

# DIGITAL OSCILLOSCOPE



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# **DIGITAL OSCILLOSCOPE**

**G R A D U A T I O N P R O J E C T**

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# CONTENTS

## CONTENTS AT A GLANCE

ACKNOWLEDGMENTS .....	i
CONTENTS .....	iii
INTRODUCTION .....	1
C-LANGUAGE .....	5
THE SOFTWARE PROJECT STEPS .....	9
THE ENVIRONMENT SCREEN.....	15
THE MAIN MENUS.....	25
SOME DETAILS .....	63
THE OVER ALL PROJECT.....	69
GOING INSIDE THE APPLICATION .....	75
PROJECT HARDWARE .....	85
DISCUSSION.....	89
REFERENCES .....	91

## TABLES

Table.1. text types and colors.....	65
Table.2. operations and sounds.....	65
Table.3. mouse cursors.....	66
Table.4. files to run .....	66
Table.5. files to compile.....	67
Table.6. header files and functions .....	68
Table.7. disk space needed.....	68
Table.8. samples in memory.....	87
Table.9. handshaking .....	87
Table.10. controlling vertical position.....	88
Table.11. controlling triggering and coupling.....	88
Table.12. controlling time and voltage scales .....	88

## FIGURES

Fig.1. the environment screen .....	19
Fig.3. the message bar .....	21
Fig.4. the menu bar.....	22
Fig.5. the special buttons.....	24
Fig.6. the main menus .....	28
Fig.7. the position menu.....	30
Fig.8. the scale or any typical menu.....	34
Fig.9. the horizontal and vertical cursor lines and the mouse position.....	38
Fig.10. the cursor menu.....	40
Fig.11. the grid on the scope screen.....	48

## CAPTURES

Capture.1. Starting the program.....	77
Capture.2. Entering the scope .....	77
Capture.3. Entering the position menu .....	78
Capture.4. Entering the scale menu .....	78
Capture.5. Entering the cursor menu .....	79
Capture.6. Entering the control menu .....	79
Capture.6. Entering the fft menu.....	80
Capture.7. Entering the options menu .....	80
Capture.8. Generating data.....	81
Capture.9. Entering the settings menu .....	81
Capture.10. Selecting drives from the file menu .....	82
Capture.12. Entering the help menu .....	83
Capture.13. Getting help on the cursor menu .....	83
Capture.14. Entering the about menu .....	84

# CONTENTS

ACKNOWLEDGMENTS .....	i
CONTENTS .....	iii
CONTENTS AT A GLANCE.....	iii
TABLES.....	iii
FIGURES .....	iv
CAPTURES.....	iv
CONTENTS .....	v
INTRODUCTION.....	1
C-LANGUAGE.....	5
2.1 LEARNING C-LANGUAGE .....	7
2.2 C-LANGUAGE AND FUNCTIONS.....	7
2.3 C-LANGUAGE AND GRAPHICS .....	7
2.4 C-LANGUAGE AND MOUSE .....	7
2.5 C-LANGUAGE AND THE PROJECT .....	8
THE SOFTWARE PROJECT STEPS .....	9
3.1 LEARNING C-LANGUAGE BASICS .....	11
3.2 A LITTLE MORE IN C .....	11
3.3 THE BASIC DIGITAL OSCILLOSCOPE FUNCTIONS.....	11
3.4 MORE DIGITAL OSCILLOSCOPE FUNCTION.....	11
3.5 DESIGNING THE DIGITAL OSCILLOSCOPE SCREEN.....	12
3.6 INTERACTING WITH THE ENVIRONMENT.....	12
3.7 WRITING THE DIFFERENT FUNCTIONS IN C- LANGUAGE.....	13
THE ENVIRONMENT SCREEN.....	15
4.1 ABOUT THE ENVIRONMENT SCREEN.....	17
4.2 USING THE ENVIRONMENT SCREEN .....	17
4.3 THE SCOPE SCREEN .....	19
4.4 THE MESSAGE BAR .....	20
4.5 THE MENU BAR .....	21
4.6 THE SPECIAL BUTTONS.....	23
THE ESCAPE BUTTON.....	23
THE SOUND TOGGLE BUTTON.....	23
THE TIME BUTTON .....	23
THE MAIN MENUS.....	25
5.1 ABOUT THE MAIN MENUS.....	27
5.2 POSITION MENU .....	28
ABOUT.....	28
SPECIFIC.....	28
UP .....	28
DOWN .....	29

	LEFT.....	29
	RIGHT .....	29
	SET .....	29
5.3	SCALE MENU.....	30
	ABOUT.....	30
	SPECIFIC.....	31
	V-SCALE HI.....	31
	V-SCALE LOW.....	31
	V-SCALE RESET.....	31
	T-SCALE HI.....	32
	T-SCALE LOW .....	32
	T-SCALE RESET .....	33
	V&T-SCALES RESET.....	33
5.4	CURSOR MENU .....	34
	ABOUT.....	34
	SPECIFIC.....	35
	V-CURSOR 1/2/OFF.....	35
	H-CURSOR 1/2/OFF.....	36
	MOUSE CURSOR ON/OFF .....	37
	ALL-OFF .....	37
	UP .....	38
	DOWN .....	38
	LEFT.....	39
	RIGHT .....	39
	SET .....	40
5.5	CONTROL MENU .....	41
	ABOUT.....	41
	SPECIFIC.....	41
	SLOPE POS(+)/NEG(-).....	41
	AC.....	41
	DC.....	41
	γGROUND.....	42
	AC TRIGGER.....	42
	DC TRIGGER.....	42
5.6	FFT MENU .....	43
	ABOUT.....	43
	SPECIFIC.....	43
	SHOW FFT.....	43
	LIN SCALE .....	43
	LOG SCALE.....	43
5.7	OPTIONS MENU .....	44
	ABOUT.....	44
	SPECIFIC.....	44
	REDRAW ALL.....	44
	GENERATE DATA .....	45
	ON LINE INFO/NO INFO .....	46
	DOS SHELL .....	47
	BACK TO SCOPE.....	47
	GRID.....	48
	FREEZE ON/OFF.....	48
5.8	SETTINGS MENU .....	49

ABOUT .....	49
SPECIFIC.....	50
POSITION .....	50
SCALE.....	51
CURSOR.....	51
GRID.....	52
5.9 FILE MENU .....	53
ABOUT .....	53
SPECIFIC.....	54
NAME.....	54
SAVE .....	54
LOAD .....	55
SET PATH.....	56
SET DRIVE .....	56
DIR.....	57
WAV/FFT/SET.....	57
EXIT .....	57
5.10 HELP MENU .....	58
ABOUT.....	58
SPECIFIC.....	58
POSITION .....	58
SCALE.....	59
CURSOR.....	59
CONTROL.....	59
FFT.....	59
OPTIONS.....	59
SETTINGS.....	60
FILE .....	60
5.11 ABOUT MENU .....	61
ABOUT.....	61
SOME DETAILS .....	63
6.1 TEXT COLORS.....	65
6.2 SOUND .....	65
6.3 MOUSE CURSORS.....	66
6.4 FILES NEEDED TO RUN PROPERLY .....	66
6.5 FILES NEEDED TO COMPILE & LINK FROM	
BC++v3.1 .....	67
6.6 THE HEADER FILES INCLUDED IN THE	
PROJECT .....	68
6.7 FREE SPACE NEEDED .....	68
THE OVER ALL PROJECT.....	69
7.1 PROJECT OVERVIEW .....	71
7.2 PROJECT FLOW CHART .....	72
THE BASIC PROJECT FLOW CHART .....	72
THE MAIN PROGRAM FLOW CHART.....	72
THE SCOPE GENERAL FLOW CHART .....	73
GOING INSIDE THE APPLICATION .....	75
PROJECT HARDWARE .....	85
9.1 OVERVIEW.....	87

9.2 HARDWARE DETAILS .....	87
DISCUSSION.....	89
REFERENCES .....	91

# CHAPTER ONE

## INTRODUCTION



Although technology is expanding widely across the world conquering nearly every aspect of our lives, there exist some people who do not accept these fast changes and whom cannot confess -not even to themselves- that all of this would result in making their lives simpler and easier; meanwhile all the remaining people are always looking for new improved things, improved in a way that mainly saves time, money and effort. Luckily there are people who are always ready to work day and night to fulfill other peoples dreams and more important to prove to themselves that they are capable of doing so.

With this wide spread of technology, personal computers have had their share from this technical development, a share which is undoubtedly a good one. Since computer manufacturers are doing their best to produce a fast, small and inexpensive computer as possible as it could be -at this time-, people are becoming more and more interested in owning personal computers and companies are always trying to computerize almost everything, so it is of no doubt that colleges, laboratories and technical institutes are even more interested.

Due to the concern of electronic and electrical institutes, colleges and departments in universities about their students and about giving them the most possible assistance, they are supplying their laboratories with PC's and networks, and rarely a laboratory can be found without having at least one PC.

From this point I can introduce my *digital oscilloscope* as a mean of making the work in electronic and electrical laboratories as simple, time-saving and beneficial as possible, by providing a tool which takes advantage of the computer revolution that has started but has not yet ended -I wonder if it will ever do-.



# CHAPTER TWO

## C-LANGUAGE



## 2.1 LEARNING C-LANGUAGE

Many topics in C-language were studied that made it possible for me to successfully continue the *digital oscilloscope* project. These topics cover:

- assignment statements.
- looping using **for**, **while**, **do...while**, **goto** statements.
- conditioning using **if**, **else**, **case** condition statements.
- text mode input commands such as the **getch** and **scanf** functions.
- text mode output commands such as the **printf** function.
- reading and writing **files** using functions such as **fscanf** and **fprintf**.
- working with **pointers**.
- arrays and variables such as **int**, **float** and **char**.
- defining functions and using **functions** from **libraries**.
- working in **graphics mode**.

## 2.2 C-LANGUAGE AND FUNCTIONS

Besides using the wide variety of functions found in the *BorlandC++v3.1* libraries, I was able from many basic functions to define other functions and since these functions were made as general as possible they can be used through out the program and in other programs as well.

## 2.3 C-LANGUAGE AND GRAPHICS

The *BorlandC++v3.1* graphics library functions has a big share in the *digital oscilloscope* program. Many general graphics functions were also defined from the basic graphics functions such as the **putpixel**, **line**, **rectangle**. Such functions are for drawing buttons, opening menus and functions for reading integers, strings and real numbers while in graphics mode.

## 2.4 C-LANGUAGE AND MOUSE

The mouse is activated in the program and functions were defined so as to use the mouse easily while using the *digital oscilloscope*. Such Functions are waiting for a mouse click and checking for a mouse click in a certain area.

## 2.5 C-LANGUAGE AND THE PROJECT

The *digital oscilloscope* application is divided into many files used in the *BorlandC++v3.1 project utility*. This project was split into files in such a way that each file contains related functions, for example; there are files for menu & button drawing functions, for audio functions and for scanning different data types in graphics mode.

# CHAPTER THREE

## THE SOFTWARE PROJECT STEPS



## 3.1 LEARNING C-LANGUAGE BASICS

Even before I had known that I was assigned this project, I was starting to learn C-language on my own. Then I continued learning more about C, writing only simple programs, compiling and debugging them. Also In this early stage I became more familiar with the *BorlandC++v3.1 IDE (Integrated Development Environment)*.

## 3.2 A LITTLE MORE IN C

The next stage was getting more into C language and using its wide variety of functions, just for practice, such as to get ready to write the project program.

## 3.3 THE BASIC DIGITAL OSCILLOSCOPE FUNCTIONS

At this stage it was time to know what the *digital oscilloscope* has to do, and what functions should necessarily be found in this application. These functions include:

- **displaying an interfaced wave.**
- **controlling the positioning of the wave.**
- **controlling time and voltage scales.**
- **calculating voltage differences and time intervals.**
- **AC, DC triggering and toggling the slope of the wave.**
- **grounding, AC and DC coupling of the wave.**

## 3.4 MORE DIGITAL OSCILLOSCOPE FUNCTION

Then thinking of new options and special functions that could be added to the *digital oscilloscope*.

These functions include:

- **displaying an internally generated or loaded wave.**
- **displaying the FFT of a wave.**
- **changing settings and freezing the wave.**
- **naming, saving or loading waves, settings and FFT files.**
- **performing DOS commands and changing drives and directories .**
- **viewing help and about *digital oscilloscope* information.**
- **adding sound and displaying the time.**

## 3.5 DESIGNING THE DIGITAL OSCILLOSCOPE SCREEN

After outlining all the functions found in the *digital oscilloscope*, It was left to my imagination to design the *digital oscilloscope* environment screen.

The **environment screen** include the following:

- **a scope screen**
- **a message bar**
- **a menu bar**
- **main menus**
- **special buttons**

## 3.6 INTERACTING WITH THE ENVIRONMENT

At this stage, I had to define the ways of **user-environment interaction**. These ways of interaction include:

- **pointing and clicking with the mouse on different buttons**
- **pointing and clicking on arrows and special buttons**
- **using space bar and return keys on the keyboard to highlight then choose buttons**
- **using the arrow keys, the delete key and the escape key on the keyboard**
- **questions that require data entry from the user**

## **3.7 WRITING THE DIFFERENT FUNCTIONS IN C-LANGUAGE**

At this final and most important stage, It was time to write the C source code for all the functions and the whole program.



# CHAPTER FOUR

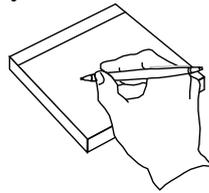
## THE ENVIRONMENT SCREEN



## 4.1 ABOUT THE ENVIRONMENT SCREEN

The *digital oscilloscope environment screen* is done in a way that is both clear and easy to use. It has a **scope screen** that occupies most of the screen area, to allow better viewing of the wave drawn, a **message bar**, that is used for computer-user interaction and also for displaying different messages and information for the user, and other **main menu buttons** categorizing the different functions into **sub-groups** where any of them if pressed will pop-up a menu in the **menu bar** with the related **sub-choices** ordered and ready for use, in addition to other **special buttons**.

The user can get access to the different parts of the *digital oscilloscope* using either the **mouse** or the **keyboard** by only applying simple mouse-clicks or few keyboard strokes. To allow more comfort for the user mouse and keyboard can be used interchangeably at any time.



### SUMMARY

The Environment Screen Is Divided Mainly Into Four Parts:

- ◇ the **scope screen**.
- ◇ the **message bar**.
- ◇ the **menu bar**.
- ◇ the **main menus**.
- ◇ the **special buttons**.

## 4.2 USING THE ENVIRONMENT SCREEN

When the program starts, the **environment screen** will be ready for use. The mouse is used easily by pointing to any of the **main menu buttons** such as **position**, **scale**, etc., then clicking the mouse there, or for short; press the main menu button, as soon as the button is pressed, the menu related to that button's name is drawn in the **menu bar** and ready for use. Then the user may activate a **sub-choice** function by pressing (pointing and clicking by mouse) another **sub-**

**button.** Finally the function is performed, unless it pops-up another **sub-menu**, from where the function will be chosen and activated.

When performing the desired function or even before the user can click the **special escape button**, to go back to the beginning and press another **main menu button**.

The above steps can likewise be performed but using the **keyboard** instead of the mouse. Instead of pointing and clicking, the user can repeatedly press the **space bar** to highlight the required main menu button, and then press return on the keyboard to pop-up the menu. Similarly the space bar can be repeatedly pressed to highlight the required sub-choice and pressing return activates the highlighted function.

Pressing **escape** on the keyboard will, similar to clicking on the escape special button, cause the user to go back to the beginning and choose one of the main menu buttons.



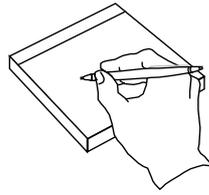
### HINT

It is worth mentioning that the mouse and the keyboard can be used interchangeably, for example; a main menu button can be highlighted using the spacebar and then activated by pressing return afterwards using the mouse to click on a sub choice and finally pressing escape key on the keyboard to go back to the beginning.



### NOTE

The user should note that some functions, when active, require either clicking on arrow buttons using the mouse or pressing the arrow keys and the delete key on the keyboard interchangeably. Such a case happens is the position & cursor main-menus. Another type of functions require the user to enter data, either numbers or strings. Here the user should use the keyboard when prompted an "enter a value" message.



## SUMMARY

### Going Around In The Environment Screen Is Done By:

- ◇ pointing and clicking using the mouse.
- ◇ pressing the space bar and the return key from the keyboard.
- ◇ pointing and clicking on the escape special button.
- ◇ pressing the escape key on the keyboard.
- ◇ pressing other keyboard keys such as arrows and delete.
- ◇ entering numbers and strings from the keyboard.

