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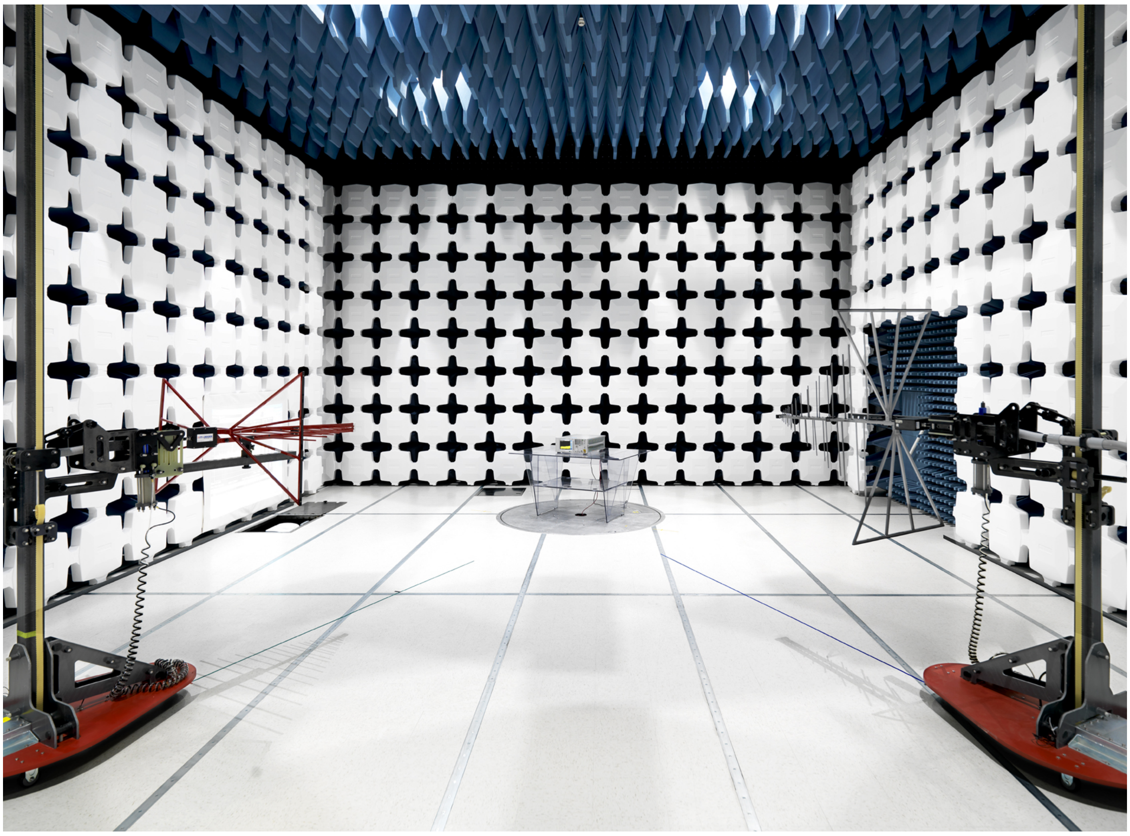

Automatic reporting of complete vehicle EMC - testing

Master's thesis in Wireless Photonics and Space Engineering

EZHIL ARASAN VINAYAGAM

CHALMERS UNIVERSITY OF TECHNOLOGY
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Ezhil Arasan Vinayagam

Examiner : Jian Yang

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Department of Wireless Photonics and Space engineering
Signals and Systems
Chalmers University of Technology
Gothenburg, Sweden 2017

Supervisor: Björn Bergqvist, Volvo Cars, EMC
Supervisor: Fredrik Forsberg, Volvo Cars, EMC
Supervisor: Göran Humleby, Volvo Cars, EMC
Examiner: Jian Yang, Signals and Systems, Chalmers University of Technology

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Wireless Photonics and Space Engineering
Signals and Systems
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Abstract

Every vehicle or electronic equipment has to satisfy the EMC requirements before it is been launched into the market. This is tested for different equipment as per to the different standards. The main aim of this study is to investigate the best way for automatically collecting information for on-board emission measurements regarding the vehicle state. On-board testing is done as per to the international standards here CISPR-25. Automatic generation of test reports for the results from test rig, Analyzes the need and proposes a database to store the test data for future use. Subsequent to this, to find the patterns between the error frames from can bus during immunity measurements. This study explains the different test standards, different test environments for EMC measurements, a methodology for report generator using visual basic and brief introduction to CANalyzer, error frames, suggest some statistical methods to find patterns and its discussion, which are the main aims of this work. Along to the aims, this study will explain the results from the test rig, results from the report generator after the gain compensation is discussed and the limit range as per to the CISPR-25 standards are stated as well. Flow chart of the report generator, a brief note on the four suitable statistical analyses for finding the pattern and very short note on the database management to store the generated reports. Future plan of this study is to make the whole test environment automated for reducing the time of the test engineer and also efficient use of chamber in the absence of test engineer for conducting different testing. To take you out from the confusion it can be said that this work is the initial step to make the test rig automated.

Keywords: EMC, FAR, SAC

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Ezhil Arasan Vinayagam, Gothenburg, June 2017

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Introduction

1.1 History

In the history of technology, Electromagnetic and Compatibility has been become the most important regulations or testing which has to be verified for all electronic gadgets. EMC was initially introduced in military environment mainly on the navy ships where many electronics devices have to be operated simultaneously in the presence of radio frequency fields. When more transmitters were operating simultaneously the receiver was not able to receive proper information this problem was know as Radio frequency Interference (RFI). During the start of 20th century the first EMC regulations was issued. To reduce the RFI problem the design of transmitter was developed by introducing narrow bandwidths.

Due to generation of electronic devices in the commercial sector it has become important to implement EMC standards. Commercial and residential devices contain many electronic devices which is been controlled by microprocessors. In 19th century number of guidelines and standards were introduced to meet the EMC requirements. These standard includes different test setup which has to be performed before the device is been setup.

As the automotive industry grows the expectation of people increased. The requirement of vehicles has been growing. This made automotive industry researchers to introduce electronic devices into vehicles to make the people more safer, happier and comfortable while driving. Electronic devices are compactly packed into the vehicles which has to communicate simultaneously. To avoid the malfunction of the devices certain standards has been introduced such has CISPR, etc... EMC has two main classes, Emission is the generation of electromagnetic energy by the devices which can be intentional or unintentional, EMC regulations helps to reduce the unwanted emissions. Susceptibility, it is the unwanted electromagnetic energy affects the other or nearby electronic device which leads to malfunction or breakdown of the device. Immunity is the visa verse of susceptibility that is the electronic device has to work in the presence of unwanted emission, to make the device more robust. Before the device is been into use it has to fulfil the standards for emission and susceptibility levels, design and testing for standard compliance. In recent years an increasing number of electronic devices are installed for controlling, monitoring, and displaying a variety of functions has been introduced into vehicle designs. It is mandatory to consider the electromagnetic environment in which these devices operate.

1.2 Aim of the project

The main task for the EMC department is to make sure that the vehicles are EMC-compliant. Both legal- and customer satisfaction limits shall be fulfilled for RF-emissions, RF-immunity (both E- and H-field) and ESD (Electro Static Discharge). Tests are performed at component level by respective supplier and by Volvo at vehicle level.Some vehicle tests are performed at SP (Sveriges Provnings- och Forskningsinstitut) and others at SMP (StörMätPlatsen) Volvo Torslanda. The outcome from the tests (Plots from spectrum analysers etc.) are then analysed and different actions may be taken in order to improve the EMC performance.

Main goal of the project is to investigate the best way of automatically collecting information regarding the vehicle during testing emission testing, Automatic generation of test reports from data provided by today's test rig, to analyse the need and propose different ways of storing the test data.This is divided in the data-sets generated by each test and possible future database structures, to decide the best data-set structure (based on analyse above) and implement support for the selected one in the automatic report generator.

There is a need for automatic collection of information about the test objects for better understanding of variation in test results from the same test sample. Information about the state of different ECUs, battery voltage, etc. are of interest. There is also a need to standardise the data format generated by the test rig in order to make it scalable, compatible with future database storage and suitable for automatic generation of test reports, statistics and other future needs. Today all test reports are written manually which is time consuming. There is also a risk of missing important details and of being non-consistent. The automatic report generator must support data generated by today's test rig as well as the future data format even if items are added or removed.

1.3 Testing Environment

Testing environment is an important aspect to investigate the vehicle to meet the required test standards. The test vehicle or device is tested in an anechoic chamber. Anechoic chamber provides non reflecting and Eco free environment. Whole room is shielded, walls are covered with the material that scatters or absorbs the incident energy and it also doesn't allow any energy from the outside environment to enter. Anechoic chamber is made of metal box above that ferrite material and pyramidal shaped absorbers. Metal box reflects the electromagnetic energy generated with in chamber back into the chamber and also it doesn't allow energy from environment inside the chamber. Absorbers have very high performance it is solid, pyramid shaped, carbon made and urethane foam absorbers. It must be at least half the wavelength long at the lowest frequency of interest. As the signal passes the pyramid it is reduced as per to the below equation ,

$$\lambda = \frac{1}{\epsilon} \tag{1.1}$$

Ferrite tiles have excellent electromagnetic absorption performance from 30 MHz 1 GHz. It is used has the observing material which is approximately equal to 377 ohms it is achieved when it satisfies the below equation,

$$z = \sqrt{\frac{\mu}{\epsilon}} \tag{1.2}$$

Ferrite is very useful when the frequency is below 1GHz where the energy gets attenuated as it passes the ferrite and again attenuated when it is reflected back at 100MHz it has attenuation of 11dB one way so after reflection it will have 22dB of loss, the losses are calculated from the below equation,

$$Loss = \exp \frac{120\pi}{\lambda} \tag{1.3}$$

1.4 Method

Method or the plan for this project is, initially to know the methods to do testing in anechoic chamber then to analysis the data to be sorted to write into report. Below flow chart shows the brief plan about the project,

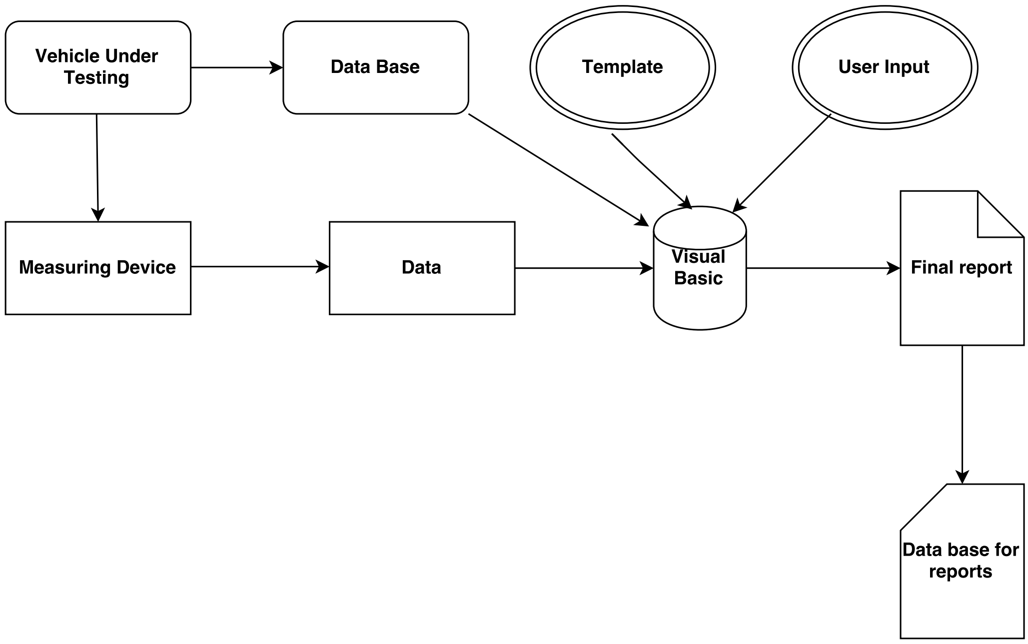


Figure 1: Flow chart of the project

2

Theory, Testing Methods and techniques

This chapter explains about some technical aspects of EMC basic definitions, chamber theory, different testing standards and testing standard for automotive industry.

2.1 Basic definitions

Electromagnetic Compatibility : It is the ability of the vehicle or individual component to function good and satisfy its electromagnetic environment without introducing any electromagnetic disturbance that will affect anything in the environment.

Electromagnetic Disturbance : Any electromagnetic disturbance such as noise or unwanted signal which may degrade the performance of the vehicle or the components of the vehicle this means electromagnetic disturbance.

Electromagnetic Immunity : It means the ability of the vehicle and its components to work in the presence of specified electromagnetic disturbances this also includes radio frequency signals from transmitters and radiated in-band emissions of the industrial scientific medical (ISM) apparatus. It is tested both internal and external to the vehicle.

Electromagnetic Environment : It means the totality of electromagnetic phenomena existing at a given location.

Common mode : The common mode refers to signals or noise that flow in the same direction of pair of lines.

Differential mode : The differential mode refers to signals or noise that flow in the opposite direction of pair of lines.

Electronic/Electrical System : It means the electronic device or set of devices associated with electrical connections which forms part of the vehicle but which is not intended to be type approved separately from the vehicle.

Electronic/Electrical sub-assembly (ESA) : Set of electronic devices intended to be part of vehicle together with any electrical connections and wiring which performs more than one specialised function. An ESA may be approved by the authorized representative as either component or separate technical unit (STU).

Vehicle Wiring Harness : It means supply voltage, bus system like CAN bus, signal or active antenna cables, which are installed by the vehicle manufacturer.

Antenna Factor : It is the ratio of the electric field strength to the voltage applied at the terminals of the antenna.

Antenna matching unit : This unit used for matching the impedance of an antenna to be 50 ohm over the antenna measuring frequency.

Broad-band emission and Narrow-band emission : Emission which has bandwidth higher than particular measuring receiver. For example The EMI meter shows the change in peak response of 3dB or lesser shows the broadband emission, changes greater than the 3dB shows the narrow band emission. Lets take the another test method, pulse repetition rate of the emission. If the pulse repetition is less or equal to the impulse bandwidth of the measuring device it is broadband emission, if it is greater than the impulse bandwidth it is narrow band emission.

Quasi-peak detector : Detector having specified electrical time constant, when the continuous pulses are applied it gives an output voltage which is a fraction of the peak value of the pulse, the fraction increases to unity as the pulse repetition rate is increased.

2.2 EMC Categories and Disturbances

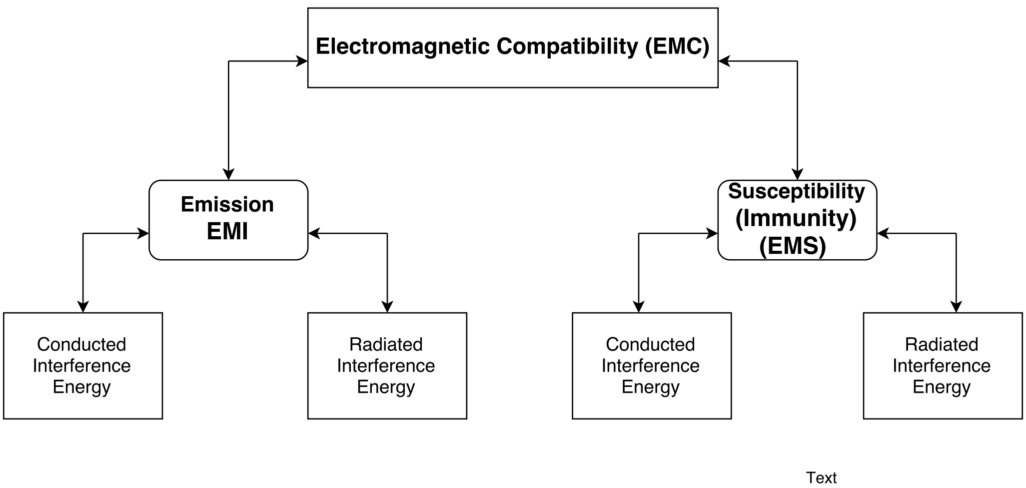


Figure 2: EMC Categories

Electromagnetic Compatibility id the ability of electronic equipment to work satisfactorily in an electromagnetic environment. All products includes all commercial, military, RF products, Telecom products etc have to pass the requirement as per to their standard. Some international standards are IEC - International Electrotechnical Commission, CISPR - International Special Committee on radio interference, MIL - Military standards, ISO standards. Different antennas are used for immunity test setups some of them are monopole antenna, Bi conical antenna etc... this will be discussed more in the following section. For commercial and Automotive industries we have the frequency range of 9 kHz to 18 GHz and military standards have 30 Hz to 40 GHz.

