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Study of an Instrument Landing System (ILS)

Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Engineering. (BEng Honor)

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الاية


سورة الفاتحة
بسم الله الرحمن الرحيم ١
الحمد لله رب العلمين ٢
الرحمن الرحيم ٣ ملك يوم الدين ٤
إياك نعبد وإياك نستعين ٥ اهدنا
الصراط المستقيم ٦ صراط الذين أنعمت
عليهم غير المغضوب عليهم
ولا الضالين ٧

ABSTRACT

The rapid increase in aviation industry requires parallel effective plans, programs and designs of systems and facilities nationwide to fulfill the increasing needs for safe air transportation. Aircraft landing remains a problem for a long time all over the world. Systems that aircraft rely on in landing are unreliable to perform a precise guidance due to many limitations such as inaccuracy, unreliability and dependency. In low visibility conditions, when pilots are unable to see the runway, the aircrafts are diverted to another airport. However, low visibility can also affect all airports in the vicinity, forcing aircrafts to land in low visibility conditions depending on Instrument Flight Rules (IFR).

Aircraft approach and landing are the most hazardous portions of flight; accidents records indicate that approximately 50 percent of the accidents occur during aircraft landing.in order to limitation this accident all A/C provided by automatic landing systems.

In this work, the concepts of automatic landing systems are studied, and a well-known method is focused on. This method is the Instrument Landing System (ILS). The detailed block diagram of this system is presented and discussed. This block diagram further is mapped to Matlab/Simulink suitable library blocks to generate the useful functions done by the subsystems of ILS. A simulation experiments are run and the performance is shown in terms of graphs. And also circuit had been designed by Proteus software, and the code of this simulation done by Micro C program.

التجريد

الزياده المتطرده في صناعة الطيران ، تتطلب زياده موازيه في الخطط ، والبرامج الفعاله ، والمؤسسات ككل لتلبي احتياجاتالنقل الجوي الامن.

هبوط الطائره كان ولا يزال يشكل مشكله على مستوى العالم ،كما ان الانظمه التي تساعد الطائره على الهبوط اصبحت لا يعتمد عليها من حيث تنفيز هبوط دقيق وموجه ؛ نسبة لعدة اسباب مثل عدم الدقه ، والاعتماديه في حالة الرؤيه الضعيفه .

عندما يكون الكابتن غير قادر على رؤية مدرج الهبوط ، يتم تحويل الطائره لمطار اخر، لكن اسباب الرؤيه الضعيفه قد تؤثر على جميع المطارات القريبه مجبره الطائرات على الهبوط رغم الظروف. وفقا لمعلومات قواعد الطيران(IFR) الاقتراب من المدرج والهبوط يعد من اخطر اجزاء التحليق ؛ فتسجيلات الحوادث تشير الى أن50%من حوادث الطائرات تحدث عند الهبوط ، للحد من هذه الحوادث تم تزويد الطائرات باجهزة هبوط آلي.

في هذا العمل تم دراسة نظام الهبوط الالي تحديدا نظام الهبوط الالي (ILS)،تم مناقشة المخطط الصندوقي بالتفصيل ، هذا المخطط تم تمثيله على برنامج الماتلاب بواسطة احدى ادواته وهي اداة المحاكاة ؛ لتوليد دوال مفيده تم اخذها من الاجهزه الفرعيه المكونه للنظام ،وتم تمثيل الناتج في شكل بياني ،وايضا تم تصميم دائر لتحاكي طريقة عمل احد فروعه ببرنامج الProteus، تم كتابة الكود باستخدام برنامج ال.Micro C

Acknowledgment

Thanks god…

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And special thanks to lecturersAHMED HAMAD EANEEL and MESHKA MOHAMMED…

Dedication

We dedicate our dissertation work to our family, special feeling of gratitude to our lovely mothers, fathers, sisters and brothers.

And also to all who supported us in each step of the way to complete this work. A lot of thank to our friend Hassan

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Glossary

A/C:	Aircraft
ALS:	approach light system
AM:	Amplitude Modulation
CAT:	category
CL:	centerline lights
CSB:	carrier and side band
DGPS:	Differential Global Positioning System
DH:	Decision Height
DME:	destine measuring equipment
FANS:	Future Air Navigation Systems
GP:	Glide-Path
GPS:	Global Positioning System
ICAO:	International Civil Aircraft Organization
ILS:	Instrument Landing System
IM:	inner marker
LOC:	localizer
LPV:	localizer performance with vertical guidance
MAX:	maximum
Mini:	minimum
MLS:	Microwave landing system

MM:	middle marker
NDB:	non-directional beacon
OM:	outer marker
REF:	Reference
RVR:	Runway Visual Range
RX:	Receiver
SBO	side band only
SFL:	sequenced flashing light
SSB:	signal side band
TDZ:	touchdown zone lights
TX:	Transmitter
UHF:	Ultra High Frequency
VHF:	Very High Frequency
VOR:	Very High Frequency Omni range

Symbols

A:	altitude
C:	speed of light
D:	horizontal distance
S:	slant rang
t:	transmit time
T:	total time

Chapter one: Introduction

1.1Overview

Aircraft instrument landing systems are used to land safely especially when the weather conditions (fog, rain & the wind) are so bad that visibility for a pilot is so impaired that it would not be possible to land his aircraft safely.

This system provides high accuracy to guide the A\C to the runway, it used where the range of radio signals and RF. and use with this product the high illumination intensity to enable a safe landing

1.2 Aim & Objectives

1.2.1 Aim

Applicate this system by our own design in real in our national airport and connect it with autopilot.

1.2.2 Objectives

1. Understand the principles operation of ILS

2.Study the transmitters of the (localizer, glide slop &DME)

3.Study the receivers of the (localizer, glide slop &DME)

4.Simulation by using mat lab and protuse

1.3Problem Statement

When the weather conditions are so bad the visibility for a pilot will be so impaired that it would not be possible to land his aircraft safely.

1.4 proposed Solution

To solve the problem of poor visibility in bad weather, an ILS is devised and became widely used as an automatic mean that helps pilots to safely land their aircrafts

1.5 Methodology

In the beginning the ILS has been studied specially that connected with the blocks diagrams of each of its components (localizer, glide path, DME), after that the data has been collected to be used as input in the design and modeling to give us a simulation as an output, also will not stop here, actually the output of the simulation should be compared with standard values which show up as graphs or shape of waves, to make sure that the result similar to the standards.

1.6 Out Line

The work is arranged and presented in five Chapters as follows:

Chapter One: includes statement of the problem under investigation, proposed solution and the methodology adopted to achieve the objectives.

Chapter Two: surveys the studies of ILS.

Chapter Three: Describes the method used to achieve the main objective related to design of ILS and simulate it using MATLAB Simulink, PROTEUS and MICRO C program.

Chapter Four: shows the results and the analysis obtained through the work.

Chapter Five: through this chapter the conclusion of whole work is presented and recommended the coming student also mentioned the future work.

Chapter two: Literature Review

The Instrument Landing System (ILS) is an instrument presented, pilot interpreted, precision approach aid. The system provides the pilot with instrument indications which, when utilized in conjunction with the normal flight instruments, enables the aircraft to be maneuvered along a precise, predetermined, final approach path.

Landing process is a complex phase that accidents often happen, for this phase, guaranteeing flight safety and comfort is more important, and it puts forward higher requirements on accuracy of control system. So far, there are three kinds of landing guidance methods, they are instrument landing system （*ILS*）, microwave landing system （*MLS*） and global positioning system （*GPS*)(see figure 1)[1]

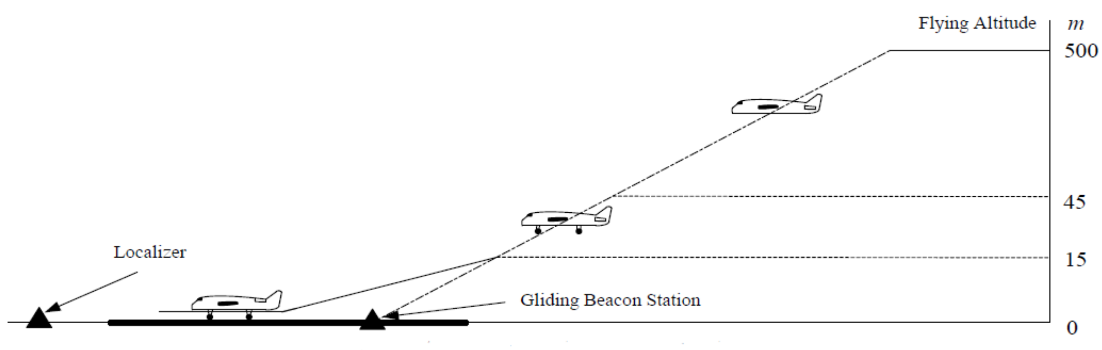

Figure 1 :landing process

2.1 The ILS ground facilities have been categorized (CAT) by international standardization as follows

2.1.1**Facility Performance Category I**

An ILS which provides a specified quality of guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 200ft or less above the threshold. Using this category of equipment and provided that appropriate supplementary ground and airborne equipment is installed and operating, operations can be permitted down to a decision height of 200 ft and with a Runway Visual Range(RVR)(is an optical system which is used to measure horizontal visibility) of the order of 800 meters.[2]

2.1.2 Facility Performance Category II

An ILS which provides a specified quality of guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 50 ft or less above the threshold. Using this category of equipment and provided that appropriate supplementary ground and airborne equipment is installed and rating, operations can be permitted down to a decision height of 100 ft and with a RVR of the order of 400 meters.[2]

2.1.3 Facility Performance category III

An ILS which, with the aid of ancillary equipment where necessary, provides the specified quality of guidance information from the coverage limit of the facility to and along the surface of the runway. Using this category of equipment and provided that appropriate supplementary ground and airborne equipment is installed and operating, operations can be permitted with no decision height limitation and without reliance on external visual reference (see Table 1).[2][3]

It should be noted that some equipment presently used in Australia is not categorized.

Table 1 : ILS cantores

	CAT I	CAT II	CAT III A	CAT III B	CAT III C
Minimum Visibility	800 m	400 m	200 m	20 m	0
Decision Height	200 ft.	100 ft.	0	0	0

2.2 Components of ILS System

1. localizer

2. glide path

2.3 Basic Principles

2.3.1The localizer

Transmitters radiate field patterns of 90-Hz and 150-Hz modulated energy on opposite sides of the instrument runway centerline to provide a course for guidance in azimuth. The 150-Hz modulation is always on the right looking towards the runway from the outer marker and is known as the ‘blue sector’. The left side is modulated at 90-Hz and is known as the ‘yellow sector’. The course line (on-course) is a locus of points of equal 90-150-Hz modulation. It is aligned along the runway centerline extended in both directions and may be separated at the localizer antenna into a front course and a back course. In order to obtain the quality in the front course of the localizer necessary for CAT I and higher, a back course is not radiated in Australia.[6]

2.3.2 Glide path

Equipment radiates field patterns of 90-and 150-Hz modulated energy to provide a path for approach slope guidance. The field patterns are orientated so that a preponderance of the 150-Hz energy lies below the glide path and a preponderance of the 90-Hz energy is above the glide path. The line of the glide path (on-path), similar to the localizer course line, is a locus of points of equal 90-and 150-Hz modulation and is aligned at the correct approach angle for descent to the runway touchdown point.[6][7]

2.4 ILS Equipment

ILS equipment is comprised of two operating units

1. Airport ground equipment,
2. Airborne equipment.

2.4.1Ground Equipment

2.4.1.1 Localizer

The localizer aerial is on the runway extended centerline at the opposite end to the approach end, at a distance which ensures that it lies below the runway take-off obstruction clearance plane. The transmitter building is usually located 100–120 meters to the side of the aerial. The field pattern radiated by the localizer is illustrated in (Figure 3) with the course line lying along the extended runway centerlines. The localizer beam 'width', as it is interpreted by the travel of the localizer needle on the aircraft cross pointer indicator from full deflection in the blue sector (150-Hz) to full deflection in the yellow sector (90Hz) is normally 5° for uncategorized systems and all other systems are adjusted to 210 meters wide at the landing threshold.[8]

The primary component of the ILS is the localizer, which provides lateral guidance. The localizer is a VHF radio transmitter and antenna system using the same general range as VOR transmitters (between 108.10 MHz and 111.95 MHz). Localizer frequencies, however, are only on odd-tenths, with 50 kHz spacing between each frequency. The transmitter and antenna are on the centerline at the opposite end of the runway from the approach threshold.