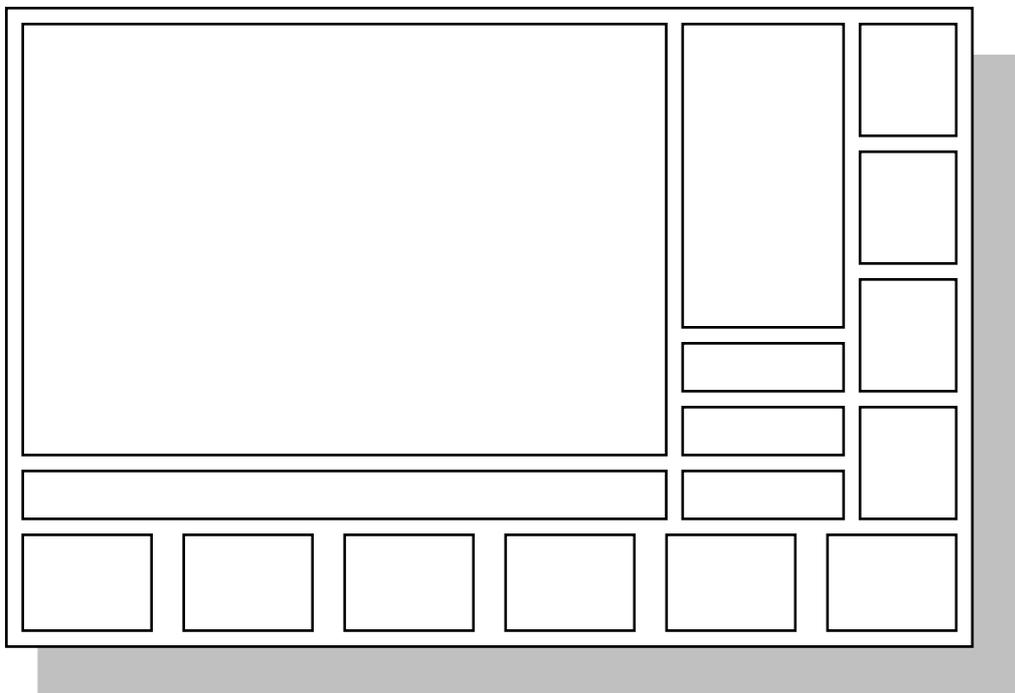
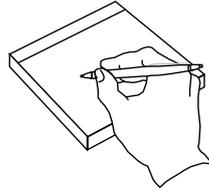


Fig.1. the environment screen

## 4.3 THE SCOPE SCREEN

The **scope screen**, which is the main part of the **environment screen** occupies biggest part of the screen. In this scope screen area the wave currently processed is drawn. In addition to the wave being drawn and depending on functions being used, some additional aids could be drawn, like the **grid**, the **mouse position**, the **cursor** lines. Furthermore, in this screen the **FFT** frequency spectrum is displayed upon request.



## SUMMARY

### The Scope Screen Is Used For Displaying:

- ◇ the wave.
- ◇ the FFT of the wave.
- ◇ the grid.
- ◇ the cursor lines.
- ◇ the mouse position.

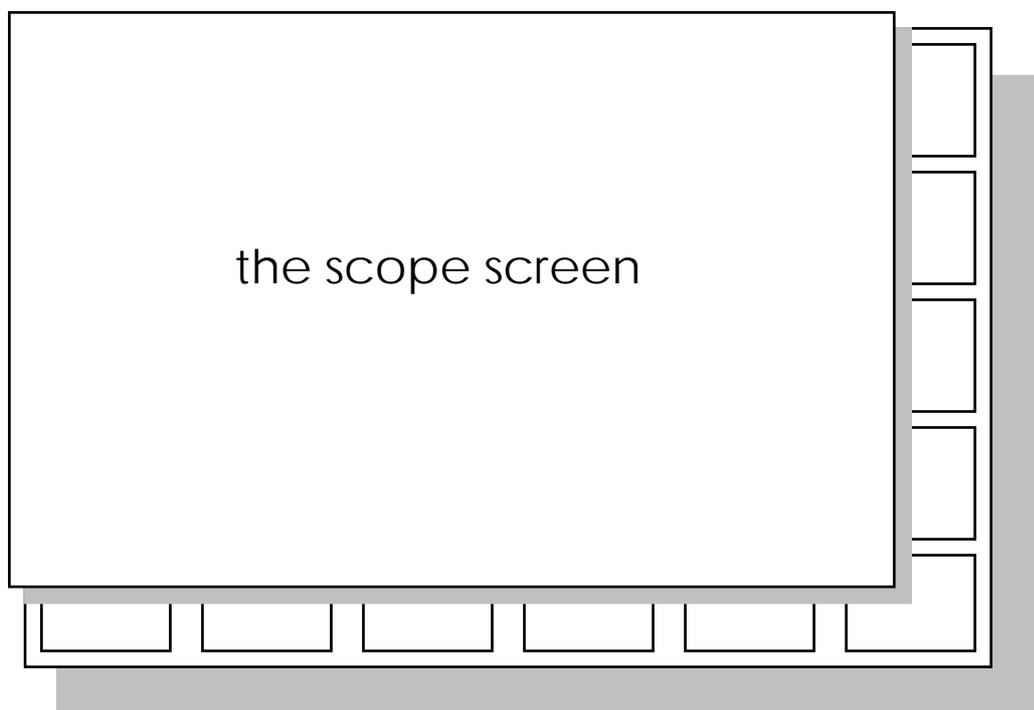


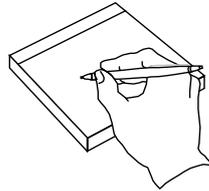
Fig.2. the scope screen

## 4.4 THE MESSAGE BAR

The **message bar** is that area of the screen where all the textual message and quantitative information are displayed, in addition to the **computer-user interaction** where displaying questions and choices and accepting the users' answers and replies take that place.

In the **message bar** on-line information about the horizontal and vertical positioning of the wave, the time and the voltage scaling are displayed upon request with up to the minute values.

also In the **message bar**, requests and data entries take place when the user is asked to enter function-coefficients for internally generated data, values for new settings, filenames or directory paths. Also drive selection, and confirming choices take place in the message bar.



## SUMMARY

### The Message Bar Is Used For Displaying:

- ◇ **messages.**
- ◇ **computer-user interaction.**
- ◇ **on line information.**
- ◇ **questions and answers.**
- ◇ **choices and selections.**

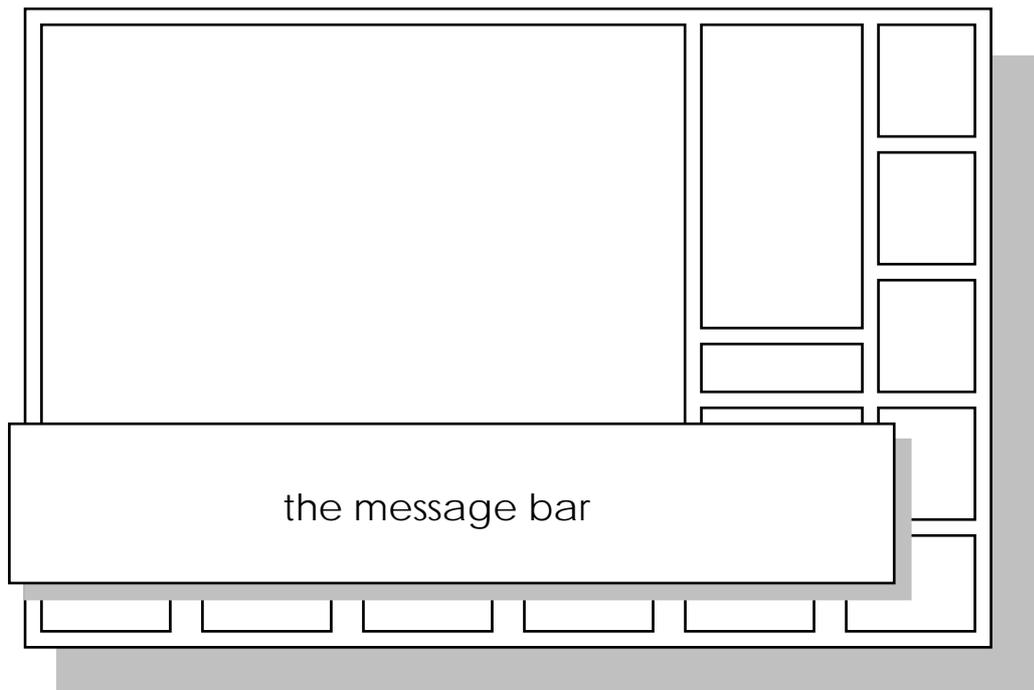
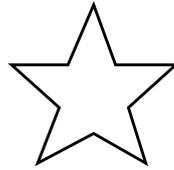


Fig.3. the message bar

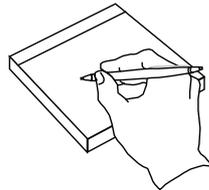
## 4.5 THE MENU BAR

The **menu bar** is a menu that contains different functional **sub-choices** for the user to choose from, these sub-choices are of common types, depending on which choice of **main menu button** was pressed. After the menu pops-up, the user can choose any of the sub-choices, to be performed.



### NOTE

It is worth mentioning that some sub-choices have sub-sub-choices, that is when a certain function is chosen it will pop-up another sub-menu to choose from.



### SUMMARY

#### The Menu Bar Is Used To:

- ◇ **display main-menus.**
- ◇ **display sub-menus.**
- ◇ **perform the chosen function.**

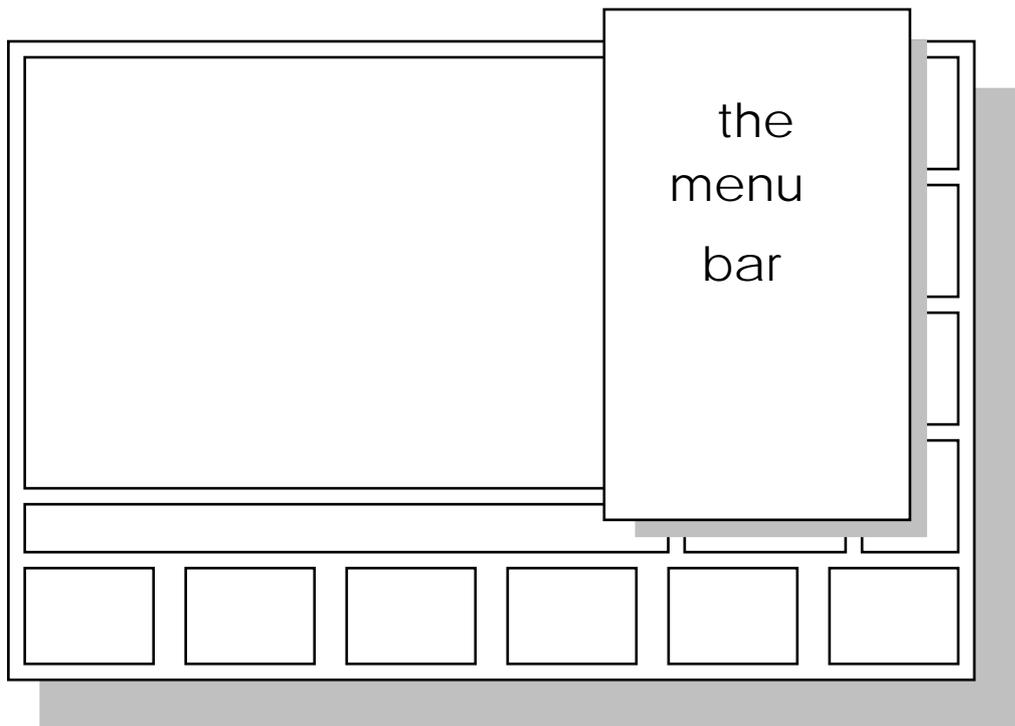


Fig.4. the menu bar

## 4.6 THE SPECIAL BUTTONS

The **special buttons** are three buttons that can not be considered as main menu buttons since they do not have a menu that will pop up and different functions to choose from. Each button performs only one function.

### THE ESCAPE BUTTON

The **escape button** was mentioned and will be mentioned many times later on. It used for canceling an operation and for negative responses to confirmation questions. It is also used for escaping from main menus and sub-menus.

### THE SOUND TOGGLE BUTTON

The **sound toggle button** is a button that is used to turn the sound on and off, and it is a toggle button, that is if sound was on and the sound button is pressed then sound will be off. On the other hand if sound was on and this button was pressed then sound will turn off.



#### HINT

When sound is on, different sounds will accompany the user while going around in the *digital oscilloscope* environment, which in my opinion gives the user more interaction with the environment of the *digital oscilloscope*.

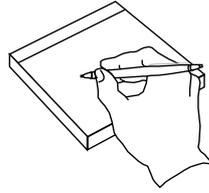


#### NOTE

Different sounds include special sounds when choosing main menus and sub menus, when a message is displayed, when the user confirms an answer or when the user performs either an invalid or a redundant choice and other.

### THE TIME BUTTON

The **time button** as the name implies, is a button that shows the time, according to the built in clock of the computer being used.



## SUMMARY

### The Special Buttons Are For:

- ◇ canceling last minute actions and exiting menus.
- ◇ toggling the sound on and off.
- ◇ showing the time.

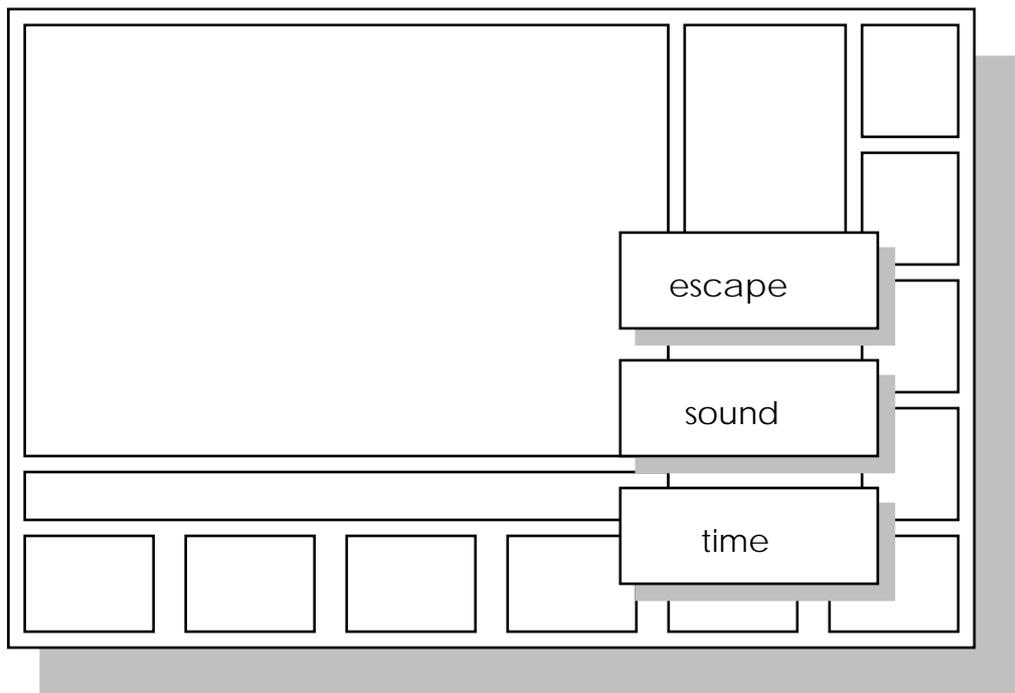


Fig.5. the special buttons

# CHAPTER FIVE

## THE MAIN MENUS

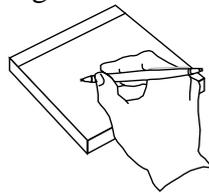


## 5.1 ABOUT THE MAIN MENUS

As it is apparent by now, the *digital oscilloscope* has several **main menus** to choose from, and as mentioned earlier a menu can be chosen either using the mouse or the keyboard.

Each **main menu** include functions of similar types. That is each main menu is concerned about performing a certain set of related functions.

The *digital oscilloscope* has ten main menus, the first of them, in the lower left corner of the screen, is the **position** menu for positioning the wave. Beside it is the **scale** menu where altering voltage and time scales is done, then the **cursor** menu which is used mainly for inquiring quantitative information about the wave. After that, there is the **control** menu for controlling the whole wave from the output port, next to it is the **Fast Fourier Transform** menu where FFT related functions are performed, and at the lower right corner of the screen is the **options** menu where a variety of optional functions are found, then the *digital oscilloscope* screen has the **settings** screen where the user can alter different functional settings, then the **file** menu where file-related functions are inserted. Also there is a **help** menu where the user can get information easily and rapidly by only a couple of keystrokes or mouse clicks. Finally in the upper right corner of the screen is the **about** menu containing information about the *digital oscilloscope*.



### SUMMARY

#### The Main Menus Are:

- ◇ the **position** menu.
- ◇ the **scale** menu.
- ◇ the **cursor** menu.
- ◇ the **control** menu.
- ◇ the **FFT** menu.
- ◇ the **options** menu.
- ◇ the **settings** menu.
- ◇ the **file** menu.
- ◇ the **help** menu.
- ◇ the **about** menu.