2.2.1 RF disturbance

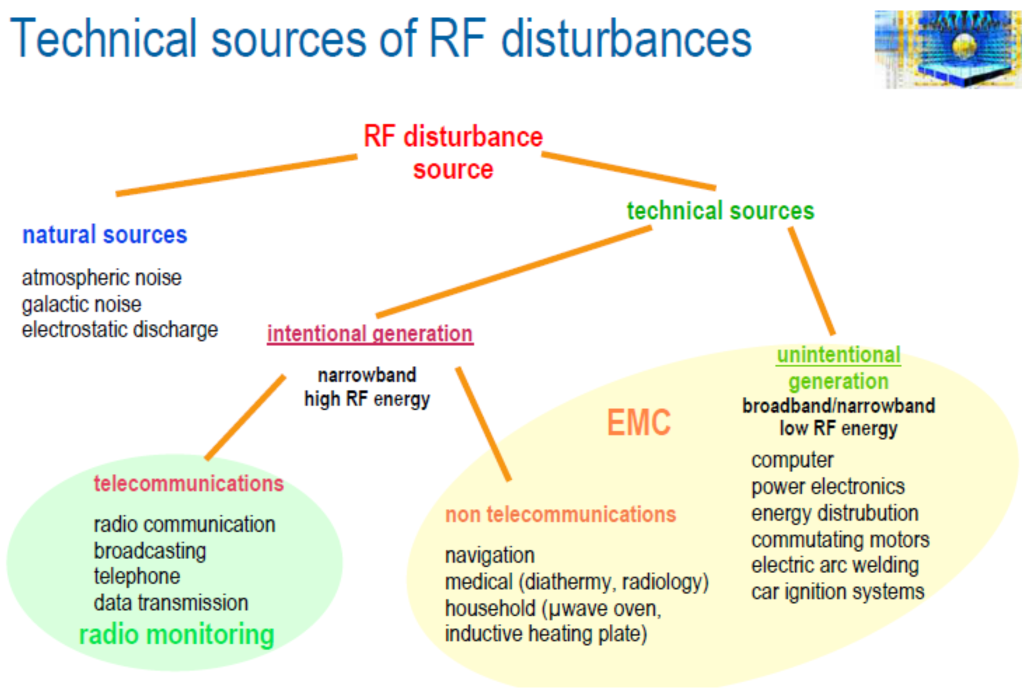


Figure 3: RF Disturbance

2.3 Basic Test Setups :

2.4 CISPR Standards

Following describes the different CISPR standards this have been taken with reference to Rohde and Schwarz presentation,

- **CISPR Publication 11** Limits and methods of measurement of radio disturbance characteristics of Industrial, Scientific and medical (ISM) radio frequency equipment's.

- **CISPR Publication 12** Limits and methods of measurement of radio disturbance characteristics of vehicles, motor boats and spark-ignited engine driven.

- **CISPR Publication 13** Limits and methods of measurement of radio disturbance characteristics of sound and television receivers.

- **CISPR Publication 14** Limits and methods of measurement of radio disturbance characteristics of household electrical applications, portable tools and similar electrical apparatus.

- **CISPR Publication 15** Limits and methods of measurement of radio disturbance characteristics of fluorescent lamps and luminaries.

- **CISPR Publication 16** Specific radio disturbance measuring apparatus and measurement methods.

- **CISPR Publication 22** Limits and methods of measurement of radio disturbance characteristics of information technology equipment (ITE).

- **CISPR Publication 25** Limits and methods of measurement of radio disturbance characteristics for the protection of receivers used on board vehicles, boats and on devices.

2.5 CISPR-25

2.5.1 Introduction to CISPR-25 :

CISPR-25 is an International standard which is been designed for vehicles, boats and internal combustion engines this includes radio disturbance characteristics, limits and methods for the protect of on board receivers. This design protect on board receivers from disturbances produced by radiated and conducted emissions from the vehicle. This standard shows the test procedure and give limits to control the emissions from the vehicles. Below points shows the overall view of this test method,

- Test method for electrical system of the vehicle to measure the electromagnetic emissions.
- Limits for the electromagnetic emissions from the electrical systems inside the vehicle.
- Testing methods for on board components and devices independent of the vehicle.
- Limits for electromagnetic emissions from components to prevent the disturbance to the on board receivers.
- Classifies automotive components by disturbance duration to establish a rage of limits.

As per to the standard measurement of radio disturbance in the frequency range of 150kHz to 2500MHz. This standard applies to all electrical and electronic components are to be used in vehicles and devices. These standards are to protect the receivers installed in the vehicle from disturbance produced by the neighboring receivers or components in the same vehicle. Receivers like broadcast receivers, land mobile radio, satellite navigation for GPS system, WiFi and bluetooth will be protected by this standard. This standard does not include protection for electronic system from RF (radio frequency) emissions. These protection are included in ISO standard publications. Vehicle test limits are based on the antennas provided on the vehicle or a test antenna. The frequency band can vary for different countries, it the test engineer or vehicle manufacturer to identify the frequency band applicable for their country.

2.5.2 General test requirements:

2.5.2.1 Source of disturbance :

For this the electromagnetic disturbance can be divided into two main types,

- Narrow band source: these are the disturbances sources such has clocks, digital logic from microprocessor's and its display.
- Broad band source: these are the disturbance sources from ignition system and electric motors.

In most of the vehicles the electronic components are the source for both narrow band and broad band disturbances but some can cause only one type of disturbances. Broadband sources can be distinguished into short duration broad band this is because of door mirrors, electric windows, washer pumps and the long duration broad band this may be due to wiper motor, engine cooling, heater blower.

2.5.2.2 Test Plan :

Test plan is established for each item to be tested. This test plan specify the following,

- Frequency range to be tested
- Emission limits
- Antenna types and locations
- Supply voltage
- Test report requirements

The test plan can be defines for different frequency band this can be obtained with average and peak limits or average and quasi-peak limits. In this project we go use the average and peak limits.

2.5.2.3 Conformance of equipment under test (EUT) :

For all the EUT cases we conform to the average limit. The EUT can also conform to quasi-peak or peak limits as below,

- When the frequency is defined for both quasi-peak and peak are defined the EUT can be conformed to either one of the them.
- When the frequency where only peak limits are defined the EUT can conformed with the peak limit.

Below flow chart shows the general procedure applicable for all frequency bands,

Figure 4: Flow chart for testing [3]

2.5.2.4 Test report :

The test report should contain the information which is been requested from the customer. Some of the information are shown below,

- Test registration number and customer information
- Time and date of the test
- Step up information
- Which standard has been followed
- Test limit
- Test data with limits
- Equipment used
- Results and Conclusions

2.5.2.5 Shielded enclosure :

The electromagnetic noise level shall be less than 6 dB below the specifies limits. The shielding of the enclosure must me sufficient to conform the required electromagnetic noise level requirement is met. In the shielded enclosure there will be reflected energy from the interior surface, this is consider to be minimal. There will be direct coupling of the measuring instrument to the EUT due to the disturbance or reflected energy in the shielded enclosure.

2.6 Absorber-lined shielded enclosure (ALSE) :

This part explains about the component test in the shielded enclosure that is the measured electric field be characteristics of the EUT and minimize the impact of ALSE. The measurement should not vary much if the EUT is tested in different ALSEs or at different locations. Certain requirements are meet to reduce or to have less deviation in EUT testing data. To minimize the error reference paper [1] have two methods to validate the ALSE. Any one of the method is enough to validate the ALSE. These two methods are discussed below,

- Reference measurement method : For this method it uses the reference test site for the reference measurements. This reference test site is OATS or semi anechoic chamber which meets the requirements of the CISPR-16. Reference measurements is similar to the normalized site attenuation (NSA) measurement are the reference test side with a standard ground plane. Corresponding measurements are made in the ALSE. ALSE measurements are compared to the reference measurements to check whether the measurements is with in the tolerance level defined in the reference measurement.

- Modeled long wire antenna method : This method uses long wire transmitting antenna of 50 cm long. Till the frequency range of 30MHz the antenna is been mounted over the ground plane that is non elevated. Above the 30 MHz frequency the antenna is elevated with the reference ground plane with respect to the standard size of 2.5 m x 1 m, therefore the measurements are made on the long wire antenna in the ALSE.

  Reference measurement method and long wire antenna method have the standard size validation for the reference ground plane for the reference measurements and modeling. Below the frequency range of 30MHz it uses the floor ground plane that is non elevated. At frequency above 30MHz an elevated reference ground plan with 2.5m x 1m dimension as per to the standard.

2.6.1 Size and Objects in ALSE :

The shielded enclosure has to be with sufficient size. Vehicle nor the test antenna has not to be placed closer than 1m from the walls or the nearest absorber materials used in the chamber. For the emission measurement all the unnecessary items has to be removed which are not shown in the test procedure because the extra objects that may have effect on the measurements. This includes extra cables, desks, chairs, storage boxes, etc.

2.6.2 Performance validation on vehicle and component :

Absorption of the material can be greater than or equal to the 6 dB over the frequency range 70 MHz to 2500 MHz.

2.7 Measuring Instruments :

Measuring instrument should have appropriate average detector is the linear detector with meter constant and should have the scanning frequency either manual or automatic. Finally, the measuring instrument has to fulfill the requirements of CISPR 16.

2.7.1 Spectrum Analyser parameters :

The scan rate of the spectrum analyser can be adjusted as per to the CISPR frequency band and detection mode. Spectrum analysers have adhered to broadband emissions from the product being tested have the PRF (Pulse repetition frequency) greater than 20 Hz. The minimum scan time is applicable when the measurement emissions where the pulse repetition interval of the signal is shorter than the minimum observation time at the frequency based on a step size equal to half the bandwidth Bres. To measure the signals with PRI longer than the minimum observation time and also for the measurement of intermittent signals the minimum scan time has to be increased.

If the known pulse repetition interval of the signal then the scan shall be performed with a scan time that allows an observation time at each frequency that is longer than the reciprocal of the PRF of the signal. For the multiple faster scans with the use of maximum hold function this can be used for the total scanning time which is equal to or greater the n the time that would have been spent using the minimum scan time. Below equation can be used to calculate the minimum scan time for multiple scans,

$$Ts, min = 2 * (\Delta f / Bres) \tag{2.1}$$

Where,
Ts,min = the minimum scan time for multiple scans
f = frequency span
Bres = Resolution Bandwidth (RBW)

Below table 1 shows the spectrum analyser parameters for the different bands,

Service / Band	Frequency MHz	Peak detection		Quasi-peak detection		Average detection	
		RBW at −3 dB	Min. scan time	RBW at −6 dB	Min. scan time	RBW at −3 dB	Min. scan time
BROADCAST							
LW	0,15 to 0,30	9 kHz or 10 kHz	10 s / MHz	9 kHz	200 s / MHz	9 kHz or 10 kHz	10 s / MHz
MW	0,53 to 1,8						
SW	5,9 to 6,2						
FM	76 to 108	100 kHz or 120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100 kHz or 120 kHz	100 ms / MHz
TV Band I	41 to 88						
TV Band III	174 to 230						
DAB III	171 to 245						
TV Band IV/V	468 to 944						
DTTV	470 to 770	100 kHz or 120 kHz	100 ms / MHz	Does not apply	Does not apply	100 kHz or 120 kHz	100 ms / MHz
DAB L band	1 447 to 1 494						
SDARS	2 320 to 2 345						
MOBILE SERVICES							
CB	26 to 28	9 kHz or 10 kHz	10 s / MHz	9 kHz	200 s / MHz	9 kHz or 10 kHz	10 s / MHz
VHF	30 to 54	100 kHz or 120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100 kHz or 120 kHz	100 ms / MHz
VHF	68 to 87						
VHF	142 to175						
Analogue UHF	380 to 512						
RKE	300 to 330						
RKE	420 to 450						
Analogue UHF	820 to 960						
GSM 800	860 to 895						
EGSM/GSM 900	925 to 960						
GPS L1 civil	1 567 to 1 583	Does not apply	Does not apply	Does not apply	Does not apply	9 kHz or 10 kHz	1 s / MHz
GLONASS L1	1 591 to 1 613						
GSM 1800 (PCN)	1 803 to 1 882	100 kHz or 120 kHz	100 ms / MHz	Does not apply	Does not apply	100 kHz or 120 kHz	100 ms / MHz
GSM 1900	1 850 to 1 990						
3G / IMT 2000	1 900 to 1 992						
3G / IMT 2000	2 010 to 2 025						
3G / IMT 2000	2 108 to 2 172						
Bluetooth/ 802.11	2 400 to 2 500						

Table 1: Spectrum Analyser Parameters [3]

2.7.2 Scanning receiver parameter :

According to the CISPR frequency band and detection mode the dwell time of the scanning the receiver can be adjusted. the maximum step size, recommended bandwidth (BW) and the minimum measurement rime are shown in figure 8. Minimum time in the figure 8 is applicable to use only when the measurement of emissions where the PRI of the signal is shorter then the minimum measurement table. For the measurements larger than the minimum measurement time in the below figure 8 then for the measurement if the signals have minimum measurements time is to be increased. If the PRI of the signal is known then the scan shall be performed with the measurement time, it is longer than the reciprocal of the PRF of the signal, below table 2 shows the scanning receiver parameters,

Service / Band	Frequency MHz	Peak detection			Quasi-peak detection			Average detection		
		BW at –6 dB	**Max. step size**	**Min. measurement time**	**BW at –6 dB**	**Max. step size**	**Min. measurement time**	**BW at –6 dB**	**Max. Step size**	**Min. measurement time**
BROADCAST										
LW	0,15 to 0,30									
MW	0,53 to 1,8	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
SW	5,9 to 6,2									
FM	76 to 108									
TV Band I	41 to 88									
TV Band III	174 to 230	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms
DAB III	171 to 245									
TV Band IV/V	468 to 944									
DTT	470 to 770									
DAB L band	1 447 to 1 494	120 kHz	50 kHz	5 ms	Does not apply	Does not apply	Does not apply	120 kHz	50 kHz	5 ms
SDARS	2 320 to 2 345									
MOBILE SERVICES										
CB	26 to 28	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
VHF	30 to 54									
VHF	68 to 87									
VHF	142 to 175									
Analogue UHF	380 to 512									
RKE	300 to 330	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms
RKE	420 to 450									
Analogue UHF	820 to 960									
GSM 800	860 to 895									
EGSM/GSM 900	925 to 960									
GPS L1 civil	1 567 to 1 583	Does not apply	Does not apply	Does not apply	Does not apply	Does not apply	Does not apply	9 kHz	5 kHz	5 ms
GLONASS L1	1 591 to 1 613									
GSM 1800 (PCN)	1 803 to 1 882									
GSM 1900	1 850 to 1 990									
3G / IMT 2000	1 900 to 1 992	120 kHz	50 kHz	5 ms	Does not apply	Does not apply	Does not apply	120 kHz	50 kHz	5 ms
3G / IMT 2000	2 010 to 2 025									
3G / IMT 2000	2 108 to 2 172									
Bluetooth/ 802.11	2 400 to 2 500									

NOTE For emissions generated by brush commutator motors without an electronic control unit, the maximum step size can be increased up to 5 times the bandwidth.

Table 2: Scanning Receiver Parameters [3]

2.8 Power Supply :

Power supply have certain regulation to maintain the supply voltage Us with in the specified range,

- **Vehicle Test: ignition on, engine off** the vehicle battery state or voltage can be recorded before and after the measurement with ignition off and battery disconnected from the vehicle. Values can be within the following values,

  Us is 12 (+2 or -1)V for the system with 12 V supply voltage
  Us is 24 (+4 or -2)V for the system with 24 V supply voltage

- **Vehicle test: engine running** the vehicle battery voltage can be noted before and after the measurement with engine running in idle mode and the battery connected to the vehicle. Values can be within the following range,

  Us is 13 (+3 or 0)V for the system with 12 V supply voltage
  Us is 26 (+6 or 0)V for the system with 24 V supply voltage

2.9 Antenna used for emission measurements :

2.9.1 Antenna measuring system :

2.9.1.1 Types of antennas :

Usually for the antenna in the vehicles can be used as the measurement antenna for the bands for which the it is designed for the radio reception. If there is no antenna with in the vehicle external antennas can be used, for 0.15MHz - 6.2MHz one meter monopole antenna, for 26MHz - 54MHz loaded quarter wave monopole antenna, for 68MHz - 1000MHz quarter wave monopole and for 1000MHz - 2500MHz according the the vehicle manufacturer the antenna s can be used for testing. Over all antenna types are stated in below table 3,

Frequency (MHz)	Antenna Types
0.15 to 6.2	1m monopole
26 to 54	Loaded quarter wave monopole
68 to 1000	Quarter wave monopole
1000 to 2500	As per to the manufacturer

Table 3: Antenna Types[3]

Antennas are used for testing the immunity of the vehicle. According to the requirements the signals are radiated on the vehicle. Frequencies are swept through the range. All the power levels in V/m is varied to check the immunity. This section we also discuss about different antennas used.

