0.185649
0.196739	0.197611	0.126397	0.032767	0.329939	0.427494	0.323095
0.10646	0.27111	0.113725	0.030812	0.389395	0.248386	0.387833
0.187085	0.23903	0.138296	0.210314	0.506763	0.524207	0.280542
0.283879	0.264549	0.102813	0.196535	0.295543	0.286745	0.507667
0.164659	0.31475	0.082955	0.042019	0.014768	0.469994	0.229947
0.234235	0.089242	0.088981	0.16401	0.317326	0.350118	-0.01087
0.115963	0.191282	0.170784	0.108685	0.100191	0.400264	0.310628
0.272817	0.267919	0.104417	0.004709	0.211299	0.185508	0.329505
-0.0297	0.358124	0.25474	0.073947	0.355482	0.211881	0.191725

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
88550000	88600000	88650000	88700000	88750000	88800000	88850000
0.220326	0.266492	0.286158	0.069835	0.142665	0.134784	0.289486
0.374998	0.256583	0.243192	0.137482	0.289403	0.279391	0.141651
0.409272	0.243126	0.280899	0.1248	0.361364	0.343226	0.179796
0.31608	0.18433	0.287525	0.481953	0.245352	0.200362	0.288354
0.372932	0.326276	0.358018	0.333276	0.132771	0.125957	-0.05011
0.163055	0.373327	0.439764	0.242342	0.257115	0.356757	0.22484
0.426452	0.193232	0.379213	0.17356	0.379921	-0.05242	0.033852
0.060621	0.045408	0.273386	0.357513	0.202387	0.105846	0.043105
0.284058	0.430385	0.167394	0.037358	0.088637	0.155235	0.186848
0.012752	0.191901	0.215415	0.099627	0.015863	0.261141	0.27698
0.091344	0.277581	0.22884	0.364782	0.356023	0.393465	0.095873
0.081796	0.147367	0.465725	0.440609	0.204656	0.350257	0.255932
0.016271	0.153535	0.233031	0.078746	0.093495	0.277878	0.258486
0.357206	0.205039	0.191765	0.140529	0.239398	0.273356	0.117322
0.600683	0.335611	0.497009	0.088082	0.18891	0.317722	0.079895
0.056882	0.32473	0.362761	0.457	0.134033	0.267742	0.203057
0.047065	0.204415	0.170689	0.177494	0.233659	0.162226	0.286289
0.070477	0.220568	0.383803	0.121783	0.064938	0.070561	0.175312
0.222261	0.376292	0.289949	0.351359	0.172106	0.13777	0.217758
0.137496	0.207993	0.119391	0.234391	0.21308	-0.00949	0.053692
0.068522	0.304325	0.371083	0.105314	0.113961	0.165402	0.230768
0.271175	0.033289	0.399896	-0.05175	0.210563	0.277229	0.076855
0.238862	0.522734	0.292831	0.320507	0.146079	0.115699	0.315033
0.428863	0.148114	0.216059	0.148464	0.278521	0.176892	0.174974

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
88900000	88950000	89000000	89050000	89100000	89150000	89200000
0.248784	0.273083	0.292548	0.229422	0.474569	0.121849	0.195332
0.422995	0.174222	0.33911	0.344954	0.196861	0.216448	0.12634
0.328593	0.150131	0.506616	0.206742	0.391318	0.247432	0.315643
0.491821	0.260983	0.146852	0.200828	0.414821	0.050833	0.236425
0.284349	0.208797	0.317012	0.347411	0.142747	0.21687	0.232713
0.384016	0.006084	0.490832	0.255405	0.198241	0.201388	0.185419
0.442797	0.210179	0.366216	0.339087	0.084032	0.175533	0.265808
0.386085	0.226771	0.316619	0.288798	0.32469	0.236853	0.222724
0.434837	0.200269	0.335082	0.153724	0.124576	0.156378	0.264291
0.542948	0.12608	0.410107	0.333668	0.12636	0.155796	0.172498
0.527022	0.096329	0.257675	0.255815	0.103759	0.449697	0.31624
0.582319	0.239915	0.346085	0.268161	0.097693	0.129724	0.246463
0.212016	0.25867	0.104513	0.208314	0.340887	0.26753	0.206837
0.201792	0.358311	0.67432	0.213795	0.445399	0.338593	0.302726
0.128128	0.317566	0.222104	0.081659	0.342006	0.171362	0.24584
0.305881	0.466313	0.321642	0.208703	0.344331	0.25533	0.142169
0.489934	0.209275	0.310378	0.16311	0.291293	0.125668	0.247962
0.389266	0.501729	0.444192	0.324012	0.506387	0.21817	0.28261
0.40714	0.140954	0.182113	0.176261	0.1311	0.272697	0.077531
0.269612	0.117657	0.259564	0.272453	0.121147	0.289769	0.260003
0.289164	0.00636	0.393247	0.278463	0.230193	0.270606	0.163604
0.221245	0.086258	0.232673	0.273348	0.29216	0.021439	0.217237
0.351926	0.348987	0.214688	0.132232	0.449069	0.13909	0.228818
0.403145	0.20279	-0.00545	0.183641	0.317069	0.175143	0.190103

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
89250000	89300000	89350000	89400000	89450000	89500000	89550000
0.176314	0.316133	0.219919	0.132918	0.203411	0.214992	0.348399
0.20037	0.147782	0.139737	0.215671	0.424947	0.216619	0.230005
0.186243	-0.04826	0.247879	0.230566	0.216148	0.286865	0.244117
0.118285	0.159532	0.262254	0.239937	0.300728	0.27545	0.470787
0.225735	0.126196	0.4543	0.102287	-0.10303	0.094488	0.300904
0.26356	0.12917	0.287628	0.221679	0.374022	0.190353	0.137082
0.216801	0.140386	0.337275	0.052186	0.314934	0.218222	0.356966
0.152352	0.32822	0.324512	0.130488	0.048131	0.207401	0.223037
0.098956	0.158605	0.1996	0.125784	0.234387	0.430048	0.287902
0.17168	0.20655	0.112704	0.2859	0.286801	0.408023	0.244553
0.215409	0.203934	0.326383	0.02054	0.132166	0.387206	0.434607
0.034258	0.236513	0.078892	0.210414	-0.11405	0.270496	0.421551
0.148015	0.322474	0.236623	0.243164	0.218861	0.364645	0.252381
0.154977	0.125583	0.257576	0.192755	0.432108	0.303143	0.237205
0.074207	0.235383	0.181424	0.153474	0.164497	0.231365	0.559121
0.223908	0.112119	0.353535	0.390783	0.179388	0.141691	0.436648
0.067154	0.050769	0.278477	0.369719	0.292208	0.308922	0.258201
0.256675	0.203581	0.210307	0.256569	0.094091	0.202843	0.252188
0.088689	0.177606	0.170125	0.051567	0.233029	0.297657	0.305163
0.241556	0.045712	0.182779	0.298212	0.127824	0.375758	0.547486
0.141305	-0.05459	-0.04438	0.193057	0.053213	0.312442	0.33107
0.201894	0.11771	0.2342	0.005476	0.245436	0.093071	0.14668
0.160852	0.099077	0.097296	0.118115	0.177391	0.217745	0.136114
0.212652	0.114294	0.284813	0.010787	0.32804	0.331314	0.411134

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
89250000	89300000	89350000	89400000	89450000	89500000	89550000
0.176314	0.316133	0.219919	0.132918	0.203411	0.214992	0.348399
0.20037	0.147782	0.139737	0.215671	0.424947	0.216619	0.230005
0.186243	-0.04826	0.247879	0.230566	0.216148	0.286865	0.244117
0.118285	0.159532	0.262254	0.239937	0.300728	0.27545	0.470787
0.225735	0.126196	0.4543	0.102287	-0.10303	0.094488	0.300904
0.26356	0.12917	0.287628	0.221679	0.374022	0.190353	0.137082
0.216801	0.140386	0.337275	0.052186	0.314934	0.218222	0.356966
0.152352	0.32822	0.324512	0.130488	0.048131	0.207401	0.223037
0.098956	0.158605	0.1996	0.125784	0.234387	0.430048	0.287902
0.17168	0.20655	0.112704	0.2859	0.286801	0.408023	0.244553
0.215409	0.203934	0.326383	0.02054	0.132166	0.387206	0.434607
0.034258	0.236513	0.078892	0.210414	-0.11405	0.270496	0.421551
0.148015	0.322474	0.236623	0.243164	0.218861	0.364645	0.252381
0.154977	0.125583	0.257576	0.192755	0.432108	0.303143	0.237205
0.074207	0.235383	0.181424	0.153474	0.164497	0.231365	0.559121
0.223908	0.112119	0.353535	0.390783	0.179388	0.141691	0.436648
0.067154	0.050769	0.278477	0.369719	0.292208	0.308922	0.258201
0.256675	0.203581	0.210307	0.256569	0.094091	0.202843	0.252188
0.088689	0.177606	0.170125	0.051567	0.233029	0.297657	0.305163
0.241556	0.045712	0.182779	0.298212	0.127824	0.375758	0.547486
0.141305	-0.05459	-0.04438	0.193057	0.053213	0.312442	0.33107
0.201894	0.11771	0.2342	0.005476	0.245436	0.093071	0.14668
0.160852	0.099077	0.097296	0.118115	0.177391	0.217745	0.136114
0.212652	0.114294	0.284813	0.010787	0.32804	0.331314	0.411134

SAMPLE OF AR COEFFICIENTS FOR GUDU (BAND 5)

Frequency (Hz)						
89600000	89650000	89700000	89750000	89800000	89850000	89900000
0.019784	0.292605	-0.01202	0.22173	0.270796	0.347807	0.23635
0.187743	0.301259	0.173211	0.190966	0.288487	0.411802	-0.01423
0.209339	0.418819	0.416495	-0.21227	0.242355	0.102956	0.377018
0.044109	-0.00544	0.043291	0.084476	0.247786	0.321553	0.362832
0.242582	0.102707	0.09416	0.079299	0.333234	0.322271	0.208036
0.010193	0.288333	-0.0435	0.149478	0.175279	0.086569	0.052949
0.169352	0.41134	0.318297	0.074069	0.273969	0.22839	0.228179
-0.12112	0.393884	-0.03072	0.275988	0.206963	0.279063	0.401639
0.3628	0.17493	0.13942	0.10178	0.340526	0.312645	-0.18004
0.322535	0.297676	0.288742	0.351616	0.328127	0.128585	0.556143
0.255084	0.248807	0.032389	0.292404	0.184709	0.321989	0.175343
0.233125	-0.03252	0.234602	0.219729	0.252382	0.211368	0.077464
0.268289	0.224854	0.254263	0.330468	0.255256	0.324619	0.409161
0.317411	0.173364	0.18591	0.268325	0.111186	0.301999	0.434704
0.213061	0.1439	0.325441	-0.03209	0.36714	0.313024	0.2376
0.042224	0.339653	0.313111	0.143395	0.247534	0.196035	0.244074
0.170331	0.227038	0.068299	0.307164	0.252622	0.188007	0.28052
0.171622	0.174488	0.104374	0.043903	0.231967	0.331422	0.208342
0.113682	0.328303	0.104951	0.29786	0.249029	0.270051	0.167331
0.019777	0.331389	0.048174	0.455752	0.352921	0.213905	0.684676
0.032433	0.382307	0.255675	0.216017	0.256921	0.281926	0.034869
0.436728	0.029465	0.141472	0.025269	0.225311	0.225334	0.188317
-0.0679	0.187273	0.378474	0.387003	0.184529	0.35442	0.419296
0.060093	0.091828	0.281787	0.274955	0.210172	0.254622	0.030225

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

	Frequency					
	108050000	108100000	108150000	108200000	108250000	108300000
1	0.058837101	0.342314867	0.293981481	0.423691737	0.169666338	-0.163095464
2	0.132773463	0.285823455	0.114135747	0.197002592	-0.316909116	0.194728238
3	0.170973576	0.46579887	0.052607255	0.034506923	0.619938121	0.175800179
4	0.190668697	-0.048546011	0.101859127	0.243589541	-0.009339515	-0.073667545
5	0.323890949	0.451208117	0.487045944	0.518991216	0.047375103	-0.064847451
6	0.220808313	-0.054393597	0.216410707	0.383283881	0.417797743	0.285340551
7	0.304337001	0.510348048	0.207381451	0.072813904	0.474907527	0.329291231
8	0.313837472	0.526381514	0.517310519	0.479733513	0.447276529	0.164422327
9	0.294071167	0.587590827	0.141518653	0.293387432	0.020400048	0.180507458
10	0.260192253	0.667791939	0.285512817	0.389765705	0.166159006	0.095677633
11	0.24174196	0.477387705	0.376688956	0.53940721	0.340068105	0.176542249
12	0.334312939	0.222994554	0.274516816	0.305058397	0.058107149	0.305764546
13	0.216752883	0.197877628	0.345402074	-0.037100957	0.323872361	0.185028354
14	0.295314152	0.460999736	0.175717961	0.219026594	0.558916284	0.234533913
15	0.320132214	0.3504986	0.222537664	0.183895969	0.782933243	0.117001074
16	0.431389413	0.465480865	0.352538408	0.136487248	0.134212122	0.286610358
17	0.40547518	0.203269847	0.397818999	0.384428458	0.089632727	0.210294998
18	0.214338059	0.128591763	0.218918187	-0.201043914	0.37949329	0.401164825
19	0.259431926	0.402778023	0.256972479	0.015294059	0.512870286	0.186789103
20	0.113756592	0.256067127	0.480633261	0.295658681	0.396080727	0.223255375
21	0.292853714	0.640009241	0.364929974	0.217173541	0.245439205	0.464252342
22	0.295793496	0.315058622	0.274478161	0.099704181	0.496160741	0.174855021
23	0.193305897	0.186032935	0.242066971	0.077639283	0.258509222	0.22054902
24	0.038684652	0.344560291	0.10906393	0.215104451	0.586998594	0.082632977

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
108350000	108400000	108450000	108500000	108550000	108600000
0.169132356	0.171124925	0.217870521	0.240121728	0.377581786	0.448448823
-0.077645521	0.208778825	0.240011877	0.167502846	0.170215739	-0.136764008
0.179494868	0.225884915	0.341770175	0.230721081	0.428783977	0.039211056
-0.050745775	0.000892584	0.277453266	0.132750431	0.455768399	0.166440639
-0.05916485	0.124288958	0.147234665	0.254989659	0.126898801	0.117179515
0.394636625	0.274329005	0.205780491	0.204660272	0.527504004	0.043290062
-0.071795472	0.336859408	0.275284326	0.176037	0.253931421	0.276143107
0.01108046	0.093605405	0.264869369	0.193922756	0.315873206	0.223024513
0.194938541	0.54471956	0.260923737	0.224501468	0.459592546	0.333408206
0.310514778	0.138023996	0.330943188	0.259733182	0.440831188	0.213073943
0.46068142	0.073656027	0.221944792	0.19757071	0.458379615	0.33889985
0.451972291	0.454058895	0.236163515	0.36354564	0.437740941	0.445561514
0.237715215	0.299100514	0.265579698	0.064016474	0.523974146	0.349301563
-0.261877397	0.62626808	0.226405377	0.130720331	0.238198279	0.157880232
-0.086793869	0.513688885	0.340233223	0.097345396	0.28032341	0.119756783
0.087633192	0.294590106	0.167838258	0.153524044	0.333381725	0.287688668
0.358021912	-0.175665433	0.224119878	0.031512456	0.445766506	0.268396256
0.631253385	0.086004502	0.409382237	0.331700469	0.489466749	0.433708437
0.318034321	0.322278192	0.33470652	0.372519777	0.469980161	0.370243722
0.162428171	0.636723225	0.046792185	0.250339724	0.411927455	0.011761939
0.471879197	0.511320695	0.051606426	0.284864852	0.260251049	-0.074177358
-0.032784244	0.373310562	0.161654067	0.19154131	0.588093705	0.340843783
0.429036098	0.003224698	0.020140306	0.153310743	0.302428105	0.144182434
0.043248684	-0.06982046	0.168270686	0.364360038	0.31803972	0.321213575

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
108650000	108700000	108750000	108800000	108850000	108900000
0.105635691	0.406444863	0.338405672	0.238626386	0.165016543	0.254674614
0.133926655	0.282283976	0.595350269	0.129237935	0.0424858	0.073682988
0.257635497	0.195075204	0.458549803	0.052559706	0.512192574	0.314591774
0.108596318	0.420129736	0.508961413	0.275156459	0.111061682	0.329501375
0.206173518	0.210434434	0.182708422	0.322234684	0.201422357	0.083765958
0.216026949	0.203708645	-0.184447002	0.04434158	0.371078176	0.240051473
0.238167129	0.418153904	0.150727031	0.245932241	0.283854916	0.133960976
0.240164076	0.344454946	0.238936194	-0.038140432	0.44779546	0.321333661
-0.003366012	0.116738942	-0.056099312	0.10370222	0.536197781	0.403945697
0.304016434	0.097674432	0.574272639	0.261522446	0.348727706	0.161840417
0.176673049	0.188563673	0.50558199	0.130511225	0.366399829	0.377000739
0.182398455	0.146161695	0.31664078	0.251739987	0.264432409	0.370591157
0.280934288	0.240084074	0.217583771	0.202015317	0.195491417	0.139418706
0.231769791	0.168734333	-0.062090767	0.101853293	0.405450192	0.173047773
0.167265721	0.205370194	0.511122287	0.271531646	0.424122903	0.199642068
0.050795011	0.146397755	0.145679561	0.260397955	0.207979416	0.021128762
0.164525379	0.108356991	-0.242902573	0.157557344	0.1273983	0.183615074
0.309634142	0.355442105	0.080591263	0.355730356	0.219002686	0.336830288
0.177065135	0.423173104	0.287430012	0.164576898	0.428114759	0.209537
0.207953894	0.42148554	-0.019186119	0.288532638	0.250190003	0.270551235
0.150834221	0.465274626	0.18211046	0.298457794	0.426398366	0.229089082
0.259657293	0.351635212	0.310518489	0.337939643	0.041194313	0.174542913
0.108775977	0.268582634	0.490064791	0.297947516	0.280096142	0.352545803
0.219408566	0.375327111	0.156454745	0.228257212	0.289926958	0.261492568

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
108950000	109000000	109050000	109100000	109150000	109200000
0.207927797	0.671841444	-0.304282325	0.216201269	0.024571953	0.167457506
0.104715287	0.428007572	0.526414384	0.173628665	0.086663316	0.223177946
0.524143761	0.148984659	0.250896102	0.257740936	0.189456459	0.203800275
0.450158493	0.532603552	-0.171901338	0.293871294	-0.109089884	0.256762338
-0.175958056	0.19979456	-0.55182036	0.239519732	0.177358598	0.10339605
0.440680928	0.031628026	0.184715916	0.173809178	0.40244371	0.270999061
0.296687147	0.347581379	0.027142841	0.247761283	0.1295992	0.103651035
0.368274416	0.530916623	0.112204954	0.196721965	0.471673599	0.050869309
0.332447886	0.404998786	-0.103783884	0.119618874	0.059710349	0.27860041
0.362906689	0.145753848	0.343452308	0.065160079	0.230389453	0.22975062
0.192571764	0.374332553	0.172557214	0.150145959	0.123234347	0.140420919
0.23730272	0.112388526	0.393028201	0.126523223	0.510928748	-0.007761448
0.419338085	0.588429196	0.277013411	0.134309746	0.308386125	0.202411658
0.320908786	0.13742729	0.518725596	0.320072733	0.49466021	0.170444996
0.434949379	0.021213333	0.306708267	0.063130714	0.326893369	0.034701605
0.295650631	0.569927599	-0.092122848	0.058619601	0.272587704	0.060453331
0.366909208	0.074091906	0.455230465	0.282375773	0.538586593	0.099609059
0.794948826	0.060058148	-0.579351602	0.087337926	0.387813033	0.061143891
-0.054779233	0.382556383	0.068967895	0.176221715	0.266509169	0.106211109
-0.00525594	0.406182384	0.627793714	0.193311177	0.237087593	0.227905474
0.342386292	0.214883055	-0.009708842	0.1045286	0.049795628	0.203032118
0.048316957	0.070127278	0.413966805	0.190322929	0.341711665	0.227236629
0.176885884	0.616841492	0.802669464	0.076498422	0.04334306	0.224813515
0.3938533	0.194626276	-0.270835628	0.102602264	0.285168819	0.120896109

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
109250000	109300000	109350000	109400000	109450000	109500000
0.066226975	0.103349391	0.161686329	0.369545126	0.066735163	0.350601363
0.079228747	0.07280378	0.23049235	0.394471349	0.075210248	-0.051250904
0.159318799	-0.112542392	0.148034857	0.156547382	0.201596556	0.161963858
0.414068111	0.179109714	0.242857772	0.399818716	0.130566575	0.261922608
0.461956238	0.352021978	0.048530387	0.232494478	0.121065685	0.085520743
0.038540846	-0.023464662	0.336151192	0.36925426	0.119010316	0.001589549
0.108666353	0.125728968	0.177910419	0.166489584	0.064294135	0.049121961
0.344776912	0.124259475	0.360696787	0.245083652	0.208600164	0.067060498
0.128908632	0.227751496	0.135157334	0.344261508	0.113798001	0.107496192
0.352798304	0.311638644	0.208506267	0.602324275	0.16773928	0.209522466
-0.02305329	0.376317675	0.320444919	0.219720775	0.207018882	-0.166066961
0.618211443	0.162333681	0.130642089	0.227556095	0.169350114	0.219099191
0.262055984	0.140996385	0.228492157	0.319387628	0.117333418	0.05721071
0.479927365	0.364474696	0.132629285	0.045236101	0.098830335	0.271512255
0.358207126	0.204121469	0.253408884	0.158173439	0.106066545	0.472216381
0.542754846	0.4289033	0.293604267	0.160953225	0.138337926	0.512666174
0.363193462	0.352209054	0.16870675	0.462698464	0.032051899	0.066282666
0.378378836	0.357518945	0.093421958	0.352170107	0.279008716	0.386277114
0.57472024	0.23102283	0.149410012	0.450820484	0.068924106	0.377032582
0.382532701	0.359137972	0.317133164	0.18705041	0.136745653	0.391547397
0.086929485	0.071608856	0.141219442	0.331738334	0.159162831	0.133338891
0.283567882	0.288010991	0.214872437	0.058321574	0.173972216	0.410941271
0.314772316	0.354573132	0.23222755	0.466956907	0.11814293	0.105602428
0.26894074	-0.036750441	0.282799297	0.18455748	0.108768612	-0.049632387

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
109550000	109600000	109650000	109700000	109750000	109800000
0.242865533	0.010404286	0.088331668	0.149039004	0.271120732	0.276946522
0.11837394	0.041975177	0.124523248	0.331412394	0.094321962	0.341689858
0.031294869	0.407238437	0.080099076	-0.007293678	0.145270161	0.327394131
0.078641532	0.318551434	0.070568769	0.175811004	0.244660981	0.337805921
0.37599809	0.200986346	0.389634878	0.057350856	0.220257844	0.097388397
0.117355169	0.069796117	0.176695005	0.238483445	0.328093963	0.323406045
0.141713045	0.118487165	0.354850344	0.268133134	0.278459584	0.279508315
-0.043887267	0.26511477	0.033245065	0.156358101	0.287080875	0.258828931
0.293217701	0.36589565	0.26307374	0.142129721	0.162880289	0.241569932
0.005128362	0.139641377	0.015457231	0.077974089	0.086665128	0.169648529
-0.029826904	-0.048071281	0.16239886	0.444265515	0.129359746	0.078338782
0.116988036	0.151682573	0.203659027	0.222274776	0.247998	0.199063807
0.085830307	0.263294041	0.204319623	0.251580143	0.22342719	0.213091283
0.359382783	0.194578584	0.015658485	0.110207418	0.173238623	0.249299782
0.058286566	0.322277704	0.375776627	0.132142344	0.159590682	0.299573826
0.062010331	0.184993556	0.065520835	0.33663197	0.192501154	0.264553432
0.22196516	0.288611717	0.246028299	0.1336964	0.286100362	0.145064849
0.086833786	0.264112414	0.085472002	0.174504778	0.190651401	0.101104042
0.094305797	0.219984231	0.16313955	0.148446786	0.181989531	0.311883919
0.303439118	0.348380429	0.338870419	0.206118396	0.259022672	0.193820073
0.222892658	0.209939677	0.233454996	0.128352603	0.2543511	0.282728712
0.166501705	0.067913367	0.355932153	0.260823868	0.242887636	0.293938347
0.055484469	0.438152193	0.022850971	0.190425403	0.241019875	0.215022603
-0.03287308	0.109376022	0.280144508	0.158931046	0.176981109	0.227624293

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
109850000	109900000	109950000	110000000	110050000	110100000
0.218414479	0.367560096	0.180864517	0.314382478	0.194823594	0.302306145
0.073583188	0.192021077	0.250114693	0.353393004	0.216431016	0.110426789
0.19779512	0.379958461	0.225486321	0.106076168	0.0983343	0.022359625
0.12917	0.147216577	0.283884491	0.236755447	0.250950723	0.231927913
0.255152406	0.117689342	0.155357183	0.146715775	0.434206928	0.268360568
0.354130728	0.270752403	0.276125704	0.115454682	0.135130407	0.189926302
0.265584565	0.083840174	0.313755862	0.328891004	0.348467178	0.237124201
0.368648675	0.274653769	0.183528303	0.187285112	0.209762129	0.148554595
0.443655906	0.162238846	0.261978247	0.282032637	0.015965666	0.304711793
0.184439569	0.111111411	0.332684848	0.376354553	0.433741756	0.191460071
0.089675883	0.427897041	0.229634518	0.149314264	0.173948432	0.302805795
0.208380645	0.08341694	0.274086532	0.150797404	0.210744981	0.127784259
0.305647781	0.460797954	0.211931641	0.407106612	0.303122931	0.56458042
0.196991588	0.201259124	0.172738743	0.363991898	0.133734374	0.318075649
0.216041194	0.408452873	0.215950999	0.151529083	0.358026149	0.169000833
0.187611932	0.204703224	0.255872558	0.352848156	0.170621323	0.315811725
0.253605048	0.354818582	0.290136694	0.138691133	0.091979354	0.271989524
0.249093957	0.164644635	0.227186203	0.318732552	0.226226408	0.235199642
0.143418161	0.072074792	0.111762687	0.27403906	0.186173727	0.154502673
0.149005904	0.298437545	0.27749241	0.121903383	0.322216133	0.276827338
0.054056669	0.162535809	0.203307283	0.375052287	0.172738668	0.37326636
0.085171471	0.209062148	0.12140315	0.348717933	0.294855893	0.171332068
0.241335251	0.324052409	0.144811608	0.247483399	0.332563102	0.32942607
0.157808626	0.147623763	0.17508019	0.318294786	0.234262759	0.166213041

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
110150000	110200000	110250000	110300000	110350000	110400000
0.04769176	0.063871764	0.252010844	0.29842526	0.775008209	0.247766455
0.180490824	0.366641795	0.305028335	0.27078191	0.362049121	0.230627588
0.05354277	0.129150619	0.128477331	0.240484104	0.228563705	0.316652947
0.121055732	0.328336908	0.066095409	0.045366742	0.074541932	0.356781286
0.123831754	-0.037002595	0.274521812	0.23990025	0.093703152	0.335838129
-0.011666513	0.310873748	0.105711596	0.339483607	0.195216388	0.200512435
0.343171322	0.14223961	0.132377795	0.107335233	-0.02778811	0.206219606
0.254441258	0.305395284	0.159143866	0.215933172	0.135304203	0.253705987
0.421938332	0.206315854	0.22531777	0.29991282	0.570732101	0.328575876
0.210991864	0.220297012	0.273360676	0.369261551	0.020013742	0.205139795
0.222116847	0.169608017	0.14010923	0.29997818	0.170685818	0.412339459
0.080684676	0.276730386	0.262179473	0.320404471	-0.044598303	0.235042275
0.37241992	0.12376317	0.22202475	0.03044386	0.31567179	0.359160169
0.254805833	0.352514842	0.323718274	-0.00285929	0.110584254	0.146607861
0.294766654	0.152688078	0.38931261	0.096106552	0.160547556	0.186685961
0.166669836	0.086228047	0.328605196	0.057615497	-0.027676169	0.17344251
0.251757654	0.14177826	0.284331702	0.199075392	-0.103469005	0.220964373
0.031932073	0.294222509	0.282011769	0.014538266	0.205157815	0.505487333
0.163369653	0.318138679	0.194093283	0.131227152	0.373340457	0.416728549
0.174419374	0.28431586	0.142889853	0.10604933	0.011310197	0.27501691
0.150258041	0.188485654	0.125066832	0.059269411	0.164175269	0.218405772
0.31235463	0.176181129	0.140159253	0.128767394	0.420373079	0.227623475
0.103233533	0.187182096	0.248076306	0.194443487	0.396254783	0.193560497
0.128891075	0.283455404	0.424189358	0.316622892	0.063269549	0.295961861

SAMPLE OF AR COEFFICIENTS FOR MAITAMA (BAND 6)

Frequency (Hz)					
110450000	110500000	110550000	110600000	110650000	110700000
0.104340846	0.07573091	0.257980386	0.270814955	0.375382505	0.072965928
0.195800984	0.322694365	0.009214741	0.125720446	0.312577674	0.133113574
0.366962247	0.216016063	0.305767615	0.104864309	-0.061605364	0.191929863
0.406954453	0.386348149	0.126904284	0.346174704	0.30479906	0.109095904
0.2808022	0.338891242	0.353939347	0.234576574	0.241834432	0.058251845
0.235806499	0.505971009	0.116535032	0.308258692	0.128052607	0.176373252
0.344221677	0.279313045	0.560407897	0.262055593	0.251510574	0.342127418
0.168044049	0.342623284	0.391192925	0.262952827	0.821281804	0.012598988
0.180565913	0.570717325	0.085150565	0.379476819	0.269681243	0.069706169
0.190200762	0.335686169	0.000938597	0.247260261	0.207114852	0.094219981
0.036467247	0.303966374	0.309031302	0.361170726	0.370262863	0.186178721
0.02182115	0.369971473	0.12796312	0.215687743	0.069712839	0.127050341
0.202344721	0.286515119	0.38472409	0.089060494	0.357812957	0.081287
0.241944051	0.278602693	0.291305174	0.57668706	0.419632295	0.079517723
-0.031851424	0.326906014	0.276229274	0.019681089	0.65176529	0.235772304
0.381729832	0.295134854	0.199109909	0.729281256	0.344568335	0.109411244
0.372714245	0.28542393	0.290379431	0.298095871	0.254809371	0.109194276
0.333716476	0.28573155	0.479834429	0.243853157	0.325813252	0.149250534
0.272071811	0.222043781	0.327769182	0.387511129	0.198279632	0.165457579
0.291919084	0.281863603	0.27973331	0.29142063	0.436085528	0.196719662
0.185182633	0.216166638	0.366687504	0.267662029	0.319681534	0.221033596
0.442419397	0.178693194	0.488953069	0.164450692	0.282265761	0.036483659
0.213445024	0.335022479	0.19189089	0.078140557	0.207820539	0.195483943
0.033485802	0.264358311	0.310839547	0.339111947	0.15389822	0.155385937

APPENDIX D: SAMPLES FEATURE MATRIX
SAMPLE OF FEATURE MATRIX FOR GK (BAND 1)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	0	1	0.5	1	0.5	0.5	0	0.5	0	0.5	1	0.5	0.5	1	1
2	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0	0	0.5	1	0	0.5	0	0
3	0.5	1	1	0.5	1	0	0.5	0.5	0	0.5	0.5	0	0.5	0.5	1	0.5
4	0.5	0.5	0.5	0.5	0	0.5	0	0	0	0.5	0	1	0.5	0.5	0	0.5
5	0	0.5	1	0.5	0.5	0	1	0	0	0	0.5	1	1	0	0.5	0.5
6	0	0.5	0	0.5	1	0.5	0.5	1	0	0.5	1	0	0.5	0	0	0.5
7	1	1	0.5	1	0	0	0.5	1	0	1	0.5	0	0	0	0.5	0.5
8	1	1	1	0	0	0.5	0	0.5	0	0	0	1	0.5	0	0	0.5
9	1	1	0.5	0	0	0	0.5	0	0	0	0	1	0.5	0	0.5	1
10	0	0	0	0.5	0	0	0	0	0.5	0.5	0	0.5	0.5	0	1	0.5
11	0.5	0	0.5	0.5	0	0	0.5	0.5	0.5	0.5	1	0.5	0	0	1	1
12	0	1	0.5	0	0	0.5	0.5	0	0	0	0	0	0.5	0.5	0	0.5
13	1	0.5	0.5	0	0.5	0	0.5	0	0.5	0	0	1	0.5	0.5	0.5	0
14	1	0	0	0	0.5	0	0.5	1	0	0.5	0	0	0.5	1	0	1
15	0	0.5	0	0	0	0	0.5	0	0.5	1	1	0	0.5	0.5	1	1
16	1	1	0	0	0	0.5	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0.5
17	0	0.5	0.5	0.5	0	0	0.5	0	0	0.5	0.5	0	1	0.5	1	0.5
18	0.5	0.5	0.5	0.5	1	0	0	0.5	0	0	0	0	0	1	1	0.5
19	0.5	1	0.5	0.5	0	0.5	0	0	0	0	0	0	1	0.5	1	1
20	1	0	0.5	0.5	0	0	0.5	0	0.5	0	0	0	0.5	0.5	1	0.5
21	1	1	0.5	1	0	0.5	0	0.5	0	0.5	0	0.5	0	0	1	0
22	1	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	1	0.5	0
23	0	1	0.5	1	0	0	0.5	0	0	0.5	1	1	0	0	1	1
24	1	0.5	0.5	0	0	0	1	0	0.5	0	0.5	1	0	0.5	0.5	0.5
25	0	0	1	0.5	0	1	0	0.5	0	1	0.5	0.5	0.5	1	1	0.5
26	0.5	1	1	0.5	0	0	0	0	0	1	0	0	0	0	1	1
27	0.5	0.5	0.5	0	0	0	0	0	0.5	0	0	0	0	0.5	0.5	1
28	0.5	1	1	1	0	0	0.5	0	0	0	0	0	0	0.5	1	1
29	0.5	0	0	0.5	0.5	0.5	1	0	0	1	0	0.5	0	1	0.5	0.5
30	0.5	1	0	0.5	0	0.5	0.5	0.5	0	0.5	1	0	0	0.5	0.5	0
31	0.5	0.5	0.5	1	0.5	0	0	0	0	0.5	0	0	0	1	0.5	1
32	0	0.5	0	0	0	0.5	0	0	0.5	1	0	0	0.5	0	1	0.5
33	0	0.5	0.5	0	0.5	0.5	0.5	1	0	0	0.5	0.5	0.5	0	0	0.5
34	0	0.5	0.5	0.5	0.5	0	0.5	1	0	0	0	0	1	0	0.5	0.5
35	0	0	0.5	1	1	0.5	1	0.5	1	0.5	0.5	0.5	0.5	1	0.5	1
36	0	0.5	0.5	0.5	1	0.5	0.5	0.5	0	0.5	1	0	0.5	1	1	0.5
37	0	0.5	0	1	0.5	0.5	1	0	0	0.5	0	1	0	0.5	1	1
38	1	0.5	0	0	0	0.5	0	0	0	0.5	0.5	0	0.5	0	0.5	0
39	0.5	0.5	0.5	0	0	0.5	0	1	0	0.5	0.5	1	0.5	0	1	0.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
40	0.5	0.5	0	0.5	0.5	0.5	0	0	0.5	0	0	0	0.5	0.5	0	0

41	0.5	0.5	0.5	0	0	0	0.5	0	0	1	0	0	0	0	1	0.5
42	0	0.5	0.5	0.5	0.5	1	0.5	0.5	0	0	0.5	0	0	0.5	0.5	0.5
43	0	1	0.5	0	0.5	0.5	0.5	1	0	1	0	0	0.5	0.5	1	0.5
44	0	0.5	1	1	0.5	1	0.5	0.5	0	0	0.5	0	1	0	0	1
45	0	1	0.5	0	0	1	0.5	0.5	0	0	0.5	0	0.5	1	1	0.5
46	0.5	0.5	0	1	0	0.5	0	0	0	0.5	0	0	0	0.5	1	0.5
47	1	0	0	0.5	0	1	0	0.5	0	0	0	0.5	0	0	1	0.5
48	1	0	0	0	0	0	0	1	0	0.5	0	0	0	0	0	0.5
49	0.5	0.5	0.5	1	0	1	0	0.5	0	0.5	1	0.5	0	0	1	0.5
50	0.5	0.5	0	0	0	0	1	0	0	0.5	1	0.5	1	0	0.5	1
51	1	0.5	0.5	0.5	0	0	0	1	0	0	0.5	0	0	0.5	1	0.5
52	1	0.5	0.5	1	0	1	0	1	0.5	0.5	0.5	1	0	0.5	1	0.5
53	1	0	0	0	0	0.5	1	0.5	0.5	0.5	0.5	0.5	0	1	1	0
54	1	0	1	1	0	1	0	1	0	1	1	0.5	0.5	0.5	0	0.5
55	1	0	0	0	0.5	1	0.5	1	0.5	0.5	0	0	0	1	1	0.5
56	0.5	0	0.5	0.5	0	0.5	0.5	0	0	0	0	0.5	0.5	1	1	0.5
57	0	0.5	0.5	0	0	0	0.5	0	0.5	0	0	0	0	0.5	1	0.5
58	0.5	0.5	0	1	0	0.5	0.5	0	0	0.5	0.5	1	0.5	0.5	1	0.5
59	1	0.5	0	0.5	0	0	0.5	1	0	0	0	0.5	1	0.5	1	1
60	0.5	0	1	0	0	0.5	0.5	1	0	0.5	0.5	0.5	1	0.5	0.5	1
61	0.5	1	0	0	0	0.5	0	0	0	0.5	0.5	0	1	0.5	1	0.5
62	0	1	0	1	0	0.5	0	0.5	0	0	0.5	0	0	0	1	0.5
63	0.5	1	0	0.5	0	1	0	1	0	0	0	0.5	0.5	0	0.5	1
64	0.5	1	0	0.5	0	0.5	0	1	0	0	0	0	0.5	0	0.5	1
65	1	1	1	0.5	0	0.5	0.5	0	0	0	0	0.5	0	0	0.5	0.5
66	1	1	0	0.5	0	0	0.5	0.5	0	0.5	0	0.5	0.5	0.5	0.5	0.5
67	0	1	1	0	0	0.5	0.5	0	0	0.5	1	0.5	1	1	0.5	1
68	0	1	0.5	0	0	0	0.5	0.5	0	1	0.5	0.5	0.5	0.5	0	0.5
69	0.5	1	0	0	0	0.5	0	0.5	0	0.5	0.5	1	0.5	0	0.5	1
70	0	1	0	0	0	0.5	0	0	0	0	0.5	1	0.5	0.5	0	0.5
71	1	1	0	1	0.5	1	0.5	0.5	1	0.5	1	0	1	0.5	1	1
72	0.5	1	0.5	0.5	0.5	0.5	0	0.5	0	0	0	0.5	0	1	1	1
73	0.5	1	0.5	0.5	0	0.5	0	0.5	0	0	0.5	0.5	0.5	0.5	1	0
74	0.5	1	0	0	0.5	1	0	0.5	0.5	1	0.5	0	0	0.5	0	0
75	1	1	0.5	0.5	0	0.5	0	0	0	0	0.5	0.5	0.5	0.5	0	1
76	0.5	1	0	0	0	0.5	0	1	0	0.5	0.5	0.5	0	0	0.5	1
77	1	1	0	1	0.5	1	0	1	0	0.5	0	1	0.5	0.5	0.5	1
78	0	1	0.5	0.5	0.5	0.5	0	1	0.5	0.5	0.5	0.5	0	0	1	0
79	0.5	1	0	1	1	0.5	0	0	0	0.5	0	0	0.5	0.5	0.5	0
80	0.5	1	0.5	0.5	0.5	1	1	0	0	0	0.5	0.5	1	0.5	0.5	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
81	0	1	0	0	0.5	1	1	0.5	0	0	0	0.5	1	0.5	0	0.5

82	0	1	0	0.5	0	1	0	0.5	0.5	0	1	0	0	0.5	1	1
83	1	1	0.5	0	0.5	1	0.5	1	0.5	1	0.5	0.5	0.5	0.5	0.5	1
84	0.5	1	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0	0	0.5	1	0.5	1
85	0.5	1	1	0	0.5	1	0.5	1	0.5	0.5	0	0.5	1	0.5	1	1
86	0.5	1	0	0.5	1	1	0	0.5	0	0	1	1	0	0	1	1
87	1	1	0	0.5	0	0.5	0	0	0	1	0	1	0.5	0.5	0.5	0.5
88	0	1	1	0	0	0	0	1	0.5	0.5	0	0.5	0.5	0	0.5	0
89	1	1	0.5	0	0	1	0	1	0.5	0.5	1	0	0	1	0	0.5
90	1	0.5	1	1	0	0.5	0.5	0.5	0.5	1	0.5	0	0	1	0.5	0.5
91	0.5	1	1	0	0.5	0.5	0	0.5	0	0.5	1	0.5	0.5	0.5	1	1
92	1	1	1	1	0.5	1	0	0.5	0.5	0	0	0.5	0.5	1	0.5	0.5
93	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	1	0.5	0.5
94	0	1	1	0	0	0	0	0	1	0	0.5	1	0.5	0	0	1
95	1	0.5	1	0	0.5	1	0	1	0.5	0.5	1	1	0	0.5	0.5	0.5
96	0.5	0	1	0.5	0	0.5	0.5	1	0	0.5	1	0.5	0	0	0.5	0.5
97	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0.5	0	0.5	0.5
98	0.5	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0.5	1	1
99	0.5	0	0	0.5	0.5	0.5	0	1	0	0	0.5	0.5	0	1	0	0.5
100	0.5	0	1	0.5	0	0.5	1	0	0	0.5	0	0.5	0	0.5	0	1
101	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0	0.5	1	0.5
102	1	0	0.5	1	1	0	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0	0.5
103	1	0	0.5	0.5	0	0.5	0	0	0.5	1	0.5	0	1	0	1	0
104	0.5	0.5	0	0.5	0.5	1	0.5	0	0.5	0	1	0	1	1	1	1
105	0	0.5	0.5	0	1	0	1	0.5	0.5	1	0	0	1	0.5	0.5	1
106	0.5	0.5	0.5	0	1	0	0.5	0.5	0	0	1	0.5	1	0	0.5	1
107	0.5	0.5	0.5	0	0.5	0	0.5	0.5	0.5	0.5	1	1	1	0	0.5	0
108	0	0	0	0.5	0	0.5	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5
109	1	0	0.5	0.5	0.5	0	0	0	0	0.5	1	0	0	0.5	0	0.5
110	0.5	0	0.5	1	0.5	0.5	0	1	0.5	0.5	1	0	0.5	0.5	0.5	0.5
111	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	1	1
112	0.5	0.5	0.5	0.5	0	1	0	0.5	0	0.5	0.5	0.5	0	0.5	0	0.5
113	0.5	1	0.5	0.5	0.5	0.5	0	0.5	0	0	0	0	0	0.5	0.5	1
114	1	0	0.5	0	0.5	0.5	0	1	0	0.5	1	0.5	0	0	1	0
115	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0.5	0	0.5	0	0.5	1	0.5	0.5
116	1	0	0.5	0.5	0	1	1	0	1	1	0.5	0.5	0.5	0	0	1
117	0	1	1	1	0.5	0.5	0.5	0.5	0.5	0	0.5	0	1	0.5	1	0
118	1	0.5	0	0.5	0	0.5	1	1	0	1	0.5	0.5	0.5	0.5	1	0.5
119	0.5	0	0	0	0.5	0.5	1	1	0.5	0.5	0.5	0	0	0	0.5	1

