

M221 100 MHz Digital Oscilloscope

Copyright © 1996 by: ETC Ltd. All rights reserved.

Printed in Slovakia.

Contents:

1. General information.....	8
1.1. Oscilloscope characteristics.....	8
1.1.1. Digital shielding	9
1.1.2. Dynamic address space allocation.....	9
2. Installation	10
2.1. Minimum computer requirements	10
2.2. Setting up the EM221 add-on card.....	10
2.3. Device installation	12
2.3.1. 4-channel oscilloscope installation.....	12
2.4. Software installation.....	13
2.4.1. Microsoft Windows 3.1 version.....	14
2.4.2. Microsoft Windows 95 version.....	14
2.4.3. Win - OS/2 version	14
2.4.4. Running the SCOPE M221 program.....	15
2.4.5. Exiting the program.....	15
2.5. Probe test.....	15
3. Using the oscilloscope.....	17
3.1. Front panel.....	17
3.2. Main window.....	17
3.2.1. Setting up the active device.....	20
3.2.2. Oscilloscope screen.....	20
3.2.3. Cursors and grid.....	20
3.2.4. Channel A, B, C and D vertical data.....	22
3.2.5. Turning channels on and off.....	22
3.2.6. Display mode.....	23
3.2.7. Functions	24
3.2.8. Storing the data.....	25
3.2.9. Loading the data	26
3.2.10. Controlling the data display length.....	26
3.2.11. Scanning through samples	28
3.2.12. Controlling the time base and time base data.....	28
3.2.13. Triggering mode controls	29
3.2.14. Trigger controls	30

3.2.15. Controlling the Digital Shielding	31
3.2.16. Setting the range.....	31
3.2.17. Controlling the vertical shift	32
3.2.18. Setting the coupling	33
3.2.19. Setting the probe attenuation	33
3.2.20. Setting up the optional control.....	34
3.2.21. Trigger level mark	34
3.2.22. Digital filter	34
3.2.23. Sweep before trigger mode.....	35
3.3. Main menu	35
3.3.1. Setting the parameters of individual devices	35
3.3.2. Automatic detection of devices	36
3.3.3. Device testing	37
3.3.4. Printing the measurement report	37
3.3.5. Setting up some features	37
3.4. Exporting data	38
3.5. Help	38
4. Hardware	40
5. Performance characteristics	42
5.1. Vertical deflection system	42
5.2. Triggering	42
5.3. Horizontal deflection system	43
5.4. Auxiliary generator.....	43
Appendix A: Hardware requirements	44
Appendix B: Host environments	44
Appendix C: m221fnc.dll library standard functions	44
Appendix D: Fast Fourier transformation	45
Appendix E: Time base ranges	46

ETC company would like to thank you for purchasing the M221 oscilloscope. We believe it will meet your expectations. To keep you informed, please fill out the registration card, you have obtained with the shipment. In case you need assistance do not hesitate to contact us at:

ETC spol. s r.o., P.O. Box 97, 010 08 Žilina, Slovak Republic

Phone: ++42-89-667894

Fax: ++42-89-667894

Package Contents

- 1 pc - EM221 PC add-on card
- 1 pc - cable with plug on one end and alligator clip on the other one
- 1 pc - cable with plug on one end and standard clip on the other one
- 2 pcs - module connection wire
- 1 pc - 3.5 inch disk containing SCOPE software
- 1 pc - User's guide

Warranty Conditions

The Limited Warranty set forth below is given by ETC Ltd. with respect to the M221 digital storage oscilloscope package excluding the SCOPE software. This limited warranty is only effective upon presentation of the warranty card. This product is warranted against defective materials or workmanship for half a year (when the registration card is filled out and sent to ETC warrant period extends to one year), and is limited to repair, adjustment and/or replacement of the defective product. Within the warranty period ETC will repair or replace the product free of charge, while the shipping fee is paid by the customer. After the warranty period, ETC will charge for parts, labor and shipping fee when returning the merchandise to customer.

ETC shall not be responsible for any abuse, misuse, accident, negligence, or modification by anyone other than the manufacturer.

Software license agreement

This legal document is an agreement between you, the end user, and ETC Ltd. By installing this product on your computer, you are agreeing to become bound by the terms of this agreement and warranty conditions.

1. **GRANT OF LICENSE.** ETC Ltd. as Licensor, grants you, the Licensee, a nonexclusive right to use and display this copy of the SCOPE software (hereinafter the "SOFTWARE"), this EM221 add-on card and accompanying written materials, on a single COMPUTER at a single location and only together so long as you comply with the terms of this License.

2. **OWNERSHIP.** As the LICENSEE, you own the magnetic or other physical media on which the SOFTWARE is originally or subsequently recorded or fixed, but an express condition of this License is that ETC Ltd. retains title and ownership of the SOFTWARE recorded on the original disk copy(ies) and all subsequent copies of the software, regardless of the form or media in or on which the original and other copies may exist. This License is not a sale of the original SOFTWARE or any copy.

3. **COPY RESTRICTIONS.** This SOFTWARE, EM221 add-on card and accompanying written materials are copyrighted. Unauthorized copying or copy attempt of the EM221 add-on card, including card which has been modified or included with any other system, or of written materials is expressly forbidden. It is, however, allowed to pass SOFTWARE on as the DEMO version. You may be held legally responsible for any copyright infringement which is caused or encouraged by your failure to abide by the terms of this License.

4. **DISCLAIMER OF THE WARRANTY OF ANY KIND CONCERNING SOFTWARE.** This SOFTWARE and accompanying written materials are provided "AS IS" without a warranty of any kind. Further, ETC Ltd. does not warrant, guarantee or make any

representations regarding the use, or the results of use, of the SOFTWARE, EM221 add-on card or written materials in terms of correctness, accuracy, reliability, currentness, or otherwise. The entire risk as to the results and performance of the software is assumed by you.

Trademarks

MS-DOS, Microsoft Windows, Microsoft Windows 95, MS Office, MS Excel, MS Word are registered trademarks of Microsoft Corporation.

IBM PC, OS/2, WARP, VGA are registered trademarks of International Business Machines, Inc.

Recommendation for the oscilloscope use

- read the READ.ME file before working with the device
- before adjusting or installing add-on card turn your computer off
- secure the front panel with the screw before turning your computer on
- do not connect voltage higher than 100 V to the channel inputs
- do not connect voltage higher than 40 V to the external trigger input
- do not connect any voltage source to the auxiliary generator output
- do not attempt to set trimmers located on the add-on card
- when setting base address always install just one jumper

Who is this book addressed to

This book is addressed to the users of the digital storage oscilloscope M221. In order to fully understand the book and the software, the user should have basic knowledge how to operate a device of this type, and some basic knowledge of working with Microsoft Windows. In case you are having problems with the environment, please consult MS Windows User's Guide or MS Windows 95 User's Guide or OS/2 Warp User's Guide.

1. General Information

The information contained in this chapter will help you to understand the features of the M221 digital storage oscilloscope.

1.1. Oscilloscope characteristics

The M221 2-channel digital storage oscilloscope uses the EM221 add-on card for data collection, and a PC computer for data processing. The accuracy of measurement is provided by combination of the stability of parts used in EM221 and of computer calculations. Information concerning device characteristics are part of the hardware; therefore, there is no need for any additional calibration data.

