

Spectrum Monitoring

Chapter one

Introduction

1.1 Background:

Historically, accessing and using radio spectrum has been highly regulated, in order to prevent interference amongst various users in adjacent frequency bands. In the last decade, there have been significant innovations in the theory and Practice of spectrum regulation. There is a growing consensus that past and current regulatory practices have delayed the introduction and growth of beneficial technologies and services or have artificially increased costs. As the result, there is a renewed emphasis on striking the best possible balance between the certainty of administrative approaches and the flexibility of more light-handed market-based regulation.

1.1.1 Interference and Efficiency:

There are two types of efficiency which regulators have to take into account when considering spectrum management.

The first, technical efficiency, which principally refers to the requirement that different users and different uses of radio frequencies should not interfere with each other. It also refers to the need to tackle a host of related problems, such as the use of faulty or non-standard equipment, the unauthorized or illegal use of frequencies, spillover signals effects from neighboring jurisdictions administrations, the use of inappropriate levels of power, finding the optimum location for antenna, and so on, all of which can effect affect the attenuation, successful transmission and reception of signals, the problems of cross-talk and the general problem of channel radio interference. These problems are what economists call ‘negative externalities’ which means that the use of one channel can have an adverse impact on those that are external to it. Achieving technical efficiency is really the work of the engineers inside the regulatory body.

The second type of efficiency is economic efficiency. This is a much wider regulatory issue because it involves a judgment regarding the allocation of relatively scarce spectrum among alternative uses to provide different, in some cases competing, types of services. How is the regulator to allocate spectrum? On a first-come-first-served basis? Using purely administrative criteria? Using some form of spectrum pricing, possibly an auction, so the market will influence the choice?

Markets will change over time, and so will the prices consumers are willing to pay for different categories of services delivered by radio, and therefore so will the value a service provider places upon the spectrum they use. If the economic value of spectrum is to be included in the allocation decision, then it follows that there should also be some mechanism to allow spectrum to be reallocated as market valuations change over time. Because both types of efficiency are required of a modern telecommunications regulator there needs to be good coordination between the engineering and the policy wings of the regulator's office.

1.2 Problem Statement

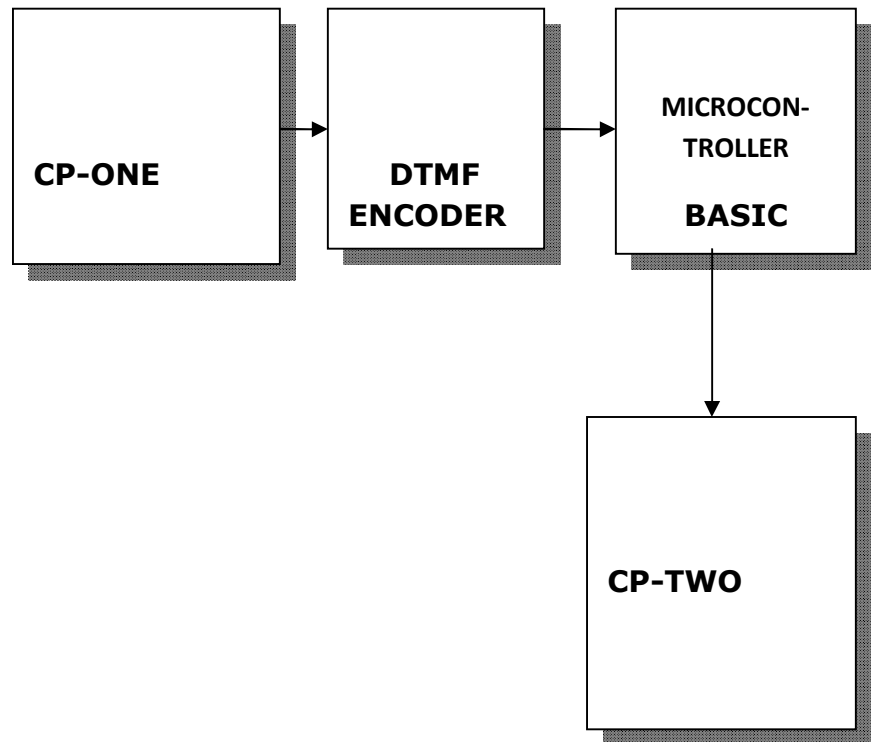
The main idea of the research how to make computer screen simulation of the spectrum display so to detect a random frequency without license to explain actions taken by regulators and stakeholders in response to changing market conditions and changing technologies so make the radio communications services without harmful interferences.

1.3 objectives

- The main aim of the project is to detect a random frequency without license to explain actions taken by regulators using computer.

1.4 methodologies

- In order to implement this system we used two computers, one for the remote control and other for the local section which received the DTMF signal
- The conversion of DTMF signal to binary code is made by DTMF Encoder.
- Database: the Database consist a lot of authorized frequency that are license by ITU-R and a NTC Sudan.
- We used BASIC STAM microcontroller and programmed by C++ language to examine incoming signals through DTMF decoder and display the outputs through CP two. The diagram of the design is shown in figure (1.1)



▪ Figure (1.1): Block diagram of the design

1.5 Research Plan

The Research consists of six chapters:-

Chapter one: An Introduction:-

It consists of the Background of research, problem statement, objective, methodology, research outline.

Chapter two: literature review

It contains electromagnetic waves (types, usage, characteristics and creation and detection), Overview for Spectrum Management (radio services, frequency band and Radio Regulations).

Chapter three: system design

It contains Basic stamp microcontroller, DTMF decoder and two computers.

Chapter four: software

The software level is the programming by turbo C++ language.

Chapter five: Results and discussion.

Chapter six: Conclusion and recommendations.

Chapter Two

Electromagnetic Waves and Spectrum Management

2.1 Overview of Electromagnetic Waves.

Electromagnetic waves consist of a combination of oscillating electrical and magnetic fields, perpendicular to each other. This is difficult to visualize, however the wave form has similar characteristics of other types of waves. Although they seem different, radio waves, and microwaves, x-rays, and even visible light are all electromagnetic waves. They are part of the electromagnetic spectrum, and each has a different range of wavelengths, which cause they waves to affect matter differently. The creation and detection of the wave depend much on the range of wavelengths.

Questions you may have include:

- What is the electromagnetic spectrum?
- What are the characteristics of electromagnetic waves?
- How are these waves?

2.1.1 Electromagnetic spectrum

The range of wavelengths for electromagnetic waves--from the very long to the very short--is called the Electromagnetic Spectrum:

- **Radio and TV:** waves are the longest usable waves created and detected, having a wavelength of 1 mile (1.5 kilometer) or more.
- **Microwaves:** are used in telecommunication as well as for cooking food.
- **Infrared:** waves are barely visible. They are the deep red rays you get from a heat lamp.
- **Visible light:** waves are the radiation you can see with your eyes. Their wavelengths are in the range of 1/1000 centimeter.

- **Ultraviolet:** rays are what give you sunburn and are used in "black lights" that make object glow.
- **X-rays:** go through the body and are used for medical purposes.
- **Gamma rays:** are dangerous rays coming from nuclear reactors and atomic bombs. They have the shortest wavelength in the electromagnetic spectrum of about 1/10,000,000 centimeter.

2.1.2 Characteristics of electromagnetic waves

Electromagnetic waves are transverse waves, similar to water waves in the ocean or the waves seen on a guitar string. This is as opposed to the compression waves of sound. All waves have amplitude, wavelength, velocity and frequency.

Amplitude

The amplitude of electromagnetic waves relates to its intensity or brightness (as in the case of visible light).with visible light, the brightness is usually measured in lumens. With other wavelengths the intensity of the radiation, which is power per unit area or watts per square meter is used. The square of the amplitude of a wave is the intensity.

Wavelength

The wavelengths of electromagnetic waves go from extremely long to extremely short and everything in between. The wavelengths determine how matter responds to the electromagnetic wave, and those characteristics determine the name we give that particular group of wavelengths.

Velocity

The velocity of electromagnetic waves in a vacuum is approximately 186,000 miles per second or 300,000 kilometers per second, the same as the speed of light. When these waves pass through matter, they slow down slightly, according to their wavelength.