SAMPLE OF FEATURE MATRIX FOR AEDC (BAND 2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	0	1	1	0	0.5	0.5	0	1	0	0.5	0.5	0.5	0.5	1	0.5	0.5
2	0.5	0.5	0	0.5	1	0.5	0.5	0.5	0	0	0.5	1	0.5	1	0	0.5
3	0.5	0	0.5	0.5	0	1	0.5	0	0	1	0	0	1	0.5	0.5	0
4	1	0.5	0.5	0.5	0.5	0.5	1	1	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	1	0.5	0.5	0	0.5
6	1	0	0.5	0.5	1	0	0.5	0.5	1	1	0.5	0	0.5	0.5	0	0.5
7	0.5	0.5	0	0	0	0.5	0.5	1	0	0	1	0	0.5	0	0.5	1
8	0.5	0	0	0.5	0	0.5	1	0.5	0.5	0.5	0	0	0.5	1	0	1
9	0	0.5	0	0.5	0.5	0	0.5	1	0	0.5	0.5	0.5	0	0	0.5	0
10	0.5	0.5	0.5	0	1	0.5	1	0.5	0	1	0.5	0	0	0.5	0	0
11	0.5	1	0.5	1	0	0.5	1	1	0.5	0.5	1	1	1	1	0.5	0
12	1	0	0	0.5	0.5	0	0.5	0.5	0.5	1	0.5	1	0	0	1	0
13	0.5	1	1	0.5	0.5	0.5	0.5	1	0	1	1	0.5	0.5	0	0	0.5
14	1	0.5	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	1	1	0.5	0	0
15	1	0.5	1	0.5	0	1	0	1	0	0	0.5	0.5	0.5	0	0.5	0.5
16	0.5	1	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	0	1	0
17	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0.5	1	0	0.5	1	0	1	1
18	0.5	0.5	0	0	0	1	0.5	0.5	0.5	1	0.5	0.5	1	0	0	1
19	0	0	0	0.5	0.5	0.5	1	0.5	0	0.5	1	0.5	0	0.5	0.5	0.5
20	0	0	0.5	0.5	0.5	0	0.5	0.5	1	0	1	0.5	1	0	0.5	0
21	0.5	0.5	0.5	0	0.5	0	1	0.5	0.5	0.5	0.5	1	0	1	0	0
22	0	0.5	0.5	1	0	0	1	0.5	1	0.5	0	0.5	0	0.5	0	0
23	1	0.5	0.5	0.5	0	0.5	0	1	0.5	0.5	1	0.5	0.5	0.5	0	0.5
24	0.5	0.5	0.5	1	0.5	1	0.5	0	0.5	0	0	0	0.5	0.5	0.5	0
25	0	0	0.5	0	1	0.5	0.5	1	0.5	0.5	0.5	0	0	0.5	0	0.5
26	0.5	0	0	0.5	0.5	0	0.5	0.5	0	0	0	1	0.5	0.5	1	0
27	0	0.5	0.5	0	0	0	0.5	0.5	0	0	0.5	1	0.5	0.5	0.5	0.5
28	0.5	0	0.5	0	0	0.5	1	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0.5
29	0	0.5	1	0	0	0	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0	0
30	0.5	0	1	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0	0.5	0.5	0	0
31	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	1	0.5	0	0.5	0	0.5	0.5
32	1	0.5	1	0.5	0	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5
33	1	1	0	0.5	0.5	0.5	0.5	0	0	0.5	1	0	0.5	0	0	0.5
34	0	1	1	0.5	0	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	0	0.5
35	0.5	0.5	0.5	0.5	1	1	0.5	1	1	0	0.5	0.5	0	0.5	0	0.5
36	0.5	0.5	0	0.5	0	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	0	1
37	1	0	1	0	0	0.5	1	1	0.5	0	1	1	0	0	0	0.5
38	0	0	0.5	0.5	0.5	0	0.5	0	0	0.5	0	0.5	0	0.5	0	0
39	0.5	0	0	0.5	0.5	0	1	1	1	0.5	0.5	0.5	0	0	0	0
40	1	0.5	0.5	0.5	0	0	0.5	0.5	0	0.5	0	1	1	0.5	0	0.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
41	0	0	0	0.5	0	0	0	0.5	0.5	0.5	0.5	0	1	0	0.5	0

42	0	1	0.5	1	0	1	0.5	0	0	1	1	0	0.5	1	0	0
43	0	0.5	0	1	0.5	0.5	0.5	0	0	0	0	0	0.5	1	0.5	0.5
44	0.5	0.5	0	0.5	1	1	0.5	0	0	1	0	0.5	0	0.5	0.5	0
45	1	0.5	0.5	0	0.5	0.5	0	1	0.5	1	0.5	1	0	0.5	0	0.5
46	1	0	0	0.5	0.5	0.5	1	0	0.5	1	0	0.5	0.5	0	0	0.5
47	0	0.5	0	1	0.5	0	0.5	0	0.5	0	1	0.5	0	0.5	1	0.5
48	0.5	0.5	0.5	1	0	1	0.5	0.5	0	0.5	0	0	0.5	0	0	0
49	0.5	0.5	0.5	0.5	0.5	0	0	1	0.5	1	0	0.5	1	0.5	1	0.5
50	0	0	0	0.5	0	0.5	0.5	1	0	1	1	0.5	0	1	0	0.5
51	0.5	0.5	0	0.5	0.5	0	1	0	0.5	0.5	0.5	0.5	0.5	0	0	0.5
52	1	0.5	0	0	0.5	0.5	0	0.5	1	0.5	0.5	0	0	0.5	1	0.5
53	0	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0.5	0	0	0	1	0.5
54	0.5	1	1	0.5	0	0	1	0.5	0	0	0.5	1	0.5	0.5	1	0.5
55	0	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
56	0.5	0	1	1	0.5	1	0	0.5	0	0	0	0	0.5	1	0.5	1
57	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	1	0	1	0.5	1	0.5
58	0.5	0.5	0.5	0	1	0	0	0	0	1	0.5	0	0.5	1	1	0
59	0	0	0.5	0.5	0.5	0.5	0.5	0	0	1	0.5	0.5	0.5	0.5	0.5	0.5
60	0.5	0.5	0	0	0	0.5	1	1	0	0.5	0	0.5	0.5	1	0.5	1
61	0.5	0.5	0.5	1	0.5	1	0	0	1	0.5	0	1	0	0.5	0.5	0.5
62	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	0.5	0.5	1	0.5	1	0	0
63	1	0.5	0.5	0	0	1	0	1	0	0	1	0.5	0.5	0.5	0	0
64	0	0.5	0	1	0	1	1	1	0	1	0	0	0	0	0	0.5
65	1	0.5	0.5	0	0	0.5	0	0	0.5	0.5	0.5	0.5	0	0.5	1	0
66	1	0.5	1	0	0	0.5	1	0	1	1	1	0.5	0.5	1	0.5	0.5
67	0.5	1	0	0	0.5	0	0.5	0	0.5	0	0	0	1	0.5	1	0.5
68	0.5	0.5	0.5	0.5	1	0.5	1	0.5	1	0	1	1	0	1	1	0.5
69	0	1	0	0	0	0.5	0	0	1	0.5	0.5	0.5	0.5	0.5	1	1
70	0	0.5	1	1	0	0.5	0.5	0	0.5	0.5	1	1	0.5	0.5	0	0.5
71	0	0	0	0.5	0.5	0	0.5	0	0	1	0.5	0.5	0	0.5	0	0.5
72	0	0.5	0.5	0	0	1	1	1	0	1	1	0	1	0	0.5	0.5
73	0	1	0.5	0	0.5	0	0.5	0.5	0	1	0.5	0	1	0.5	1	1
74	0	0	0	0	0	0	0.5	1	0.5	0.5	1	1	0	0	0	0
75	0	0.5	0.5	0.5	0	0.5	0	0	0.5	0	0	0.5	0	0.5	0.5	1
76	0.5	1	0.5	0.5	0.5	0	1	0	0.5	0.5	0	0.5	0.5	1	0	0
77	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
78	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	0.5	0	0	1	0	0	0
79	0.5	0	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0	1	0.5	0	0.5	0.5
80	0.5	1	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0
81	1	0.5	0.5	0.5	0	1	1	0.5	0	0	0.5	0.5	0	1	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
82	0.5	0.5	0	0	0	0.5	1	0	1	1	0	1	0	0	1	0.5

83	0.5	0	0.5	0	0.5	0	1	0.5	0.5	0.5	0	0	0.5	0	0.5	0
84	0	0.5	0	0	0	1	0	0.5	0	0	1	0	0	0.5	0	0.5
85	0	0	0.5	0.5	0.5	1	0	1	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5
86	0	1	1	0.5	0.5	0.5	1	0	0	0	0.5	1	1	0	1	0.5
87	0.5	0.5	0	0	0.5	1	1	0.5	0	0.5	0	0.5	0.5	0.5	0	0
88	0	1	0	0.5	0.5	0.5	0	1	0	0	0.5	0	0.5	1	0.5	0
89	0	0.5	0.5	0.5	0	0	1	1	0	0	1	0.5	0.5	0	0.5	0
90	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0.5	0	0	0.5	0.5	1	0.5	0.5
91	0.5	1	0.5	0.5	0.5	0.5	0.5	0	0.5	1	1	0	1	0	1	1
92	1	0.5	0.5	0.5	0	1	0.5	0	1	0.5	0.5	0.5	0.5	0.5	0.5	0
93	0	0.5	0.5	0	0	0	0	0	0.5	0.5	0	0	1	0.5	0	0.5
94	0	0.5	0.5	0.5	0	0	1	0.5	0.5	0.5	0	0	0.5	1	0.5	0.5
95	0	0	0	0.5	0	0.5	1	0.5	0	0.5	0	0	0	0.5	0	0.5
96	0	0.5	1	1	0.5	0	0	0	0	0	0	0	0	0.5	0	0.5
97	1	0.5	0	0.5	0.5	0.5	1	0.5	0	0.5	0	0.5	0.5	0.5	0.5	0.5
98	0	0.5	0.5	0.5	0.5	0.5	1	0	0.5	1	1	0.5	0.5	0.5	0.5	0.5
99	0.5	0	0	0.5	0.5	0	0.5	0.5	0.5	0	0	0	0.5	0.5	0	1
100	0.5	0.5	0	0.5	0.5	0	0.5	0	1	0.5	0	0	0	0.5	0.5	0.5
101	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	0.5	0	0	0.5	0.5	0.5
102	1	0	0.5	0.5	0	0.5	0	0	0.5	0.5	0.5	1	1	1	0.5	0.5
103	0.5	1	1	0	0	0.5	1	0.5	0.5	1	0.5	0	0	0	0.5	0.5
104	0.5	0.5	0.5	0.5	0	0.5	0.5	0	1	0	0	0.5	0	0.5	1	0.5
105	0	0.5	0.5	1	0.5	0	0	0	0.5	1	0.5	0.5	0	0	0.5	0.5
106	0.5	1	0	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0
107	1	0.5	0	0.5	0	0	1	0.5	0.5	0.5	0.5	1	0	1	1	0
108	0.5	0	0.5	0.5	0	0	0.5	0.5	0	1	1	0.5	1	0	0.5	1
109	1	0.5	1	1	0	0	0.5	0.5	0.5	0	0.5	1	0.5	0	1	0.5
110	0.5	0	1	0.5	0	0	0.5	0	0.5	0.5	0.5	0	0.5	1	1	0.5
111	0	0.5	0.5	0.5	0.5	0.5	0	0.5	1	1	0	0.5	0	0	0	0.5
112	1	0.5	1	0	1	0.5	1	0.5	0.5	0	0	0.5	0.5	0	0.5	0.5
113	0.5	0.5	1	0.5	0.5	0	0.5	0	1	0	0.5	0	0	0.5	0	0
114	0.5	0	0	0	1	0.5	0.5	0	0	0.5	0.5	0.5	0	0.5	1	0.5
115	1	0	0.5	1	0.5	0	0.5	1	0.5	1	1	0.5	0	0	0	0.5
116	0	0	0.5	1	1	1	1	0.5	0	0	0.5	0.5	0.5	0	0.5	0
117	1	1	0	0	0	1	0.5	0	0.5	0.5	0	0.5	0.5	0	0	0
118	0	0.5	0	0.5	0	1	0.5	0	0	0.5	0.5	0	0.5	0	0.5	0.5
119	1	0.5	0.5	0	0	0	0	0.5	0	1	0.5	0.5	0	0.5	0.5	0

SAMPLE OF FEATURE MATRIX FOR TUNGA (BAND 3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	1	1	0.5	0	1	0.5	0.5	0.5	0.5	1	0.5	0.5	1	0.5	0.5	0.5
2	0.5	1	0	1	1	1	1	1	1	0.5	0	1	1	0.5	1	1
3	0.5	0.5	1	1	0.5	1	1	1	1	0.5	0.5	1	0.5	0.5	0.5	1
4	1	1	0.5	1	0.5	0.5	1	0.5	0.5	0.5	1	1	1	0.5	0.5	1
5	1	0.5	1	0	1	0.5	1	0.5	0.5	0.5	1	0.5	0	1	0.5	0
6	1	1	0.5	1	0.5	0.5	1	0.5	1	1	1	0	0	1	1	0
7	1	1	0	0.5	0.5	0.5	0.5	1	1	0	1	1	0.5	1	0.5	1
8	1	1	1	0.5	1	0.5	0.5	0.5	0.5	1	1	1	0	1	0.5	0
9	1	0.5	0.5	0	1	0	0.5	0.5	1	0.5	1	0.5	0	1	1	1
10	1	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0	0.5	1	1	0.5	0	0.5
11	0.5	0	1	0	0.5	0	0.5	1	0.5	0.5	0.5	0.5	1	0	0.5	0.5
12	1	1	0.5	1	1	1	1	0.5	0.5	0.5	0.5	0	1	1	0.5	0.5
13	0.5	1	1	1	0.5	0	0	0.5	0.5	1	0	1	1	0.5	1	0.5
14	0.5	0	0.5	1	1	1	0	0.5	0.5	0	1	1	0	1	0	1
15	0.5	1	0.5	1	0.5	0	0.5	0.5	1	0.5	0.5	1	0	0.5	1	1
16	1	0	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0	1
17	1	1	0.5	1	0	1	0.5	1	1	0.5	1	1	1	0.5	1	0.5
18	0.5	1	1	0.5	0.5	0.5	0	1	0.5	0.5	0.5	0.5	1	0.5	0.5	1
19	1	1	0.5	0	0.5	1	0	0.5	0	1	1	1	0.5	0	0.5	1
20	0.5	1	0.5	1	1	1	0.5	1	0.5	0.5	1	0	0.5	0.5	1	0.5
21	0.5	1	1	0.5	1	1	0.5	0.5	1	0.5	1	1	0	1	1	0
22	1	1	0.5	1	0.5	1	1	1	1	0	1	0.5	0.5	0	0.5	0
23	0.5	0	0.5	1	1	1	1	0.5	0.5	0.5	0.5	1	1	0.5	0	1
24	0.5	1	0	1	0.5	1	0	0.5	0.5	0	0	0.5	1	0.5	0.5	0.5
25	0.5	1	1	1	0.5	1	0.5	1	1	1	0.5	0.5	1	0.5	1	0.5
26	1	0.5	0.5	0.5	0.5	1	0.5	1	1	1	0.5	1	0	0	0.5	0.5
27	1	1	0.5	0	1	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1
28	0.5	0.5	0.5	1	1	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	1
29	1	1	1	1	1	0.5	0	1	1	0.5	1	1	1	1	1	1
30	1	0.5	0	0	0.5	1	0.5	1	0	1	1	0	0.5	0.5	1	1
31	1	0.5	1	1	0.5	1	0.5	1	1	1	0	1	0	1	0.5	1
32	1	0.5	1	1	0.5	1	1	1	0	1	1	0.5	0.5	1	0.5	0
33	1	1	1	0.5	1	0	0.5	0.5	0	0.5	1	0.5	1	1	0.5	0.5
34	0.5	0.5	0.5	1	1	0.5	1	1	0.5	0.5	0	0.5	1	0.5	0.5	0.5
35	1	0.5	0	1	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5	1	1
36	0	0.5	1	1	1	0.5	0.5	1	1	1	0.5	1	0.5	1	1	1
37	0	0.5	0.5	0	0	0.5	1	0.5	1	1	1	1	0.5	0.5	0.5	0.5
38	1	0.5	1	1	0.5	1	0.5	0	1	0.5	0	0.5	1	0	1	1
39	0.5	0	0.5	0.5	0.5	1	1	1	0.5	0.5	0.5	1	0.5	0.5	0.5	1
40	1	1	0.5	1	0	0.5	0	1	1	1	0	0.5	1	0.5	1	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
41	0.5	0	0.5	1	1	0	0.5	1	1	0.5	0.5	0.5	0.5	1	1	0

42	0.5	0.5	1	1	0.5	0	0.5	0	0.5	0.5	0.5	0	0.5	1	1	1
43	1	1	0	0.5	1	1	1	1	0	0.5	0	1	1	0.5	1	1
44	0.5	0.5	0.5	1	1	1	1	0.5	0.5	0.5	1	1	1	1	0.5	1
45	1	0.5	1	0.5	1	0.5	0	0.5	1	1	1	1	1	0.5	1	0.5
46	0.5	0.5	1	1	1	1	0.5	1	1	0	0	1	0.5	1	0.5	0
47	1	0	0.5	0.5	1	0	0.5	0	0.5	0.5	0	1	0.5	1	1	0.5
48	1	0	0.5	1	1	0.5	1	0.5	1	1	1	1	1	0.5	0.5	0.5
49	0	0.5	1	1	1	0.5	0.5	0.5	1	1	1	0.5	0	1	0.5	1
50	0.5	1	0	0	1	1	0.5	1	0.5	0.5	0.5	1	0.5	0.5	1	0.5
51	0.5	0	0.5	1	0.5	1	1	1	0.5	0.5	1	0.5	1	1	0.5	0.5
52	1	1	0	1	1	0	0.5	0.5	1	0.5	1	0	1	1	1	1
53	1	1	0.5	0.5	0.5	0	1	0.5	0	0	1	1	1	1	1	0
54	0.5	0.5	0	1	0.5	0.5	1	0	0	0.5	0.5	0	1	1	0.5	1
55	0.5	0	0.5	1	1	0	1	1	0	1	1	1	1	1	0.5	0.5
56	1	1	1	1	0	0	0	0	1	0.5	1	0.5	1	0.5	0.5	1
57	1	0.5	0.5	1	1	1	0	1	0.5	1	0.5	0.5	1	0.5	1	0.5
58	0.5	1	1	0	0.5	1	1	0.5	1	1	0.5	0	1	1	1	0.5
59	1	0.5	1	0.5	1	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	0	1
60	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	1	1	1	1	1	0.5	1
61	0.5	0.5	0.5	0.5	1	0.5	0.5	1	0.5	0.5	1	0.5	1	1	0.5	0.5
62	0.5	1	1	0.5	1	0.5	1	0.5	1	0.5	0.5	1	0	0.5	1	0.5
63	0.5	1	0.5	1	1	1	0.5	1	1	0.5	0.5	0.5	0	0.5	0.5	0.5
64	1	0.5	0	0.5	1	1	0.5	0.5	1	0	1	1	0.5	0.5	0.5	0.5
65	0.5	0	1	0.5	0.5	1	1	0.5	1	1	0.5	1	0.5	1	0.5	0.5
66	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	1	1	1	0.5	1
67	0.5	1	1	1	0.5	1	0.5	0.5	0	0.5	1	0.5	1	0.5	1	1
68	0.5	0.5	0	0.5	1	0.5	1	1	0	0	1	0.5	0	1	1	0.5
69	1	0.5	1	1	0.5	0	1	0.5	0.5	1	1	0	0	0	0.5	1
70	1	1	1	0.5	1	1	0.5	0.5	1	1	0.5	1	0.5	1	1	0.5
71	1	0.5	1	0.5	0.5	1	1	0.5	1	0.5	0.5	0.5	0.5	1	1	0.5
72	0.5	0.5	1	1	0.5	1	1	0	1	1	0.5	1	1	1	1	1
73	1	0	1	1	0.5	0.5	0.5	1	1	0	0.5	1	1	1	1	0.5
74	1	0.5	0.5	0.5	0.5	1	0.5	1	0.5	1	1	1	0.5	0.5	1	1
75	0.5	0.5	0.5	1	1	1	0.5	0.5	0.5	1	0.5	1	1	1	1	0.5
76	1	1	0.5	1	1	0.5	0	0.5	0.5	1	0.5	0.5	1	1	0.5	0.5
77	0	1	1	0.5	0.5	0.5	0.5	1	1	1	0	0.5	0.5	1	0.5	1
78	0.5	0.5	1	1	0.5	0	0.5	1	1	0.5	0.5	1	0	0.5	0	0.5
79	1	0.5	0.5	0.5	1	0.5	1	1	0.5	1	0.5	0.5	1	0.5	0	0.5
80	0.5	1	1	0	0.5	1	0.5	0	1	1	1	0.5	1	1	0.5	1
81	1	1	0.5	1	0.5	1	1	0.5	1	0	0	0.5	1	0.5	0.5	0.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
82	0	1	0.5	0.5	0	0.5	0.5	1	1	0.5	1	1	0.5	1	0.5	0.5

83	1	0.5	0	1	1	1	1	0.5	1	0.5	1	1	1	0.5	0.5	0
84	0	1	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5	1	1	0.5	0.5
85	0.5	1	0	1	1	0	0	1	0.5	0.5	0.5	1	0.5	0.5	1	1
86	1	1	0.5	0.5	0.5	0.5	1	1	0.5	1	1	0.5	0.5	1	0	1
87	1	0.5	0.5	0	1	1	0	0	0.5	1	0.5	0.5	1	0	0	0
88	0.5	1	0	0	0.5	1	1	1	0.5	0	0.5	1	0.5	0.5	1	1
89	0.5	0.5	1	0.5	1	1	1	0.5	0.5	0	1	0.5	0.5	1	1	0.5
90	1	1	0	0.5	0.5	1	0.5	0.5	1	1	0.5	1	0.5	1	1	1
91	0.5	0	0	0.5	0.5	1	1	0	1	0	0.5	0	0.5	1	1	1
92	0.5	1	0.5	1	0.5	1	0.5	0.5	1	1	0.5	0.5	1	0.5	1	0.5
93	0.5	0.5	0.5	1	1	0.5	1	0.5	1	0	1	1	0.5	1	0.5	0.5
94	1	1	1	0.5	1	1	0.5	0.5	0	1	0.5	0.5	1	0.5	1	1
95	0.5	0.5	0	0.5	0.5	1	1	1	0	1	0.5	1	0.5	1	1	0
96	1	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	1	0.5	0	0.5	1	0.5
97	1	0.5	0.5	1	1	0	1	1	0.5	0.5	1	0	0.5	0.5	1	0.5
98	0.5	0.5	1	1	1	0.5	1	0.5	1	1	0.5	0.5	1	1	1	0.5
99	1	0.5	1	1	1	1	0.5	0.5	1	0.5	1	0.5	1	0.5	0.5	1
100	0.5	0.5	1	0.5	1	1	1	0.5	1	0.5	0.5	0.5	1	0.5	0	0.5
101	1	0.5	1	1	0.5	0.5	0.5	0	0.5	0.5	0.5	1	1	0.5	0.5	0.5
102	1	1	1	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0	1	1	1	1
103	0.5	1	1	1	1	1	0.5	0	0.5	1	1	1	0	0.5	0.5	1
104	1	1	0	1	0.5	0	1	0.5	0.5	0.5	0.5	1	0	1	0.5	1
105	1	0.5	0.5	0.5	0.5	1	0.5	0	0	1	0.5	1	0.5	1	1	1
106	1	1	0.5	0.5	0.5	0	1	0.5	0	1	0.5	1	0	0.5	1	1
107	0.5	0.5	0.5	0.5	0	0.5	0.5	1	0.5	1	0.5	1	1	1	1	1
108	1	0.5	0.5	0.5	0.5	0.5	0.5	1	1	0.5	1	0.5	0.5	0.5	1	1
109	1	0.5	0.5	1	1	1	0.5	1	0	1	0.5	0.5	0.5	0.5	0.5	0.5
110	0.5	0	0.5	0.5	1	0.5	1	1	0.5	0	1	0.5	1	1	1	0.5
111	0.5	1	0	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	1	0.5	1	0	0.5
112	0.5	0.5	0.5	1	0.5	0.5	1	0.5	1	1	0.5	1	0.5	1	0.5	1
113	1	1	0.5	1	1	0.5	1	0.5	0.5	0.5	0	1	0.5	1	0.5	1
114	1	0.5	1	1	0.5	1	1	0	0.5	0.5	1	0	0.5	0.5	1	1
115	0.5	1	1	1	1	0.5	0	1	0.5	0.5	0.5	1	0.5	1	1	1
116	0.5	0.5	1	0	1	0.5	1	1	1	0.5	1	1	1	1	1	0
117	0.5	1	1	1	1	0	1	1	0.5	0.5	0.5	1	1	0.5	1	1
118	1	1	0.5	1	0.5	0.5	0.5	1	0.5	1	0.5	1	0.5	0.5	0	1
119	0.5	0	0.5	0	0.5	0	1	1	0	0.5	0.5	0.5	1	0.5	0.5	0.5

SAMPLE OF FEATURE MATRIX FOR KUBWA (BAND 4)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	0.5	1	0	0	0.5	0	0.5	0.5	1	0	0.5	0	1	0.5	1	0
2	0	0	1	0.5	0	1	1	0.5	0.5	1	0.5	0	0	1	0.5	0.5
3	0.5	0	0	0.5	0	1	0	0.5	1	0.5	0.5	0.5	0.5	1	0	0
4	0.5	1	0.5	1	1	0.5	0.5	0	0.5	0.5	0	1	0	0.5	0	0
5	0.5	0	0	0.5	0.5	0.5	0.5	1	0	0.5	1	1	0	0	0.5	0
6	0	0	1	1	0	0	0	0	0.5	1	0	0.5	1	0	0	0.5
7	0.5	1	0	0.5	0	0	0	0.5	0.5	0	1	0.5	0.5	1	0.5	1
8	0.5	0.5	1	0.5	0.5	0	0	1	0	0	0.5	0.5	0	1	0	0
9	0	0.5	1	0	0	0.5	0	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0
10	0.5	0	0.5	0	1	0	0.5	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5
11	0.5	1	0.5	1	1	0	0	0	0	0	0.5	1	0	1	0.5	0.5
12	1	0	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	0.5	1	0.5	0	0.5
13	0.5	1	0.5	0	0	1	1	0.5	0	1	1	0	0	0.5	0	0
14	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0	0.5	0.5	1	0	0	0.5	1
15	0.5	0.5	0.5	0.5	0	0.5	1	0.5	0	0.5	1	0	0	0.5	0.5	0.5
16	1	1	0	0.5	1	0	0	1	0.5	1	0.5	0	1	0.5	0.5	0.5
17	0.5	0.5	0	1	0	0	0.5	0.5	0.5	0	0.5	0.5	1	0.5	1	0
18	0	0	0	0	0	0.5	1	1	0	0.5	0.5	0.5	1	0	1	0.5
19	0.5	0.5	1	0.5	0.5	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5
20	0.5	0.5	0	0	0	0	0	1	0	0	0.5	0.5	0.5	0.5	0	0.5
21	0.5	0.5	0	0.5	0	0.5	0.5	0	0	0	0	0	0.5	0.5	0.5	0
22	0.5	0	0.5	0.5	0	0.5	0.5	1	0.5	0	0.5	1	0.5	0.5	0.5	0.5
23	0	0.5	0.5	0.5	0.5	0	0	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0
24	0	0.5	0	0.5	0	0	0.5	1	0.5	0.5	0	0.5	0.5	0	1	0.5
25	1	1	0.5	0.5	1	0	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5
26	0	1	0.5	0	0.5	0.5	0	0.5	1	0.5	0	0.5	1	0	0	1
27	0.5	0	0	0.5	0	0.5	0	0	0.5	0.5	0	0	0	1	0.5	0.5
28	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0.5	1	0.5	0	0.5	0	0.5	0.5
29	0.5	0.5	0	1	0.5	0	0.5	0.5	0	0	0	0	0	0.5	0	0
30	0	0.5	0	0	0	0.5	0	0.5	0	0.5	0	1	0.5	0.5	0.5	0.5
31	1	0.5	0	0.5	0.5	0.5	0	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5
32	0	1	0	0.5	0.5	0	0.5	0.5	0	1	0	0.5	0	0.5	0.5	0
33	1	0.5	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0.5	0	0.5
34	0.5	0.5	1	0	0	0	1	0	0.5	0.5	0.5	0	0	0	0.5	0.5
35	0	0	1	0.5	0	0.5	0	0	1	0.5	0.5	1	0.5	0.5	0.5	0.5
36	0	0.5	0	0	0.5	0.5	1	0.5	0.5	0.5	0	1	0	0.5	0.5	0
37	0	0.5	0	0.5	0	0.5	0.5	1	0.5	0	1	0.5	0	0.5	0.5	0
38	0.5	0.5	0.5	0	0	0	0	0.5	0.5	0.5	0.5	1	0.5	1	0	0.5
39	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0.5	0	0	0.5	0	1	0	0.5
40	0.5	0	0	0	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
41	0	0	0.5	0.5	0.5	0	0.5	0.5	0	1	0.5	0	0	0	0.5	0.5

42	0.5	0.5	0	0.5	0	0	0	1	0.5	1	0	0.5	0.5	0.5	1	0.5
43	1	0.5	1	0	0.5	0.5	0	0.5	0	1	0	0	0	0	0.5	0
44	0	0.5	0	0	1	1	0	0.5	0.5	0.5	0.5	1	0.5	1	0.5	0.5
45	0.5	0.5	0	0.5	0	0	0	1	1	0.5	0	0.5	0.5	0.5	0.5	0
46	1	0	0	1	0	0	0.5	1	0	0	0	0	0.5	1	0	0
47	0	0.5	0.5	0	0	0	0	1	0.5	1	0.5	0.5	0.5	0	0	0.5
48	0.5	0.5	1	0.5	0	0	1	1	1	0	0	0.5	0	0.5	0.5	0.5
49	0.5	1	0.5	0	0	0.5	0	1	0.5	0	0.5	1	0	0.5	0.5	0.5
50	1	0.5	1	0.5	0	0.5	0	0.5	0	0	0.5	0.5	0.5	0	0.5	0
51	0.5	0	0	0.5	0	0	0	0.5	0.5	0	0	0	0	0.5	1	0.5
52	0.5	0.5	0	0	0	0.5	0	0	0.5	1	0.5	0	0.5	0.5	1	0.5
53	1	0	0.5	0	1	0.5	0	0	0.5	0	0	0.5	0.5	0	0	0.5
54	1	0.5	0.5	0	0.5	0	0	0.5	0	1	0.5	1	0.5	1	0	0
55	0.5	1	0.5	0.5	1	0	1	0	0	0.5	1	0	0.5	0.5	0.5	0.5
56	0.5	0	0	1	0	0	0.5	0	0.5	0.5	0	0	1	1	1	0
57	0.5	0.5	1	0	0.5	0	0	0	0.5	0.5	1	0.5	0.5	1	0.5	0
58	0.5	0.5	1	0	0.5	0	0.5	0	0.5	0	0	0.5	0.5	0.5	0	0
59	0.5	1	0	0	0	0	0	0.5	0	1	0.5	0	0.5	0	0.5	1
60	0.5	0	0.5	0.5	0	0.5	0	0.5	0.5	0.5	0	0.5	1	0	0.5	0.5
61	0	0	0.5	1	0	0.5	0	0.5	0.5	0.5	0	0	0.5	1	0.5	0.5
62	0	0.5	0.5	0	0.5	0	0	0	1	0	0	0.5	0.5	0.5	1	0.5
63	0	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0.5	0	0.5	1	0.5	0.5
64	0	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0.5	1	0.5	0	1
65	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0.5	1	0.5	0.5	1	0	0	0.5
66	1	0	0	1	1	0.5	0.5	0	0.5	0	0.5	1	0.5	0	0	0.5
67	0.5	0.5	0.5	0.5	0.5	0	0.5	0	1	0.5	0.5	0.5	0	0.5	0	0.5
68	1	0.5	0.5	0.5	0.5	0	0.5	1	0	0.5	0.5	1	0.5	0.5	0	0
69	0.5	0.5	0	0	0.5	0	0.5	0.5	0	0.5	0.5	1	0.5	0	0.5	0.5
70	0	1	0.5	0.5	0.5	0	1	0.5	1	0	0.5	0	0.5	1	0	0
71	0	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0.5
72	1	0.5	0.5	0.5	0	0	0.5	0.5	0	0.5	1	0	0	1	0	0.5
73	0.5	0.5	0	0	0	0	0.5	1	0.5	0	1	0.5	0	1	0	0
74	0	0.5	0	0	1	0.5	0.5	0.5	1	0.5	0	1	0.5	0	0.5	0
75	0.5	0	1	0	1	0.5	1	0	1	0	0	0.5	1	0.5	1	1
76	0.5	0.5	0	0	0.5	1	0.5	0.5	0.5	0.5	1	0.5	0	0.5	0	0.5
77	0.5	0.5	0	0	0	0	0.5	0.5	0.5	0	0	0	0	0.5	0.5	0.5
78	0.5	0.5	0.5	0	0.5	0	0	0	1	0.5	0.5	0	0.5	0.5	0	0
79	1	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0	0.5	0.5	0.5	0	0	0.5
80	0	0	0.5	1	0.5	0.5	0	0	0.5	0	0.5	1	0.5	0.5	0.5	0
81	0	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0	0.5	0.5	1	1	0.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
82	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0	1	0.5	0.5	1	0	0	0.5

83	1	0	0.5	0	0	0	1	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0
84	0	0	0	0.5	0	0	0.5	0.5	0	0.5	0.5	1	0.5	0	0.5	0.5
85	0.5	0.5	0.5	0.5	1	0.5	0.5	1	0	0	1	0	0.5	0.5	0.5	0.5
86	1	0.5	1	0.5	0	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0
87	0.5	0.5	1	0	0.5	0	0.5	0.5	0	1	0	1	0.5	0.5	1	0.5
88	1	0.5	1	0.5	0	0	0.5	0	0.5	0.5	0	0.5	1	0	0.5	0
89	0.5	0.5	0	0	0.5	0	0	0.5	0	1	0.5	0.5	0	0	0.5	0.5
90	0.5	1	0.5	0	0.5	0.5	0.5	1	0.5	1	0.5	0	0	0	0.5	0
91	0.5	0.5	0.5	0	0	0.5	0.5	0.5	1	0.5	1	0.5	1	0	1	0.5
92	1	0	0	0.5	0.5	1	0	0	0.5	0.5	0.5	0	0.5	0	0.5	0.5
93	0	1	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5
94	0.5	0.5	0.5	0.5	0	0	0	0	0	0.5	1	0.5	0.5	0	0.5	0.5
95	0.5	1	0.5	0	1	0	0	0	0	0	0.5	0	0.5	0.5	1	0.5
96	1	1	0	1	1	0.5	0	0.5	0	0.5	0	0.5	0.5	1	0.5	0.5
97	1	1	0	0.5	0.5	0	0	0	0.5	0	0	0	1	0	0.5	0.5
98	0	0.5	0	0	0	0.5	0	0.5	1	0.5	0	0.5	0.5	0.5	0	0.5
99	0	0.5	0.5	0.5	0.5	1	0.5	1	0.5	0	0.5	0	0	0.5	0.5	0
100	0.5	0	0.5	0	0.5	0.5	0.5	0	0	0.5	0.5	1	0.5	0.5	1	1
101	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0	0	1	0	0	1	1
102	0.5	0.5	0	0	0.5	0.5	0.5	0	0	0.5	0.5	0	0	0.5	0	0.5
103	0.5	0.5	1	0.5	0.5	0.5	0	1	1	0.5	0	0.5	0	0	0	0.5
104	0.5	0	0.5	0	0.5	0	0.5	0	0	0	0.5	0.5	0	0	0.5	0.5
105	1	0	0	0	0.5	0.5	1	0.5	0.5	0.5	0	0	0	0.5	0	1
106	0.5	0.5	0.5	0	0.5	0	0.5	0.5	1	0.5	0.5	1	0.5	1	0.5	0
107	1	0.5	0	0	0.5	0	0.5	0	0	0	0	0.5	0	0.5	0	0
108	0.5	1	1	1	0	0.5	0	0.5	0.5	0	0	1	0	0	0	0
109	0.5	0	0.5	0.5	1	0.5	0	1	1	0	1	0.5	0.5	0.5	1	0.5
110	0.5	0	0.5	0	0.5	0.5	1	0.5	0	0	0.5	0	0.5	0.5	0	1
111	0	0	0	1	0	0	0.5	1	0	0.5	0	1	0	1	1	0
112	1	0	0.5	0	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0
113	0	0.5	0	1	0.5	0	0	0.5	0.5	0.5	0.5	1	0.5	0.5	1	1
114	1	0.5	0	0.5	0	0.5	0	1	1	0.5	0	0	1	0.5	0	0.5
115	0	0.5	1	1	0	0.5	0	0.5	0.5	0	1	0.5	0.5	0.5	0.5	0
116	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0	0	1	0.5	0	0.5	0.5	1
117	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0	1	0.5	0.5
118	0	0.5	0	0.5	0	0.5	0	0.5	1	0.5	0	0	0.5	0	0.5	0
119	0	1	0.5	1	0.5	0	1	0.5	0	0	0.5	1	0.5	0	0	0.5

SAMPLE OF FEATURE MATRIX FOR GUDU (BAND 5)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	0.5	0.5	0	0.5	0.5	0	1	0	0.5	0	1	0	0.5	0	0.5	0
2	0.5	0.5	0	0.5	0.5	0.5	0	0	0	0.5	1	0	0.5	0.5	1	0.5
3	0.5	0.5	0.5	0.5	0	0.5	0.5	1	0	0	0.5	0.5	1	0.5	0.5	0.5
4	1	0.5	0.5	1	1	1	0.5	0	0	0	0	0	0	0	0.5	0.5
5	0.5	0	0	0.5	0.5	0	1	0	0	0.5	0.5	0.5	0	0.5	0	0
6	1	0.5	0	0	0	0.5	1	0	0.5	0	0	0	0	0.5	1	0
7	1	0	0.5	0.5	1	0	0.5	0.5	0	0.5	1	0.5	1	1	0	1
8	0.5	0.5	0.5	0	0	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	0.5	0.5
9	0.5	0.5	1	0.5	0	0.5	1	0.5	0	0.5	0.5	0	0	0.5	0	0.5
10	1	1	0.5	0	0	0.5	0	0.5	1	1	0	1	0.5	0.5	1	1
11	0.5	0.5	1	1	0.5	0.5	0.5	0	1	0.5	0	1	1	0	0.5	0
12	0.5	0.5	0	0.5	0	0.5	0	0	1	0.5	1	0	1	0.5	1	0.5
13	0.5	0.5	1	1	0.5	0.5	0	0.5	0.5	0	1	0.5	0	0	0.5	0
14	0.5	0	1	0.5	0	0.5	1	0.5	0	0.5	1	1	1	1	0.5	0.5
15	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0	0.5	0.5	0	0	0.5	0.5
16	0	1	1	0.5	0.5	0.5	0	0	0	1	1	0.5	0.5	0.5	0	0.5
17	1	0.5	0.5	1	0	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0
18	1	0	1	0	0.5	0.5	0	0.5	0	0	0.5	1	0	1	1	0.5
19	0	0.5	0.5	0	1	0.5	0.5	0.5	0	0	0.5	0.5	0.5	1	0.5	0.5
20	1	0	0.5	0.5	1	0.5	1	0.5	1	1	0.5	0.5	0.5	0.5	0	0
21	0.5	0	0.5	0.5	0	0.5	0	0	0.5	1	0	0	0	0.5	0	0
22	0.5	0.5	1	1	0.5	1	0	0.5	0.5	0	0.5	0	0.5	0.5	0.5	1
23	0.5	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
24	0.5	1	0.5	0.5	0	1	0.5	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
25	0.5	0.5	0	0.5	1	0.5	0	0	0.5	1	0.5	0.5	0.5	0	0.5	0.5
26	0	1	0	0.5	0.5	0	1	0	0.5	0.5	0.5	0	0.5	1	0.5	0.5
27	0	0.5	0.5	0	0.5	0	0.5	1	0	0.5	1	0.5	0.5	1	0.5	0.5
28	1	0.5	0	0	1	0.5	0.5	0	0	0.5	0.5	0	0	0	0.5	0.5
29	1	0.5	0.5	1	0	0	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5
30	1	0	0	0.5	1	0	0.5	1	0.5	0.5	0	0.5	0	1	1	0.5
31	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0.5	1	0	0	0.5	0.5	0.5	0.5
32	1	0	0	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0	0.5	0	1	0
33	0	0	0.5	1	0.5	0	0	0	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5
34	0.5	0.5	1	1	0.5	1	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5
35	0.5	0.5	0	0.5	1	0.5	0	0.5	0.5	0.5	0	0.5	1	0.5	0	1
36	0.5	0.5	0	0	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0
37	0.5	1	0.5	0.5	1	1	0.5	0.5	0.5	1	0	0	0.5	0.5	1	0.5
38	0	0.5	1	0.5	1	0.5	0	0	0	1	0.5	0.5	1	0.5	0	0.5
39	1	0	0	0.5	1	0.5	1	1	0	1	0.5	0.5	0.5	0.5	0.5	1
40	0	0.5	0.5	0.5	0.5	1	0.5	0	0.5	0.5	1	1	1	0	0	0.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
41	0	0.5	0	1	0.5	0.5	0	0.5	0	1	0.5	0.5	0.5	0	1	1

42	1	0.5	0.5	1	0	0.5	0.5	0	0	0	0.5	0	0.5	0.5	0.5	0
43	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0	0.5	0	0.5	0.5	0	1	0
44	0.5	1	0.5	0.5	1	0.5	0.5	0.5	0.5	0	0.5	1	0.5	0	1	0
45	1	0.5	0	1	1	0.5	1	0	0.5	0.5	0.5	0.5	0	0.5	0	0.5
46	0.5	1	0	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0	1	0.5
47	0	0	1	1	1	0.5	0	0	0	0	0	0	0.5	0	0.5	1
48	1	0	1	0	0.5	0	1	0	0	1	0.5	1	0.5	0.5	0	0.5
49	0.5	0	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0
50	0.5	1	0	1	0	0.5	0.5	0.5	0	1	0.5	1	1	0	0.5	0.5
51	0	0	0	1	0	0.5	0.5	1	0	0	0.5	0	0	0.5	0	1
52	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
53	0.5	0.5	1	1	0.5	0.5	1	0	0	0	0	0	0.5	1	1	1
54	0	0	0.5	0	0.5	0.5	1	0	0.5	1	1	0.5	0	0.5	0.5	0.5
55	0.5	1	0	0	1	0.5	0.5	0	0.5	1	0	0.5	0.5	0.5	0	0.5
56	0	0	0	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0	0	0.5	0.5	0
57	0.5	0	0	0.5	0.5	0	0.5	1	1	0.5	1	0.5	0.5	0.5	0	0.5
58	0	0.5	1	0.5	0	0.5	0	0	0.5	1	0.5	0	0	0.5	0	0
59	0	0	0	1	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	1	0	0.5
60	1	1	0.5	0.5	1	0.5	0	0.5	1	0.5	1	0	0.5	0	0.5	0
61	0	1	0.5	1	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0	0.5	0	0.5
62	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5
63	0	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5
64	1	1	1	0.5	0	1	0.5	0.5	0	0.5	1	0	0.5	0	1	0.5
65	0.5	0.5	0.5	0	0	0	0.5	0.5	0.5	0.5	0	0	0	0.5	0	1
66	1	0.5	0	0.5	0	0.5	1	1	0.5	0	1	0.5	0	0	0.5	0.5
67	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0.5	0.5	0	0.5	1	0.5	0	0.5
68	0.5	1	0.5	0	0.5	0	1	0.5	0	0	0	0.5	0	0	0.5	0.5
69	1	0.5	0.5	0	0.5	0	0	0.5	0.5	0	0.5	1	0.5	0	0	0.5
70	1	0	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0	0.5	0.5	0	1
71	0	0	0	1	0.5	0.5	0	0	0	0.5	1	0	0.5	0	0	0.5
72	1	1	0	0.5	0.5	1	1	0	0.5	0.5	0	0.5	0.5	0	0	0
73	1	1	0	0.5	0.5	1	0.5	0	0	0.5	0.5	1	0.5	0.5	0.5	0.5
74	0.5	0	0	0.5	0.5	0	0	0.5	0.5	0	0	0.5	1	0.5	0	0
75	0	0.5	0	0	0	0.5	0	0.5	0	0.5	0	1	0.5	0	0.5	0
76	1	0.5	0.5	0.5	0.5	1	0	0	0	0.5	0	1	0.5	0	0.5	0.5
77	0.5	1	0.5	1	0.5	0.5	0	0	0.5	0.5	0.5	1	0.5	0.5	0	1
78	0.5	0.5	1	0.5	0	1	0	0.5	0.5	1	0	1	0.5	0	1	1
79	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0	0.5	0	1	0	1	0.5	1
80	1	0	1	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0	0.5	1	0	0.5
81	0	0	0.5	0	0	0.5	0.5	0	0.5	0.5	0.5	0.5	1	0.5	1	0.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
82	0	0.5	0.5	0	0.5	0.5	1	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5