This oscilloscope allows the user to measure waveforms using two different channels with a resolution of 8 bits. The vertical deflection system range is from 50 mV/div to 2 V/div in a six steps sequence. The input impedance of this device conforms to the usual standards; it is therefore possible to use either a 1:1 or a 1:10 probe. You can set the coupling (AD or DC) for each channel individually. One step in the track vertical shift is smaller than 1% of the oscilloscope screen range. You can select the trigger source to be channel A, channel B, External trigger input or their combination. It is possible to set the trigger level individually for each channel. External trigger input is TTL compatible. EM221 chipset allows data collection frequency to be a maximum of 20 MS/s (megasamples per second), it

means that it is not possible to sample nonperiodic waveforms faster than 50 ns per sample. However, the random sampling method allows the possibility of sampling periodic waveforms at the rate of 0.5 ns per sample (2 GS/s). The time base range is from 20 ns/div to 2 s/div (when measuring periodic waveform).

The M221 digital storage oscilloscope is equipped with two A-D converters, that allows independent measuring on both channels, without any distortions, that can happen when using oscilloscopes with multiplexed measuring channels. The record length of each channel is 8000 samples when the sweep runs after the trigger. Furthermore, this device allows to run the sweep before the trigger. In this mode it displays 7872 samples before the trigger and 128 samples after the trigger.

1.1.1 Digital Shielding (DSH)

To solve the problem of the interference of the computer circuits and of the display unit to the measured object, ETC Ltd. has designed Digital Shielding circuits which are cheaper and as equally effective as the classical electromagnetic shielding of input circuits. DSH circuits remove all interference not synchronized with the measured signal, and it does not affect frequency characteristics of the measured signal. The only negative effect of DSH is a longer time period of stabilization. It is, however, very simple to turn the DSH off using the on-screen controls. You affect the PC and monitor interference level in a positive way by keeping the rules that will be described later. The level of efficiency of DSH corresponds to the DSH level factor that can be set to 2, 4, 8, 16, 32 and 64. The higher the level you choose, the longer it takes to stabilize.

1.1.2. Dynamic address space allocation (DSA)

A serious problem of measuring devices designed as PC add-on cards is the lack of I/O address space. To solve this problem ETC Ltd. has designed the DSA system, which allows you to connect 248 devices using just 8 I/O addresses. We will describe the DSA system very briefly. In case you would like to use the EM221 card in bigger systems, please contact the manufacturer.

Each device using the DSA system allocates eight consecutive I/O addresses. The lowest one is called the Base Address and its value is indicated by a jumper on the add-on card. To differentiate the active device, there is also the Module User Code (MUC), that is also indicated by a jumper on the add-on card. The MUC value can be from 0 to 7; therefore only eight devices of the same type can be installed into the same system. Before installing devices into the computer, it is important to set the same base address on each module.



WARNING: When installing two devices of the same type, make sure they do not have the same MUC.

2. Installation

This chapter contains all the useful information concerning the hardware and software installation.

2.1. Minimum computer requirements

- 386 compatible computer
- 4 MB RAM
- 3.5 inch FDD
- VGA display adapter
- mouse or other pointing device
- 2 MB hard disk free space
- MS Windows 3.1, MS Windows 95 or Win-OS/2, depending on purchased software version.

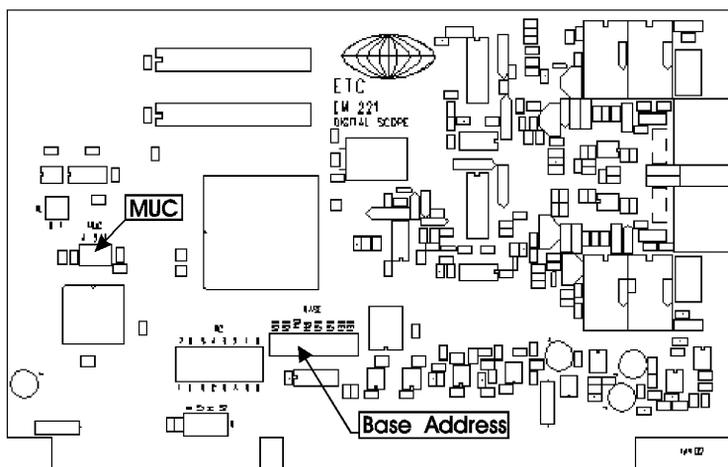
2.2. Setting up the EM221 add-on card

Before installing the module to the computer it is important to set the Base Address and MUC.

To set the Base Address, simply install one jumper to the BASE part. When looking on the card (front panel is on right side),

jumpers represent the following addresses (from left to right): 100h, 108h, 110h, 118h, 120h, 128h, 130h and 138h. In case you want to add this device to the EML System (ETC Measuring Lab), it is important to set the same base address as on the already installed devices. When using the 4-channel oscilloscope (two EM221 card), both cards have to have the same Base Address.

WARNING: Never install two Base Address jumpers. It can cause a device malfunction.



To set the MUC, you can install any combination of up to three jumpers on the EM221 add-on card in the MUC part. The jumpers represent following values (from left to right): 4, 2, 1. To set the specific MUC, please see the following table:

MUC	4	2	1
0	CLOSED	CLOSED	CLOSED
1	CLOSED	CLOSED	OPEN
2	CLOSED	OPEN	CLOSED
3	CLOSED	OPEN	OPEN

4	OPEN	CLOSED	CLOSED
5	OPEN	CLOSED	OPEN
6	OPEN	OPEN	CLOSED
7	OPEN	OPEN	OPEN



WARNING: It is very important that no two devices have the same MUC, because the software is not capable of handling this type of situation; therefore it might lead to undesired results. When installing two devices as the 4-channel oscilloscope, they have to have a different MUC.



IDEA: We recommend, that you make a note of the MUC. It will ease the installation of the software.

2.3. Device installation

To install this device, simply insert it into any open ISA Bus slot. Please, consult this action with your computer dealer. Always turn your computer off before installation. Before you turn your computer back on, put the screw back in its place.

To minimize the interference obey the following rules:

- Install the device as far from the power source as possible.
- Leave the by slot open.

These rules are not categorical. Not following these rules, can just lead to an increase in the interference.

2.3.1. 4-channel oscilloscope installation

Besides the steps described in the previous chapter, you need to connect these two devices. For this very purpose, you have received two connection cables. To install the cables correctly see Fig. 2.3.1.1. We recommend you to follow these steps:

- plug the connection cables into one device
- insert this device into the computer
- plug the connection cables into the other device

- install the other device into the computer

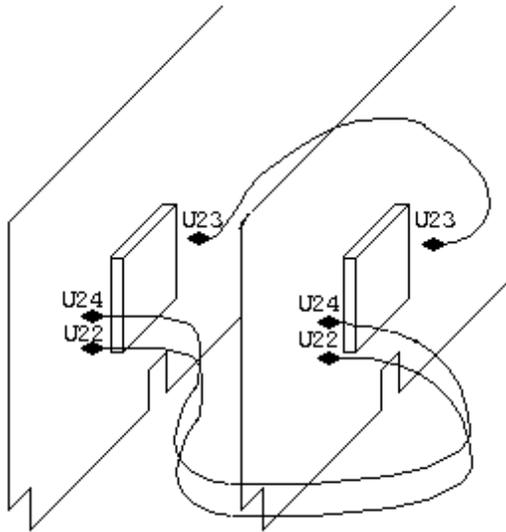


Fig. 2.3.1.1.
Connection of two devices

2.4. Software installation

There are software versions for MS Windows 3.1, MS Windows 95 and Win-OS/2 available. The standard EM221 shipment includes only one of these versions. It is possible to purchase more software versions for an extra fee.