The localizer back course is used on some, but not all ILS systems. Where the back course is approved for landing purposes, it is generally provided with a 75 MHz back marker facility or NDB located 3 to 5 NM from touchdown. The course is checked periodically to ensure that it is positioned within specified tolerances.[8]

2.4.1.1.1Signal transmission

The signal transmitted by the localizer consists of two vertical fan-shaped patterns that overlap, at the center (see ILS Localizer Signal Patternfigure3). They are aligned with the extended centerline of the runway. The right side of this pattern, as seen by an approaching aircraft, is modulated at 150 Hz and is called the "blue" area. The left side of the pattern is modulated at 90 Hz and is called the "yellow" area. The overlap between the two areas provides the on-track signal.

The width of the navigational beam may be varied from approximately 3º to 6º, with 5º being normal. It is adjusted to provide a track signal approximately 700 ft wide at the runway threshold. The width of the beam increases so that at 10 NM from the transmitter, the beam is approximately one mile wide.

Total width in terms of degrees will depend on position of aerials and length of runway. The equipment is designed to provide a usable on-course signal at a minimum distance of 25 NM from the runway at a minimum altitude of 2,000 ft above the threshold. Each localizer is identified aurally by a coded designator consisting of three letters, the first of which is the letter ‘I’. The transmitters are usually duplicated, with an automatic changeover facility from primary to secondary equipment in the event of failure or malfunction.[9]

2.4.1.2 Glide Path

The transmitter buildings and glide path aerial are in close proximity and are usually located approximately 225–380 meters from the approach end and 120–210 meters to the side of the runway centerline. The field pattern radiated by the glide path equipment is illustrated in (see Figure4).

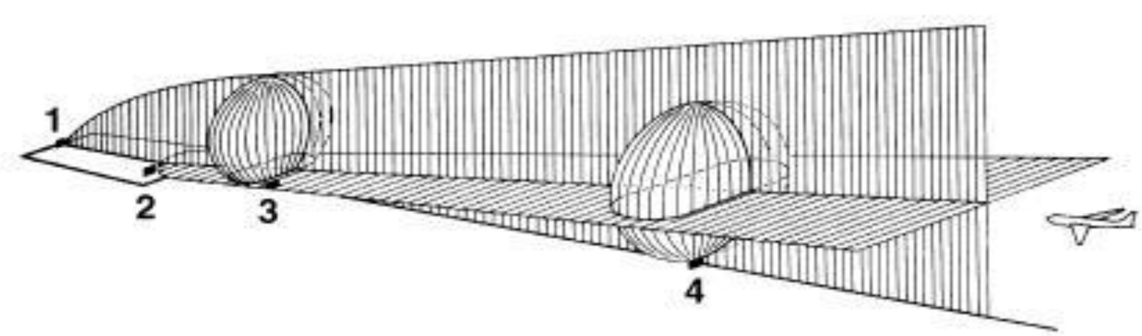

Figure 2 :The radiation

The glide path ‘width’ as it is interpreted by the travel of the glide path needle on the aircraft cross pointer indicator from a full ‘fly-up’ indication to a ‘fly-down’ indication, varies from 1° to 1.5°. There is no sector color identification associated with the glide path. The transmitters are duplicated, with an automatic change-over facility from primary to secondary equipment in the event of failure or malfunction.[8]

Transmitter The glide slope provides vertical guidance to the pilot during the approach. The ILS glide slope is produced by a ground-based UHF radio transmitter and antenna system, operating at a range of 329.30 MHz to 335.00 MHz, with a 50 kHz spacing between each channel. The transmitter is located 750 to 1,250 ft down the runway from the threshold, offset 400 to 600 ft from the runway centerline. Monitored to a tolerance of ± 1/2 degree, the UHF glide path is "paired" with (and usually automatically tuned by selecting) a corresponding VHF localizer frequency.

Like the localizer, the glide slope signal consists of two overlapping beams modulated at 90 Hz and 150 Hz (see Glide Slope Signal Pattern figure 2). Unlike the localizer, however, these signals are aligned above each other and are radiated primarily along the approach track. The thickness of the overlap area is 1.4º or .7º above and .7º below the optimum glide slope.[8]

This glide slope signal may be adjusted between 2º and 4.5º above a horizontal plane. A typical. Adjustment is 2.5º to 3º, depending upon such factors as obstructions along the approach path and the runway slope.[10]

False signals may be generated along the glide slope in multiples of the glide path angle, the first being approximately 6º degrees above horizontal. This false signal will be a reciprocal signal (i.e. the fly up and fly down commands will be reversed). The false signal at 9º will be oriented in the same manner as the true glide slope. There are no false signals below the actual slope. An aircraft flying according to the published approach procedure on a front course ILS should not encounter these false signals.[9]

2.4.2 Airborne Equipment

The advent of CAT II and higher ILS requires an increase in the amount and quality of airborne equipment. This extra equipment is in addition to that previously carried. There has been no change in the basic airborne equipment for ILS use other than receiver sensitivity and reliability. Most of the additional equipment has been added to allow automatic approach, overshoot or landing and is only utilized in conjunction with a duplex (two system) or triplex (three system) auto pilot.[2]

There are several different types of airborne equipment and installations vary with different types of aircraft. Basic components of a simple installation, however, are listed in the following paragraphs.[10]

2.4.2.1Receiver

2.4.2.1.1Localizer receiver

The localizer signal is received in the aircraft by a localizer receiver. The localizer receiver is combined with the VOR receiver in a single unit. The two receivers share some electronic circuits and also the same frequency selector, volume control, and ON-OFF control.[10]

The localizer signal activates the vertical needle called the track bar (TB). Assuming a final approach track aligned north and south an aircraft east of the extended centerline of the runway (position 1) is in the area modulated at 150 Hz. The TB is deflected to the left. Conversely, if the aircraft is in the area west of the runway centerline, the 90 Hz signal causes the TB to deflect to the right (position 2). In the overlap area, both signals apply a force to the needle, causing a partial deflection in the direction of the strongest signal. Thus, if an aircraft is approximately on the approach track bur slightly to the right, the TB is deflected slightly to the left. This indicates that a correction to the left is necessary to place the aircraft in precise alignment.

At the point where the 90 Hz and 150 Hz signals are of equal intensity, the TB is centered, indicating that the aircraft is located precisely on the approach track (position3).[10]

When the TB is used in conjunction with the VOR, full scale needle deflection occurs 10º either side of the track shown on the track selector. When this same needle is used as an ILS localizer indicator, full-scale needle deflection occurs at approximately 2.5º from the center of the localizer beam.[11]

2.4.2.1.2 GP Receiver

The glide slope signal is received by a UHF receiver in the aircraft. In modern avionics installations, the controls for this radio are integrated with the VOR controls so that the proper glide slope frequency is tuned automatically when the localizer frequency is selected.

The glide slope signal activates the glide slope needle, located in conjunction with the TB.

There is a separate OFF flag in the navigation indicator for the glide slope needle. This flag appears when the glide slope signal is too weak. As happens with the localizer, the glide slope needle shows full deflection until the aircraft reaches the point of signal overlap. At this time, the needle shows a partial deflection in the direction of the strongest signal. When both signals are equal, the needle centers horizontally, indicating that the aircraft is precisely on the glide path.[10]

The pilot may determine precise location with respect to the approach path by referring to a single instrument because the navigation indicator provides both vertical and lateral guidance. In the Glide Slope Signal Pattern figure, above, position 1, shows both needles centered, indicating that the aircraft is located in the center of the approach path. The indication at position 2 tells the pilot to fly down and left to correct the approach path. Position 3 shows the requirements to fly up and right to reach the proper path. With 1.4º of beam overlap, the area is approximately 1,500 ft thick at 10 NM, 150 ft at l NM, and less than one foot at touchdown.

The apparent sensitivity of the instrument increases as the aircraft nears the runway. The pilot must monitor it carefully to keep the needle centered. As said before, a full deflection of the needle indicates that the aircraft is either high or low but there is no indication of how high or low. [4]

Figure 3: localizer signal pattern

The glide path receiver output is also separated into 90-Hz and 150-Hz components, rectified and the voltages applied to the horizontal needle of the cross pointer indicator. There is no audio identification signal associated with the glide path.

The output from the marker beacon receiver actuates the appropriate marker beacon lamps and provides an identifying audio signal.[12]

Radio altimeter receiver output information is presented on an appropriate instrument on the pilot's instrument panel. The radio altimeter is normally only used for auto pilot coupled approaches.[9]

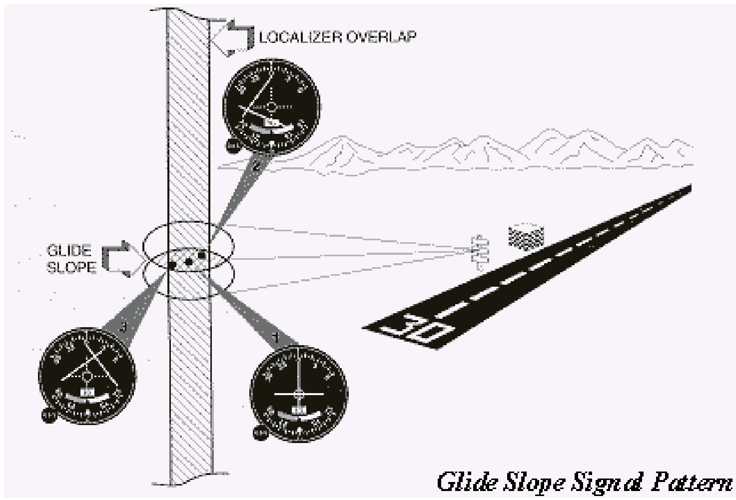

Figure 4: GS slop signal pattern

2.5 DME

Provides distance (slant range) from the aircraft to the Ground DME., DME operates on Ultra High Frequency (UHF) which is between 962 to 1213 MHz, DME works based on pulse techniques, where pulse means a Single vibration of electric current.[12]

The DME aircraft's antenna sends out paired pulses at specific Spacing. The ground DME antenna receives the pulses and then responds with paired pulses at the same spacing but a different frequency.