2.9.2 Monopole antenna :

A monopole antenna is half of a dipole antenna, its shape is like straight rod shaped conductor which is always mounted over a ground plane. Matching unit for between the antenna and measuring instrument can be 50 ohm for the frequency range selected. If the VSWR is maximum in 2:1 ratio at the output port of the matching unit then the required and Its radiation pattern is omnidirectional as shown below,

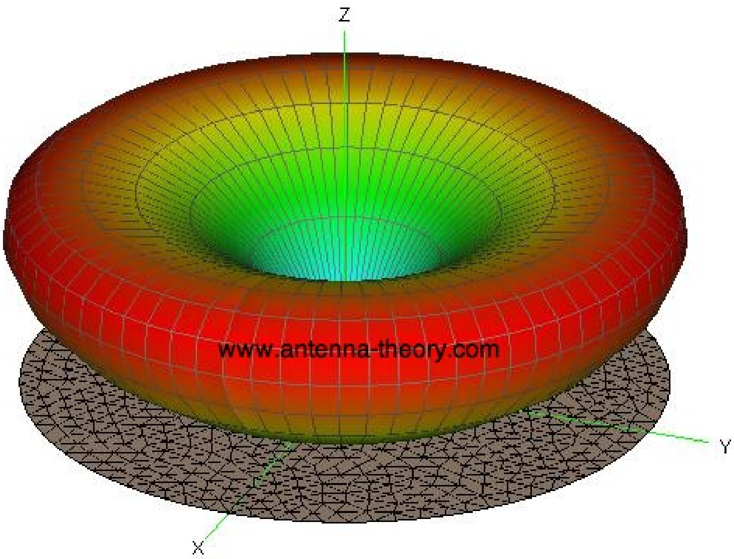


Figure 5: Radiation pattern of Monopole antenna [2]

2.9.3 Log Periodic antenna :

log periodic antenna is a multi-element directional antenna this can cover over large wide bandwidth. Larger bandwidth depend on the size of the antenna and the smaller features on the antenna, larger size determines how small the frequency can be and the smaller size determines the how large the frequency can be. Its radiation pattern is highly directional. Typical log periodic antenna which has range of 250-2400 MHz is shown below,

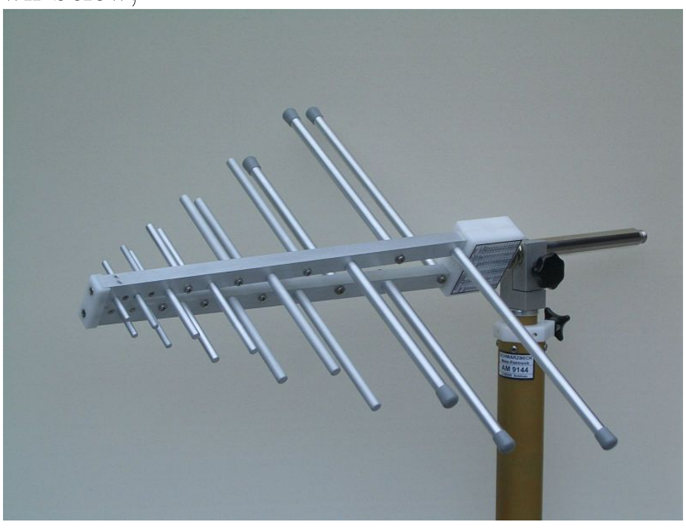


Figure 6: Log Periodic antenna

2.9.4 Biconical Antenna :

Biconical Antenna is a broad band antenna it is achieved with double cone element. It is mostly used in EMI testings for immunity or emission testing, since it is broad band it has poor efficiency at low frequencies which results in low field strength compared to the input power. Below show the biconical antenna,

Figure 7: Biconical antenna

2.9.5 Measuring System Requirements :

2.9.5.1 AM broadcast :

Long wave in the range 0.15 MHz to 0.3 MHz, Medium wave in the range 0.53 MHz to 1.8 MHz and short wave in the range of 5.9 MHz to 6.2 MHz.Measuring system consists of an antenna matching unit, antenna element, preamplifier's and coaxial cables. Limit for the noise floor of the measurement can be at least below the 6 dB. Matching unit for antenna,Input for the impedance can have the resistance 100 kohm in parallel with maximum capacitance 10 pF and output resistance 50 ohm.

2.9.5.2 FM broadcast, Digital audio and TV broadcast :

These ranges from 76 MHz to 108 MHz, Input impedance of the measuring instrument can be 50 ohm. If the VSWR (Voltage standing wave ratio) of the antenna is greater than 2:1 then matching network can be used. <Correction can be made according to the attenuation pr gain of the matching unit.

2.9.5.3 Mobile Services :

This ranges from 26 MHz to 2500 MHz, Input impedance of the measuring instrument can be 50 ohm. If the VSWR (Voltage standing wave ratio) of the antenna is greater than 2:1 then matching network can be used. Correction can be made according to the attenuation pr gain of the matching unit. For the test setup CISPR 25 standard can be refereed [3].

2.9.6 UWB antenna Research activities at Chalmers:

Antenna group at Chalmers has been developing several UWB antennas. The hat-fed reflector antenna is a kind of wideband antenna [5-10] that can be applied in satellite communication systems. The self-grounded Bowtie antenna [11-16] is another kind of ultra-wideband antenna, and it can be applied under many scenarios, for instance, UWB radar and medical detection and EMC measurement setups. The quad-ridge are horn is an ultra-wideband antenna [17] applied mainly in radio telescopes.

3

More about testing Environment

As we know the growth of the automotive has been increasing a lot which intended to bring lots of electronic equipment into the vehicle to increase the safety features and to give the customers more sophisticated driving. As the industries move towards the autonomous vehicle system it also should have a robust system which has to withstand and shouldn't affect the other systems, which means to withstand the electromagnetic pollution in the environment. Starting from the basic features like airbags, electric braking system, key less cars, GPS, Bluetooth systems, communication buses like CAN, Flex everything has to withstand in the environment. In the real time environment, there are lots of electromagnetic waves/signals from the communication system, strong power line, electric trains which has more EM emissions. The system in the car has to be more robust to the environment. These can be done by testing the vehicle in a similar kind of environment according to the international standards. As we seen in the previous section about CISPR 25 it is one of the standards which is performed for On-board emission. These test have to be performed in a EM noise free environment. EM signals are induced over the vehicle for the immunity test and for the emission of EM signals from the vehicle is measured using antennas. In the previous section briefly discussed different antennas used and this section will deal with the different testing environments.

3.1 Different Testing Environment :

3.1.1 Reverberation Chamber :

Reverberation chamber is formed of a large cavity with highly conductive walls and equipped with metal stirrers. These stirrers provide an isotropic environment by changing the electromagnetic field distributions within the cavity and it also creates a uniform field environment during the EMI testing and measurements. The electromagnetic field distribution is characterized by the standing wave pattern this is due to the reflection by the conducting walls. It was widely used for antenna measurements and mobile communication but now it's been widely used in automotive and aerospace industries as well. The main advantage of reverberation chamber over the anechoic chamber are the cost of chamber less since no carbon absorbers are not used, reverberation chamber provides the most realistic environment for testing and since the chamber is highly conductive it allows high field levels so moderate input.

Figure 8: Reverberation Chamber

3.1.2 Anechoic Chamber :

An anechoic chamber is an echo free zone which means it absorbs all the reflections of sound or electromagnetic waves and it also does not allow any signals to enter the chamber. It is used perform different EMC measurements as per to the published EMC standards. This chamber is widely used for testing many field applications including telecommunication, antenna measurements, military, aerospace, automotive etc.Standards are developed and published worldwide by different organizations resulting in different requirements and consequently different chamber types. Chamber which has conductive floor is know has semi anechoic chamber. The requirements for performing tests whether is can be for military applications or commercial applications this tests has to follow the international standards like ISO/IES standards. Many measurement of electromagnetic ISO/IEC standards require, fully anechoic or semi anechoic chamber.

Fundamentally, the EMC anechoic chamber is a shielded room with RF absorber materials installed on the four walls and ceiling and possibly on the floor. The design of EMC anechoic chambers is dictated by the standards and the available technology.RF shield technology of the chamber itself will almost always be a shielded room or Faraday cage, which means that it is an isolated RF environment that is not disturbed by external interference and in turn does not disturb the external environment itself. The shielding specification is typically defined from 10 kHz to 18 GHz (or 40 GHz) with accepted test methods described in IEEE 299 or EN 50147-1. Bellow we will see the some important technologies used in anechoic chamber,

- **RF Absorbers :** RF absorbers are placed all over the chamber that is it line the surface of the shielded room. There basic types of absorbers are Microwave Pyramidal Absorbers, unlike to the name this material is used down to 200MHz or even to 80MHz which is traditional below microwave range. This material is generally referred to as the traditional "blue stuff" or "blue foam." This is a material where a substrate (usually polyurethane) is loaded with carbon. the level of absorption depends on the electrical size of the pyramid from base to it tip. Ferrite tile, these tiles was introduced as a non-linear absorbing material. These are magnetic loss materials that are truly narrow band materials and for ferrite's to work optimally, they need to be mounted on a metal backing and the spacing between the tile and the metal is critical. Tiles have excellent absorption characteristics given their low profile, usually 5 to 7 mm in thickness. Ferrite's stop being absorbers at frequencies around 1.5 GHz or even lower. Hybrid absorbers these are combination of the microwave pyramidal absorber and ferrite tiles. This is not as simple as placing the traditional microwave "blue stuff" on top of the ferrite tile. By doing this combination, the ferrite performance is eliminated. Basically what happens is that as the EM wave penetrates the absorber, it starts traveling in a media that has a wave impedance very different from that of air. This wave impedance in the absorber is so different from that of the ferrite that the EM energy bounces off the ferrite without penetrating it, and penetration is the key to absorption. The problem is solved by adjusting the carbon content of the "blue pyramid." This can be done by reducing the carbon on the foam or by using hollowed pyramids. A different approach uses shaped coatings of lossy paint on polystyrene substrates to create a lossy impedance transform that makes a smooth change from the free space wave impedance to the wave impedance of ferrite. This transformation makes the ferrite more efficient at low frequencies. At high frequencies, the lossiness of the coating on the shape provides the absorption.

- **Turntable Technology :** For both radiated and emission tests will require full azimuth rotation of the EUT or vehicle. Usually it is made of metal topped turntables installed in the chamber floor. According to chamber they have different speed operation and can also be operated by remote controllers.

- **Semi-Anechoic Chamber (SAC) :**The walls and ceiling are covered with absorber while the floor is a metal reflecting ground plane. Below figure shows the SAC chamber,

Figure 9: Semi-Anechoic Chamber with turntable

- **Fully Anechoic Room (FAR) :**All surfaces are covered with absorber including the top of any turntable used where the turntable is at the same elevation as that of the bare floor of the chamber or room. below figure shows the FAR chamber,

Figure 10: Fully Anechoic Room/Chamber

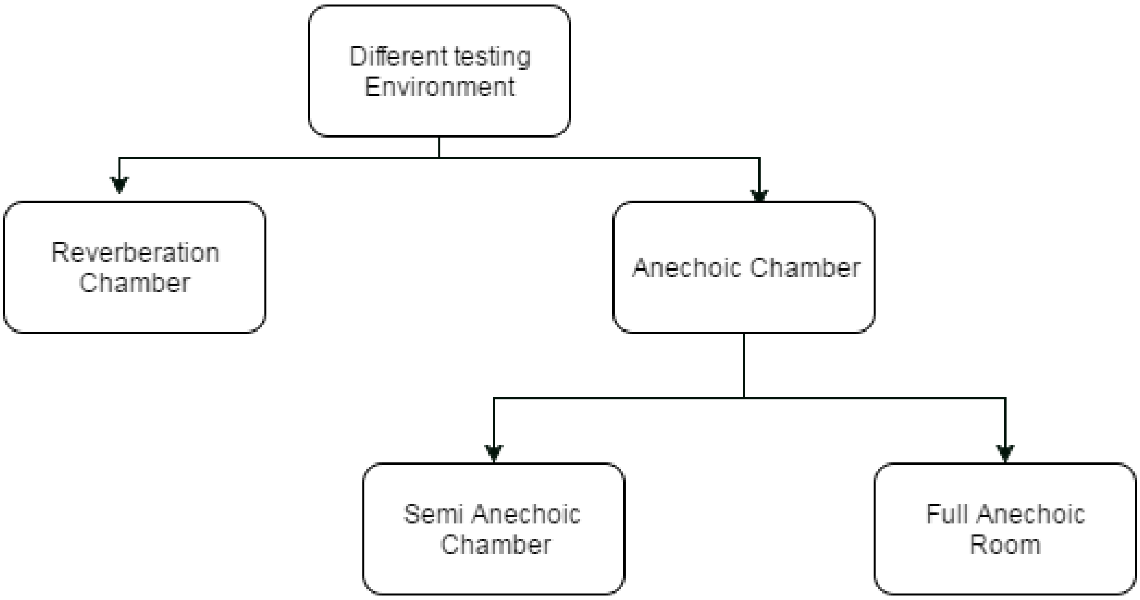


Figure 11: Overall structure of EMC different testing Environment

4

Results from Report Generator using Visual Basic

This chapter give the brief introduction to the visual basic and its advantages. It also explains the results from the test rig, user interface from visual basic, program results.

4.1 Introduction to visual basic :

Microsoft latest version is visual basic 2010. it main strength is that the user interface is very ease, user friendly and to create the windows form is very simple kind of drag and drop. With this program it is ease to create windows form application, web application, browser application and web services. The window form has button which has the background code to do certain or desired process. It also ease to access the all Microsoft application such as MS Excel, MS Word, MS Access etc. Below figure shows the button in the widows form and its tool box.