Frequency

The frequency of any wave form equals the velocity divided by the wavelength. The units of measurement are in cycles per second or Hertz.

2.1.3 Creation and detection

When electrons move, they create a magnetic field. When electrons move back and forth or oscillate, their electric and magnetic fields change together, forming an electromagnetic wave. This oscillation can come from atoms being heated and thus moving about rapidly or from alternating current (AC) electricity. The opposite effect occurs when an electromagnetic wave hits matter. In such a case, it could cause atoms to vibrate, creating heat, or it can cause electrons to oscillate, depending on the wavelength of the radiation.

Sources of electromagnetic radiation

Electromagnetic radiation is emitted from all matter with a temperature above absolute zero. Temperature is the measure of the average energy of vibrating atoms and that vibration causes them to give off electromagnetic radiation. As the temperature increases, more radiation and shorter wavelengths of electromagnetic radiation are emitted.

Sources of long wavelengths

Microwaves, radio, and television waves are emitted from electronic devices. Sparks and alternating current cause vibrations at the appropriate frequencies.

Sources of visible light

Visible light is emitted from matter hotter than about 700 degrees Celsius. This matter is said to be incandescent. The sun, a fire, and the ordinary light bulb are incandescent sources of light. as the element in an electric stove gets warm, it gives off infrared radiation, and then when it gets hotter than 700 degrees, it starts to glow. Visible light is being emitted from the hot element.

Sources of short wavelengths

By smashing high-energy electrons into other particles, such as atoms in a metal, X-rays are created. Gamma rays are emitted from nuclear reactions, atomic bombs, and explosions on the Sun and other stars.

Detectors of electromagnetic radiation

There are a number of different types of detectors of electromagnetic radiation. We know the common ones for detecting visible light: the eye, camera film, and the detectors on some calculators. Your skin can also detect both visible light and infrared heat rays. Electronic devices are necessary to detect most of the longer waves, such as radio waves. Special film can detect shorter wavelengths such as X-rays

Summary

Electromagnetic waves are transverse waves that travel at the speed of light. The spectrum of their wavelengths results in waves that are used in many of our useful devices. The waves are formed by heat, electronics, and nuclear forces.

2.2 Spectrum Management

2.2.1 Radio Services

In the parlance of the World Radio Conference (WRC) the uses of radio are typically divided into:

1. Radio services,
2. The spectrum used is divided into frequency bands
3. Administrations allocate frequency bands to different categories of services

4. Often with a licensing process for different types of transmission by service providers who use the frequencies assigned to them by the administration.

Public and private service requirements are two distinct areas. The spectrum required for government and public services, for example the emergency services, national defense, public service, broadcasting, and so forth, has traditionally been determined by administrative means, which raises some problems.

On the other hand, it is necessary to reserve spectrum for these services because a market mechanism would almost certainly result in the relevant spectrum being used for other, more commercial purposes.

political and security concerns may well result in an over-allocation of spectrum to these services, and the use of the spectrum by public service operators

may become very wasteful if there is no mechanism to enforce the most efficient use of frequencies.

Spectrum allocated to private services, and frequencies assigned to private service providers, may confer either property rights or rights of usage, which can raise difficult questions of whether spectrum should be tradable, of the dangers of monopoly, and what, if any, regulations or obligations should be imposed upon the assignment of frequencies. a further question concerns the re-assignment of frequencies that may become necessary, and whether the holders of the frequencies are under an obligation to return them before the expiry of their licenses. And in the absence of strict regulations governing the use and non-use of frequencies, private operators may be tempted to ‘bank’ licenses, being motivated by the prospect of a future sale, or simply by the desire to keep the frequency out of the hands of a competitor. For all these reasons the allocation of spectrum and the assignment of frequencies needs close co-ordination between the technical, engineering side of the regulator’s office to monitor the efficient use of spectrum, and the economic, policy side to monitor the market and possible abuses of market power.

2.2.2 Frequency Bands

Nothing illustrates better the explosive growth in the demand for radio spectrum than the upper limits of the ITU’s frequency tables.

- Pre-1947 = 200 MHz
- 1947 = 10.5 GHz
- 1959 = 40 GHz
- 1971 = 275 GHz

By the time of WRC 1997 most of the bands below 25GHz were in use, and although the higher bands have less utilization, additional applications, such as fixed wireless, have encroached above 25 GHz. a growing interest in space exploration and in broadcasting satellite services have also created a demand for the higher end of the spectrum.

2.2.3 WRC Regional Frequency Allocations

As far as possible the ITU tries to achieve harmonization of frequency allocations intra-regionally and inter-regionally. In some cases frequency

allocations are specific to a particular service; in other cases a group of services can share a band and it is left up to the local administration to assign frequencies according to local requirements. For example, in some areas the demand for cellular mobile telecommunications services will be far greater than in others. Climatic variations and signal propagation characteristics may also be important considerations. Sharing frequency bands obviously raises problems of potential interference and regulators have to consider safeguards such as constraints on usage, for example restrictions on power levels, on the direction of antenna, on day time or night time transmission, on the use of guard bands, and so on. Interference may be impossible to eliminate altogether, in which case acceptable levels have to be imposed.

1. Primary and Secondary allocations

The mechanisms for doing this vary from the carefully calibrated use of algorithms to simple trial and error, but in the allocation of frequency bands the ITU recommendations include primary and secondary allocations. Primary allocations are indicated by upper case in frequency tables, such as FIXED or MOBILE, whereas only the first letter is capitalized in secondary allocations, for example Fixed or Amateur. In the event of interference, operators with secondary assignments are required to accommodate the requirements of those with primary assignments.

2. Frequency Table

The WRC frequency tables contain over thirty footnotes (treated as paragraphs in the ITU's Radio Regulations or RR) which specify a variety of addenda, such as primary and secondary allocations, jurisdictions where exceptions apply, and so on. They also cover the allocation of radio bands for technical, scientific and medical equipment and apparatus which use radio frequency (RF) and from which there is a danger of radiation which could prove either hazardous or an interference.

2.2.4 Radio Regulations

The ITU's Radio Regulations (RR) are the primary reference point for all regulators of spectrum management, and are derived from the recommendations of the World Radio Conference (WRC) and the Regional Radio communications Conferences (RRCs). Part 2 examined the division of the spectrum into frequency bands and the use of spectrum among different radio services. Part 3 examines the allocation of frequencies among radio services. Fixed Service frequency allocations, FS frequency allocations are extensive, but are all shared. Between 30 – 1000 MHz allocations to FS with primary status accounts for 90 per cent of

spectrum in Region 3, and around 45 per cent in Regions 1 and 2. In Region 3 FS is mostly shared with MS and BS, along with other services. Above 1 GHz around 55 – 60 per cent of all spectrums is allocated to FS with primary status, but shared with BS, BSS, FSS, MS, MSS, RLS, SR and ISS. The ability to re-use frequencies varies according to service types, for example, FSS may be highly directional leaving space for simultaneous terrestrial FS use.

Broadcasting Service frequency allocations

WRC allocations of HF spectrum up to the year 2007 provides for 3715 kHz of exclusive bandwidth distributed between the 5950 kHz – 21850 kHz bands, although country variations allow for some sharing with low-powered FS. Both FS and MS services had to shifted to clear these bands. For wide-area continuous sound and television broadcasting much greater bandwidth is required, up to 80 MHz per TV programmed and 2 MHz per audio radio broadcast. In the VHF and UHF bands about 60 per cent of all the spectrum below 960 MHz is allocated to BS, a total of 674 MHz of bandwidth in Region 3 where BS is shared equally with FS and MS. above 1 GHz various world and regional allocations have been made. In Region 3 11.7 – 12.5 GHz was allocated to BS on a primary shared basis. BSS allocations have been made near the 12 GHz band and the 40.5 – 42.5 GHz and 84-86 GHz bands.