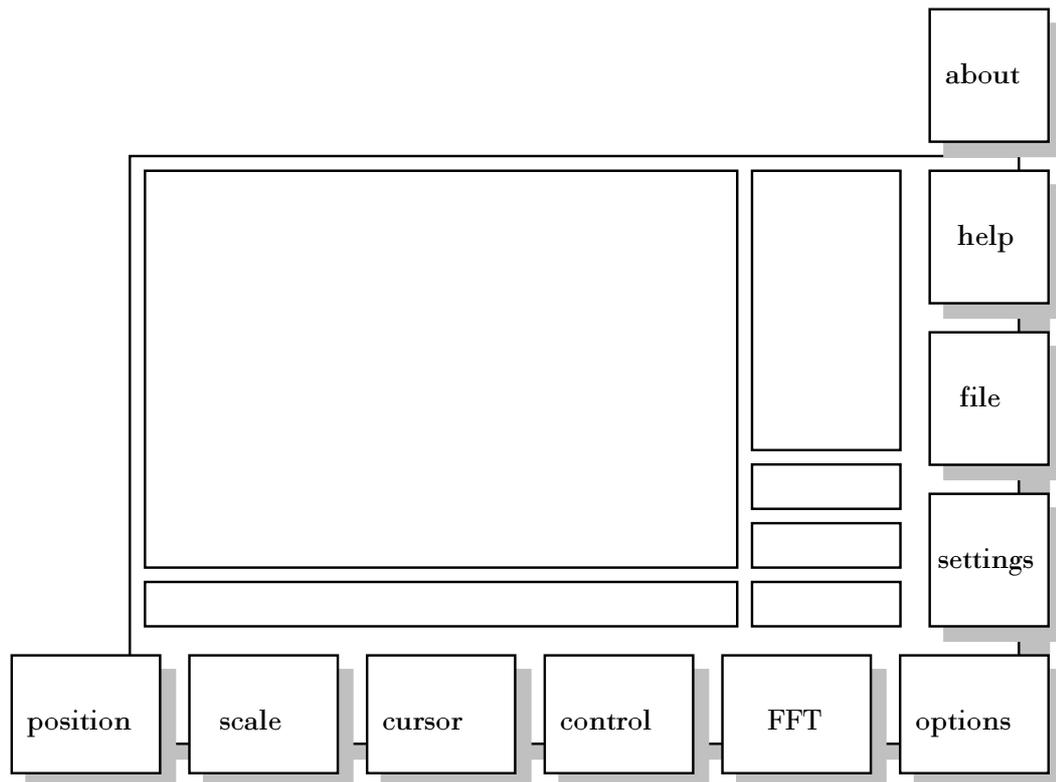


Fig.6. the main menus

## 5.2 POSITION MENU

### ABOUT

The **position menu** is the menu used for controlling the position of the wave being displayed on the **scope screen**.

This menu can be entered by either clicking on the **position button** with the mouse or by highlighting the position button using the space bar and then pressing return on the key board.

Going out of this menu can be done by either clicking the **special escape button** with the mouse or by pressing the keyboard escape.

### SPECIFIC UP

The **position menu** allows the user to move the wave upwards by either clicking the mouse on the **up button** in the position main menu, or by simply pressing the upward key on the key board.

## DOWN

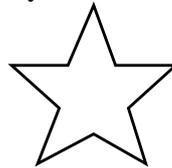
The **position menu** allows the user to move the wave downwards by either clicking the mouse on the **down button** in the position main menu, or by simply pressing the downward key on the key board.

## LEFT

The **position menu** allows the user to move the wave leftwards by either clicking the mouse on the **left button** in the position main menu, or by simply pressing the leftward key on the key board.

## RIGHT

The **position menu** allows the user to move the wave rightwards by either clicking the mouse on the **right button** in the position main menu, or by simply pressing the rightward key on the key board.



### NOTE

The up, down, left and right buttons cannot be pressed infinitely, that is there is a limit value for up, down, left or right positioning the wave. When any of these limits is to be exceeded and the sound is active, the program would generate a warning sound to indicate that the limit is reached.

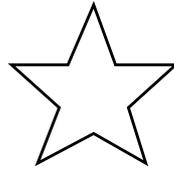


### HINT

If any of the limit values for up, down, left and right is not suitable for the user, then it could be changed from the settings main menu and more specifically from position-settings. Also from the position-settings menu the user can change the step size, that is the amount the wave moves up, down, left or right with each mouse click or keyboard stroke on the corresponding button.

## SET

The **position menu** has the set feature that can be activated by either clicking the mouse on the **set button** in the position menu or by pressing the delete key on the key board. Once activated it would assign the position of the wave, both vertical and horizontal, the reset values.



NOTE

If the position of the wave is already reset and the user tries to activate the set function and if the sound is active an error sound will be produced indicating a redundant choice.

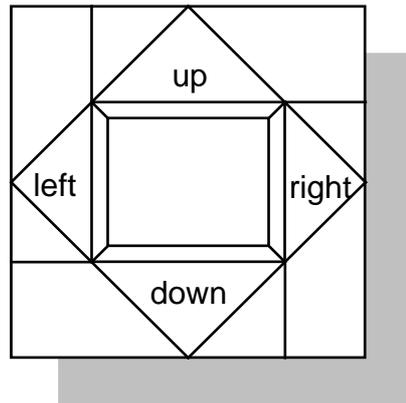
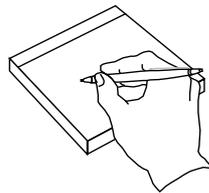


Fig.7. the position menu



SUMMARY

The Position Menu Is Used For:

- ◇ moving the wave up.
- ◇ moving the wave down.
- ◇ moving the wave left.
- ◇ moving the wave right.
- ◇ setting standard position.

5.3 SCALE MENU

ABOUT

The **scale menu** is the menu used for controlling both the time (horizontal) and the voltage (vertical) scaling of the wave being displayed on the scope screen

This menu can be entered by either clicking on the **scale button** with the mouse or by highlighting the scale button using the space bar and then pressing return on the key board.

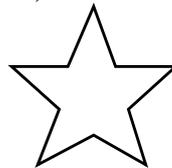
Going out of this menu can be done by either clicking the **special escape button** with the mouse or by pressing the keyboard escape.

## SPECIFIC V-SCALE HI

The **v-scale hi** indicating voltage (vertical) scale increment, can be activated by either clicking the mouse on that button or by moving the space bar until the **v-scale hi** button is highlighted preceded by a return hit on the keyboard. When activated the voltage (vertical) scale is increased.

## V-SCALE LOW

The **v-scale lo** indicating voltage (vertical) scale decrement, can be activated by either clicking the mouse on that button or by moving the space bar until the **v-scale lo** button is highlighted preceded by a return hit on the keyboard. When activated the voltage (vertical) scale is decreased.



NOTE

The v-scale hi/lo function cannot be pressed infinitely that is there is a maximum/minimum limit for the voltage (vertical) scale of the wave. When this limit is to be exceeded and the sound is active, the program would generate a warning sound to indicate that the limit is reached.



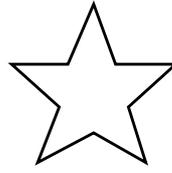
HINT

If the maximum/minimum value of the voltage scale is not suitable for the user, then it could be changed from the settings main menu and more specifically from scale-settings. Also from the scale-settings menu the user can change the step sizes, that is the amount the voltage (vertical) scale is increased or decreased with each mouse click or keyboard stroke.

## V-SCALE RESET

The scale menu has the **v-scale reset** feature, denoting voltage (vertical) scale reset, can be activated by either clicking with the mouse on that button or by moving the space bar until the **v-scale reset** button is highlighted then preceded

by a return hit on the keyboard. Once activated it would assign the voltage (vertical) scale of the wave the reset value.



NOTE

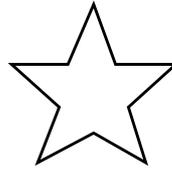
If the voltage (vertical) scale of the wave is already reset and the user tries to activate the v-scale reset function and if the sound is active an error sound will be produced indicating a redundant choice.

## T-SCALE HI

The **t-scale hi** indicating time (horizontal) scale increment, can be activated by either clicking the mouse on that button or by moving the space bar until the **t-scale hi** button is highlighted then preceded by a return hit on the keyboard. When activated the time (horizontal) scale is increased.

## T-SCALE LOW

The **t-scale lo** indicating time (horizontal) scale decrement, can be activated by either clicking the mouse on that button or by moving the space bar until the **t-scale lo** button is highlighted then preceded by a return hit on the keyboard. When activated the time (horizontal) scale is decreased.



NOTE

The t-scale hi/lo function cannot be pressed infinitely that is there is a maximum/minimum limit for the time (horizontal) scale of the wave. When this limit is to be exceeded and the sound is active, the program would generate a warning sound to indicate that the limit is reached.



HINT

If the maximum/minimum value of the time scale is not suitable for the user, then it could be changed from the settings main menu and more specifically from scale-settings. Also from the scale-settings menu the user can change the step sizes, that is the amount the voltage (vertical) scale is increased or decreased with each mouse click or keyboard stroke.

## T-SCALE RESET

The scale menu has the **t-scale reset** feature, denoting time (horizontal) scale reset, can be activated by either clicking with the mouse on that button or by moving the space bar until the **t-scale reset** button is highlighted then preceded by a return hit on the keyboard. Once activated it would assign the time (horizontal) scale of the wave the reset value.

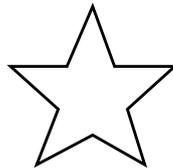


### NOTE

If the time (horizontal) scale of the wave is already reset and the user tries to activate the t-scale reset function and if the sound is active an error sound will be produced indicating a redundant choice.

## V&T-SCALES RESET

The scale menu has the **v&t-scale reset** feature, denoting both voltage (vertical) and time (horizontal) reset, can be activated by either clicking with the mouse on that button or by moving the space bar until the **v&t-scale reset button** is highlighted then preceded by a return hit on the keyboard. Once activated it would assign the both the time (horizontal) scale and the voltage (vertical) scale of the wave the reset values.



### NOTE

If both voltage (vertical) scale and the time (horizontal) scale of the wave are already reset and the user tries to activate the v&t-scale reset function and if the sound is active an error sound will be produced indicating a redundant choice.

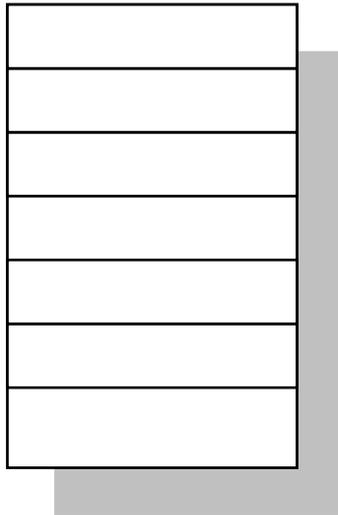
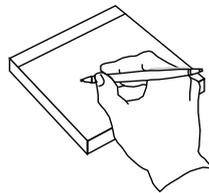


Fig.8. the scale or any typical menu



## SUMMARY

### The Scale Menu Is Used For:

- ◇ **increasing voltage scale.**
- ◇ **decreasing voltage scale.**
- ◇ **increasing time scale.**
- ◇ **decreasing time scale.**
- ◇ **setting standard voltage scale.**
- ◇ **setting standard time scale.**
- ◇ **setting standard voltage and time scales together.**

## 5.4 CURSOR MENU

### ABOUT

The **cursor menu** is the menu used for obtaining quantitative information about the wave being displayed on the scope screen, in addition to displaying the mouse position.

This menu can be entered either by clicking on the position button with the mouse or by highlighting the position button using the space bar and then pressing return on the key board.

Going out of this menu can be done either by clicking the **special escape button** with the mouse or by pressing the keyboard escape.

## SPECIFIC V-CURSOR 1/2/OFF

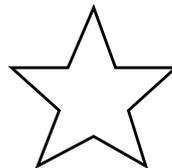
The cursor menu has the **v-cursor 1/2/off** button. From which the can choose vertical (time) cursor 1, vertical (time) cursor 2 or vertical (time) cursor off. This button can be activated by either clicking mouse on that button or by moving the space bar until the **v-cursor /1/2/off** button is highlighted then preceded by a return hit on the keyboard.

This function could be assigned one of three values which is changed with each button press, the first is vertical (time) cursor off, which turns the vertical (time) cursor off, the second is vertical (time) cursor 1 and the third is vertical (time) cursor 2.

When the vertical (time) cursor 1 is active two vertical lines are displayed on the scope screen, at this time one of the lines is green, meaning that this line can be moved left or right, the other vertical line would be at that time red meaning that this line is prohibited from moving left or right. Now, if the **v-cursor 1/2/off button** is pressed once again the vertical (time) cursor 2 will become active, and the two vertical lines will swap colors, therefore the green becomes red and thus prohibited from movement and the red line becomes green and thus can be moved left or right. If once again the **v-cursor 1/2/off button** is pressed the vertical (time) cursor off will be active and thus turning off both lines but with their locations stored and not lost.

With **v-cursor 1/2/off** assigned a non-off value the lines are turned on and a message showing the time separation between the lines is prompted.

As a result the vertical (time) lines are used to measure and show the time separation between any two points of the wave.



### NOTE

The vertical lines cannot be moved infinitely and their limits are the left and right limits of the scope screen, so once the user tries to exceed these limits, a warning sound is produced indicating that the limit is reached.

To move either lines left or right the user can use either the left or right arrows of the keyboard or the mouse and press the left or right button in the cursor menu, respectively. If the user tries to do that when the vertical (time) cursor is

off, an error sound will be produced indicating that lines vertical (time) cursor should be activated first.



### HINT

For the convenience of the user, the step size of the vertical lines can be altered using the settings menu, more specifically the cursor-settings, to obtain the required vertical (time) cursor step size.

## H-CURSOR 1/2/OFF

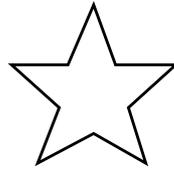
The **cursor menu** has the **h-cursor 1/2/off** button. From which the user can choose horizontal (voltage) cursor 1, horizontal (voltage) cursor 2 or horizontal (voltage) cursor off, this button can be activated by either clicking with the mouse on that button or by moving the space bar until the **h-cursor 1/2/off button** is highlighted then preceded by a return hit on the keyboard.

This function could be assigned one of three values which is changed with each button press, the first is horizontal (voltage) cursor off, which turns the horizontal (voltage) cursor off, the second is horizontal (voltage) cursor 1 and the third is horizontal (voltage) cursor 2.

When the horizontal (voltage) cursor 1 is active two horizontal lines are displayed on the scope screen, at this time one of the lines is green, meaning that this line can be moved up or down, the other horizontal line would be at that time red meaning that this line is prohibited from moving up or down. Now, if the **h-cursor /1/2/off button** is pressed once again the horizontal (voltage) cursor 2 will become active, and the two horizontal lines will swap colors, therefor the green becomes red and thus prohibited from movement and the red line becomes green and thus can be moved up or down. If once again the **h-cursor /1/2/off button** is pressed the horizontal (voltage) cursor off will be active and thus turning off both lines but with their locations stored and not lost.

With **h-cursor /1/2/off** assigned a non-off value the lines are turned on and a message showing the voltage separation between the lines is prompted.

As a result the horizontal (voltage) lines are used to measure and show the voltage separation between any two levels of the wave.



### NOTE

The horizontal lines cannot be moved infinitely and their limits are the up and down limits of the scope screen, so once the user tries to exceed these limits, a warning sound is produced indicating that the limit is reached.

To move either lines up or down the user can use either the up or down arrows of the keyboard or the mouse and press the up or down button in the cursor menu, respectively. If the user tries to do that when the horizontal (voltage) cursor is off, an error sound will be produced indicating that lines horizontal (voltage) cursor should be activated first.



### HINT

For the convenience of the user, the step size of the horizontal lines can be altered using the settings menu, more specifically the cursor-settings, to obtain the required horizontal (voltage) cursor step size.

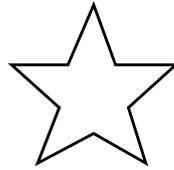
## MOUSE CURSOR ON/OFF

From the **cursor menu** the user can display the current mouse position coordinates by either pointing and clicking on the mouse cursor button in the cursor menu, or by pressing the space bar until the **mouse cursor button** is highlighted, then preceded by enter.

The **mouse cursor** is a toggle button that is if it is pressed when mouse position is off it will be active and if pressed when active it will turn off the mouse position.

## ALL-OFF

When it is desired to turn off all cursor menu sub choices which are the vertical (time) cursor and the horizontal (voltage) cursor and the mouse position coordinates, this button is pressed either by pointing to it and clicking with the mouse or by pressing the space bar until this button is highlighted then pressing the enter key from the keyboard.



### NOTE

If this button is pressed when all cursor sub choices are off, a warning sound is produced to indicate a redundant choice.