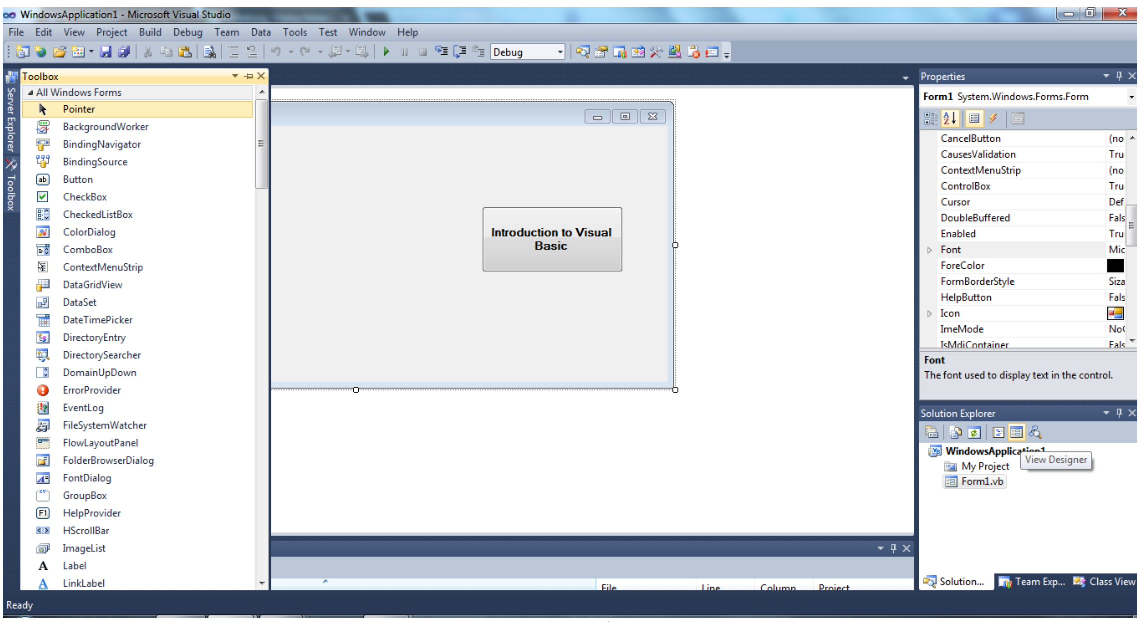


Figure 12: Windows Form

4.2 Results from the test rig :

As we have discussed in the previous section by testing the on board measurement according to the CISPR-25 we get the different results from the chamber for AM, DAB, FM and TV. These results are discussed below,

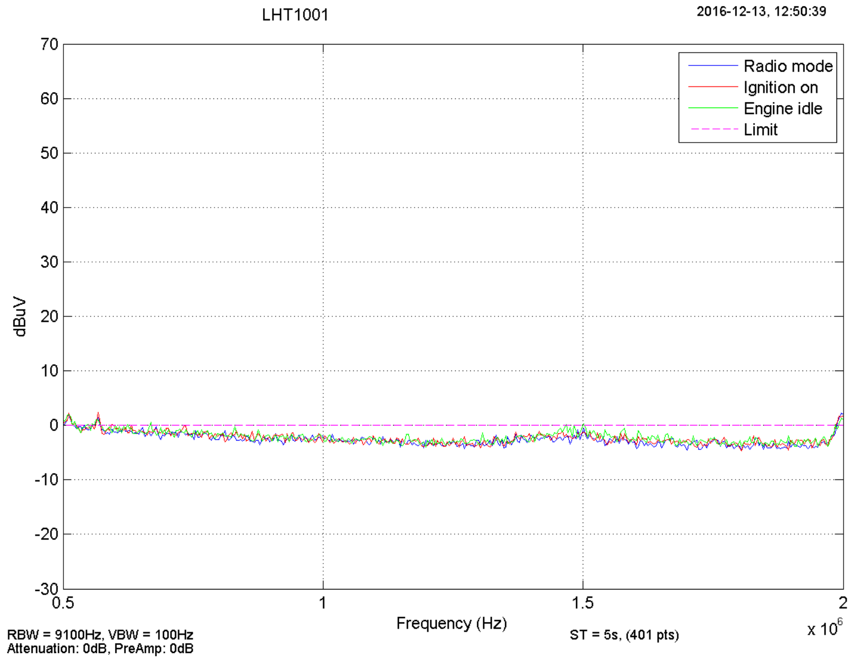


Figure 13: AM average

Results from the test rig has the fixed limit as per to the test standards for this measurement follow the CISPR-25 standard. Figure 12 show the emission from the AM antenna which has the limit 0 dBuV and the legends shows the different state of the vehicle. Radio mode state when only the radio is on, Ignition mode is when the key is on or also can be said when ignition is on, Engine idle mode is when the vehicle is in running state that is the engine is on and the limit line which is 0dBuV. While measuring in the test rig it is sweep across the frequency range for AM it is sweep from 0.5MHz to 2MHz.

Similarly, below figure shows the result of the AM antenna for the peak here the limit as per to the standard is 20 dBuV this limit various for different measurements. Sweep is similar to the AM average that is 0.5MHz to 2MHz.

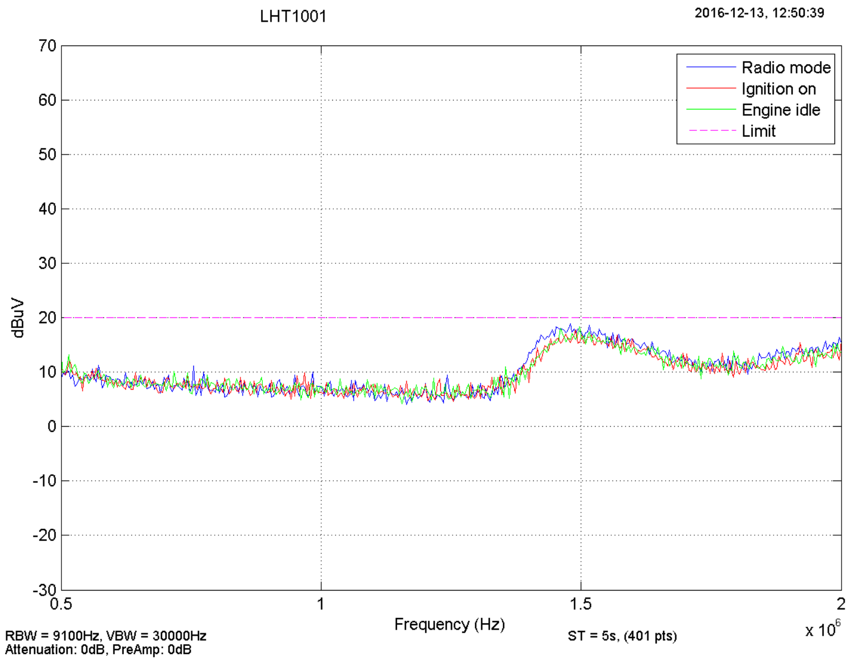


Figure 14: AM peak

4.3 Report Generator without Gain Compensation:

Aim of this code is to copy the results from the test rig into an report file which is generator from the lotus notes.

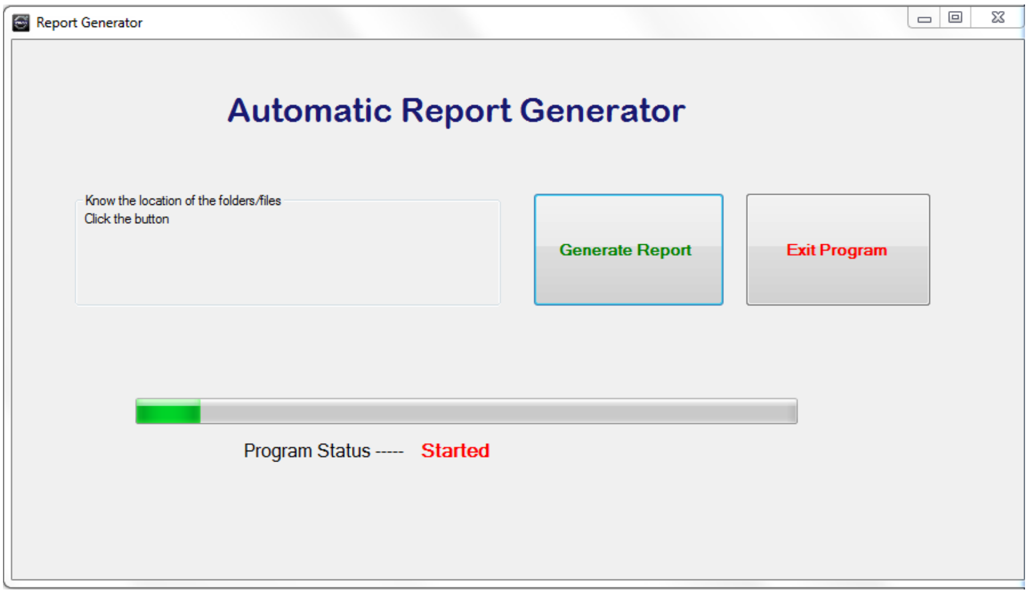
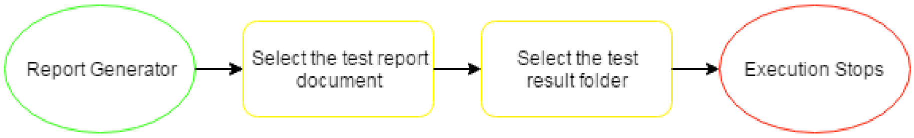


Figure 15: Windows form of report generator with out gain compensator



Flow Chart 1: Report Generator with out gain Compensation

Figure 14 shows the user interface of the program. Once the button is clicked an pop up window pops up and the used has to select the report file or document which the results has to be pasted. Then another pop up is out to select the file from which the results to be copied to the word document. Once this selection is done by the user the program executes and the results will be pasted in document. For more about code refer appendix A. Outcome of this program is that it reduces the time taken by the test engineer to generate the report after testing.

4.4 Report Generator with Gain Compensation:

Aim of this code is to compensate the gain from the internal amplifier in the vehicle. This can lead to miss measurements in the test results at the first sight. This code copies the results from the text files to an excel and removes the gain from the amplifier this is entered by the user in windows form as shown in figure 15 and also the cable losses are taken into consideration. This plots the chart similar to the results from the test rig and copy the charts into word file.

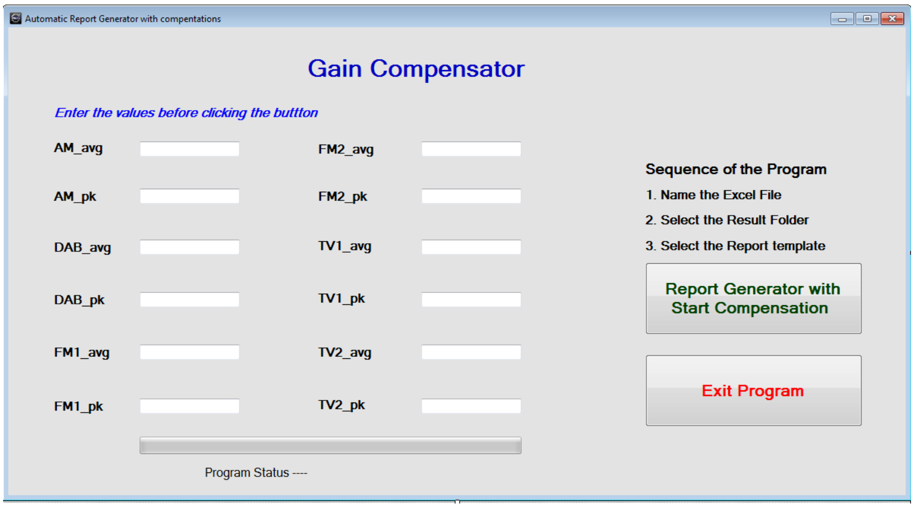
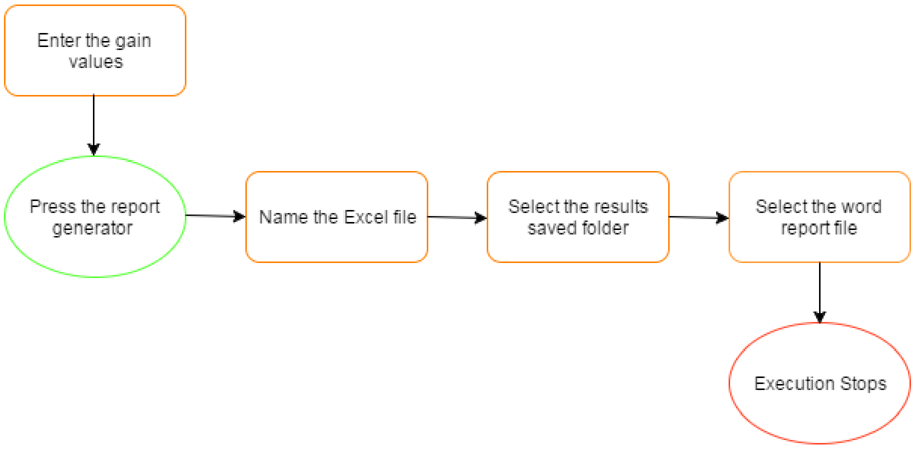


Figure 16: Windows form of report generator with gain compensator

Figure 15 shows the user interface, once the user clicks the button named click here to generate report it pops up with the dialog window which helps the user to create the new excel file, then another window pops out to select the location of the different text files from the test rig and last pop up is for selecting the word file. Once the execution is over the chart is plotted and copied into word file. The excel is also been saved this can be used for further references. Extra fields can be easily added to the code. Figure 16 and figure 17 shows the graph plotted for the AM average and AM peak without gain and cable loss respectively.



Flow Chart 2: Report Generator with gain Compensation

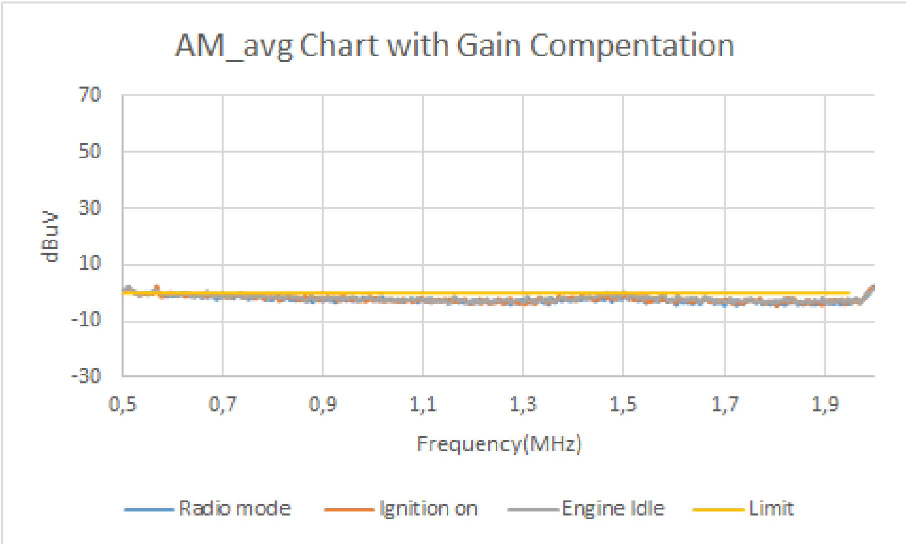


Figure 17: AM average from the report generator after gain compensation

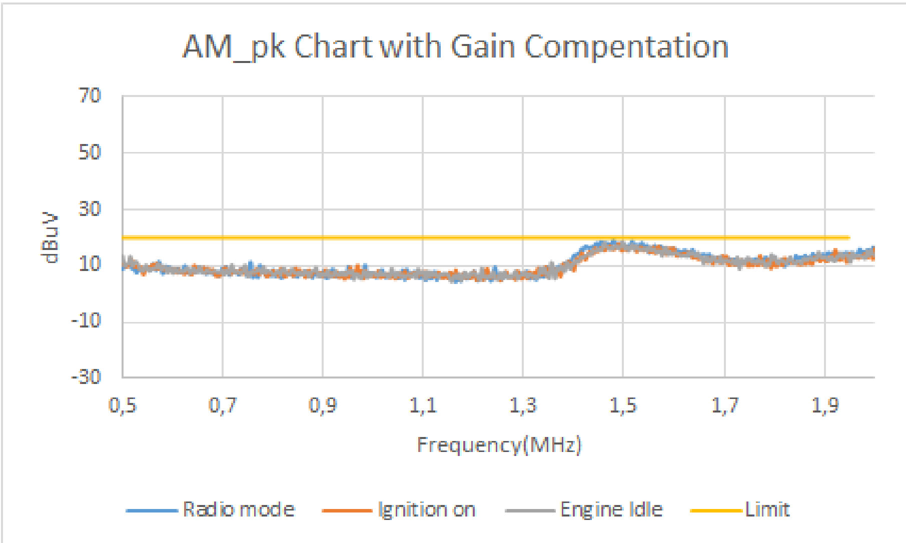


Figure 18: AM peak from the report generator after gain compensation

Flow chart 2 shows the all around view of the program how it works. Figure 17 and 18 are the plots after gain compensation. Here the pre-amplifier gain and the cable loss are removed. The cables loss has been taken care by the program so there is no need of any data which has to be given by the user. From these results we will be able to clearly see the real on board emission results for the vehicle from the test rig.

5

Statistical analysis of CAN log files and Database Management

This chapter discusses briefly about CANalyzer, error frames from the log files, different statistical methods can be used for analyzing these error frames and finally a short description how the database can look like to storing the test files. These files are to be stored in the database which should be easily accessible in future.

5.1 Introduction to CANalyzer :

CANalyser is used to analysis tool for ECU networks and distributed systems in the vehicle. It also makes it easy to supplement the data traffic in the supported bus systems. This software helps user to do various analysis on the window screen of the computer screen and to the logging file. The system is parametrized in the block diagrams and its functional blocks such has filter, generator or replay blocks can be placed and configured. In this study we load the log files from the test rig. From these files are exported in csv file format. From the file empty data are removed and empty cells are filled with correlated data using visual basic.

5.2 Filtering of CAN data :

CSV files from the CAN have large amount of data this has to be filtered and have only the data which can be used for future analysis. Below user interface filter the data by deleting the empty columns and fill the empty cells.