The SCOPE software has to be installed on the hard disk, and it needs approximately 2 MB of free space.

IDEA: We recommend that you make a backup copy before the first installation.





WARNING: When installing more than one oscilloscope, it is not necessary to install the software more than once. It is possible to control several devices using just one software package.

Software is provided on one 3.5" disk. It contains the program that installs the whole software for you (SETUP.EXE). A version of the host operating system is indicated on the disk label.

2.4.1. Microsoft Windows 3.1 version

1. Insert the install disk into A or B drive.
2. Run Windows 3.1
3. Start PROGRAM MANAGER
4. Select FILE from the main menu
5. Select RUN
6. Input "a:\setup.exe" or "b:\setup.exe"
7. After running the installation software, it is possible to change the directory the software is going to be installed into. (C:\ETC - default)
8. Press the Start button, which initiates the installation of the software.
9. After the installation is finished, remove the disk from the drive and store in a safe place.

2.4.2. Microsoft Windows 95 version

1. Insert the install disk into A or B drive.
2. Run Windows 95
3. Open the Control Panel group
4. Select Add/Remove programs
5. Enter the name and location of the installation software "a:\setup.exe" or "b:\setup.exe" and press ENTER
6. After running the installation software, it is possible to change the directory the software is going to be installed into. (C:\ETC - default)
7. Press the Start button, which initiates the software installation.
8. After the installation is finished, remove the disk from the drive and store in a safe place.

2.4.3. Win - OS/2 version

1. Insert the install disk into A or B drive.
2. Run OS/2
3. Open the OS/2 Full Screen
4. Enter "a:\install.cmd" or "b:\install.cmd", disk drive name and path, where the software is supposed to be installed into, and press ENTER.

Example: a:\install.cmd c:\etc <ENTER>

5. Press the Start button, which initiates software installation.
5. Exit the Win - OS/2
6. After the installation is finished, remove the disk from the drive and store in a safe place.

2.4.4. Running the SCOPE M221 program

After a successful installation, SETUP creates a group called ETC Measuring Lab. In this group you will find an icon which runs the SCOPE M221 program. You can run the program by double-clicking, or pressing ENTER when it is selected.

When running the program for the first time, the program tries to find and work with a device on the default base address (110h) and the default MUC (0). In case you have moved the jumpers on the card, an error message will appear and Demo mode will start. How to fix this problem see chapter 3.3.1.

2.4.5. Exiting the program

It is possible to exit the program by several different ways:

- Select the item File/Exit from the main menu and press ENTER
- Press ALT+F and then ALT+X
- Use the host environment controls for exiting the running program

When exiting the program, program will ask whether you really want to exit. If your answer is positive, it will end. In case your reply was negative, it will keep running.

2.5. Probe test

This test serves as a simple oscilloscope check. To perform the test, follow the subsequent steps:

Connect the 1:10 probe to channel A. In case you do not have the 1:10 probe available, you can connect the auxiliary generator output to the channel A input through the attenuator with approximately a 1:10 ratio.

Connect the probe tip to the Compensation Generator.

Activate testing mode by selecting Device/Test from the main menu.

After this a waveform similar to either 2.5.1.a, b or c figure should appear on the screen. If it does not, there is an error in the oscilloscope circuits or probe.

It is possible to use this test to adjust the probe precisely for the particular oscilloscope. Probe is not adjusted by the manufacturer; therefore, we recommend you to adjust it before the first use. To adjust the probe keep twisting the adjustable capacitor on the probe, until the waveform looks exactly like the 2.5.1.b. figure.

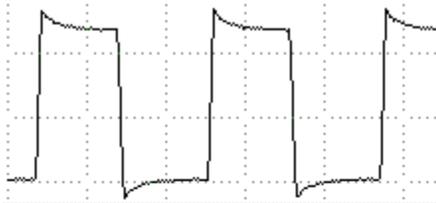


Fig. 2.5.1.a

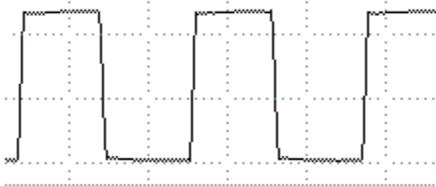
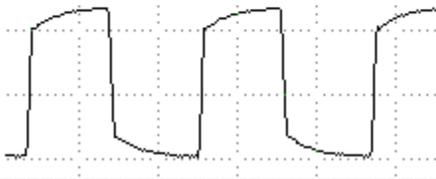


Fig. 2.5.1.b

Fig. 2.5.1.c

3. Using the oscilloscope

3.1. Front panel

All connectors are located on the EM221 card's front panel. Two BNC connectors are used to connect the A or B channel. Beneath the two BNC connectors, there are three sockets. They have the following purpose:

- GND - common potential (ground)
- ET - external trigger input
- KG - Auxiliary generator output

When using two cards as a 4-channel oscilloscope, the ET input is active only on the primary card.

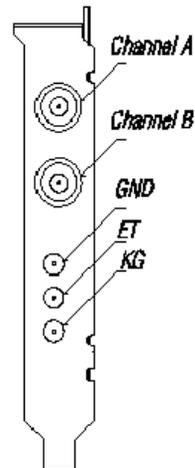


Fig. 3.3.1. Front Panel

3.2. Main window

After running the SCOPE program, the oscilloscope screen and control panel is displayed on your monitor. (See fig. 3.2.1). All common functions are easy to access on the control panel. Others can be reached through the main menu.

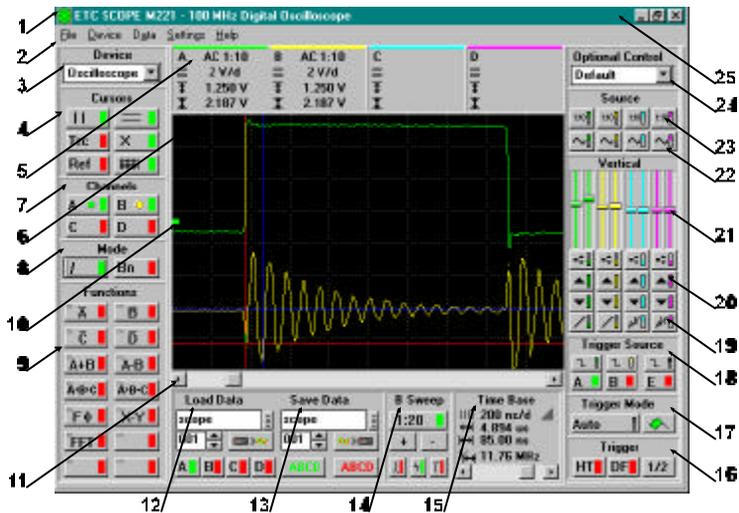


Fig 3.2.1. Main Window

Short on-screen controls description:

1. System menu
2. Main menu
3. Current device
4. Cursors and grid switches
5. Data of vertical deflection system of A, B, C, D channels
6. Oscilloscope screen
7. Active channels switches
8. Waveform display mode
9. Functions
10. Trigger level mark
11. Scroll bar for moving within the measured data array
12. Load data
13. Save Data
14. Displayed data control
15. Time base control and time base data
16. Triggering mode control
17. Trigger control
18. Trigger source switch

19. Digital shielding switch
20. Vertical range controls
21. Vertical shift controls
22. Coupling control (AC/DC)
23. Probe attenuation setting (1:1, 1:10)
24. Optional control setting
25. Title

All control elements having direct relation to any of the measuring channels are color coded. It means that they are marked by the color of the channel they are related to. For example, channel B color is yellow; therefore, all control elements related to channel B (i.e., deflection factor, synch, probe setting, coupling, etc.) are yellow.