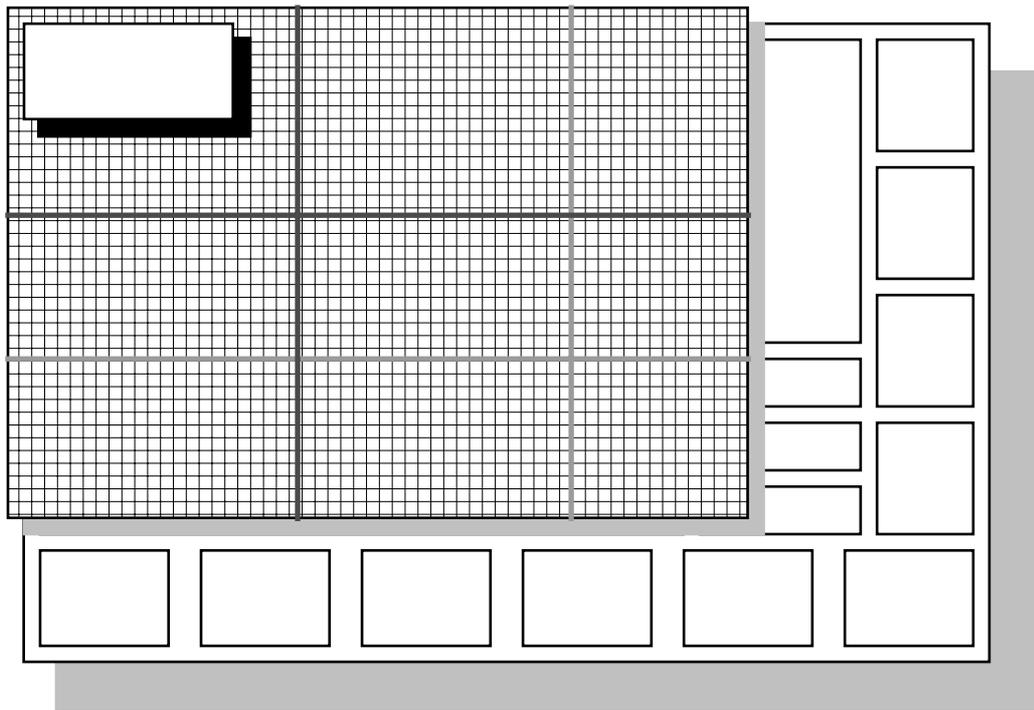


Fig.9. the horizontal and vertical cursor lines and the mouse position

## UP

The **up button** is used for moving the green horizontal line upwards, only when the horizontal (voltage) cursor is active, otherwise a warning sound will be produced indicating that the horizontal (voltage) cursor should be activated first. Also if the green line reaches its upward upper limit, that is the top of the scope screen, an error sound will be produced to indicate that the vertical line upward movement has reached its maximum limit.

The **up button** can be pressed by either pointing and clicking on the up arrow with the mouse, or by pressing the up arrow from the keyboard.

## DOWN

The **down button** is used for moving the green horizontal line downwards, only when the horizontal (voltage) cursor is active, otherwise an error sound will be produced indicating that the horizontal (voltage) cursor should be activated first. Also if the green light reaches its downward lower limit, that is the bottom

of the scope screen, an error sound will be produced to indicate that the vertical line downward movement has reached its maximum limit.

The **down button** can be pressed by either pointing and clicking on the down arrow with the mouse, or by pressing the down arrow from the keyboard.



### HINT

If the downward or upward step size is not convenient for the user, either one can be changed from the settings menu and more specifically from the cursor settings.

### LEFT

The **left button** is used for moving the green vertical line leftwards, only when the vertical (time) cursor is active, otherwise an error sound will be produced indicating that the vertical (time) cursor should be activated first. Also if the green light reaches its leftward limit, that is the leftmost of the scope screen, an error sound will be produced to indicate that the vertical line leftward movement has reached its maximum limit.

The **left button** can be pressed by either pointing and clicking on the left arrow with the mouse, or by pressing the left arrow from the keyboard.

### RIGHT

The **right button** is used for moving the green vertical line rightwards, only when the horizontal (time) cursor is active, other wise an error sound will be produced indicating that the vertical (time) cursor should be activated first. Also if the green light reaches its rightward limit, that is the rightmost of the scope screen, an error sound will be produced to indicate that the vertical line rightward movement has reached its maximum limit.

The **right button** can be pressed by either pointing and clicking on the right arrow with the mouse, or by pressing the right arrow from the keyboard.

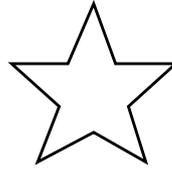


### HINT

If the leftward or rightward step size is not convenient for the user, either one can be changed from the settings menu and more specifically from the cursor settings.

## SET

The **set button** in the cursor menu is used to reset both the vertical and horizontal cursor lines their preset values. This button is pressed either by pointing and clicking the mouse on that button or by pressing the delete key on the keyboard.



### NOTE

If this button is pressed when both vertical cursor lines and horizontal cursor lines are in their preset places, an error sound will be produced to indicate redundant operation.

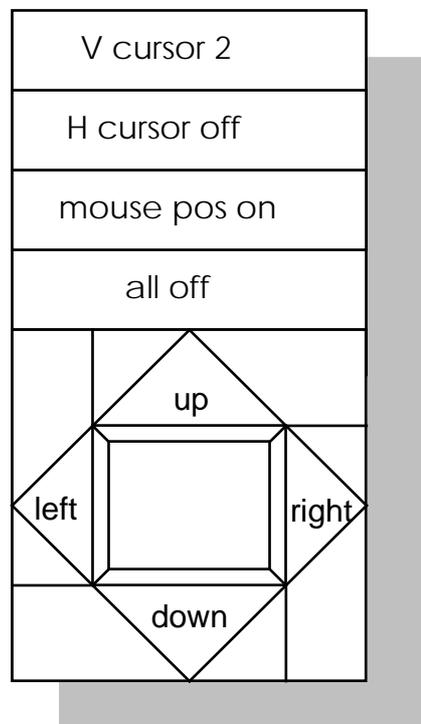
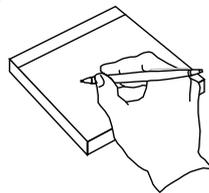


Fig.10. the cursor menu



## SUMMARY

### The Cursor Menu Is Used For:

- ◇ showing the mouse position coordinates.
- ◇ measuring voltage differences by moving cursor lines up and down.
- ◇ measuring time intervals by moving cursor lines left and right.
- ◇ setting standard location of cursor lines.

## 5.5 CONTROL MENU

### ABOUT

The **control menu** is the menu used for controlling the wave samples coming from the input port.

This menu can be entered either by clicking the mouse on the control button or by highlighting the control button using the space bar and then pressing return on the key board.

Going out of this menu can be done either by clicking the **special escape button** with the mouse or by pressing the keyboard escape.

### SPECIFIC SLOPE POS(+)/NEG(-)

This button is used to change the slope of the beginning of the wave being displayed on the scope screen.

This button is pressed either by pointing and clicking the mouse on that button or by pressing the space bar continuously until the button is highlighted then pressing return on the keyboard.

### AC

This button is used to AC couple the input signal to the scope hardware. Thus showing the wave without any DC offset.

This button is pressed either by pointing and clicking with mouse on that button or by pressing the pressing the space bar until the button is highlighted then pressing return on the keyboard.

### DC

This button is used to DC couple the input signal to the scope hardware. Thus only the DC part of the signal that is the average value of the signal without AC variations is displayed.

This button is pressed either by pointing and clicking with mouse on that button or by pressing the pressing the space bar until the button is highlighted then pressing return on the keyboard.

## GROUND

This button is used to ground the input of the scope hardware.

This button is pressed either by pointing and clicking with mouse on that button or by pressing the space bar until the button is highlighted then pressing return on the keyboard

## AC TRIGGER

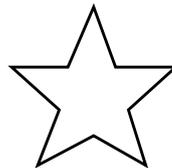
This button is used to trigger the input signal using AC coupled triggering.

This button is pressed either by pointing and clicking with mouse on that button or by pressing the space bar until the button is highlighted then pressing return on the keyboard.

## DC TRIGGER

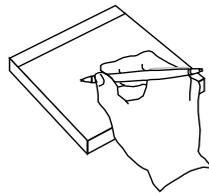
This button is used to trigger the input signal using DC coupled triggering.

This button is pressed either by pointing and clicking with mouse on that button or by pressing the space bar until the button is highlighted then pressing return on the keyboard.



### NOTE

In order to go back and read the wave from the input port the user is required to choose **BACK TO SCOPE** from the options menu.



### SUMMARY

#### The Control Menu Is Used For:

- ◇  **toggling the slope positive and negative**
- ◇  **AC, DC coupling or grounding the wave**
- ◇  **AC, DC triggering**

## 5.6 FFT MENU

### ABOUT

The **FFT menu** is the menu used for performing Fast Fourier Transform on the signal being displayed.

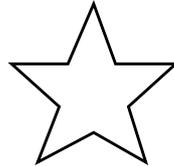
This menu can be entered either by clicking on the FFT button with the mouse or by highlighting the control button using the space bar and then pressing return on the keyboard.

Escaping from this menu can be done either by clicking the special escape button with the mouse or by pressing the keyboard escape.

### SPECIFIC SHOW FFT

This button is used for displaying the frequency spectrum of the wave currently being displayed on the scope screen.

The **show FFT button** is pressed either by pointing and clicking with mouse on that button or by pressing the space bar repeatedly until the button is highlighted then pressing return on the keyboard.



#### NOTE

In order to go back and view the wave from the input port the user is required to choose back to scope from the options menu.

### LIN SCALE

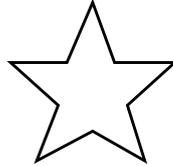
This button is used for drawing the FFT of the wave on a linear scale on the scope screen.

The **lin scale button** is pressed either by pointing and clicking the mouse on that button or by pressing the space bar until the button is highlighted then pressing return on the keyboard.

### LOG SCALE

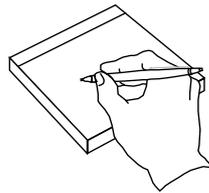
This button is used for drawing the FFT of the wave on a logarithmic amplitude scale on the scope screen.

The **log scale button** is pressed either by pointing and clicking the mouse on that button or by pressing the space bar continuously until the button is highlighted then pressing return on the keyboard.



### NOTE

In order to go back and view the wave as it is originally read from the input port the user is required to choose **BACK TO SCOPE** from the options menu.



### SUMMARY

The FFT Menu Is Used For:

- ◇ finding the FFT the displayed signal
- ◇ showing the frequency spectrum on a linear scale
- ◇ showing the frequency spectrum on a logarithmic amplitude (dB) scale

## 5.7 OPTIONS MENU

### ABOUT

In this menu the *digital oscilloscope* has some optional functions that may be helpful for the user in certain cases.

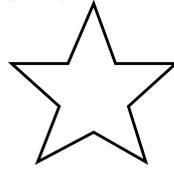
In order to activate this menu; point and click the mouse on the **options menu button** or use the space bar to highlight the **options main menu button** and then press return on the keyboard.

Escaping from this menu can be done either by clicking the **special escape button** with the mouse or by pressing escape.

### SPECIFIC REDRAW ALL

In the **options menu**, the redraw all function is used for redrawing the whole screen of the *digital oscilloscope*, without any information being lost. The wave will be displayed again, the **mouse position**, any **cursor lines** and the **grid**; if active.

This function can be activated after choosing the options menu, then by pointing and clicking the mouse on the redraw all button or by pressing the space bar until the redraw all button is highlighted and then pressing enter.



### NOTE

The redraw can be used to get rid of any inconvenient leftovers from the different drawing procedures.

## GENERATE DATA

The options data added a **data generator** and function plotter utility, where the user can choose from a set of general functions, for their data to be generated and their graph to be plotted and thus manipulated by using all the other menus and treating the generated wave as an ordinary wave as if it has been read from the input port.

The **data generator** function can be activated after choosing the options menu, then by pointing and clicking the mouse on **generate data** button or by pressing the space bar until generate data button is highlighted and then pressing enter.

Once the data generator is activated, another sub menu pops up with a list of general functions for the user to select and their data to be generated and then plotted or saved. These functions include the following:

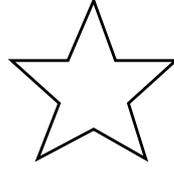
- **linear**
- **quadratic**
- **logarithmic**
- **exponential**
- **square root**
- **sinusoidal**

When a function is selected either by pointing and clicking the mouse, or by using the space bar to highlight the specified function and pressing return, the user will now be required to enter the coefficients of these functions in order for the data to be generated. The functions with their coefficients are listed below:

- $f(x) = bX+a$
- $f(x) = cX^2+bX+a$
- $f(x) = a\ln(bX)$
- $f(x) = ae^{bX}$
- $f(x) = a\text{SQRT}(b^2-X^2)$
- $f(x) = a\text{SIN}(bX)$

The coefficients to be inserted by the user are the a, b, c where these coefficients can be either real or integer, positive or negative.

It is also required from the user to specify the starting and ending values for the variable X in the functions. If the values of X would cause over flow as in  $f(X) = a \ln(bX)$ . Where X takes the value zero then this value will not be accepted.



### NOTE

With each message prompted by the computer to the user to enter a value, a certain value would be placed between parentheses, this value is the default value that if the user presses enter without entering a number then this value is taken as if it is the entered value.

When all values are entered performing domain and out of range check is performed. All values together are displayed and the user is asked to confirm those values where two buttons appear in the message screen indicating NO and OK. If the user chooses the NO then function coefficients and starting and ending values of X are to be entered once again.

On the other hand if the user chooses OK then the data would be generated and the function will be drawn and ready for manipulation as any other wave.

Choosing NO or OK is done by either pointing to the required answer NO or OK and then clicking with the mouse or by pressing return on the keyboard for OK or pressing the escape key on the keyboard for NO.

## ON LINE INFO/NO INFO

This option is a toggle option that toggles between on line info and no info. If on line info is active, then the following information will displayed in the message bar most of the time:

- **voltage (vertical) scale value**
- **time (horizontal) scale value**
- **vertical position**
- **horizontal position**

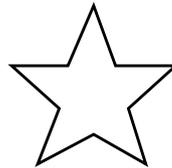
To activate this option while in the options menu, just point and click the mouse on the **on line info/no info button** or using the space bar highlight the mentioned button and the press return. If the button was originally prompting on line info and the button is pressed then no information will be prompted and no on line information will be available. Meanwhile if the button was originally prompting no info and the button is pressed then on line info will be prompted and on line information will be available.

## DOS SHELL

The options menu has also the feature of the **DOS shell** utility where if selected the *digital oscilloscope* screen will disappear and the DOS text mode screen will be available for the user to perform any DOS commands required and supported by his own disk operating system (DOS).

To activate this option while in the options menu just point and click with the mouse on the DOS shell button or using the space bar highlight the mentioned button and the press return.

Once in the DOS shell a message "*DIGITAL OSCILLOSCOPE DOS SHELL... type EXIT to go back*" is prompted to the user in the screen's text mode, and as the message explicitly says; the user should type exit followed by enter on the DOS command line any time he wishes to go back to the *digital oscilloscope* environment screen.



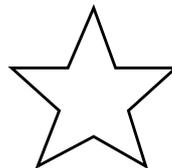
### NOTE

After the user uses the DOS shell the environment settings are not altered and the wave will be drawn in addition to any grid, mouse position coordinates or vertical and horizontal cursor lines will be re displayed if they were originally active.

## BACK TO SCOPE

This option **back to scope** in the options menu is needed when the user makes a choice of displaying a wave other than the wave from the output port, that is this wave could be either internally generated or a loaded wave or an FFT wave.

To activate this option while in the options menu just point and click the mouse on the **back to scope** button or using the space bar highlight the mentioned button and the press return.



### NOTE

When the user tries to activate this button, and at the same time the currently displayed wave is the wave from the output port, then a warning sound will be produced indicating that the wave is currently read from the output port and the current action is redundant.

## GRID

This option is a toggle option that toggles between Grid on and grid off. If Grid is active, then the grid lines will be displayed on the scope screen, meanwhile if the grid is not active no grid lines will be displayed.

To activate this option while in the options menu just point and click the mouse on the **grid button** or using the space bar highlight the mentioned button and the press return. If the button was originally prompting grid on and the button is pressed then grid off will be prompted and no grid lines will be available, meanwhile if the button was originally prompting grid off and the button is pressed then no grid lines will be displayed on the scope screen.



### NOTE

It is worth noting that the grid line spacing, both vertical and horizontal, can be changed freely from that settings menu, more specifically from settings-grid, where the user can enter the spaces between either vertical lines or horizontal lines independently.