83	0	0	0.5	0	1	0	0	1	0.5	0.5	0	0	0.5	0.5	0	0.5
84	0	0.5	0.5	0.5	0.5	0	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5
85	0.5	0.5	1	0	0.5	0.5	0.5	0.5	0	0.5	0	0	0.5	0.5	0.5	0.5
86	0	0	1	0	0.5	0	0.5	0.5	0	0.5	1	0.5	0	0	0.5	0.5
87	0.5	0	0.5	1	0	0.5	0	0.5	0.5	0.5	0.5	0.5	1	1	1	1
88	1	1	0.5	0.5	1	0.5	0	1	0.5	1	0.5	0	1	0	0	0
89	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	0	0.5
90	0.5	0	0.5	0.5	1	0	0.5	0	1	0	0	0.5	0.5	0	1	0.5
91	1	0	1	0.5	1	0	0	0	0.5	0.5	0.5	0.5	0.5	1	0.5	1
92	0.5	0.5	0.5	0	0.5	0.5	1	0	0	0	0	0.5	0.5	1	0.5	0.5
93	0.5	1	1	0	0.5	1	0.5	0	1	0.5	0	0.5	0.5	1	0	0
94	0	0.5	0.5	1	0.5	0	0	0.5	0.5	0	0.5	0.5	0	1	0.5	0.5
95	0	0.5	0.5	0.5	1	1	1	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
96	0.5	0	0.5	0	0	0	0.5	0	1	0.5	0	0	0.5	1	1	0
97	0	1	0.5	0.5	0	0.5	0.5	1	1	0.5	1	0.5	0.5	0	0	0
98	0	1	0	0.5	0.5	0	0	0	0	0.5	0.5	0.5	0.5	1	0	0.5
99	1	1	0.5	0	0.5	0	0	0	0.5	0	1	0	0.5	0.5	1	0.5
100	1	0.5	0.5	0	1	0.5	0	0	0	0	1	0	0	0.5	1	1
101	0	0	0.5	1	1	0.5	1	1	0.5	1	0.5	0	1	0.5	0.5	0
102	0	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0	1	1	1	0.5	0
103	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0	0.5	1	0.5	0.5	0	1	1
104	0.5	0.5	0.5	0.5	1	0.5	0	0.5	0	0	1	0.5	0.5	0	0.5	0.5
105	0	0	0.5	1	0.5	0	0.5	0	0	0	1	1	0.5	0.5	0.5	0
106	0.5	0.5	0.5	1	0	0	1	0	0.5	0	0.5	1	0	0.5	0.5	0.5
107	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0.5	0	0.5	0.5	1	1	0.5	0.5
108	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0.5	0	0	0	0.5
109	0.5	0.5	0	0.5	0.5	0	0	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0
110	0	0	0	0.5	0.5	0.5	0	0.5	0	1	0.5	0.5	0	1	0	0.5
111	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	1	0.5	0.5	0.5	1	0.5	1	0.5
112	1	0.5	0.5	0	0.5	0	1	1	0	1	0.5	1	0.5	0	0.5	0.5
113	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0	0	0	1	0	0.5	1
114	1	0	0	0.5	0.5	0.5	0	0.5	0	0.5	1	1	0.5	1	1	0.5
115	0	0.5	0.5	0.5	1	0.5	0	0	0	0	0.5	0	0.5	0	0	0
116	0.5	0.5	0.5	0.5	1	0.5	0.5	0	0	1	0	0	0.5	0.5	0	0.5
117	0.5	0.5	0.5	1	0	0.5	0.5	0.5	0	0	1	1	0	0.5	0.5	1
118	0.5	0.5	0.5	1	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0	1	1	0
119	0.5	0	1	0.5	0.5	0.5	0	0.5	0.5	1	1	0.5	0	0.5	0.5	0

SAMPLE OF FEATURE MATRIX FOR MAITAMA (BAND 6)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0	0	1	0	0.5	0	0
2	0.5	1	1	1	1	0.5	0	1	1	0	0.5	0.5	0.5	0.5	0	0.5
3	0.5	1	1	0.5	1	0.5	0	1	0.5	0.5	0.5	0	0	0	0	0.5
4	1	1	1	0.5	0.5	0.5	0	0.5	0	0	0	0.5	0	1	0	0.5
5	1	1	1	0.5	0.5	0.5	0	0	0.5	0.5	1	0.5	0.5	0.5	0	0
6	0.5	1	1	1	0.5	1	1	0	0.5	1	0.5	0	0.5	0	0.5	0.5
7	0.5	0.5	0.5	1	1	0.5	0	0.5	0.5	1	0	0.5	0	0	0	0
8	0.5	0	1	1	1	0.5	0	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0
9	1	0.5	0	0	1	1	0.5	0.5	1	1	0.5	0	0.5	0	0	0
10	0.5	1	0.5	0.5	1	1	0	1	0	0	1	0	0	0.5	0	0.5
11	0.5	1	0.5	0.5	1	1	0.5	0.5	0	0	0.5	0	0.5	0	0	0
12	0.5	1	0	1	1	0	0.5	1	0.5	0	0.5	0	0	0	0	0
13	1	1	0	0.5	1	0.5	0	1	1	1	1	0.5	0	0	0	0
14	1	1	0	0	1	0.5	0	0	0.5	0.5	1	0	0	0	0	0
15	1	1	1	0	1	0.5	0.5	1	0	0.5	0.5	0.5	1	0.5	0	0
16	1	0.5	0.5	0	1	0	0	1	0	0.5	1	0.5	1	0	0	0
17	0.5	1	0	0.5	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0	0	0.5	0
18	0.5	1	0.5	0	1	0	0	0.5	1	1	0.5	0	0.5	0.5	0	0
19	1	1	0.5	1	1	0	0	1	1	0.5	1	0	0.5	0	0	0
20	0	0.5	0	0.5	1	0.5	0	0.5	0	1	1	0	0	0	0	0.5
21	0	1	0	0	1	0.5	0	0	0	1	1	0	0.5	0.5	0	0
22	0.5	1	0	0.5	1	0.5	0.5	0.5	1	0.5	0	0	0	0.5	0	0
23	1	0	0.5	0.5	1	1	0	1	1	0.5	1	0	0	0	0	0.5
24	0.5	1	0	0.5	1	0	0	0	1	0.5	1	0	0	0	0.5	0
25	0.5	1	0	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0
26	1	1	0.5	0.5	1	0.5	0	0.5	1	1	0.5	0.5	0.5	0	0.5	0
27	0.5	1	0.5	1	1	0.5	0.5	0.5	1	0.5	1	0.5	0	0.5	0.5	0
28	0.5	0.5	0.5	1	1	1	0	0.5	0.5	1	0	0.5	0	0	0	0
29	0.5	1	0	1	1	0.5	0	0	0	0.5	1	0	0	0	0	0
30	0.5	1	0	1	1	0	0.5	0.5	0.5	1	1	0.5	0	0	0	0
31	1	0	0.5	1	1	0.5	1	0	0	0.5	0.5	0	0	0.5	0.5	0
32	0	1	1	1	1	0.5	0	0.5	0.5	0.5	0.5	0.5	0	0	0	0
33	1	0.5	0.5	1	1	0.5	0	0.5	0	1	0	0	0	0	0	0
34	1	1	1	1	1	0	1	0	0	0.5	0.5	0.5	0.5	0	0	0
35	0.5	1	1	1	1	0	0.5	0	1	0.5	0.5	0.5	0	0	0	0.5
36	1	1	0.5	1	1	0.5	0	1	0	0.5	0	0	1	0.5	0	0
37	0	1	1	1	0.5	0	1	1	0.5	0.5	0	0	0.5	0.5	0	0
38	0.5	0.5	1	1	0.5	0	0.5	1	0	0.5	1	1	0.5	0	0	0.5
39	0.5	1	0.5	1	0	0	0	0	1	0.5	0	0.5	1	0	0.5	0.5
40	1	1	1	1	1	1	0.5	0.5	1	0	1	0.5	0	0	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
41	0.5	1	1	1	0	1	0	1	0	0.5	0.5	0	0	0	0	0

42	0.5	0.5	1	1	0.5	0.5	0.5	0	0.5	1	0.5	0.5	0.5	0	0.5	0.5
43	1	1	1	1	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0.5
44	0.5	0.5	1	1	0.5	0	0.5	0	0.5	0	1	0.5	0	0	0	0
45	1	1	1	1	1	0.5	0.5	0	0.5	0	0.5	0.5	0	0	0	0
46	0.5	1	1	1	1	0	0.5	1	0	0.5	0.5	0.5	0.5	0	0	0
47	1	1	1	1	0.5	0	0	0.5	0	0.5	0	0	0	0	0	0
48	0.5	1	1	1	1	0.5	0	0.5	0.5	0	1	0	0.5	0	0.5	0.5
49	1	1	1	1	0.5	0	1	0	0.5	0.5	0.5	0.5	0	0	0	0
50	1	1	1	1	1	1	0.5	1	0.5	1	1	0.5	0	0	0	0
51	0.5	1	1	1	1	0.5	0	0.5	0.5	0	1	0	0	0	0	0.5
52	1	0.5	1	1	0.5	0	0	0.5	0.5	0.5	1	0	0.5	0	0	0
53	1	1	1	1	0	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0	0	0
54	0.5	1	1	1	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0
55	1	1	1	1	1	0	0.5	1	0.5	1	0.5	1	0	0	0	0
56	1	1	1	1	1	0	0	1	0	0.5	0	0.5	0.5	0	0	0
57	0.5	0.5	1	1	0	0	0.5	1	0	0.5	1	0	0	0.5	0.5	0.5
58	0.5	0.5	1	1	0	0	0.5	1	0.5	0.5	0	0	0.5	0	0	0.5
59	0.5	1	1	1	0	0.5	0	0.5	0	0	0	0	0	0.5	0.5	0
60	1	1	1	1	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0
61	1	1	1	1	1	0.5	0.5	1	0.5	1	0	1	0	0	0.5	0
62	0.5	1	1	1	0	0	0.5	0	1	0.5	0.5	0.5	0	0	0.5	0
63	1	1	1	1	0.5	0	0.5	0	0	0	0.5	1	0	0	0	0
64	0.5	1	1	1	1	0	0.5	0.5	0	1	0.5	0.5	0	0.5	0	0
65	1	1	1	1	1	1	0.5	0	0	1	1	0	0	0	0	0.5
66	1	0.5	1	1	0.5	0.5	0.5	0.5	1	0.5	0	0.5	0.5	0	0.5	0
67	1	1	1	1	1	0.5	0.5	0	1	0	0.5	0	0.5	0.5	0.5	0
68	1	0.5	1	1	0.5	1	1	0	0	0.5	0	0	0.5	0.5	0	0
69	1	1	1	1	0.5	1	1	0.5	0	1	0.5	0.5	0	0	0	0
70	0	1	1	1	0.5	1	1	0	0	1	1	0.5	0.5	0	0.5	0
71	0.5	1	1	1	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0.5	0	0	0
72	1	1	1	1	0.5	1	0.5	0.5	0	0.5	0.5	0.5	0	0	1	0
73	1	1	1	0.5	0.5	0.5	0	0.5	0.5	0	0.5	0	0	0	0.5	0
74	0.5	0.5	1	0.5	1	0.5	0.5	0.5	1	1	0.5	0	0	0	0	0
75	0	0.5	1	1	0.5	0	0.5	0	0	0.5	0.5	0	0	0	0	0
76	0.5	1	1	0.5	0.5	0	0.5	1	0.5	1	0.5	0.5	0.5	0	0	0
77	1	1	1	1	0	0.5	0.5	1	0.5	0.5	0	0	0	0	0	0
78	1	1	1	0.5	0.5	1	0	0.5	0	0	0.5	0	0	0	0.5	0
79	1	1	1	0.5	1	0	0.5	1	0.5	0	0	0	0	0	0	0
80	0	1	1	0.5	1	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0	0	0
81	1	1	1	0.5	1	1	0	0	1	0.5	0.5	0.5	0	0	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
82	0.5	1	0.5	0	0.5	1	0	1	1	0.5	0.5	1	0.5	0	0	0

83	1	0.5	1	1	0.5	0.5	1	1	1	0.5	0.5	0	0.5	0	0	0
84	0.5	1	1	0.5	1	0	1	0.5	1	1	0	0	0.5	0.5	0	0
85	1	1	1	0.5	1	0.5	1	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0
86	1	0.5	0.5	0.5	1	1	0.5	0.5	1	0.5	0.5	0	0	0	0	0
87	0.5	0.5	0.5	0.5	1	0	0.5	0	0	1	0.5	0	0	0.5	0	0
88	0.5	1	1	0	0.5	1	0.5	0.5	0.5	0.5	0	1	0	0	0	0
89	1	1	0.5	0.5	0.5	0	0	1	0	0	0	0	0.5	0	0	0
90	1	1	1	0.5	0.5	0	0.5	0.5	0.5	0	0.5	1	1	0.5	0	0
91	1	1	0.5	0.5	0.5	0	0	0	1	0.5	0.5	0	0	0.5	0.5	0
92	1	1	1	0.5	0.5	0	0	0	0.5	0.5	0	0	0	0	0.5	0
93	1	1	1	0.5	0	0.5	0	0.5	0.5	0.5	0.5	1	0	0	0	0
94	1	1	0.5	0.5	0.5	1	0	0	0.5	0	0	0.5	0.5	0.5	0	0.5
95	1	1	0.5	0	1	0	0	0.5	1	1	0	0	0	1	0	0
96	1	1	0.5	0.5	0.5	0.5	1	0.5	1	0.5	1	0	0	0	0.5	0
97	0.5	1	0.5	0	0.5	0.5	0	0	0	0.5	0	0.5	0.5	0	0	0
98	1	1	0.5	1	0.5	0.5	0	0	1	1	0.5	0.5	0	0	0	0
99	1	1	1	1	0.5	0.5	0	1	1	0	0.5	0	0	0	0.5	0
100	1	1	0.5	0.5	1	0	0.5	0.5	0	1	0.5	0.5	0	0	0	0
101	0.5	1	0.5	1	1	0	0	0.5	0.5	0	0	0	0.5	0	0	0
102	0.5	1	1	0	0.5	0.5	0	0	1	0.5	0	0	0.5	0	0.5	0
103	1	0.5	1	0.5	1	0	0	0	0.5	0	0.5	0.5	0	0	0	0
104	1	1	0	1	0.5	0	1	0.5	0	1	0	0.5	0	0.5	0.5	0
105	0.5	0.5	1	1	0.5	0.5	0	1	0.5	0.5	1	0.5	0	0.5	0.5	0
106	1	1	1	0.5	0.5	1	0.5	0	1	0.5	0.5	0	0	0.5	0.5	0
107	1	1	0.5	1	1	0	0	0.5	0	0	0	0	0	0.5	0	0
108	1	1	1	0.5	1	0.5	0	0.5	1	0.5	0.5	0.5	0	0	0	0
109	1	1	1	1	0.5	0	0.5	0.5	1	1	0	0.5	0	0	0	0
110	1	1	0	0.5	1	0	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0
111	0.5	1	1	0.5	1	0	0	0	1	1	1	0	0	0	1	0.5
112	1	1	0.5	1	0.5	0.5	0.5	0.5	0.5	0	1	0.5	0	0.5	0	0
113	1	0.5	1	1	0	0	0	0.5	0	1	0.5	0	0.5	0	0	0.5
114	1	1	0.5	0.5	1	0.5	0.5	0.5	0	0	0	0	0.5	0	0	0
115	0.5	0.5	1	1	1	0	0.5	1	0.5	0.5	0.5	0.5	0.5	0	0	0.5
116	0.5	1	1	1	0.5	0.5	0	1	0	1	0	0	0.5	0	0	0
117	0.5	0.5	1	0.5	0	0	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0	0
118	1	1	1	0	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0.5	0	0
119	1	1	1	0	0.5	0	1	0	1	0.5	1	0.5	0	0	0	0

APPENDIX E: SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER

SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER FOR GK (BAND 1)

	1	2	3	4	5	6	7	8	9	10

1	0.2963	0.1334	0.4013	0.2855	-0.1183	0.3773	-0.5099	-0.2249	0.2445	0.2432
2	0.3112	0.4922	-0.3885	-0.4017	-0.6734	-0.2962	-0.1384	0.5562	0.3215	-0.3474
3	0.0590	0.2464	-0.1742	0.1945	-0.1314	-0.1187	0.0379	0.2861	-0.2305	-0.2234
4	-0.1729	0.4438	-0.4880	0.0183	-0.5007	-0.0563	-0.2783	0.2470	-0.1421	0.3433
5	-0.0289	0.2472	0.4959	0.1106	0.1086	-0.2502	0.4174	0.0040	-0.2498	-0.4364
6	0.1184	-0.1596	-0.0770	-0.1863	0.0256	0.4791	-0.0145	-0.4651	-0.6421	-0.5397
7	0.1662	0.1727	0.3277	0.0329	-0.3321	-0.3093	-0.4444	0.0423	0.0765	0.1313
8	-0.1030	0.4470	0.0093	0.4971	-0.5446	-0.4949	0.3044	0.5983	-0.3114	0.1532
9	0.1051	0.0190	-0.2592	-0.0932	0.1129	-0.2829	0.4392	0.0267	0.1998	-0.4918
10	-0.1858	-0.2989	0.2964	0.6661	-0.3670	0.5740	-0.0228	-0.3616	-0.0091	-0.7192
11	-0.5731	0.0580	-0.2938	0.3871	-0.2886	0.4964	0.3039	-0.2938	0.4785	-0.4373
12	0.0673	0.2925	0.4532	0.6688	0.0048	-0.0853	-0.0145	0.1511	-0.0759	-0.5650
13	-0.3640	-0.2034	0.4379	0.1909	0.0314	-0.3109	-0.4011	0.1297	-0.6960	-0.1317
14	-0.3231	0.0924	0.3687	0.0034	-0.0437	0.4311	-0.2571	0.2764	-0.8896	0.0512
15	0.0509	0.3340	-0.1451	-0.1732	0.3102	0.0001	-0.1943	0.1282	-0.8125	-0.0258
16	-0.2596	-0.0456	0.1853	0.0563	-0.3766	0.4970	-0.3977	-0.0481	-0.0779	-0.0623
17	-0.0923	0.6987	0.3907	-0.2847	0.2082	-0.3239	-0.4509	-0.1070	0.2578	-0.0615
18	0.1710	-0.1392	-0.3028	-0.2437	-0.4850	-0.3545	0.3206	-0.2166	-0.3259	-0.5234
19	-0.2082	0.2783	0.3121	-0.3571	0.1342	0.4148	-0.5316	0.1312	-0.6483	-0.2405
20	-0.5009	0.4358	-0.2559	0.1118	-0.4738	-0.1949	0.2840	0.2461	0.3666	0.4034
21	-0.5256	0.1164	0.2486	-0.2951	-0.5207	0.3003	0.3351	0.2095	-0.1304	-0.5916
22	0.4790	0.0178	0.0888	0.4090	-0.3703	0.2316	-0.0939	0.6096	-0.1291	0.3455
23	0.1452	-0.2409	-0.1878	0.0414	-0.5796	0.2560	-0.1788	-0.1346	-0.1343	-0.1504
24	-0.2987	0.4129	0.4982	-0.4435	0.3341	0.4014	0.1130	-0.2316	-0.0113	-0.0473

SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER FOR AEDC (BAND 2)

	1	2	3	4	5	6	7	8	9	10

1	-0.1676	0.1035	-0.0963	0.3541	0.1496	-0.4850	0.4607	0.0534	-0.3682	0.4112
2	0.3009	-0.3406	0.4738	0.5165	0.0335	-0.0795	-0.4392	-0.0223	0.3059	0.1095
3	0.1737	-0.3963	0.1776	-0.1969	-0.4980	-0.1398	-0.2540	0.4134	-0.2051	-0.3163
4	0.1960	0.4064	0.4081	0.5294	-0.2410	0.1556	-0.1565	-0.0342	0.1556	-0.2161
5	0.1549	-0.0760	-0.3112	0.0310	0.2092	-0.4685	0.3085	-0.6194	-0.3032	0.4572
6	-0.1558	0.2294	0.6809	0.3649	0.1706	0.1924	-0.4175	0.2096	0.1243	0.4270
7	-0.0888	0.2508	0.2560	-0.1554	-0.6016	0.1862	0.4856	-0.3919	-0.0965	0.1004
8	0.0882	0.4499	-0.1820	-0.0207	-0.5217	-0.3735	0.4986	0.2244	0.3754	0.5550
9	-0.0158	-0.5762	0.6823	-0.0446	0.0370	0.3299	-0.0341	-0.0919	0.3334	0.0770
10	-0.0602	-0.1226	-0.2174	-0.3638	0.3605	-0.3553	0.3030	-0.4350	0.5006	0.3613
11	-0.0283	0.2591	-0.3398	0.3792	-0.6491	-0.2535	0.0097	-0.3217	-0.1889	-0.0397
12	-0.2094	-0.2476	0.1529	-0.2558	0.2291	0.0222	-0.5233	-0.3594	0.2550	0.5236
13	-0.0043	-0.4243	0.3146	0.0703	-0.1326	-0.1159	-0.3221	0.0739	-0.2982	0.1346
14	-0.2238	0.1768	0.3185	-0.5695	-0.1340	-0.1774	-0.2447	-0.3778	-0.4098	-0.1932
15	-0.4665	-0.0747	0.0324	0.3964	0.1363	-0.4080	-0.1292	0.3035	0.3849	0.4996
16	-0.3993	-0.4585	-0.2329	-0.3520	-0.7255	-0.0482	0.1648	-0.0158	0.2903	0.1705
17	-0.4720	-0.0287	-0.1512	-0.0968	0.1488	-0.5951	-0.4214	0.0039	0.3689	-0.2249
18	0.2797	-0.6317	0.4533	-0.3508	-0.1075	-0.2534	0.0721	0.3725	-0.4260	-0.0066
19	0.4875	-0.0179	0.0257	-0.0950	0.3648	0.1492	-0.3630	-0.8206	-0.3137	0.3771
20	-0.5456	0.3087	0.3732	-0.1829	-0.5933	-0.0197	0.0400	-0.1844	0.3350	-0.2211
21	0.4278	-0.0577	0.2553	0.1712	0.1596	-0.2205	0.0304	0.0546	-0.0827	0.3730
22	-0.2745	-0.3224	0.0250	0.5704	-0.0598	-0.1442	-0.1405	-0.2416	-0.3374	0.3972
23	0.4732	-0.2522	0.4255	0.3316	0.1442	0.2172	0.3024	-0.2833	-0.0412	0.2160
24	-0.0468	0.1763	-0.1207	0.1406	-0.3734	-0.4177	-0.3766	0.2023	0.3839	0.1288

SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER FOR TUNGA (BAND 3)

	1	2	3	4	5	6	7	8	9	10

1	-0.0109	-0.0270	-0.5004	-0.2411	-0.3251	-0.3062	-0.3882	0.0506	-0.2785	-0.2814
2	0.7381	-0.2222	-0.1447	-0.3010	-0.1576	-0.2562	-0.4501	0.2312	0.0065	0.1944
3	0.3368	-0.0084	-0.2686	0.0363	0.2612	0.5728	0.2495	-0.3398	-0.0024	0.1233
4	-0.4897	0.1984	-0.0792	-0.2025	0.2005	0.1297	0.2528	-0.4101	-0.2124	0.4616
5	0.2370	0.4325	0.0453	0.2392	-0.2425	-0.5157	-0.5656	-0.0107	0.1633	0.2260
6	-0.3977	0.1805	-0.4718	0.3341	0.3824	-0.0964	-0.3159	-0.0209	-0.4401	0.0328
7	0.0167	0.5650	-0.3794	0.1912	-0.0071	-0.3141	0.1406	-0.1863	-0.2884	-0.0147
8	-0.0028	0.4941	0.1201	-0.6547	-0.1668	0.0252	0.2674	-0.0654	-0.0378	-0.1978
9	0.1060	-0.2197	0.2083	0.1666	-0.1545	-0.1424	0.1725	-0.2179	-0.4606	-0.2056
10	-0.3508	0.1247	0.2092	-0.6091	-0.3782	0.2155	0.0747	-0.3149	-0.1623	0.0955
11	0.4496	0.1470	0.4150	0.2280	0.4460	-0.1302	0.0748	0.2863	-0.4746	-0.5067
12	0.0610	0.3706	0.3705	-0.3650	0.0317	0.1578	-0.2811	-0.5558	0.5249	0.5117
13	0.5750	0.3621	-0.2176	-0.1660	-0.0383	0.3398	-0.0749	-0.0328	-0.3943	0.4978
14	0.3088	-0.2040	0.0800	0.2361	0.3069	0.4740	0.3705	-0.6964	0.5172	0.3537
15	-0.1601	0.3919	0.4993	0.0172	0.5313	0.3474	0.0634	-0.0389	0.1589	0.0594
16	-0.1925	0.2588	0.3609	0.1555	0.2877	-0.0843	0.0375	0.2146	-0.2686	-0.0660
17	-0.1340	-0.5722	0.0064	0.3173	-0.3284	0.0372	-0.6820	0.0769	0.0255	-0.4363
18	-0.4342	-0.0227	0.4600	0.0242	-0.3253	0.2852	-0.2651	-0.5301	0.3872	-0.1862
19	0.4791	0.0457	0.5001	0.1238	0.1619	0.4439	-0.4099	0.1875	0.3004	0.2231
20	0.0192	-0.2468	-0.1250	-0.3473	-0.3687	0.2484	-0.0207	-0.2048	-0.6584	-0.2010
21	0.2742	0.3159	0.4836	-0.4593	0.1551	0.2520	0.0455	0.1660	0.0419	0.1357
22	-0.0205	0.2799	-0.0381	-0.1247	0.3558	0.5343	-0.1510	-0.1805	0.0350	0.0991
23	-0.2386	-0.0076	0.1913	-0.3336	0.2076	-0.3471	0.1677	-0.4195	0.2580	0.4894
24	-0.1689	0.5959	-0.3349	-0.2974	0.2332	-0.1645	0.0267	0.1518	-0.1779	-0.5181

SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER FOR KUBWA (BAND 4)

	1	2	3	4	5	6	7	8	9	10

1	0.3482	0.0195	-0.1481	-0.1639	-0.5339	-0.1813	-0.1400	-0.5370	0.2120	0.3603
2	0.2375	-0.0348	0.1518	-0.3523	-0.1864	-0.0456	-0.2779	-0.4315	0.0292	0.2701
3	0.0176	0.0122	0.8263	-0.3499	0.4291	0.4116	0.2757	0.3961	-0.0268	0.1198
4	0.4452	-0.1400	0.1132	-0.0408	-0.5959	0.4470	-0.0097	-0.4298	-0.5904	0.2488
5	-0.1273	-0.1851	0.3862	0.0279	-0.4826	0.3379	0.0167	-0.0640	0.0546	0.4778
6	0.4761	0.3873	-0.2326	-0.4119	-0.1855	-0.1536	0.1898	-0.4643	0.2798	0.1573
7	0.4258	0.0563	-0.5780	-0.1711	-0.5238	-0.0580	-0.1739	-0.2481	0.3183	0.5524
8	0.1405	0.2429	-0.2928	-0.1234	-0.2196	0.6237	0.3342	0.1152	0.6026	0.0699
9	0.4674	0.3834	0.0880	-0.4895	-0.2025	-0.0054	-0.1361	-0.0310	-0.2377	-0.6618
10	-0.1744	0.2410	0.3709	0.0451	-0.0043	0.3853	-0.2373	-0.0514	-0.1267	-0.5054
11	0.4068	0.1169	0.3506	-0.1595	0.0774	-0.0161	-1.0492	0.4995	0.1213	0.3678
12	-0.3697	0.2226	0.4952	-0.1416	0.6226	0.4100	-0.4478	0.2320	-0.3270	0.1308
13	-0.3157	0.5788	0.2606	-0.2922	0.4625	0.2674	0.1362	-0.1223	-0.0875	-0.5394
14	0.1310	0.0404	0.0918	0.3012	-0.0743	0.2632	-0.1787	-0.3072	0.4230	0.2566
15	0.0651	0.1934	-0.0698	-0.6799	0.7232	0.1593	0.0076	-0.1803	0.1784	0.2777
16	0.2677	0.3842	0.3181	-0.0252	0.2559	0.1459	0.1912	-0.0497	0.1521	0.1839
17	-0.3516	-0.1739	0.4063	-0.1773	-0.3104	0.0570	-0.6675	-0.0752	-0.4402	0.5571
18	0.3748	0.0993	0.2210	-0.7288	0.0935	0.2382	0.1238	0.1625	0.3437	0.4015
19	0.3887	-0.3622	0.2263	0.1760	-0.2776	0.4977	0.0219	-0.2645	0.3640	-0.2083
20	0.5088	0.2026	-0.0530	-0.3248	-0.2201	0.1071	-0.2528	-0.0579	0.0603	0.0069
21	0.1367	0.1971	-0.1660	-0.1332	-0.0527	0.5640	0.1286	-0.4502	-0.3642	0.3843
22	0.0832	0.1911	0.5127	-0.2283	0.1868	0.1730	0.3123	-0.2127	-0.1652	-0.1104
23	0.1342	0.2715	0.0541	-0.2140	-0.2103	0.3480	0.1433	0.3019	0.0973	-0.0746
24	-0.3419	0.4084	0.1486	-0.3436	0.4795	-0.1445	0.5419	-0.5064	-0.3097	-0.1649

SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER FOR GUDU (BAND 5)

	1	2	3	4	5	6	7	8	9	10

1	-0.2744	0.6081	-0.6445	-0.2138	0.2494	0.0812	-0.3389	0.4089	-0.5133	0.3479
2	0.2974	-0.1993	-0.1387	-0.1234	0.4014	-1.0730	-0.0424	0.6211	-0.6834	-0.5955
3	0.3516	-0.6300	0.1570	0.8866	-0.5053	-0.6442	0.3233	0.0992	-0.8752	-0.2063
4	-0.3268	0.0919	-0.2103	0.2646	0.2055	0.3355	0.9235	0.0479	-0.4966	-0.3190
5	0.0943	0.2880	0.5701	0.2621	-0.1345	0.2156	0.4509	0.7062	-0.0297	-0.8098
6	-0.2450	-0.1647	-0.5819	0.9115	0.8204	-0.7432	0.4182	0.6914	0.3564	-0.5237
7	0.6912	-0.1531	0.0899	0.8783	0.3099	0.0309	0.3964	0.2462	-0.2347	0.0595
8	0.1018	-0.0644	0.0256	0.2657	0.0155	0.0187	0.1729	0.1578	-0.4083	-0.4792
9	0.1619	0.5629	-0.2030	-0.1982	-0.2664	-0.3514	0.1808	0.0616	-0.1834	0.5149
10	0.6892	0.6151	-0.2804	-0.0954	0.3166	0.1935	1.0242	0.2076	-0.6292	-0.3228
11	0.5346	0.4597	-0.5652	-0.2500	0.5009	0.2257	0.2371	-0.4986	-0.2880	-0.8963
12	0.3151	-0.5697	0.5201	0.9678	0.5029	-1.4369	0.1687	0.4476	-0.4628	-0.5691
13	0.7817	0.2466	-0.3080	0.0323	0.2672	0.1245	0.2510	0.4819	-0.1475	-0.4519
14	-0.1960	-0.5149	0.2627	0.1220	-0.5060	0.2272	0.6204	0.4924	-0.7190	0.3822
15	-0.2544	-0.6324	-0.0792	-0.0204	0.2281	-1.6653	-0.1071	0.2735	-1.0466	-0.3801
16	-0.1066	0.1241	-0.3309	0.3266	-0.1162	0.9091	1.7999	0.3999	0.0834	0.1730
17	-0.2317	-0.0640	-0.2716	0.0962	-0.0264	-0.3623	-0.3155	-0.0744	-0.8744	-0.6170
18	0.5590	0.3829	-0.6645	0.0233	-0.1734	-0.9539	0.4714	0.2430	-0.4157	-0.5504
19	0.3222	-0.2561	-0.8218	0.8259	0.2121	-0.3168	-0.2119	0.6396	-0.1121	0.1124
20	0.2853	-0.0625	0.2175	-0.6387	0.2973	-1.5647	0.3064	0.0399	-0.8993	-1.2060
21	-0.2717	0.4058	-0.1060	0.9084	0.9312	-1.2216	0.2971	0.3969	-0.0925	-0.5836
22	0.5211	0.0115	-0.4792	-0.3113	-0.1819	0.2181	1.0583	-0.3755	-0.2312	0.6695
23	-0.0405	-0.1005	-0.0617	0.1050	-0.6158	0.1203	1.3331	0.4637	-0.1256	-0.0288
24	0.1211	0.2328	0.0949	0.1008	-0.3329	-0.3807	-0.1191	1.1356	-0.3687	0.3604

SAMPLE WEIGHTS OF INPUTS TO HIDDEN LAYER FOR MAITAMA (BAND 6)

	1	2	3	4	5	6	7	8	9	10

1	0.2215	-0.4685	-0.0751	0.5725	0.0681	0.0661	0.3890	-0.0424	0.4718	0.3560
2	0.2832	0.1736	-0.3161	0.6191	0.4119	0.6800	-0.1233	-0.1277	-0.0571	0.0558
3	0.3868	0.2834	0.2201	0.8235	0.2490	-0.0234	0.3060	-0.1223	0.4529	0.7185
4	-0.3554	0.1072	0.2801	0.5269	0.1488	0.0718	0.1200	-0.3117	-0.3865	0.1975
5	-0.1549	0.5556	0.0154	-0.1555	0.4301	0.2605	0.5441	0.2659	-0.2133	0.1850
6	-0.0281	0.1881	-0.5185	0.0398	-0.1942	0.1762	0.2222	-0.2796	0.4110	0.1773
7	-0.1506	-0.2601	0.3705	0.1991	-0.5113	0.2015	0.2057	-0.3738	-0.3311	0.4812
8	0.5159	-0.2481	-0.2610	0.6573	-0.0523	-0.3019	0.2183	-0.4808	-0.3100	0.4385
9	0.1253	0.0370	-0.2176	-0.1678	0.1362	0.4905	0.1497	-0.2915	0.1494	-0.0786
10	0.1086	-0.0376	0.3836	-0.3352	0.4824	0.1831	0.4861	-0.8184	-0.2816	0.3879
11	-0.0300	0.2793	-0.2907	0.3254	-0.3395	0.0303	0.5796	0.0156	0.2774	-0.1335
12	0.2063	-0.4779	-0.1494	0.7669	0.5556	-0.3470	0.3133	0.1445	0.3171	-0.3201
13	0.1900	-0.0401	0.4324	0.0865	0.3688	-0.3020	0.5907	0.1294	-0.3166	-0.1865
14	0.7688	-0.3326	0.2420	0.3960	0.6204	0.0053	-0.0376	-0.6894	0.1008	0.5099
15	0.2278	-0.2856	-0.7651	0.3717	0.3287	-0.0618	0.0964	-0.5544	-0.4536	0.3150
16	0.2026	-0.2786	-0.2313	0.1924	-0.2855	0.2038	0.2434	0.4389	-0.1693	0.0994
17	0.1583	0.3942	0.1388	-0.1828	0.5101	0.5501	-0.0515	0.0108	-0.3607	-0.1287
18	0.5307	0.0179	-0.3811	-0.2268	0.1883	0.5334	0.2243	0.1170	-0.2865	-0.5138
19	0.0254	0.2735	-0.0136	0.2702	0.1440	-0.1608	0.4060	0.3685	-0.4014	0.3684
20	0.4721	-0.3527	0.3677	0.5022	-0.5359	-0.2298	-0.1207	0.1279	-0.4586	-0.2047
21	-0.0856	-0.4196	-0.1822	-0.5463	0.2331	-0.1290	-0.6880	0.2274	-0.2280	0.2226
22	0.6918	-0.3186	0.0189	0.0371	-0.1502	-0.0063	0.5061	-0.5987	0.1016	-0.2509
23	-0.5677	0.0960	0.3453	-0.2547	-0.1938	0.5894	0.7324	0.4427	-0.1323	0.1077
24	0.3915	-0.1738	0.2636	0.3775	0.5221	0.4436	0.0263	0.2590	0.2932	-0.0188

APPENDIX F
ACTUAL AND PREDICTED VALUES OF SPECTRUM OCCUPANCY

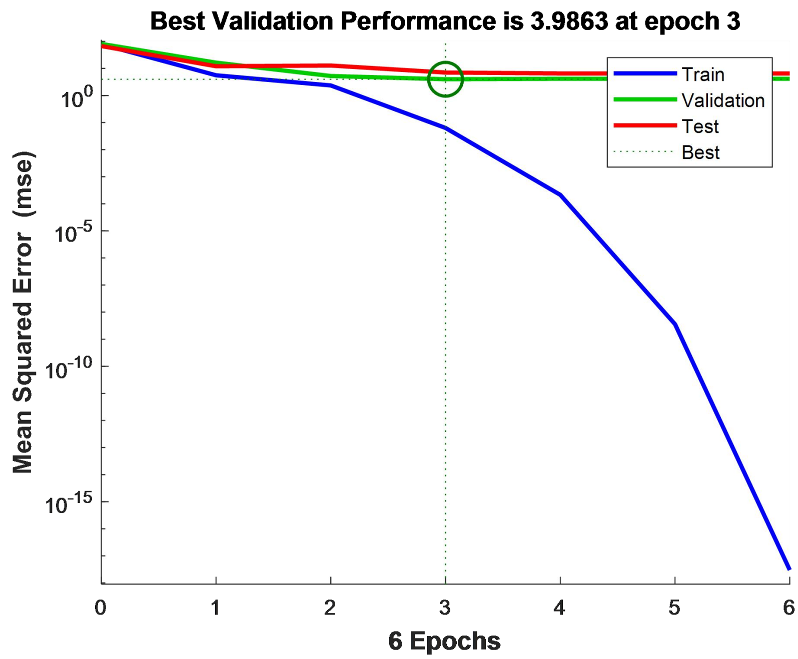
VALUES OF ACTUAL AND PREDICTED SPECTRUM OCCUPANCY FOR MINNA

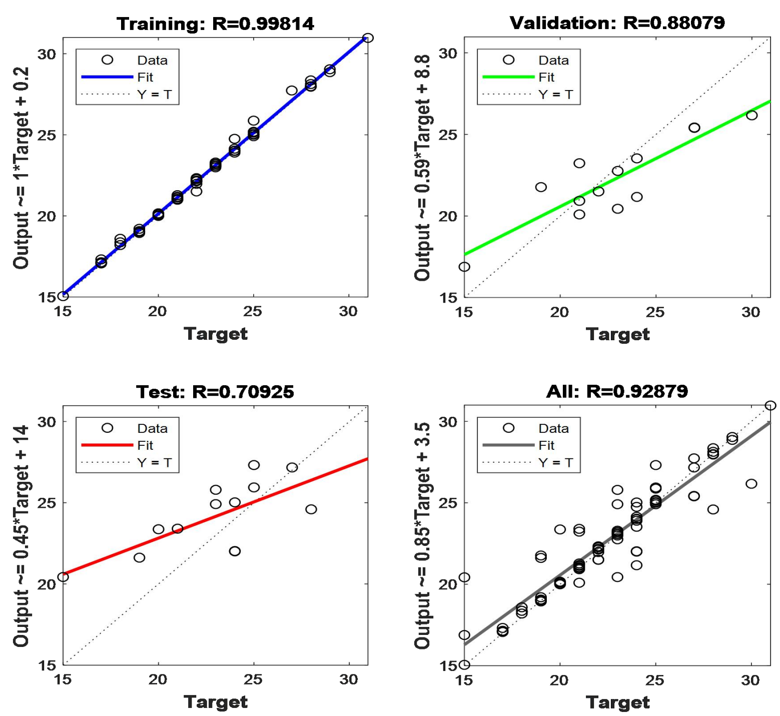
		GK				AEDC				TUNGA				MINNA			
BANDS	FREQUENCY SUB BANDS (MHz)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)
Band 1	30-47	38.4231	38.4768	0.0537	94.63	38.8935	38.9254	0.0319	96.81	44.4619	44.3481	0.1138	88.62	40.59283	40.5834	0.0094	99.06
Band 2	47.05-68	21.293	21.254	0.039	96.1	22.2688	22.2682	0.0006	99.94	35.2311	35.144	0.0871	91.29	26.2643	26.2221	0.0422	95.78
Band 3	68.05-74.8	20.4105	20.3198	0.0907	90.93	22.2586	22.238	0.0206	97.94	33.8231	33.746	0.0771	92.29	25.4974	25.4346	0.0628	93.72
Band 4	74.85-87.45	20.4559	20.4325	0.0234	97.66	22.23871	22.2976	0.05889	94.111	34.1645	34.2164	0.0519	94.81	25.6197	25.6488	0.0291	97.09
Band 5	87.50-108	20.016	19.9632	0.0528	94.72	23.347	23.3584	0.0114	98.86	33.8292	33.8854	0.0562	94.38	25.73073	25.7357	0.0049	99.51
Band 6	108.05-137	21.5346	21.5391	0.0045	99.55	23.6015	23.597	0.0045	99.55	32.1425	32.1925	0.05	95	25.75953	25.7762	0.0167	98.33
Band 7	137.05-144	24.8429	24.831	0.0119	98.81	26.0898	26.0605	0.0293	97.07	24.7855	24.806	0.0205	97.95	25.2394	25.2325	0.0069	99.31
Band 8	144.05-174	23.5734	23.5505	0.0229	97.71	26.1648	26.1792	0.0144	98.56	28.7679	28.7996	0.0317	96.83	26.1687	26.1764	0.0077	99.23
Band 9	174.05-200	25.2475	25.2488	0.0013	99.87	26.6928	26.777	0.0842	91.58	25.7692	25.7834	0.0142	98.58	25.90317	25.9364	0.0332	96.68
Band 10	200.05-230	27.4098	27.4235	0.0137	98.63	26.5673	26.5454	0.0219	97.81	26.6381	26.6382	1E-04	99.99	26.87173	26.8690	0.0027	99.73
Band 11	230.05-267	27.3871	27.4145	0.0274	97.26	25.2417	25.2424	0.0007	99.93	26.9227	26.9563	0.0336	96.64	26.51717	26.5377	0.0206	97.94
Band 12	267.05-300	26.671	26.6782	0.0072	99.28	26.8569	26.8401	0.0168	98.32	27.1329	27.0949	0.038	96.2	26.88693	26.8711	0.0159	98.41
	AVERAGE	24.7721	24.7610	0.0111	98.89	25.8518	25.8608	0.0090	99.10	31.1391	31.1342	0.0048	99.52	27.2543	27.2520	0.0023	99.77