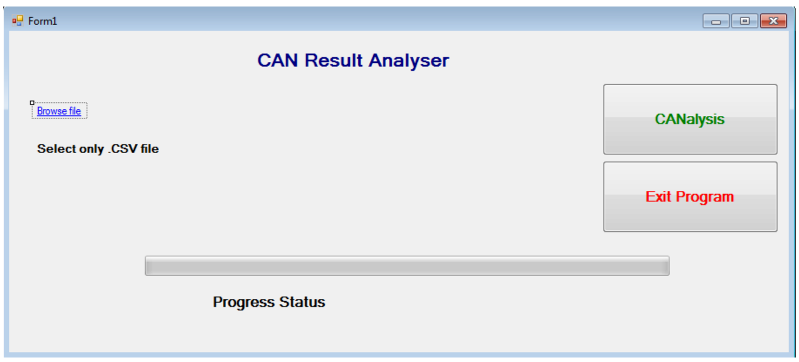


Figure 19 : Windows dorm of CAN result Analyser

The main aim of this analysis is to find patterns between the frames. These plots are made by deleting the empty column and filling the empty cells with data by correlating it with the consecutive cells in the .CSV file this will be done by the program, once its done graph can be plotted from the saved .CSV excel file. This projects gives few suggestions that can be taken into consideration for finding the patterns. Initially, the figure shows the plot between the field strength VS time, it can be considered to follow some statistical analysis to find the pattern, these are listed below,

- Non Linear Cluster Analysis
- Principal Component Analysis
- Hierarchical Cluster Analysis
- Discriminant Analysis

Secondly, it can also taken into consideration to go through each column in the .CSV file to find the difference between the highest and lowest values which has more those data can be plotted into the graph to check the correlation of the plot with this plot.

5.3 Database management :

This section discusses about the database management system for storing the data collected from the test rig. Firstly the simplest database system is flat file database, for example, we could say excel spreadsheet. Secondly hierarchical database, this has the data model in which the data are organized in a tree like structure. Finally one of the most commonly used databases is the relational database, In this, data are stored in several table format and they have common fields between them. For storing the data and report file from test rig, database needs to be a mixture of the hierarchical and relational database system features. Data has to be stored in the database according to the test type, for example, whether it is an immunity or emission test, this database need to have some subsections inside to handle different test results, by storing data in this format it will be easier for the future users. Also this will help to save time on manual search on old reports for analysis if needed.

6
Conclusion

This project has discussed about basic EMC, different test environments, antenna and instruments used during test. The main intention was to perform on-board measurements as per to the CISPR 25 standard and collect the results from test rig. Since the main of the work focus is to make the test rig automated, this projects leads to first step towards it. As this project shows the automatic report generator without gain compensate and also with gain compensate using visual basic. As it was stated before future work of this project is to make the whole test rig automated this includes making the vehicle to change its state automatically and also making the report. During the test, it can also be monitored by the tester through cameras and required changes can also be done. This reduces the consumption of time also increases the extensive use of chamber. Extended to this project also suggests some idea find the pattern between the CAN error frames during immunity measurements and it also briefly suggests idea have a database which can be used for future work.

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A

Appendix A

Listing A.1: Automatic Report Generator

```
Imports Microsoft.Office.Interop
Imports System.Text
Imports System
Imports System.IO
Public Class Form1

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
        System.EventArgs) Handles Button1.Click
starting:
        ProgressBar1.Value = 0
        Label.Text = "Started"

        Dim wrdApp
        Dim doc
        wrdApp = CreateObject("Word.Application")
        ProgressBar1.Value = 5

        'location of the file has to be changed along with the correct
            file name and format (doc or docx)
        OpenFileDialog.Filter = "Word Documents|*.doc|Word
            Documents|*.docx"
        OpenFileDialog.Title = "Select the report file"

        ProgressBar1.Value = 10

        If OpenFileDialog.ShowDialog() =
            System.Windows.Forms.DialogResult.Cancel Then
            Select Case MsgBox("Kindly select the report template / file?
                " + Chr(34) + "Click yes to select the template or click
                no for the main window", MsgBoxStyle.YesNo, "Warning")
                Case MsgBoxResult.Yes
                    GoTo firstline
                Case MsgBoxResult.No
                    GoTo Endline
            End Select
        End If
```

```
firstLine:

        wrdApp.Documents.Open(OpenFileDialog.FileName)
        doc = wrdApp.Documents(1)
        doc.Activate()
        ProgressBar1.Value = 20
        Label.Text = "In progress"

        Select Case MsgBox("Are you sure about the selected file ?" +
            Chr(34) + OpenFileDialog.FileName, MsgBoxStyle.YesNo,
            "Conformation")
            Case MsgBoxResult.Yes
                GoTo Continueprogram
            Case MsgBoxResult.No
                doc.Save()
                doc.Close()
                GoTo starting
        End Select

Continueprogram:

        Label.Text = "Almost Done - Stay Calm"

        If ProgressBar1.Value < 60 Then
            ProgressBar1.Value = ProgressBar1.Value + 2
        End If
        ProgressBar1.Value = 60

        wrdApp.Selection.EndKey(Unit:=6)

        'location of the picture or results with format (bmp)
        FolderBrowserDialog.Description = "Select the test results folder"
        If FolderBrowserDialog.ShowDialog() =
            System.Windows.Forms.DialogResult.Cancel Then
            Select Case MsgBox("Kindly select the source file folder? " +
                Chr(34) + "Click yes to select the folder or click no for
                the main window", MsgBoxStyle.YesNo, "Warning")
                Case MsgBoxResult.Yes
                    doc.Save()
                    doc.Close()
                    GoTo Continueprogram
                Case MsgBoxResult.No
                    GoTo Endline
            End Select
        End If

        IO.Directory.GetFiles(FolderBrowserDialog.SelectedPath)
```

```
Dim fileEntries As String() =
   Directory.GetFiles(FolderBrowserDialog.SelectedPath, "*.bmp")
Dim fileName As String

If ProgressBar1.Value < 80 Then
    ProgressBar1.Value = ProgressBar1.Value + 2
End If
ProgressBar1.Value = 80

Dim i As Integer
'Original Dimensions of the image
Dim oH As Long, oW As Long

i = 1
Dim shp As Word.InlineShape
For Each fileName In fileEntries
    If (System.IO.File.Exists(fileName)) Then
        'Read File and Print Result if its true
        shp =
           doc.ActiveWindow.Selection.InlineShapes.AddPicture(fileName:=fileName,
           LinkToFile:=False, SaveWithDocument:=True)
        oW = shp.Width
        oH = shp.Height
        shp.Height = 250
        shp.Width = 300
        doc.ActiveWindow.Selection.TypeParagraph()
        doc.ActiveWindow.Selection.TypeText(Text:=fileName)
        doc.ActiveWindow.Selection.ParagraphFormat.Alignment =
           Word.WdParagraphAlignment.wdAlignParagraphCenter
        doc.ActiveWindow.Selection.TypeParagraph()
    End If
Next
ProgressBar1.Value = 90

With doc.ActiveWindow.Selection.Find
    'location of the picture or results
    .Text = FolderBrowserDialog.SelectedPath
    .Replacement.Text = ""
    .Wrap = Word.WdFindWrap.wdFindContinue
    .Execute(Replace:=Word.WdReplace.wdReplaceAll)
End With

With doc.ActiveWindow.Selection.Find
    'location of the picture or results
    .Text = "\"
    .Replacement.Text = ""
    .Wrap = Word.WdFindWrap.wdFindContinue
    .Execute(Replace:=Word.WdReplace.wdReplaceAll)
End With
```

```
        With doc.ActiveWindow.Selection.Find
            'location of the picture or results
            .Text = ".bmp"
            .Replacement.Text = ""
            .Wrap = Word.WdFindWrap.wdFindContinue
            .Execute(Replace:=Word.WdReplace.wdReplaceAll)
        End With

        Label.Text = "Completed"
        ProgressBar1.Value = 100

        doc.Save()
        doc.Close()
click:
        Select Case MsgBox("Do you want to continue the program ?",
            MsgBoxStyle.YesNo, "Want to work more ?")
            Case MsgBoxResult.Yes
                ProgressBar1.Value = 0
                Me.Show()
            Case MsgBoxResult.No
                Me.Close()
        End Select

Endline:
        ProgressBar1.Value = 0
        Me.Show()
    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
        System.EventArgs) Handles Button2.Click
        Me.Close()
    End Sub
End Class
```