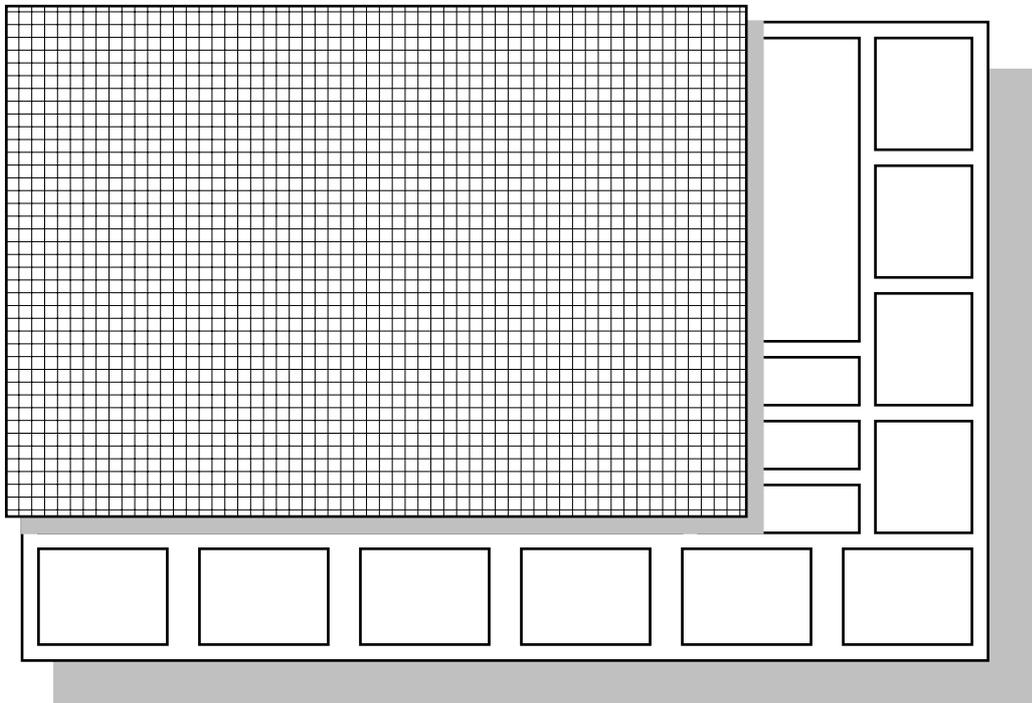


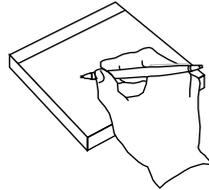
Fig.11. the grid on the scope screen

## FREEZE ON/OFF

This button is used to freeze, the wave currently being drawn on the scope screen. When this button is pressed no data will be read from the input port and the data of the wave will not change.

The **freeze on/off button** is pressed either by pointing and clicking the mouse on that button or by pressing the space bar continuously until the button is highlighted then pressing return on the keyboard.

The **freeze** button is a toggle button, that is if this button was active i.e. the wave is captured and the button is pressed once again then the wave will unfreeze, meanwhile when the wave is being continuously read from the input port and this key is pressed then it will be captured.



## SUMMARY

### The Options Menu Is Used For:

- ◇ redrawing the whole screen.
- ◇ toggling on-line information on and off.
- ◇ generating wave data internally.
- ◇ **Error! Bookmark not defined.** executing DOS commands.
- ◇ ignoring loaded & internally generated waves
- ◇ toggling the grid on and off
- ◇ freezing the wave

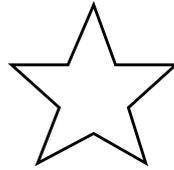
## 5.8 SETTINGS MENU

## ABOUT

In the **settings menu** the user can change different settings concerning different objects in the *digital oscilloscope*.

In order to activate this menu; point and click the mouse on the **settings button** or use the space bar to highlight the **settings button** and then press return on the keyboard.

Escaping of this menu can be done either by clicking the **special escape button** with the mouse or by pressing the keyboard escape.



### NOTE

It should be noted here that all the different settings can be both saved and loaded, so the user can change the settings to his own, and then use these settings, the user can save these settings and load them whenever he wants. There could be many settings files for the user to choose from.

## SPECIFIC POSITION

The **position settings** are the settings concerned with position main menu, where different position settings can be changed according to the users request.

To activate the position settings while in the settings menu, you either point by the mouse to the position button and then click, or press the space bar until the position button is highlighted then press enter.

Once this button is pressed the position settings are activated, and different messages will be prompted to the user requesting the user to enter certain data.

The user is asked to enter the **maximum vertical position** and the **minimum vertical position**, these two values limit the up & down positioning - from the position main menu- of the wave being displayed.

Then the user is asked to enter the **vertical position step**, this number controls the step size that the wave moves up or down with each press on the up or down buttons from the position main menu.

Afterwards, another message will be prompted and requesting the user to enter the **horizontal position step**, which controls the space the wave moves left or right with each press on the left or right buttons from the position main menu.



### NOTE

With each message requesting data entry, a certain default value is printed between parentheses, this value will be considered as the entered value if the user only presses return without entering any number.

When the user finishes entering position settings data a message will be prompted for the user indicating that.

## SCALE

The **scale settings** are the settings concerned with scale main menu, where different scale settings can be changed according to the users request.

To activate the scale settings while in the settings menu, either you should point by the mouse to the scale button and then click, or press the space bar until the scale button is highlighted then press enter.

Once this button is pressed the scale settings are activated, and different messages will be prompted to the user requesting the user to enter certain data.

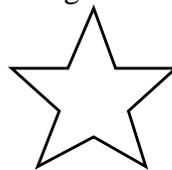
The user is asked to enter the **maximum voltage scale** and the **minimum voltage scale**. These two values limit the v-scale hi & v-scale lo from the scale main menu, of the wave being displayed.

Then the user is asked to enter the **voltage scale step**. This number controls the step size that the wave moves up or down with each press on the up or down buttons from the position main menu.

The user is asked to enter the **maximum time scale** and the **minimum time scale**, these two values limit the up & down positioning from the position main menu, of the wave being displayed.

Then the user asked to enter the **time scale step**, this number controls the step size that the wave moves up or down with each press on the up or down buttons from the position main menu.

Afterwards, another message will be prompted and requesting the user to enter the horizontal position step, which controls the step size the wave moves left or right with each press on the left or right buttons from the position main menu.



### NOTE

With each message requesting data entry, a certain default value is printed between parentheses, this value will be considered as the entered value if the user only presses return without entering any number.

When the user finishes entering position settings data a message will be prompted for the user indicating that.

## CURSOR

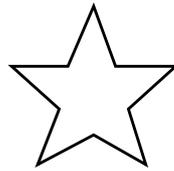
The **cursor settings** are the settings concerned with cursor main menu, where different cursor scale settings can be changed according to the users request.

To activate the cursor settings while in the settings menu, point and click the mouse on the cursor button, or press the space bar until the scale button is highlighted then press enter.

Once this button is pressed the scale settings are activated, and different messages will be prompted to the user requesting the user to enter certain data.

The user is asked first to enter the vertical cursor step, this number controls the step size that the green horizontal cursor line moves up or down with each press on the up or down buttons from the cursor main menu.

Then the user is asked to enter the horizontal cursor step, this number controls the step size that the green vertical cursor line moves up or down with each press on the up or down buttons from the cursor main menu.



### NOTE

With each message requesting data entry, a certain default value is printed between parentheses, this value will be considered as the entered value if the user only presses return without entering any number.

When the user finishes entering cursor settings data a message will be prompted for the user indicating that.

## GRID

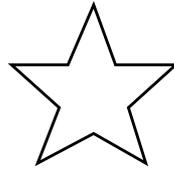
The **grid settings** are the settings concerned with grid option in the options main menu, where grid settings can be changed according to the users request.

To activate the grid settings while in the settings menu, point and click the mouse on the grid button and then click, or press the space bar until the grid button is highlighted then press enter.

Once this button is pressed the grid settings are activated, and different messages will be prompted to the user requesting the user to enter certain data.

First the user is asked to enter the **horizontal grid step**, which is the size of horizontal step between vertical grid lines that appear when the grid is activated. The user can enter any convenient value.

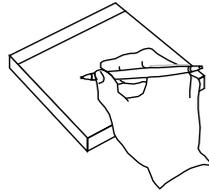
Then the user is prompted to enter the **vertical grid step**, which is the size of vertical step between horizontal grid lines that appear when the grid is activated. The user can enter any convenient value.



### NOTE

With each message prompted for the user to enter data, a certain default value is printed between parentheses, this value will be considered as the entered value if the user only presses return without entering any number.

When the user finishes entering grid settings data a message will be prompted for the user indicating that.



### SUMMARY

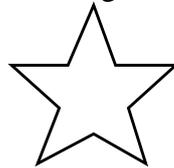
**The Settings Menu Is Used For Changing Settings Of:**

- ◇ **positioning the wave.**
- ◇ **scaling the wave.**
- ◇ **cursor movements.**
- ◇ **grid specifications.**

## 5.9 FILE MENU

### ABOUT

In the **file menu** the user is able to perform different operations concerning dealing with files, such as specifying the files type and name or save and load files. Also the user can specify the working drive and directory in addition to viewing certain files in the current working directory.



### NOTE

It important for the user to note that the *digital oscilloscope* deals with three types of files the *wav*, *set*, *fft* files, and corresponding to the file type is the files extension, i.e. a wav ,set or fft file should be of *.wav*, *.set*, *.fft* extension, respectively.

As it is apparent the wav files correspond to the wave samples currently processed. This can be either a wave from the input port or a loaded wave or a internally generated wave. The set files correspond to the settings files which

contain environment settings. The fft files are the Fast Fourier Transform files which contain the frequency spectrum data of certain signals.

In order to activate this menu; point and click with the mouse on the **file main menu button** or use the space bar to highlight the **file main menu button** and then press return on the keyboard.

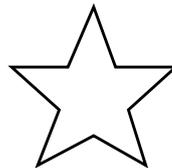
Going out of this menu can be done either by clicking the **special escape button** with the mouse or by pressing the keyboard escape.

## SPECIFIC NAME

This button in the file menu is chosen when the user wants to name a new file or rename the current file.

To activate the **name button** while in the file menu, either you should point by the mouse to the name button and then click, or press the space bar until the **name** button is highlighted then press enter.

Once this button is pressed a messages will be prompted to the user requesting the user to enter a file name.



### NOTE

The user should note that the file name entered is related to the file type currently active, this file type could be either wav, set or fft file. This can be easily determined by looking at the wav fft set button just down below in the file menu, where the highlighted file type is the one currently active.

The user can now enter the name of the file with the proper extension, or enter the complete path of the file name or even more, start with the drive name.

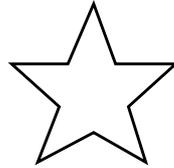
## SAVE

This button in the file menu is chosen when the user wants to save a file, either a wav file, a set file or an fft file.

To activate the **save button** while in the file menu, you should point the mouse to the save button and then click, or press the space bar until the **save** button is highlighted then press enter.

Once this button is pressed a message will be prompted for the user to confirm that he wants to save the file whose type is highlighted on the **wav fft set button**, and whose name is specified by the name button. Here the user can either

confirm the information or not conform it and in this case the user will be allowed here to enter once again the name if the file he wants the information to be saved in.



### NOTE

It should be noted that if the name of the file was specified with a complete path then the file will be saved accordingly, otherwise the file will be saved by the name specified but on the current drive and in the current directory.



### HINT

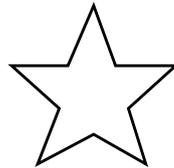
A message will appear when saving is successfully completed informing that, or another message of unsuccessful saving could be displayed if an error in saving has occurred. This happens generally when the user specifies an unfound path, and hence the user is recommended to check the path of the file and most probably needs to correct it.

## LOAD

This button in the file menu is chosen when the user wants to load a file, either a wav file, a set file or an fft file.

To activate the **load button** while in the file menu, point the mouse to the load button and click, or press the space bar until the load button is highlighted then press enter.

Once this button is pressed a message will be prompted to the user to confirm that he wants to load the file whose type is highlighted on the **wav fft set button**, and whose name is specified by the name button. Here the user can either confirm the information or not conform it and in this case the user will be allowed here to enter once again the name of the file he wants to load.



### NOTE

It should be noted that if the name of the file was specified with a complete path then the file will be loaded accordingly, otherwise the file will be loaded by the name specified but from the current drive and in the current directory.



## HINT

A message will appear when loading is successfully completed informing that. Another message of unsuccessful loading could be displayed if an error in loading has occurred. This happens generally when the user specifies an unfound path, and hence the user is recommended to check the path of the file and most probably needs to correct it.

## SET PATH

This button in the file menu is chosen when the user wants to set the current working directory or path.

To activate the **set path button** while in the file menu, point the mouse to the **set path** button and then click, or press the space bar until the **set path button** is highlighted then press enter.

Once this button is pressed a message will be prompted to the user to enter the required new path. If the path entered is invalid for some reason then the original path will not be changed.

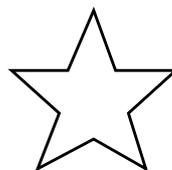
## SET DRIVE

This button in the file menu is chosen when the user wants to set the current working drive.

To activate the **set drive button** while in the file menu, point and click the mouse on the drive button, or press the space bar until the **set drive button** is highlighted then press enter.

Once this button is pressed different drive-button choices will be displayed for the user to choose from a set of drives. To choose a drive just point by the mouse to the required drive-button and click the mouse or simply press the letter denoting the required drive.

When a drive is chosen a message will appear asking the user to confirm the new drive.



## NOTE

Sometimes the user will choose an unavailable drive, in this case the current valid drive will not be changed.

## DIR

This button in the file menu as it is obviously clear is used as the DOS dir. command, i.e. to show the directory of the files.

To activate the **dir button** while in the file menu, you should point the mouse to the **dir button** and then click, or press the space bar until the **dir button** is highlighted then press enter.

This **dir button** is used to display only the files with current type highlighted in the **wav fft set button** just bellow the dir button. Even more, only the files in the current drive and directory.

Activating this button will cause the prementioned files found to be displayed one by one in the message bar of the screen, and the user should press the OK button to see next file which is done by either pointing to the OK button and clicking the mouse or by simply pressing the keyboards enter.

When files are all viewed or if no files exist at all from the beginning a message indicating no files will be prompted to the user.

## WAV/FFT/SET

This button in the file menu is used to specify the current file type either wav file, set file or fft file.

To activate the **wav fft set button** while in the file menu, either you should point by the mouse to the **wav fft set button** and then click, or press the space bar until the **wav fft set button** is highlighted then press enter.

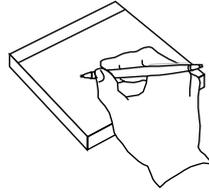
This button at any instance has only one of the three file types highlighted. with each time the button is pressed the highlighted type is changed to the next type, indicating that a new current file type is now available, so the user should press this button a number of times just enough to highlight the desired current file type.

## EXIT

This button in the file menu is pressed when the user wants to exit or quit the *digital oscilloscope* programs.

To activate the **exit button** while in the file menu, either you should point by the mouse to the **exit button** and then click, or press the space bar until the **exit button** is highlighted then press enter.

Then the button is pressed two buttons are displayed for the user to either confirm the exiting action by pressing the OK button, or to cancel the exit by pressing the no button and an "exit denied" message is now displayed.



## SUMMARY

### The File Menu Is Used For:

- ◇ **naming files.**
- ◇ **saving files.**
- ◇ **loading files.**
- ◇ **setting path.**
- ◇ **setting drive.**
- ◇ **showing directory.**
- ◇ **changing file type.**
- ◇ **exiting from application.**

## 5.10 HELP MENU

### ABOUT

The **help menu** in the *digital oscilloscope* environment screen is done to provide the user with a fast and right to the point help hints and instructions for the different menus and functions found all around the different menus.

In order to activate this menu; point and click the mouse on the **help main menu button** or use the space bar to highlight the **help main menu button** and then press return on the keyboard.

Going out of this menu can be done either by clicking on the **special escape button** or by pressing the keyboard escape.

This menu has different help topics to choose from and selecting any of them will cause a totally new help screen about the specified subject to be displayed.

### SPECIFIC POSITION

To activate the **position button** while in the help menu, either you should point by the mouse to the **position button** and then click, or press the space bar until the **position button** is highlighted then press enter.

When activated help on vertical and horizontal positioning the wave is available for the user to read.

To go back to the scope just press the button that reads "**click here to go back**".

## SCALE

To activate the **scale button** while in the help menu, either you should point by the mouse to the **scale button** and then click, or press the space bar until the **scale button** is highlighted then press enter.

When activated help on time and voltage scaling the wave is available for the user to read. To go back to the scope just press the button that reads "**click here to go back**".

## CURSOR

To activate the **cursor button** while in the help menu, either you should point by the mouse to the **cursor button** and then click, or press the space bar until the **cursor button** is highlighted then press enter.

When activated help on the cursor functions & mouse position coordinates is available for the user to read. To go back to the scope just press the button that reads "**click here to go back**".

## CONTROL

To activate the **control button** while in the help menu, either you should point by the mouse to the **control button** and then click, or press the space bar until the **control button** is highlighted then press enter.

When activated help on controlling the wave is available for the user to read. To go back to the scope just press the button that reads "**click here to go back**".

## FFT

To activate the **FFT button** while in the help menu, either you should point by the mouse to the **FFT button** and then click, or press the space bar until the **FFT button** is highlighted then press enter.

When activated help on Fast Fourier Transform operations are available for the user to read.

To go back to the scope just press the button that reads "**click here to go back**".

## OPTIONS

To activate the **options button** while in the help menu, either you should point by the mouse to the **options button** and then click, or press the space bar until the **options button** is highlighted then press enter.

When activated help on the different options found in the options main menu is available for the user to read. To go back to the scope just press the button that reads "**click here to go back**".