VALUES OF ACTUAL AND PREDICTED SPECTRUM OCCUPANCY FOR ABUJA

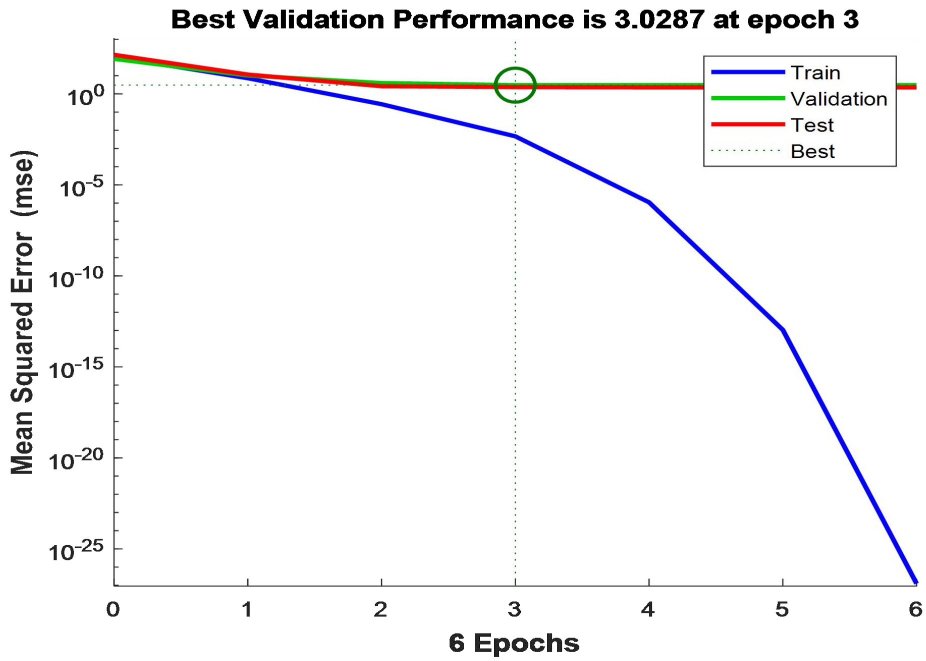
		KUBWA				GUDU				MAITAMA				ABUJA			
BANDS	FREQUENCY SUB BANDS (MHz)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)	ACTUAL (%)	PREDICTED (%)	DIFFERENCE (%)	ACCURACY (%)
Band 1	30-47	37.1844	37.2356	0.0512	94.88	37.1108	37.1044	0.0064	99.36	43.0269	42.9399	0.087	91.3	39.1074	39.0933	0.0141	98.59
Band 2	47.05-68	20.1867	20.1736	0.0131	98.69	19.933	19.9791	0.0461	95.39	34.4264	34.3203	0.1061	89.39	24.8487	24.8243	0.0244	97.56
Band 3	68.05-74.8	19.7248	19.6851	0.0397	96.03	20.4204	20.4342	0.0138	98.62	34.2628	34.2229	0.0399	96.01	24.8027	24.7807	0.0219	97.81
Band 4	74.85-87.45	19.8652	19.8596	0.0056	99.44	20.7463	20.812	0.0657	93.43	34.1166	34.1067	0.0099	99.01	24.9094	24.9261	0.0167	98.33
Band 5	87.50-108	20.2414	20.1938	0.0476	95.24	22.6062	22.6103	0.0041	99.59	31.1067	31.0464	0.0603	93.97	24.6514	24.6168	0.0346	96.54
Band 6	108.05-137	20.4944	20.4232	0.0712	92.88	24.1141	24.1186	0.0045	99.55	28.2962	28.2839	0.0123	98.77	24.3016	24.2752	0.0263	97.37
Band 7	137.05-144	23.5902	23.5868	0.0034	99.66	25.5821	25.5963	0.0142	98.58	23.3524	23.3784	0.026	97.4	24.1749	24.1872	0.0123	98.77
Band 8	144.05-174	24.3898	24.4105	0.0207	97.93	25.5374	25.5464	0.009	99.1	27.7163	27.6858	0.0305	96.95	25.8812	25.8809	0.0003	99.97
Band 9	174.05-200	22.093	22.051	0.042	95.8	27.6173	27.5896	0.0277	97.23	25.7852	25.8057	0.0205	97.95	25.1652	25.1488	0.0164	98.36
Band 10	200.05-230	17.0382	17.0616	0.0234	97.66	27.5968	27.5525	0.0443	95.57	24.5455	24.5668	0.0213	97.87	23.0602	23.0603	0.0001	99.99
Band 11	230.05-267	20.4762	20.4533	0.0229	97.71	27.2924	27.2666	0.0258	97.42	18.6279	18.6586	0.0307	96.93	22.1322	22.1262	0.0060	99.40
Band 12	267.05-300	21.1423	21.1902	0.0479	95.21	27.7121	27.689	0.0231	97.69	18.1455	18.1909	0.0454	95.46	22.3333	22.3567	0.0234	97.66
	AVERAGE	22.2022	22.1937	0.0085	99.15	25.5224	25.5249	0.0025	99.75	28.6174	28.6005	0.0168	98.32	25.4473	25.4397	0.0076	99.24

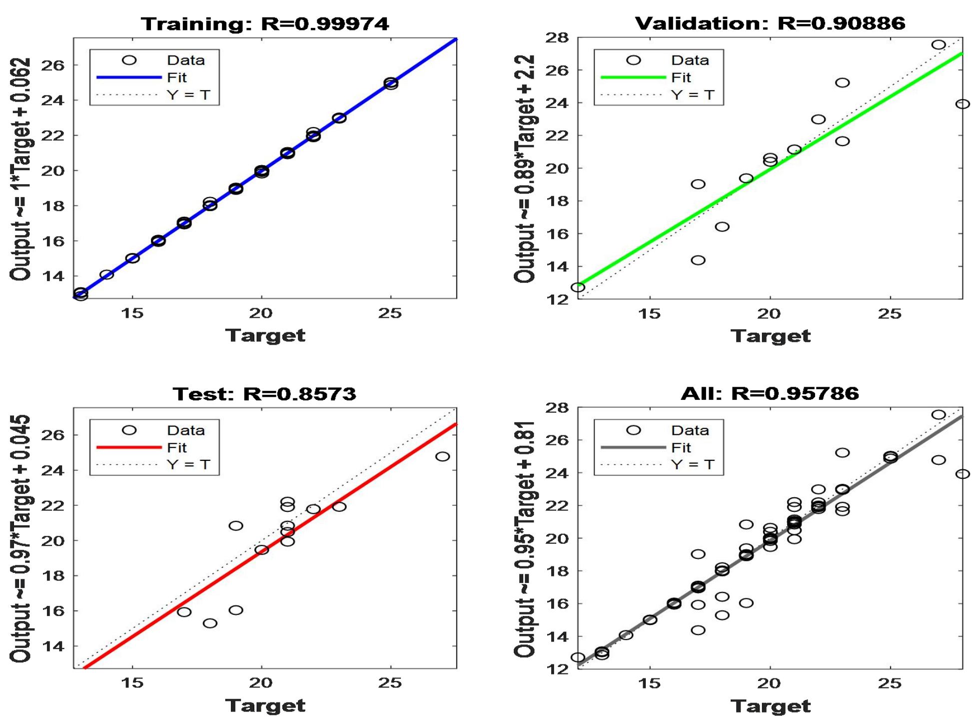
APPENDIX G
PERFORMANCE RESULTS OF ANN MODEL FOR GK BAND 1 (30-47 MHZ)



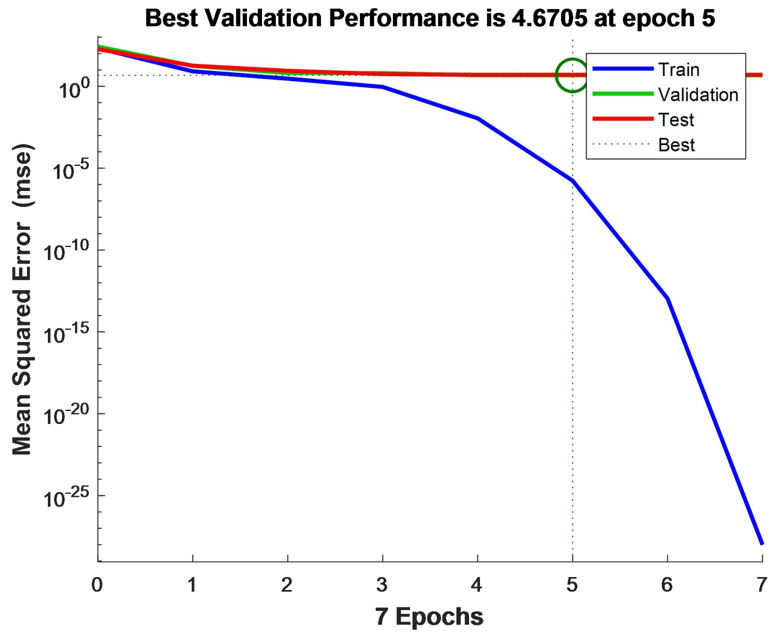


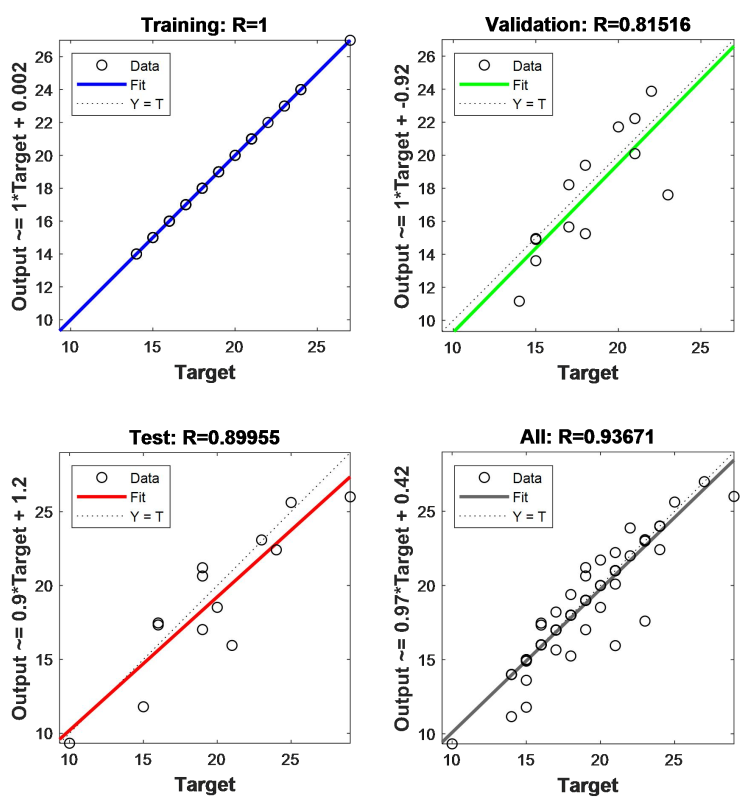
BAND 2 (47.05-68 MHZ)



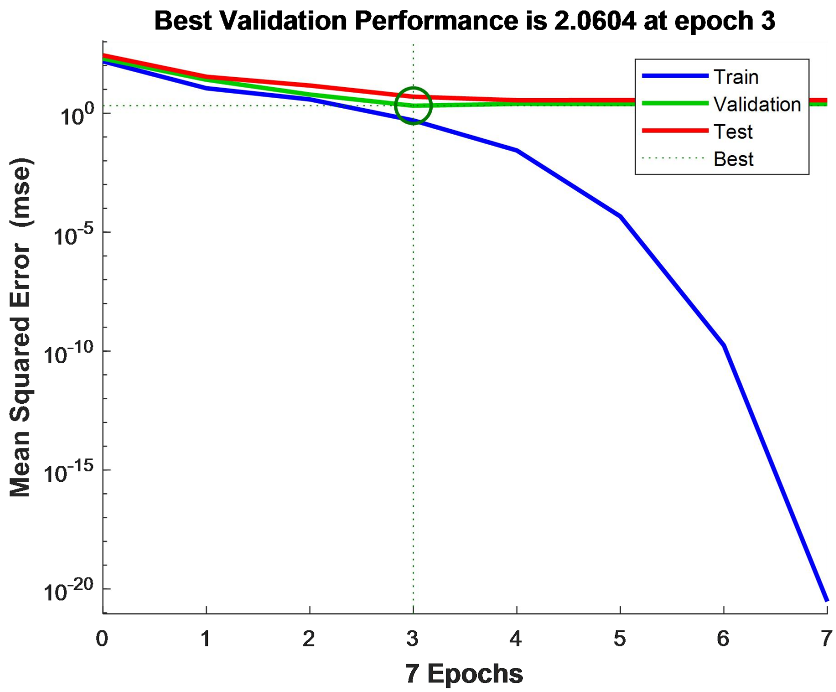


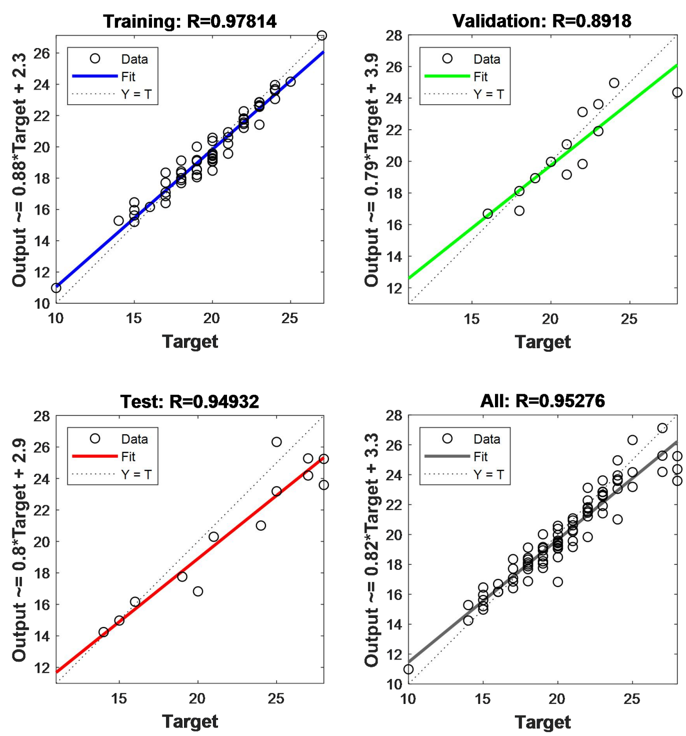
BAND 3 (68.05-74.80 MHZ)



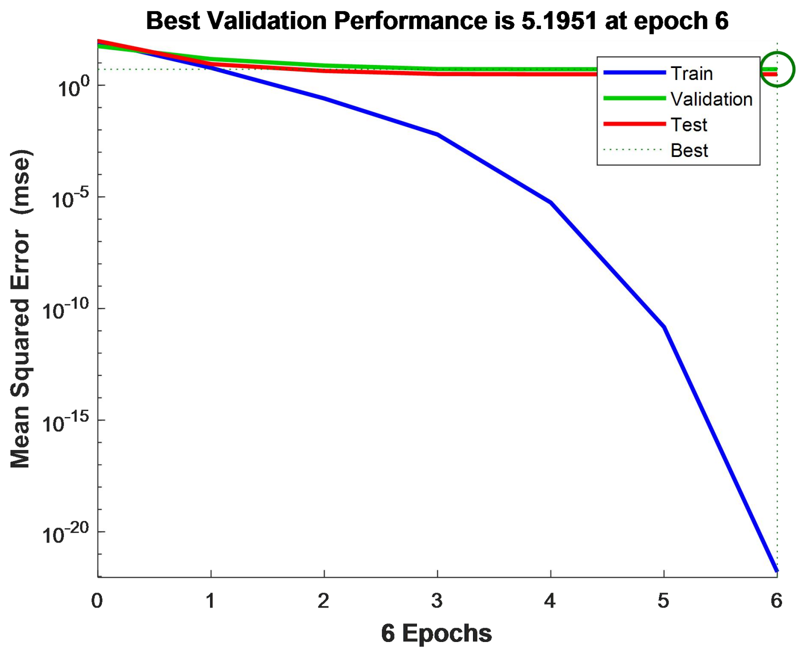


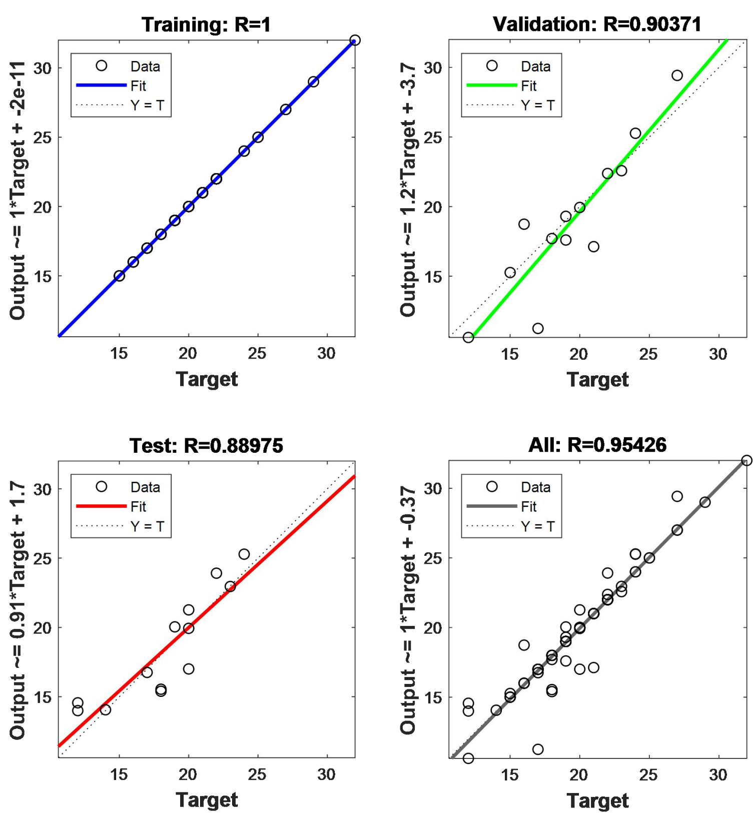
BAND 4 (74.80-87.45 MHZ)



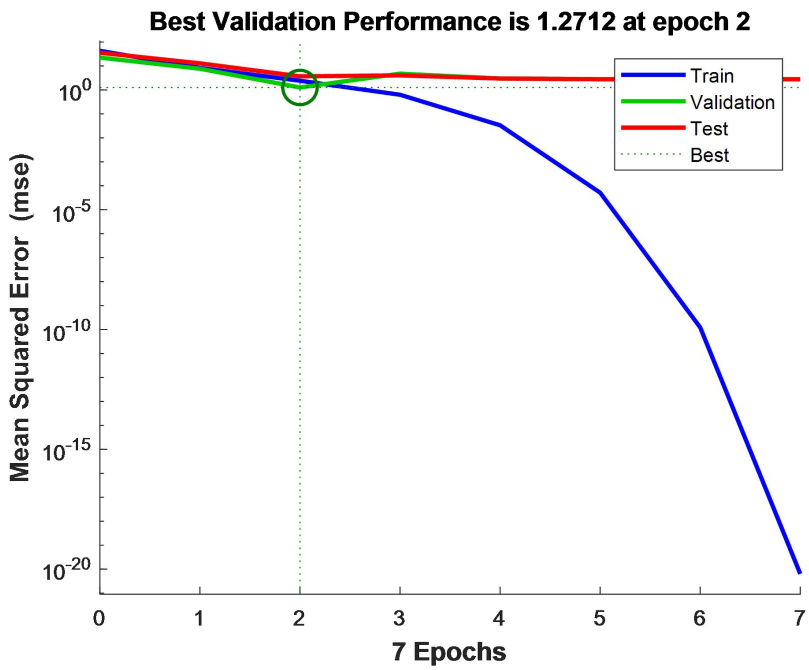


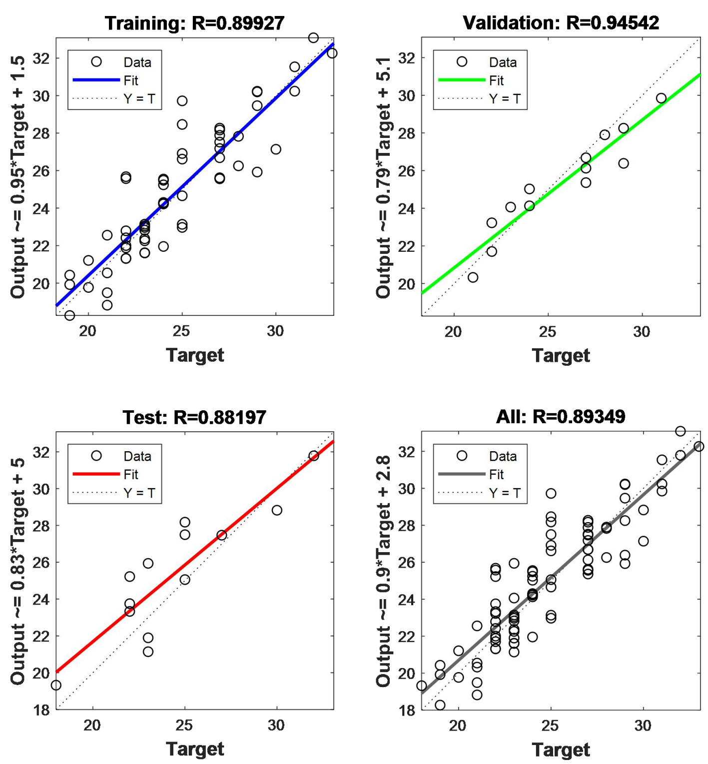
BAND 5 (87.45-108 MHZ)



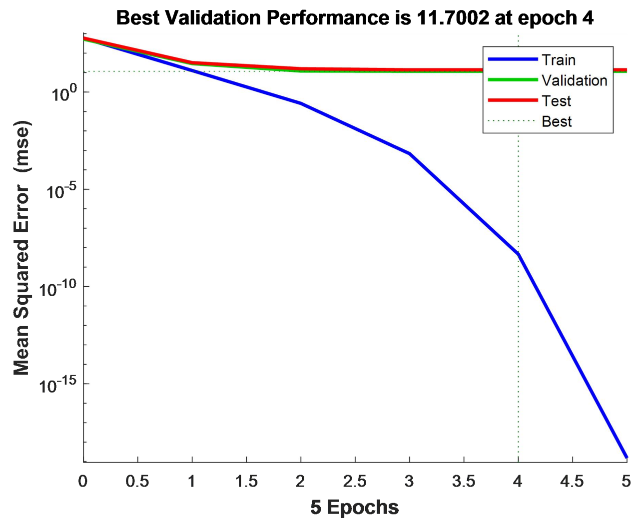


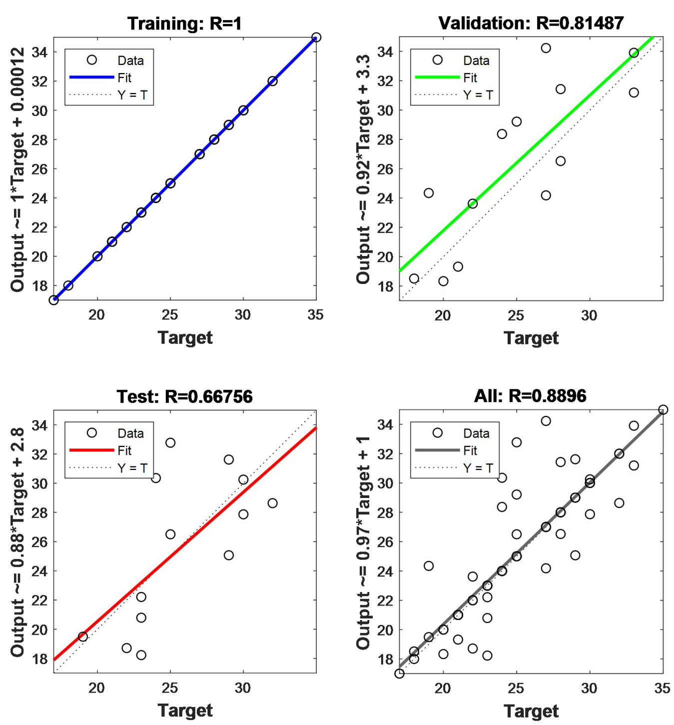
BAND 6 (108.05-137 MHZ)



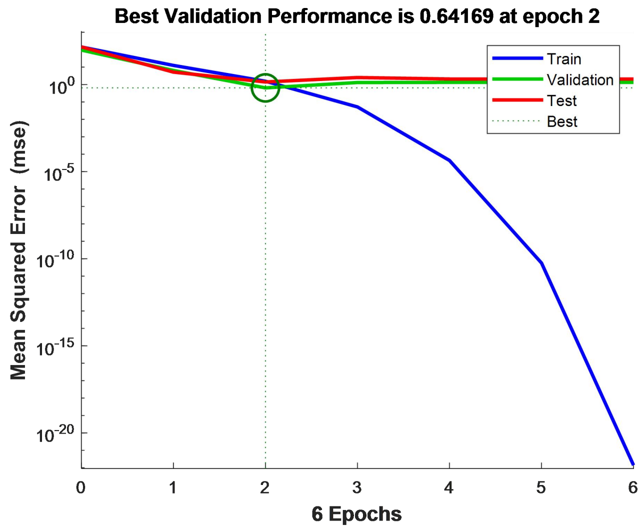


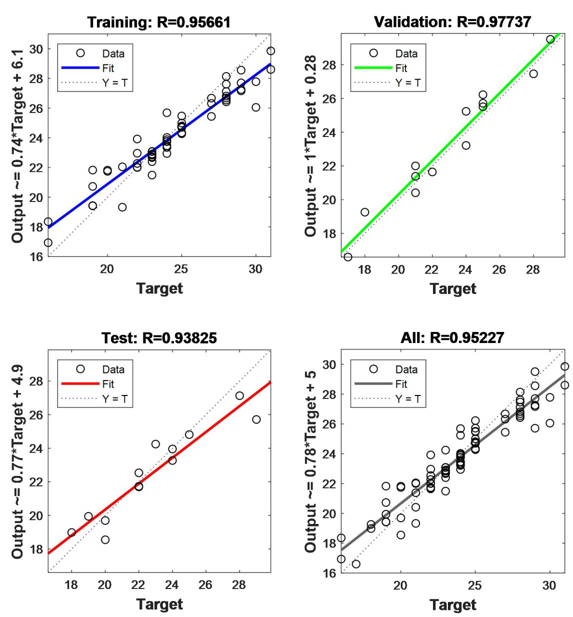
BAND 7 (137.05-144 MHZ)



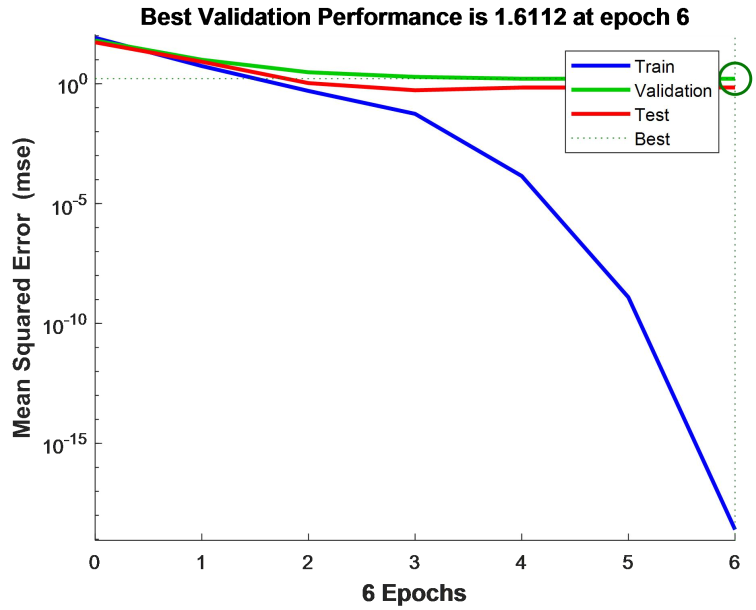


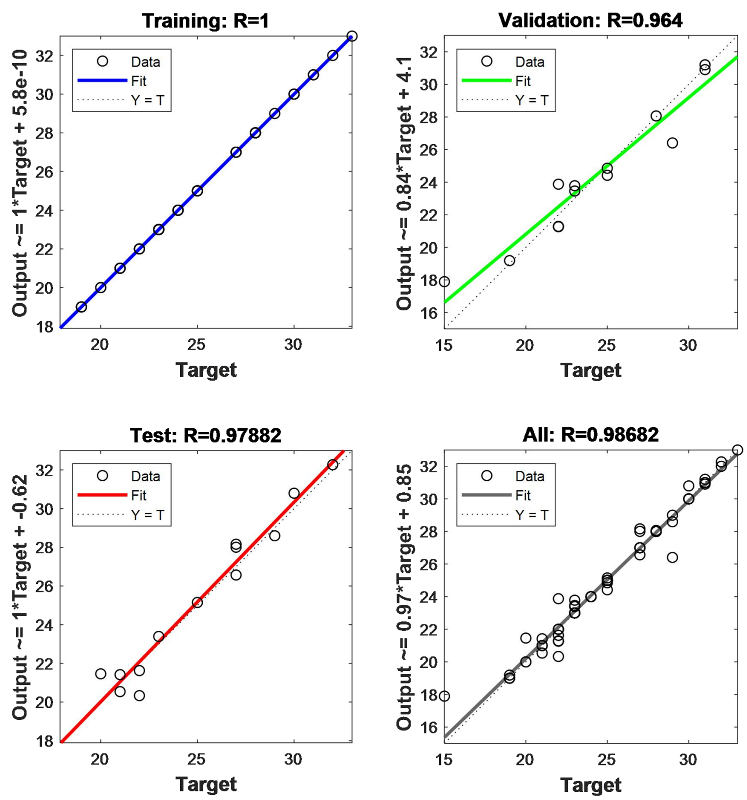
BAND 8 (144.05-174 MHZ)



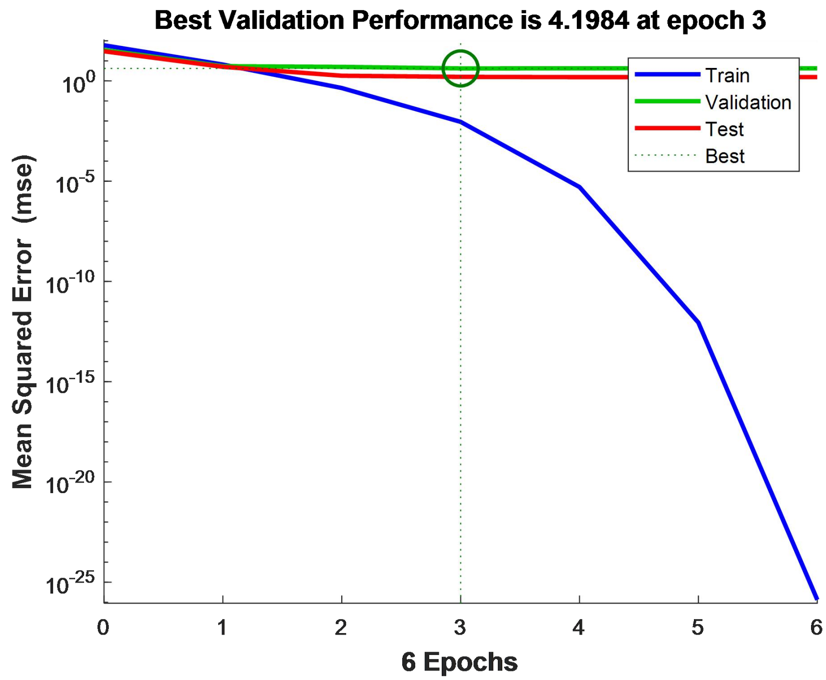


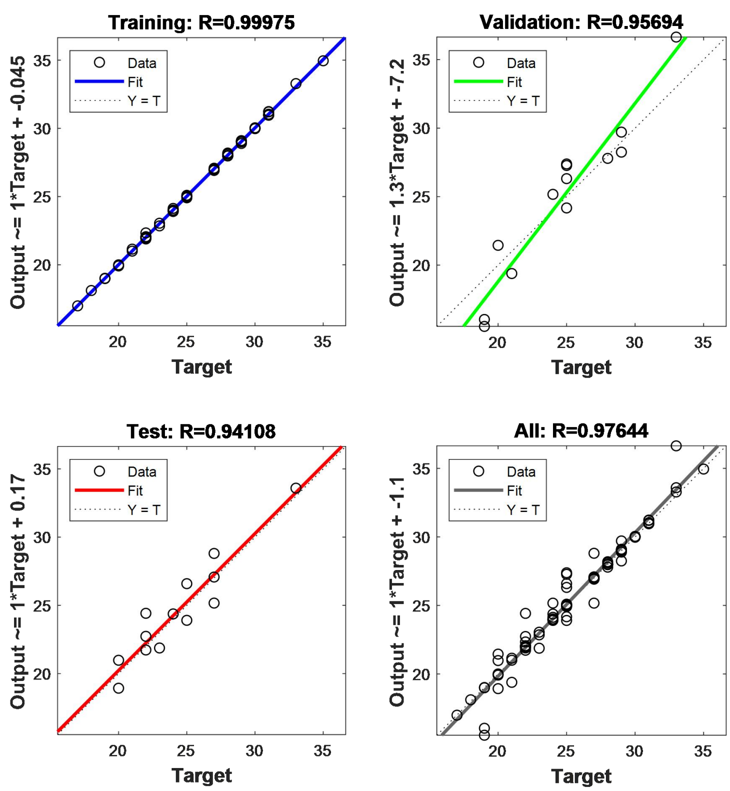
BAND 9 (174.05-200 MHZ)



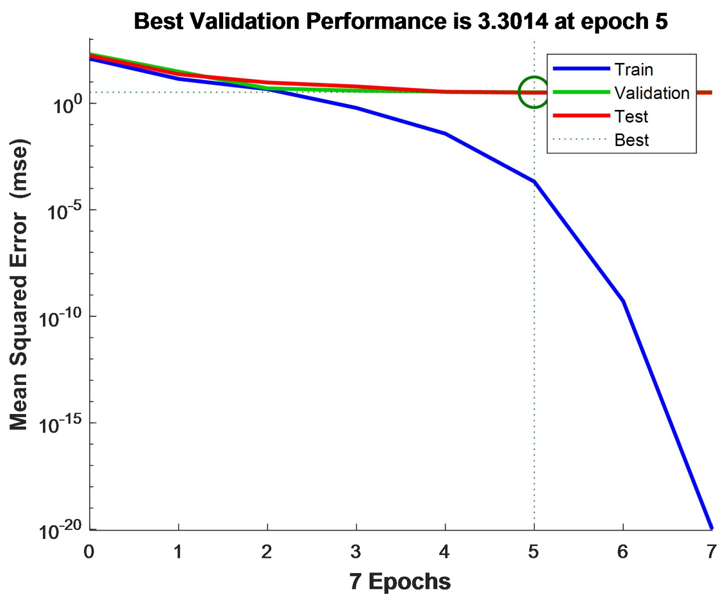


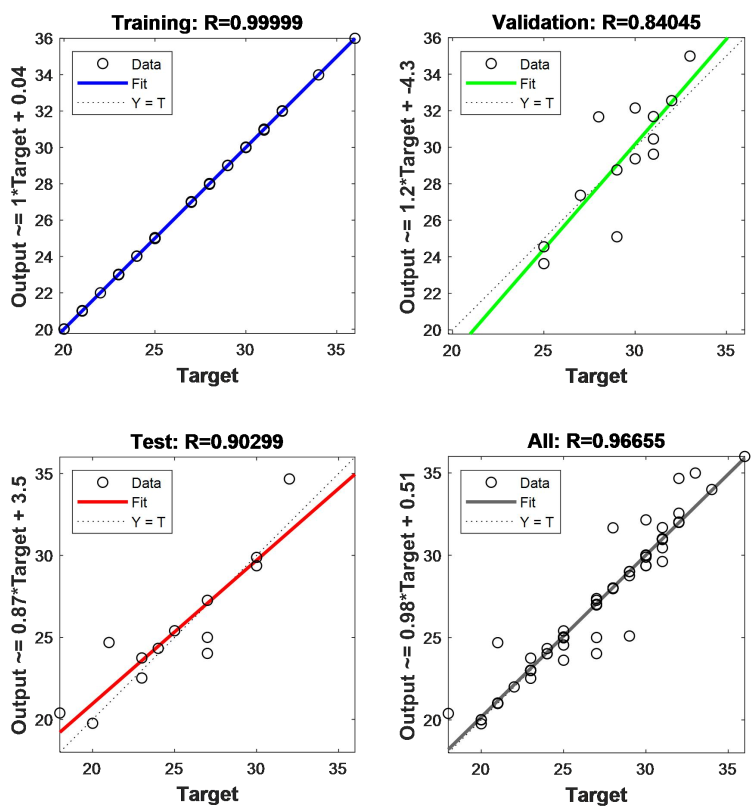
BAND 10 (200.05-230 MHZ)



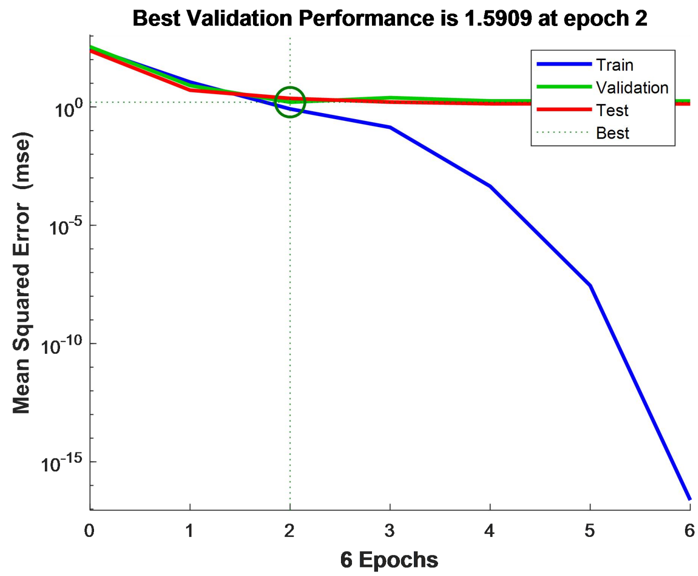


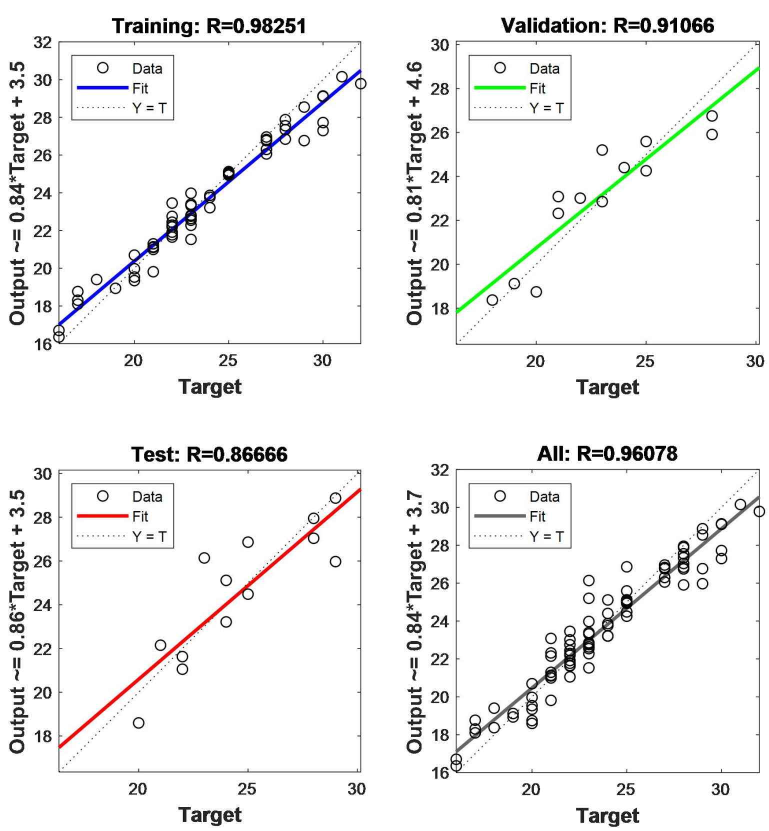
BAND 11 (230.05-267 MHZ)



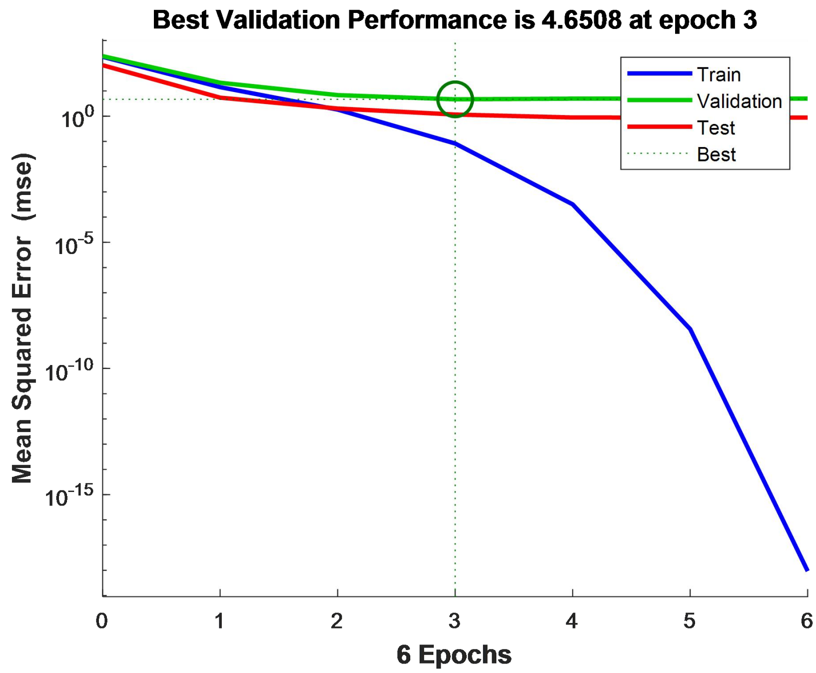


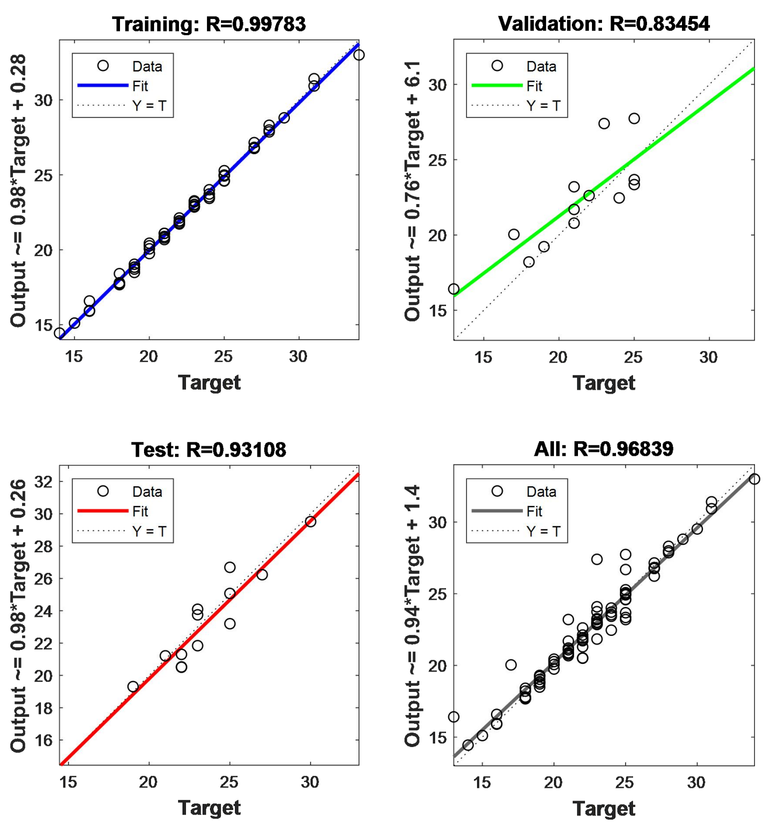
PERFORMANCE RESULTS OF ANN MODEL FOR AEDC BAND 1 (30-47 MHZ)