IDEA: In case you are not satisfied with channel colors, it is possible to change them. See Main menu *Settings / Color*.



Control elements, which turn functions on and off are green when they are ON and red when they are OFF. Every single element can be controlled by either keyboard or mouse. Software was designed to be easy-to-use, keeping all MS Windows control standards. In the following text, the mouse control will be described as a main, and the keyboard one as an additional. You should understand the following terms in order to understand the rest of the text in this manual.

Click - point the mouse cursor over the component and press the left mouse button.

Double click - point the mouse cursor over the component and press the left mouse button twice quickly.

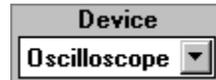
Grab - point the mouse cursor over the component you want to move and press the left mouse button (do not release). Move the mouse cursor together with the component. After releasing the mouse button, component will move to its final position.



Recommendation: To work with the SCOPE software, we recommend you to use a mouse or other pointing device. Operating the software through the keyboard seems very clumsy compared to using a mouse.

3.2.1. Setting up the active device

The SCOPE program allows the user to work with more measuring devices connected to the same computer. To choose the active device (i.e., the device you are currently working with) click on the element in upper left hand corner and the list of devices configured to work with the SCOPE software will appear. To select the desired device just simply click on it. It is possible to change the list of configured devices. See chapter 3.3.1. “Setting up the individual devices”.

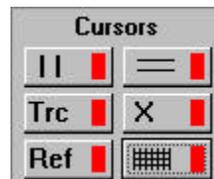


3.2.2. Oscilloscope screen

By the term “Oscilloscope screen” we understand the rectangle part in the middle of the monitor screen; trace, grid, horizontal and vertical cursors, a reference cursor and a trigger mark can be displayed there.

3.2.3. Cursors and grid

Next to the left of the oscilloscope screen, there is a group of elements, which controls the cursor and the grid display. To move the cursor around the oscilloscope screen, just simply grab it, and move it to the desired location. While moving the cursor, you will notice, the measured data of the time base and each channel changing. You can also notice that cursors have different colors; the red one has a special function (See Next Chapter)



- turns vertical cursors ON and OFF. Using the vertical cursors, it is possible to measure time or frequency

characteristics of the waveform. The measured data is displayed beneath the oscilloscope screen, where the time base is set.



- turns horizontal cursors ON and OFF. Using the horizontal cursors, it is possible to measure the voltage of the waveform. The measured values are displayed among the data of each channel above the oscilloscope screen.



- turns Track cursors mode ON and OFF. With this mode on, it is possible to move both vertical or horizontal cursors at the same time by moving the red cursor. The distance between the cursors is kept at all times.



- turns XCursors mode ON and OFF. With XCursors mode on, it is possible to move two cursors together at the same time. To do so, just grab the cursors at the place where they cross and move them. When you do not grab them at the place of intersection, they can be moved independently.



- turns reference cursor ON and OFF. It belongs to the group of horizontal cursors and is used for measuring in combination with the red cursor. Using the reference cursor we can, for example, measure voltage with respect to the ground:

1. Make the short connection of the probe to the ground.
2. Set the reference cursor to position corresponding with the zero voltage.
3. Connect the probe with the measured point. Using the red cursor, it is now possible to measure the voltage with respect to the ground.

IDEA: In case both types of cursors are turned off, and you want to turn them on in the XCursor mode, simply click on the XCursor. The SCOPE software understands, that horizontal and vertical cursors are also required to be turned on; therefore, they will be turned on automatically.





WARNING: When using 1:10 probe, do not forget to turn each channel's probe attenuation switch to 1:10. If you fail to do so, the measured data will be approximately 10 times smaller and not precise.



- turns grid ON and OFF. You can use the grid to find out the approximate characteristics of a waveform.

Grid dimensions:

Time Base: 1 division per 40 pixels; i.e. 10 divisions, 400 pixels whole screen

Vertical: 1 division per 32 pixels; i.e. 8 divisions, 256 pixels whole screen

3.2.4. Channels A, B, C, D vertical data

Above the oscilloscope screen, there are four boxes (one for each channel) containing these data:

- Channel name (the box is also marked by a colored strip in the upper part)
- Probe attenuation (i.e. 1:1 or 1:10)
- Coupling status (i.e. AC or DC)
- Voltage per division
- Voltage between red and reference cursors
- Voltage between horizontal cursors

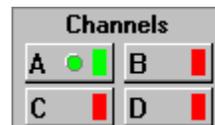
A	AC 1:10
≡	200 mV/d
⌋	118 mV
⌋	537 mV



WARNING: Channel data is displayed only when the channel is active. Measured data is displayed only when the horizontal cursors are on.

3.2.5. Turning channels on and off

Next to the left of the oscilloscope screen there are four buttons that control A, B, C and D channel. By clicking these buttons, you are able to turn each measuring channel



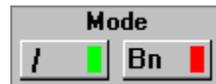
on or off.

WARNING: In case you are using just a two-channel oscilloscope (i.e. just one card or several independent cards) it is not possible to activate channels C and D. It is possible to use them to display the results of the functions.

IDEA: In case you are measuring only one channel, turn off the rest; it will speed up the performance.

3.2.6. Display mode

Next to the left of the oscilloscope screen there are two buttons for controlling the waveform display mode.



 - turns the “Interpolation mode” ON and OFF. With the interpolation mode on, the software connects the measured data into a continuous line, otherwise the waveform is displayed as an independent series of dots.

IDEA: The convenience of this mode being on or off depends on the waveform characteristics; therefore, we recommend to set the mode off first and then to turn it on. This is to assure the exclusion of errors of comprehension concerning the waveform shape.

WARNING: We do not recommend you to use the interpolation mode in sampling mode; therefore, when the oscilloscope is switched to sampling mode, interpolation is turned off automatically.

 - turns “Beam Finder mode” ON and OFF. When the BF mode is on, all measured data exceeding the range of the

oscilloscope screen is displayed on either the top or bottom of the oscilloscope screen. When this mode is off, data exceeding the range of the oscilloscope screen is not displayed.



IDEA: Before taking the actual measurement it is advisable to turn the Beam finder mode on, because the line either on top or bottom of the oscilloscope screen gives us a clue whether the actual track is located above or below the oscilloscope screen.