Digital television and audio broadcasting

The introduction of digital television is subject to the ITU-R Digital television terrestrial broadcasting 1997 Recommendation (BT.798-1) guidelines which propose digital systems should fit into one of the existing 6, 7 or 8 MHz analogue channels. as the migration towards digital television gathers pace, and that depends upon television industry standards and the pace of technological development and the rate of take-up of digital TV sets by the general public, so more channels will become available for broadcast. But also bandwidth may be freed up from BS for other uses. Digital broadcasts may also migrate to cable systems, or to BSS systems, which would free up yet more spectrum in the VHF and UHF bands.

Digital audio broadcasting systems would offer improvements in quality of reception and will use less transmission power, but it will be some time before digital radio receivers become low cost enough for the general public to accept a switch-over. So unlike the shift to digital television, which has been time-tabled in many countries even though a cut-off date for analogue broadcasts may not always have been determined, for example in the case of Hong Kong, it is unlikely that regulations will mandate digital radio for any time soon.

But satellite digital audio broadcasting (S-DAB) for reception by vehicles and mobile handsets is finding a market. The 1452 – 1492 MHz band has been allocated for BSS for S-DAB outside the USA and one or two other countries, but it is shared with FS and other services. The ITU has also proposed reserving part of the corresponding frequencies of the BS band for terrestrial digital audio broadcasting (T-DAB).

Mobile Services frequency allocations

Mobile services cover land, sea and air. Below 30 MHz maritime and aeronautical mobile services, including satellite, have primary and often exclusive status. Tuned to the pair of frequencies assigned to them.

a. Private Mobile Services The demand for PMR is usually very high, and grows in parallel with commercial development as transportation companies approaches open to regulators to minimize channel interference:

1. Same channel-pair assignment may be possible if the base stations are sufficiently far apart, given the frequencies used,
2. Ensuring the use of narrow bandwidth equipment, which can be encouraged by pricing the use of spectrum.
3. Channel sharing can be possible using selective calling devices which can detect when neighboring networks are not utilizing channels,
4. Sharing channels can work even during periods of heavy traffic on neighboring networks if a trucking system is used.

b. Public Mobile Radio Services (PMRS) is virtually an extension of the PSTN. First generation (1G) mobile was an analogue system, introduced into Hong Kong in 1985. Second generation (2G) mobile came to Hong Kong during the 1990s, and by 1995 there were three 2G operators who replaced the AMPS 800, TACS 900, and TDMA ETACS networks with D-AMPS, CDMA , D-TDMA and GSM systems. The D-AMPS system has since been replaced by a narrow band CDMA network. In 1996 six Personal Communications Network (PCN) licenses were issued for GSM 1800, bringing the total of networks to eleven, operated by six companies. Three of these operators are able to offer seamless handover between their GSM and CDMA.

c. Fixed Satellite Services occupy around 55 per cent of WRC allocations of spectrum between 2.5 and 31 GHz. The major services include commercial C, Ku and Ka band Geostationary Orbit (GSO) satellite networks services, non-GSO satellite networks services, BBS and MSS feeder links, among others.

Broadcasting Satellite Services frequency allocations

Broadcasting satellite service (BSS) is sometimes known as direct broadcasting satellite (DBS) and needs to be distinguished from direct-to-home satellite television (DTH) which comes under FSS and is probably today the dominant activity of FSS.

Mobile Satellite Services frequency allocations

There are six groups of spectrum allocations for MSS, plus some FSS feeder links to MSS and in recent years direct links between Medium and Low Earth.

2.2.5 Licensing of Spectrum Use

Spectrum management is first and foremost about tackling the problems of interference between different users of the spectrum. When Member States sign up to the ITU they agree to abide by the Radio Regulations which stipulate they should manage their national spectrum in ways which prevent cross-border interference. Three key issues concern regulators of spectrum:

1. Interference issues
2. Potential radiation hazards on health and safety issues
3. Efficiency issues

In addition, the regulator must study the following:

1. WRC recommendations and other ITU spectrum allocation issues
2. Other international agreements, such as come under the WTO, including the Basic Agreement on Telecommunications (BAT) Reference Paper on transparent regulatory procedures, the International Technology Agreement (ITA) commitment to remove tariffs on equipment imports, APEC's Mutual Recognition Agreement (MRA) for mutual equipment type approval procedures, and so on.
3. Recent developments in technologies
4. Market developments
5. Developments in regulatory practices world wide
6. And finally the regulator is guided by the policies of the government.

2.2.6 Spectrum Planning

Logically, the first job of the regulator is to draw up a national spectrum plan based upon the ITU's regional allocations. the national plans are usually far more detailed than the ITU's because there will be many different types of service under each major radio service heading.

A second reason is that many frequency bands are allocated to different radio services which share the bands.

1. Spectrum planning and allocation.
2. Assignment and licensing of frequencies.
3. Regulation and rule.
4. Frequency coordination with adjacent administrations,
5. Spectrum engineering,
6. Database of existing frequency utilization.
7. Monitoring system, run by the Radio Monitoring Unit (RMU).
8. Enforcement of regulations and license conditions.

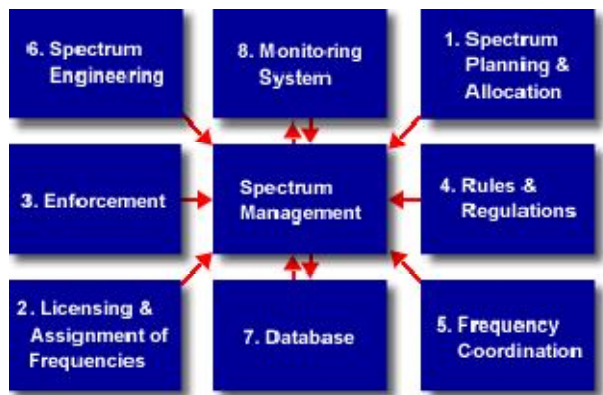


Figure (2.1) Procedures and Consultation for Frequency Assignment

2.2.7 Frequency Coordination

A Frequency Coordination Agreement was originally endorsed in 1992 by OFTA and the Office of Guangdong Wireless Management Committee. And the coordination of the use the frequencies to avoid mutual harmful interference.

2.2.8 Spectrum Management and EMC

OFTA, or rather its predecessor unit within the Post Office, did not start serious spectrum management and planning until the early 1980s. Until then frequencies were issued on a first-come-first-served basis within the spectrum band allocations.

2.2.9 Public Mobile Radio Services

A senior OFTA official describes the situation in those days as follows, Before OFTA instituted a proper frequency planning system, and there was only a simple frequency registration process. Radio assignment was done in a very simple way. If there was a vacant channel, you simply put the operator in it.

2.2.10 Private Radio Mobile Services

A recommendation for the use of private radio mobile systems. The Electrical and Mechanical Services Department had suggested that the equipment

life was 7 years and 60% of the UHF portable radios were licensed within the past 4 years.

2.2.11 Re-assignment of Spectrum

Re-assignment of spectrum is a task that becomes necessary as new technologies give rise to new types of devices and new radio services while making old ones redundant. Conforming to ITU guidelines is another factor.

2.2.12 (3G) generation mobile networks.

The process of returning spectrum can be an awkward one unless it was written into the license awarding the original frequency assignment. In some cases the regulator has to wait for licenses to expire, in other cases to trade one set of frequencies for another, or, in the case of many fixed radio services, encourage their migration to wire lines or cables or fiber.

2.2.13 New Licenses and Services

When new technologies give rise to new radio services, for example third generation (3G) mobile radio communications, OFTA follows standard procedures. These begin with a working group set up to examine the technology and the spectrum requirements. the second step is drawing up a license and its conditions, a process involving legal drafters and taking about three months to complete.

2.2.14 Health and Safety

No-one doubts that radiation at high levels and in high doses causes health and safety risks, the problem is knowing for sure what transmitting devices emit dangerous levels, when and under what circumstances they may do so, over what periods of time exposure reaches critical levels, and so forth.

2.2.15 License Fees and Spectrum Pricing

The issue of efficiency involves both technical efficiency, in using spectrum in a way that avoids mutual interference between users, and economic efficiency, in using spectrum as a scarce resource in a way that brings the greatest social gain. For reasons spelt out in Part 1, market mechanisms may not ensure that some public goods, such as emergency services, are adequately provided with spectrum.