## SETTINGS

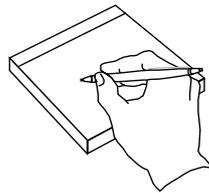
To activate the **settings button** while in the help menu, either you should point by the mouse to the **settings button** and then click, or press the space bar until the **settings button** is highlighted then press enter.

When activated help on how to change the different *digital oscilloscope* environment settings is available for the user to read. To go back to the scope just press the button that reads "**click here to go back**".

## FILE

To activate the **file button** while in the help menu, either you should point by the mouse to the **file button** and then click, or press the space bar until the **file button** is highlighted then press enter.

When activated help on different filing function is available for the user to read. To go back to the scope just press the button that reads "**click here to go back**".



## SUMMARY

### The Help Menu Contains Information About:

- ◇ **positioning the wave.**
- ◇ **scaling the wave.**
- ◇ **using the cursors.**
- ◇ **controlling the wave.**
- ◇ **using FFT menu.**
- ◇ **using the different options.**
- ◇ **changing the settings.**
- ◇ **managing files.**

## 5.11 ABOUT MENU

### ABOUT

When the **about main menu** is activated by either pointing and clicking the mouse on the **about main menu**, or by pressing the space bar until **about main menu** is highlighted and then enter, information about the *digital oscilloscope* is displayed.

Going out of this menu can be done either by clicking the **special escape button** with the mouse or by pressing the keyboard escape.



# CHAPTER SIX

## SOME DETAILS



## 6.1 TEXT COLORS

Each text displayed in **message screen** has a certain color:

<b>TEXT TYPE</b>	<b>COLOR</b>
Question that require user to enter data	light green
Data entered by user	white
Messages prompted by the application	light red
First line quantitative information	light cyan
Second line quantitative information	yellow

Table.1. text types and colors

## 6.2 SOUND

With each action performed an accompanying **sound** is available if sound is activated:

<b>OPERATION</b>	<b>SOUND FUNCTION</b>	<b>SPECIFIC</b>
Choosing from main menus	void music_main(void)	one note
pressing up/down/left/right/right buttons	void music_udlr(int m)	different notes with different keys pressed
choosing a sub menu	void music_sub(int m)	different notes with different sub-menus chosen
pressing the escape button	void music_escape(void)	one note
prompting a message	void music_message(void)	attention sound
invalid or operation	void music_buzz(void)	annoying low pitch sound

Table.2. operations and sounds

## 6.3 MOUSE CURSORS

Different **mouse cursors** were introduced and used while in different main menus:

<b>MOUSE CURSOR</b>	<b>USED IN</b>
Cross	position menu
Scale	scale menu
Watch	time viewing
Help	help & about menus
Disk	file menu
Arrow	settings & options menus
Check	control & FFT menus

Table.3. mouse cursors

## 6.4 FILES NEEDED TO RUN PROPERLY

<b>FILES</b>
digital.exe
egavga.bgi
bold.chr
euro.chr
goth.chr
lcom.chr
litt.chr
sans.chr
scri.chr
simp.chr
trip.chr
tscr.chr

Table.4. files to run

## 6.5 FILES NEEDED TO COMPILE & LINK FROM BC++v3.1

<b>C FILES</b>	<b>DESCRIPTION OF INCLUDED FILES</b>
about.c	the about menu function
audio.c	the different sound function
buttons.c	different drawing buttons functions
control.c	functions for controlling the wave
cursor.c	the different cursor functions
draw.c	different drawing functions
fft.c	Fast Fourier Transform functions
file .c	file management functions
fill&drw.c	functions for obtaining data and drawing wave
gscan .c	functions for reading data while in graphics
help.c	functions for the help menu
intro.c	the introduction function
main.c	the main program
options.c	functions of the different options in the options menu
position.c	functions for positioning the wave
scale.c	functions for scaling the wave
settings.c	functions for changing the settings
sound.c	function for toggling sound on and off
time .c	function for viewing the time
watch.c	function for knowing the time
window.c	includes functions for opening menus & windows

Table.5. files to compile

## 6.6 THE HEADER FILES INCLUDED IN THE PROJECT

header file	some used functions
graphics.h	initgraph, setgraphmode, setcolor, line, rectangle, floodfill, settextstyle
stdio.h	sprintf, scanf, fscanf, printf, fprintf
dos.h	sound, nosound, inport, outport
conio.h	kbhit, getch
math.h	abs, log, sin, sqrt, pow
cctype.h	toupper
stdlib.h	atoi, atof, system, random
time.h	time, asctime
process.h	system
string.h	movedata
dir.h	chdir, getcwd

Table.6. header files and functions

## 6.7 FREE SPACE NEEDED

FILE	approximate SIZE
digital.exe	200 KB
fonts *.chr	130 KB
egavga.bgi	6 KB
<b>TOTAL</b>	<b>336 KB</b>

Table.7. disk space needed

# CHAPTER SEVEN

## THE OVER ALL PROJECT



## 7.1 PROJECT OVERVIEW

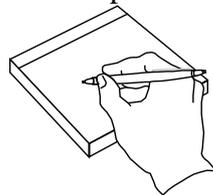
The project in its final stage is a *digital oscilloscope* used to display signals that mainly are interfaced through an input port or could be also internally generated or loaded from a disk.

Once a signal is displayed, the *digital oscilloscope* could be used for positioning the wave in the four directions, changing time and voltage scales, calculating voltage differences and time intervals between certain points of the displayed wave, controlling the slope or grounding the wave, AC & DC triggering, AC & DC coupling and showing the frequency spectrum of the wave.

The *digital oscilloscope* defines three types of files; a wave file, a settings file and an FFT file. Different file utilities can be performed on these files; they can be named, saved and loaded. Also drives and directories can be controlled and executing DOS commands from a DOS shell is also possible.

In addition to the above mentioned, the *digital oscilloscope* has an internal data generator, optional wave freezing. Setable grid and on-line information. Other options such as adding sound while working, knowing the time, viewing the mouse position coordinates or redrawing the whole screen, are all available.

The *digital oscilloscope* has a help menu, for fast and straight forward instructions and hints. Changing the settings for positioning or scaling the wave, for cursor control and for the grid is also possible.



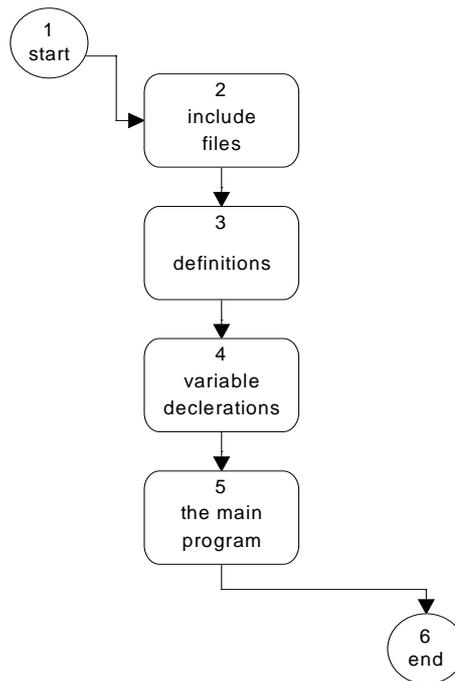
### SUMMARY

#### In The *Digital Oscilloscope* You Can:

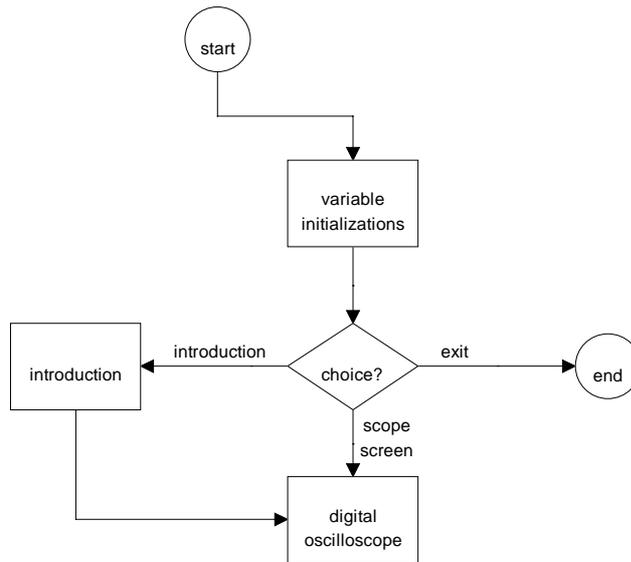
- ◇ display an interfaced wave, internally generated or loaded wave.
- ◇ control the positioning of the wave.
- ◇ control time and voltage scaling.
- ◇ calculate voltage differences and time intervals.
- ◇ freeze and control the slope of the wave.
- ◇ control the triggering either AC or DC trigger.
- ◇ use different coupling modes AC, DC, ground.
- ◇ display FFT of wave.
- ◇ change settings.
- ◇ name save or load wave, settings and FFT files.
- ◇ perform DOS commands and change drives and directories
- ◇ view help and about *digital oscilloscope* information
- ◇ add sound and know the time.

