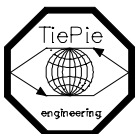User manual

Handyprobe HP2

a multifunctional
PC measuring instrument

TiePie engineering

ATTENTION!

Measuring directly on the LINE VOLTAGE can be very dangerous. The crocodile clip of the Handyprobe HP2 is connected with the GROUND of the computer.

Use a good isolation transformer or a differential probe when measuring at the LINE VOLTAGE or at GROUNDED POWER SUPPLIES!

In case this has not been considered and the GROUND of the Handyprobe HP2 is connected to any voltage other than ground level, a short-circuit current will be flowing. Because of this short-circuit current both the Handyprobe HP2 and the computer can be damaged.
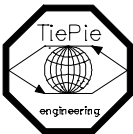
User manual

Handyprobe HP2

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Contents

Contents

Safety

Before you start working with the Handyprobe HP2, first read these safety rules.

C   Avoid working **alone**.
C   Take care when measuring at voltages higher than 25V AC or 60 V DC.
C   Measuring directly on the LINE VOLTAGE can be very dangerous. The crocodile clip of the Handyprobe HP2 is connected with the GROUND of the computer.
        Use a good isolation transformer or a differential probe when measuring at the LINE VOLTAGE or at GROUNDED POWER SUPPLIES!
        In case this has not been considered and the GROUND of the Handyprobe HP2 is connected to a voltage other than ground level, a short-circuit current will be flowing. Because of this short-circuit current both the Handyprobe HP2 and the computer can be damaged.
C   Do not connect the Handyprobe HP2 to other ports at your PC than the Centronics parallel printer port. Connecting the Handyprobe HP2 to any other port may damage your Handyprpbe HP2.

Declaration of confirmity

TiePie engineering
Kopeslagersstraat 37
8601 WL Sneek
Nederland

EG-verklaring van overeenstemming

Wij verklaren geheel onder eigen verantwoordelijkheid, dat het produkt

Handyprobe HP2

waarop deze verklaring betrekking heeft, in overeenstemming is met de geharmoniseerde Europese normen

EN55011, EN55022, EN50081-1 en EN50082-1

Volgens de bepalingen van de EMC-richtlijn 89/336/EEG, gewijzigd door de richtlijn 92/31/EEG en 93/68/EEG

Sneek, 1-9-1999   ir. A.P.W.M. Poelsma

TiePie engineering
Kopeslagersstraat 37
8601 WL Sneek
The Netherlands

EC declaration of Confirmity

We declare, on our own responsibility, that the product

Handyprobe HP2

for which this declaration is valid, is in compliance with

EN55011, EN55022, EN50081-1 and EN50082-1

according the conditions of the EMC standard 89/336/EEG, and the amendments 92/31/EEC and 93/68/EEC

Sneek, 1-9-1999   ir. A.P.W.M. Poelsma

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Kopeslagersstraat 37
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The Netherlands

EG - Konformitätserklärung

Wir erklären, in Eigenverantwortlichkeit, hiermit, daß das Produkt

Handyprobe HP2

für das diese Erklärung gültig ist, mit

EN55011, EN55022, EN50081-1 und EN50082-1,

gemäß den Anforderungen des EMC-standards 89/336/EEC, und den Zusatzbestimmungen 92/31/EEC und 93/68/EEC übereinstimmt.

Sneek, 1-9-1999   ir. A.P.W.M. Poelsma

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The Netherlands

Déclaration de conformité C.E.

Nous déclarons, sous notre responsabilité, que le produit

Handyprobe HP2

pour lequel cette déclaration est valide, est conforme aux:

EN55011, EN55022, EN50081-1 et EN50082-1

selon les conditions du standard CEM N° 89/336/EEC, et les amendements 92/31/EEC et 93/68/EEC

Sneek, 1-9-1999   ir. A.P.W.M. Poelsma

Chapter 1
Introduction

Many technicians investigate electrical signals. Though the measurement may not be electrical, the physical variable is often converted to an electrical signal, with a special transducer. Common transducers are accelerometers, pressure probes, current clamps and temperature probes. The advantages of converting the physical parameters to electrical signals are large, since several instruments for examining electrical signals are available.

The Handyprobe HP2 is a one channel, 8 bits, 1 - 20 Msamples/sec measuring instrument. With the acompanying software the Handyprobe HP2 can be used as an oscilloscope, a storage oscilloscope, a spectrum analyzer, a true RMS voltmeter or a transient recorder. All instruments measure by sampling the input signals, digitizing the values, process them, save them and display them.