B

Appendix B

Listing B.1: Report Generator with Gain Compensation

```
Imports System.Text
Imports Microsoft.Office.Interop.Excel
Imports Microsoft.Office.Interop
'Imports Microsoft.Office.Tools.Word
Imports System
Imports System.IO
Imports System.Data.OleDb

Public Class Form1
    Dim xlPrimary As XlAxisGroup
    Dim xlValue As Object
    Dim xlCategory As Object

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
        System.EventArgs) Handles Btnmain.Click
        '==============================================================================
        'Open new Excel file
        Dim SaveFileDialogexcel As New SaveFileDialog()
        SaveFileDialogexcel.Filter = "Excel|*.xls|Excel Worksheets|*.xlsx"
        SaveFileDialogexcel.Title = "Name the Excel report file with gain
            compensation"

        If SaveFileDialogexcel.ShowDialog() = DialogResult.Cancel Then
            Select MsgBox("Name the Excel file? " + Chr(34) + "Click yes
                to name it or click no for the main window",
                MsgBoxStyle.YesNo, "Warning Box")
                Case MsgBoxResult.Yes
                    GoTo Continueexcel
                Case MsgBoxResult.No
                    GoTo Endline
            End Select
        End If

Continueexcel:
        SaveFileDialogexcel.ShowDialog()
        Dim SavePath As String
```

```
SavePath = SaveFileDialogexcel.FileName

Label.Text = "Started"
Dim xl As Excel.Application = New
    Microsoft.Office.Interop.Excel.Application()
Dim xlsheet1
Dim xlsheet2
Dim xlsheet3, xlsheet4, xlsheet5, xlsheet6, xlsheet7, xlsheet8,
    xlsheet9, xlsheet10, xlsheet11, xlsheet12
Dim xlwbk

If xl Is Nothing Then
    MessageBox.Show("Excel is not properly installed!!")
    Return
End If

xlwbk = CreateObject("Excel.Application")
Dim xlBook As Excel.Workbook
xlBook = xlwbk.Workbooks.Add

xlsheet1 = xlwbk.Worksheets(1)
xlsheet1.Name = "AM_avg"
xlsheet2 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet2.Name = "AM_pk"
xlsheet3 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet3.Name = "DAB_avg"
xlsheet4 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet4.Name = "DAB_pk"
xlsheet5 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet5.Name = "FM1_avg"
xlsheet6 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet6.Name = "FM1_pk"
xlsheet7 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet7.Name = "FM2_avg"
xlsheet8 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet8.Name = "FM2_pk"
xlsheet9 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet9.Name = "TV1_avg"
xlsheet10 =
    xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
xlsheet10.Name = "TV1_pk"
```

```
        xlsheet11 =
            xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
        xlsheet11.Name = "TV2_avg"
        xlsheet12 =
            xlwbk.Sheets.Add(After:=xlwbk.Sheets(xlwbk.Sheets.Count))
        xlsheet12.Name = "TV2_pk"
        ProgressBar1.Value = 10
        '===============================================================================
        '===============================================================================
        'Copy note pad data's to excel
Folderselection:
        FolderBrowserDialog1.Description = "Select the test results folder"

        If FolderBrowserDialog1.ShowDialog() =
            System.Windows.Forms.DialogResult.Cancel Then
            Select Case MsgBox("Kindly select the source file folder? " +
                Chr(34) + "Click yes to select the folder or click no for
                the main window", MsgBoxStyle.YesNo, "Warning Box")
                Case MsgBoxResult.Yes
                    GoTo Folderselection
                Case MsgBoxResult.No
                    xlwbk.Save()
                    xlwbk.Close()
                    xlwbk.kill()
                    GoTo Endline
            End Select
        End If

        Select Case MsgBox("Are you sure about the selected folder ?" +
            Chr(34) + FolderBrowserDialog1.SelectedPath,
            MsgBoxStyle.YesNo, "Conformation Box")
            Case MsgBoxResult.Yes
                GoTo continueprogram
            Case MsgBoxResult.No
                GoTo Folderselection
        End Select
continueprogram:

        Label.Text = "In Progress"
        Dim files() As String =
            IO.Directory.GetFiles(FolderBrowserDialog1.SelectedPath)
        For Each file As String In files
            Dim filename As String
            filename = System.IO.Path.GetFileName(file)
            Dim i As Integer = 1
            Dim j As Integer = 1
            Using MyReader As New
                Microsoft.VisualBasic.FileIO.TextFieldParser(file)
                MyReader.TextFieldType = FileIO.FieldType.Delimited
```

```
MyReader.SetDelimiters(";")
Dim row As String()
While Not MyReader.EndOfData
    Try
        row = MyReader.ReadFields()
        Dim field As String
        For Each field In row

            filename = filename.Replace(".e01", "")

            If filename = "AM_avg" Then
                xlwbk.Worksheets("AM_avg").Cells(i, j).Value
                    = field
            ElseIf filename = "AM_pk" Then
                xlwbk.Worksheets("AM_pk").Cells(i, j).Value
                    = field
            ElseIf filename = "DAB_avg" Then
                xlwbk.Worksheets("DAB_avg").Cells(i,
                    j).Value = field
            ElseIf filename = "DAB_pk" Then
                xlwbk.Worksheets("DAB_pk").Cells(i, j).Value
                    = field
            ElseIf filename = "FM1_avg" Then
                xlwbk.Worksheets("FM1_avg").Cells(i,
                    j).Value = field
            ElseIf filename = "FM1_pk" Then
                xlwbk.Worksheets("FM1_pk").Cells(i, j).Value
                    = field
            ElseIf filename = "FM2_avg" Then
                xlwbk.Worksheets("FM2_avg").Cells(i,
                    j).Value = field
            ElseIf filename = "FM2_pk" Then
                xlwbk.Worksheets("FM2_pk").Cells(i, j).Value
                    = field
            ElseIf filename = "TV1_avg" Then
                xlwbk.Worksheets("TV1_avg").Cells(i,
                    j).Value = field
            ElseIf filename = "TV1_pk" Then
                xlwbk.Worksheets("TV1_pk").Cells(i, j).Value
                    = field
            ElseIf filename = "TV2_avg" Then
                xlwbk.Worksheets("TV2_avg").Cells(i,
                    j).Value = field
            ElseIf filename = "TV2_pk" Then
                xlwbk.Worksheets("TV2_pk").Cells(i, j).Value
                    = field
            End If
            j = j + 1
```

```
                Next
                j = 1
                i = i + 1
            Catch ex As
                Microsoft.VisualBasic.FileIO.MalformedLineException

            End Try
        End While
    End Using
Next

Label.Text = "In Progress"
ProgressBar1.Value = 15
'=================================================================================
'=================================================================================
'Writing limits and dBuV to the excel

xlsheet1.Cells(13, 10) = "dBuV"
xlsheet2.Cells(13, 10) = "dBuV"
xlsheet3.Cells(13, 10) = "dBuV"
xlsheet4.Cells(13, 10) = "dBuV"
xlsheet5.Cells(13, 10) = "dBuV"
xlsheet6.Cells(13, 10) = "dBuV"
xlsheet7.Cells(13, 10) = "dBuV"
xlsheet8.Cells(13, 10) = "dBuV"
xlsheet9.Cells(13, 10) = "dBuV"
xlsheet10.Cells(13, 10) = "dBuV"
xlsheet11.Cells(13, 10) = "dBuV"
xlsheet12.Cells(13, 10) = "dBuV"

xlsheet1.Cells(13, 11) = "Limit"
xlsheet2.Cells(13, 11) = "Limit"
xlsheet3.Cells(13, 11) = "Limit"
xlsheet4.Cells(13, 11) = "Limit"
xlsheet5.Cells(13, 11) = "Limit"
xlsheet6.Cells(13, 11) = "Limit"
xlsheet7.Cells(13, 11) = "Limit"
xlsheet8.Cells(13, 11) = "Limit"
xlsheet9.Cells(13, 11) = "Limit"
xlsheet10.Cells(13, 11) = "Limit"
xlsheet11.Cells(13, 11) = "Limit"
xlsheet12.Cells(13, 11) = "Limit"


Dim x As Integer
'Limits for FM2,FM1,AM and DAB
x = 14
Do While x < 401
    xlsheet1.Cells(x, 11) = "0"
```

```
    xlsheet2.Cells(x, 11) = "20"
    xlsheet3.Cells(x, 11) = "0"
    xlsheet4.Cells(x, 11) = "10"
    xlsheet5.Cells(x, 11) = "0"
    xlsheet6.Cells(x, 11) = "26"
    xlsheet7.Cells(x, 11) = "0"
    xlsheet8.Cells(x, 11) = "26"
    x = x + 1
Loop

'limits for TV1 and TV2
x = 14
Do While x < 4015
    xlsheet9.Cells(x, 11) = "10"
    xlsheet10.Cells(x, 11) = "20"
    xlsheet11.Cells(x, 11) = "10"
    xlsheet12.Cells(x, 11) = "20"
    x = x + 1
Loop

Dim y As Integer
Dim q As Integer
y = 14
q = 70
'dbuV for AM
Do While y < 25
    xlsheet1.Cells(y, 10) = q
    xlsheet2.Cells(y, 10) = q
    y = y + 1
    q = q - 10
Loop

'dBuV for DAB,FM2 and FM1 avg
y = 14
Dim w = 30
Do While y < 25
    xlsheet3.Cells(y, 10) = w
    xlsheet5.Cells(y, 10) = w
    xlsheet7.Cells(y, 10) = w
    y = y + 1
    w = w - 5
Loop

'dBuV for DAB,FM2 and FM1 pk
y = 14
Dim r = 40
Do While y < 25
    xlsheet4.Cells(y, 10) = r
    xlsheet6.Cells(y, 10) = r
```

```
    xlsheet8.Cells(y, 10) = r
    y = y + 1
    r = r - 5
Loop

'dBuV for TV1 and TV2 pk
y = 14
Dim t = 30
Do While y < 25
    xlsheet9.Cells(y, 10) = t
    xlsheet11.Cells(y, 10) = t
    y = y + 1
    t = t - 5
Loop

'dBuV for TV1 and TV2 pk
y = 14
Dim u = 40
Do While y < 25
    xlsheet10.Cells(y, 10) = u
    xlsheet12.Cells(y, 10) = u
    y = y + 1
    u = u - 5
Loop

ProgressBar1.Value = 20
'================================================================================
'================================================================================
'Getting the Gain to be compensated from the user
Dim AM_avg, AM_pk, DAB_avg, DAB_pk, FM1_avg, FM1_pk, FM2_avg,
    FM2_pk, TV1_avg, TV1_pk, TV2_avg, TV2_pk

AM_avg = CSng(TxtBxAM_avg.Text)
AM_pk = CSng(TxtBxAM_pk.Text)
DAB_avg = CSng(TxtBxDAB_avg.Text)
DAB_pk = CSng(txtBxDAB_pk.Text)
FM1_avg = CSng(TxtBxFM1_avg.Text)
FM1_pk = CSng(TxtBxFM1_pk.Text)
FM2_avg = CSng(TxtBxFM2_avg.Text)
FM2_pk = CSng(TxtBxFM2_pk.Text)
TV1_avg = CSng(TxtBxTV1_avg.Text)
TV1_pk = CSng(TxtBxTV1_pk.Text)
TV2_avg = CSng(TxtBxTV2_avg.Text)
TV2_pk = CSng(TxtBxTV2_pk.Text)

'Writing in to excel
xlsheet1.Cells(13, 12) = "Gain Compensated"
xlsheet2.Cells(13, 12) = "Gain Compensated"
xlsheet3.Cells(13, 12) = "Gain Compensated"
```

```
xlsheet4.Cells(13, 12) = "Gain Compensated"
xlsheet5.Cells(13, 12) = "Gain Compensated"
xlsheet6.Cells(13, 12) = "Gain Compensated"
xlsheet7.Cells(13, 12) = "Gain Compensated"
xlsheet8.Cells(13, 12) = "Gain Compensated"
xlsheet9.Cells(13, 12) = "Gain Compensated"
xlsheet10.Cells(13, 12) = "Gain Compensated"
xlsheet11.Cells(13, 12) = "Gain Compensated"
xlsheet12.Cells(13, 12) = "Gain Compensated"

xlsheet1.Cells(14, 12) = AM_avg
xlsheet2.Cells(14, 12) = AM_pk
xlsheet3.Cells(14, 12) = DAB_avg
xlsheet4.Cells(14, 12) = DAB_pk
xlsheet5.Cells(14, 12) = FM1_avg
xlsheet6.Cells(14, 12) = FM1_pk
xlsheet7.Cells(14, 12) = FM2_avg
xlsheet8.Cells(14, 12) = FM2_pk
xlsheet9.Cells(14, 12) = TV1_avg
xlsheet10.Cells(14, 12) = TV1_pk
xlsheet11.Cells(14, 12) = TV2_avg
xlsheet12.Cells(14, 12) = TV2_pk

'==============================================================================
'==============================================================================
'Getting the Gain to be compensated from the user
Dim AM_avg_cb, AM_pk_cb, DAB_avg_cb, DAB_pk_cb, FM1_avg_cb,
   FM1_pk_cb, FM2_avg_cb, FM2_pk_cb, TV1_avg_cb, TV1_pk_cb,
   TV2_avg_cb, TV2_pk_cb

AM_avg_cb = -0.1993
AM_pk_cb = -0.1993
DAB_avg_cb = -0.6414
DAB_pk_cb = -0.6414
FM1_avg_cb = -1.2624
FM1_pk_cb = -1.2624
FM2_avg_cb = -1.2624
FM2_pk_cb = -1.2624
TV1_avg_cb = -3.404
TV1_pk_cb = -3.404
TV2_avg_cb = -3.404
TV2_pk_cb = -3.404

'Writing in to excel
xlsheet1.Cells(13, 13) = "Cable Loss"
xlsheet2.Cells(13, 13) = "Cable Loss"
xlsheet3.Cells(13, 13) = "Cable Loss"
xlsheet4.Cells(13, 13) = "Cable Loss"
xlsheet5.Cells(13, 13) = "Cable Loss"
```

```
xlsheet6.Cells(13, 13) = "Cable Loss"
xlsheet7.Cells(13, 13) = "Cable Loss"
xlsheet8.Cells(13, 13) = "Cable Loss"
xlsheet9.Cells(13, 13) = "Cable Loss"
xlsheet10.Cells(13, 13) = "Cable Loss"
xlsheet11.Cells(13, 13) = "Cable Loss"
xlsheet12.Cells(13, 13) = "Cable Loss"

xlsheet1.Cells(14, 13) = AM_avg_cb
xlsheet2.Cells(14, 13) = AM_pk_cb
xlsheet3.Cells(14, 13) = DAB_avg_cb
xlsheet4.Cells(14, 13) = DAB_pk_cb
xlsheet5.Cells(14, 13) = FM1_avg_cb
xlsheet6.Cells(14, 13) = FM1_pk_cb
xlsheet7.Cells(14, 13) = FM2_avg_cb
xlsheet8.Cells(14, 13) = FM2_pk_cb
xlsheet9.Cells(14, 13) = TV1_avg_cb
xlsheet10.Cells(14, 13) = TV1_pk_cb
xlsheet11.Cells(14, 13) = TV2_avg_cb
xlsheet12.Cells(14, 13) = TV2_pk_cb

'==============================================================================
'Frequency calculation
xlsheet1.Cells(13, 17) = "Frequency(MHz)"
xlsheet2.Cells(13, 17) = "Frequency(MHz)"
xlsheet3.Cells(13, 17) = "Frequency(MHz)"
xlsheet4.Cells(13, 17) = "Frequency(MHz)"
xlsheet5.Cells(13, 17) = "Frequency(MHz)"
xlsheet6.Cells(13, 17) = "Frequency(MHz)"
xlsheet7.Cells(13, 17) = "Frequency(MHz)"
xlsheet8.Cells(13, 17) = "Frequency(MHz)"
xlsheet9.Cells(13, 17) = "Frequency(GHz)"
xlsheet10.Cells(13, 17) = "Frequency(GHz)"
xlsheet11.Cells(13, 17) = "Frequency(GHz)"
xlsheet12.Cells(13, 17) = "Frequency(GHz)"

For g As Integer = 14 To 414
    xlsheet1.Cells(g, 17) = xlsheet1.Cells(g, 1).value / 10 ^ 6
    xlsheet2.Cells(g, 17) = xlsheet2.Cells(g, 1).value / 10 ^ 6
    xlsheet3.Cells(g, 17) = xlsheet3.Cells(g, 1).value / 10 ^ 6
    xlsheet4.Cells(g, 17) = xlsheet4.Cells(g, 1).value / 10 ^ 6
    xlsheet5.Cells(g, 17) = xlsheet5.Cells(g, 1).value / 10 ^ 6
    xlsheet6.Cells(g, 17) = xlsheet6.Cells(g, 1).value / 10 ^ 6
    xlsheet7.Cells(g, 17) = xlsheet7.Cells(g, 1).value / 10 ^ 6
    xlsheet8.Cells(g, 17) = xlsheet8.Cells(g, 1).value / 10 ^ 6
Next

For z As Integer = 14 To 4014
    xlsheet9.Cells(z, 17) = xlsheet9.Cells(z, 1).value / 10 ^ 9
```

```
        xlsheet10.Cells(z, 17) = xlsheet10.Cells(z, 1).value / 10 ^ 9
        xlsheet11.Cells(z, 17) = xlsheet11.Cells(z, 1).value / 10 ^ 9
        xlsheet12.Cells(z, 17) = xlsheet12.Cells(z, 1).value / 10 ^ 9
    Next
    ProgressBar1.Value = 25
    Label.Text = "Stay Calm"
    '=================================================================================
    'Code to remove the pre amplifer gain sheet1 AM_avg
    Dim Gn
    Dim rm = Nothing

    Gn = xlsheet1.Cells(14, 12).Value

    'Code to remove the gain from radio mode
    xlsheet1.Cells(13, 14) = "Radio mode "
    For x = 14 To 415
        Dim nrm = Nothing 'Radio mode without gain
        rm = xlsheet1.Cells(x, 2).Value
        nrm = rm - Gn - AM_avg_cb
        xlsheet1.Cells(x, 14) = nrm
    Next

    'Code to remove the gain from Ignition on
    rm = Nothing
    xlsheet1.Cells(13, 15) = "Ignition on"
    For x = 14 To 415
        Dim nio = Nothing 'Ignition on without gain
        rm = xlsheet1.Cells(x, 3).Value
        nio = rm - Gn - AM_avg_cb
        xlsheet1.Cells(x, 15) = nio
    Next

    'Code to remove the gain from Engine Idle
    rm = Nothing
    xlsheet1.Cells(13, 16) = "Engine Idle"
    For x = 14 To 415
        Dim nei = Nothing 'Engine Idle without gain
        rm = xlsheet1.Cells(x, 4).Value
        nei = rm - Gn - AM_avg_cb
        xlsheet1.Cells(x, 16) = nei
    Next

    '---------------------------------------------------------------------------------
    'Code to remove the pre amplifer gain sheet2 AM_pk
    Gn = Nothing
    rm = Nothing

    Gn = xlsheet2.Cells(14, 12).Value
```

```
'Code to remove the gain from radio mode
xlsheet2.Cells(13, 14) = "Radio mode"
For x = 14 To 415
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet2.Cells(x, 2).Value
    nrm = rm - Gn - AM_pk_cb
    xlsheet2.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet2.Cells(13, 15) = "Ignition on"
For x = 14 To 415
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet2.Cells(x, 3).Value
    nio = rm - Gn - AM_pk_cb
    xlsheet2.Cells(x, 15) = nio
Next


'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet2.Cells(13, 16) = "Engine Idle"
For x = 14 To 415
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet2.Cells(x, 4).Value
    nei = rm - Gn - AM_pk_cb
    xlsheet2.Cells(x, 16) = nei
Next

'--------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet3 DAB_avg
Gn = Nothing
rm = Nothing

Gn = xlsheet3.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet3.Cells(13, 14) = "Radio mode"
For x = 14 To 415
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet3.Cells(x, 2).Value
    nrm = rm - Gn - DAB_avg_cb
    xlsheet3.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet3.Cells(13, 15) = "Ignition on"
```

```
For x = 14 To 415
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet3.Cells(x, 3).Value
    nio = rm - Gn - DAB_avg_cb
    xlsheet3.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet3.Cells(13, 16) = "Engine Idle"
For x = 14 To 415
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet3.Cells(x, 4).Value
    nei = rm - Gn - DAB_avg_cb
    xlsheet3.Cells(x, 16) = nei
Next

'-------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet4 DAB_pk
Gn = Nothing
rm = Nothing

Gn = xlsheet4.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet4.Cells(13, 14) = "Radio mode"
For x = 14 To 415
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet4.Cells(x, 2).Value
    nrm = rm - Gn - DAB_pk_cb
    xlsheet4.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet4.Cells(13, 15) = "Ignition on"
For x = 14 To 415
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet4.Cells(x, 3).Value
    nio = rm - Gn - DAB_pk_cb
    xlsheet4.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet4.Cells(13, 16) = "Engine Idle"
For x = 14 To 415
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet4.Cells(x, 4).Value
```

```
    nei = rm - Gn - DAB_pk_cb
    xlsheet4.Cells(x, 16) = nei
Next
'----------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet5 FM1_avg
Gn = Nothing
rm = Nothing

Gn = xlsheet5.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet5.Cells(13, 14) = "Radio mode"
For x = 14 To 415
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet5.Cells(x, 2).Value
    nrm = rm - Gn - FM1_avg_cb
    xlsheet5.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet5.Cells(13, 15) = "Ignition on"
For x = 14 To 415
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet5.Cells(x, 3).Value
    nio = rm - Gn - FM1_avg_cb
    xlsheet5.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet5.Cells(13, 16) = "Engine Idle"
For x = 14 To 415
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet5.Cells(x, 4).Value
    nei = rm - Gn - FM1_avg_cb
    xlsheet5.Cells(x, 16) = nei
Next

'----------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet6 FM1_pk
Gn = Nothing
rm = Nothing

Gn = xlsheet6.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet6.Cells(13, 14) = "Radio mode"
For x = 14 To 415
```

```
        Dim nrm = Nothing 'Radio mode without gain
        rm = xlsheet6.Cells(x, 2).Value
        nrm = rm - Gn - FM1_pk_cb
        xlsheet6.Cells(x, 14) = nrm
    Next

    'Code to remove the gain from Ignition on
    rm = Nothing
    xlsheet6.Cells(13, 15) = "Ignition on"
    For x = 14 To 415
        Dim nio = Nothing 'Ignition on without gain
        rm = xlsheet6.Cells(x, 3).Value
        nio = rm - Gn - FM1_pk_cb
        xlsheet6.Cells(x, 15) = nio
    Next

    'Code to remove the gain from Engine Idle
    rm = Nothing
    xlsheet6.Cells(13, 16) = "Engine Idle"
    For x = 14 To 415
        Dim nei = Nothing 'Engine Idle without gain
        rm = xlsheet6.Cells(x, 4).Value
        nei = rm - Gn - FM1_pk_cb
        xlsheet6.Cells(x, 16) = nei
    Next
    '--------------------------------------------------------------------------------
    'Code to remove the pre amplifer gain sheet7 FM2_avg
    Gn = Nothing
    rm = Nothing

    Gn = xlsheet7.Cells(14, 12).Value

    'Code to remove the gain from radio mode
    xlsheet7.Cells(13, 14) = "Radio mode"
    For x = 14 To 415
        Dim nrm = Nothing 'Radio mode without gain
        rm = xlsheet7.Cells(x, 2).Value
        nrm = rm - Gn - FM2_avg_cb
        xlsheet7.Cells(x, 14) = nrm
    Next

    'Code to remove the gain from Ignition on
    rm = Nothing
    xlsheet7.Cells(13, 15) = "Ignition on"
    For x = 14 To 415
        Dim nio = Nothing 'Ignition on without gain
        rm = xlsheet7.Cells(x, 3).Value
        nio = rm - Gn - FM2_avg_cb
        xlsheet7.Cells(x, 15) = nio
```

```
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet7.Cells(13, 16) = "Engine Idle"
For x = 14 To 415
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet7.Cells(x, 4).Value
    nei = rm - Gn - FM2_avg_cb
    xlsheet7.Cells(x, 16) = nei
Next
'--------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet8 FM2_pk
Gn = Nothing
rm = Nothing

Gn = xlsheet8.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet8.Cells(13, 14) = "Radio mode"
For x = 14 To 415
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet8.Cells(x, 2).Value
    nrm = rm - Gn - FM2_pk_cb
    xlsheet8.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet8.Cells(13, 15) = "Ignition on"
For x = 14 To 415
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet8.Cells(x, 3).Value
    nio = rm - Gn - FM2_pk_cb
    xlsheet8.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet8.Cells(13, 16) = "Engine Idle"
For x = 14 To 415
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet8.Cells(x, 4).Value
    nei = rm - Gn - FM2_pk_cb
    xlsheet8.Cells(x, 16) = nei
Next
'--------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet9 TV1_avg
Gn = Nothing
```

```
rm = Nothing

Gn = xlsheet9.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet9.Cells(13, 14) = "Radio mode"
For x = 14 To 4015
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet9.Cells(x, 2).Value
    nrm = rm - Gn - TV1_avg_cb
    xlsheet9.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet9.Cells(13, 15) = "Ignition on"
For x = 14 To 4015
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet9.Cells(x, 3).Value
    nio = rm - Gn - TV1_avg_cb
    xlsheet9.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet9.Cells(13, 16) = "Engine Idle"
For x = 14 To 4015
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet9.Cells(x, 4).Value
    nei = rm - Gn - TV1_avg_cb
    xlsheet9.Cells(x, 16) = nei
Next
'-----------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet10 TV1_pk
Gn = Nothing
rm = Nothing
Gn = xlsheet10.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet10.Cells(13, 14) = "Radio mode"
For x = 14 To 4015
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet10.Cells(x, 2).Value
    nrm = rm - Gn - TV1_pk_cb
    xlsheet10.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
```

```
xlsheet10.Cells(13, 15) = "Ignition on"
For x = 14 To 4015
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet10.Cells(x, 3).Value
    nio = rm - Gn - TV1_pk_cb
    xlsheet10.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet10.Cells(13, 16) = "Engine Idle"
For x = 14 To 4015
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet10.Cells(x, 4).Value
    nei = rm - Gn - TV1_pk_cb
    xlsheet10.Cells(x, 16) = nei
Next
'-------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet11 TV2_avg
Gn = Nothing
rm = Nothing
Gn = xlsheet11.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet11.Cells(13, 14) = "Radio mode"
For x = 14 To 4015
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet11.Cells(x, 2).Value
    nrm = rm - Gn - TV2_avg_cb
    xlsheet11.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet11.Cells(13, 15) = "Ignition on"
For x = 14 To 4015
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet11.Cells(x, 3).Value
    nio = rm - Gn - TV2_avg_cb
    xlsheet11.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet11.Cells(13, 16) = "Engine Idle"
For x = 14 To 4015
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet11.Cells(x, 4).Value
    nei = rm - Gn - TV2_avg_cb
```

```
    xlsheet11.Cells(x, 16) = nei
Next
'----------------------------------------------------------------------------------
'Code to remove the pre amplifer gain sheet12 TV2_pk
Gn = Nothing
rm = Nothing
Gn = xlsheet12.Cells(14, 12).Value

'Code to remove the gain from radio mode
xlsheet12.Cells(13, 14) = "Radio mode"
For x = 14 To 4015
    Dim nrm = Nothing 'Radio mode without gain
    rm = xlsheet12.Cells(x, 2).Value
    nrm = rm - Gn - TV2_pk_cb
    xlsheet12.Cells(x, 14) = nrm
Next

'Code to remove the gain from Ignition on
rm = Nothing
xlsheet12.Cells(13, 15) = "Ignition on"
For x = 14 To 4015
    Dim nio = Nothing 'Ignition on without gain
    rm = xlsheet12.Cells(x, 3).Value
    nio = rm - Gn - TV2_pk_cb
    xlsheet12.Cells(x, 15) = nio
Next

'Code to remove the gain from Engine Idle
rm = Nothing
xlsheet12.Cells(13, 16) = "Engine Idle"
For x = 14 To 4015
    Dim nei = Nothing 'Engine Idle without gain
    rm = xlsheet12.Cells(x, 4).Value
    nei = rm - Gn - TV2_pk_cb
    xlsheet12.Cells(x, 16) = nei
Next
ProgressBar1.Value = 35
'==================================================================================
'==================================================================================
'Code for creating chart

Dim Chart1, Chart2, Chart3, Chart4, Chart5, Chart6, Chart7,
    Chart8, Chart9, Chart10, Chart11, Chart12 As Chart

Chart1 = xlsheet1.Shapes.AddChart.Chart
Chart2 = xlsheet2.Shapes.AddChart.Chart
Chart3 = xlsheet3.Shapes.AddChart.Chart
Chart4 = xlsheet4.Shapes.AddChart.Chart
Chart5 = xlsheet5.Shapes.AddChart.Chart
```

```
Chart6 = xlsheet6.Shapes.AddChart.Chart
Chart7 = xlsheet7.Shapes.AddChart.Chart
Chart8 = xlsheet8.Shapes.AddChart.Chart