The DME aircraft's antenna receive back the signal and measures the time taken to transmit and receive the signal.[13-15]

2.6 System antenna

On most modern high speed aircraft flush or recessed localizer aerials are normally located in the vertical stabilizer. The same aerial may feed two localizer receivers; the aerial system and receivers are generally used for VOR also. If a third localizer receiver is installed its aerial is generally located in the nose section, typically within the random provided for weather radar.[8]

The glide path receiver aerial is normally located on the nose of the aircraft or within the Radom. On very large aircraft, or those which land with an unusually high nose attitude.[2]

2.6.1 Localizer antenna array

Localizer antenna array or simply localizer (LLZ) operating at a frequency 108 – 112MHz is a piece of equipment that with the help of radio waves creates a so called course plane in the direction of the aircraft approach within a distance 30NM from the runway touchdown zone. The antenna system is able to transmit a carrier frequency fanned two side amplitude modulated frequencies, one being 90 Hz (left of the landing direction) and the other 150Hz (right of the landing direction). The dual-frequency localizers are extremely precise and can be used for the ILS categories II/III.[6]

2.6.2 Glide-slope array

Glide-slope array (also called Glide Slope) forms an electromagnetic field to guide the aircraft in vertical direction and in the approach direction. Glide-slope array must provide sufficient signal to guide the aircraft, which is equipped with a standard ILS installation, through a system of amplitude modulated signals along both sides of the ILS descent line, at least 18.5 km distant from runway. The ILS descent line, so called Glide Path is formed by aground UHF transmitter and its antenna system operating on a principle very similar to the localizer. The glide-slope array operates at a frequency range of 328.6MHz to 335.4MHz, which is approximately a threefold higher frequency than LLZ3 (higher frequency also generally offers higher precision).[6]

2.6.3 Marker beacon array

The marker beacon receiver aerial is in most cases mounted on the underside of the fuselage or wings of the aircraft in a position clear of all other aerials and obstructions. In some aircraft an aerial in boat shaped housing is used, whilst other installations use an aerial recessed flush with the skin of the aircraft2.8 Marker beacons and DME equipment.[6]

The purpose of marker beacons is to inform the pilot about the horizontal distance from the runway touchdown zone, where it is deemed to be significant (e.g. aircraft's altitude is checked when passing over the beacon).

All beacon types operate at a carrier frequency of 75.0 MHz and operate in such a way that they vertically transmit a cone of radio waves. The receiver onboard an aircraft is fixed to75 MHz and will catch the signal during antenna flyover. Traditional ILS installation, besides glide-slope and localizer array also contains at least two marker beacons, which are generally placed on lots more remote from the airport.[13]

2.7 Instrumentation

There are a number of different types of ILS indicators in operational use. A description of a basic type of cross pointer indicator is given in this section to best illustrate the function of the instrument. The cross pointer indicator is a special type of meter, which is located on the instrument panel in easy view of the pilot.[14]

The indicator is constructed with two needles. The localizer needle is pivoted on the top of the dial and swings in pendulum fashion from left to right. The glide path needle is pivoted at the left side of the dial and swings up and down.

The stationary scale on the instrument is marked with a target circle in the center of the dial, and four radial rows of four dots each, extending up, down, left and right from the circle The perimeter of the target circle is the 'first dot' position. These markings serve to divide the scale of the instrument into equal vertical and horizontal spaces. At the bottom of the dial the left side of the scale is marked with blue, the right side with yellow.[2, 8, 14]

2.7.1 Localizer Indications

The localizer (vertical) needle indicates, by deflection, the color area of the sector in which the aircraft is flying. If the aircraft is flying in the blue sector of the localizer, the vertical needle will be deflected into the blue area of the indicator. Conversely, if the aircraft is flying in the yellow sector, the needle will be deflected into the yellow area of the indicator. When the aircraft is directly on the localizer course, the needle will be centered vertically across the circle in the middle of the dial. Regardless of the position or heading of the aircraft, the localizer needle will always be deflected in that color area in which the aircraft is flying.[1]

Movement of the needle is very sensitive and will give a full scale deflection (5dots) when the aircraft is approximately 2½° to either side of the on-course. This high sensitivity permits the use of the indicator for accurate runway directional guidance.[12]

2.7.2Glide Path Indications

The glide path (horizontal) needle indicates, by deflection, the position of the glide path in relation to the aircraft. When the aircraft is above the glide path, the horizontal needle is deflected downward. Conversely, when the aircraft is below the glide path, the needle will be deflected upward. When the aircraft is directly on the glide path, the needle will be centered horizontally across the circle, in the middle of the dial. The glide path course is much sharper than the localizer, measuring less than 1.5° from full ‘fly up’ to full ‘fly down’ on the instrument.[16]

2.7.3 Cross Pointer Flag Alarm

Two tiny meters are installed within the case of the cross pointer indicator. Only a current sufficient to operate the localizer or glide path needle will suppress the flag alarm and hold it out of sight beyond the rim of the dial. The flag alarm, a small red tag, with the word ‘OFF’ clearly inscribed, will move across either the localizer needle or the glide path needle when.[8]

A usable signal is not being received from the ground equipment either receiver is malfunctioning to such an extent that the output is not sufficient to hold the flag alarm out of sight.

The localizer or glide path should only be used for an instrument approach when the associated flag alarm is fully suppressed.

Instrument landing system (ILS) facilities are a highly accurate and dependable means of navigating to the runway in IFR conditions. When using the ILS, the pilot determines aircraft position primarily by reference.[10]

ToINSthe ‘HI-LO’ switch allows a choice of two sensitivity settings of the marker receiver. When the switch is in the ‘HI’ position, the receiver is in its most sensitive condition and it is in this position the equipment is normally operated. Changing the switch to the ‘LO’ sensitivity position decreases, by approximately one half, the time that the signal may be received trumpets.[12]

2.8 Development

The ILS system for precision guidance system for aircraft landing is one that is most widely known among all navigation systems. The ILS was developed in the 1940s and in1949 it was approved by the ICAO to be commissioned. And to this day it is used at most other airports around the world practically without modifications. The main reason for the expansion of ILS is its exceptional operational reliability and low demand on aircraft instrumentation, which in addition can also be used by other navigation systems. ILS is highly durable against atmospheric disturbances.[12]

ILS was developed just after the Second World War. It is the ICAO standard and the fact that it is still the standard approach aid indicates how well it performs its task as well as the difficulty in making changes to internationally standardized systems. This latter point will be mentioned again when MLS is discussed. There are over 110 ILS installations in Canada and more than 1000 in the United States.[6]

2.8.1 Microwave Landing System

Microwave Landing System Enables approach under various descent angles individually for each plane. It is considered to be a possible successor to ILS. MLS is impossible in the near future due to the system's high installation costs at airports and in airplanes new technology is available, technology that will help mitigation of some of the challenges connected to the installation and operation of the ILS.[11]

The terrain in front of an ILS antenna installation must be flat over a relatively large area. In many cases this is an expensive.

Requirement to meet, and in some cases even impossible. Especially in countries like Norway this may be a challenge.

Traffic is not allowed in sensitive areas in front of the antennas. This implies that there must be a certain separation between landing aircrafts, which again reduces the airport capacity.[7]

The frequency spectrum is a rare resource, and in some congested areas, the airports are located so close geographically, that it becomes impossible to install new landing systems.

With ILS, it is only possible to follow a linear flight path for landing. Use of satellite technology will enable new flight patterns, like curved and parallel approaches, new approach angles and several touch-down points. This may solve environmental problems connected with flight over inhabited areas that are today bothered by excessive noise, and it may also increase the airport capacity.[4]

ILS requires two installations at each runway end for approaching traffic, one indicating the direction, and one indicating the glide path. Hence, each runway requires four installations. One GBAS ground station can serve all runways on an airport. This reduces the need for space; it reduces cost and need for maintenance.[17]

2.8.2Global Positioning System

One challenge for instrument pilots is that the rapid change in technology found elsewhere in our lives has invaded the cockpit. In the past, pilots had it easy when flying an ILS approach. By dialing in the right frequency and keeping the needles centered, a pilot could successfully fly an approach even using radios he or she had never seen before.[18]

GPS changed everything. If you know how to operate a particular GPS model and can successfully load a GPS approach, flying an approach to LPV minimums can be as simple as flying an ILS approach. Of course each GPS is different and the odds of successfully loading an approach on an unfamiliar GPS are slim. So flying a GPS approach to LPV minimums can be as simple as flying an ILS approach, but only if you're extremely familiar with the GPS in your cockpit.[16]

To take advantage of the benefits Honey Well Smart Path provides, aircraft need to be equipped with the technology and pilots trained to use it. The Honeywell Smart Path guidance information is displayed to the pilot as it would be using an ILS. Pilot actions for GLS approaches are exactly the same for ILS approaches. This eliminates the need for any dedicated Honeywell Smart Path pilot training. The only significant difference between an ILS and GLS approach, for a pilot, is they dial in a Honeywell Smart Path channel number rather than and ILS radio frequency.[13]

The system can provide significant safety, capacity, efficiency and environmental benefits for airlines, airports and air navigation service providers.

For airlines, the benefits of Honeywell Smart Path include less flight disruptions and associated cost caused by ILS interference and requires minimal pilot training to achieve this.[18]

Chapter three: Study and simulation

3.1 introduction

In thesis chapter study and simulation of an ILS have been done, and the simulation of the circuit of loc and GP have been done by using mat lab Simulink tool and the circuit of DME by proteus software.

3.2 localizer

A loc circuit has been constructed, it consists of RX and TX as (figure 5).