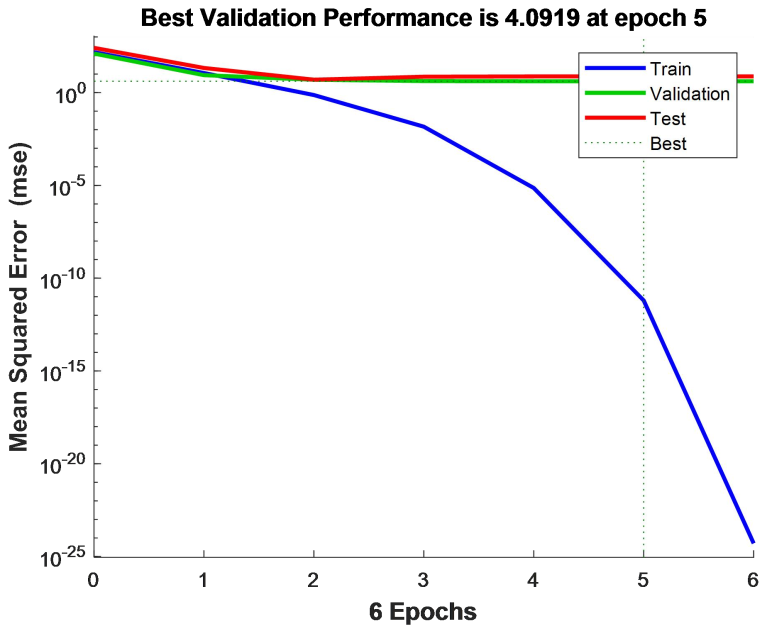


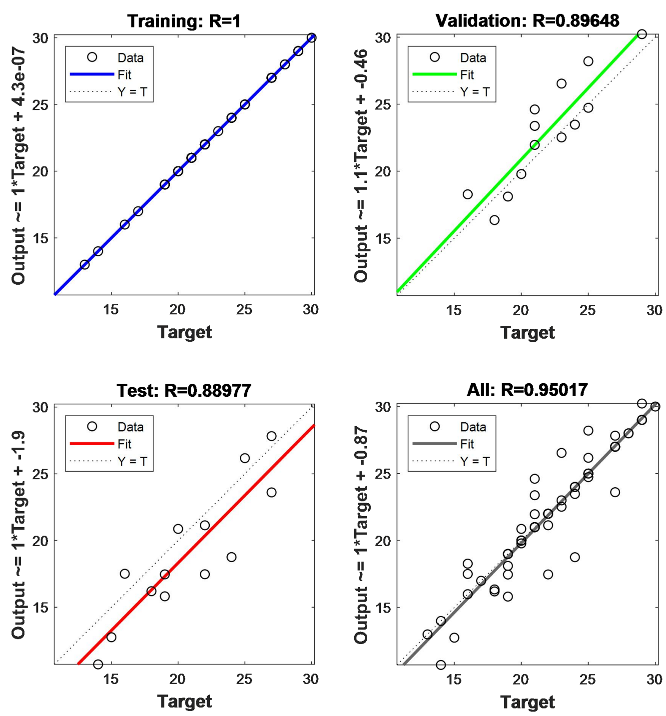
BAND 2 (47.05-68 MHZ)



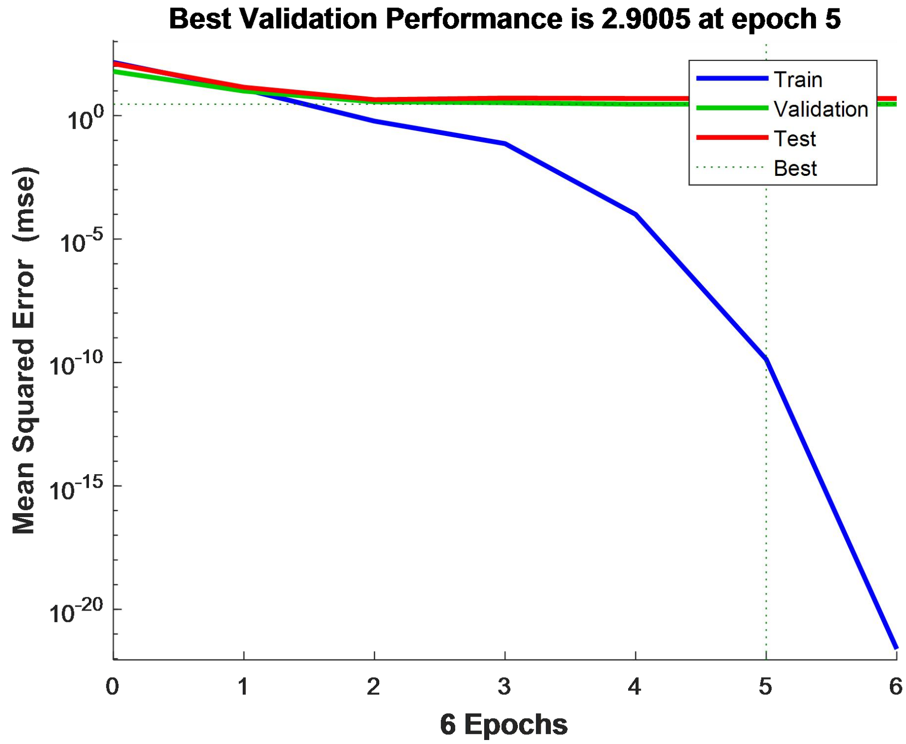


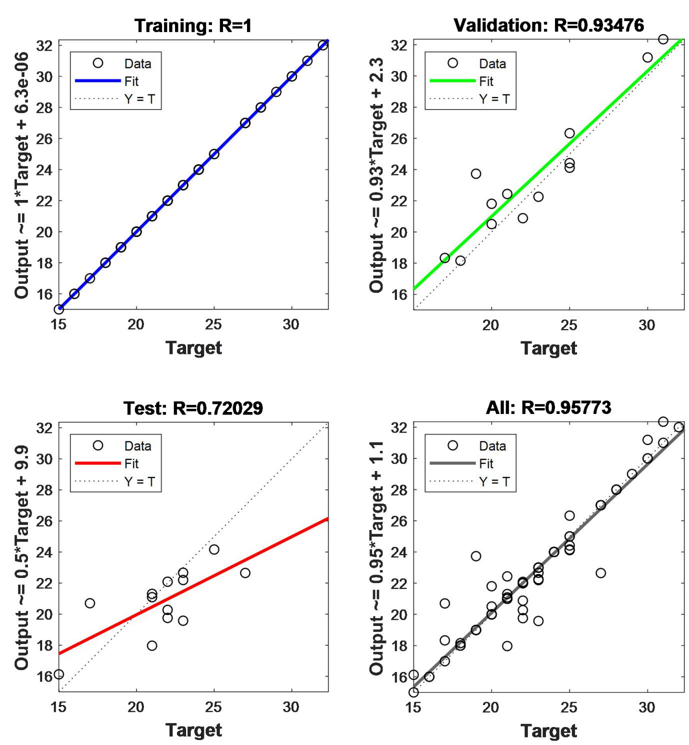
BAND 3 (68.05-74.80 MHZ)



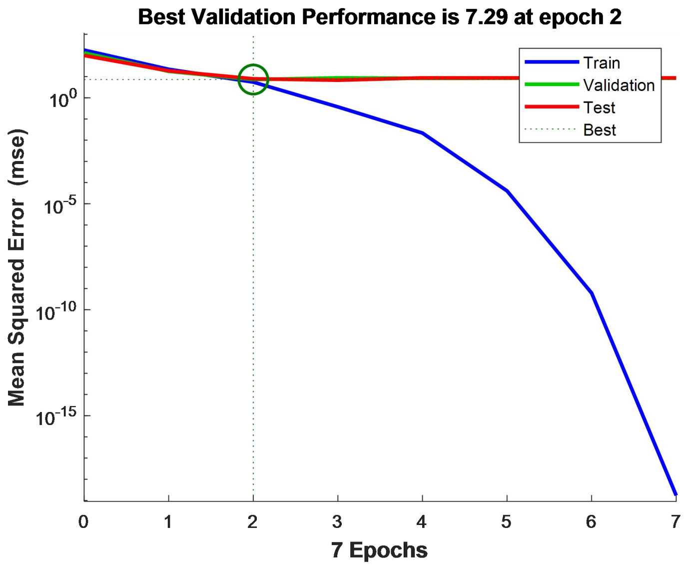


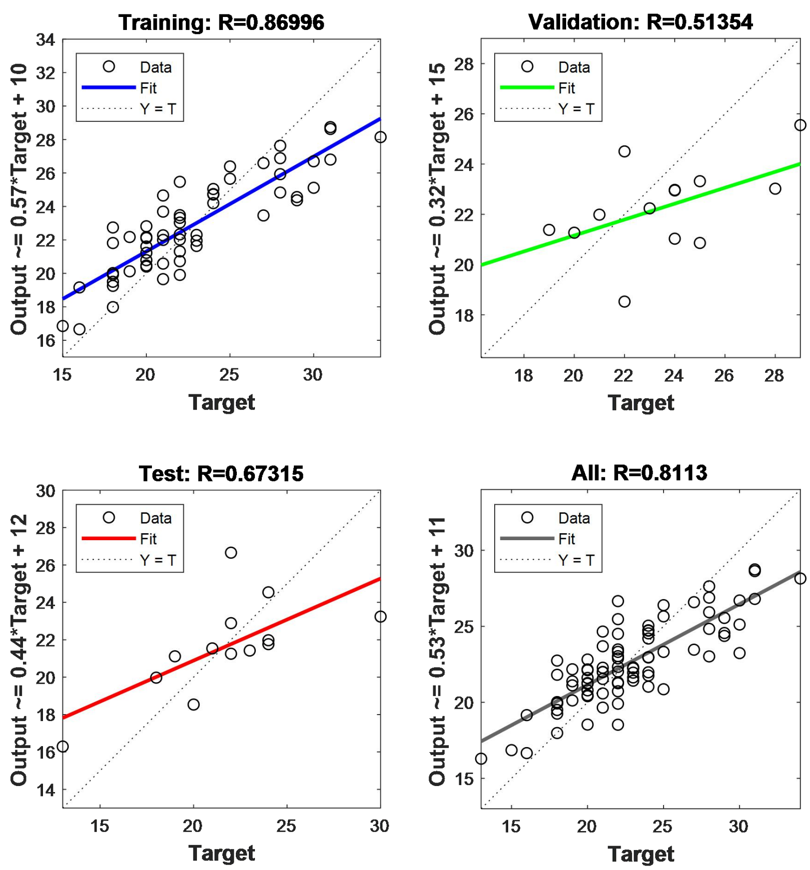
BAND 4 (74.80-87.45 MHZ)



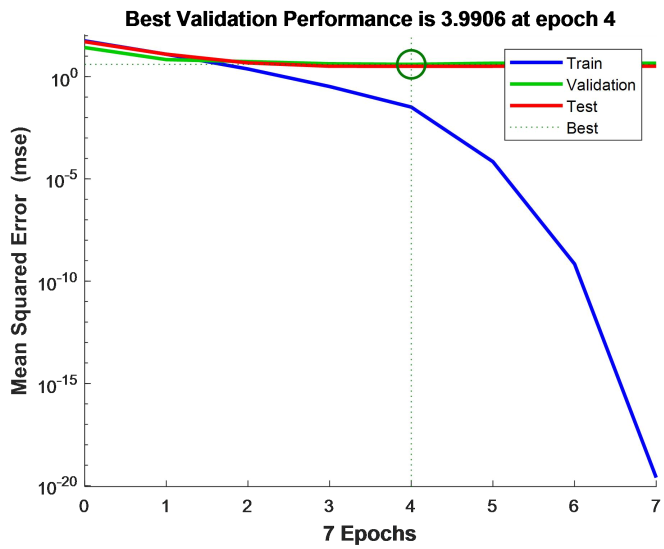


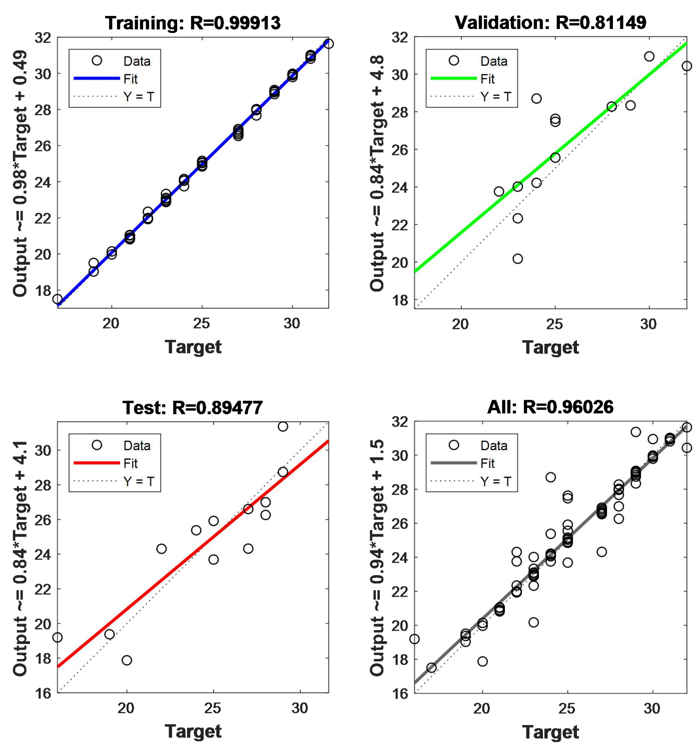
BAND 5 (87.45-108 MHZ)



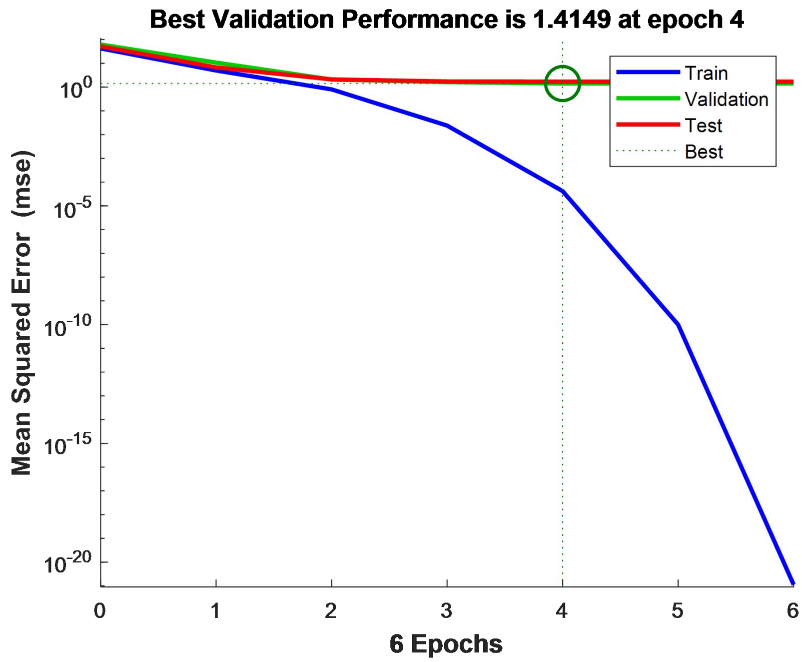


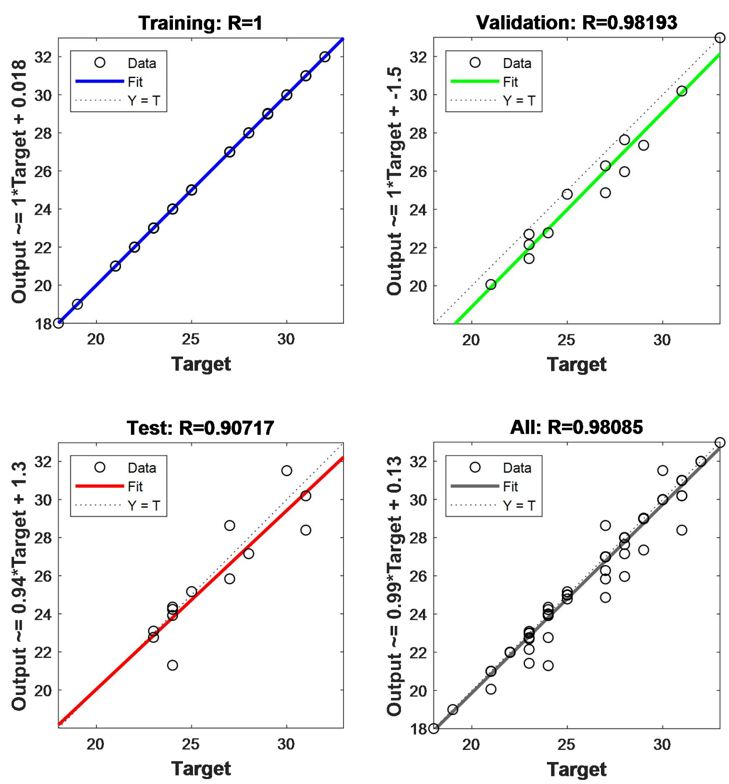
BAND 6 (108.05-137 MHZ)



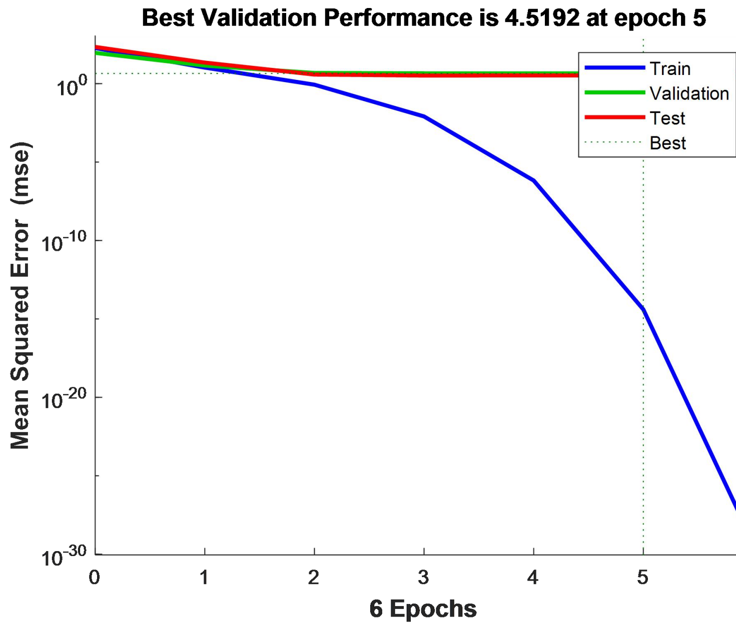


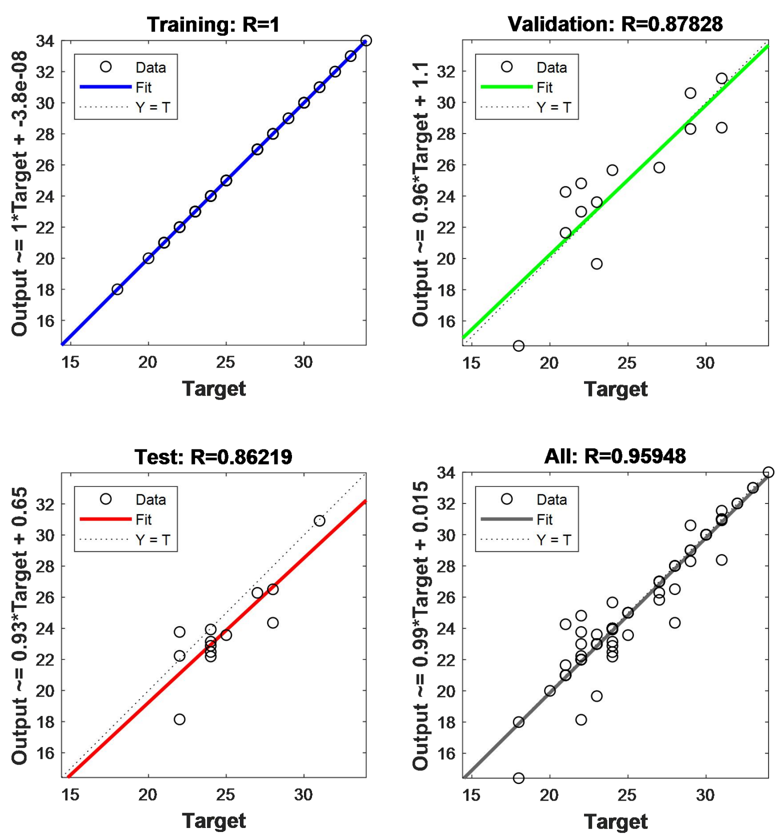
BAND 7 (137.05-144 MHZ)



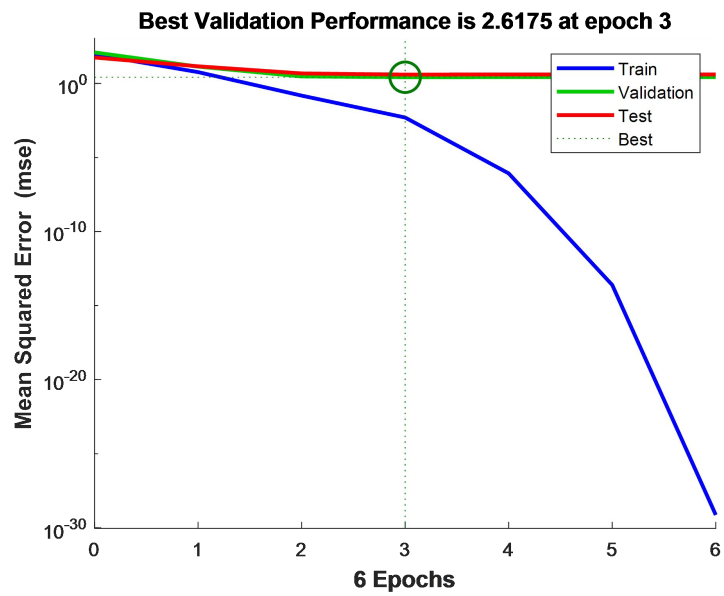


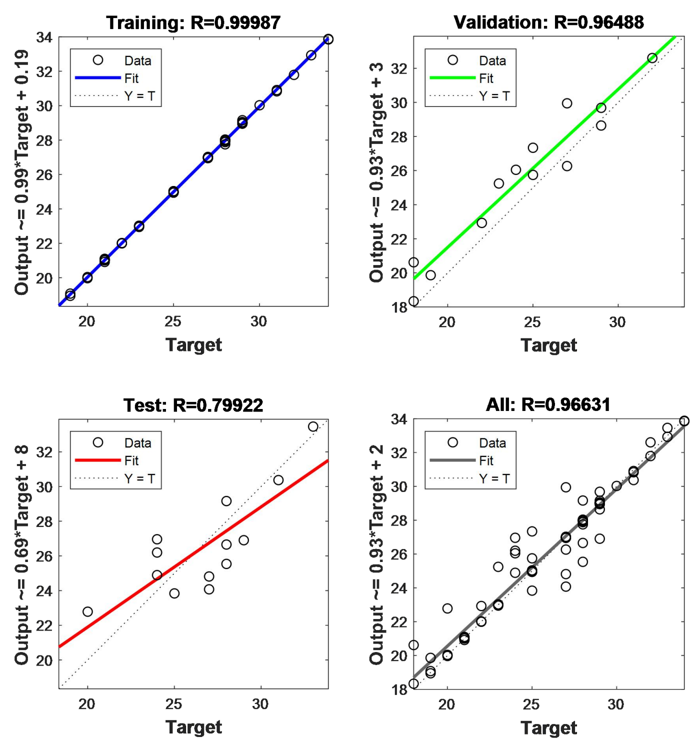
BAND 8 (144.05-174 MHZ)



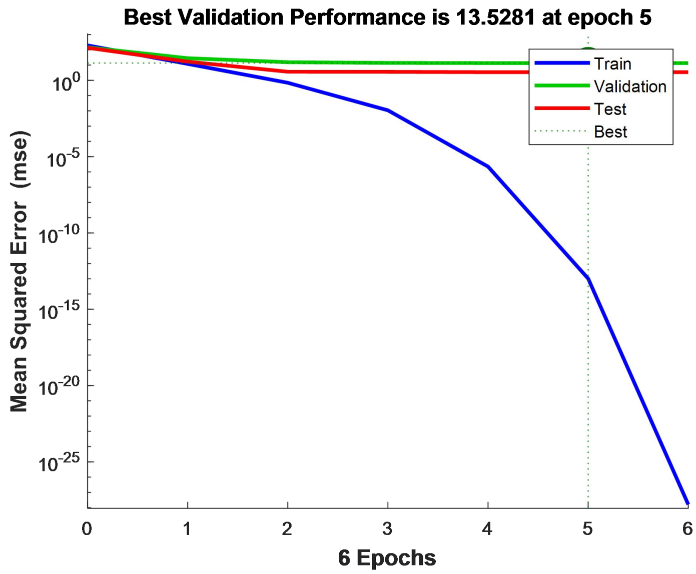


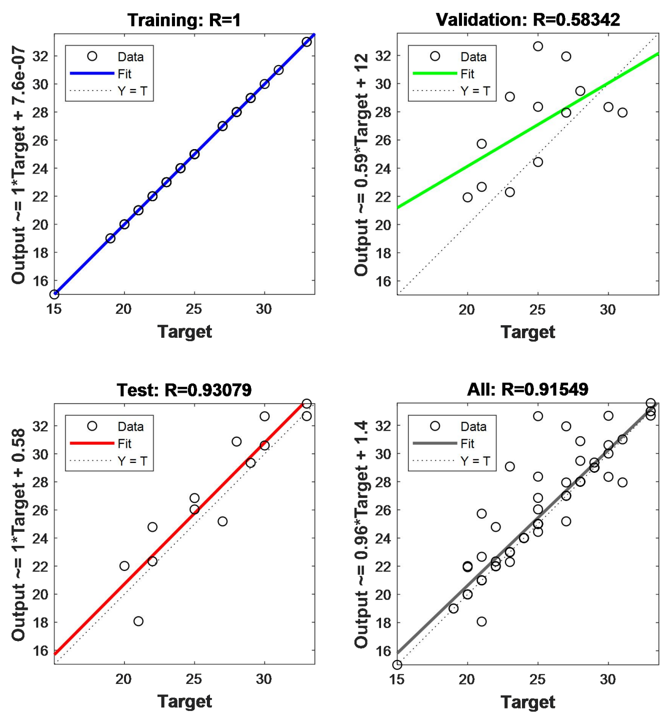
BAND 9 (174.05-200 MHZ)



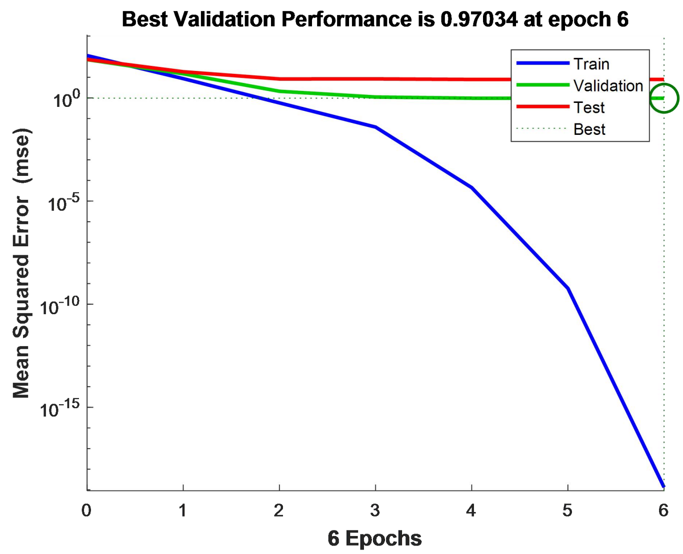


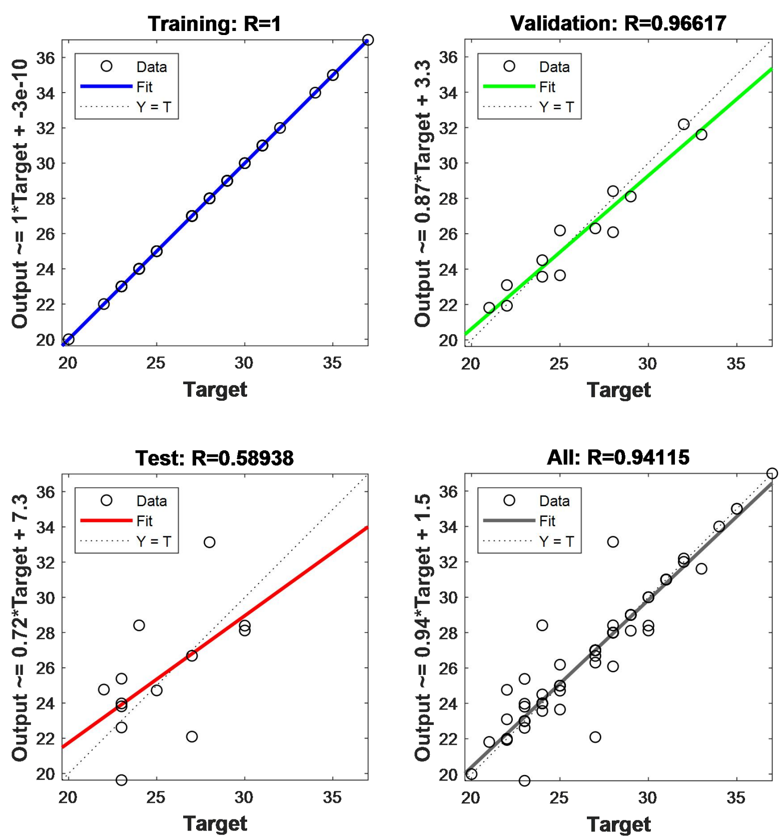
BAND 10 (200.05-230 MHZ)



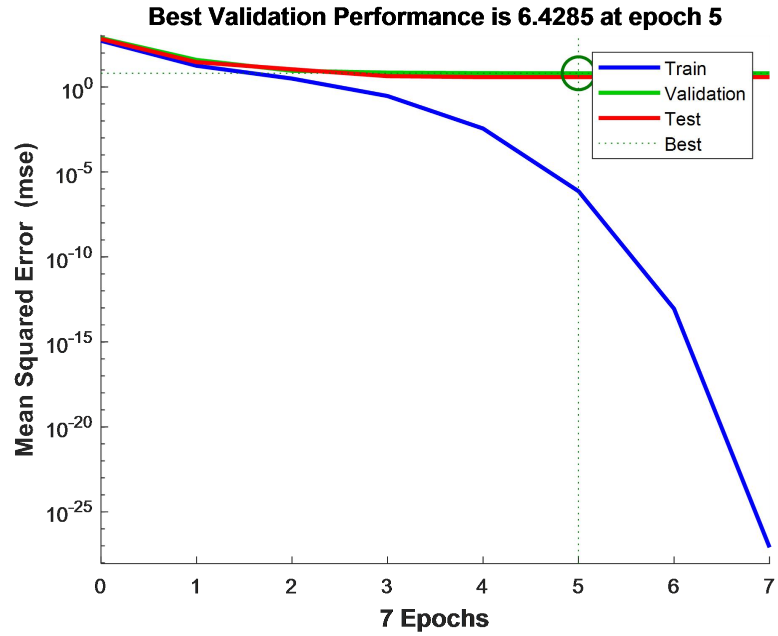


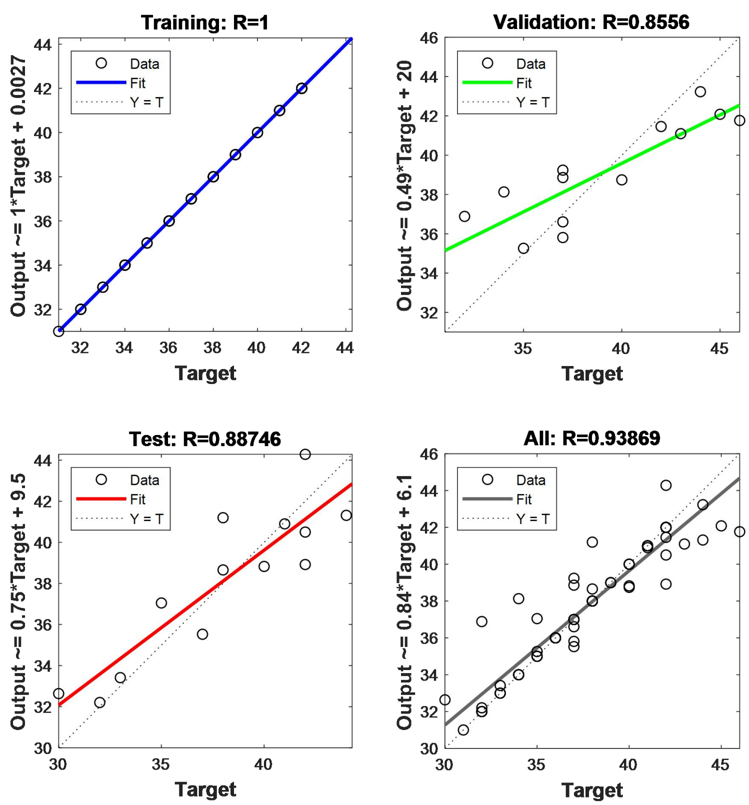
BAND 11 (230.05-267 MHZ)



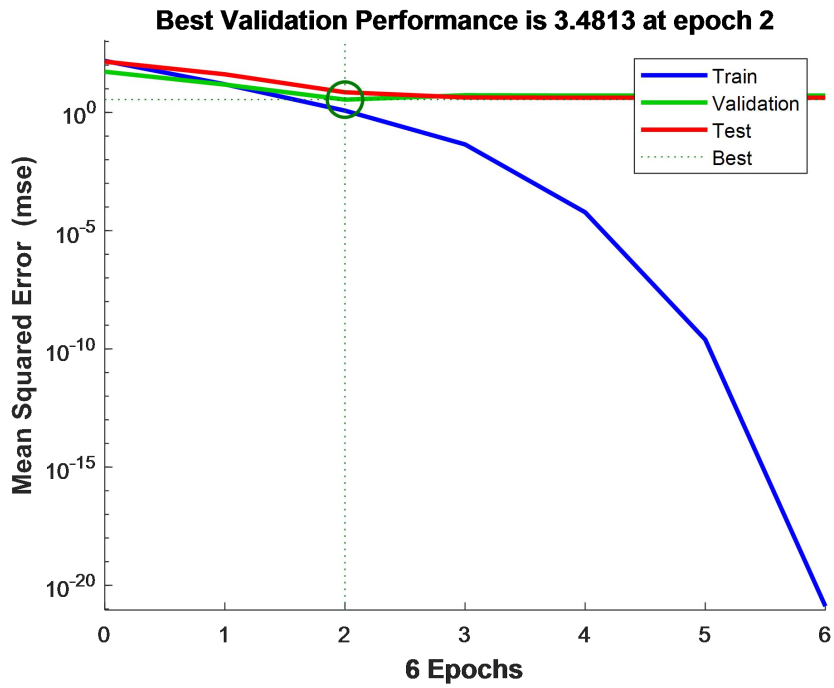


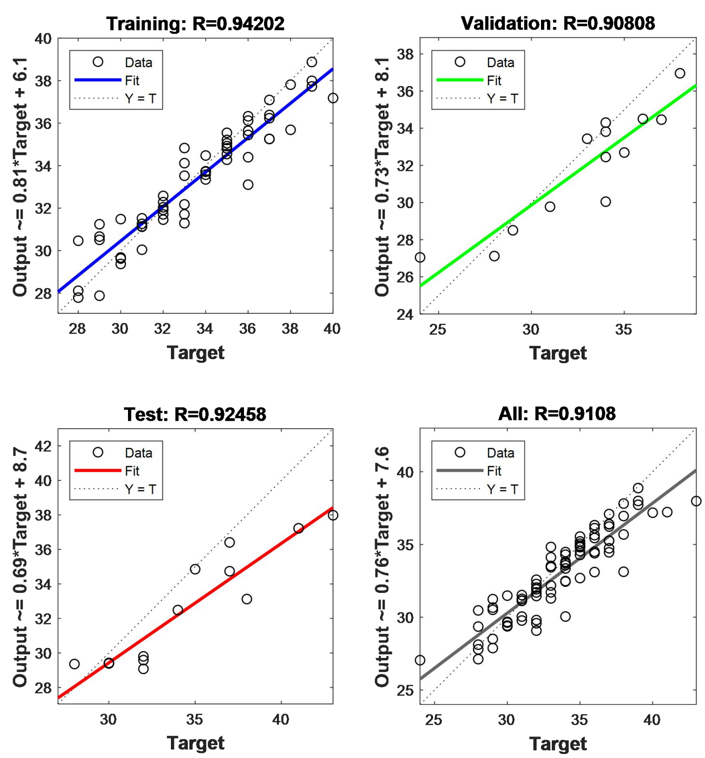
PERFORMANCE RESULTS OF ANN MODEL FOR TUNGA BAND 1 (30-47 MHZ)



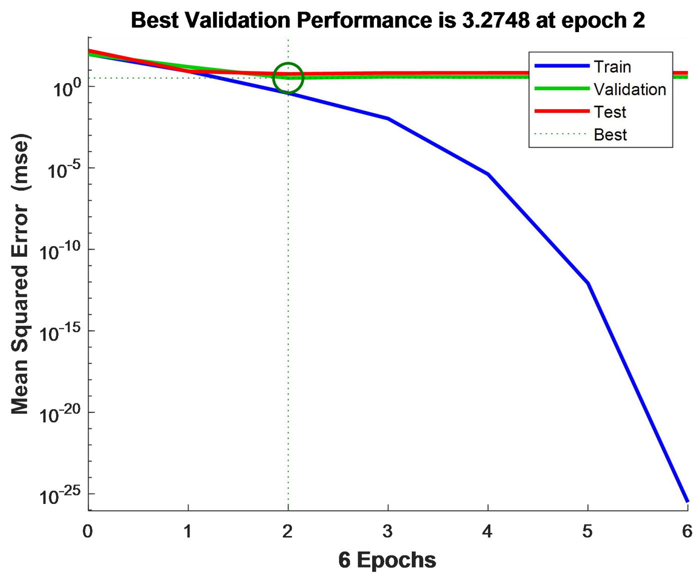


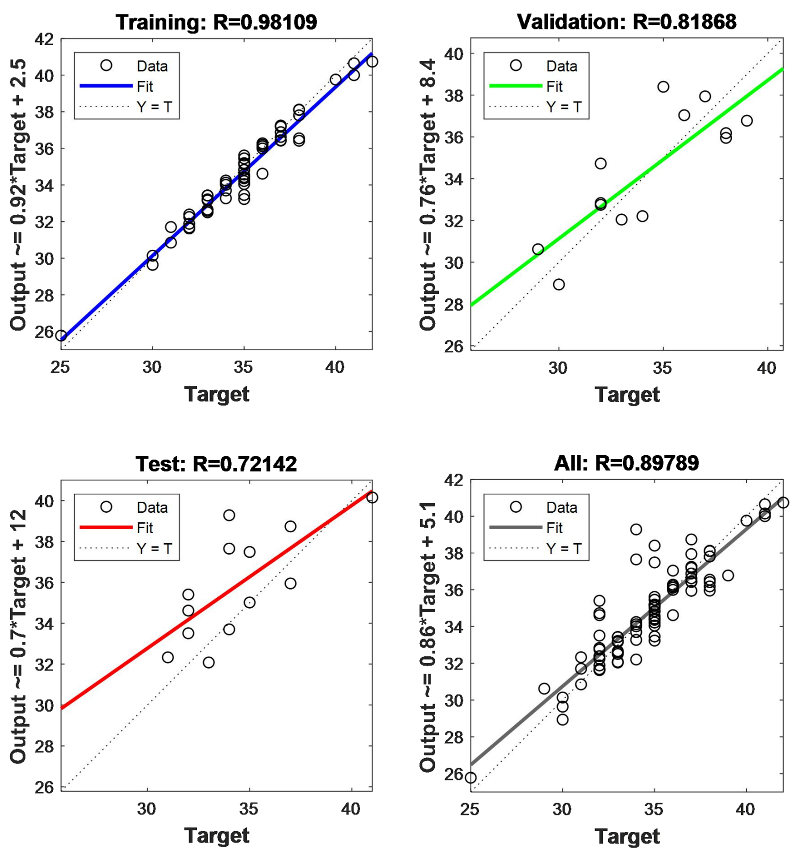
BAND 2 (47.05-68 MHZ)



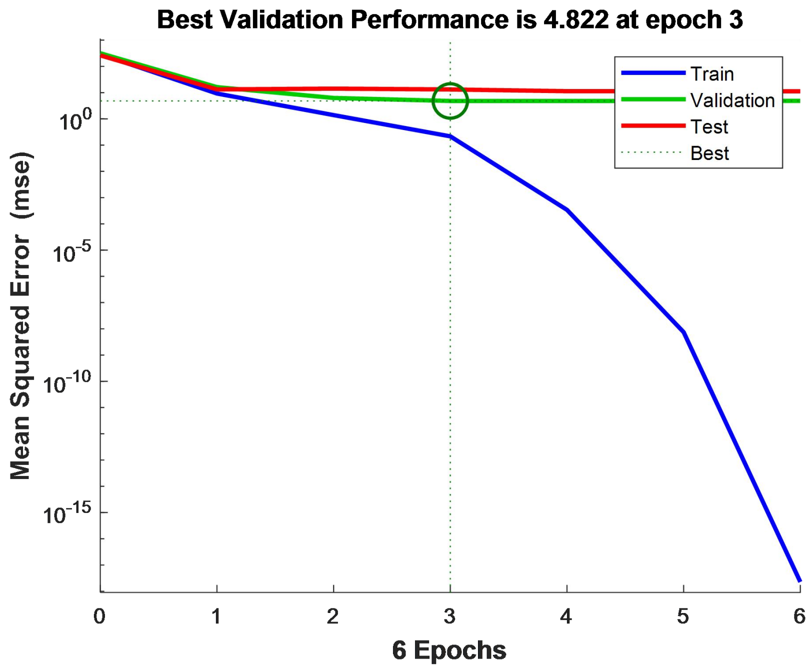


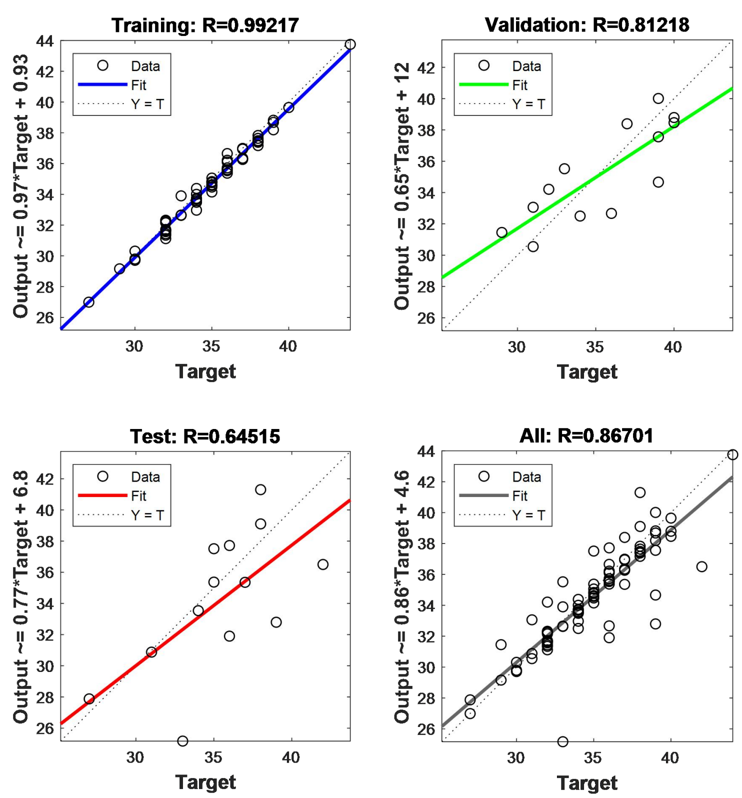
BAND 3 (68.05-74.80 MHZ)



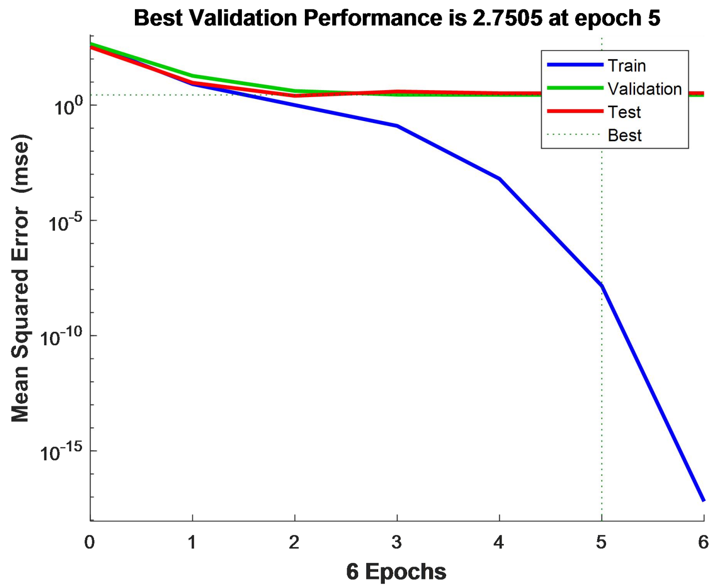


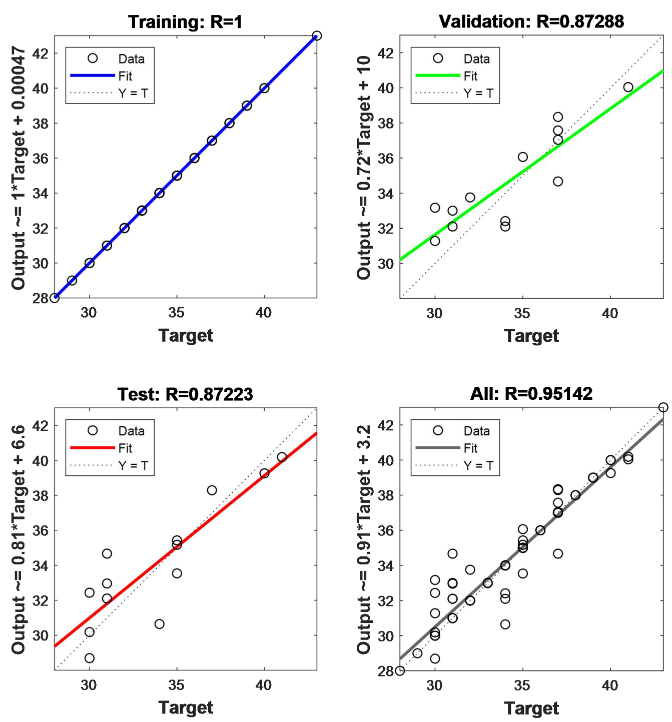
BAND 4 (74.80-87.45 MHZ)