WARNING: The Beam finder mode may lead to some distortions on the bottom or top edge of the oscilloscope screen. When you are not quite sure about the shape of the waveform, turn the Beam finder mode off.

3.2.7. Functions

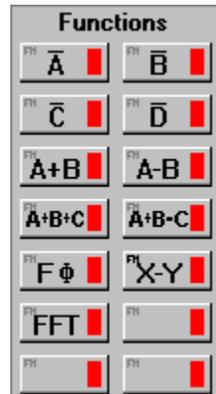
In the left hand corner of the screen there are 14 buttons. Using these buttons it is possible to execute functions that work with the measured data. More detailed description of the standard functions is in the appendix.

To execute a function follow these steps:

1. Grab the desired function
2. Move it to the channel that you have chosen to show the function results. (Moving to the channel means to release it on the desired channel's button)

In case you want to execute the function from the keyboard follow these steps:

1. Set the rectangle on the desired function and press space.
2. In the dialogue window you indicate the desired channel.



Turning the function off is possible by either clicking on channel button or clicking on the function button.

While a function is being performed on a certain channel all, control elements of the function will be colored by the channel's color.

WARNING: It is not possible to use same function on two channels at the same time.



3.2.8. Storing the data

Underneath the oscilloscope screen, there is a group of control elements that control data storage. Only waveforms displayed on the oscilloscope screen are stored into file. To enter the filename there are two input lines, one for the name (SCOPE by default) and the other one for the extension (001 by default), which combined together make a filename (SCOPE.001 by default). It is possible to change the name simply by clicking on it, and entering a new one. The extension is required to be a number from 000 to 999.



 - clicking this button pulls out a standard file-handling dialog window, and there you can pick a file where data will be stored .

 - this button starts the process of data storage. After a successful operation, the value of extension will increase by one.

WARNING: Only displayed data are stored to file, it is therefore impossible to trace stored and then loaded data.

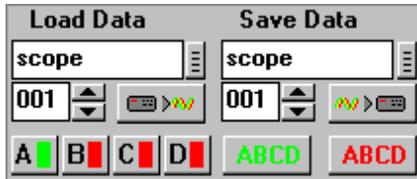


IDEA: Store data are in Windows Profile format; therefore it is possible to add your own comments by simply adding a new line in the very beginning of the file and writing “;” character followed by your comments. The number of comment lines is not limited. After this you can, for example, send this file to your colleague by E-mail.



3.2.9. Loading the data

Beneath the oscilloscope screen, there is a group of control elements, that control data loading. Entering the filename works in the same way as described in chapter 3.2.8. Storing the data. Besides the filename it is important to indicate which channels are to be displayed on the oscilloscope screen. Buttons A,B,C and D represent individual channels. The loaded channel will be displayed only if the corresponding button is on.



It is possible to load only the file which were created with the use of the function described in previous chapter. When data is read from the file, the time base and vertical parameters are set in the same way as when the file was created. The color of the loaded data is easy to adjust from the menu. They are gray by default. Loaded waveforms will stay on the screen until the time base or vertical parameters are changed.



IDEA: In case that loaded data has the same color. To identify which track belongs to which channel, simply turn the channel off and then back on.



IDEA: It is possible to display loaded data either in interpolated or dot-only mode (See chapter 3.2.6.). Switching between these two modes does not cause them to disappear.

3.2.10. Controlling the data display length

Beneath the oscilloscope screen there is a group of elements controlling the data display length. There are 8000 samples measured and stored into memory for each channel. Oscilloscope screen, however, can display a maximum of 400 samples, it is therefore very important to indicate which samples are



to be displayed on the oscilloscope screen. Default setting is 400 samples from 8000. This is indicated in the upper part of the B Sweep window by 1:20 label, because just 1/20 of stored samples is displayed. By clicking the “+” or “-” buttons it is possible to change the display ratio from 1:2 to 1:20 (See tab. 3.2.10)

ratio	displayed data length	one pixel on screen represents x measured samples
1:20	400	1
1:10	800	2
1:4	2000	5
1:2	4000	10
1:1	8000	20

Table 3.2.10.

When the ratio button is off, data is displayed in a 1:1 ratio, otherwise the display ratio is equal to the ratio indicated on the button. The SCOPE software allows the user to choose one of the three modes of transformation x samples into one pixel. To choose the transformation mode simply click on one of the three transformation buttons.



Maximum: from x measured samples the computer displays the maximal one



Average: the computer computes the average value and displays it on screen



Minimum: from x measured samples the computer displays the minimal one

The standard setting of these control elements is Average. The Average mode has a special feature of smoothing out the waveform; therefore it does not display any glitches. If you are looking for any imperfections switch the transformation mode to Minimum or Maximum.



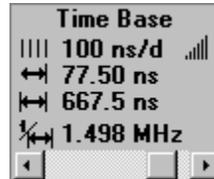
IDEA: When the ratio selected is other than 1:1, the user is able to scan through all 8000 samples. See next chapter.

3.2.11. Scanning through samples

A scroll bar is located right under the  oscilloscope screen. Using this scroll bar the user is able to scan through the samples. The very left position corresponds to data displayed from the very beginning of the whole array of 8000 samples. The very right position corresponds to the end of the 8000 samples array. When using 1:1 ratio any scroll bar movement causes two grid colored cursors to appear. The area between these two cursors will be zoomed to the whole oscilloscope screen when switched to the B sweep.

3.2.12. Controlling the time base and time base data

To control the time base there is a scroll bar located in the lower part of the time base window. Above this scroll bar there are values representing time base settings. To set the time base simply grab the scroll bar and move it either left or right. Moving it left causes the time base to lengthen (i.e. allows measuring slower events). Moving the scroll bar right causes the time base to shorten (i.e. allows measuring faster events). By clicking on the arrows on the sides of the scroll bar we can change the time base in steps. The current time base is displayed above the scroll bar in seconds per division.



 100 ns/d 



- this mark is displayed only when the oscilloscope works in sampling mode.

Besides the values corresponding directly to the time base setting, the software also displays the following data measured with the use of vertical cursors (only if they are on):

 **77.50 ns** - time from beginning of displayed data to red vertical cursor

 **667.5 ns** - value represents time between vertical cursors

 **1.498 MHz** - value representing frequency in hertz between vertical cursors

A list of time base ranges is in Appendix D

WARNING: The time base and other values in this window change with the changing display ratio. It is because time is in time units per division, and when the ratio changes, the amount of samples per division changes too.

IDEA: If you want to know the sampling frequency, simply move the vertical cursors together, that there is no space between them. The frequency between these two cursors is the sampling frequency.



3.2.13. Triggering mode controls

Next to the right of the oscilloscope screen there are two control elements. Using these two elements it is possible to control the triggering mode and start this mode (right, flag marked button). By clicking on the left button it is possible to set following modes:



- Measurement is repeatedly triggered. If the trigger does not occur until half the time required to fill the whole buffer, the sweep free-runs without the trigger signal; otherwise it is triggered by trigger. This mode is recommended when you are trying to display an unknown waveform. When you click on the start button (flag marked button), the software will try to get the signal on the screen using the vertical

shifting and voltage range switching. While the program is performing this action, flag button turns to red color.