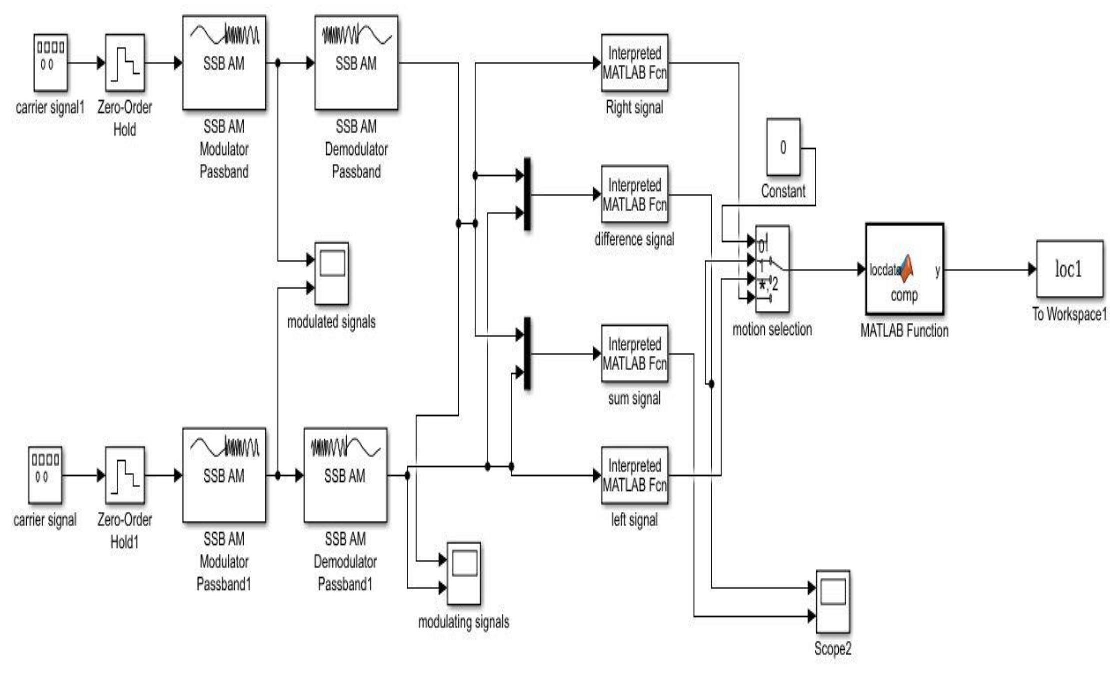

Figure 5: the simulation of loc and GP by mat lab

3.2.1 Transmitter (TX)

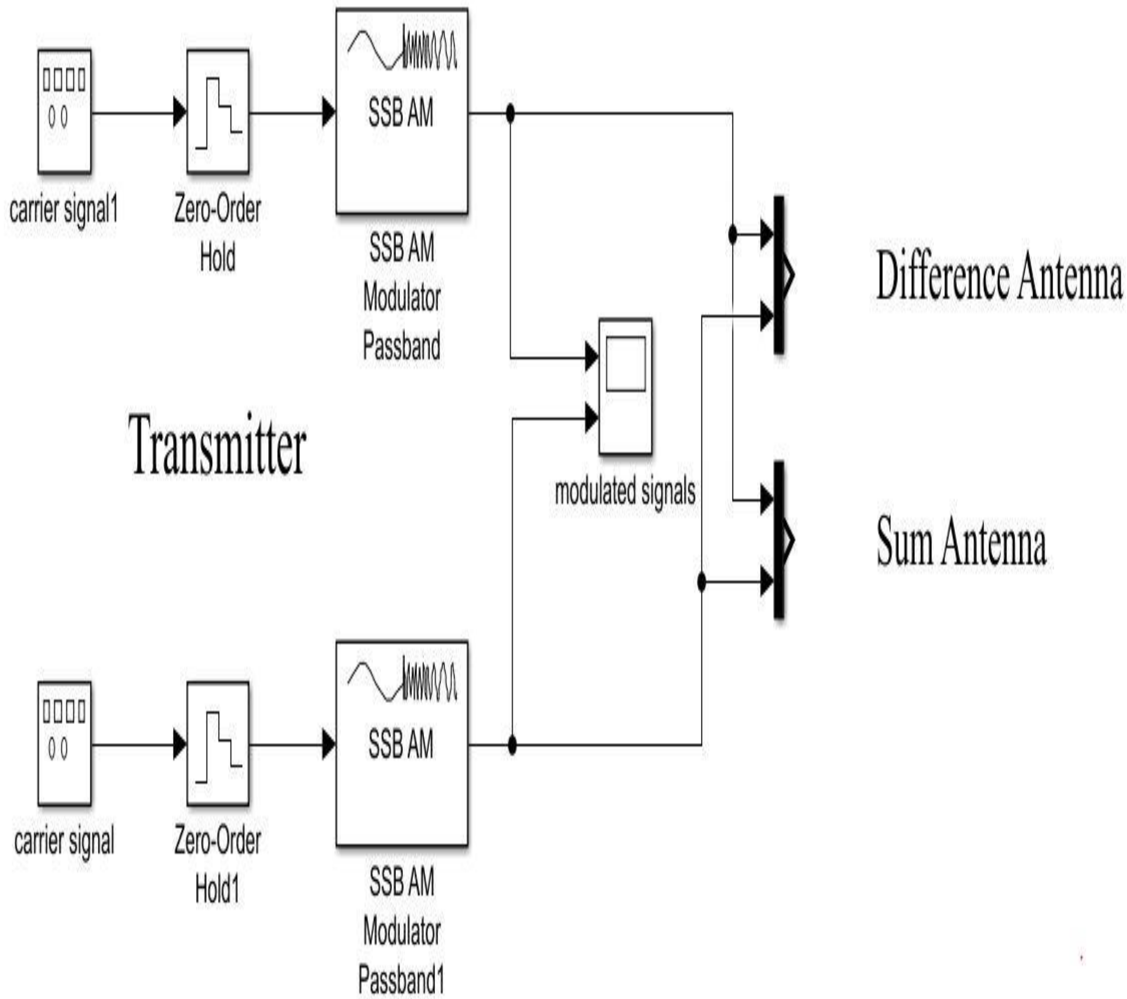

Figure 6: the simulation of the transmitter

It consist of two circuit ,The first one consist of a carrier signal has a frequency of 300,000 Hz work as a modulation signal, this signal has been an input to a (zero –order –hold) (see figure 8)to convert the signal to discreet signal by a sample time of $\frac{1}{900000}$ then modulated by 90 Hz by using (SSB AMMODULATOR PASSPAND)(see figure 7) .and the modulated signal has been displayed on scope, The second circuit has been connected by the same way just the modulation signal has been changed from 90 Hz to 150 Hz.

The out puts of the two circuits has been connected to three antennas, two of them known as different antennas has an output signal called SBO(see figure 9),The third one known as sum antenna has an output called CSB (see figure 10).