## 7.2 PROJECT FLOW CHART

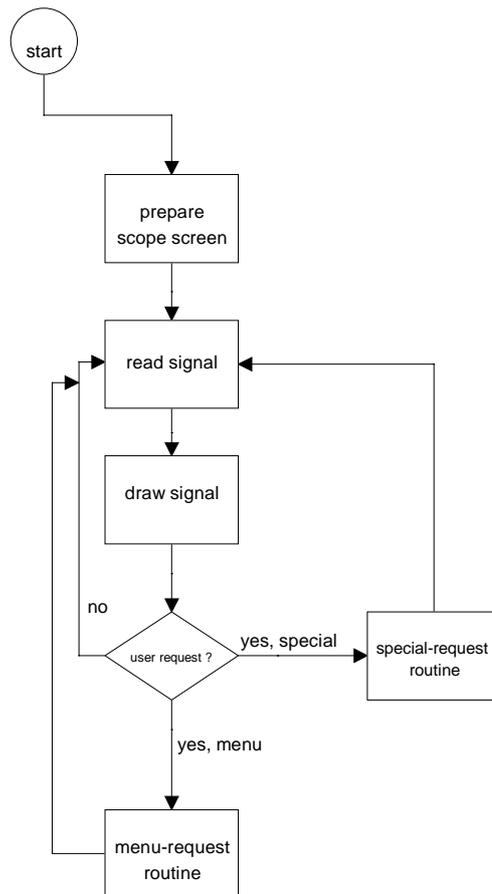
### THE BASIC PROJECT FLOW CHART



### THE MAIN PROGRAM FLOW CHART



## THE SCOPE GENERAL FLOW CHART

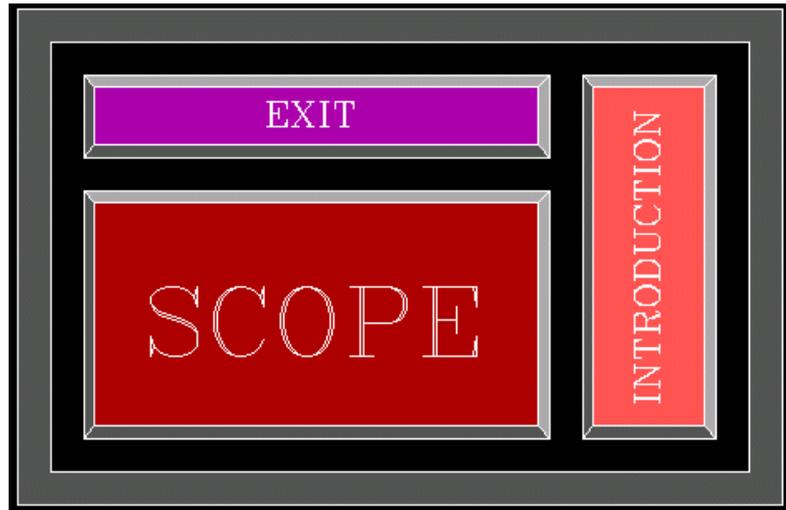




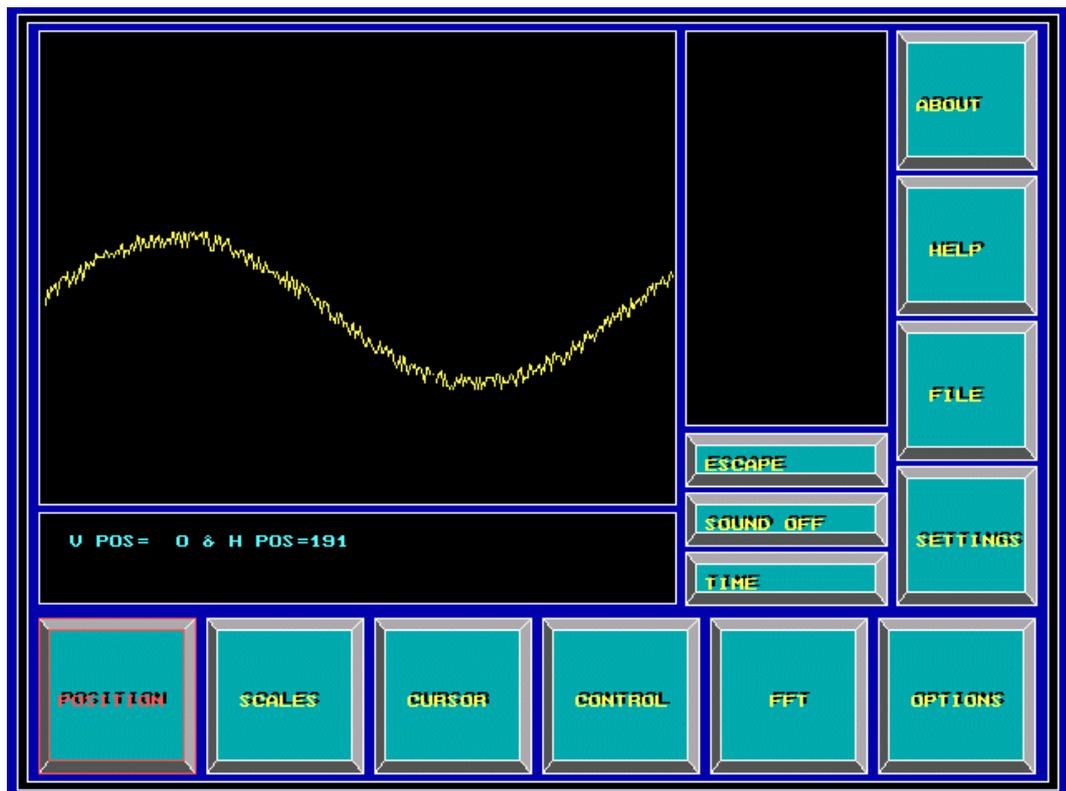
# CHAPTER EIGHT

## GOING INSIDE THE APPLICATION

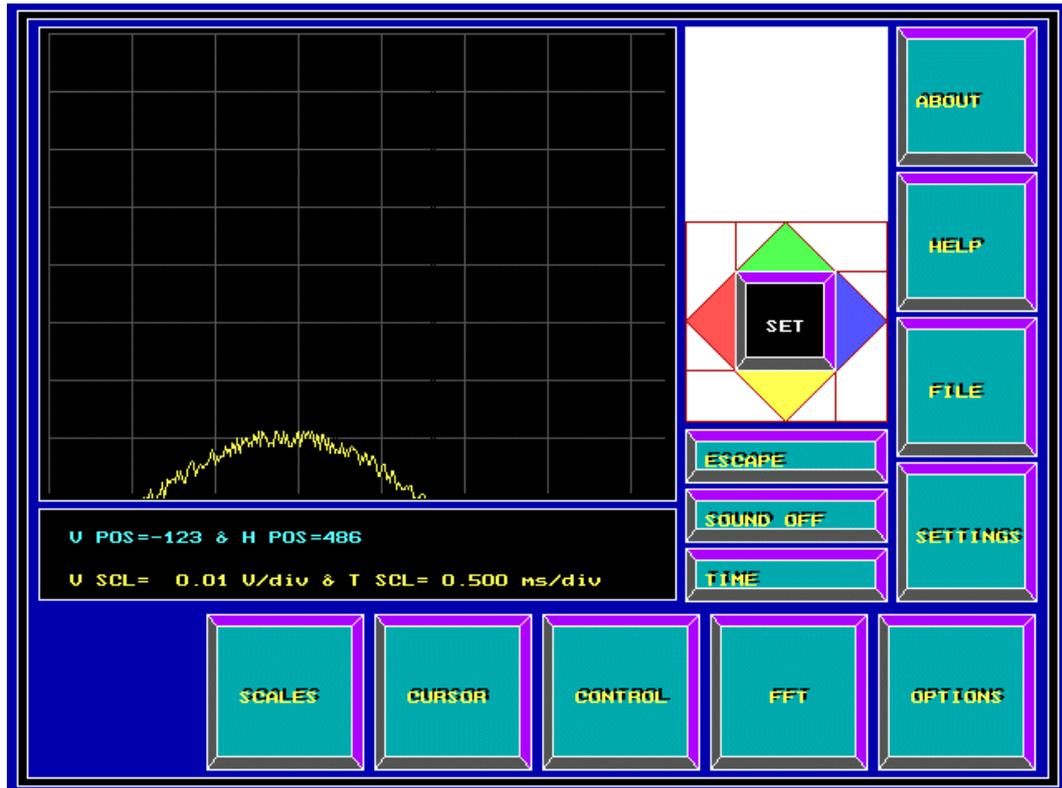




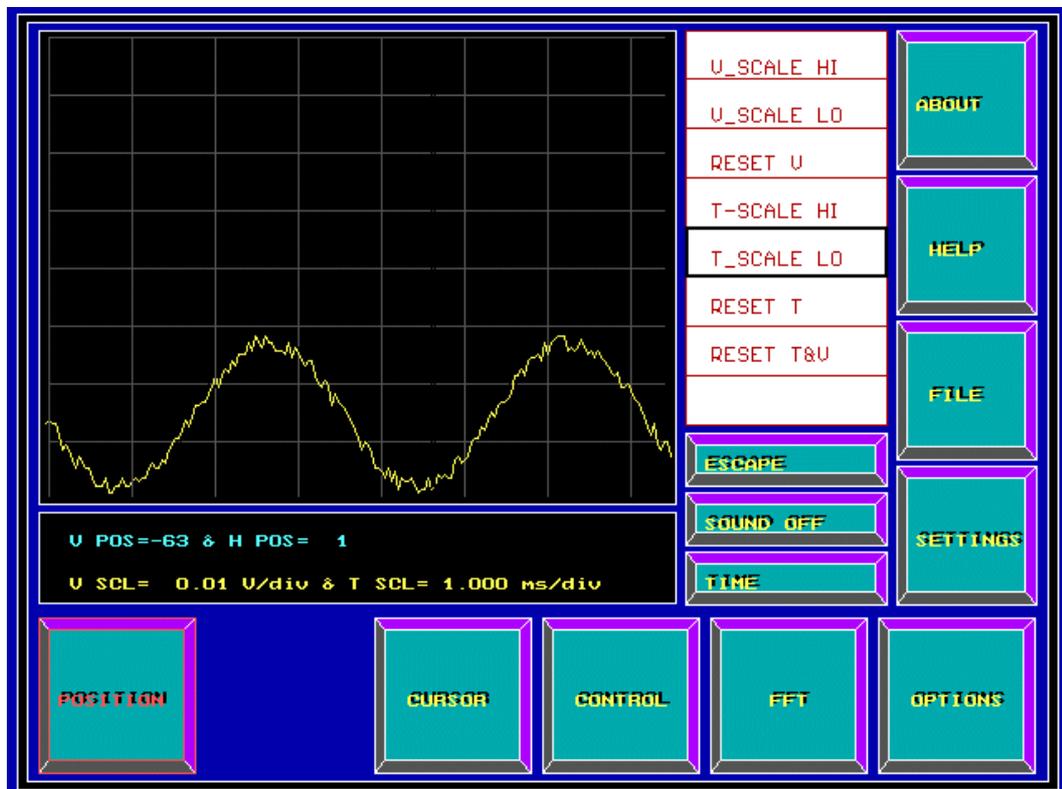
Capture.1. Starting the program



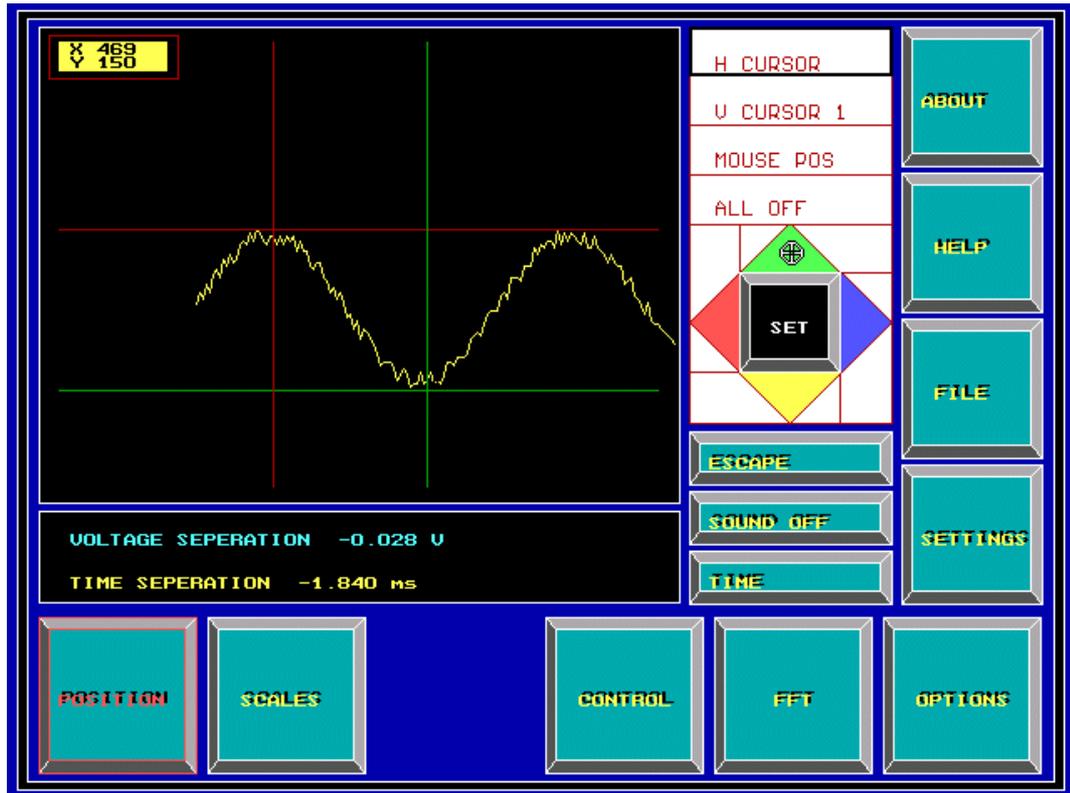
Capture.2. Entering the scope



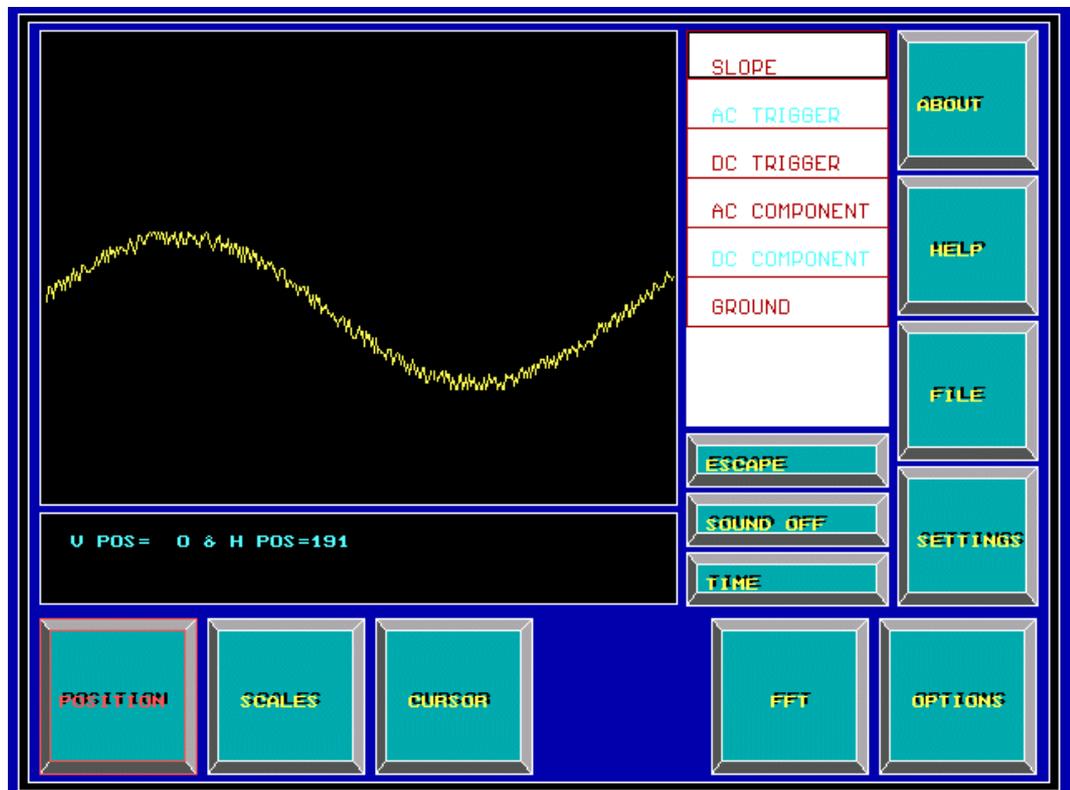
Capture.3. Entering the position menu



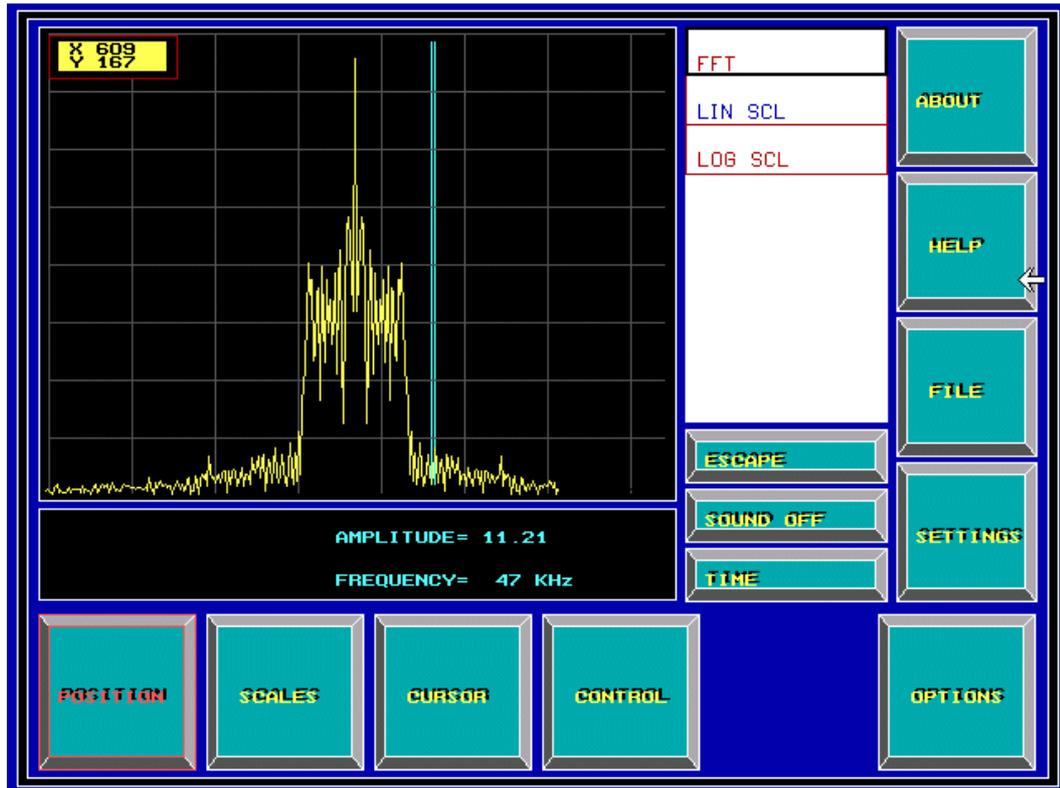
Capture.4. Entering the scale menu



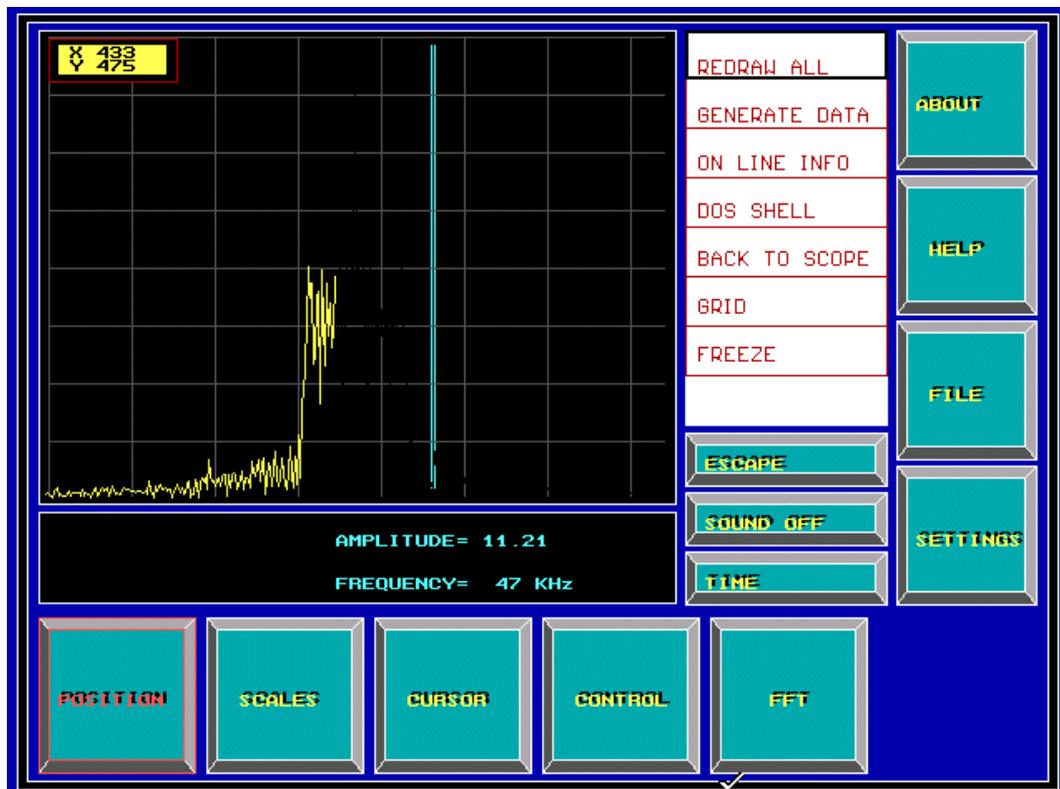
Capture.5. Entering the cursor menu



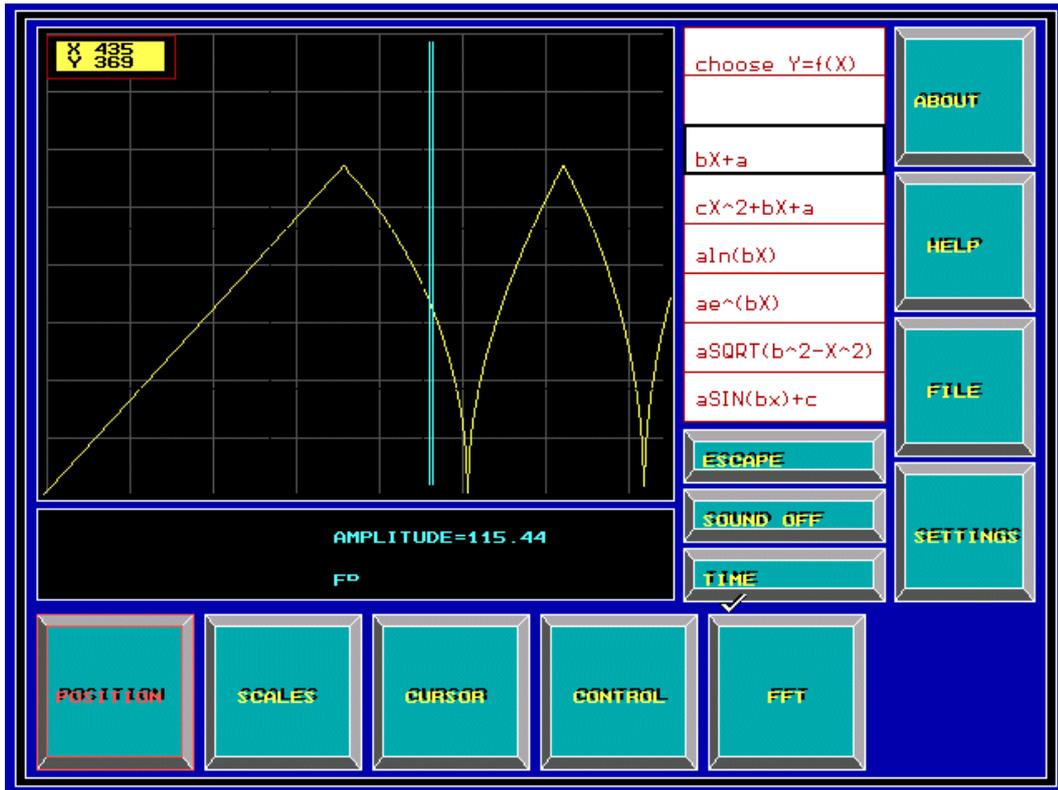
Capture.6. Entering the control menu



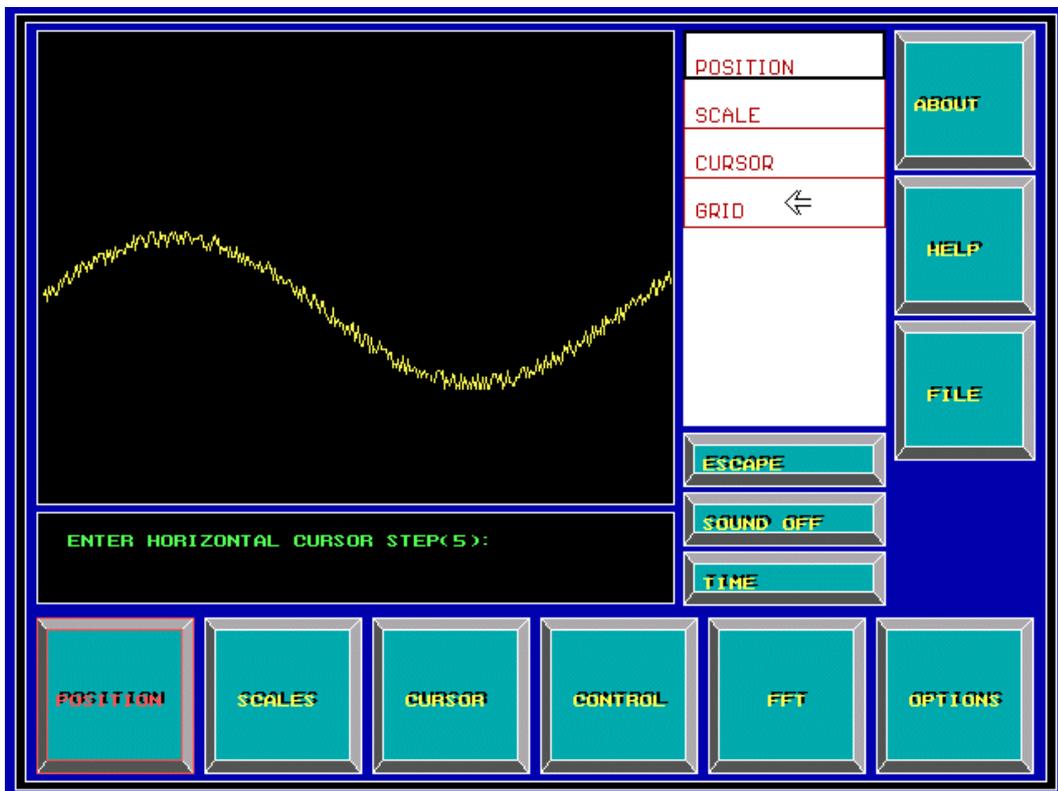
Capture.6. Entering the fft menu



Capture.7. Entering the options menu



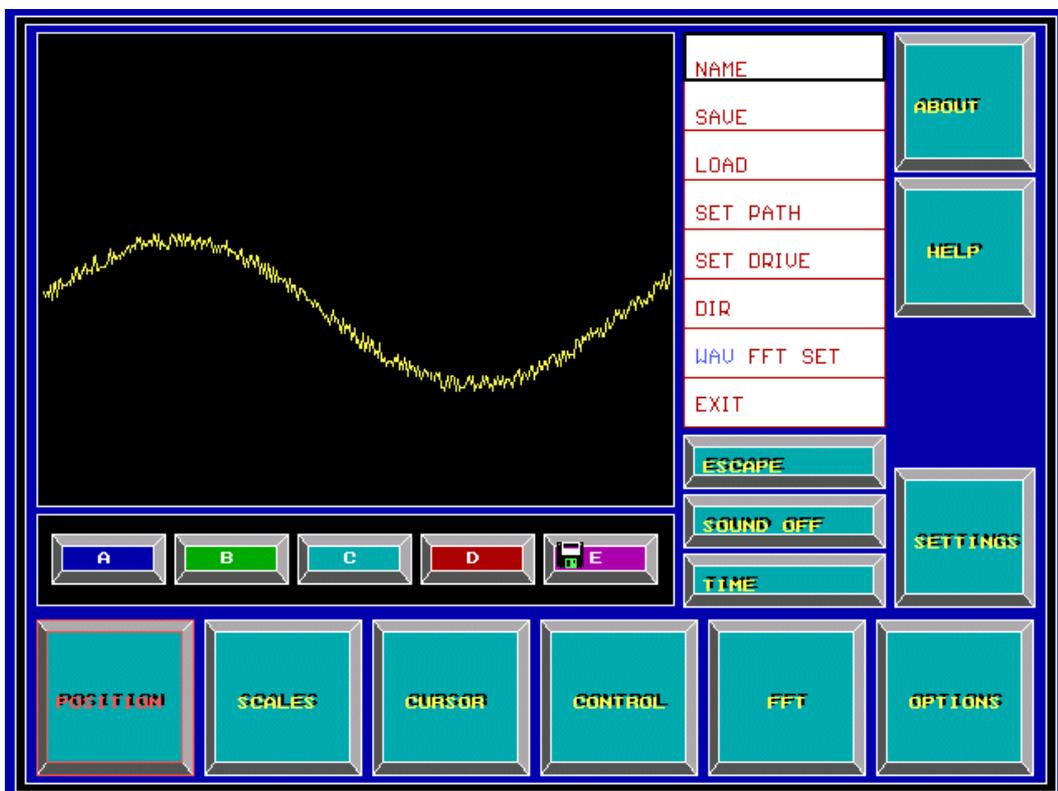
Capture.8. Generating data



Capture.9. Entering the settings menu



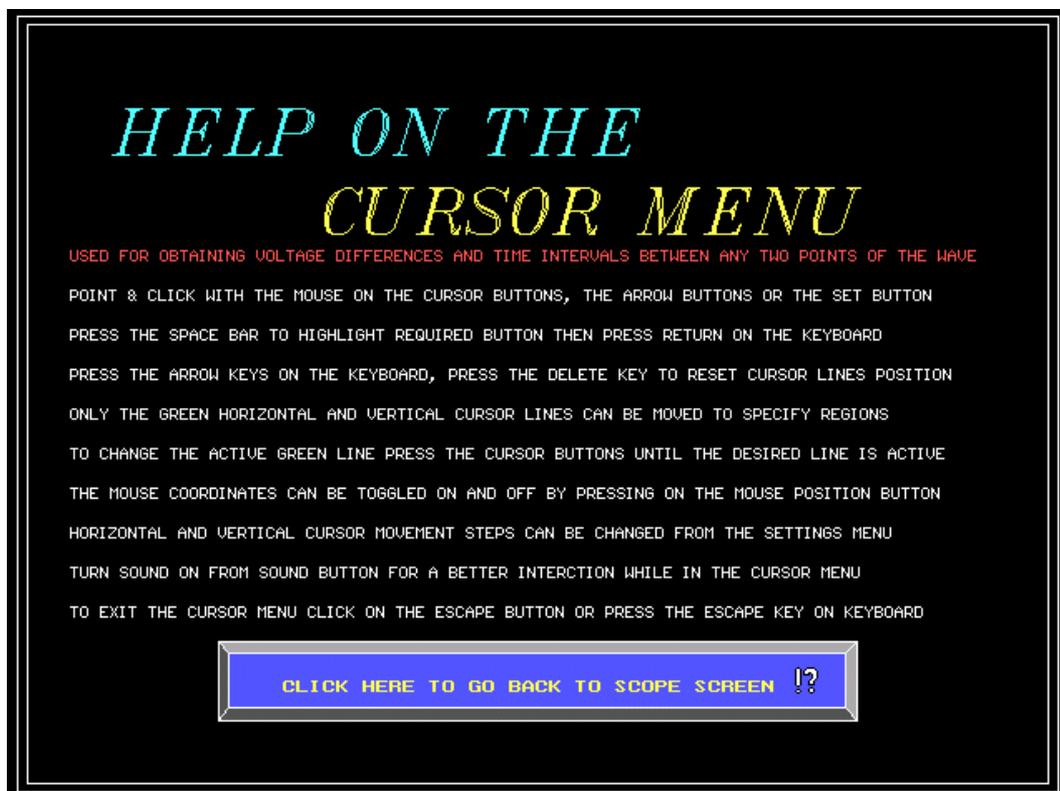
Capture.10. Selecting drives from the file menu



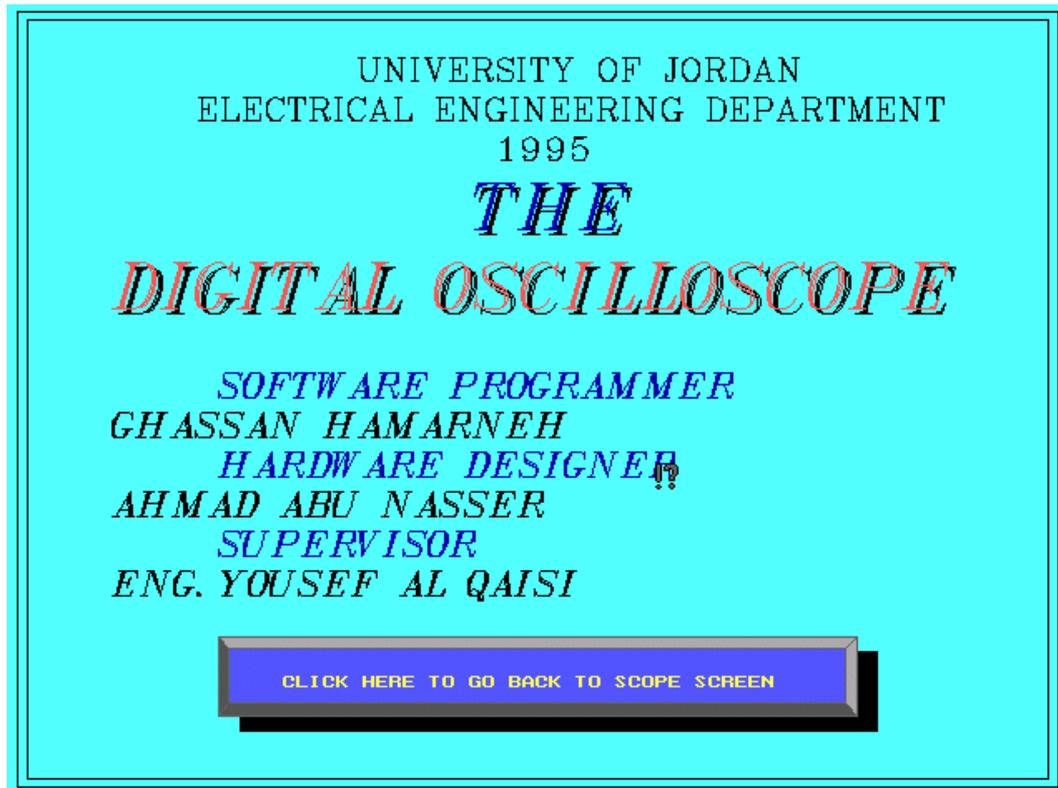
Capture.11. Loading a wave from the file menu



Capture.12. Entering the help menu



Capture.13. Getting help on the cursor menu



Capture.14. Entering the about menu

# CHAPTER NINE

## PROJECT HARDWARE



## 9.1 OVERVIEW

The hardware interface card designed to work with software, is mainly an analog to digital converter (ADC) but with a high input impedance so as to get as correct readings as possible, and this ADC is controlled from the PC with several control bits that determine time & voltage scale, and passing either ground or AC or DC, every 1024 samples are stored in a 1KB memory chip and are read by the PC once they are ready and a control signal is then sent to the ADC to start a sampling.

## 9.2 HARDWARE DETAILS

Listed in the tables below are specifications concerning the following:

- ◇ **addresses in memory where sampled data are stored.**
- ◇ **the handshaking signals going between PC and the interfaced circuit.**
- ◇ **vertical position control word and its address.**
- ◇ **control word for triggering and coupling and its address.**
- ◇ **control word for time and voltage scales and its address.**

<b>SAMPLES IN MEMORY</b>	
<b>MEMORY ADDRESS</b>	<b>SAMPLE NUMBER</b>
A0000 Hex	0
through....	
A03FF Hex	1023

Table.8. samples in memory

<b>HANDSHAKING</b>		
<b>SIGNAL</b>	<b>ADDRESS</b>	<b>BIT</b>
DATA READY	350 Hex	bit 7 (msb) = 1
RESET	330 Hex	bit 7 (msb) = 0
START SAMPLING	330 Hex	bit 7 (msb) = 1

Table.9. handshaking

<b>VERTICAL POSITION</b>	
<b>PARALLEL PORT ADDRESS=320 Hex</b>	
<b>VERTICAL POSITION CONTROL BYTE</b>	<b>VERTICAL POSITION</b>
0000 0000	-128
through.....	
1000 0000	0
through.....	
1111 1111	+127

Table.10. controlling vertical position

<b>CONTROL</b>						
<b>PARALLEL PORT ADDRESS = 330 Hex</b>						
<b>bit 3</b>	<b>triggering</b>	<b>bit 2</b>	<b>slope</b>	<b>bit 1</b>	<b>bit 0</b>	<b>coupling</b>
0	dc	0	-ve	0	0	ac
1	ac	1	+ve	0	1	ground
				1	0	dc
				1	1	ground (also)

Table.11. controlling triggering and coupling

<b>TIME &amp; VOLTAGE SCALES</b>			
<b>PARALLEL PORT ADDRESS = 340 H</b>			
<b>MOST SIG. NIBBLE</b>	<b>VOLTAGE SCALES</b>	<b>LEAST SIG. NIBBLE</b>	<b>TIME SCALES</b>
<b>bit numbers 7654</b>	<b>volts/div.</b>	<b>bit numbers 3210</b>	<b>ms/div.</b>
0000	0.01	0000	0.2
0001	0.02	0001	0.5
0010	0.05	0010	1
0011	0.1	0011	2
0100	0.2	0100	5
0101	0.5	0101	10
0110	1	0110	20
0111	2	0111	50
1000	5	1000	100
1001	10		

Table.12. controlling time and voltage scales

# DISCUSSION

With this project being completed, I would like to specify some points. These preceding points would summarize the **benefits** of this great experience of writing the digital oscilloscope software program.

I consider being able to carry out and complete the task being given to me, as the most important benefit that I've gained from working on this project. Now, I'm even more sure that nothing can stop in front of strongly motivated persons, who always has the will to keep searching, working and asking until he solves all problems and completes all tasks.