2.2.16 Spectrum Fees

Spectrum and license fees are supposed to cover the administrative costs of the studies and monitoring required to plan and manages the relevant part of the spectrum, and the amount of frequency that is used, because the more frequency used the greater the problems of monitoring and managing interference. In addition

a variable factor is built-in to encourage the use of higher frequencies in order to reduce the crowding at lower frequencies.

2.2.17 Broadband and Convergence

The delivery of broadband services, such as digital terrestrial and satellite television, cable television and cable modem services, interactive television over telephone lines, fast Internet services over digital subscriber lines, or over fixed wireless broadband to the building, or through packet-switched mobile networks to different handheld devices, poses new challenges for regulators and spectrum management besides the obvious one of allocating frequency to different services. Indeed, the problem of allocating new frequencies to new services and issuing new licenses is nothing new at all, just an extension of the regulator's traditional tasks. What is new is the degree of attention that now must be placed upon customer access networks for the delivery of broadband services.

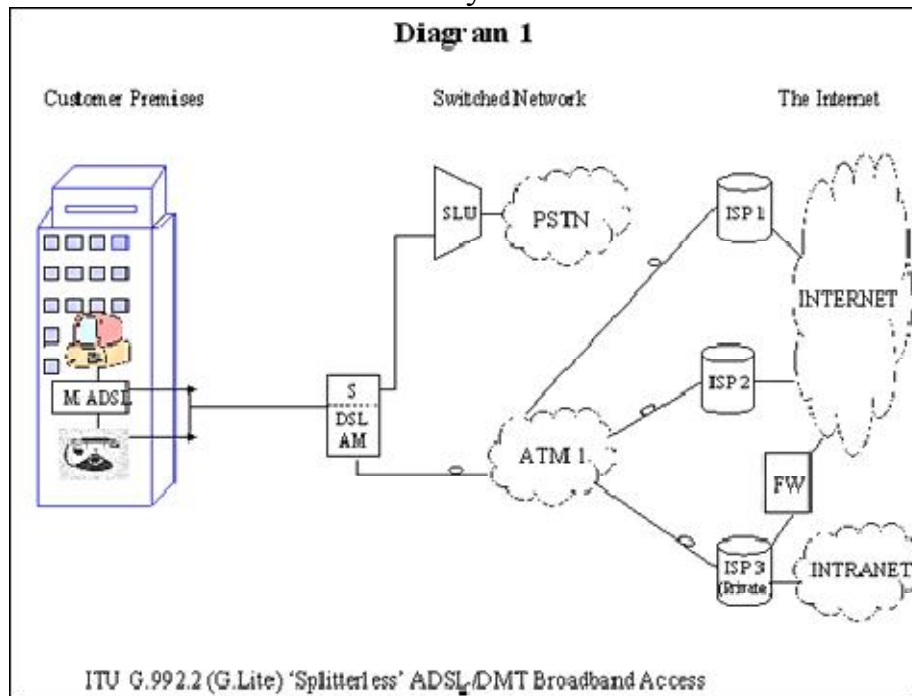


Figure (2.2) In-building Coaxial Cable Distribution Systems

In-building Coaxial Cable Distribution Systems (IBCCDSs) are the block wiring systems inside multi-storey buildings that provide connectivity for a variety of broadcast and multimedia networks. Cable television is one system which is distributed through a hybrid fibre coaxial network to the building basement and channels are then relayed through the IBCCDS to individual subscribers.

2.2.18 Third Generation (3G) Public Mobile Radio Services

A major development in mobile communications is taking place, the shift from circuit to packet switched networks. This has been called second-and-a-half generation mobile phone or 2.5G but so far as the issuing of new frequencies are concerned it is the development of UMTS or 3G that is important. There are many complex policy issues surrounding the issuing of 3G licenses, for example whether they should be auctioned, and if so what method of auctioning is preferable. This debate has been vigorous in Hong Kong, and focuses on OFTA's two Consultation Papers, issued in March and October 2000.

OFTA has allocated frequencies at 1920 – 1980 MHz and 2110 – 2170 MHz per second FDD and 20 MHz for unpaired TDD, and WRC2000 recommended additional frequencies become available. Managing spectrum allocations and assignments for 3G and future generations of broadband mobile services will clearly be a major role for regulators in the coming years.

Chapter Three

Basic stamp microcontroller

3.1 Overview about basic stamp microcontroller

BASIC Stamp module is a microcontroller (tiny computer) runs the Parallax PBASIC language interpreter in its microcontroller. It is called a "Stamp" because it is close to the size of an average postage stamp. The developer's code is stored in an EEPROM, which can also be used for data storage. The PBASIC language has easy-to-use commands for basic I/O, like turning devices on or off, more advanced commands let the BASIC Stamp module interface with other integrated circuits,

3.2 basic stamp applications

“Typical application areas for BASIC Stamp's are:-

- General electronics
- Home automation

- Robotics
- Mini PLC
- Education
- Prototyping
- HAM related applications
- Special effects in films
- Industry control
- Geological instruments
- Computer peripherals
- Scale model hobbyists

3.3 BASIC Stamp Modules

There are currently eight models of the BASIC Stamp:-

3.3.1 BASIC Stamp Rev Dex model (27100)

Is the original basic stamp module. Often underestimated, but powerful enough for many applications. BASIC Stamp microcontroller and programming board all in one package. Operating on many custom projects.



Figure (3.1): BASIC Stamp Rev Dex model (27100)

3.3.2 BASIC Stamp 1 model (BS1-IC)

It is equivalent to the Rev.Dex except it is packaged in 14 pin 8 I/O and it is windows environment and ideal for the small jobs

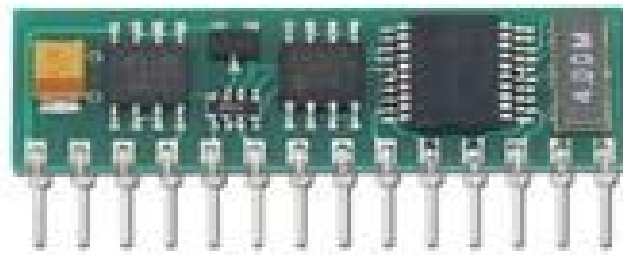


Figure (3.2): BS1-IC

3.3.3 BASIC Stamp 2 model (BS2 -IC)

BASIC Stamp 2 microcontroller it is the single most popular basic stamp module, widely used in industrial, education and hobbyist applications, The BS2-IC has plenty of I/O pins, processing speed, and program space for most designs. No compiler is required, and a serial interface provides enhanced debug features.



Figure (3.3): BS2-IC

3.3.4 BASIC Stamp 2e model (BS2E -IC)

A good fit for your BASIC Stamp 2 projects that require extra program and RAM space. All additional EEPROM and RAM (variables) of the BS2sx module without the associated current draw of higher speed.



Figure (3.4): BS2E –IC

3.3.5 BASIC Stamp 2sx model (BS2SX -IC)

The high-speed version of the BS2 module with extra EEPROM, RAM, and faster serial I/O. Ideal for BS2 users who need more horsepower. Only the BS2p modules are faster.



Figure (3.5): BS2SX –IC

3.3.6 BASIC Stamp 2p 24 models

The BS2p modules have several advantages over all previous BASIC Stamp microcontrollers. They're 300% faster than the BS2 module and 20% faster than the BS2sx module

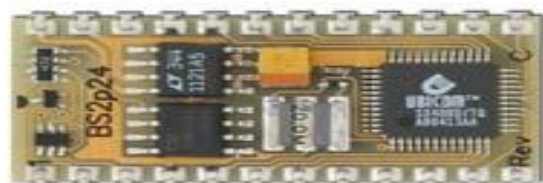


Figure (3.6): BS 2p 24

3.3.7 BASIC Stamp 2p 40 models

It is 40 pin version of the BS2p and provides 16 extra I/O pins

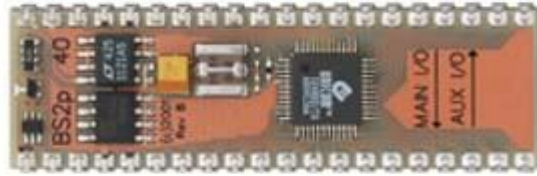


Figure (2.7): BS2p 40

3.3.8 BASIC Stamp 2pex Module

All the commands of a BS2p, with twice the EEPROM size and lower power consumption. Ideal for a battery-powered or data logging application. Program execution speed is less than the BS2p24 and p40 at 6,000 instructions/second.