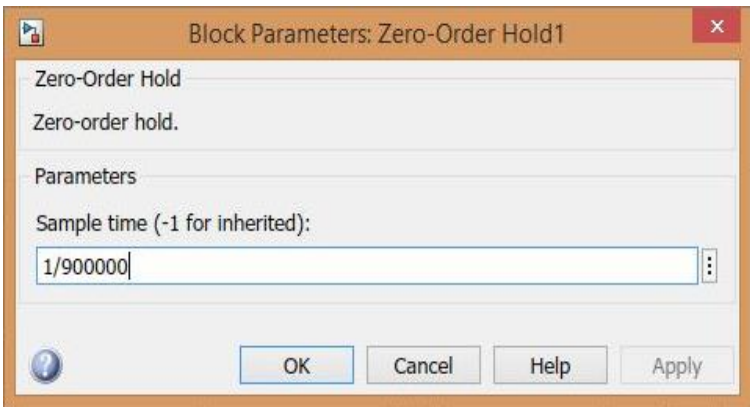

Figure 8: zero order hold

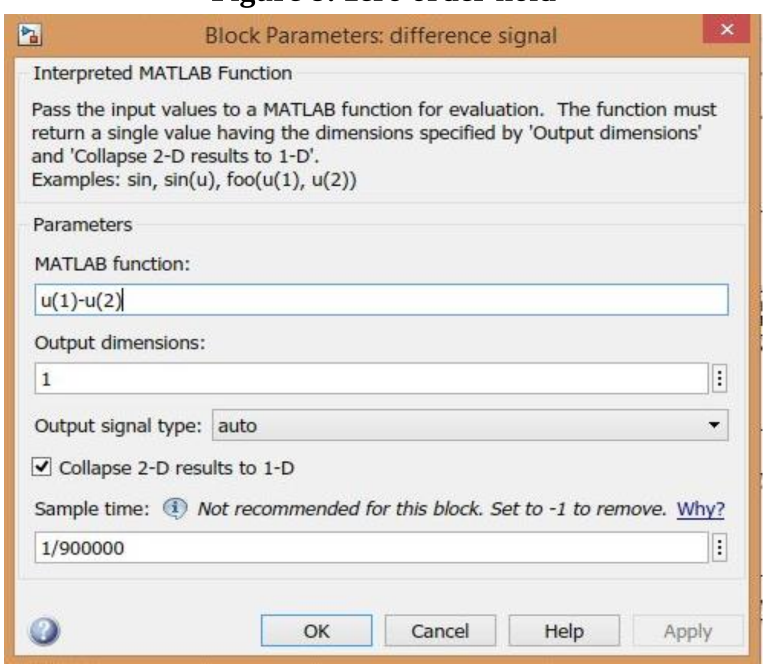

Figure 7: AM modulator

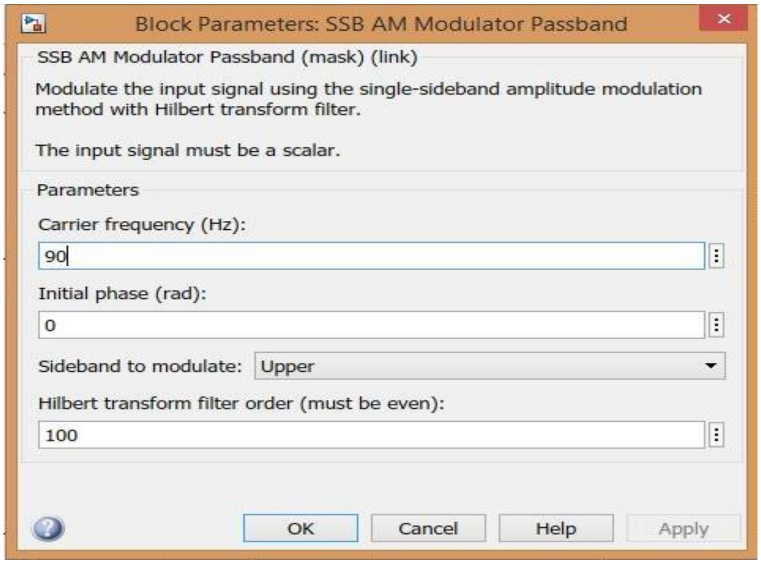

Figure 9: different signal

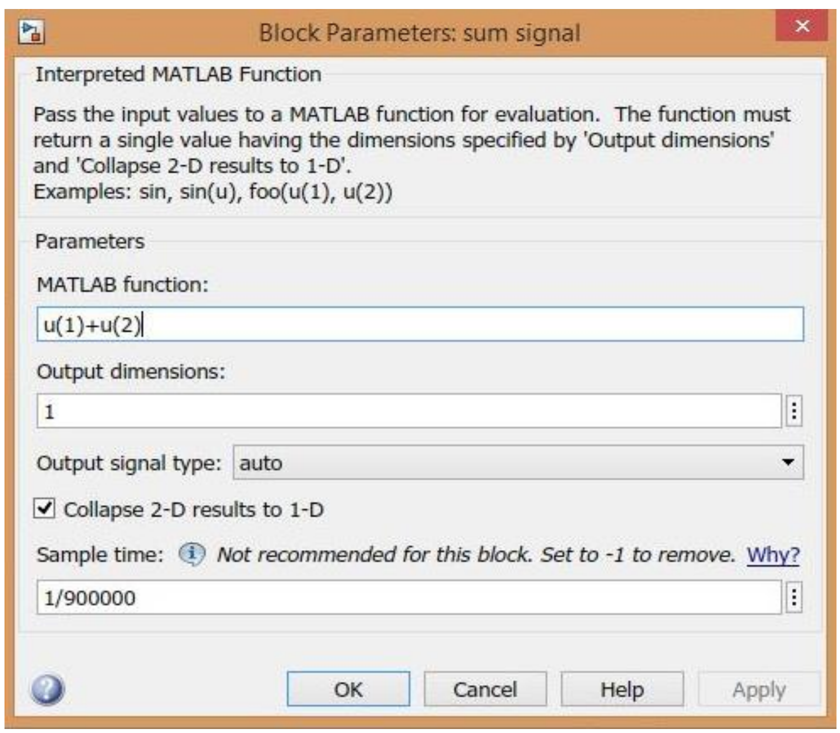

Figure 10: sum signal

3.2.2 Receiver (RX)

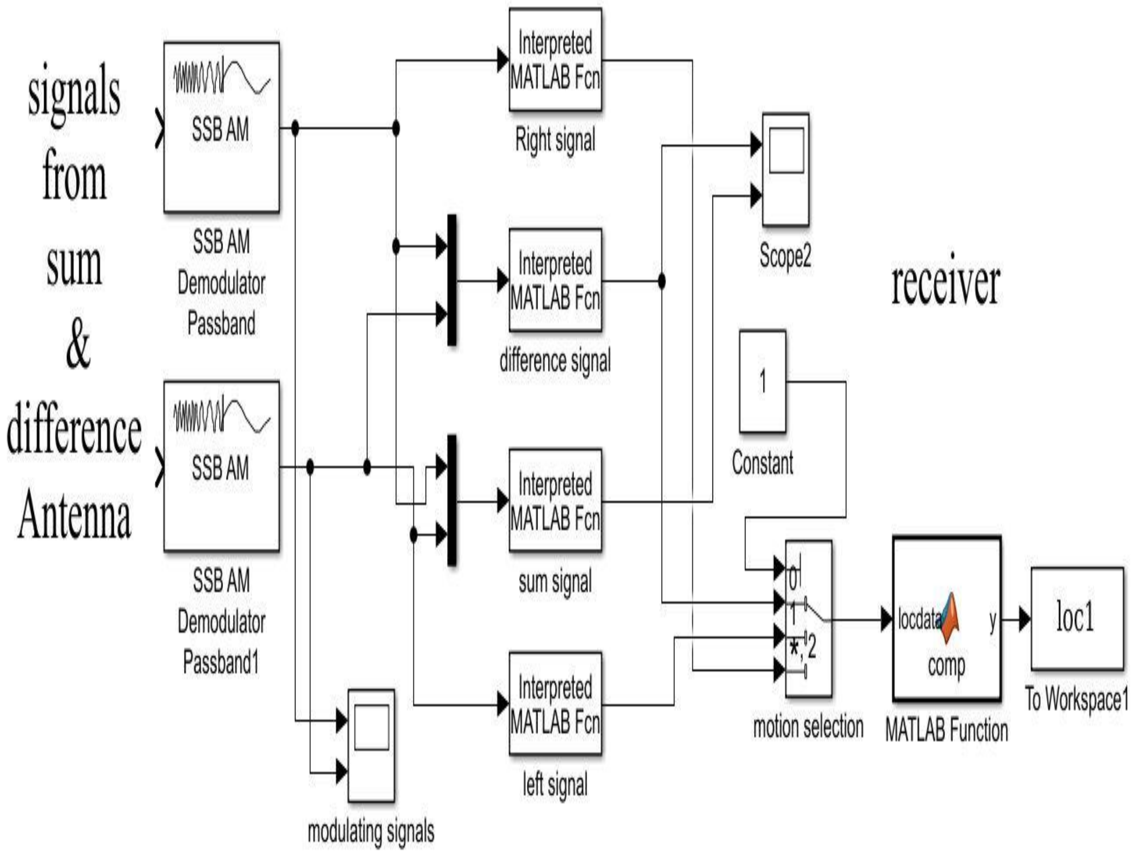

Figure 11: the simulation of receiver

Consist of antenna to receive the signal, this signal has been applied to a demodulator called (SSB AM demodulator) (see figure 12 ,13), then the modulated signals traveled from the SSB AM to a mux where the first signal of a 90 Hz represent the left side of the run way, and the second signal of a 150 Hz represent the right side of the run way.

The mux represents the two situations of the sum signal and different signal, the first signal and the second one and that signal has been given by the mux has been gone through (INTERPRETED MATLAB FUNCTION).

The Matlab function has a code (see it in the Appendices), this function make compare between the received signal which coming from the switch (select motion switch), and the situation of the A/C (right, center, left) (see figures14 ,15,16) determined according to the written code and displayed as message.

This circuit has been tested at time of 1 second in the Matlab, and the run has been done, results have been given.

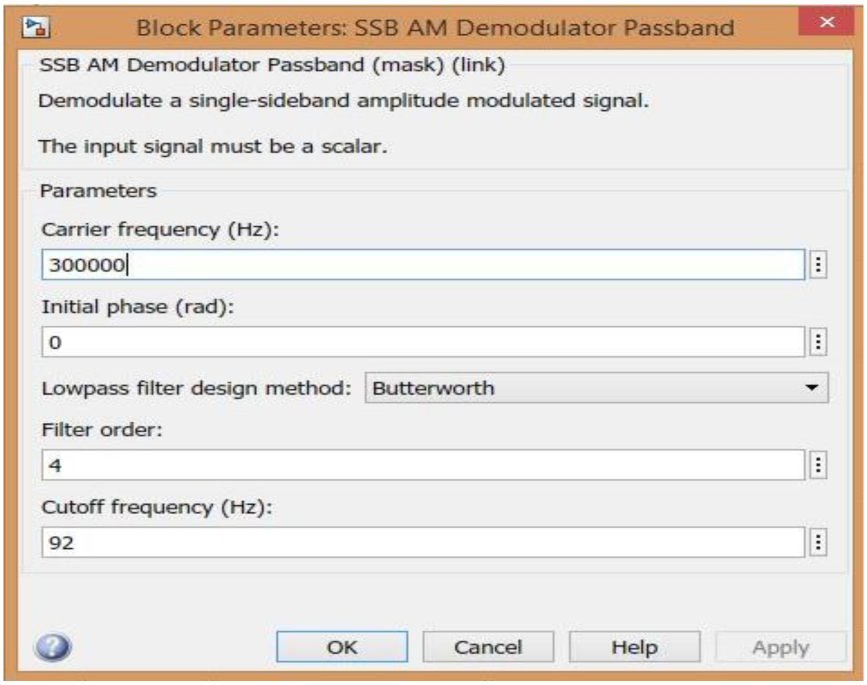

Figure 12: de modulator

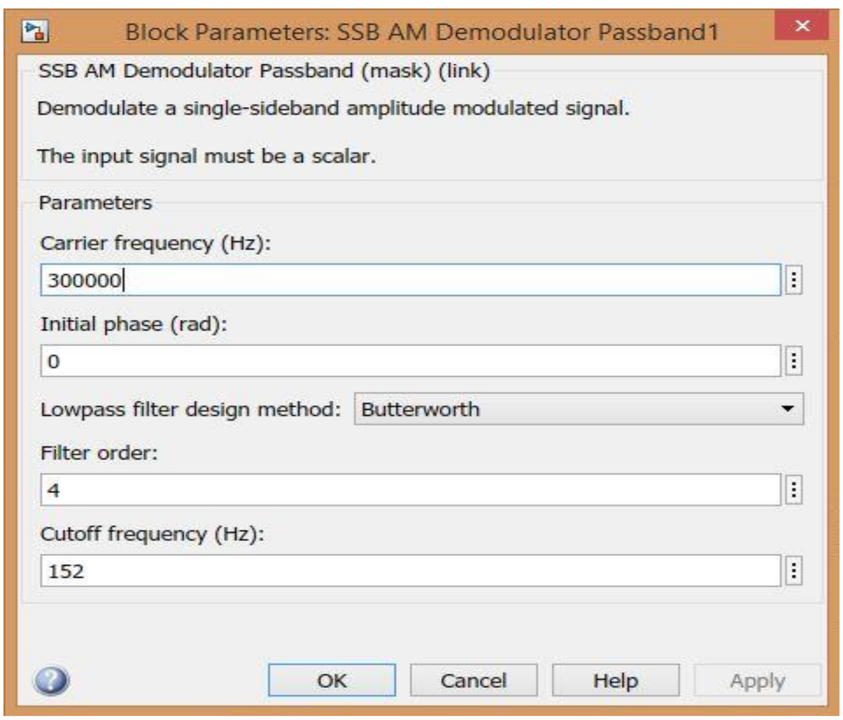

Figure 13: de modulator

Figure 16: massage box

Figure 15: massage box

Figure 14: massage box

3.3 Glide path

The glide path has the same circuit of the loc, just has a change in the Matlab function code, the situations here are (up, in the path, below) (see figures 17 ,18 ,19) according to the touch point, Also the frequency 90 Hz represent the signal up the path, and 150 Hz represent the signal below the path.

And the circuit has been tested at the same time of the loc (0.1second), the run successful, the expected results has been given.

Figure 17: massage box

Figure 18: massage box

Figure 19: massage box

3.4 DME

Here a circuit of DME has been designed by using protuse software, two microcontrollers connected together designed it by two codes see it in the Appendices, one represents the DME U (1) as onboard equipment and the other represents the DME U (2) as ground equipment (see the figures 20,21,22,23).