Sampling

When sampling the input signal, samples are taken at certain moments. The frequency at which the samples are taken is called the sampling frequency. By taking a (large) number of samples, the input signal can be reconstructed.
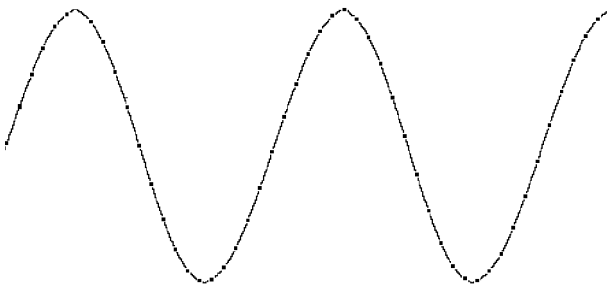
In the latter illustration a sine wave signal is sampled with 50 samples. By connecting the adjacent samples, the original signal can be reconstructed. See also the next illustration.
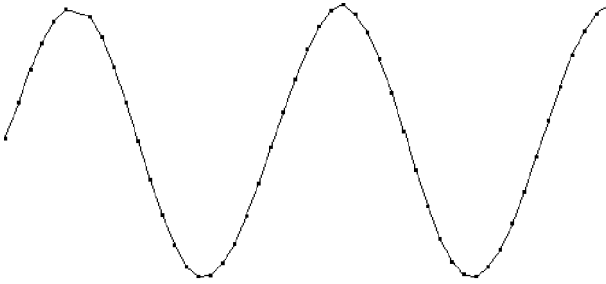
The more samples are taken, the better the signal can be reconstructed. The sampling frequency must be higher than 2 times the highest frequency in the input signal. This is called the Nyquist frequency. Theoretically it is possible to reconstruct the input signal with more than 2 samples. In practice, 10 to 20 samples are necessary to be able to examine the signal thoroughly.

Aliasing

If the sampling frequency is lower than 2 times the frequency of the input signal, 'aliasing' will occur. The following illustration shows how aliasing occurs.
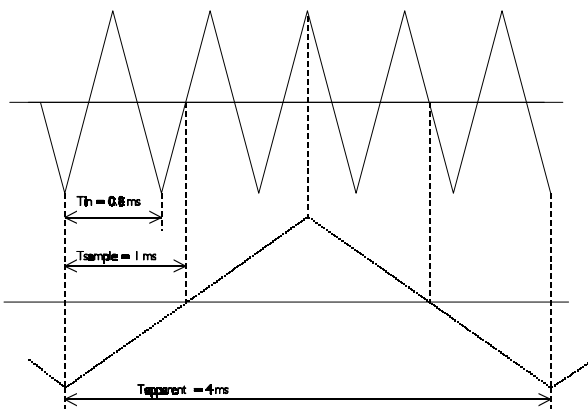
The input signal is a triangular signal with a frequency of 1.25 kHz (upper

most in the illustration). The signal is sampled at a frequency of 1 kHz. The dotted signal is the result of the reconstruction. From that triangular signal the periodical time is 4 ms, which corresponds with an apparent frequency (alias) of 250 Hz (1.25 kHz - 1 kHz).

To avoid aliasing, the sample frequency must be higher than 2 times the maximum frequency of the input signal.

Aliasing is not always visible on an oscilloscope. In the latter illustration, it gives a 'good looking' picture. It is not apparent that aliasing occurs. The next illustration gives an example of visible aliasing.
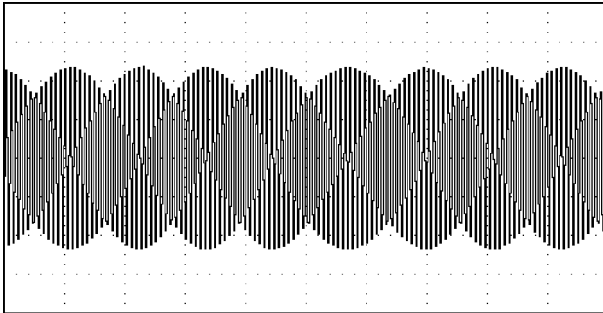
This time it is a sine wave signal with a frequency of 25.7 kHz, which is sampled at a frequency of 5 kHz. The minimal sampling frequency should have been 51.4 kHz. For proper analysis, the sampling frequency should have been 500 kHz.