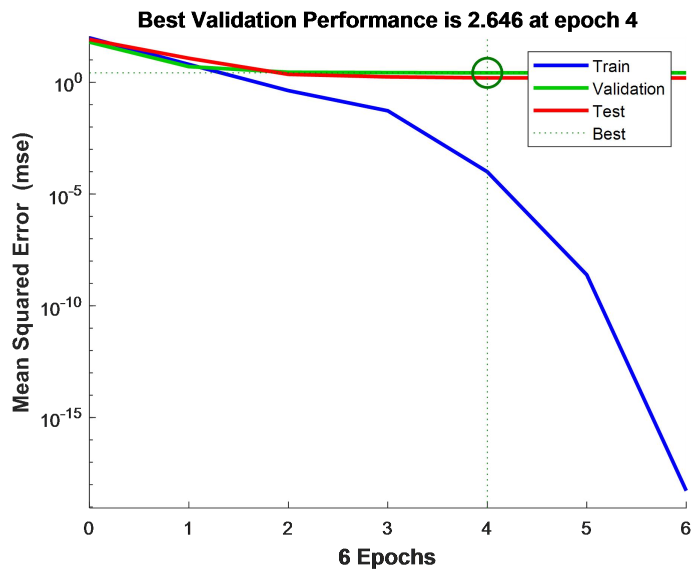


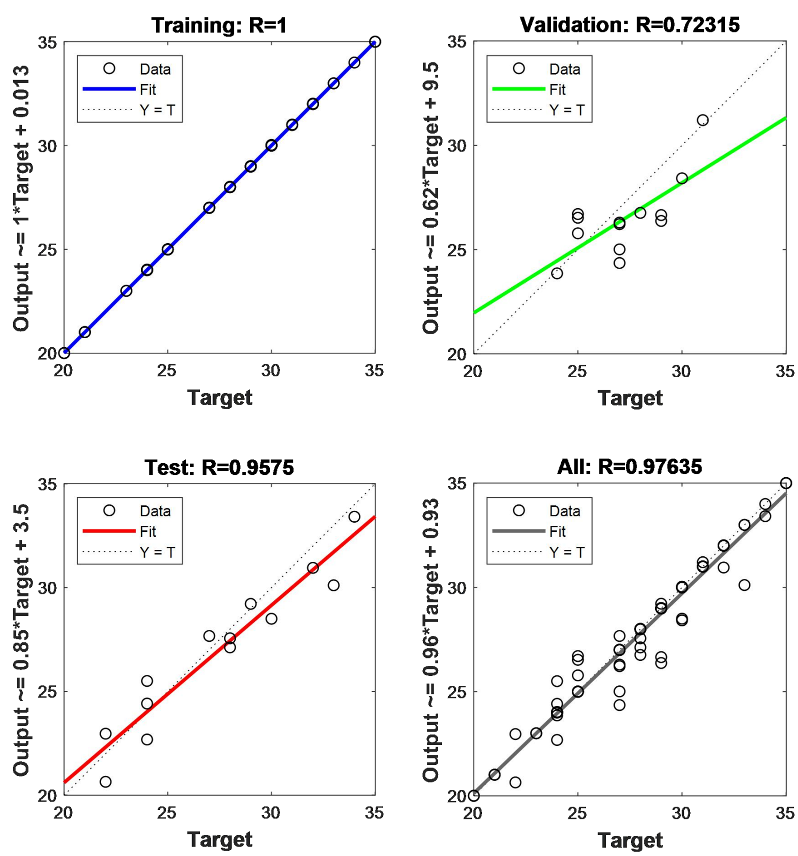
BAND 5 (87.45-108 MHZ)



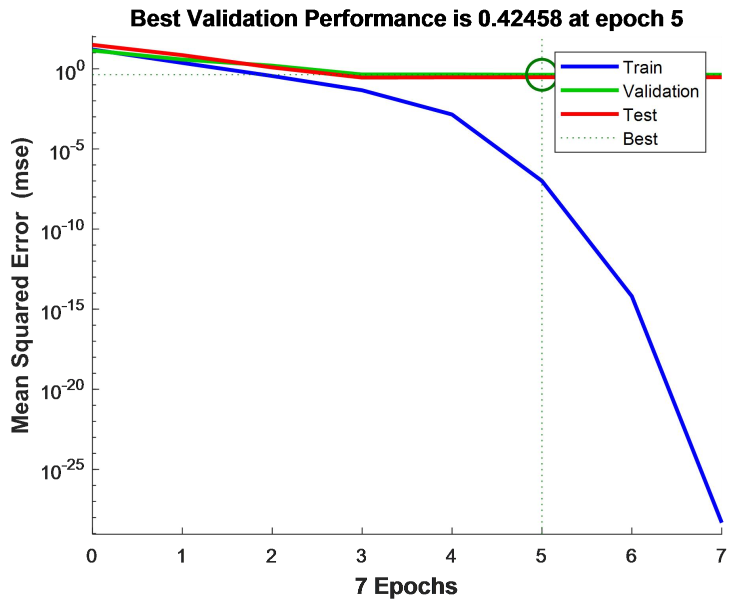


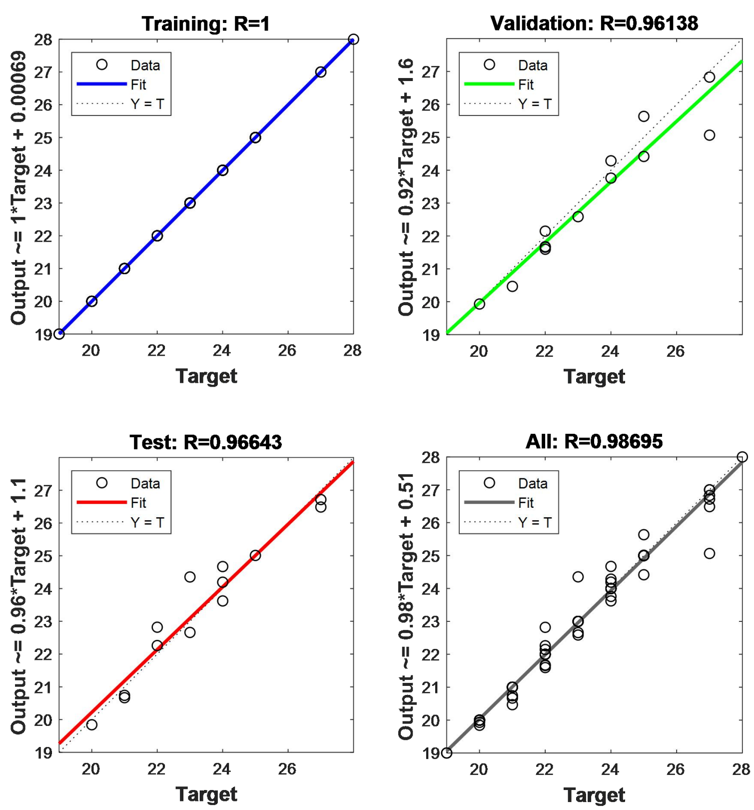
BAND 6 (108.05-137 MHZ)



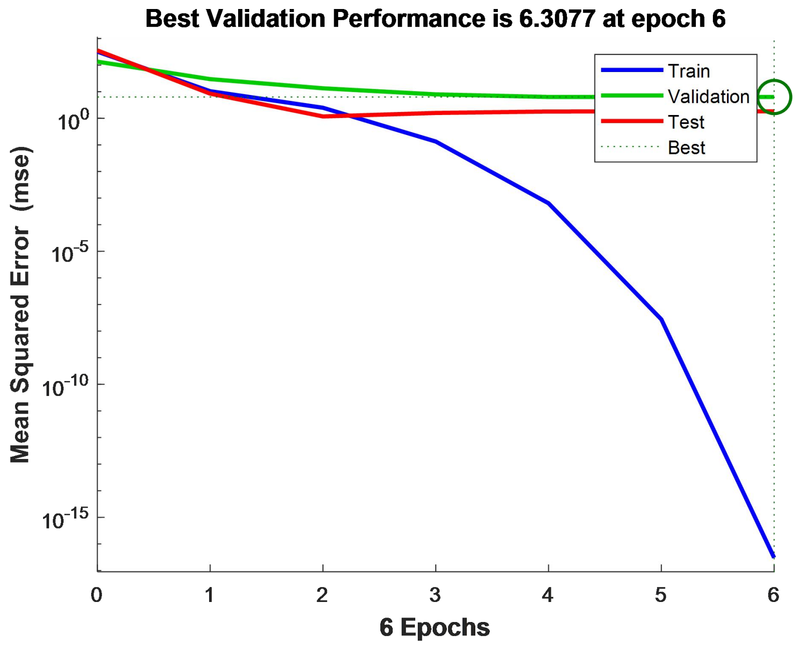


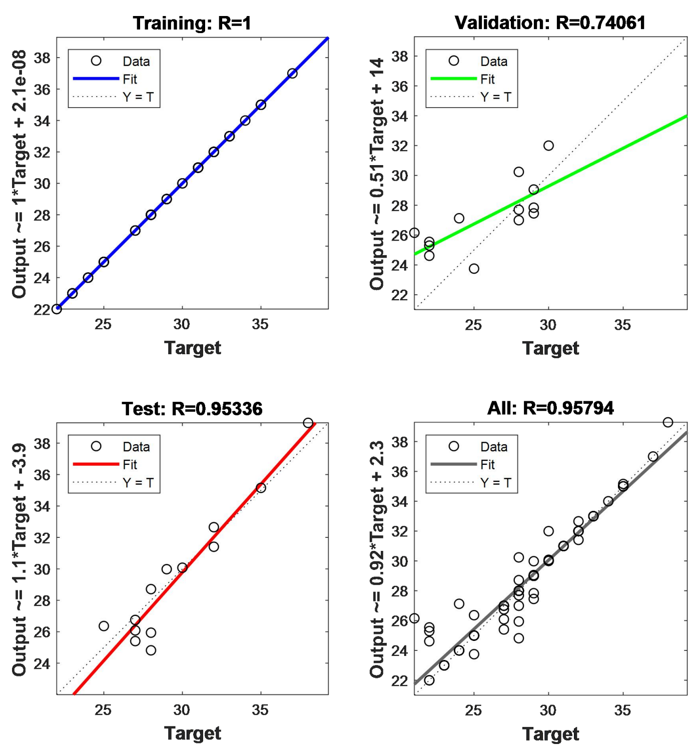
BAND 7 (137.05-144 MHZ)



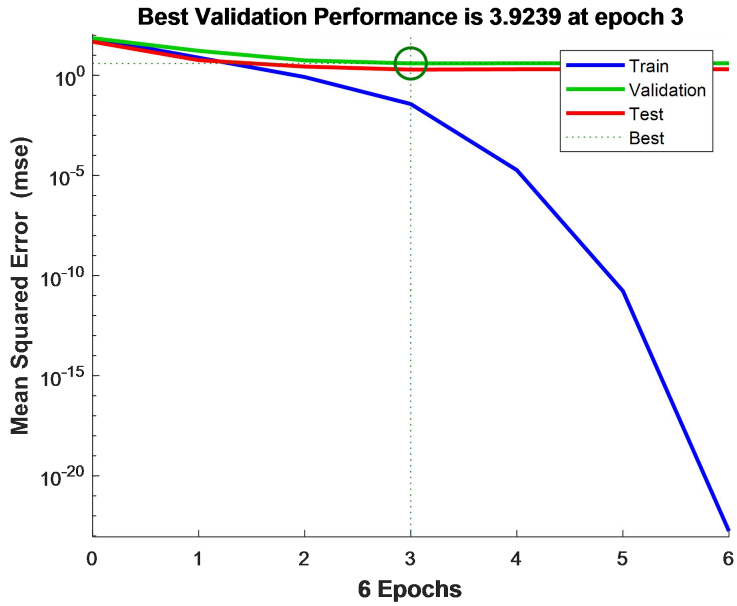


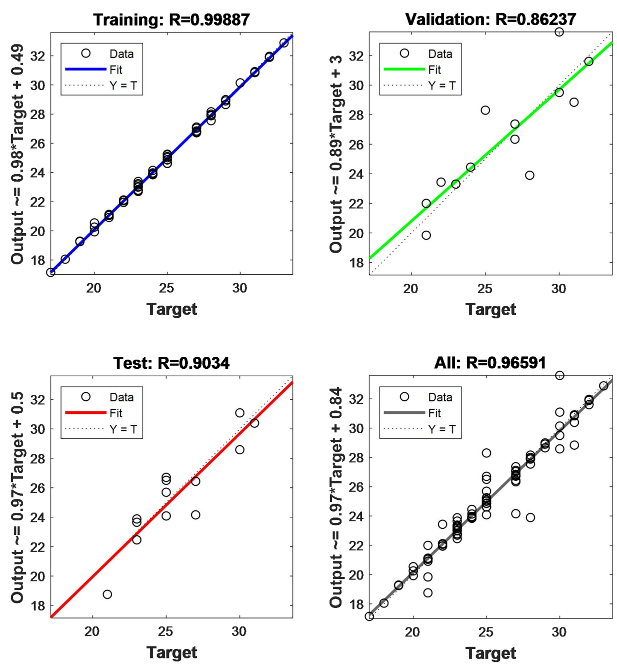
BAND 8 (144.05-174 MHZ)



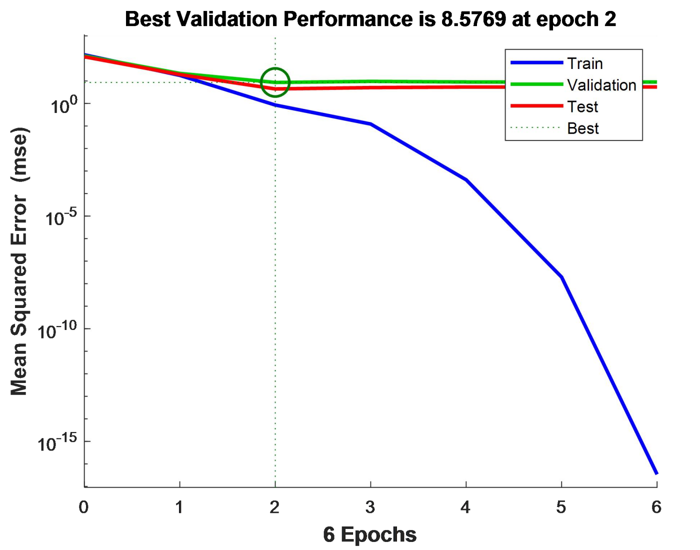


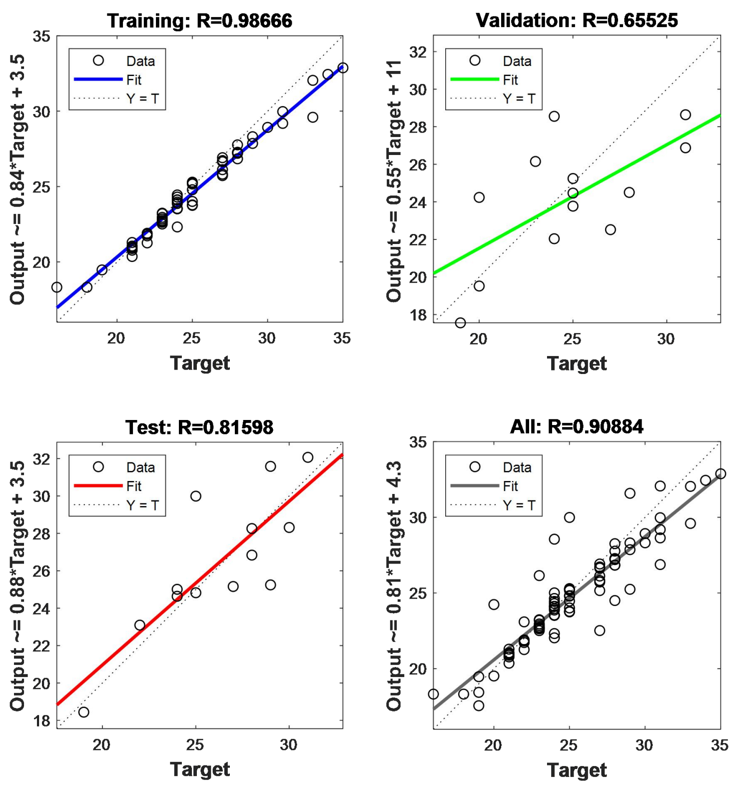
BAND 9 (174.05-200 MHZ)



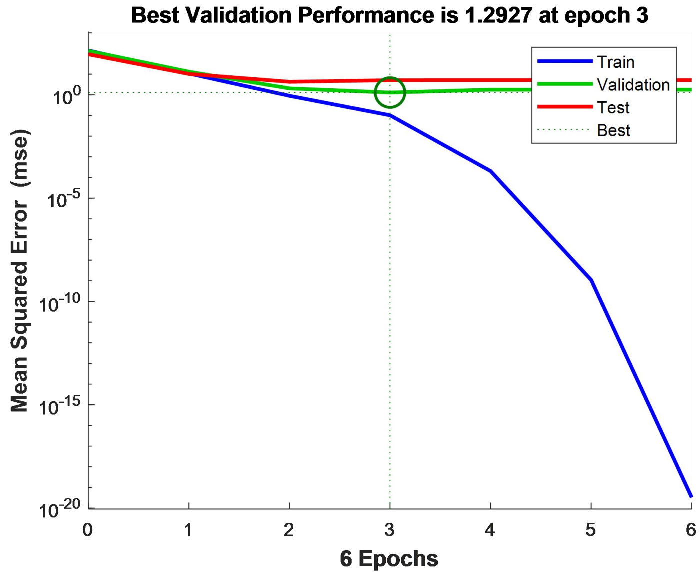


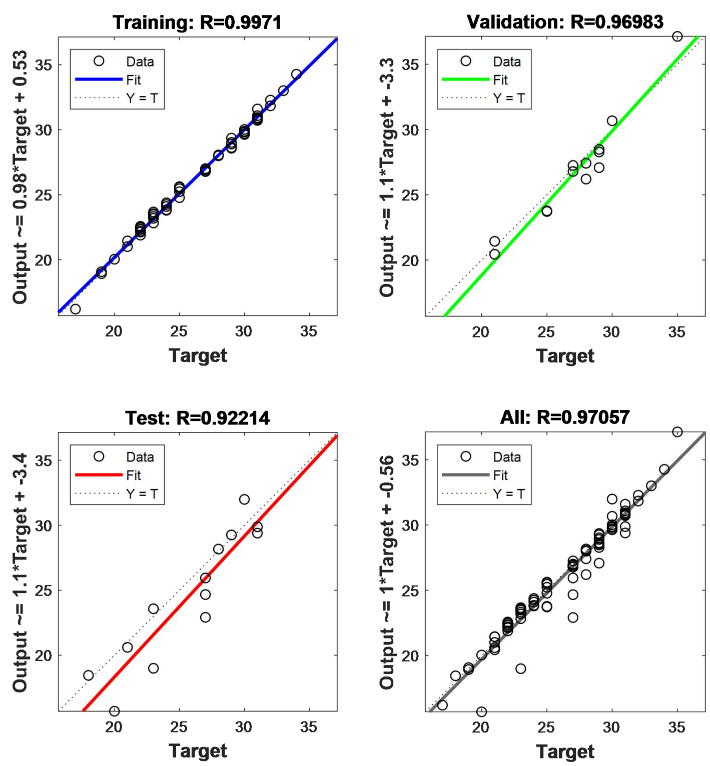
BAND 10 (200.05-230 MHZ)



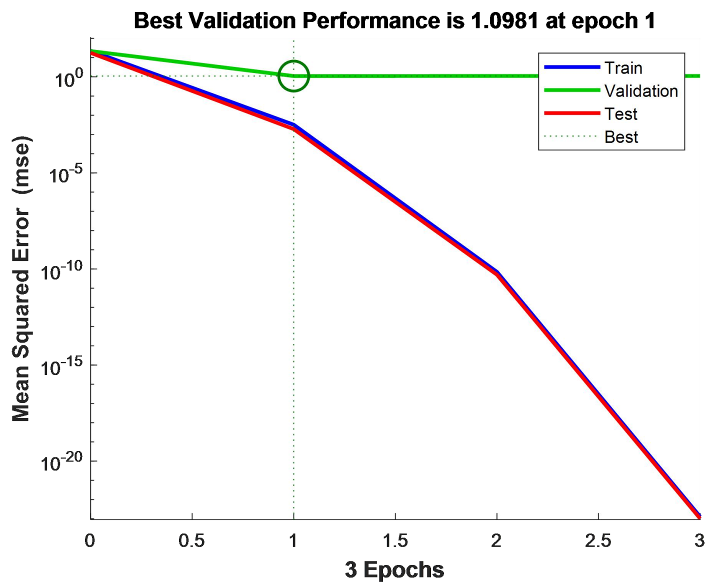


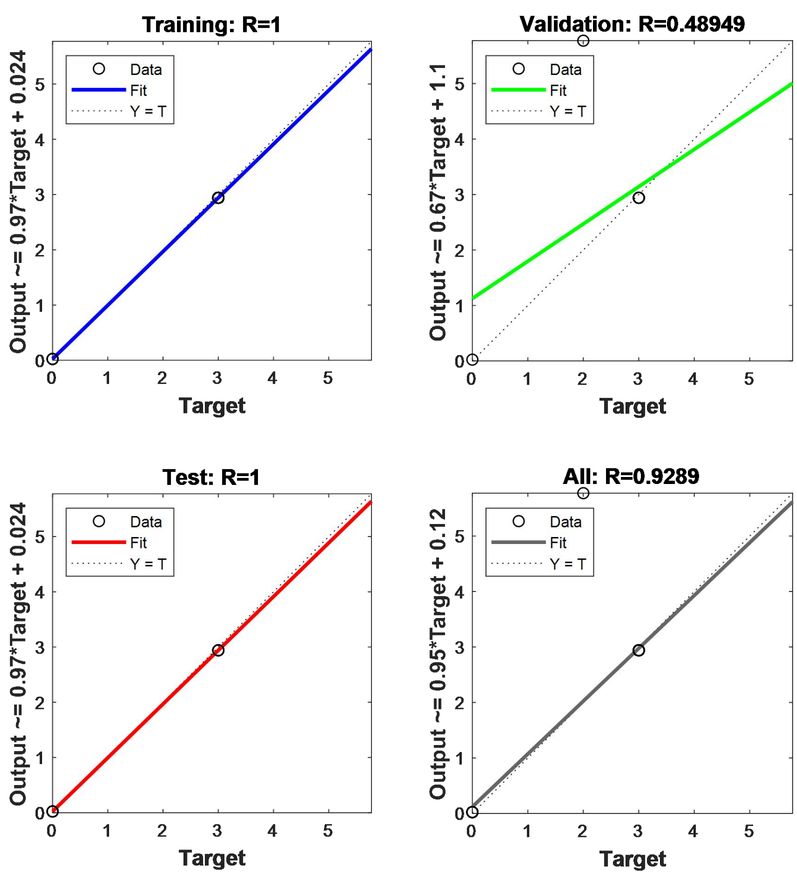
BAND 11 (230.05-267 MHZ)



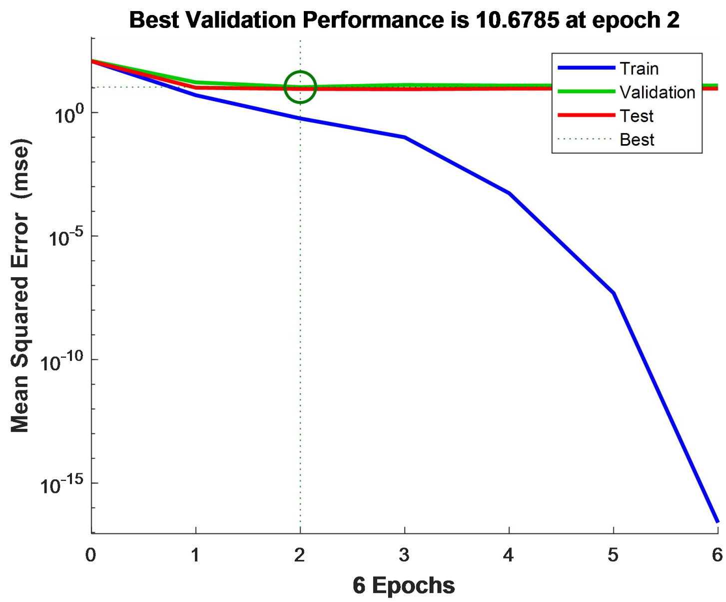


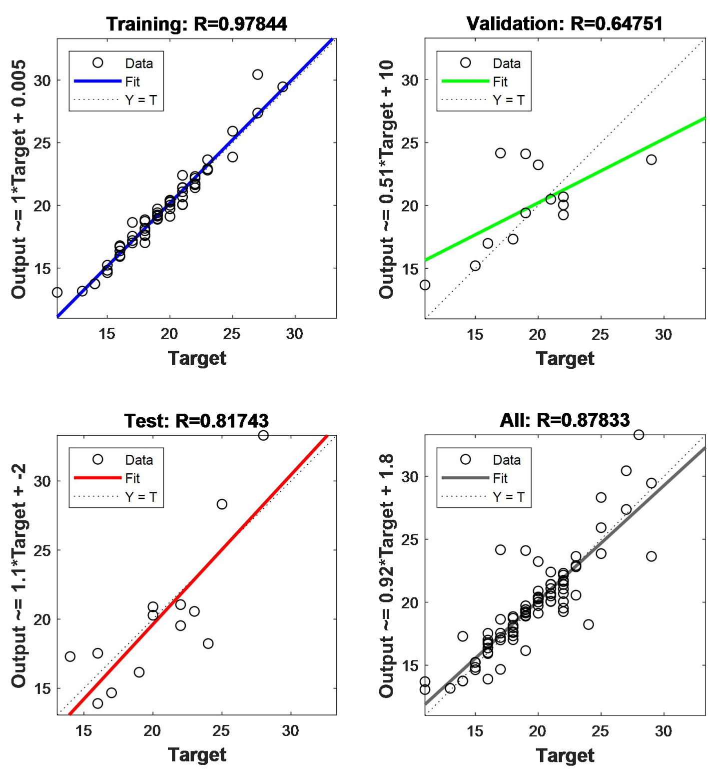
BAND 12 (267.05-300 MHZ)



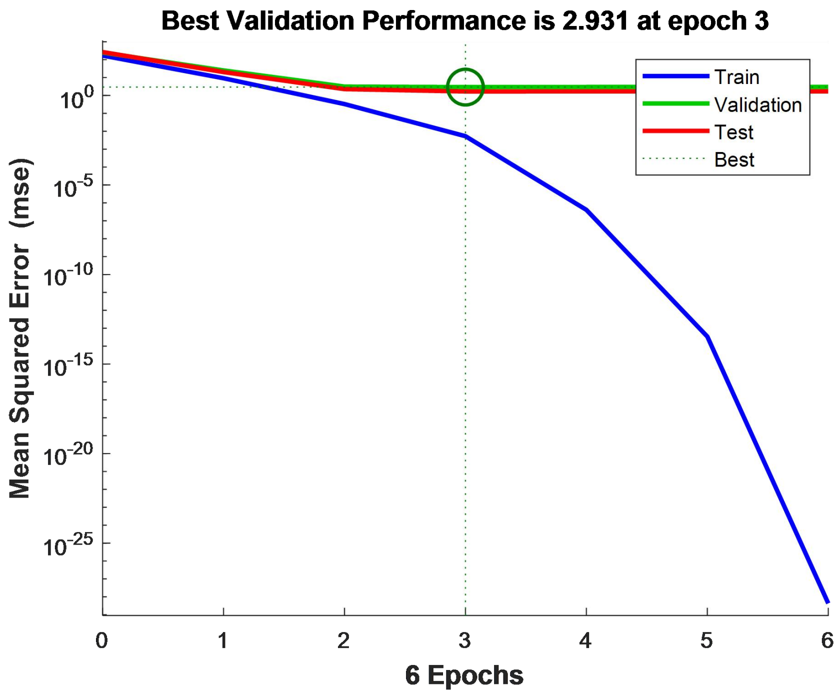


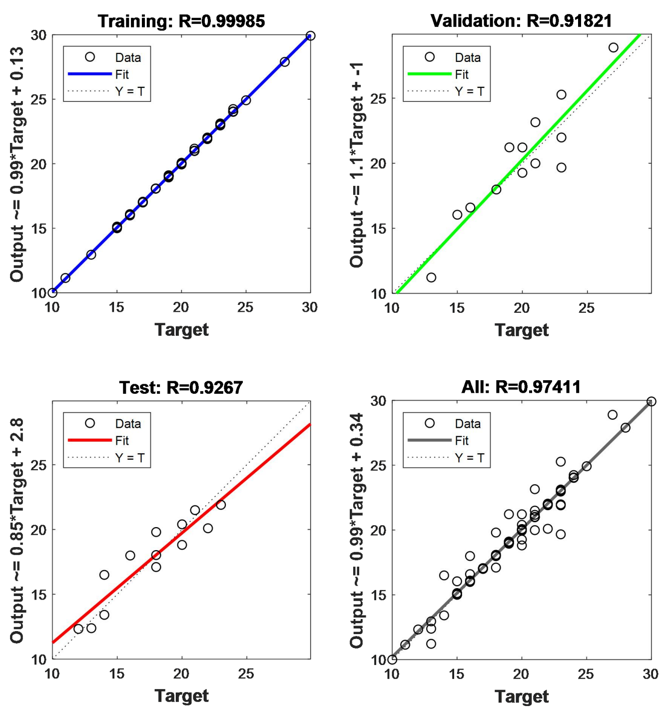
PERFORMANCE RESULTS OF ANN MODEL FOR KUBWA BAND 1 (30-47 MHZ)



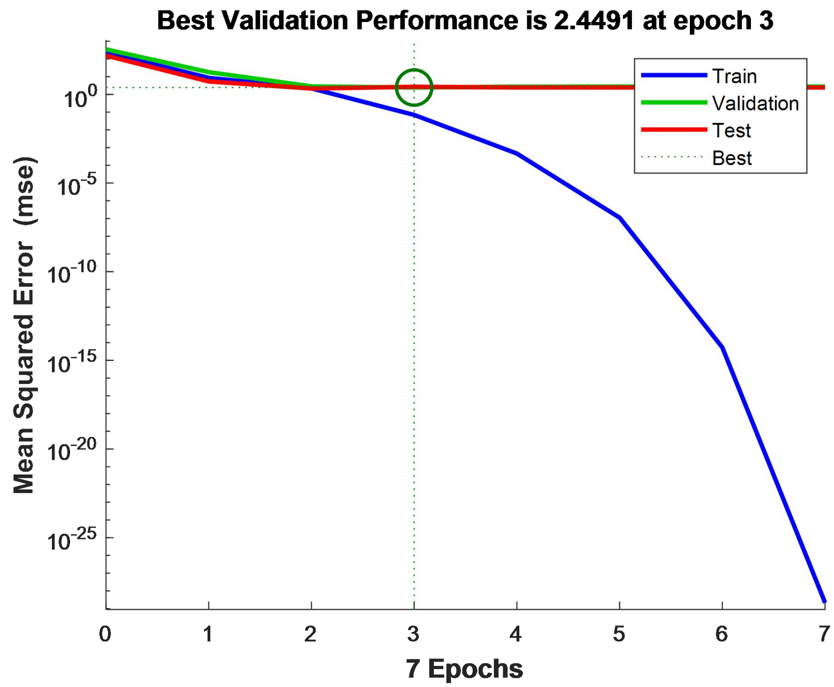


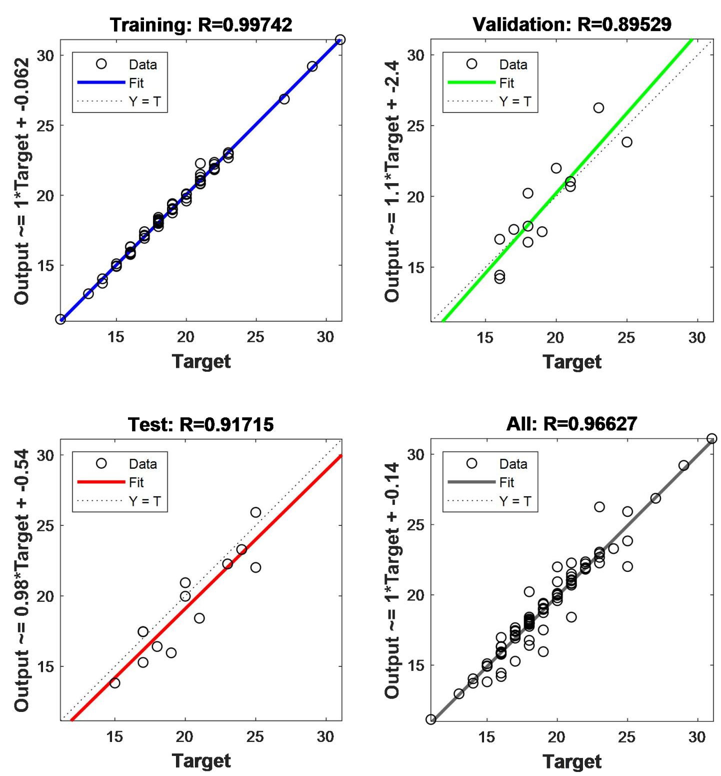
BAND 2 (47.05-68 MHZ)



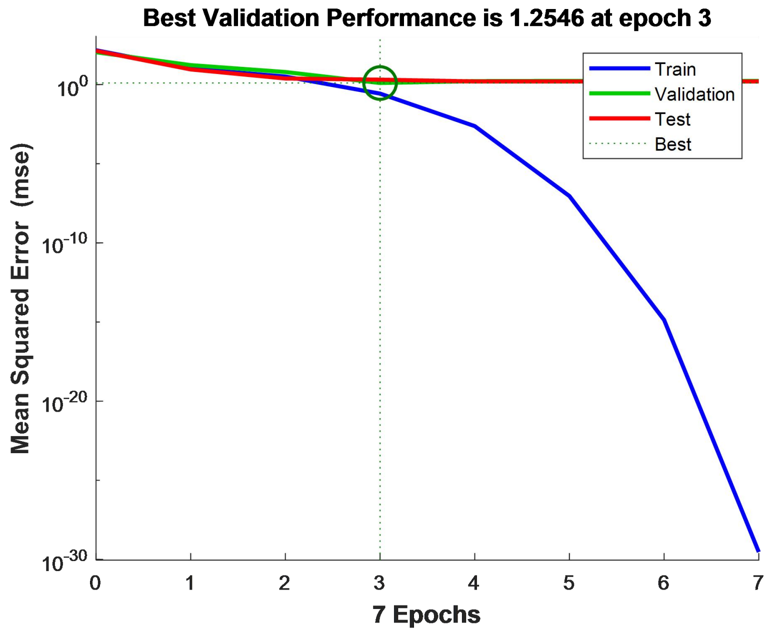


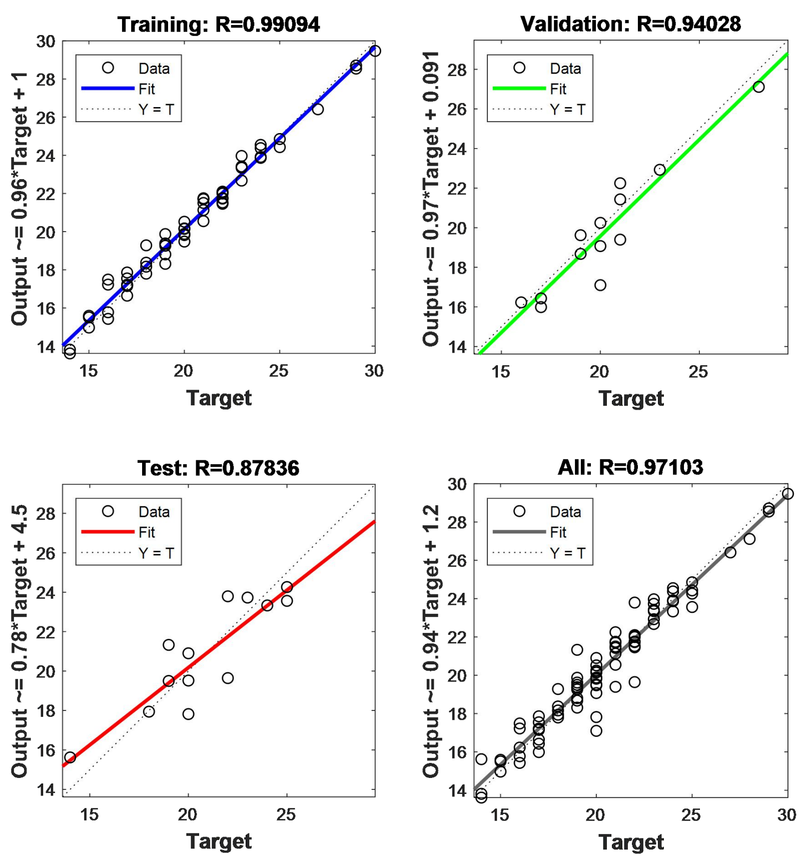
BAND 3 (68.05-74.80 MHZ)



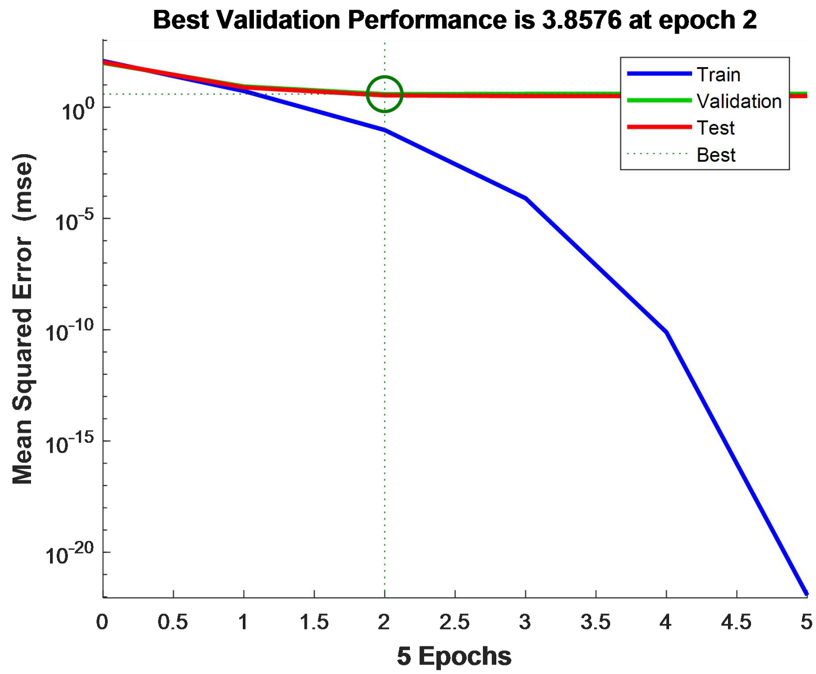


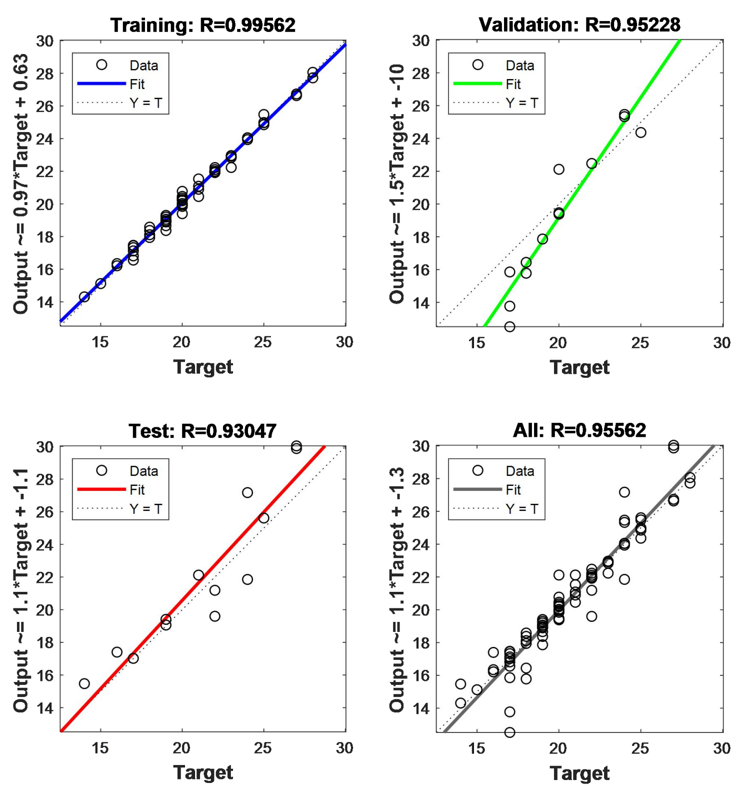
BAND 4 (74.80-87.45 MHZ)



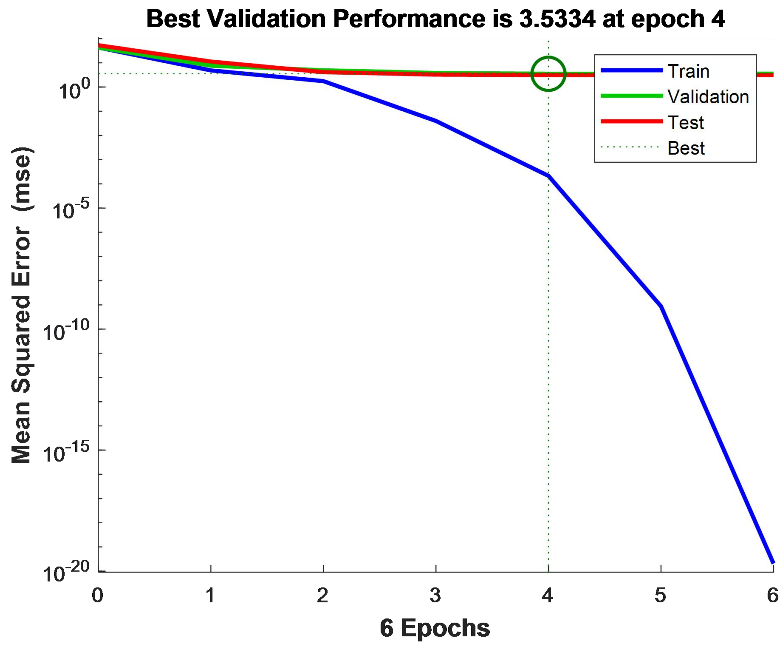


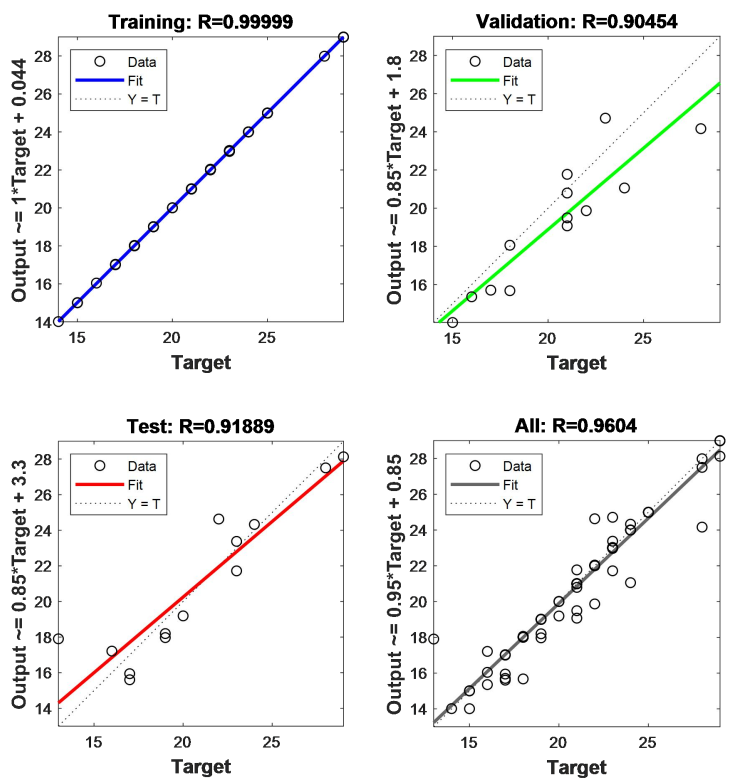
BAND 5 (87.45-108 MHZ)