Chart9 = xlsheet9.Shapes.AddChart.Chart
Chart10 = xlsheet10.Shapes.AddChart.Chart
Chart11 = xlsheet11.Shapes.AddChart.Chart
Chart12 = xlsheet12.Shapes.AddChart.Chart

'--------------------------------------------------------------------------------
'Chart1 for AM_avg
With Chart1
    .HasTitle = True
    .ChartTitle.Text = "AM_avg Chart with Gain Compentation"
End With

For Each s In Chart1.SeriesCollection
    s.Delete()
Next

With Chart1.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='AM_avg'!$N$13"
    .Values = "='AM_avg'!$N$14:$N$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
    .XValues = "='AM_avg'!$Q$14:$Q$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
End With


With Chart1.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='AM_avg'!$O$13"
    .Values = "='AM_avg'!$O$14:$O$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
    .XValues = "='AM_avg'!$Q$14:$Q$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
End With

With Chart1.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='AM_avg'!$P$13"
    .Values = "='AM_avg'!$P$14:$P$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
    .XValues = "='AM_avg'!$Q$14:$Q$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
End With

With Chart1.SeriesCollection.NewSeries
    .ChartType = 73
```

```
    .Name = "='AM_avg'!$K$13"
    .Values = "='AM_avg'!$K$14:$K$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
    .XValues = "='AM_avg'!$Q$14:$Q$" +
       CStr(xlsheet1.UsedRange.Rows.Count)
End With

With Chart1
    .ChartStyle = 240
    .Axes(2).MinimumScale = -30
    .Axes(2).MaximumScale = 70
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 0.5
    .Axes(1).MaximumScale = 2
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With
'--------------------------------------------------------------------------------
'Chart2 for AM_pk
With Chart2
    .HasTitle = True
    .ChartTitle.Text = "AM_pk Chart with Gain Compentation"
End With

For Each s In Chart2.SeriesCollection
    s.Delete()
Next

With Chart2.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='AM_pk'!$N$13"
    .Values = "='AM_pk'!$N$14:$N$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
    .XValues = "='AM_pk'!$Q$14:$Q$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
End With

With Chart2.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='AM_pk'!$O$13"
    .Values = "='AM_pk'!$O$14:$O$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
    .XValues = "='AM_pk'!$Q$14:$Q$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
End With

With Chart2.SeriesCollection.NewSeries
```

```
    .ChartType = 73
    .Name = "='AM_pk'!$P$13"
    .Values = "='AM_pk'!$P$14:$P$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
    .XValues = "='AM_pk'!$Q$14:$Q$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
End With

With Chart2.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='AM_pk'!$K$13"
    .Values = "='AM_pk'!$K$14:$K$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
    .XValues = "='AM_pk'!$Q$14:$Q$" +
       CStr(xlsheet2.UsedRange.Rows.Count)
End With

With Chart2
    .ChartStyle = 240
    .Axes(2).MinimumScale = -30
    .Axes(2).MaximumScale = 70
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 0.5
    .Axes(1).MaximumScale = 2
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With
'-----------------------------------------------------------------------------
'Chart3 for DAB_avg
With Chart3
    .HasTitle = True
    .ChartTitle.Text = "DAB_avg Chart with Gain Compentation"
End With

For Each s In Chart3.SeriesCollection
    s.Delete()
Next

With Chart3.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_avg'!$N$13"
    .Values = "='DAB_avg'!$N$14:$N$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
    .XValues = "='DAB_avg'!$Q$14:$Q$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
End With
```

```
With Chart3.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_avg'!$O$13"
    .Values = "='DAB_avg'!$O$14:$O$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
    .XValues = "='DAB_avg'!$Q$14:$Q$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
End With

With Chart3.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_avg'!$P$13"
    .Values = "='DAB_avg'!$P$14:$P$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
    .XValues = "='DAB_avg'!$Q$14:$Q$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
End With

With Chart3.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_avg'!$K$13"
    .Values = "='DAB_avg'!$K$14:$K$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
    .XValues = "='DAB_avg'!$Q$14:$Q$" +
       CStr(xlsheet3.UsedRange.Rows.Count)
End With

With Chart3
    .ChartStyle = 240
    .Axes(2).MinimumScale = -20
    .Axes(2).MaximumScale = 30
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 170
    .Axes(1).MaximumScale = 245
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With
ProgressBar1.Value = 40
'--------------------------------------------------------------------------------
'Chart4 for DAB_pk

With Chart4
    .HasTitle = True
    .ChartTitle.Text = "DAB_pk Chart with Gain Compentation"
End With

For Each s In Chart4.SeriesCollection
```

```
    s.Delete()
Next

With Chart4.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_pk'!$N$13"
    .Values = "='DAB_pk'!$N$14:$N$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
    .XValues = "='DAB_pk'!$Q$14:$Q$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
End With

With Chart4.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_pk'!$O$13"
    .Values = "='DAB_pk'!$O$14:$O$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
    .XValues = "='DAB_pk'!$Q$14:$Q$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
End With

With Chart4.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_pk'!$P$13"
    .Values = "='DAB_pk'!$P$14:$P$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
    .XValues = "='DAB_pk'!$Q$14:$Q$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
End With

With Chart4.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='DAB_pk'!$K$13"
    .Values = "='DAB_pk'!$K$14:$K$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
    .XValues = "='DAB_pk'!$Q$14:$Q$" +
        CStr(xlsheet4.UsedRange.Rows.Count)
End With

With Chart4
    .ChartStyle = 240
    .Axes(2).MinimumScale = -20
    .Axes(2).MaximumScale = 30
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 170
    .Axes(1).MaximumScale = 245
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
    .Axes(2, 1).HasTitle = True
```

```
        .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
    End With
    '-------------------------------------------------------------------------------
    'Chart5 for FM1_avg
    With Chart5
        .HasTitle = True
        .ChartTitle.Text = "FM1_avg Chart with Gain Compentation"
    End With

    For Each s In Chart5.SeriesCollection
        s.Delete()
    Next

    With Chart5.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM1_avg'!$N$13"
        .Values = "='FM1_avg'!$N$14:$N$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
        .XValues = "='FM1_avg'!$Q$14:$Q$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
    End With

    With Chart5.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM1_avg'!$O$13"
        .Values = "='FM1_avg'!$O$14:$O$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
        .XValues = "='FM1_avg'!$Q$14:$Q$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
    End With

    With Chart5.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM1_avg'!$P$13"
        .Values = "='FM1_avg'!$P$14:$P$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
        .XValues = "='FM1_avg'!$Q$14:$Q$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
    End With

    With Chart5.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM1_avg'!$K$13"
        .Values = "='FM1_avg'!$K$14:$K$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
        .XValues = "='FM1_avg'!$Q$14:$Q$" +
           CStr(xlsheet5.UsedRange.Rows.Count)
    End With
```

```
With Chart5
    .ChartStyle = 240
    .Axes(2).MinimumScale = -25
    .Axes(2).MaximumScale = 25
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 68
    .Axes(1).MaximumScale = 108
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With

ProgressBar1.Value = 50
'--------------------------------------------------------------------------------
'Chart6 for FM1_pk
With Chart6
    .HasTitle = True
    .ChartTitle.Text = "FM1_pk Chart with Gain Compentation"
End With

For Each s In Chart6.SeriesCollection
    s.Delete()
Next

With Chart6.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='FM1_pk'!$N$13"
    .Values = "='FM1_pk'!$N$14:$N$" +
       CStr(xlsheet6.UsedRange.Rows.Count)
    .XValues = "='FM1_pk'!$Q$14:$Q$" +
       CStr(xlsheet6.UsedRange.Rows.Count)
End With

With Chart6.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='FM1_pk'!$O$13"
    .Values = "='FM1_pk'!$O$14:$O$" +
       CStr(xlsheet6.UsedRange.Rows.Count)
    .XValues = "='FM1_pk'!$Q$14:$Q$" +
       CStr(xlsheet6.UsedRange.Rows.Count)
End With

With Chart6.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='FM1_pk'!$P$13"
    .Values = "='FM1_pk'!$P$14:$P$" +
       CStr(xlsheet6.UsedRange.Rows.Count)
```

```
        .XValues = "='FM1_pk'!$Q$14:$Q$" +
           CStr(xlsheet6.UsedRange.Rows.Count)
    End With

    With Chart6.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM1_pk'!$K$13"
        .Values = "='FM1_pk'!$K$14:$K$" +
           CStr(xlsheet6.UsedRange.Rows.Count)
        .XValues = "='FM1_pk'!$Q$14:$Q$" +
           CStr(xlsheet6.UsedRange.Rows.Count)
    End With

    With Chart6
        .ChartStyle = 240
        .Axes(2).MinimumScale = -10
        .Axes(2).MaximumScale = 40
        .Axes(2).CrossesAt = -40
        .Axes(1).MinimumScale = 68
        .Axes(1).MaximumScale = 108
        .Axes(1, 1).HasTitle = True
        .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
        .Axes(2, 1).HasTitle = True
        .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
    End With
    '-------------------------------------------------------------------------------
    'Chart for FM2_avg

    With Chart7
        .HasTitle = True
        .ChartTitle.Text = "FM2_avg Chart with Gain Compentation"
    End With

    For Each s In Chart7.SeriesCollection
        s.Delete()
    Next

    With Chart7.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM2_avg'!$N$13"
        .Values = "='FM2_avg'!$N$14:$N$" +
           CStr(xlsheet7.UsedRange.Rows.Count)
        .XValues = "='FM2_avg'!$Q$14:$Q$" +
           CStr(xlsheet7.UsedRange.Rows.Count)
    End With

    With Chart7.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM2_avg'!$O$13"
```

```
    .Values = "='FM2_avg'!$O$14:$O$" +
       CStr(xlsheet7.UsedRange.Rows.Count)
    .XValues = "='FM2_avg'!$Q$14:$Q$" +
       CStr(xlsheet7.UsedRange.Rows.Count)
End With

With Chart7.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='FM2_avg'!$P$13"
    .Values = "='FM2_avg'!$P$14:$P$" +
       CStr(xlsheet7.UsedRange.Rows.Count)
    .XValues = "='FM2_avg'!$Q$14:$Q$" +
       CStr(xlsheet7.UsedRange.Rows.Count)
End With

With Chart7.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='FM2_avg'!$K$13"
    .Values = "='FM2_avg'!$K$14:$K$" +
       CStr(xlsheet7.UsedRange.Rows.Count)
    .XValues = "='FM2_avg'!$Q$14:$Q$" +
       CStr(xlsheet7.UsedRange.Rows.Count)
End With

With Chart7
    .ChartStyle = 240
    .Axes(2).MinimumScale = -25
    .Axes(2).MaximumScale = 25
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 68
    .Axes(1).MaximumScale = 108
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With
'---------------------------------------------------------------------------------
'Chart for FM2_pk
With Chart8
    .HasTitle = True
    .ChartTitle.Text = "FM2_pk Chart with Gain Compentation"
End With

For Each s In Chart8.SeriesCollection
    s.Delete()
Next

With Chart8.SeriesCollection.NewSeries
    .ChartType = 73
```

```
        .Name = "='FM2_pk'!$N$13"
        .Values = "='FM2_pk'!$N$14:$N$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
        .XValues = "='FM2_pk'!$Q$14:$Q$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
    End With

    With Chart8.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM2_pk'!$O$13"
        .Values = "='FM2_pk'!$O$14:$O$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
        .XValues = "='FM2_pk'!$Q$14:$Q$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
    End With

    With Chart8.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM2_pk'!$P$13"
        .Values = "='FM2_pk'!$P$14:$P$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
        .XValues = "='FM2_pk'!$Q$14:$Q$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
    End With

    With Chart8.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='FM2_pk'!$K$13"
        .Values = "='FM2_pk'!$K$14:$K$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
        .XValues = "='FM2_pk'!$Q$14:$Q$" +
            CStr(xlsheet8.UsedRange.Rows.Count)
    End With

    With Chart8
        .ChartStyle = 240
        .Axes(2).MinimumScale = -10
        .Axes(2).MaximumScale = 40
        .Axes(2).CrossesAt = -40
        .Axes(1).MinimumScale = 68
        .Axes(1).MaximumScale = 108
        .Axes(1, 1).HasTitle = True
        .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(MHz)"
        .Axes(2, 1).HasTitle = True
        .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
    End With

    ProgressBar1.Value = 60
    '-----------------------------------------------------------------------------------
```

```
'Chart for TV1_avg
With Chart9
    .HasTitle = True
    .ChartTitle.Text = "TV1_avg Chart with Gain Compentation"
End With

For Each s In Chart9.SeriesCollection
    s.Delete()
Next

With Chart9.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV1_avg'!$N$13"
    .Values = "='TV1_avg'!$N$14:$N$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
    .XValues = "='TV1_avg'!$Q$14:$Q$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
End With

With Chart9.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV1_avg'!$O$13"
    .Values = "='TV1_avg'!$O$14:$O$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
    .XValues = "='TV1_avg'!$Q$14:$Q$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
End With

With Chart9.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV1_avg'!$P$13"
    .Values = "='TV1_avg'!$P$14:$P$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
    .XValues = "='TV1_avg'!$Q$14:$Q$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
End With

With Chart9.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV1_avg'!$K$13"
    .Values = "='TV1_avg'!$K$14:$K$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
    .XValues = "='TV1_avg'!$Q$14:$Q$" +
       CStr(xlsheet9.UsedRange.Rows.Count)
End With

With Chart9
    .ChartStyle = 240
    .Axes(2).MinimumScale = -20
```

```
        .Axes(2).MaximumScale = 30
        .Axes(2).CrossesAt = -40
        .Axes(1).MinimumScale = 0.47
        .Axes(1).MaximumScale = 0.89
        .Axes(1, 1).HasTitle = True
        .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(GHz)"
        .Axes(2, 1).HasTitle = True
        .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
    End With
    '-----------------------------------------------------------------------------
    'Chart for TV1_pk

    With Chart10
        .HasTitle = True
        .ChartTitle.Text = "TV1_pk Chart with Gain Compentation"
    End With

    For Each s In Chart10.SeriesCollection
        s.Delete()
    Next

    With Chart10.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='TV1_pk'!$N$13"
        .Values = "='TV1_pk'!$N$14:$N$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
        .XValues = "='TV1_pk'!$Q$14:$Q$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
    End With

    With Chart10.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='TV1_pk'!$O$13"
        .Values = "='TV1_pk'!$O$14:$O$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
        .XValues = "='TV1_pk'!$Q$14:$Q$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
    End With

    With Chart10.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='TV1_pk'!$P$13"
        .Values = "='TV1_pk'!$P$14:$P$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
        .XValues = "='TV1_pk'!$Q$14:$Q$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
    End With

    With Chart10.SeriesCollection.NewSeries
```

```
        .ChartType = 73
        .Name = "='TV1_pk'!$K$13"
        .Values = "='TV1_pk'!$K$14:$K$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
        .XValues = "='TV1_pk'!$Q$14:$Q$" +
            CStr(xlsheet10.UsedRange.Rows.Count)
    End With

    With Chart10
        .ChartStyle = 240
        .Axes(2).MinimumScale = -10
        .Axes(2).MaximumScale = 40
        .Axes(2).CrossesAt = -40
        .Axes(1).MinimumScale = 0.47
        .Axes(1).MaximumScale = 0.89
        .Axes(1, 1).HasTitle = True
        .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(GHz)"
        .Axes(2, 1).HasTitle = True
        .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
    End With

    ProgressBar1.Value = 70
    '-------------------------------------------------------------------------------------
    'Chart for TV2_avg
    With Chart11
        .HasTitle = True
        .ChartTitle.Text = "TV2_avg Chart with Gain Compentation"
    End With

    For Each s In Chart11.SeriesCollection
        s.Delete()
    Next

    With Chart11.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='TV2_avg'!$N$13"
        .Values = "='TV2_avg'!$N$14:$N$" +
            CStr(xlsheet11.UsedRange.Rows.Count)
        .XValues = "='TV2_avg'!$Q$14:$Q$" +
            CStr(xlsheet11.UsedRange.Rows.Count)
    End With

    With Chart11.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='TV2_avg'!$O$13"
        .Values = "='TV2_avg'!$O$14:$O$" +
            CStr(xlsheet11.UsedRange.Rows.Count)
        .XValues = "='TV2_avg'!$Q$14:$Q$" +
            CStr(xlsheet11.UsedRange.Rows.Count)
```

```
End With

With Chart11.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV2_avg'!$P$13"
    .Values = "='TV2_avg'!$P$14:$P$" +
       CStr(xlsheet11.UsedRange.Rows.Count)
    .XValues = "='TV2_avg'!$Q$14:$Q$" +
       CStr(xlsheet11.UsedRange.Rows.Count)
End With

With Chart11.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV2_avg'!$K$13"
    .Values = "='TV2_avg'!$K$14:$K$" +
       CStr(xlsheet11.UsedRange.Rows.Count)
    .XValues = "='TV2_avg'!$Q$14:$Q$" +
       CStr(xlsheet11.UsedRange.Rows.Count)
End With

With Chart11
    .ChartStyle = 240
    .Axes(2).MinimumScale = -20
    .Axes(2).MaximumScale = 30
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 0.47
    .Axes(1).MaximumScale = 0.89
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(GHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With
'--------------------------------------------------------------------------------
'Chart for TV2_pk

With Chart12
    .HasTitle = True
    .ChartTitle.Text = "TV2_pk Chart with Gain Compentation"
End With

For Each s In Chart12.SeriesCollection
    s.Delete()
Next

With Chart12.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV2_pk'!$N$13"
    .Values = "='TV2_pk'!$N$14:$N$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
```

```
    .XValues = "='TV2_pk'!$Q$14:$Q$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
End With

With Chart12.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV2_pk'!$O$13"
    .Values = "='TV2_pk'!$O$14:$O$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
    .XValues = "='TV2_pk'!$Q$14:$Q$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
End With

With Chart12.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV2_pk'!$P$13"
    .Values = "='TV2_pk'!$P$14:$P$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
    .XValues = "='TV2_pk'!$Q$14:$Q$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
End With

With Chart12.SeriesCollection.NewSeries
    .ChartType = 73
    .Name = "='TV2_pk'!$K$13"
    .Values = "='TV2_pk'!$K$14:$K$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
    .XValues = "='TV2_pk'!$Q$14:$Q$" +
       CStr(xlsheet12.UsedRange.Rows.Count)
End With

With Chart12
    .ChartStyle = 240
    .Axes(2).MinimumScale = -10
    .Axes(2).MaximumScale = 40
    .Axes(2).CrossesAt = -40
    .Axes(1).MinimumScale = 0.47
    .Axes(1).MaximumScale = 0.89
    .Axes(1, 1).HasTitle = True
    .Axes(1, 1).AxisTitle.Characters.Text = "Frequency(GHz)"
    .Axes(2, 1).HasTitle = True
    .Axes(2, 1).AxisTitle.Characters.Text = "dBuV"
End With

ProgressBar1.Value = 85
'-----------------------------------------------------------------------
'=======================================================================
'=======================================================================
'Code to copy chart to word file
```

```
        Dim wrdApp
        Dim WDDoc
        wrdApp = CreateObject("Word.Application")

startingwordfile:
        OpenFileDialogwordfile.Filter = "Word Documents|*.doc|Word
            Documents|*.docx"
        OpenFileDialogwordfile.Title = "Select the report file"

        If OpenFileDialogwordfile.ShowDialog() =
            System.Windows.Forms.DialogResult.Cancel Then
            Select Case MsgBox("Kindly select the report template / file?
                " + Chr(34) + "Click yes to select the template or click
                no for the main window", MsgBoxStyle.YesNo, "Warning")
                Case MsgBoxResult.Yes
                    GoTo wordfileopen

                Case MsgBoxResult.No
                    xlwbk.Save()
                    xlwbk.Close()
                    GoTo Endline
            End Select
        End If

Wordfileopen:
        OpenFileDialogwordfile.ShowDialog()
        wrdApp.Documents.Open(OpenFileDialogwordfile.FileName)

        WDDoc = wrdApp.Documents(1)
        WDDoc.Activate()
        Select Case MsgBox("Are you sure about the selected file ?" +
            Chr(34) + OpenFileDialogwordfile.FileName, MsgBoxStyle.YesNo,
            "Conformation")
            Case MsgBoxResult.Yes
                GoTo Continueprogram
            Case MsgBoxResult.No
                WDDoc.Save()
                WDDoc.Close()
                GoTo startingwordfile
        End Select

        wrdApp.Selection.EndKey(Unit:=6)

        Chart1.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
            Size:=XlPictureAppearance.xlScreen,
            Format:=XlCopyPictureFormat.xlPicture)
        wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
            Placement:=0, DisplayAsIcon:=False)
        wrdApp.Selection.EndKey(Unit:=6)
```

```
Chart2.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)

Chart3.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)

Chart4.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)

Chart5.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)

Chart6.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)

Chart7.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)

Chart8.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
    Size:=XlPictureAppearance.xlScreen,
    Format:=XlCopyPictureFormat.xlPicture)
wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
    Placement:=0, DisplayAsIcon:=False)
wrdApp.Selection.EndKey(Unit:=6)
```

```
        Chart9.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
            Size:=XlPictureAppearance.xlScreen,
            Format:=XlCopyPictureFormat.xlPicture)
        wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
            Placement:=0, DisplayAsIcon:=False)
        wrdApp.Selection.EndKey(Unit:=6)

        Chart10.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
            Size:=XlPictureAppearance.xlScreen,
            Format:=XlCopyPictureFormat.xlPicture)
        wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
            Placement:=0, DisplayAsIcon:=False)
        wrdApp.Selection.EndKey(Unit:=6)

        Chart11.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
            Size:=XlPictureAppearance.xlScreen,
            Format:=XlCopyPictureFormat.xlPicture)
        wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
            Placement:=0, DisplayAsIcon:=False)
        wrdApp.Selection.EndKey(Unit:=6)

        Chart12.CopyPicture(Appearance:=XlPictureAppearance.xlScreen,
            Size:=XlPictureAppearance.xlScreen,
            Format:=XlCopyPictureFormat.xlPicture)
        wrdApp.Selection.Range.PasteSpecial(Link:=False, DataType:=3,
            Placement:=0, DisplayAsIcon:=False)
        wrdApp.Selection.EndKey(Unit:=6)

        WDDoc.SaveAs(OpenFileDialogwordfile.FileName)
        WDDoc.Close()
        WDDoc = Nothing
        wrdApp = Nothing
        '=================================================================================
        'Saving Excel file:
        xlwbk.ActiveWorkbook.SaveAs(FileName:=SavePath)
        xlwbk.ActiveWorkbook.Close()
        xlwbk.Quit()
        Label.Text = "Completed"
        ProgressBar1.Value = 100

Endline:
        ProgressBar1.Value = 0
        Me.Show()

        '=================================================================================
    End Sub
```

```
    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
        System.EventArgs) Handles Button1.Click
        Me.Close()
    End Sub
End Class
```