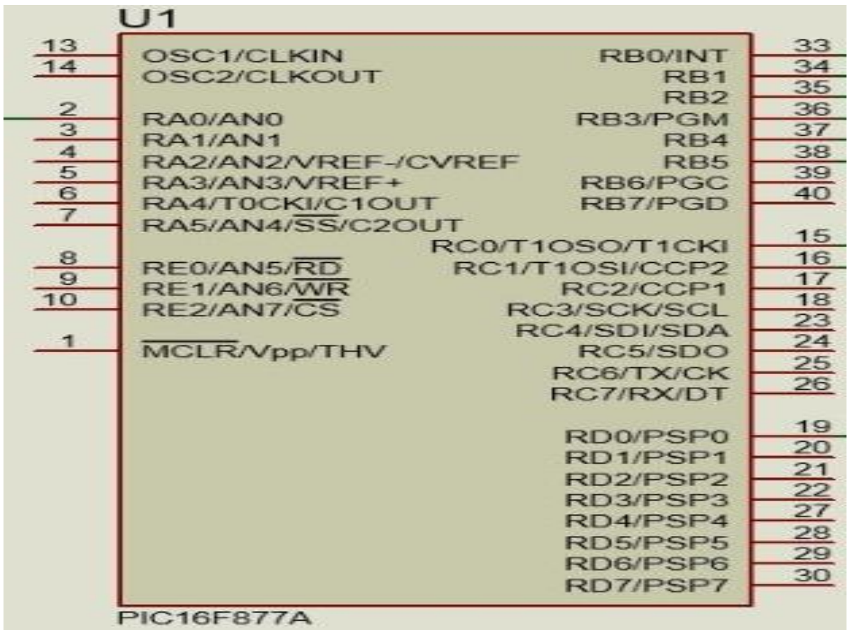

Figure 20: microcontroller one

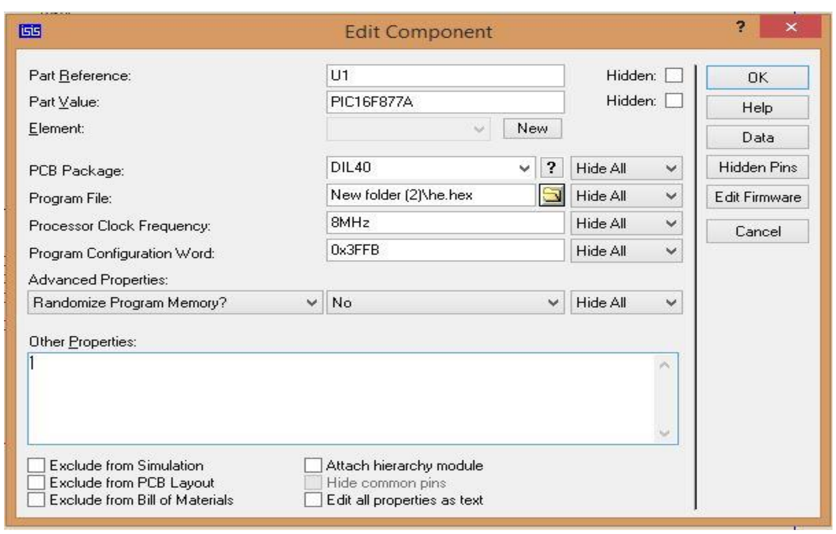

Figure 21: feature of microcontroller one

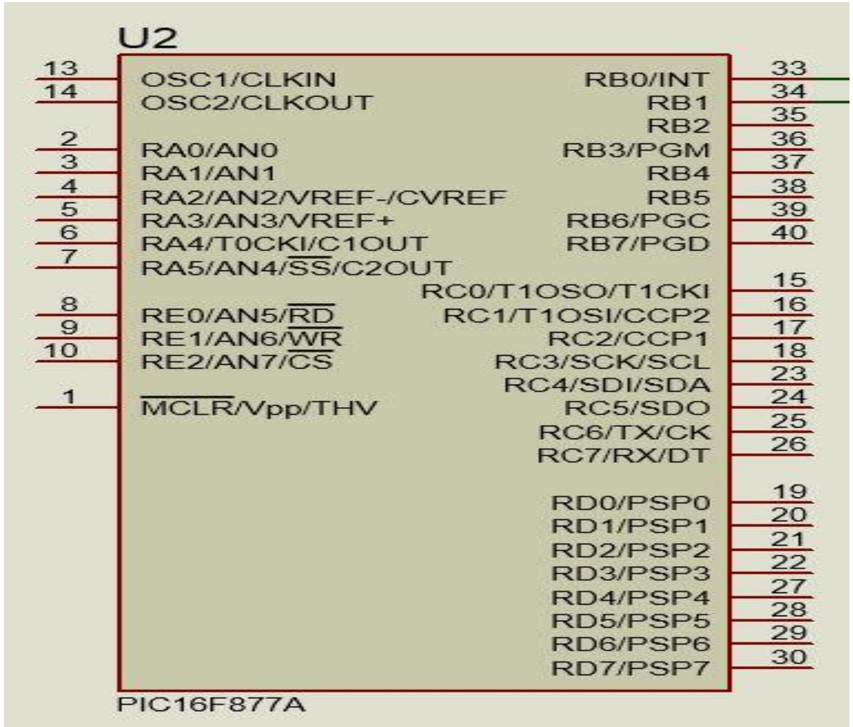

Figure 23: microcontroller two

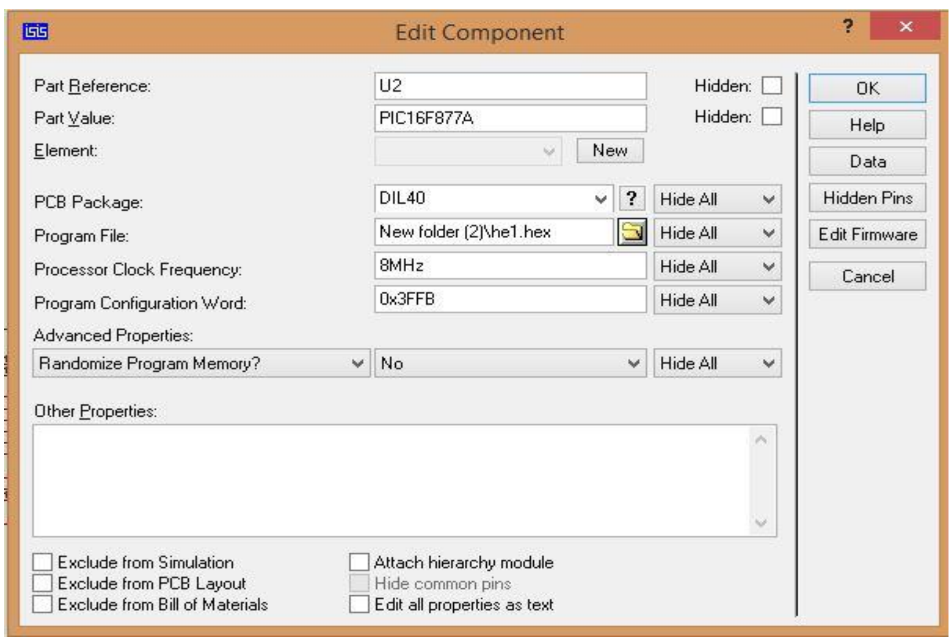

Figure 22: feature of microcontroller two

The code of the microcontroller has been desigind by the microc, in U(1) The pin 15 acting as a TX and pin 16 as RX , In U(2) the pin 33 acts as TX and pin 34 acts as RX.

The microconroller U(1) has been connected to LCD screen to show up(see figure 24), then a switch RV(1) has been added to U(1) and the screen, this switch govern the time delay of the o pulse.

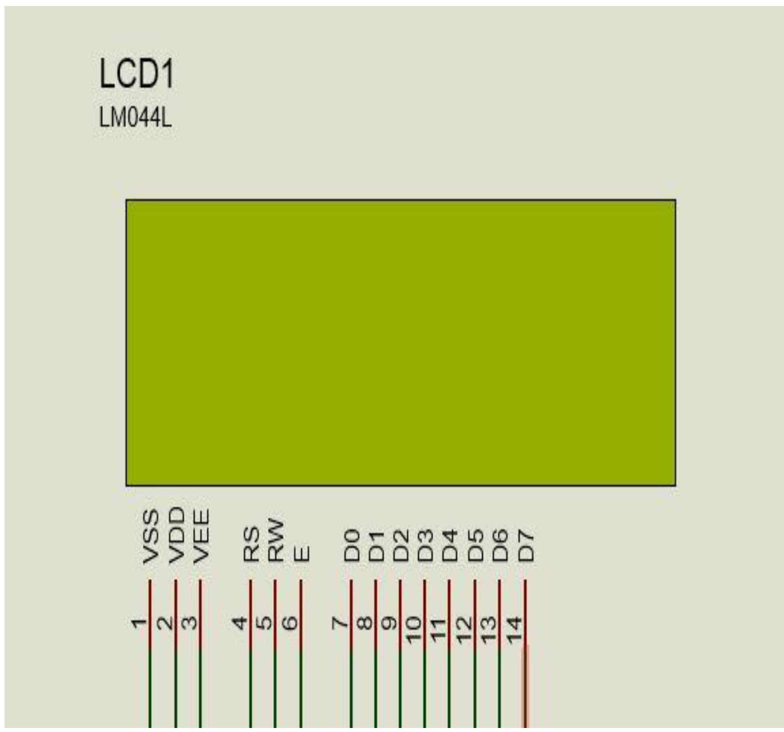

Figure 24: LCD display

3.4.1The operation

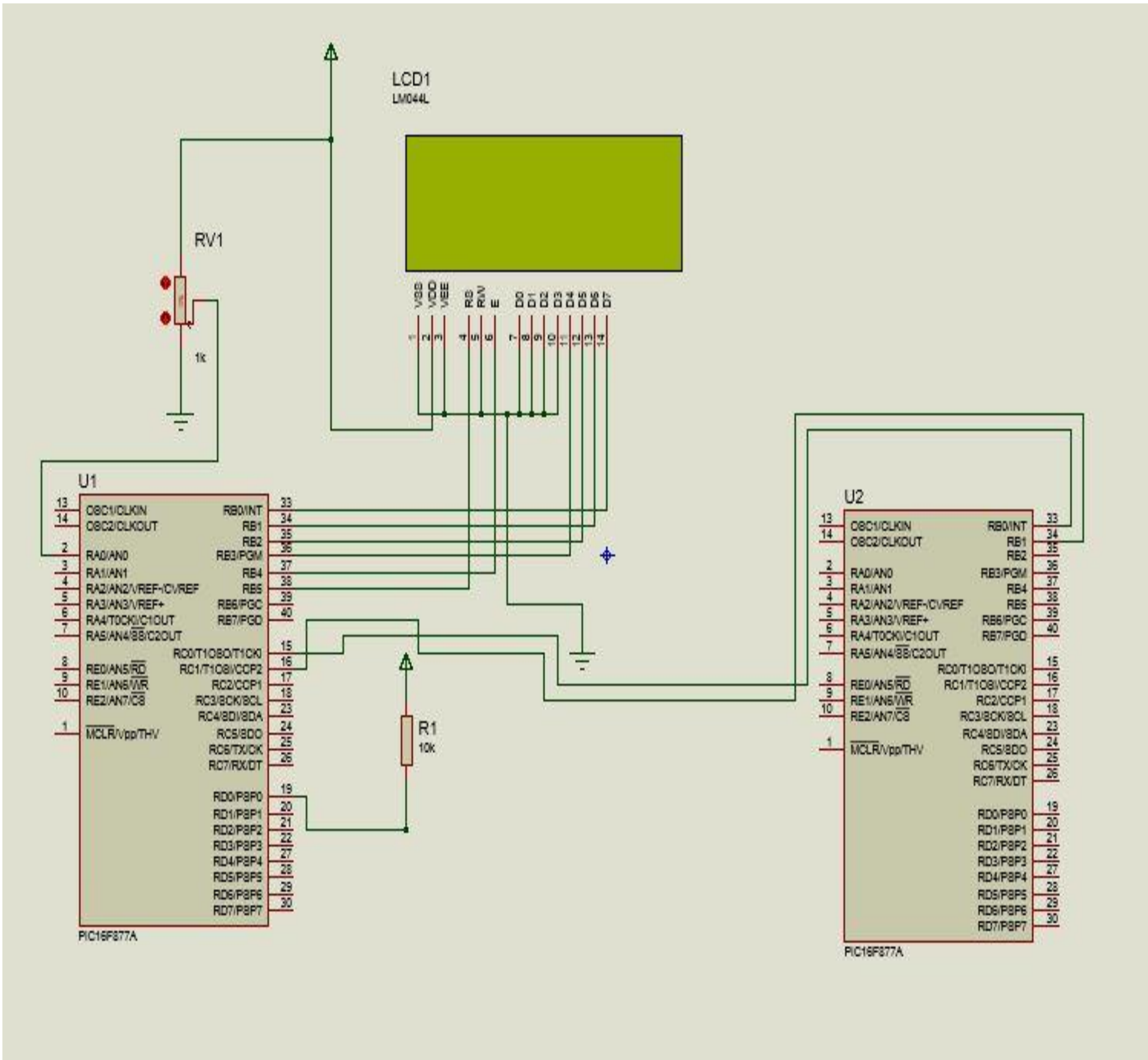

Figure 25: the circuit of DME

Assuming an A/C has the flowing parameters:

Slant range =13 NM , horizontal distance =12.8 NM , altitude =2 NM

This circuit determinate the distance from the A/C to the ground station according to delay time in the pulse.

In the beginning of the operation , a pulse has been sent from pin 15 in U(1) to pin 33 in U(2) and this fabricate the pulse transimitted from the A/C to the ground station , when the pulse has been received by U(2) a delay by 50 microsecond has been done by this controller then send it again by pin 34 to pin 16 in U(1) after that the calculated distance has been displayed on the LCD screen, which determind by:

$$S = C * \frac{T}{2} \quad (3.1)$$

$$T = t - 50 \quad (3.2)$$

$$A = \sqrt{S^2 - D^2} \quad (3.3)$$

An example has been taken the max and min in time delay and the distance displayed in the screen (see the figure 26,27,28,29).