Learning **C language** is one of the main benefits of this project. At this time I gained experience in the following topics:

- assignment statements.
- looping using **for**, **while**, **do...while**, **goto** statements.
- conditioning using **if**, **else**, **case** condition statements.
- text mode input commands such as the **getch** and **scanf** functions.
- text mode output commands such as the **printf** function.
- reading and writing **files** using functions such as **fscanf** and **fprintf**.
- working with **pointers**.
- arrays and variables such as **int**, **float** and **char**.
- defining functions and using **functions** from **libraries**.
- working in **graphics mode**.

Also I got acquainted to the *BorlandC++v3.1 IDE (Integrated Development Environment)*. The IDE has many menus for a wide variety of functions. Such menus are for file management, and for editing commands. Other menus are for changing options and settings. Another important menu is for **compiling**, **linking** and **running** programs. A very useful menu is the **debug** menu used for debugging your program in different ways. Also, The **help** menu was of a great help to me. In addition to the above is advantage of Learning to work with the **project utility** of *BorlandC++v3.1*.

During the time I've been working on the project I got familiar with the **DOS 6.2** and many of its commands. Also I gained more experience working under windows. Using many applications that aided in many aspects of the project is also an important benefit. Such as the **Microsoft Word** mainly for writing the project. **Microsoft Excel** for displaying waves. **Microsoft Draw** for the illustrations found in this report.

One of the advantages from this project is learning how to deal with big programs that consist of tens of files and thousands of lines of code. Also, Finding better ways for performing certain tasks but choosing the most efficient way that would save both **memory** and **time**.

Another experience I gained when writing many **graphics** codes is how to manage many objects that are required to be displayed at the same time. Keeping in mind that these objects are variables. They either change color, places, values or shapes or even all.

Adding **sound** into the program turned out to be an important aspect in writing applications. Sound would cause sensible effects on the computer-user interaction. These effects would help the user working with the program and with time the different sound will guide the user while performing different functions.

Getting more into the details of the **digital oscilloscope**, we'll find that in each function written in each of the different menus many problems were encountered before reaching the final stage of the project.

In the file menu, I learned how to deal with files directories and drives from the program. The control menu, scale menu and the position menu had a lot to do with sending control words to the **hardware circuitry**. The help and about menu, in addition to the introduction of the digital oscilloscope taught me more about displaying text in graphics.

Learning how to use the **mouse** in the program was of a great benefit. This had opened a way for me to think of many things that could make use of the mouse for later programs.

All of the above would not have been possible without fully understanding the different functions found in any oscilloscope. Functions such as **positioning**, time and voltage **scaling**, **triggering** and **coupling**.

The above are some advantages that could seem rather obvious. One should not forget that during this period of working on a program would surely lead to better ways of thinking, approaching problems and finding solutions.

## REFERENCES

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- *Signal Processing Algorithms*, Samuel D. Stearns, Ruth A. David, Prentice Hall, 1988
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