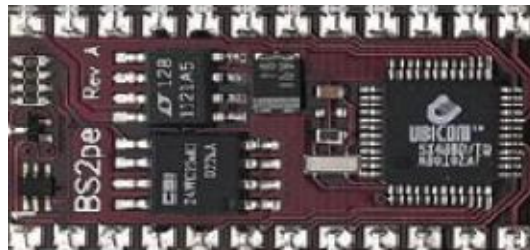


Figure (3.8): BS2pex

3.4 BASIC Stamp Boards

There are number of development boards to make using the BASIC Stamps more convenient. Below is a short description of the boards and their intended use.

3.4.1 BASIC Stamp 1 Carrier Board (Rev. E)

The BASIC Stamp 1 Carrier Board (also called the BS1 Carrier Board) is designed to accommodate the BS1-IC module. The BASIC Stamp 1 Carrier Board provides nearly the same form factor and prototyping space as with the BASIC

Stamp 1 Rev. D, but with the added feature of the reset button. Figure 2.1 shows the BASIC Stamp 1 Carrier Board with the BS1-IC, properly inserted into the socket. This board features a 3-pin programming header and 9-volt battery clips to connect a power source. A male, 14-pin 0.1" header (to the left of the through-hole array) allows access to all the BS1's pins. The first two columns of solder pads (closest to the header) are connected to the respective header pin. All other solder pads are isolated from each other. The entire through-hole array is provided for permanent or semi-permanent circuit design.

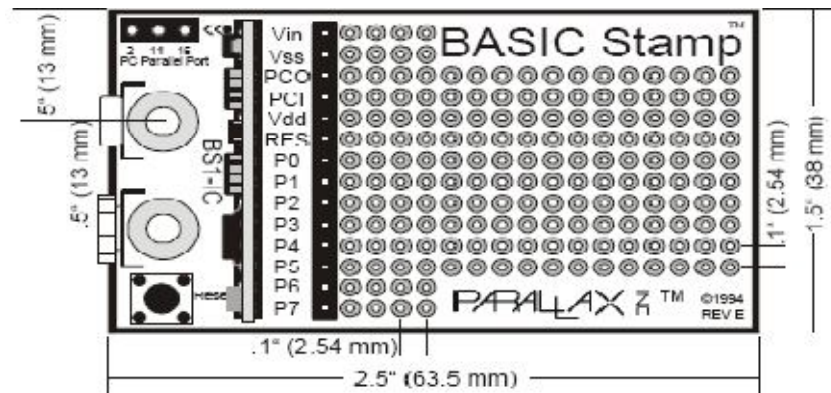


Figure (3.9): BASIC Stamp 1 Carrier Board (Rev. E)

3.4.2 BASIC Stamp 2 Carrier Board (Rev. B)

The BASIC Stamp 2 Carrier Board (also called the BS2 Carrier Board) is designed to accommodate the BS2-IC, BS2e-IC and BS2sx-IC modules. The BASIC Stamp 2 Carrier Board provides ample prototyping space for simple or moderate circuits.. This board features a DB9 programming connector, reset button, and 9-volt battery clips. Two male, 12-pin 0.1" headers (to the left and

right of the chip socket) allows access to all the module's pins. The first two columns of solder pads (closest to the headers) are connected to the respective header pin. All other solder pads are isolated from each other. The entire through-hole array is provided for permanent or semi- permanent circuit design.

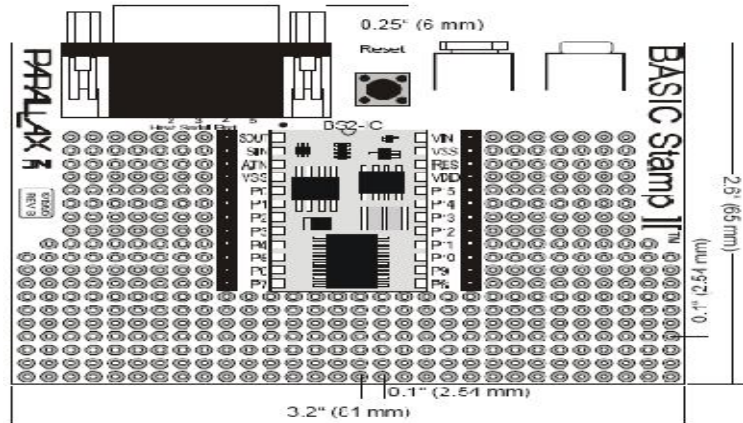


Figure (3.10): BASIC Stamp 2 Carrier Board (Rev. B)

3.4.3 BASIC Stamp Super Carrier (Rev. A)

The BASIC Stamp Super Carrier board is designed to accommodate the BS1-IC, BS2-IC, BS2e-IC and BS2sx-IC modules. This board provides ample prototyping space for simple or moderate circuits. This board features a 3-pin programming connector (Stamp 1), DB9 programming connector Stamp 2, 2e, 2sx), reset button, 9-volt battery clips, barrel connector, separate 5-volt regulator, and power LED. A female, 20-pin 0.1" socket allows access to all the module's pins.

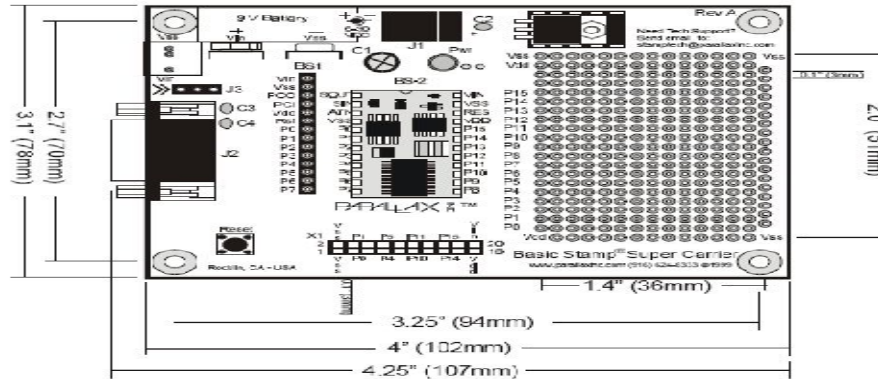


Figure (3.11): BASIC Stamp Super Carrier Board (Rev. A)

3.4.4 Board of Education (Rev. B)

The Board of Education is designed to accommodate the BS2-IC, BS2e-IC and BS2sx-IC modules. This board provides a small breadboard for quickly prototyping simple or moderate circuits. This board features a, DB9 programming connector, reset button, 9-volt battery clips, barrel connector, separate 5-volt regulator, power LED, 4 servo connectors and a breadboard. Three female 0.1" sockets allow for access to all the module's pins plus Vdd, Vin and Vss. Vdd is +5 volts and Vin is 6 – 9 volts (depending on your power supply).