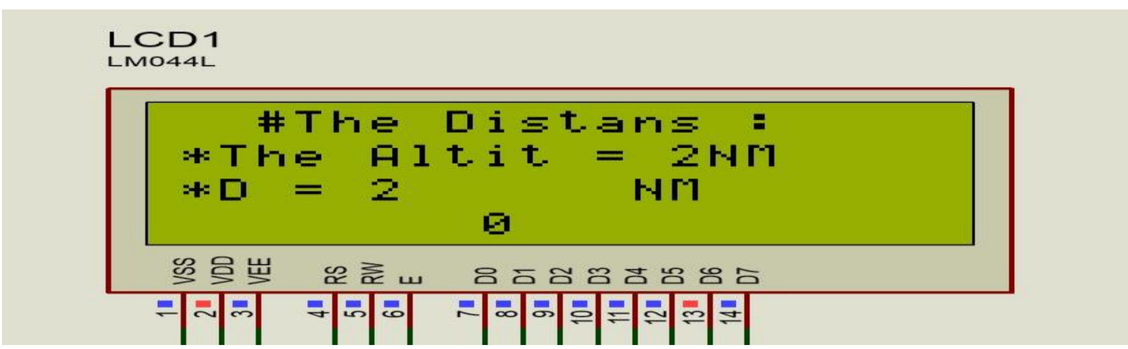

Figure 26: the min distance

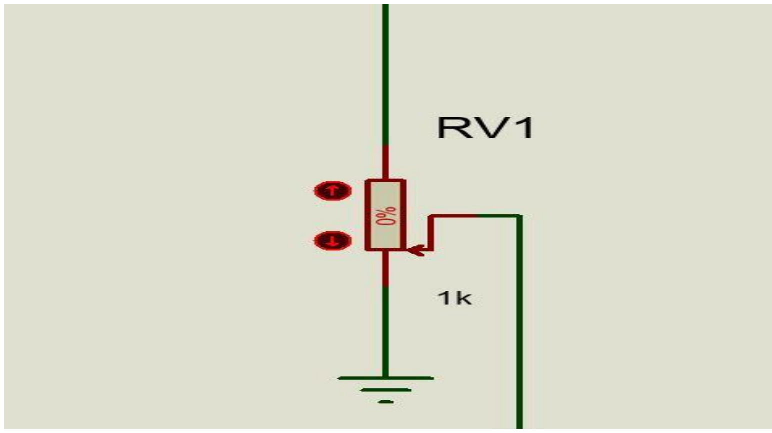

Figure 27: time delay at min distance

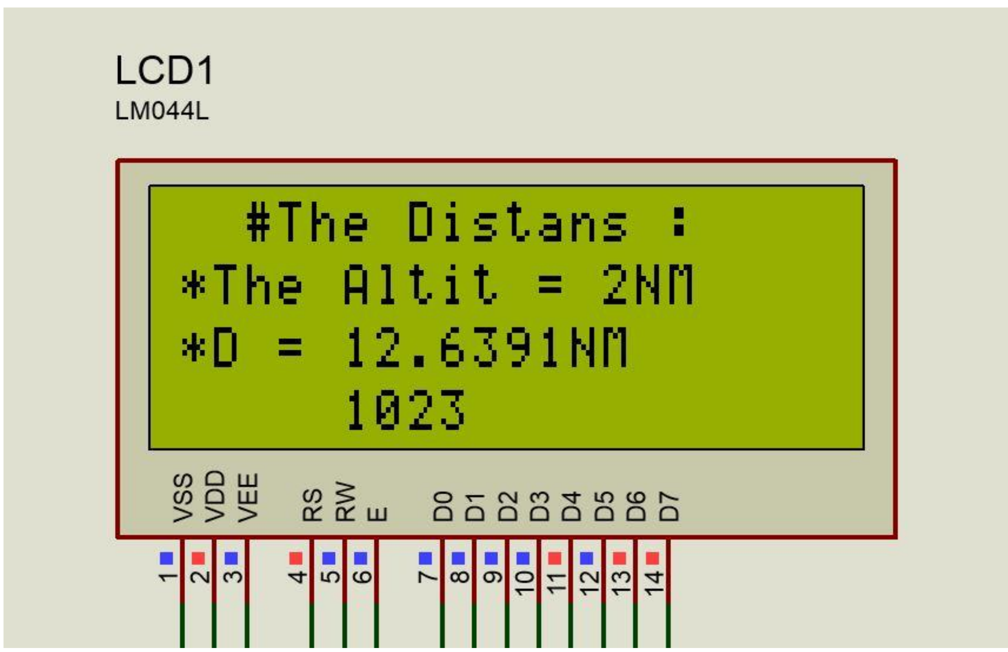

Figure 28: max distance

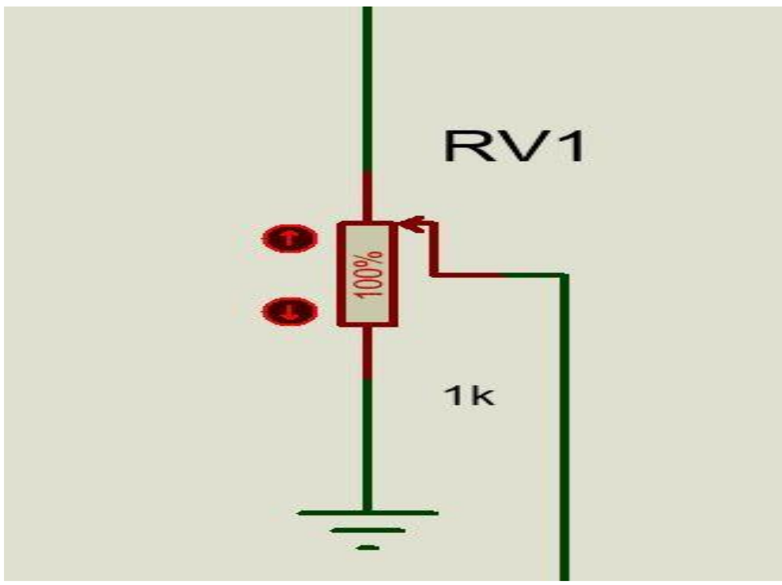

Figure 29: time delay at max distance

Chapter four: Results and Discussion

The following sections will illustrate the results obtained from each tuning step presented in chapter three.

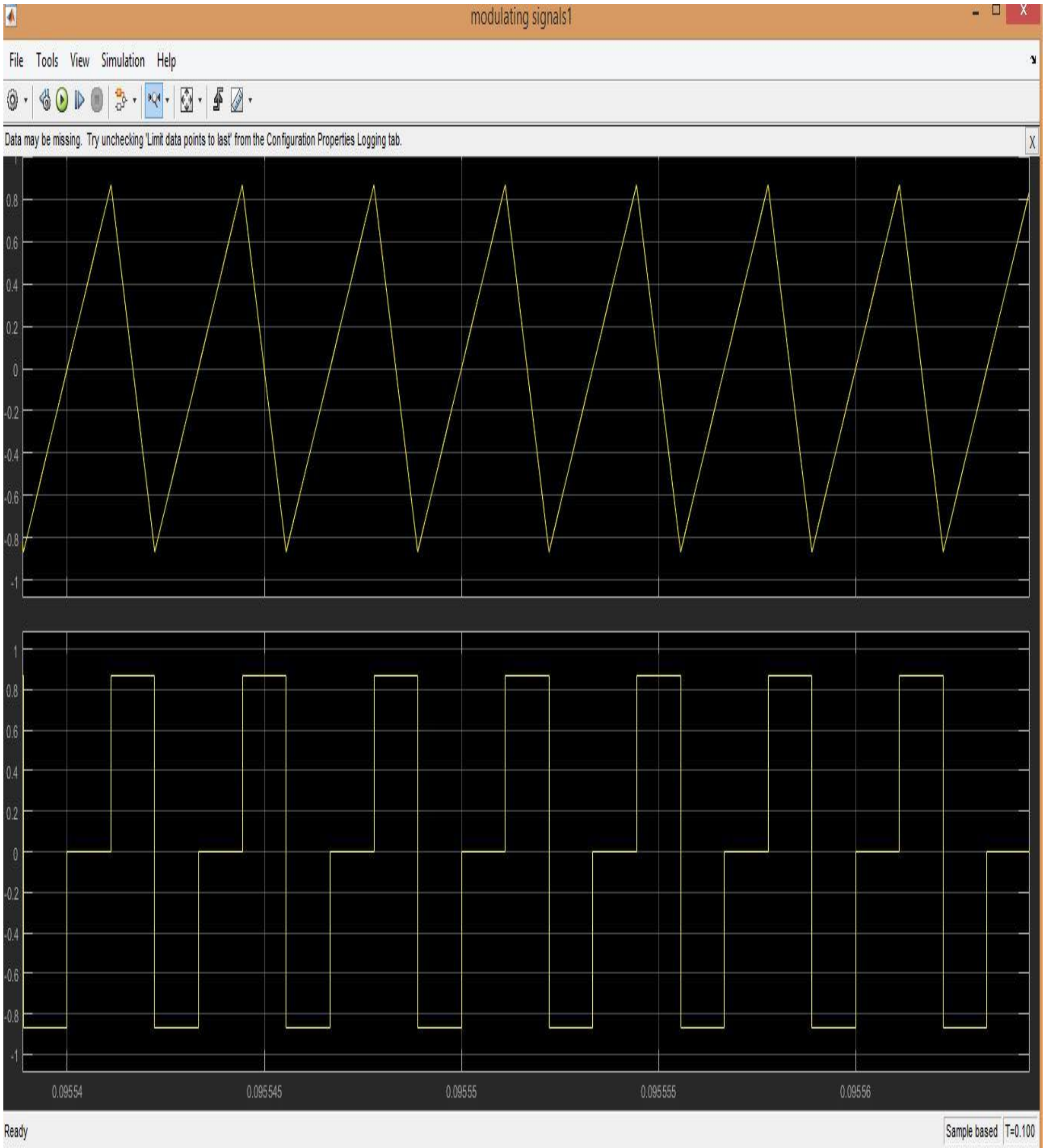

Figure 30: carrier frequency

This figure shown Carrier wave has frequency 300000Hz

This is the first result which came from the TX to represent the modulating signal the above one is coming from the sum antenna and the below coming from different antenna (see figure 31).

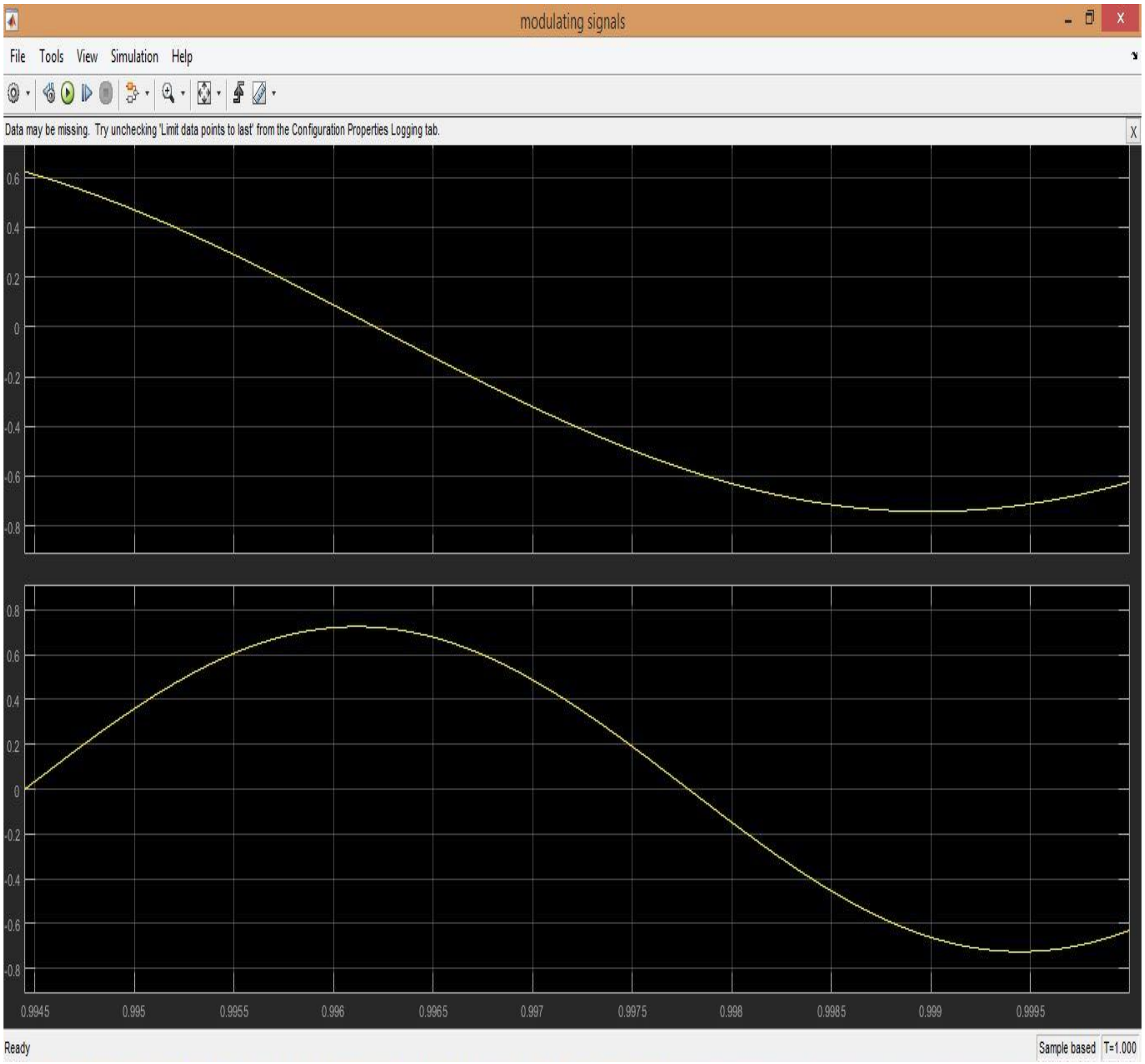

Figure 31: modulated signal

This the second result which represent the modulated signal with the carrier wave, coming from modulated signal block, also above one came from sum antenna and the below one came from different antenna (see figure 32).