Digitizing

After taking a sample of the input signal, it is digitised. This is done with an Analog to Digital Convertor, ADC. The ADC converts the size of the signal to a digital number. This is called quantifying.

The first condition for accurate measurement is to have as many as possible quantifying steps. This can be realised by using an ADC with a resolution as high as possible.

The resolution of ADC's is often given in bits. The number of bits determines the number of quantifying steps according the formula:

$$\text{number of quantifying steps} = 2^{\text{ number of bits}}$$

A 2 bits ADC has 4 quantifying steps. With an input range of 10 Volt, this ADC can divide the input range in 4 parts of each 2.5 Volt.

By increasing the number of bits, the resolution increases, the number of quatifying steps increases and the sub-divisions get smaller.

The oscilloscope

The oscilloscope is an instrument with which electrical voltages varying in time can be displayed. With the oscilloscope time dependent electrical signals can be examined easily.

The Handyprobe HP2 is equipped with two types of oscilloscopes, LIVE and HOLD. The oscilloscope LIVE measures 1000 samples, 2 page. The oscilloscope HOLD measures 15000 samples, 30 pages.

The sensitivity range for the channel goes from 125 mV/div to 100 V/div. The timebase goes from 2.5 **F**sec/div to 10 sec/div.

The display of the oscilloscope is built of 500 x 256 (wxh) pixels, which corresponds with 10x8 (wxh) divisions. Left of the display the units of the channel is displayed. Under the display, the time axis is displayed.

The spectrum analyzer

The common way to examine electrical signals is in the time domain, using an oscilloscope. The time domain is used to determine amplitude, time and phase information, which is necessary to describe the behaviour of an electrical system.

Not all electrical systems can be characterised in the time domain. Circuits like filters, amplifiers, oscillators, mixers, modulators and detectors can be characterised best by their frequency behaviour. That frequency behaviour is best obtained by observing the electrical signals in the frequency domain. To display the frequency domain, an instrument is needed that can distinguish different frequencies from each other and measure the signal size at the different frequencies. An instrument that can display the frequency

domain is the spectrum analyzer. It graphically displays voltage as a function of frequency.

In the time domain all frequency components of a signal are seen summed together. In the frequency domain, complex signals (signals composed of more than one frequency) are separated in their frequency components, where the voltage of each frequency component is displayed.

The frequency domain contains information which is not available in the time domain. Therefore the spectrum analyzer has certain advantages compared with an oscilloscope.

C   With a spectrum analyzer small harmonic distortions on a signal can be displayed better than on an oscilloscope. A sine wave may look good in the time domain, however in the frequency domain the harmonic distortion is visible.
C   A noise signal may look fully random in the time domain, in the frequency domain it can appear that one frequency is dominantly present.
C   In the frequency domain it is very simple to determine carrier frequency, modulation frequency, modulation level and modulation distortion from a modulated signal (AM or FM).

The Handyprobe HP2 is equipped with a spectrum analyzer. The spectrum analyzer takes 1024 samples, of which a spectrum of 512 spectral components is calculated by means of FFT.

The sensitivity of the channel can be set from 125 mV/div to 100 V/div. The frequency range of the spectrum analyzer goes from 0.025 Hz to 10 MHz.

The display of the spectrum analyzer is built of 500 x 256 (wxh) pixels, which corresponds with 10x8 (wxh) divisions. Left of the display the units of the channel are displayed. Under the display, the frequency axis is displayed.

The voltmeter

If from the input signals only the size is important and not time information or frequency components, the voltmeter is a suitable instrument to mea-

sure with. The voltmeter measures the size of the input signal and displays the values using a large 7 segment display.

The voltmeter can measure the input signal in several ways:

TRUE RMS   the true RMS value is measured
PEAK PEAK   the peak peak value is measured
MEAN   the mean value is measured
MAX   the maximum value is measured
MIN   the minimum value is measured
dBm   the value is given in decibel
POWER   the power of the input signal is determined
CREST   the crest factor is calculated
FREQ.   the frequency of the input signal is measured

The input of the voltmeter is autoranging or manually settable between 500 mV full scale and 400 V full scale.

Besides this, the voltmeter has the possibility to measure at certain times and send the data to a printer or write it on disk.