- Measurement is repeatedly triggered. It produces a sweep only when the trigger signal meets the level and slope criteria. The start (flag marked button) does not have any function in this mode.



- Single measurement. Starts by clicking on the start button (flag marked button). The sweep runs after trigger signal occurred. While waiting for trigger signal flag button color changes to red. It is possible to repeat the measurement by clicking on start button (flag marked button).



- Single measurement. It starts by clicking on the start button (flag marked button). The sweep runs immediately, it does not wait for the trigger signal. It is possible to repeat the measurement by clicking on the start button (flag marked button).

3.2.14. Trigger controls

Next to the right of the oscilloscope screen there is a group of six control elements. Using these elements, the user is able to set up the trigger conditions. It is possible to set the trigger source on channel A, B or external input using the lower row of buttons (A, B or E button). The upper button row indicates whether the oscilloscope triggers on the leading or the trailing edge. Clicking them switches the function to opposite state.



- triggers on leading edge



- triggers on trailing edge



WARNING: When the trigger source is either channel A or channel B, it is also important to adjust the trigger level.

3.2.15. Controlling the Digital Shielding

Next to the right of the oscilloscope screen there are four control elements corresponding to individual channels A, B, C or D. Using them, the user is able to turn the Digital shielding on or off.



- switch turned on



- switch turned off

When the Digital shielding is on, the oscilloscope tries to separate the repetitive waveform from the noise (See chapter 1.1.1.). To turn Digital shielding on is advisable only for a well synchronized waveform.

IDEA: It is possible to change the Digital shielding level. See chapter 3.3.5. Setting other parameters.



3.2.16. Setting the range

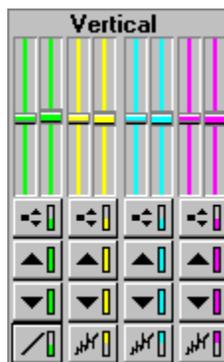
Next to the right of the oscilloscope screen there are eight control elements. Their function is to control the setting of the oscilloscope voltage range. There are two buttons for each channel. By clicking them, you can either increase or decrease the voltage range.



- increase the voltage range



- decrease the voltage range



The value of the voltage range is displayed for each channel individually in the channel parameter box above the

oscilloscope screen. For the M221 it is possible to set the following ranges:

voltage per division	voltage per whole screen
50 mV / div	400 mV / scr
100 mV / div	800 mV / scr
200 mV / div	1.6 V / scr
500 mV / div	4 V / scr
1 V / div	8 V / scr
2 V / div	16 V / scr

Tab. 3.2.16.1. Ranges for 1:1 probe

voltage per division	voltage per whole screen
500 mV / div	4 V / scr
1 V / div	8 V / scr
2 V / div	16 V / scr
5 V / div	40 V / scr
10 V / div	80 V / scr
20 V / div	160 V / scr

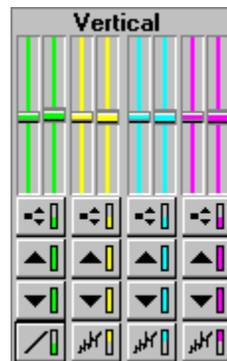
Tab. 3.2.16.1. Ranges for 1:10 probe



IDEA: Before you change the range we recommend you to set the triggering mode to Auto. Thus, the waveform does not disappear from the screen.

3.2.17. Controlling the vertical shift

To control the vertical shift there are eight scroll bars (two for each channel) located next to the right of the oscilloscope screen. The purpose of the right scroll bar is to make an approximate shift. However, the left one helps to make a fine shift. To control these scroll bars simply grab one and move it to the desired location. If you wish to move



the scroll bar only one step up or down simply click on the upper or lower edge.

Under the scroll bars there is a button, which controls the vertical shifting mode.



- when attempting to make a vertical shift using the approximate scroll bar, the fine scroll bar will be centered



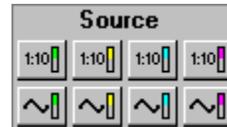
- changing the location of the approximate scroll bar does not influence the fine scroll bar.

IDEA: To find and get the measured waveform on the oscilloscope screen quickly, set triggering mode to Auto and click on Start (flag marked button) (see 3.2.13).



3.2.18. Setting the coupling

Next to the right side of the oscilloscope screen there is a group of four control elements. Using them, the user is able to switch the coupling either on AC or DC.



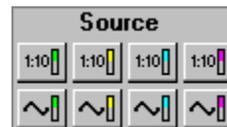
- DC coupling



- AC coupling

3.2.19. Setting the probe attenuation

Using the four buttons located next to the right of the oscilloscope screen, the user is able to set the each channel's probe attenuation (1:1 or 1:10). When you switch the probe, always switch the corresponding button by clicking on it.

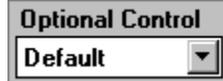


WARNING: When the probe attenuation switch does not correspond to the actual probe setting, the measured values are not accurate.



3.2.20 Setting up the optional control

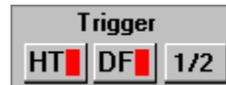
This control element is reserved for future use with other ETC Measuring Lab line devices.



3.2.21. Trigger level mark

After setting the trigger source on channel A or B, the trigger level mark in the same color as the channel appears on the left hand edge of the oscilloscope screen. The mark location represents the level. To set a different level, simply grab the level mark and move it to the desired location.

In the lower right corner of screen there is a button labeled "1/2". After clicking on this button the trigger level mark moves to the location representing the waveform average.



3.2.22. Digital filter

The button labeled DF (digital filter) controls the digital filter activity (ON/OFF). The digital filter stands in the way of all synchro signals. It is a low pass filter, which automatically changes its frequency and therefore it adjusts itself to the measured waveform.

WARNING: When the oscilloscope works in the sampling mode, the digital filter is turned off automatically, and it is not possible to turn it back on until in sampling mode.



TIP: Probe exposure to the electromagnetic field of the high frequency and intensity can cause a measured waveform distortions and/or synch problems. When you change the grounding point of the probe, it will solve the problem partially.

3.2.23. Sweep before trigger mode

In the lower right corner of screen there is a button labeled HT. This element controls the turning of the "Sweep before trigger mode" to either on or off. If this mode is on, the oscilloscope collects 7872 samples before and 128 after the trigger.



WARNING: In case the trigger signal comes too soon, the number of samples could be smaller.

WARNING: In Sweep before trigger mode, the oscilloscope is not able to work in sampling mode; therefore the sampling speed is limited to be less or equal to 20 MS / s.

3.3. Main menu

The menu bar allows the user to access all menu commands. To pick an individual menu item using the mouse, simply click on it. When using the keyboard you can access individual items using a combination of ALT and the underlined letter. It is possible to use arrow keys within the menu. If the item is followed by three dots (...), it causes the dialog window to open. If the item is followed by a right arrow (>), it opens another submenu.

WARNING: When using the menu, measurement stops. It comes back on after exiting the menu.

3.3.1. Setting parameters of individual devices

To set parameters such as base address and user code (MUC) simply pick *Device / Setup* from the main menu. It opens a dialogue window in which the user is able to change the device parameters.