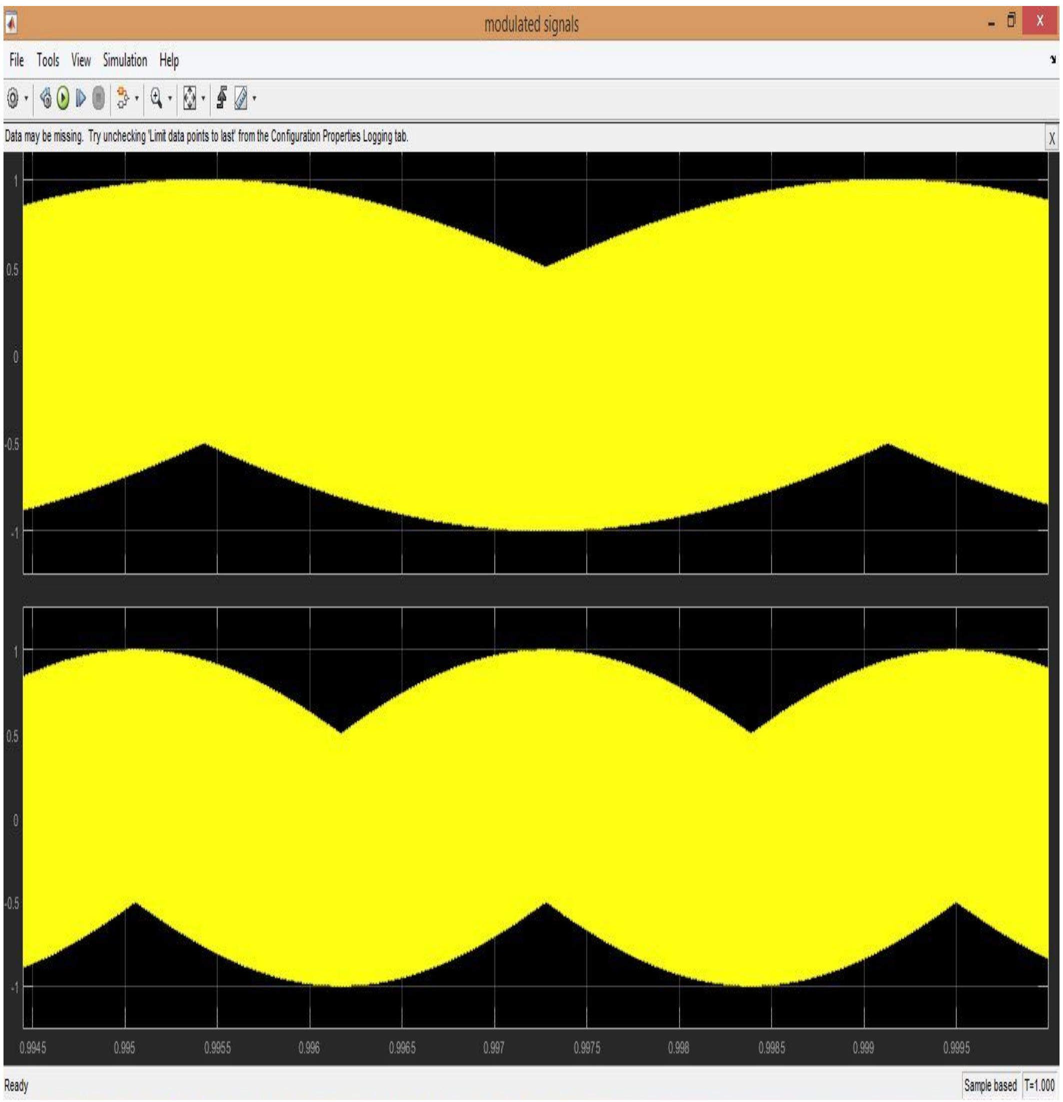

Figure 32: modulating signal

This is the final result which coming from scope 2 to represent the demodulating signal, the final output from the Rx (see figure 33).

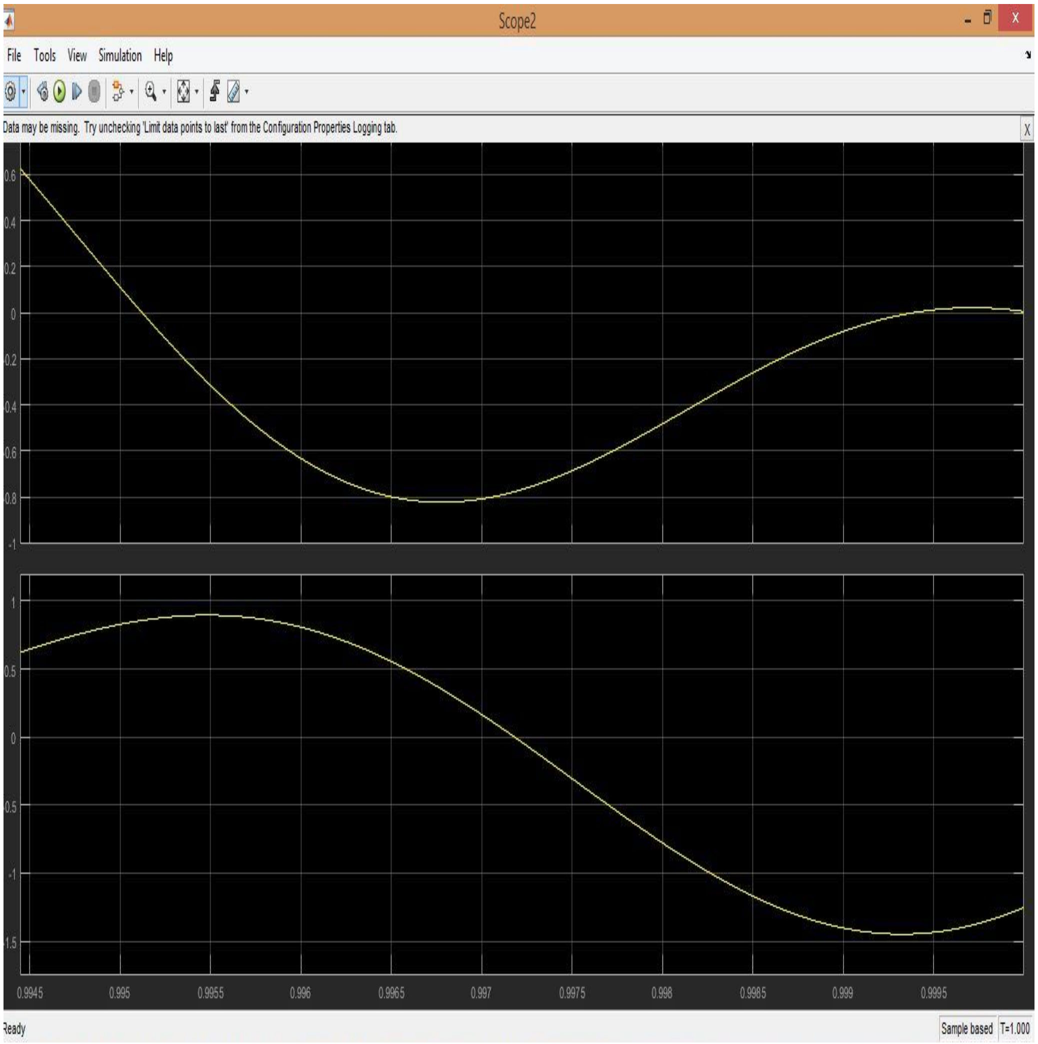

Figure 33: modulating signal

Chapter five: Conclusion and Recommendations

5.1Conclusion

The study and simulation has been done for each of localizer, glide path and DME, localizer and glide slope gave us the indication massage according to the runway and the DME show up the measuring of distance according to the delay time of pulse that transmitted and delayed in the ground station by 50 microseconds then transmitted again to the onboard station to calculate the distance from the delay time.

5.2Recommendations

This project can be applied by using ADS and P SPAICE programs, the circuit of VOR also can be simulated.

5.3Future Work

In the future………

Localizer signal can be couple to aerodynamic model of A\C and with auto land process.

A complete model can be done and simulated on it a signal of an ILS and also can be fabricated the ILS into hardware.

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Appendices

Appendix A

Code of microcontroller one (U1)

```
sbit LCD_RS at RB5_bit;

sbit LCD_EN at RB4_bit;

sbit LCD_D7 at RB0_bit;

sbit LCD_D6 at RB1_bit;

sbit LCD_D5 at RB2_bit;

sbit LCD_D4 at RB3_bit;

sbit LCD_RS_Direction at TRISB5_bit;

sbit LCD_EN_Direction at TRISB4_bit;

sbit LCD_D7_Direction at TRISB0_bit;

sbit LCD_D6_Direction at TRISB1_bit;

sbit LCD_D5_Direction at TRISB2_bit;

sbit LCD_D4_Direction at TRISB3_bit;

unsigned int sig1;

 char sig1_txt[10];

  float x ;

  char x_txt[10];
```

```
void main() {
   trisd.b0=1;
   portd.b0=1;
    trisc.b0=0;
   portc.B0=0;
            adc_init();
   ADCON1 = 0b00000000;
   lcd_init();
   lcd_cmd(_lcd_clear);
   lcd_cmd(_lcd_cursor_off);
   for(;;)
   {
     sig1 = adc_read(0);
     wordtostr(sig1,sig1_txt);
     lcd_out(4,5,sig1_txt);
     lcd_out(1,2," #The Distans : ");
     lcd_out(2,1,"*The Altit = 2NM");
     lcd_out(3,1,"*D =");
     lcd_out(3,13,"NM");
```

```
 // if(portd.b0==0)
 // {
  DELAY_ms(100);
   portc.b0=1;
   x = 0.0052*sig1;
   x = x+1;
   x = x*2;
  floattostr(x,x_txt);
   lcd_out(3,6,x_txt);
 // }
  DELAY_ms(100);
  portc.b0=0;
}  }
```

Appendix B

Code of microcontroller (U2)

```
void main() {
trisb.b0=1;
portb.b0=0;
trisb.b1=0;
portb.b1=0;
 while(1)
 {
  if(portb.B0==1)
  {
   delay_us(50);
   portb.b1=1;
  }
 }
}
```

Appendix C

Code of mat lab simulation

```
function y = comp(locdata)

%#eml

x=locdata

eml.extrinsic('msgbox')

y=x

   if y > 0.9

      msgbox('center runway')

   elseif y>0.63 && y<0.8

      msgbox('left to runway')

   else if y<0.63

      msgbox('right to runway')

      end

   end

end
```

Appendix D

$c = 3 * 10^8\ m/s$