The transient recorder

For measuring slowly changing signals (e.g. the temperature change in a room) the transient recorder is the most suitable instrument.

The two channel transient recorder measures the input signals at adjustable times. The time between two measurements is adjustable from 0.01 second to 300 seconds. The number of samples is also adjustable from 1 to 30000. The maximum measuring time is 300 sec x 30000 samples = 9000000 seconds (104.16 days).

The sensitivity is adjustable between 25 mV/div and 100 V/div.

The display of the transient recorder is built of 500 x 256 (wxh) pixels, which corresponds with 10x8 (wxh) divisions. Left of the display the units of the channel are displayed. Under the display, the time axis is displayed. In addition, the value, time and date of the samples are given.

The transient recorder measures in one of the following ways:

MOMENTAL   the momentary value of the input signal is measured
TRUE RMS   the true RMS value of the input signal is measured
MEAN   the mean value of the input signal is measured
MAX   the maximum value of the input signal is measured
MIN   the minimum value of the input signal is measured

Chapter 2
Hardware installation

The Handyprobe HP2 is an external measuring instrument which can be connected to a PC.

The Handyprobe HP2 is connected to the parallel printer port of the PC using the attached cable.

Note Do not connect the Handyprobe HP2 to any other port at the PC than the Centronics parallel port. Connecting to other ports may damage your Handyprobe HP2

The Handyprobe HP2 does not need an external power supply, but is powered by the computer.

Note Switch, to avoid damage at the Handyprobe HP2 or the computer, before connecting the cable the computer off.

If your computer is equipped with one parallel printer port, a conflict may arise when printing waveforms. The Handyprobe HP2 has to be disconnected from the PC and the printer be connected to the PC. Then the print job can be finished. After that the printer has to be disconnected and the Handyprobe HP2 has to be connected to the PC again.

Note Place, to avoid much switching between printer and Handyprobe HP2, an extra printer port in your PC.

Chapter 3
Software

Installation of the software

The software of the Handyprobe HP2 is shipped on one diskette.

First you have to make a backup of the original diskette. Refer to your DOS manual for making a backup of a diskette. When you have made the backup, store the original diskette in a safe place and use the backup.

The software is shipped ready to use, without installation program. You can run the software direct from the diskette or from a hard disk.

Hint A hard disk is much faster than a diskette and has usually more free space available to store data.

To install the software on a hard disk, first make a directory for the software. Then copy all files from the diskette to the directory. The files are:

HP2.EXE	the program
HP2_ENG.HLP	the English help file
HP2_ENG.INF	information for the help file
HP2.FNT	font file for printing output
HP2.DEF	file with program settings
dpmi16.ovl	Dos protected mode driver
rtm.exe	protected mode run time manager

An example, where the diskette is in drive A: and the software has to be installed in a directory called HP2 on the C: drive.

```
C:
MD HP2
CD HP2
COPY A:*.*
```

The software is now installed on the harddisk. After starting the program, the DEFAULT DIRECTORIES can be set. These indicate where the program has to store and look for help files, instrument setting files and measurement data files. You can set the DEFAULT DIRECTORIES with the

menu **SETTINGS**, in the lower right corner of the screen.

Structure of the program

The program contains five integrated measuring instruments:

1   An oscilloscope   device: LIVE
2   A storage oscilloscope   device: HOLD
3   A spectrum analyzer   device: SPECTRUM
4   A true RMS voltmeter   device: VOLT
5   A transient recorder   device: TRANS

Only one measuring instrument can be active at the same time.

From each measuring instrument another measuring instrument can be activated. Standard features of the above five measuring instruments are options to make print outs and to leave the program to return to DOS.

Starting the program

The program can easily be started according to the below-mentioned procedure:

```
HP2 par1 par2
```

If no parameters are given, the device LIVE is selected, with the default settings.

The parameters par1 and par2 have the following meaning:

par1 Indicates the device that will be activated after starting the program. Valid values are:
C   LIVE   :   Measuring instrument oscilloscope.
C   HOLD   :   Measuring instrument storage oscilloscope.
C   SPECTRUM :   Measuring instrument spectrum analyzer.
C   VOLT :   Measuring instrument true RMS voltmeter.
C   TRANS   :   Measuring instrument transient recorder.
par2 Indicates the filename of the instrument setting (see for writing or reading instrument settings: SETTINGS menu).