To add a new device, pick *Device | Add device* from the main menu. It opens the same dialog window. The user is expected to state the device name, type, version, base address, user's code and number of channels (for 4-channel oscilloscope see chapter 2.3.1.). In

case you want to use the 4-channel oscilloscope, it is important to input the other device's MUC. Channels A and B will be represented by the primary device and channel C and D by the secondary one. After confirmation, it will be possible to pick the device in the upper left corner of the screen.

Name - device's user given name (can be anything). This name will represent the relevant measuring device in the list of measuring devices.

Type - when using the SCOPE software, always enter "Oscilloscope".

Version - when using the SCOPE software, always enter "EM221".

Base address - address corresponding to the jumpers installed on EM221 card.

User's code - code (MUC) corresponding to jumpers installed on EM221 card.

Picking the item *Device | Remove* from main menu opens the dialog window, in which the user can select the device to be removed.

3.3.2. Automatic detection of measuring devices

The SCOPE software includes the built-in possibility of detecting all ETC Measuring Lab line devices. After clicking on the *Device | Autodetect* item in the main menu, a dialog window opens. It is important to indicate all the addresses where you want the software to attempt the detection of devices. After clicking on the *Detect* button, the list of detected devices will be displayed.



WARNING: In case you attempt detection of a device on address which is already used by some other device not manufactured by ETC, the computer can "freeze". When this happen try to reinstall measuring devices on a different address.



WARNING: The fact, that a device is not found even on the address where it is installed can be caused by having some other device from some other manufacturer occupying the same address.

3.3.3. Device testing

Item *Device | Test*, what can be pulled out from the main menu, is used to test the measuring device. After selecting this item, the dialogue window containing all instructions will appear.

3.3.4. Printing the measurement report

To print out the measurement report simply click on the *File | Print* item in the main menu. It opens a standard dialog window, in which you can choose a printer. After selecting the desired printer, the software prints out the report.

In case you want to set up the printer before printing, just click on *File | Printer* setup item in the main menu.

3.3.5. Setting up some of the features

The SCOPE software allows you to store and restore the configuration of all control elements. Configuration is stored into a file, which is indicated by the user. Such a file has the default extension INI. There is also the SCOPE.INI file, in which the software stores the configuration of control elements when exiting the program. This data is used to set up the device when the program is restarted. For storing and loading the configuration data use the *Settings | Save* item or *Settings | Load* item from the main menu. Besides these two items, there is a *Setting | Load defaults* item. Using this item all control elements will be set to their default state.

In case you are not comfortable with the preset colors of channels, cursors and some other elements, it is possible to change them by clicking on the *Settings | Colors* item from the main menu. In the dialogue window which appears after choosing this item, the program displays control elements and their colors. To change the color, click on Set color button, and pick the color in the dialog window, that follows it.

WARNING: After changing the color of channels A, B, C or D, all elements related to certain channel in any way will change their color too.



After clicking on the *Settings | Shielding* item in the main menu, a dialog window, allowing user to set the digital shielding level, appears on the screen. It is possible to set shielding level to values: 2, 4, 8, 16, 32 or 64. The default value is 4.



IDEA: We recommend you to use higher levels of Digital shielding for well synchronized signals only.

The last item in the *Settings* submenu is *Commix*. If there is a “✓” in front of the word *Commix*, it means, that this option is on. With *Commix* help on, when you point the mouse cursor over any element, after a short period of time a brief help text is displayed.



IDEA: For the user, who has already mastered the oscilloscope, it would be better to turn the *Commix* help off, so as not to be disturbed from the measurement.

3.4. Exporting data

In case you need to transfer the measured data to other software for further processing, use the function *Export*. This function was designed to allow user exporting data to any Windows oriented software. This is why it uses a clipboard. As an example we will describe exporting data to MS Excel. Using the controls for storing and restoring, choose which data to export. Click on the *Export* item in the main menu, and the program will store the selected data to the clipboard. Now you have to run the destination application, which in this case is MS Excel, and select *Paste* from the main menu, which makes data to form a table of up to 4 columns (1 column per channel). Following the same steps, it is possible to copy data into any program that works under the MS Windows and allows working with clipboard..

3.5. Help

When you are struck by a problem while working with the SCOPE software, you can find help either in the User's guide or in the SCOPE software by selecting the Help item in the main menu. The help option in the SCOPE software is written with respect to the standards of MS Windows environment. You can find more thorough information concerning Help and its use in the MS Windows User's guide.

4. Hardware

The block scheme of the EM221 ISA bus add-on card is on the fig. 4.1. The EM221 card consists of analog and digital part.

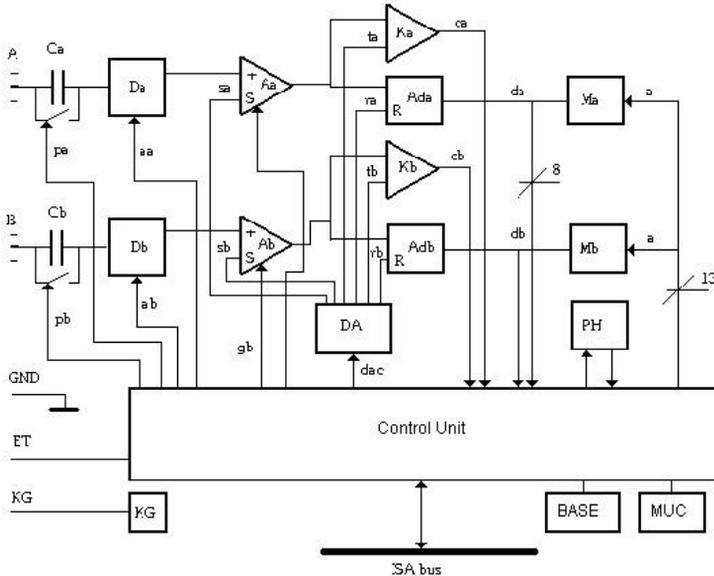


Fig. 4.1. EM221 Block scheme

Through the standard connector (BNC) and capacitor (Ca or Cb), which can be shorted by digital signal (pb), the measured signal is connected to the digitally controlled attenuator (Da or Db). Digital signals aa, (ab) control the input attenuator ratio (1:1 or 1:10). Attenuator output is connected to the input of amplifier with adjustable offset and gain. It is possible to adjust amplifier vertical offset (track vertical location) using the analog signals sa (sb). Amplifiers' outputs are connected to the fast A-D converters Ada (Adb) inputs, which provide digitization of the measured waveform. It is also connected to comparator inputs, that generate the trigger

signals. Comparator threshold voltages can be controlled by ta (tb) signals. The waveform's digitized pattern is stored into Ma (Mb) memory.

The device's control unit, which communicates with the computer's bus, is equipped with sufficient logic and registers to generate the control signals pa (pb), aa (ab), which we have already described. It also generates a ga (gb) signal, which change the input amplifier's gain ratio to 1:2. From the digital information, the DA converters connected to the control unit make the control analog signals. To adjust the comparators' threshold voltage, ta (tb) signal is used. By using the sa (sb) signals, you can control the track's vertical shift.

The External trigger (ET) signal and sampling pulse phase measurement circuits are connected directly to the control unit.

The auxiliary generator is a free running generator with no possibility of any control.

5. Performance characteristics

The following characteristics are valid for temperature between 5°C and 35°C and relative humidity of less than 70 percent.