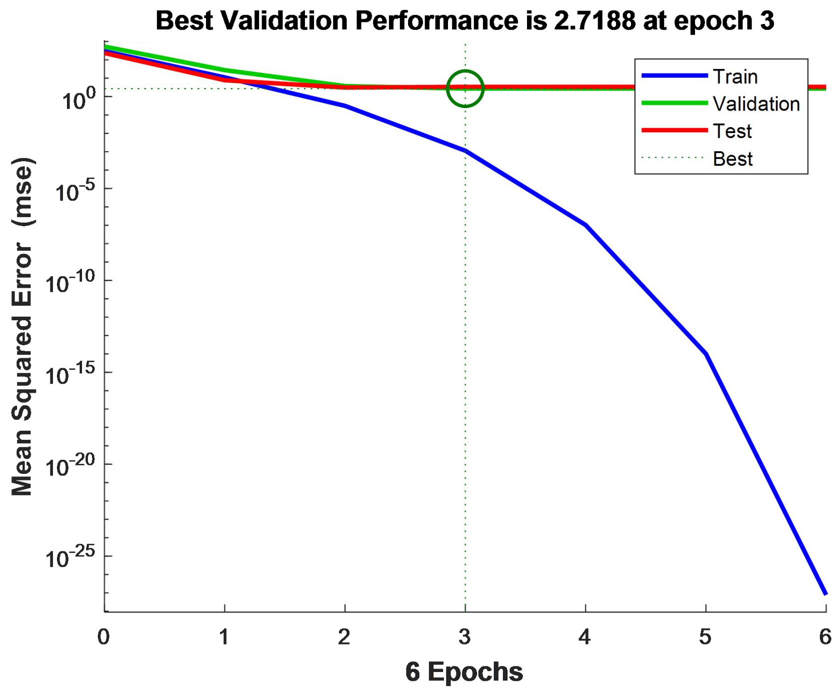


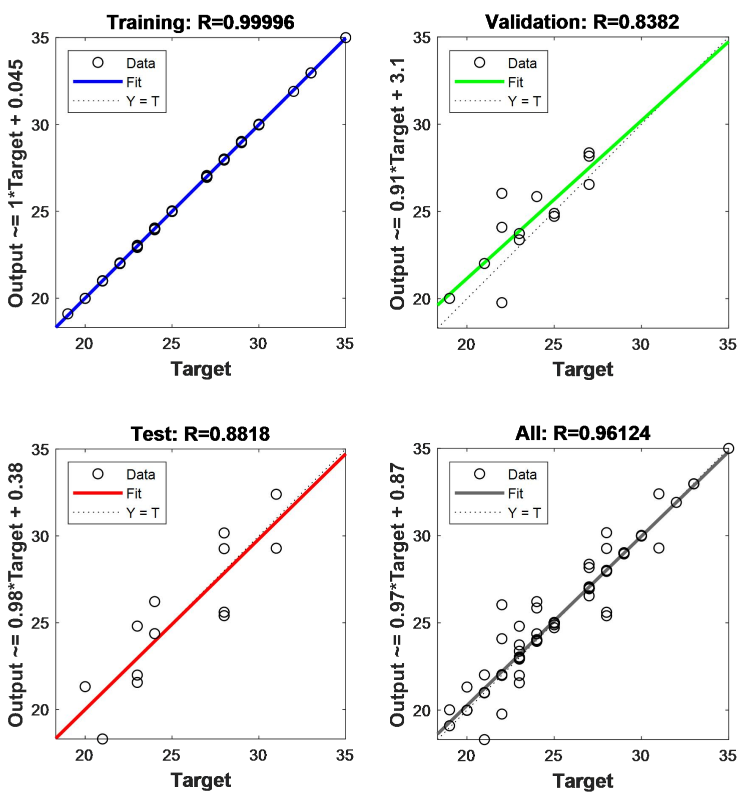
BAND 6 (108.05-137 MHZ)



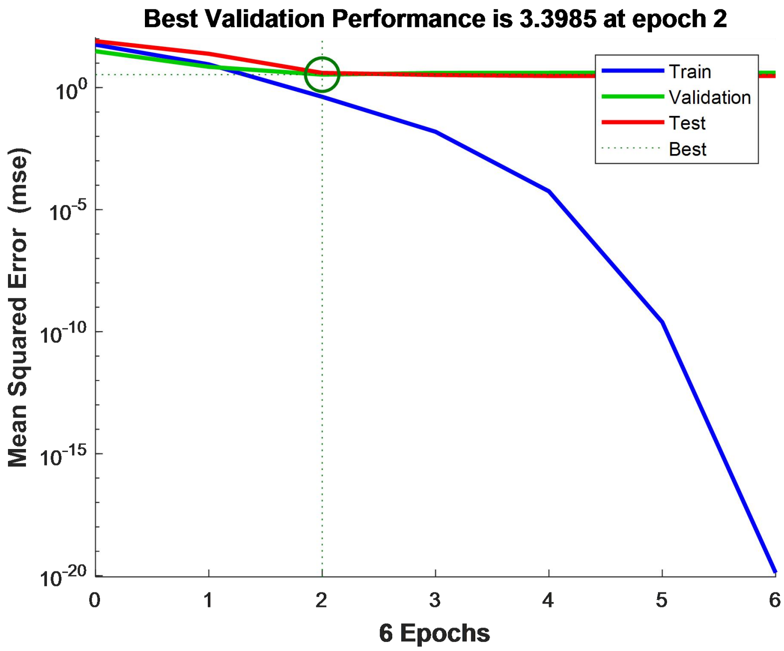


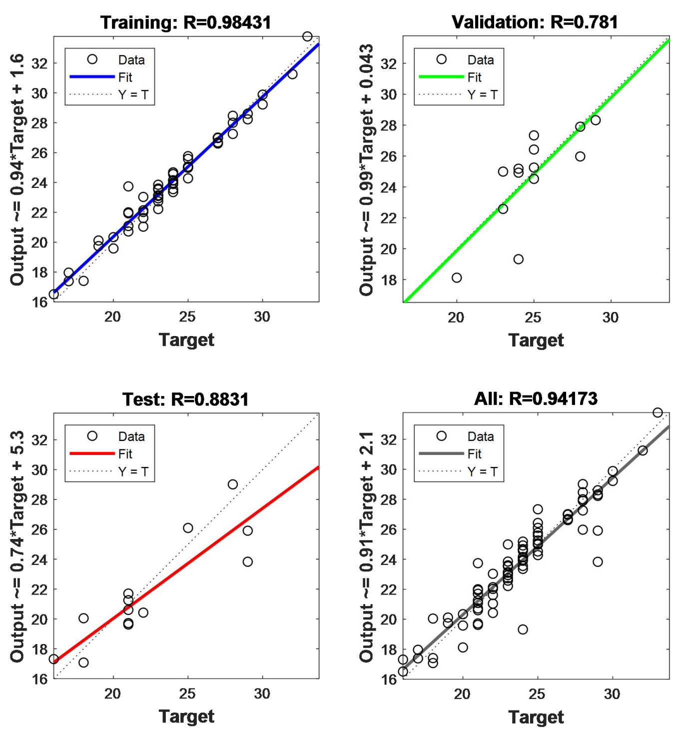
BAND 7 (137.05-144 MHZ)



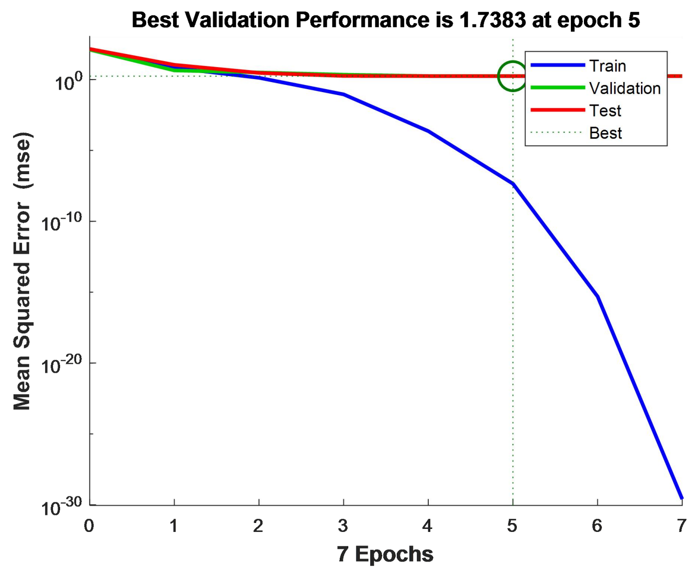


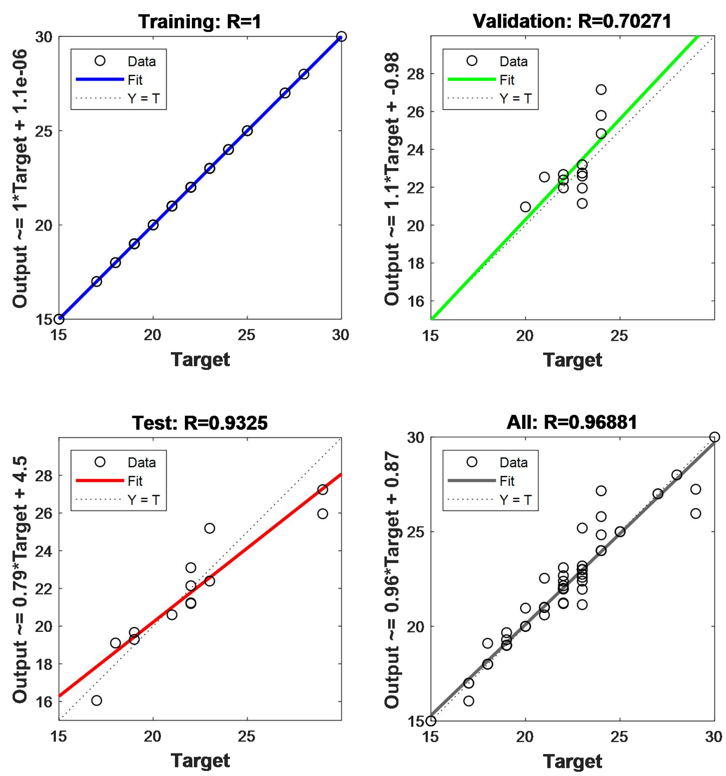
BAND 8 (144.05-174 MHZ)



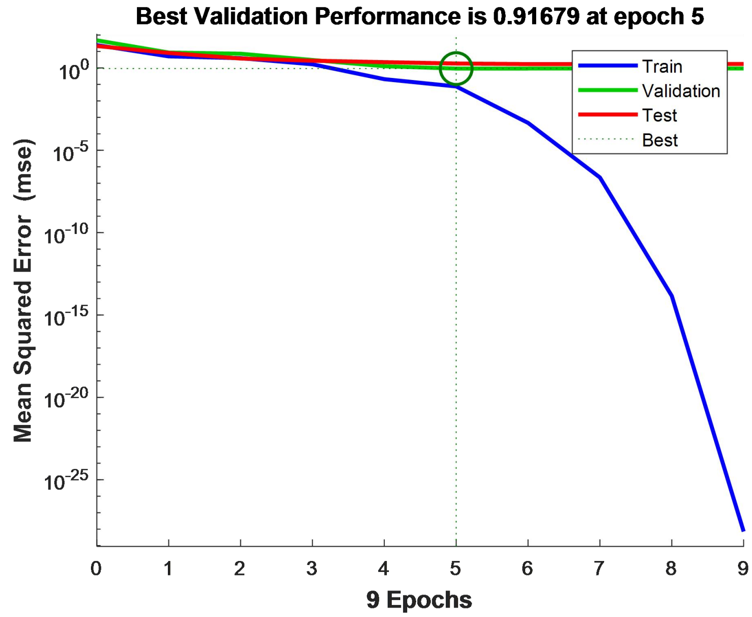


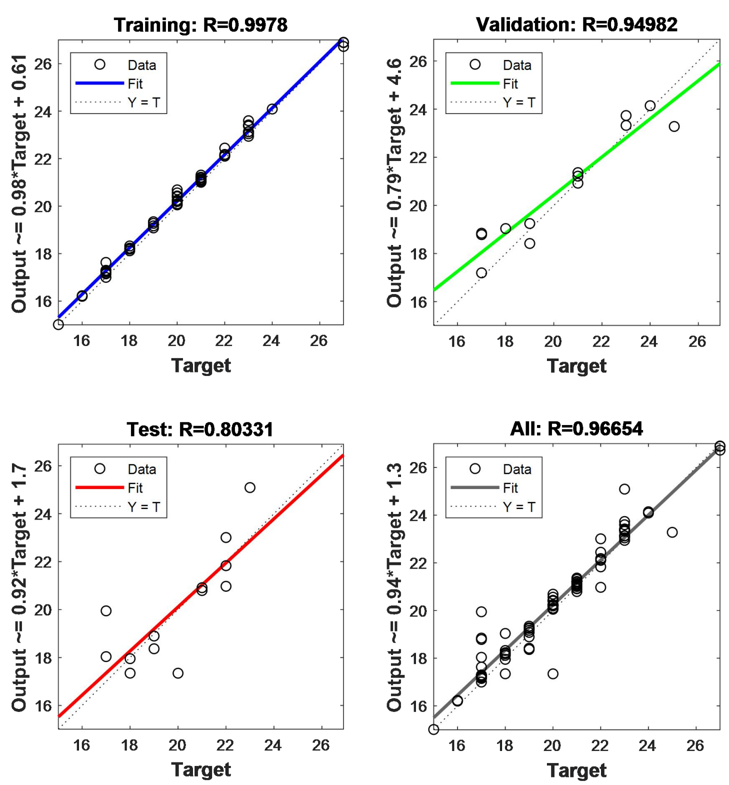
BAND 9 (174.05-200 MHZ)



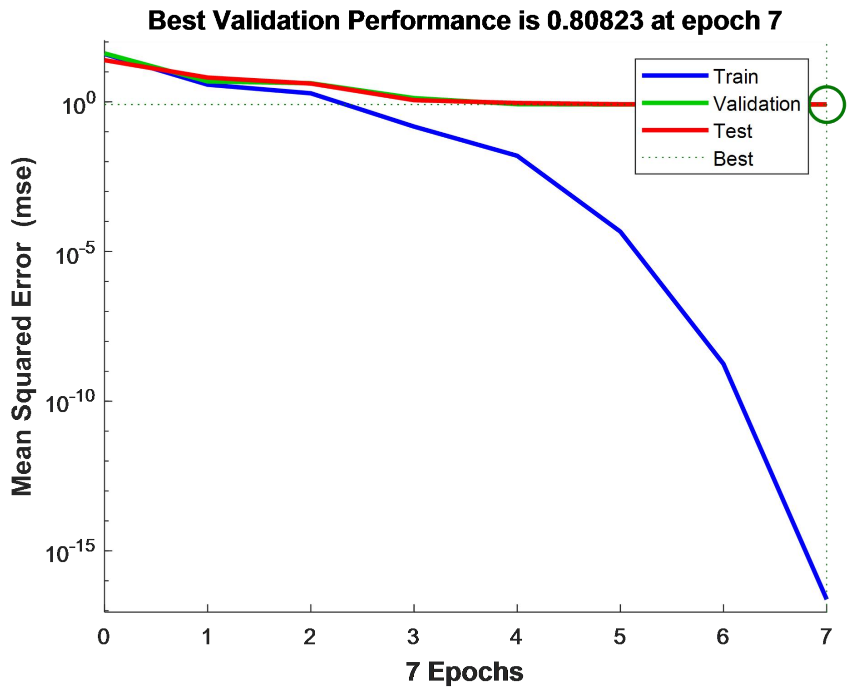


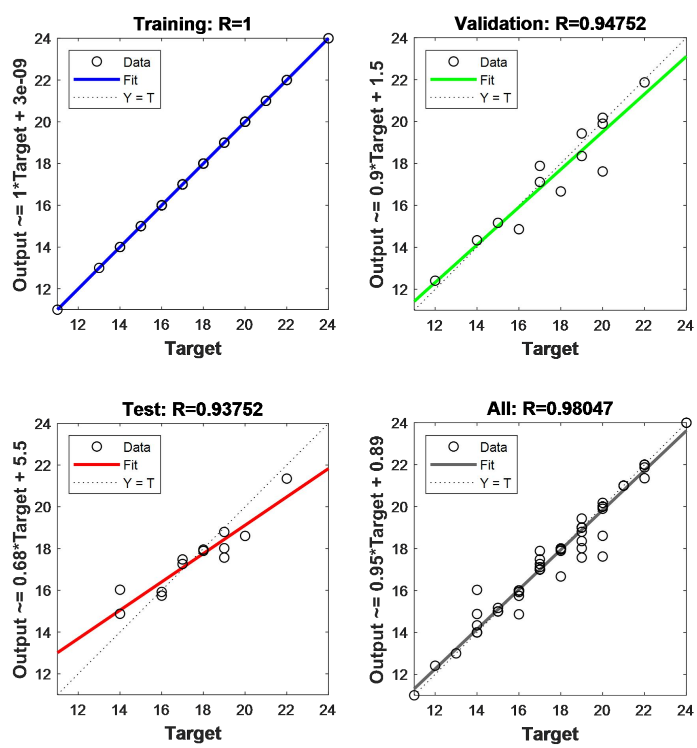
BAND 10 (200.05-230 MHZ)



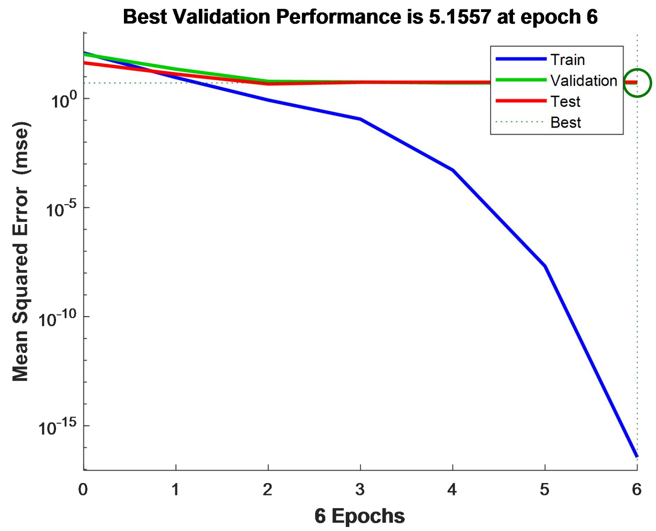


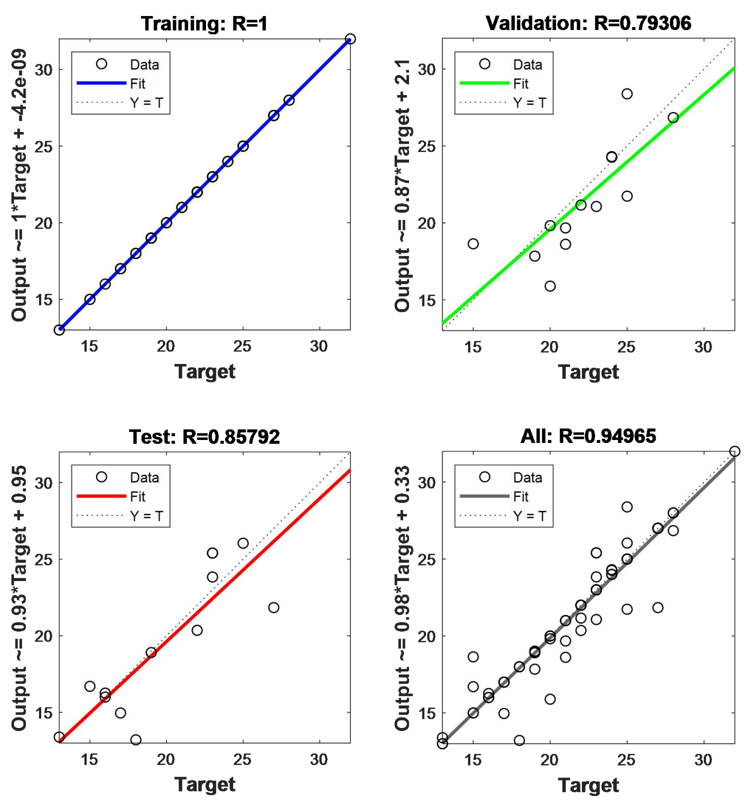
BAND 11 (230.05-267 MHZ)



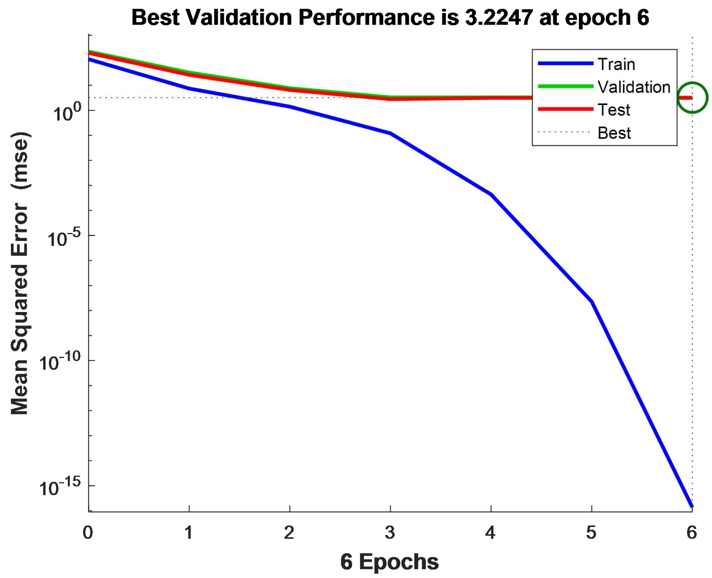


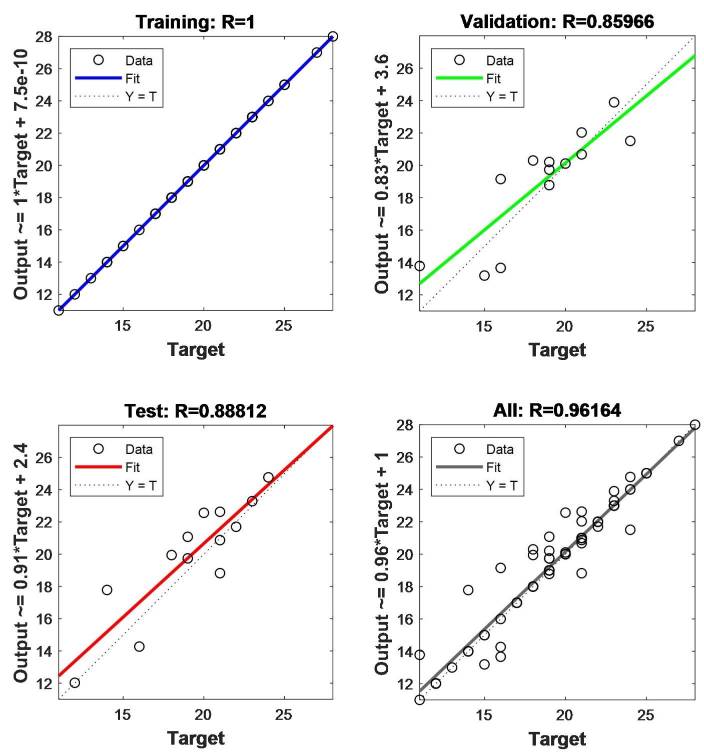
PERFORMANCE RESULTS OF ANN MODEL FOR GUDU
BAND 1 (30-47 MHZ)



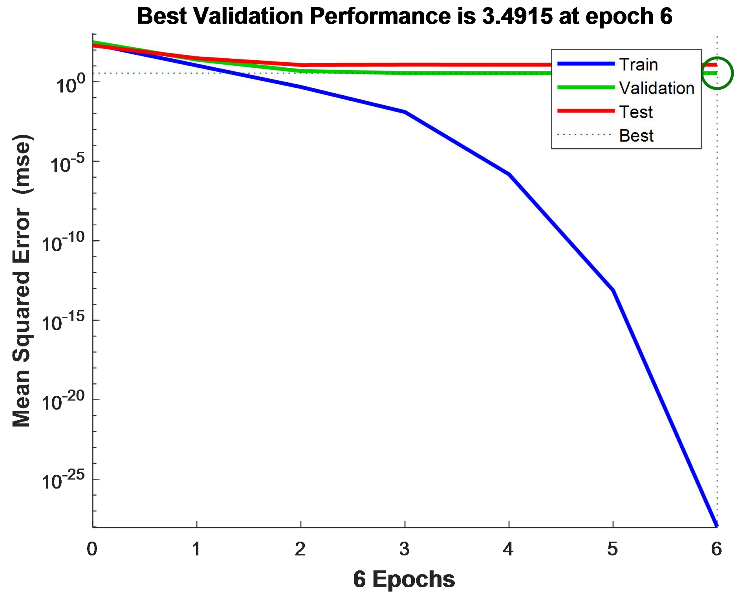


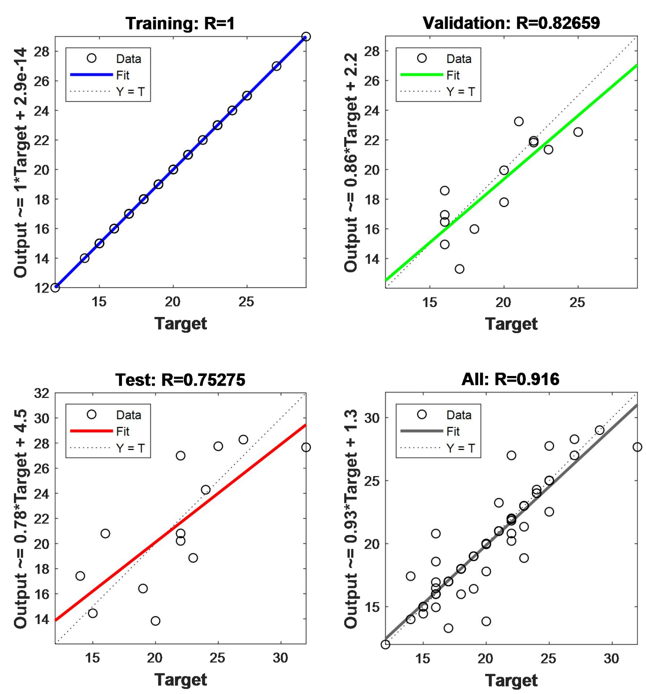
BAND 2 (47.05-68 MHZ)



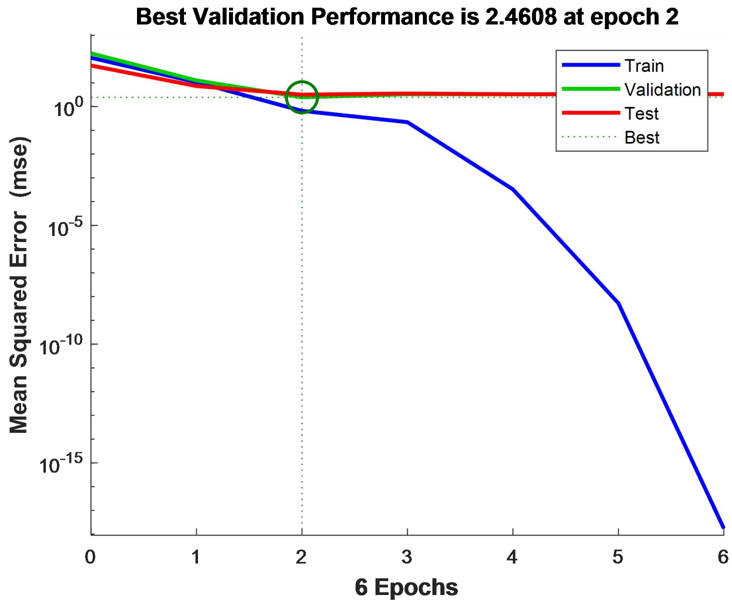


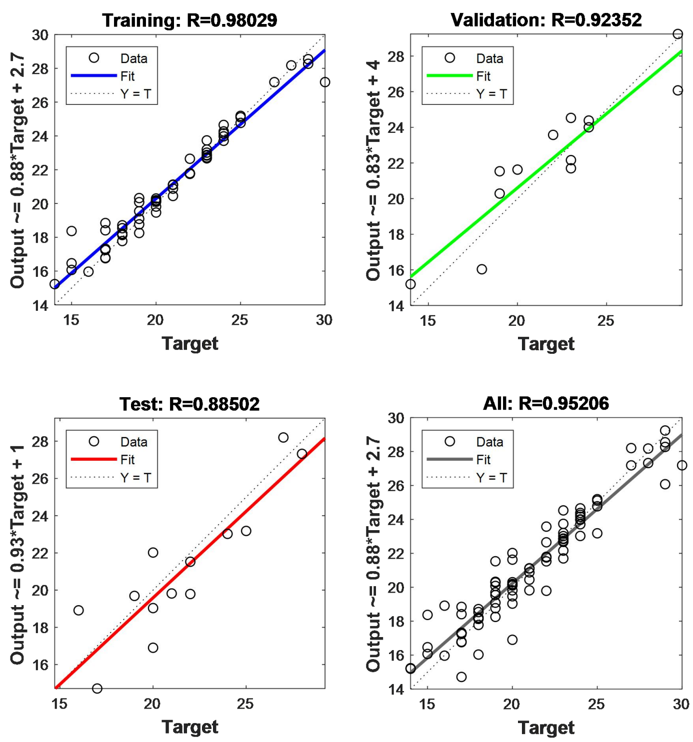
BAND 3 (68.05-74.80 MHZ)



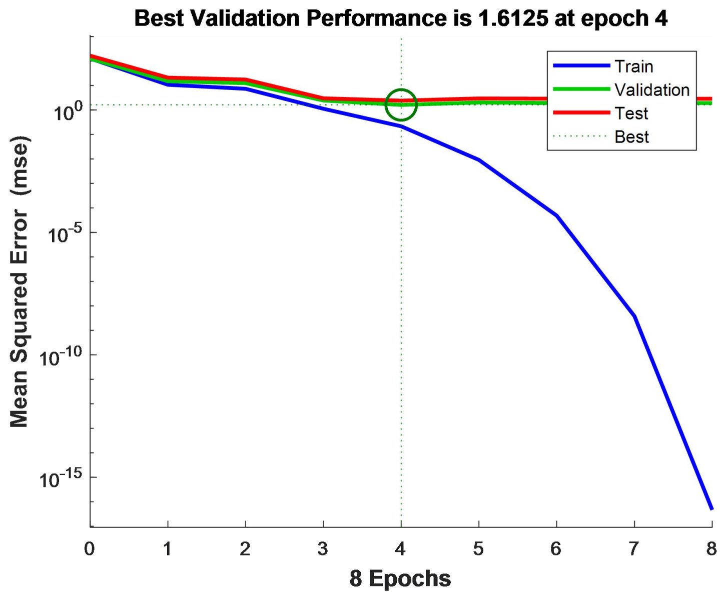


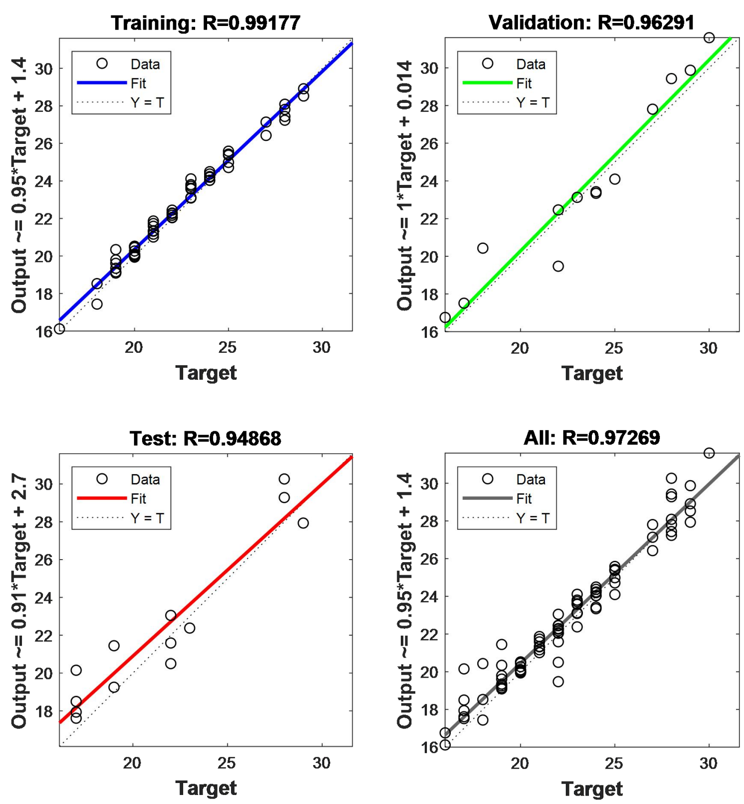
BAND 4 (74.80-87.45 MHZ)



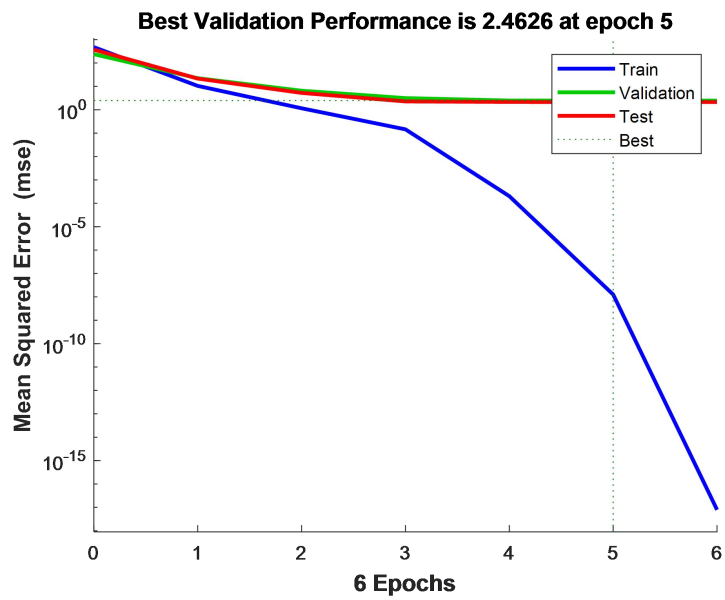


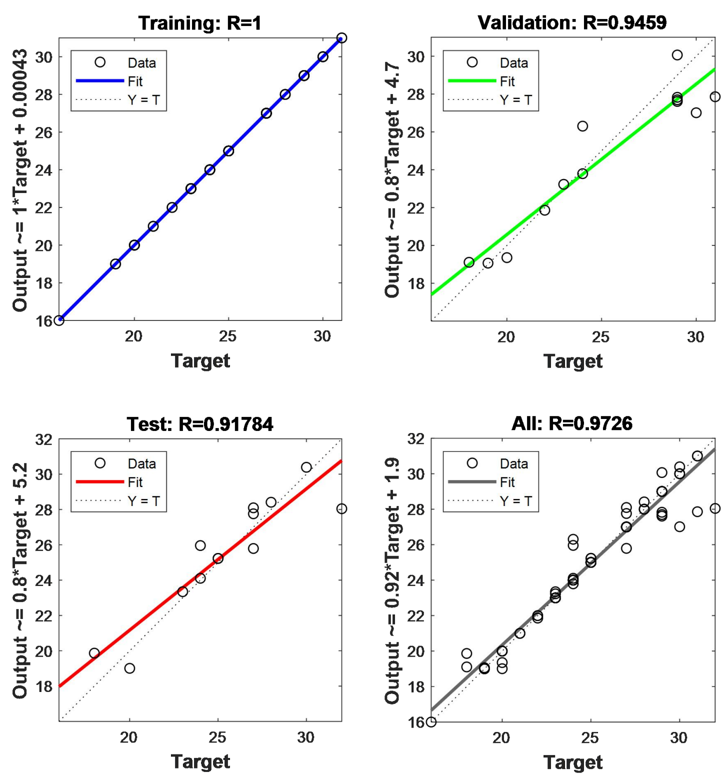
BAND 5 (87.45-108 MHZ)



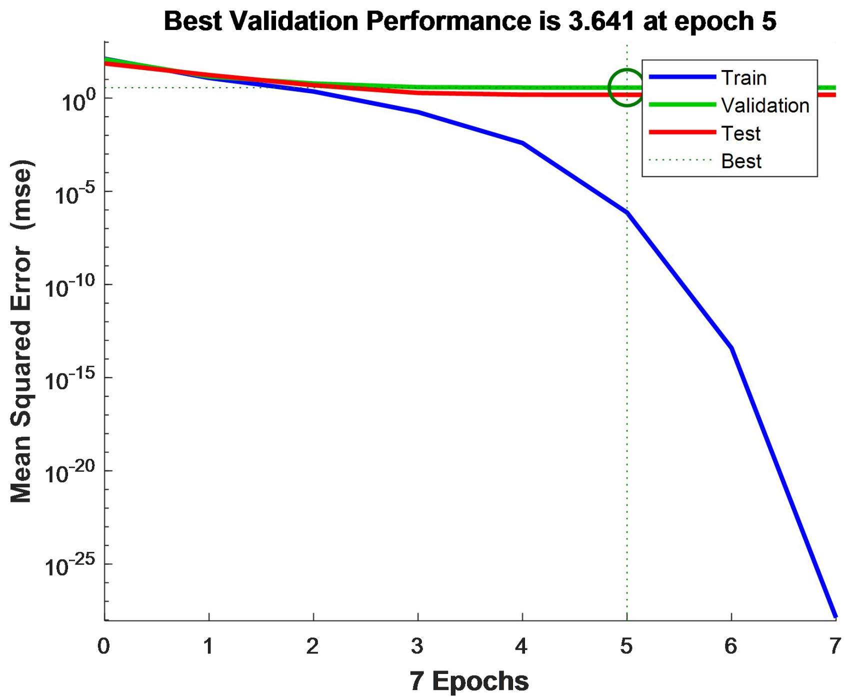


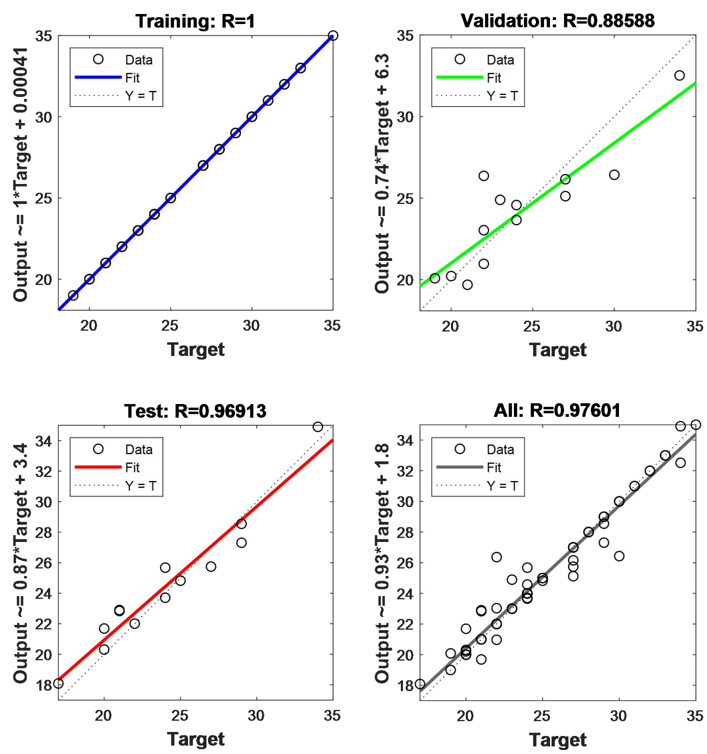
BAND 6 (108.05-137 MHZ)



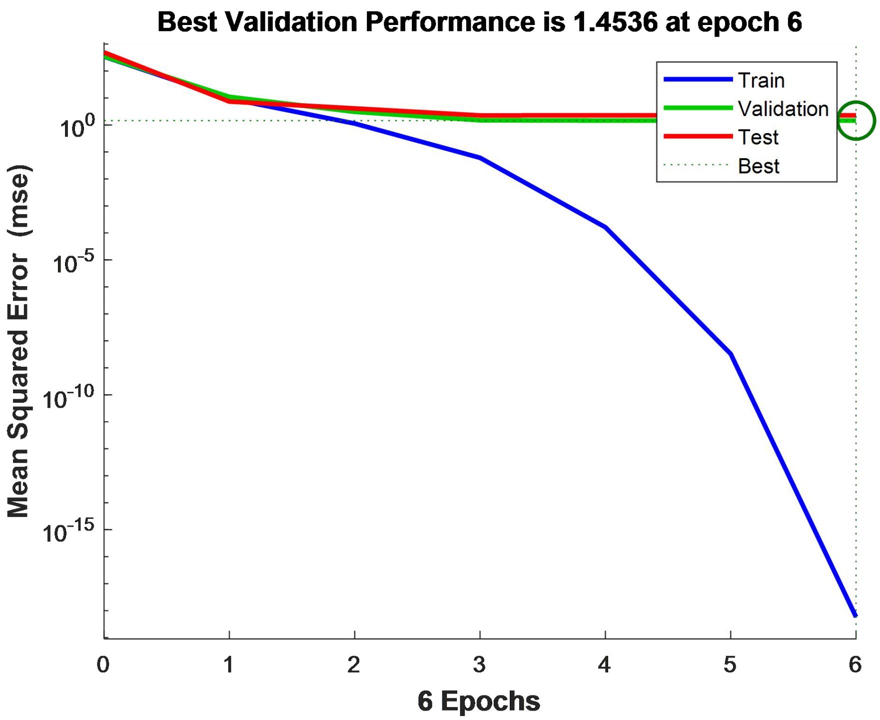


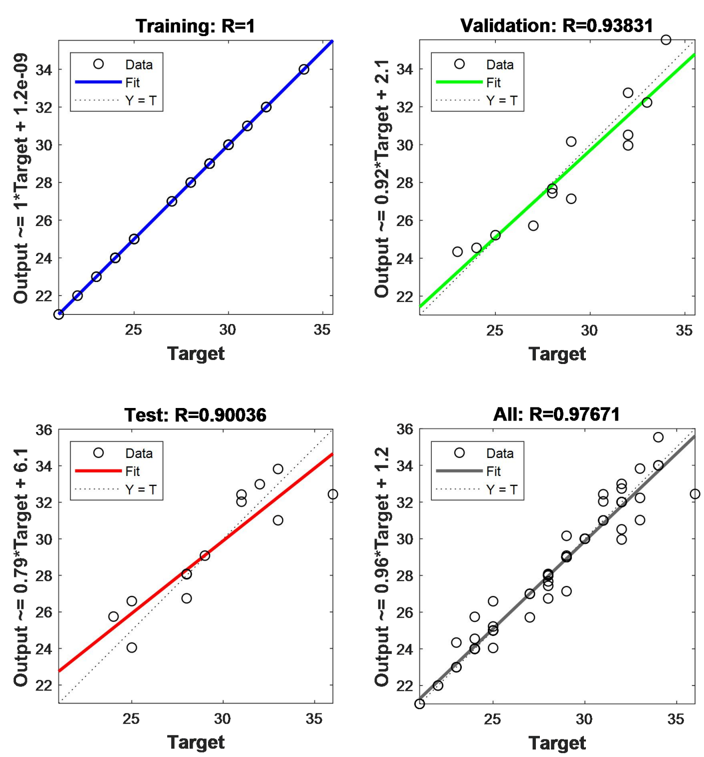
BAND 7 (137.05-144 MHZ)