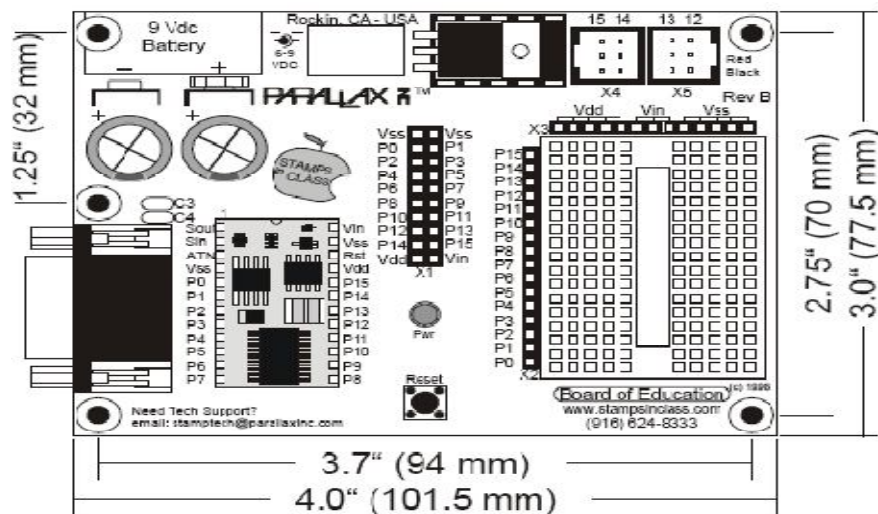


Figure (3.12): Board of Education

3.4.5 BASIC Stamp Activity Board (Rev. C)

The BASIC Stamp Activity Board (sometimes called BSAC) is designed to accommodate the BS1-IC, BS2-IC, BS2e-IC, BS2sx-IC and BS2p24-IC modules. This board provides a number of rewired components for quick prototyping of common, simple circuits. This board features , aDB9 programming connector, reset button, barrel connector for power, power LED, 4 push-buttons, 4 LEDs, a piezo speaker a 10K potentiometer, an RJ-11 jack (for interfacing to an X10 power line interface), an analog output pin and two 8-pin sockets for EEPROM and ADC chips. One female 0.1" socket allows for access to all the module's pins plus Vdd, Vin and Vss. Vdd is +5 volts and Vin is 6 – 9 volts

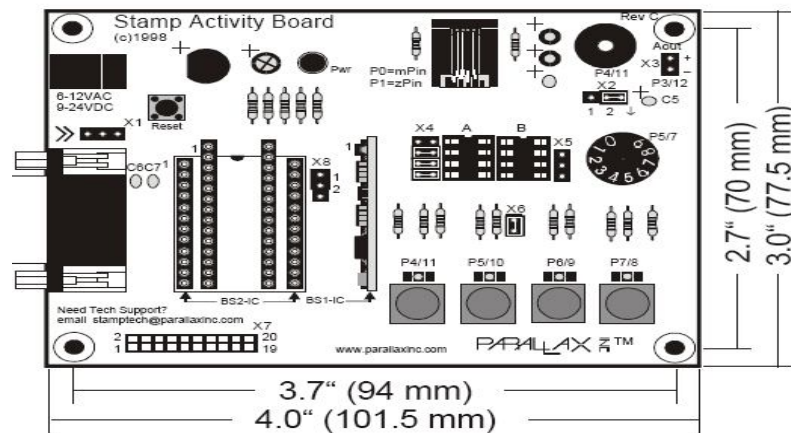


Figure (3.13): BASIC Stamp Activity Board (Rev. C)

3.5 BASIC Stamp specification

The tables below show the specification of basic stamp BS2-IC which used it for design of systems .see the other type in appendix A

Table (3.1): BS2-IC specification

Released Products	BS2-IC
Package	24-pin DIP
Package Size (L x W x H)	1.2"x0.6"x0.4"
Environment	-40 to +185 °F (-40 to +85 °C) **
Processor Speed	20 MHz
Program Execution Speed	~4,000 instructions/sec.
RAM Size	32 Bytes (6 I/O, 26 Variable)
Scratch Pad RAM	N/A
EEPROM (Program) Size	2K Bytes, ~500 instructions
Number of I/O pins	16 +2 Dedicated Serial
Voltage Requirements	5 - 15 vdc
Current Draw @ 5V	3 mA Run / 50 µA Sleep
Source / Sink Current per I/O	20 mA / 25 mA
Source / Sink Current per unit	40 mA / 50 mA per 8 I/O pins

PBASIC Commands	42
PC Programming Interface	Serial Port (9600 baud)
Windows Text Editor	Stampw.exe (v1.04 and up)

DTMF Receiver

3.6.1 MT8870D/MT8870D-1

The MT8870D/MT8870D-1 is a complete DTMF receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters, the decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code. External component count is minimized by on chip provision of a differential input amplifier, clock oscillator and latched three-state bus interface.

3.6.2 DTMF Receiver Functional Block Diagram

The DTMF Receiver Functional Block Diagram diagram of the design is shown in figure below