5.1. Vertical deflection system

Deflection factor Range	50 mV/division to 2 V/division in 1-2-5 sequence
Accuracy	± 2.5 % of whole screen range
Resolution	8 bits (0.4%)
Frequency response in ± 3dB band	DC coupling - 0 Hz - 100 MHz AC coupling - 1.2 Hz - 100 MHz
Step response rise time	± 3.5 ns
Channel isolation	min -40 dB for 0 Hz to 50 MHz min -23 dB above 50 MHz
Input resistance	1 M Ω - 5 % +15 %
Input resistance inaccuracy adjustment	Digital for absolute measurement accuracy ± 3 % + probe inaccuracy
Input capacity	22 pF ± 3 pF
Maximum input voltage	100 V (dc + peak ac)

5.2. Triggering

Trigger source	Channel A, Channel B and External
Threshold setting	Channel A and Channel B on the whole display range, External fixed about 1.2 V
Maximum External input voltage	40 V (dc + peak ac)
Minimum trigger	10 ns

pulse length	
Minimum trigger pulse period	50 ns

5.3. Horizontal Deflection System

Sweep time base range	2 s/division to 20 s/division in a 1-2-4 sequence of 25 steps
Sweep accuracy	± 0.25 % of whole displayed range for 2 s/division to 200 ns/division ± 2 % of whole displayed range for 200 ns/division to 20 ns/division
Sampling frequency range	real time 400 Hz to 20 Mhz repetitive 400 Hz to 2 Ghz
Sampling jitter	2 ns ± 1 sample
Record length	max. 8000 samples per channel

5.4. Auxiliary generator

Output resistance	1 k Ω
Output waveform	Rectangle with 1:1 ratio
Output waveform period	approx. 850 ms
Output voltage	approx. 22 Vpp

Appendix A : Hardware requirements

Minimum:

- PC386 compatible computer
- 4 MB RAM
- 3.5" FDD
- hard disk
- mouse or other pointing device

Recommended:

- PC486/100 Mhz or more
- 8 MB RAM or more
- rest the same as minimum

Appendix B: Host environments

Host environment	Compatible versions
Microsoft Windows 3.1	Microsoft Windows 3.11 Microsoft Windows For Workgroups Microsoft Windows 95
Microsoft Windows 95	N/A
Win - OS/2	OS/2 2.X Full Pack OS/2 Warp Full Pack OS/2 Warp Connect Full Pack

Full Pack means OS/2 version which include WIN-OS/2

Appendix C: m221fnc.dll library standard functions

1. Channel A inversion
2. Channel B inversion

3. Channel C inversion*
4. Channel D inversion*
5. Sum of channels A and B
6. Channel A and B difference
7. Sum of channels A, B and C*
8. Sum of channels A and B minus channel C*
9. Average
10. X-Y display (channel A = X, channel B = Y)
11. Fast Fourier Transformation (FFT)

* only for 4-channel oscilloscope

Appendix D: Fast Fourier transformation

This function allows user to display the measured signal frequency spectrum.

To display the frequency spectrum follow this:

1. Highlight one period of the measured signal using the vertical cursors.
2. Execute the function on any of the available channels.
3. On the right side of the screen the window appears. It contains the channel A frequency spectrum. The first column displays numebrs of harmonics. Second one dispalys the frequency, and the third one shows amplitude of specific frequency.

In case you are unable to highlight period using the cursors, you can change the range by simply entering the numbers. Using the four control elements labeled as A, B, C and D you are able to select the channel for which the FFT will be calculated.

Frequency spectrum of selected channel is displayed on the oscilloscope screen. Graph is displayed in the area between the cursors, where:

- x axis - frequency (right - highest, left - lowest)
- y axis - frequency spectrum amplitudes

Appendix E: Time base ranges

	mode	t/div400 samples	t/div8000 samples	measure-ment period	samplin g period	samplin g frequenc y
1	R	20 ns/d	400 ns/d	400 μ s	500 ps	2 GHz
2	R	40 ns/d	800 ns/d	400 μ s	1 ns	1 GHz
3	R	100 ns/d	2 μ s/d	400 μ s	2.5 ns	400 MHz
4	R	200 ns/d	4 μ s/d	400 μ s	5 ns	200 MHz
5	R	400 ns/d	8 μ s/d	400 μ s	10 ns	100 MHz
6	R	1 μ s/d	20 μ s/d	400 μ s	25 ns	40 MHz
7	N	2 μ s/d	40 μ s/d	400 μ s	50 ns	20 MHz
8	N	4 μ s/d	80 μ s/d	800 μ s	100 ns	10 MHz
9	N	10 μ s/d	200 μ s/d	2 ms	250 ns	4 MHz
10	N	20 μ s/d	400 μ s/d	4 ms	500 ns	2 MHz
11	N	40 μ s/d	800 μ s/d	8 ms	1 μ s	1 MHz
12	N	100 μ s/d	2 ms/d	20 ms	2.5 μ s	400 kHz
13	N	200 μ s/d	4 ms/d	40 ms	5 μ s	200 kHz
14	N	400 μ s/d	8 ms/d	80 ms	10 μ s	100 kHz
15	N	1 ms/d	20 ms/d	200 ms	25 μ s	40 kHz
16	N	2 ms/d	40 ms/d	400 ms	50 μ s	20 kHz
17	N	4 ms/d	80 ms/d	800 ms	100 μ s	10 kHz
18	N	10 ms/d	200 ms/d	2 s	250 μ s	4 kHz
19	N	20 ms/d	400 ms/d	4 s	500 μ s	2 kHz
20	N	40 ms/d	800 ms/d	8 s	1 ms	1 kHz
21	N	100 ms/d	2 s/d	20 s	2.5 ms	400 Hz

Mode: N - Real time sampling

R - repetitive sampling (only for periodic waveforms)

INDEX

4

4-channel oscilloscope.....12

A

Autodetect36
 auxiliary generator.....16, 41, 43
 output17

B

Base address.....9
 Change10, 36

C

calibration data8
 clipboard38
 color37
 commix38
 connectors17
 converter
 AD.....9, 40
 AD - resolution42
 DA41
 coupling.....33
 cursor.....20

setting20
 track.....21

D

data
 display26
 export38
 load.....26
 store25
 demo6, 15
 digital filter.....34
 digital shielding9
 control.....31
 level.....38
 display mode23
 dynamic address space
 allocation9

E

EM221 setup10

F

functions
 control.....24
 description44

G

grid	20
control.....	22

I

input attenuator	40
input impedance.....	8
installation	10
4-channel oscilloscope	12
device	12
software	13

J

jumpers	10
---------------	----

M

menu	
main	35
system.....	18
MUC	10
setting	11, 35

O

oscilloscope screen	18, 20
---------------------------	--------

P

probe	
adjusting	15
attenuation.....	33
range	31
test	15

R

range	8, 42
setting.....	31
time base	46
record length.....	9
report	37
resolution	8, 42

S

software	6, 15
----------------	-------

T

time base.....	28
grid	22
track	
color.....	19
display mode	23
vertical shift	8, 32, 41
trigger.....	42
controls	30
external input	17
level.....	34
mode	29

signal	40	sweep before	35
--------------	----	--------------------	----