C

Appendix C

Listing C.1: CAN Analysis

```
imports System.Text
Imports Microsoft.Office.Interop.Excel
Imports Microsoft.Office.Interop
imports System
imports System.IO
imports System.Data.OleDb


public class Form1
    public void Button1_Click(ByVal sender As System.Object, ByVal e As
        System.EventArgs) Handles Button1.Click

CSVfileopen:

        ProgressBar1.Value = 0
        Label.Text = "Started"
        OpenFileDialog.Filter = "CSV Files|*.csv"
        OpenFileDialog.Title = "Select the Can File (.CSV)"
        Dim xl As Excel.Application = Nothing
        Dim xlWorkBooks As Excel.Workbooks = Nothing
        Dim xlWorkBook
        Dim xlWorkSheet As Excel.Worksheet = Nothing
        Dim xlWorkSheets As Excel.Sheets = Nothing
        Dim xlCells As Excel.Range = Nothing
        Dim xlSheet1 As Excel.Worksheet = Nothing
        Dim xlsheet2 As Excel.Worksheet = Nothing
        ProgressBar1.Value = 5
        Label.Text = "In progress"

        If OpenFileDialog.ShowDialog() =
            System.Windows.Forms.DialogResult.Cancel Then
            Select Case MsgBox("Kindly select the Can File (.CSV)? " +
                Chr(34) + "Click yes to select the template or click no
                for the main window", MsgBoxStyle.YesNo, "Warning")
                Case MsgBoxResult.Yes
                    GoTo CSVfileopen
                Case MsgBoxResult.No
```

```
                GoTo Endline
            End Select
        End If

startingCSV:

        Select Case MsgBox("Are you sure about the selected file ?" +
            Chr(34) + OpenFileDialog.FileName, MsgBoxStyle.YesNo,
            "Conformation")
            Case MsgBoxResult.Yes
                GoTo Continueprogram
            Case MsgBoxResult.No
                GoTo startingCSV
        End Select

Continueprogram:

        FilePathlabel.Text = OpenFileDialog.FileName
        xl = New Excel.Application
        xl.DisplayAlerts = False
        xlWorkBooks = xl.Workbooks
        xlWorkBook = xlWorkBooks.Open(Filename:=FilePathlabel.Text,
            Local:=True)

        ProgressBar1.Value = 10

        xlWorkSheets = xlWorkBook.Sheets
        xlSheet1 = xlWorkBook.ActiveSheet

        'To create new excel sheets
        xlsheet2 =
            xlWorkBook.Sheets.Add(After:=xlWorkBook.Sheets(xlWorkBook.Sheets.Count))

        xlsheet2.Name = "Filtered Data"

        Dim minRow As Integer
        Dim maxRow As Integer
        Dim minCol As Integer
        Dim maxCol As Integer
        minRow = xlSheet1.UsedRange.Row
        maxRow = xlSheet1.UsedRange.Rows.Count
        minCol = xlSheet1.UsedRange.Column
        maxCol = xlSheet1.UsedRange.Columns.Count
        Label.Text = "Stay Calm"
        ProgressBar1.Value = 20
        '------------------------------------------------------------------------------
        'Program to delete the empty column

        Dim var As Boolean
```

```
var = False
Dim t As Integer = 0
For c As Integer = 1 To maxCol
    var = False
    For r As Integer = 2 To maxRow
        If CStr(xlSheet1.Cells(r, c).Value) <> "" Then
            var = True
            Exit For

        End If
    Next
    If var = True Then
        t = t + 1
        xlsheet2.Cells(1, t).Value = CStr(xlSheet1.Cells(1,
            c).Value)
        For r As Integer = 2 To maxRow
            xlsheet2.Cells(r, t) = xlSheet1.Cells(r, c).Value
        Next

    End If
    If ProgressBar1.Value = 90 Then
        ProgressBar1.Value = 20
    End If
    ProgressBar1.Value = ProgressBar1.Value + 1

Next
Label.Text = "Almost done"
ProgressBar1.Value = 60
'--------------------------------------------------------------------------------
'Code to fill the empty cells
minRow = xlsheet2.UsedRange.Row
minCol = xlsheet2.UsedRange.Column
maxCol = xlsheet2.UsedRange.Columns.Count

For c As Integer = 1 To maxCol
    Dim lastval = -1
    For r As Integer = 2 To maxRow
        If CStr(xlsheet2.Cells(r, c).Value) = "" Then
            If lastval = -1 Then
                For rr As Integer = r + 1 To maxRow
                    If CStr(xlsheet2.Cells(rr, c).Value) <> "" Then
                        lastval = xlsheet2.Cells(rr, c).Value
                        Exit For
                    End If
                Next
                xlsheet2.Cells(r, c).Value = lastval
                Continue For
            Else : xlsheet2.Cells(r, c).Value = lastval
            End If
```

```
            Else
                lastval = xlsheet2.Cells(r, c).Value

            End If
        Next
    Next

    ProgressBar1.Value = 80
    '-----------------------------------------------------------------------------
    Dim Chart1
    Chart1 = xlsheet2.Shapes.AddChart.Chart
    With Chart1
        .HasTitle = True
        .ChartTitle.Text = "Field Strength VS Time"
    End With

    For Each s In Chart1.SeriesCollection
        s.Delete()
    Next

    With Chart1.SeriesCollection.NewSeries
        .ChartType = 73
        .Name = "='Field Strength VS Time'!$I$13"
        .Values = "='Field Strength VS Time'!$LV$1:$LV$" +
            CStr(xlSheet1.UsedRange.Rows.Count)
        .XValues = "='Field Strength VS Time'!$A$1:$A$" +
            CStr(xlSheet1.UsedRange.Rows.Count)
    End With
    '-----------------------------------------------------------------------------
    Label.Text = "Completed"
    ProgressBar1.Value = 100
    xl.Visible = True
    Select Case MsgBox("Do you want to continue the program ?",
        MsgBoxStyle.YesNo, "Want to work more ?")

        Case MsgBoxResult.Yes
            ProgressBar1.Value = 0
            Me.Show()
        Case MsgBoxResult.No
            GoTo lastline

    End Select

Endline:
    ProgressBar1.Value = 0
    Me.Show()

lastline:
```

```
        Me.Close()
    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
        System.EventArgs) Handles Button2.Click
        Me.Close()
    End Sub
End Class
```