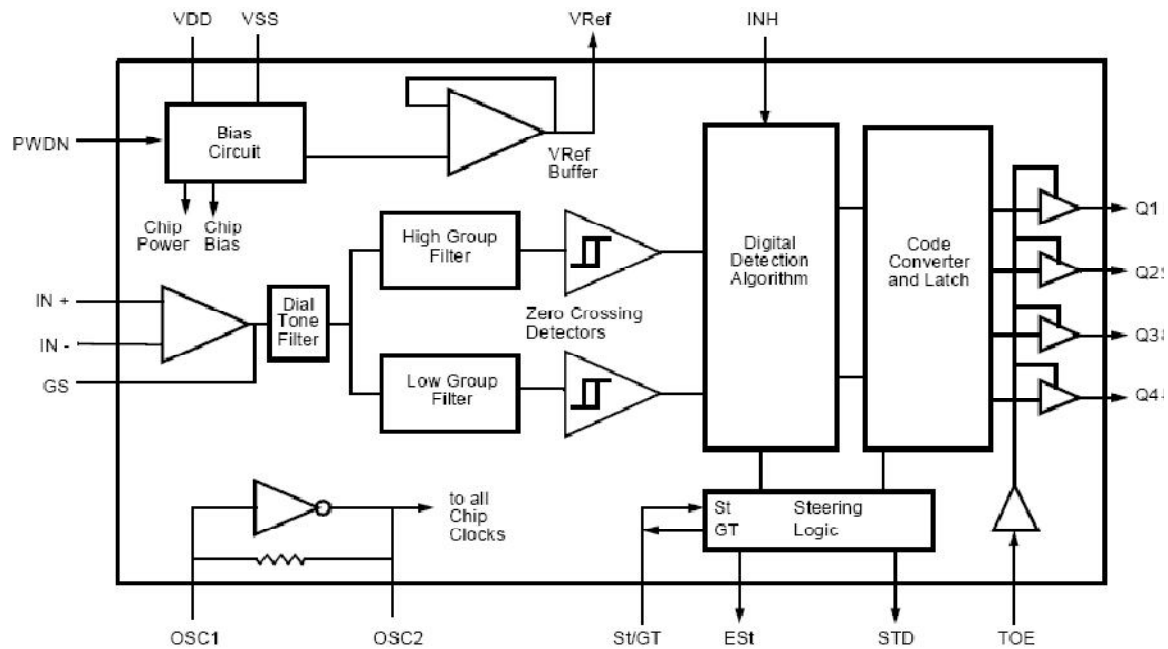


Figure (4.1): DTMF Receiver Functional Block Diagram

3.6.3 Single-Ended Input Configuration

The DTMF Receiver Single-Ended Input Configuration is shown in figure below

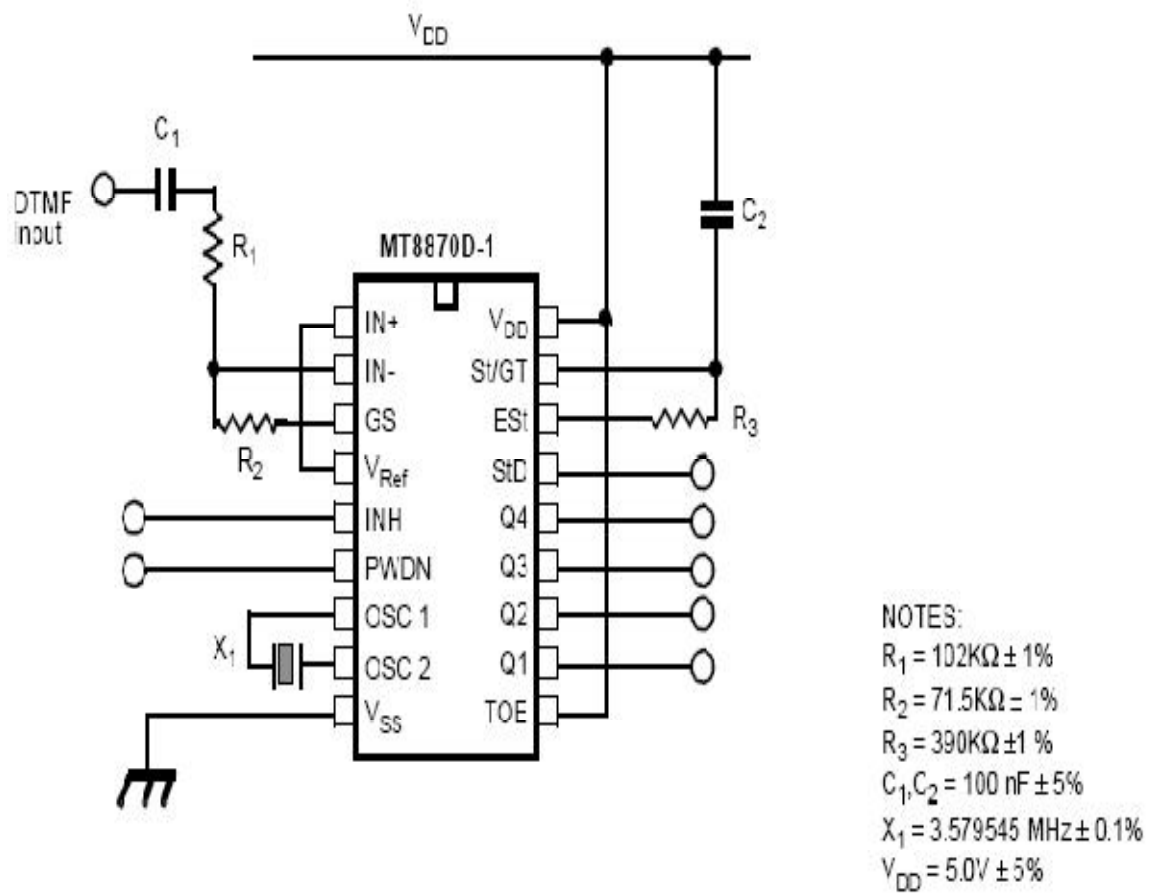


Figure (4.2): DTMF Receiver Single-Ended Input Configuration

Chapter Four

Software

4.1 Turbo C++ Over view

Turbo C++ is one of programming language it was developed at the Bell laboratories in the mid of 1980's. C++ designed to support:

- Procedural programming
- Modular programming
- Data abstraction
- Object-oriented programming

Table (4.1) Opeartor's service frequency in sudan

MTN	Service	Band	Frequency Range	Bandwidth
	GSM	900 MHz	890-898MHz	8MHz
	GSM	900MHz	935-943MHz	8MHz
	GSM	900MHz	858-900MHz	7MHz
	GSM	900MHz	943-944MHz	1MHz
	GSM	1800MHz	1710-1720MHz	20MHz
	GSM	1800MHz	1805-1815	10MHz
CANAR	service	Band	Frequency Range	Bandwidth
SUDANI	CDMA	450MHz	452-457MHz	5MHz
	CDMA	450MHz	462-467MHz	5MHz
	TD-SCDMA	2GHZ	2010-2025MHz	15MHz
	P-TO-M	450MHz2GHZ	450-452MHz	2MHz
	WIRELESS LAN	450 MHz	460-4622150MHz	2MHz
	service	Band	Frequency Range	Bandwidth
	CDMA	800MHz	825.030-834.331 870.030-879.330960 835.680-844.320+ 880.680-889.320A MHz	9.3MHz 8.64 MHz
	GSM	1800MHz	1740-1760+ 1845-1855 MHz	12.5MHz
	CDMA	2100MHzH	1960-1980+ 2150-2170MHz	15MHz
ZAIN	GSM	900MHz	900-915MHz	15MHz
	GSM	900MHz	943-960MHz	15MHz
	GSM	1800MHz	1765-1785MHz	20MHz
	GSM	2GHZ	1945-1960MHz	15MHz

C++ supports all the fundamental data types of C as well as all of the control constructs of C:

Char, short, int, long, float, double, long double

For { }

If () { } else if () { } else { }

Do { } while ()

While () { }

Switch () {case.....}

4.2 System Algorithm and Flow Chart.

a) System Algorithm

Step1: Initialize of the Radio spectrum monitoring System

Step2: Start operation of real time data acquisition

Step3: Display the authorized reserved radio

Step4: Wait for acquisition of data transmission

Step5: If the transmission is authorized, give it permission

Step6: If the transmission is not authorized, give it rejection.

b) System Flowchart

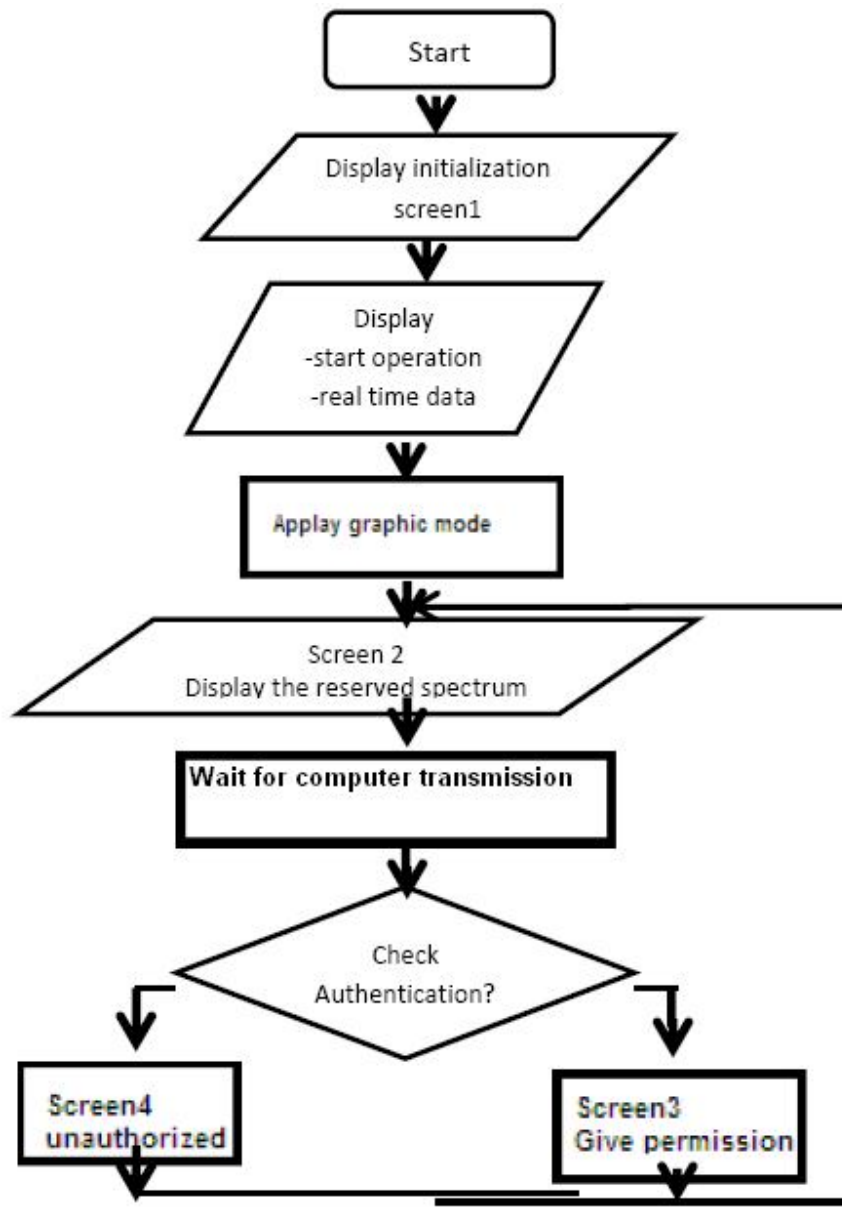


Figure (4.1): Show flow chart of the program

4-3 The program

```
#include<stdio.h>
#include<conio.h>
```

```

#include<dos.h>
/* This program is written by ADEL */
main()
{
/* initialisation */
int x;
intcolorcode=0;

screen1:
/* title for the thesis */
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(colorcode);
cprintf("\n  ADEL ALI  ");
delay(2000);
gotoxy(5,6);
cprintf("\n  SUDAN UNIVERSITY- CETS  ");
gotoxy(2,10);
cprintf("\nSpectrum monitoring");
gotoxy(5,14);
cprintf("\n    start operation  ");
struct date d;
getdate(&d);
printf("\n\n %d / %d / %d", d.da_day, d.da_mon,d.da_year);
delay(3000);
textmode(1);
colorcode = colorcode+1;
if (colorcode == 3) goto screen3;
textcolor(WHITE);
textbackground(colorcode);
clrscr();
goto screen1;

screen3:
/* check the status of the DTMF decoder */
clrscr();
textmode(1);