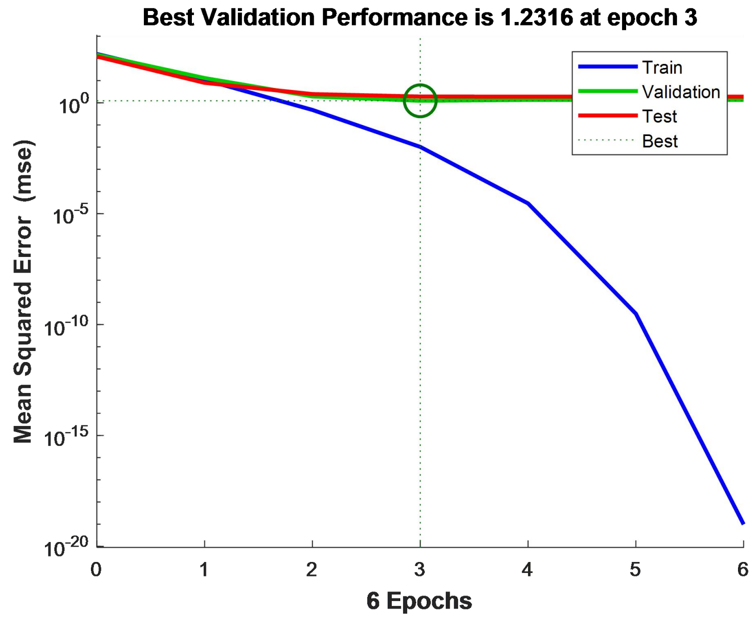


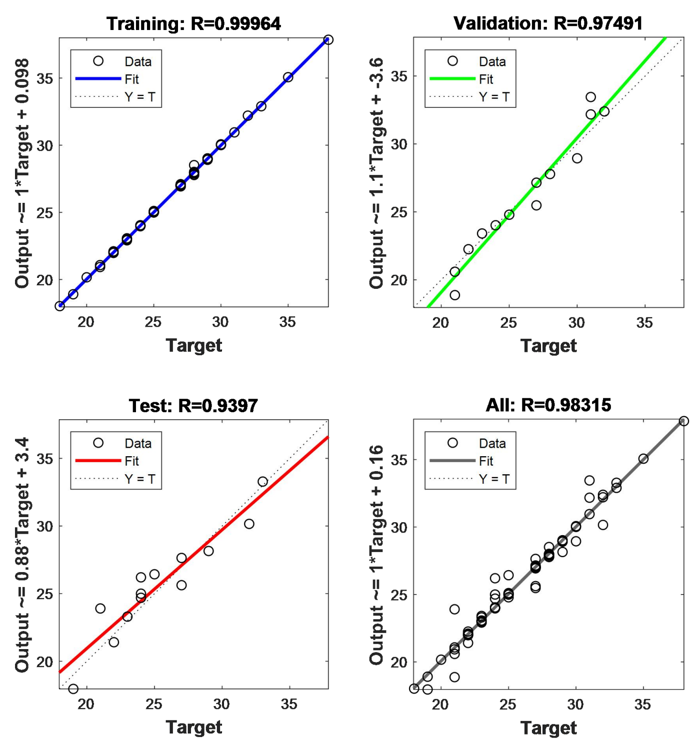
BAND 8 (144.05-174 MHZ)



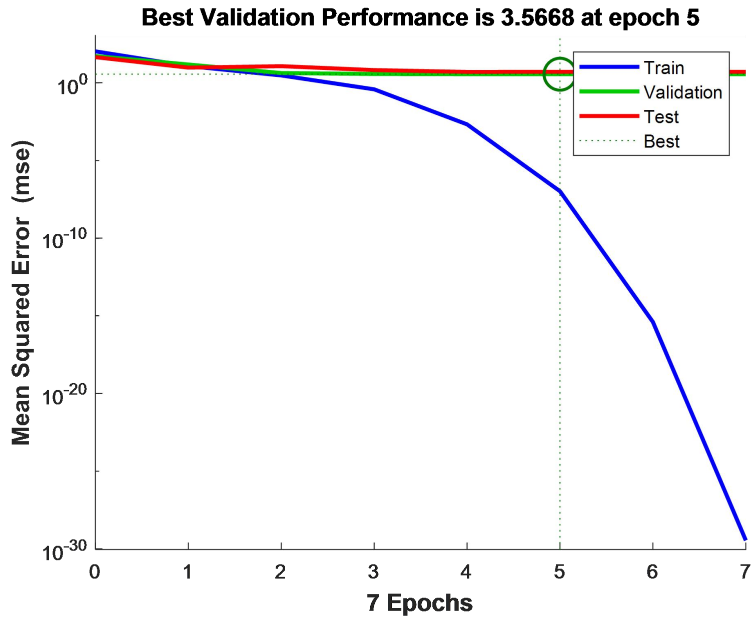


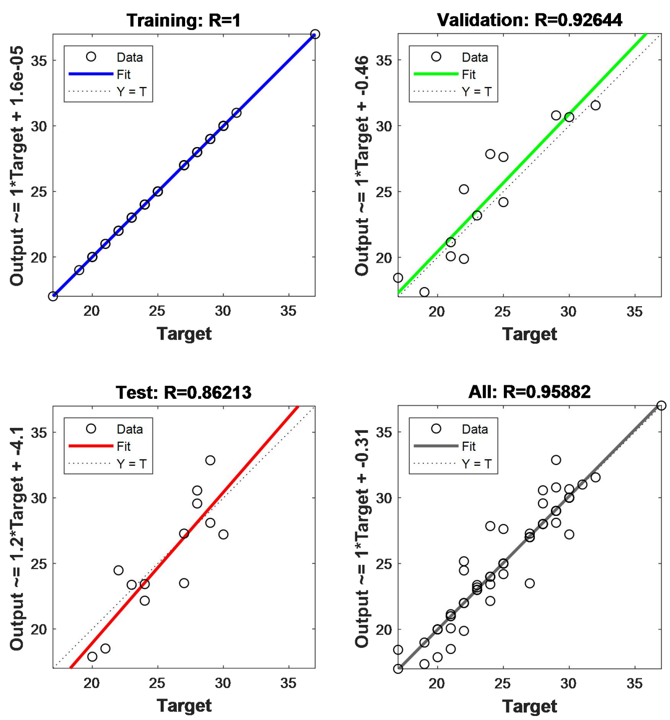
BAND 9 (174.05-200 MHZ)



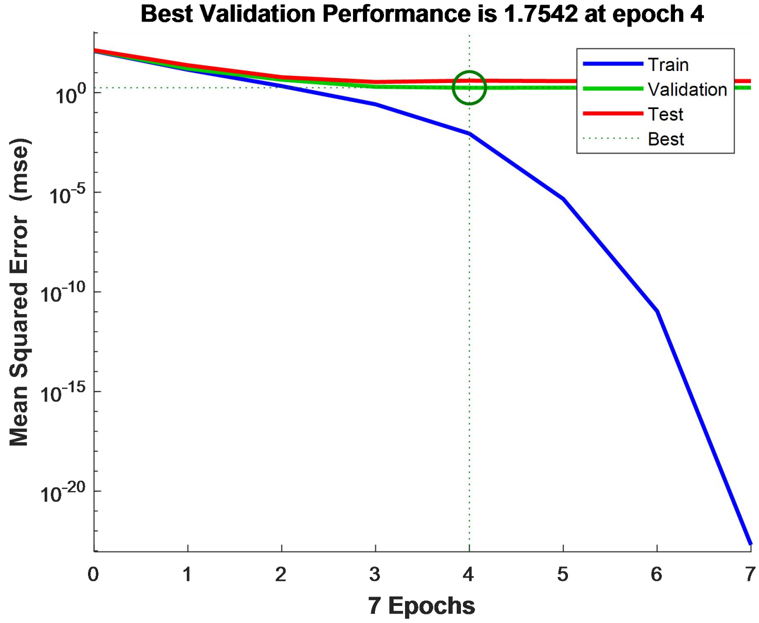


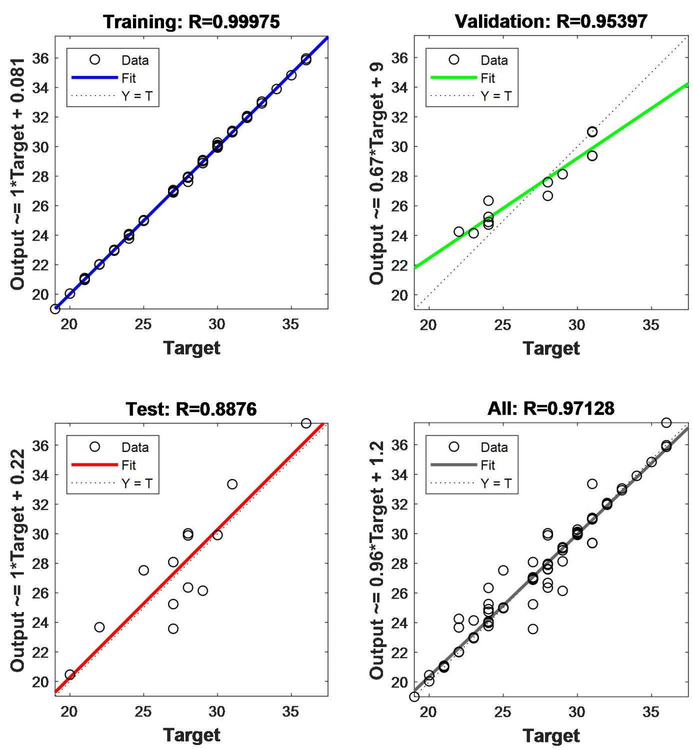
BAND 10 (200.05-230 MHZ)



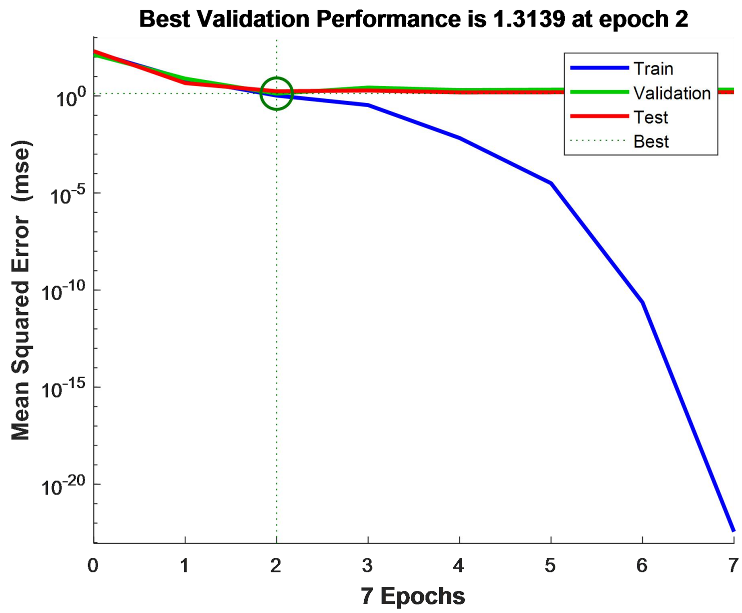


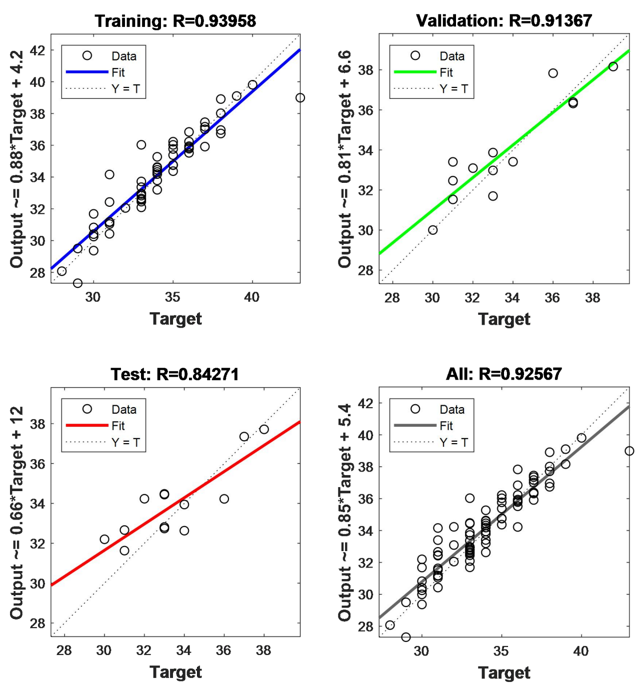
BAND 11 (230.05-267 MHZ)



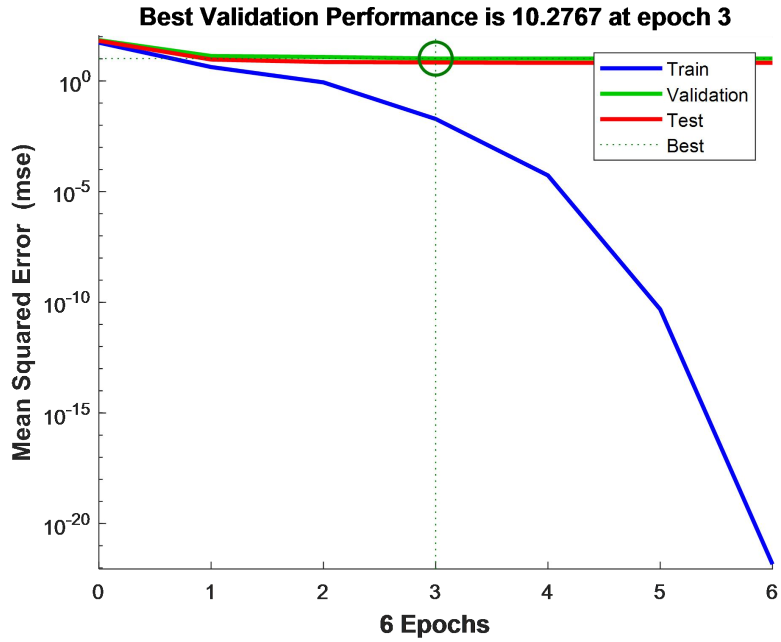


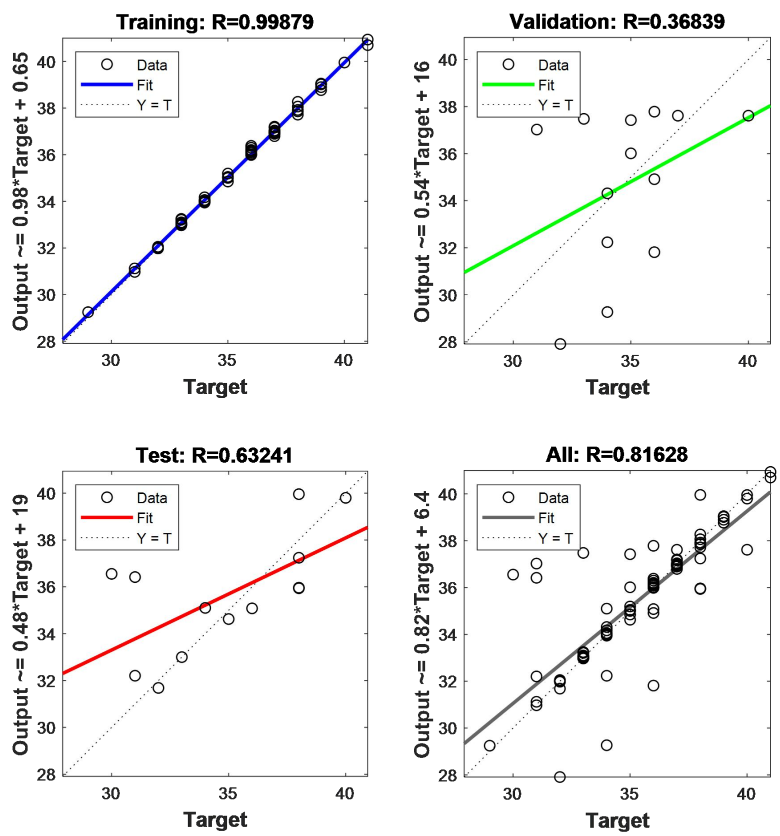
PERFORMANCE RESULTS OF ANN MODEL FOR MAITAMA BAND 1 (30-47 MHZ)



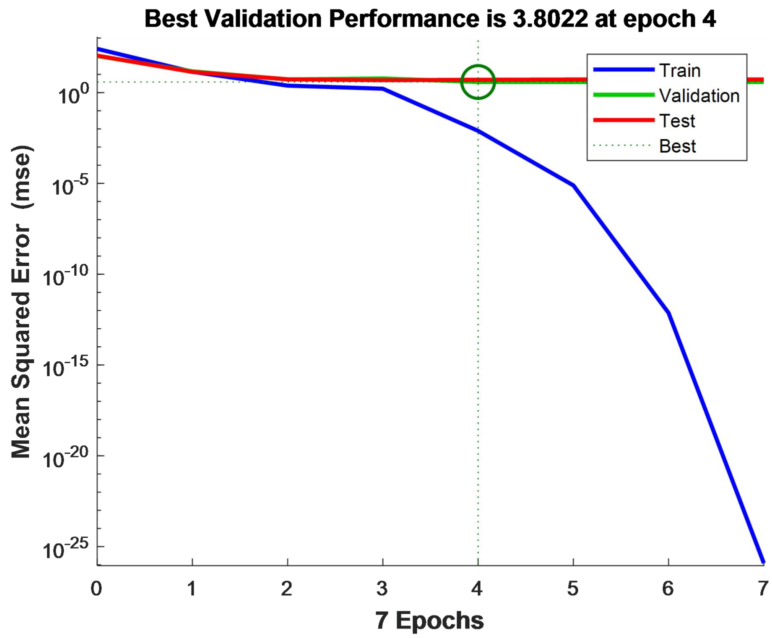


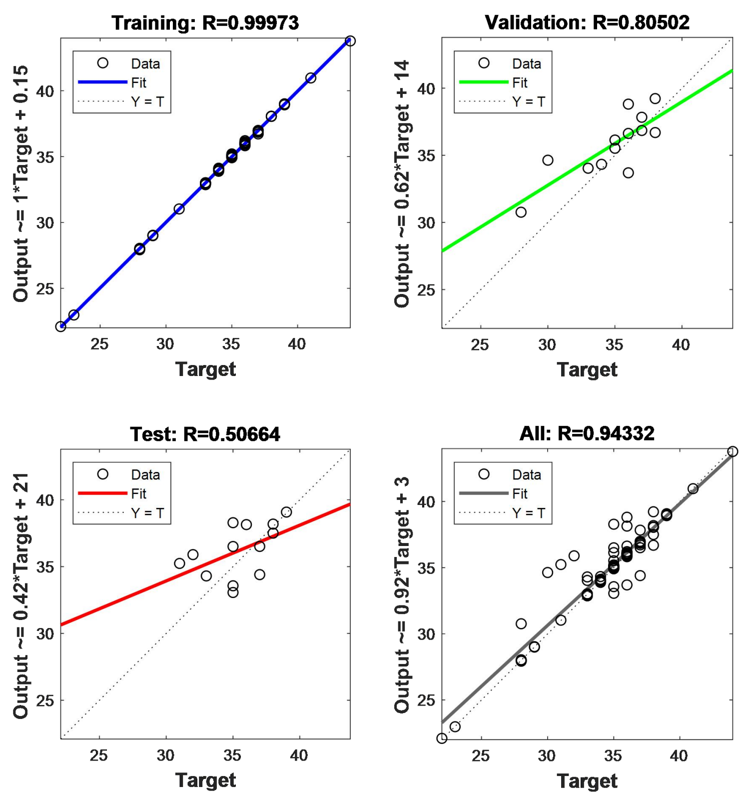
BAND 2 (47.05-68 MHZ)



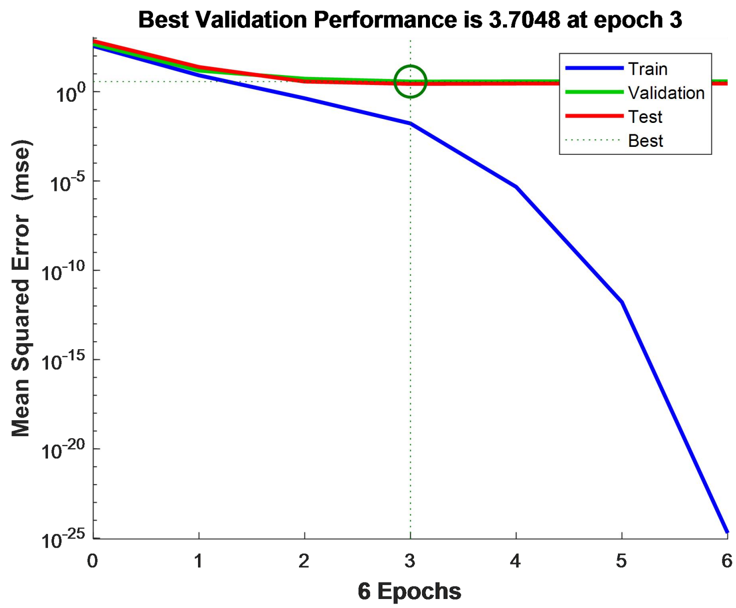


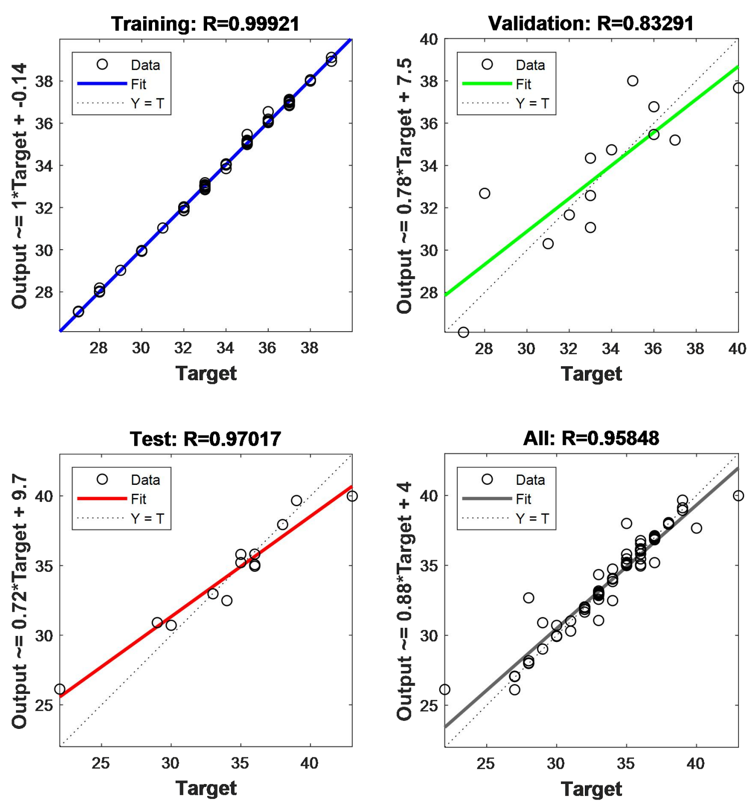
BAND 3 (68.05-74.80 MHZ)



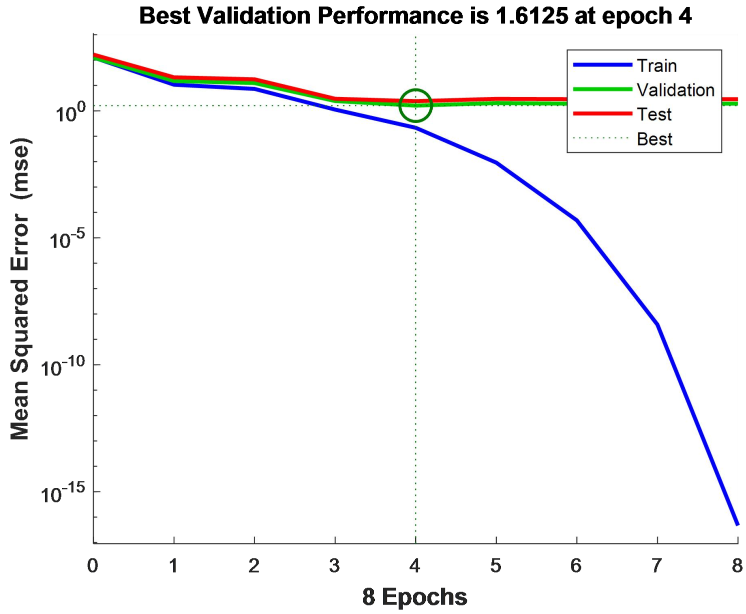


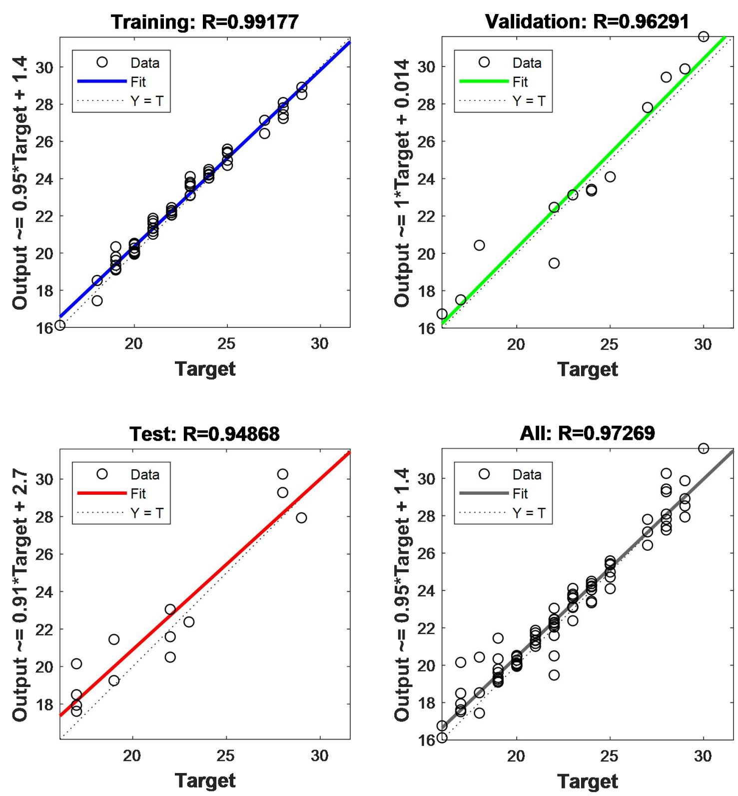
BAND 4 (74.80-87.45 MHZ)



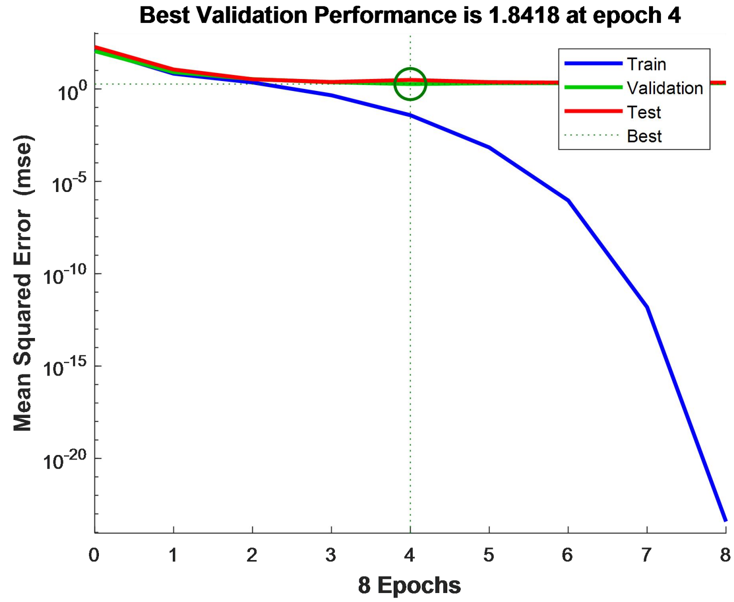


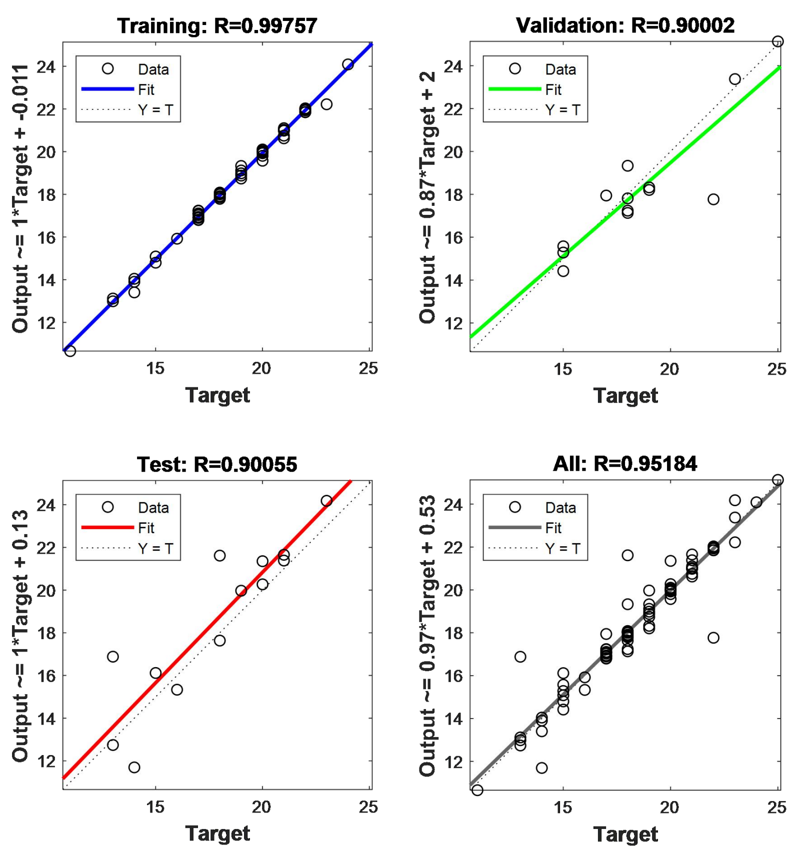
BAND 5 (87.45-108 MHZ)



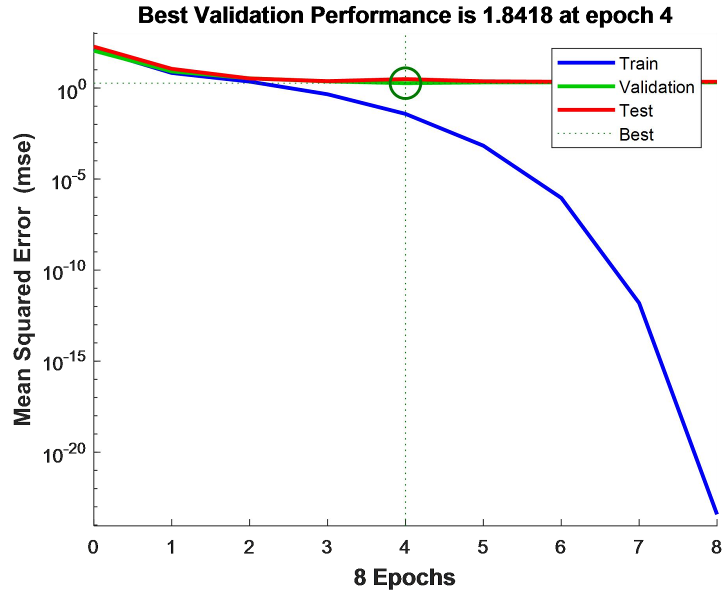


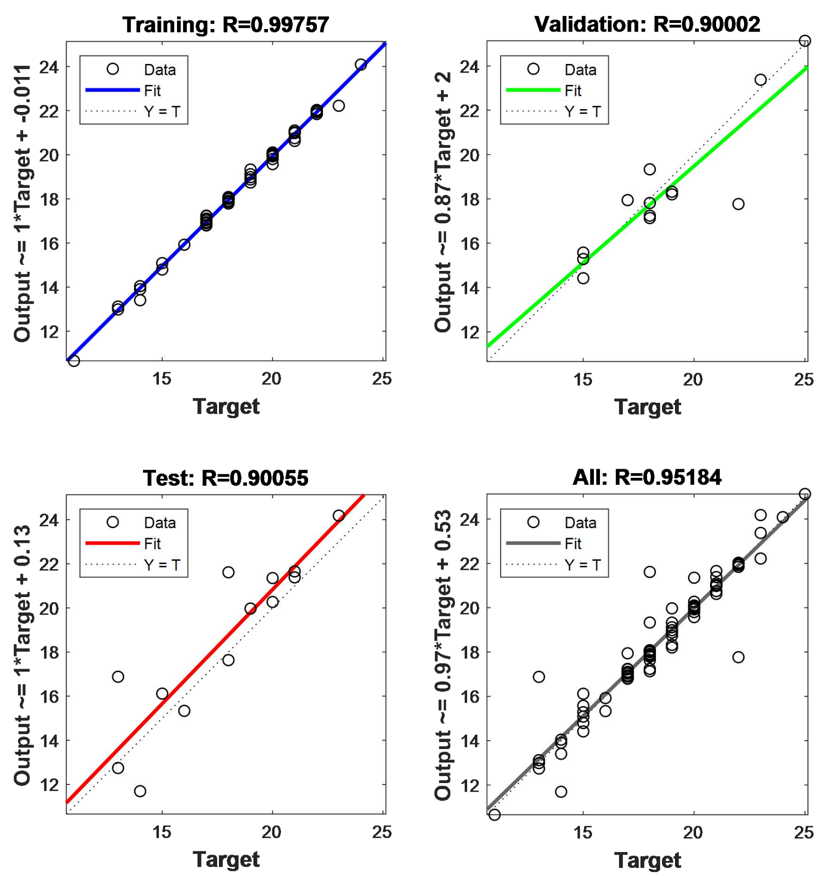
BAND 6 (108.05-137 MHZ)



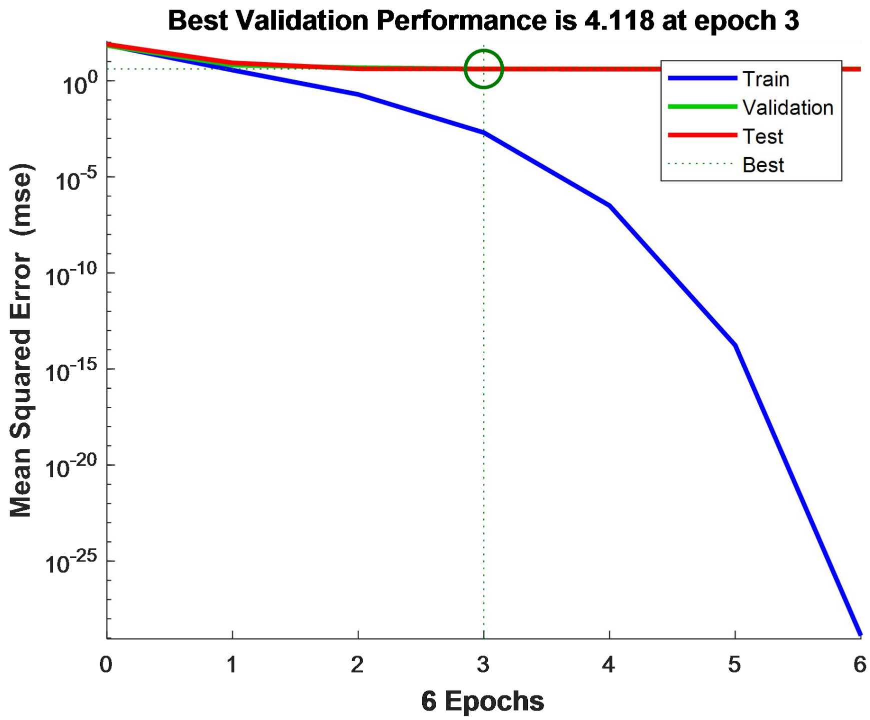


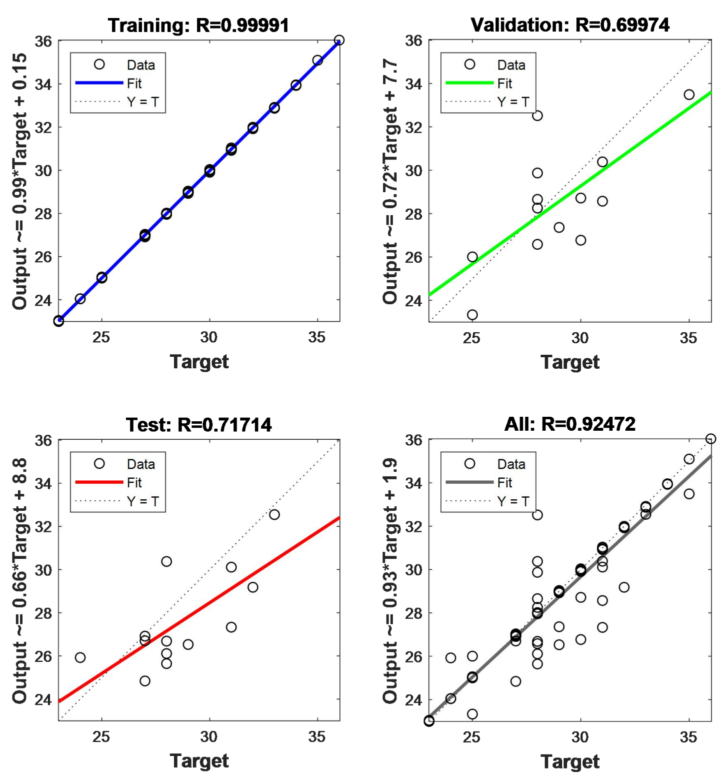
BAND 7 (137.05-144 MHZ)



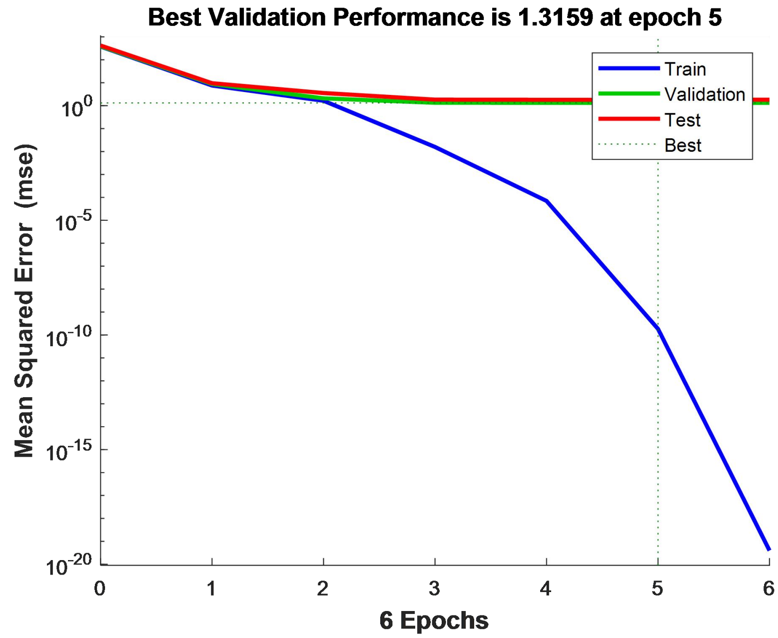


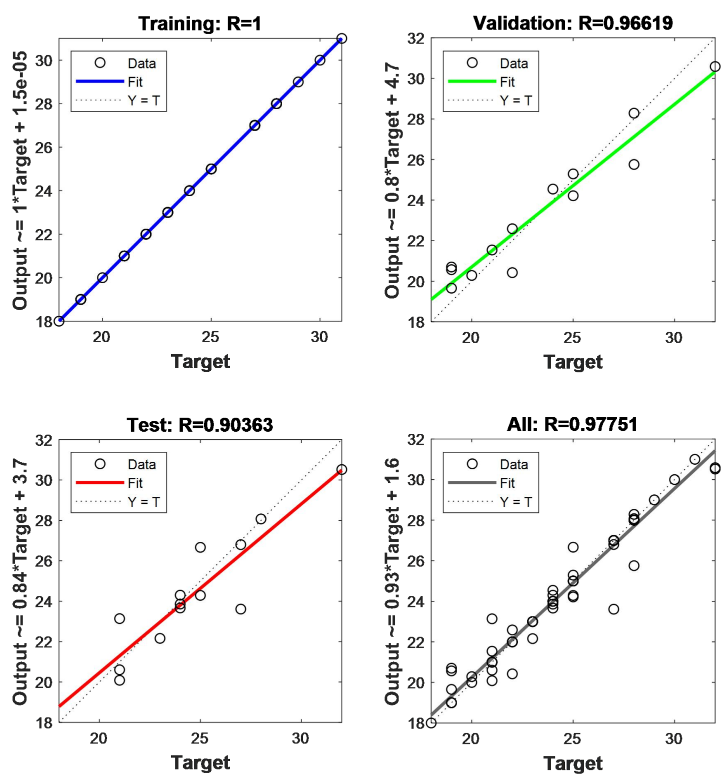
BAND 8 (144.05-174 MHZ)



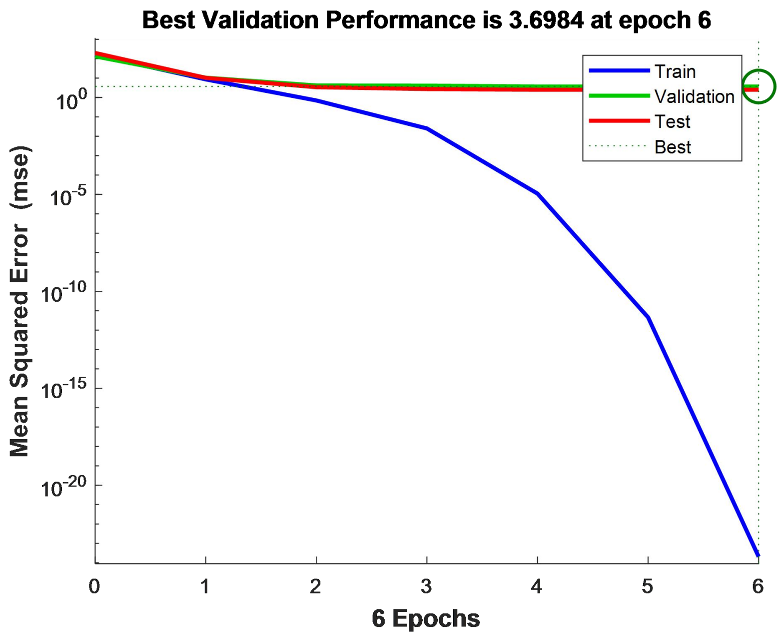


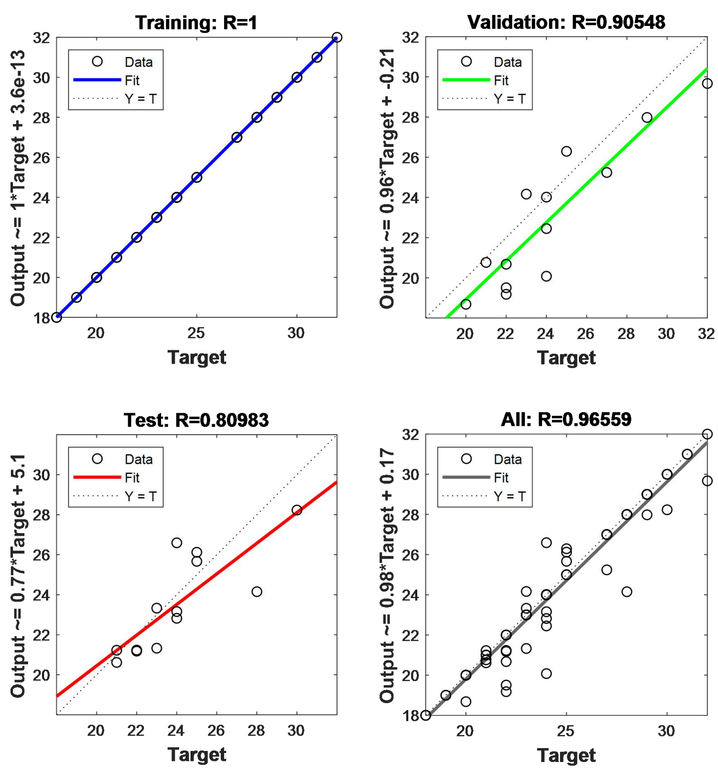
BAND 9 (174.05-200 MHZ)





BAND 10 (200.05-230 MHZ)





BAND 11 (230.05-267 MHZ)