```



```

gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n WAITING FOR A FREQUENCY ");

```

```

if (kbhit()) goto finish;
x = inportb(0x379);
x = x & 0xf0;
x = x | 0x80;

```

```

printf("\n\n %d ", x);
delay(1000);
/*goto finish;*/

```

```

if ( x == 144) goto screen4;
if ( x == 160) goto screen5;
if ( x == 176) goto screen6;
if ( x == 192) goto screen7;
if ( x == 208) goto screen8;
if ( x == 224) goto screen9;
if ( x == 240) goto screen10;
if ( x == 128) goto screen11;
/*if ( x == 0x90) goto screen12;
if ( x == 0x00) goto screen13; */
delay(5000);
goto screen3;

```

```

screen4:
/* licenced */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE+BLINK);
textbackground(GREEN);
cprintf("\n LICENCED ");
delay(10000);
goto screen3;

```

```
screen5:
/* licenced */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE+BLINK);
textbackground(GREEN);
cprintf("\n  LICENCED  ");
delay(10000);
goto screen3;
```

```
screen6:
/* licenced */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE+BLINK);
textbackground(GREEN);
cprintf("\n  LICENCED  ");
delay(10000);
goto screen3;
```

```
screen7:
/* licenced */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE+BLINK);
textbackground(GREEN);
cprintf("\n  LICENCED  ");
delay(10000);
goto screen3;
```

```
screen8:
/* not */
clrscr();
```

```
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n  NOT XXXXXXXX  ");
delay(10000);
goto screen3;
```

```
screen9:
/* not */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n  NOT XXXXXXXX  ");
delay(10000);
goto screen3;
```

```
screen10:
/* not */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n  NOT XXXXXXXX  ");
delay(10000);
goto screen3;
```

```
screen11:
/* not */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n  NOT XXXXXXXX  ");
delay(10000);
```

```

goto screen3;

screen12:
/* not */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n  NOT XXXXXX  ");
delay(10000);
goto screen3;

screen13:
/* not */
clrscr();
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(GREEN);
cprintf("\n  NOT XXXXXX  ");
delay(10000);
goto screen3;

finish:
getch();
return(0);
}

```

Chapter Five

Results and Discussion

5.1 The Results

According to rapid development of communication industry, communication service varies. Since Popularization of radio wave in use, technology development of new frequency band, technology revolution of wireless communication increase in radio consumption, radio environment is charged with illegal wireless equipment, unwanted electromagnetic signal, increase in wireless station, system variation, highly developed communication configuration. So we need radio monitoring system that can manage radio efficiently and measure radio quality accurately through spectrum analysis for protecting wireless equipment and maintaining quality level of radio, communication service. Also, since conventional radio monitoring system can't measure frequency efficient use investigation and spectrum analysis that is equivalent to occupied bandwidth measurement, broadband frequency measurement, high-speed spectrum measurement, unwanted electromagnetic signal in radio quality measurement, radio monitoring system need to be developed for executing efficient radio monitoring work with reservation measurement function and automatic result storage function that can be done accurate radio measurement of local operators

The spectrum monitoring simulation was done successfully by using one computer for remote control unit and other computer for local unit which received the DTMF signal through D-25 connector.

The simulation had below functions:

- I connected computer as remote control system (transmitter unit) with programmed computer through D-25 connector.
- PC computer hosts developed software using C++ programming language to simulation radio spectrum monitoring system.
- The PC computer is connected with DTMF decoder via parallel port inputs.
- The software dictates the processor and the database to handle monitoring process.

- A corresponding signal is then sent via the output pins of the parallel port.
- Data base consist a lot of authorized frequency that are license by ITU-R and a NTC.
- The main goal of the proposed system is to send controlling signal remotely from transmitter (first computer) to controlled machine (second computer). The whole system can be divided into following stages:
- The first computer is a transmitter it sends DTMF freq from the key bat 0 to 9 and in the C/t from 0 to 5 in the data base was used as authorized transmitter frequency while DTMF freq, Tone from 6 to 9 is treated as a non-Authorized freq tone.

5.2 Discussion

Firstly a study to discuss the spectrum management , Electromagnetic Waves , Basic stamp microcontroller, DTMF Receiver ,DC-25 connector , computer and turbo c++ programming language .

Secondly implementation of detection non-Authorized frequencies.

Finally the software to display on the computer monitor, hence the research shows the simulation of the operation of spectrum monitoring.

Chapter six

Conclusion and Recommendations

6.1 Conclusion

- There is general agreement among industry analysts that the traditional models of spectrum management are in need of reform.
- Most economists agree that the reform
- should seek to increase the ability of market forces to shape how spectrum is allocated and used.
- Traditional licenses that were encumbered with restrictions on the choice of technology, the services offered, their coverage, and the transferability of access rights
- have imposed a high opportunity cost for spectrum for many advanced communication
- services, while precluding the deployment of under-utilized spectrum to higher-value uses.
- increased industry costs, reduced incentives to innovate, and slowed the deployment and adoption of new services.
- One solution that has been proposed is to transition to regime of tradable property rights for spectrum based on exclusive use frequency licenses.
- managing spectrum would be to allocate a band or bands of frequencies for unlicensed uses. There seems to be an emerging consensus among those who support
- mechanism for spectrum management, especially for the valuable lower frequency spectrum below 3GHz. The spectrum in these bands that is available for commercial use
- support for unlicensed uses can be adequately provided via underlay and overlay easements to allow secondary usage of licensed spectrum.
- While the transition to a flexible licensing regime and making provision for unlicensed easements are important reform policies, there is also a need to allocate additional spectrum for dedicated unlicensed use in the lower frequencies below 3GHz.
- supports a fundamentally different model for how wireless services may be developed and deployed. This offers a valuable contribution to the wireless ecosystem, as the success of Wi-Fi in recent years attests.
- Opposition to dedicated unlicensed is often conflated with the view that

unlicensed is inconsistent with auctions, implies spectrum use should be “free,” or that supporting unlicensed means opposing liberalization of licensed spectrum. These are misconceptions.

6.1 Recommendations

- An allocation of additional unlicensed spectrum could be included as part of a spectrum auction. Unlicensed use is not “free” but it does preclude a private party using its license to extract rents for access to the spectrum.
- unlicensed spectrum does not imply more regulation and is consistent with increased reliance on market forces.
- Additional spectrum for dedicated unlicensed use is important because secondary use easements are neither a foregone conclusion nor an adequate substitute. Furthermore, an allowance below 3GHz is important because spectrum at different frequencies is useful for different things.
- Additional spectrum for dedicated unlicensed use above 3GHz will be available, and in any case, the difference between a licensing and unlicensed regime are less pronounced at higher frequencies.
- Promoting regulatory diversity is consistent with supporting increased reliance on market forces since no regime will be completely free of regulation and its incumbent distortions.
- By providing for multiple models in the lower frequencies, the forces of Market-fueled innovation and competition are enhanced.
- Spectrum monitoring serves as the eyes and ears of the spectrum management process.
- Its importance is continuously increases due to the accelerating expansion of terrestrial and satellite radio communication systems and of equipment that may cause interference, such as numerous computers and other unintentional radiators. The monitoring system provides a method of verification and “closes the loop” on the spectrum management process.

Reference:

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