Example:

```
HP2 trans b:HP.set
```

means the measuring instrument transient recorder is activated with the file settings b:HP.set. Incorrect instrument or filenames will be ignored.

The parameters par1 and par2 may be exchanged sequentially, but have to be separated by a space.

Controlling the program

After starting the program, first an intro screen with program information is displayed. This screen indicates what kind of display adapter the program has detected and whether a *Microsoft ®* compatible mouse is available.

After the intro screen has disappeared, the normal working screen appears. This screen is divided in two parts: a part for displaying the measurement data and a part for the main menu, for controlling the program. The program can be controlled by the keyboard as well as by a mouse.

Controlling by mouse

When using the mouse, the left mouse button is used for <**Enter**> and the right mouse button is used for <**Esc**>.

Controlling the main menu

Each instrument has its own main menu, in the lower part of the screen. The menu is built of three rows of 6 columns.

One of the buttons of the menu is always displayed inverted. That is the cursor, indicating the selected choice. For controlling the main menu, the following keys are available:

i	places the cursor one row up
k	places the cursor one row down
j	places the cursor one column to the left
l	places the cursor one column to the right
b	activates the selected choice
s	displays a list of instruments

Depending on the choice, after activating, a popup menu appears or the text in the menu changes, as well as the instrument setting.

Controlling popup menus

Various settings in the software are made by means of popup menus. For controlling the popup menus the following keys are valid:

i		Move the cursor up
k		Move the cursor down
h		Move the cursor to the top of the menu
u		Move the cursor to the bottom of the menu
q	l	Move the popup menu to the right
q	j	Move the popup menu to the left
q	i	Move the popup menu up
q	k	Move the popup menu down
b		Accept the selected choice
s		Leave the popup menu without changes
Space		Leave the popup menu without changes
Character		Place the cursor at the choice beginning with that character

When a popup menu has been moved by means of the <6789> keys in combination with the <**Shift**> key, the new position of the menu will be saved in the file HP2.DEF.

Help screens

The program contains integrated help screens. The screens can be invoked at several places in the program, by pressing function key < F1 >. The invoked help screen gives information about controlling the active program part or information about the active program part.

Program settings

Several parts of the program are configurable. To do that, activate the choice SETTINGS from the main menu. A popup menu will appear.

The contents are partly dependent on the type of graphics card in your PC. If an EGA or VGA card is available, two choices for setting the screen colors and the monitor type are present. If no EGA or VGA card is detected, those two choices will not be present.

Settings concerning the program itself (and not the measuring instruments of the program) are saved immediately in the file HP2.DEF, which is read at the start of the program.

Setting the main menu type

By using the choice SIMPLE MENU a more simple main menu containing 8 choices is selected. The simple menu has the following choices:

MEASUREMENT TYPE	With this a saved instrument setting can be read
START/STOP MEASUREMENT	Stop or start the measurements
REFERENCE	Show or don't show a reference signal. The reference signal can be read using READ MEASUREMENT
WIPE SCREEN	The signal display is cleared
SAVE MEASUREMENT	The last measured waveform, together with the instrument settings
PRINT MEASUREMENT	The last measured data is printed

MISCELLANEOUS	Through this choice, three choices are available:

MISCELLANEOUS   Through this choice, three choices are available:
ADVANCED MENU to return to the normal main menu
SAVE SETTINGS to save the current instrument settings to disk
QUIT PROGRAM to quit the program

Saving instrument settings

If you often use the same settings for an instrument, you can save the setup on disk. By loading the file with the setup, you can set your instrument very easy. The setups for all five instruments are saved.

To save an instrument setup, first you have to set the instrument completey. After the instrument is set, you can save the setup.

With TEXT FOR SETTINGSa dialog box appears, in which three lines of explanatory text for the setup to be saved can be entered. You can enter e.g. for what type of measurements this setup is to be used.

```
          Comment text display by select settings
 With this setting, channel 1 is used for measuring at
 a temperature probe._


                                    F1: Help   Esc: Exit
```

After the text is entered, the dialog box is closed with <Esc>

The popup menu SETTINGS will become active again. Choose from the menu the choice COMMENT FOR SETTINGS A dialog box appears.

```
 Temperature probe_
          F1: Help   Esc: Exit
```

In this dialog box a name for the setup can be entered. The maximum length for the name is 25 characters. This name is used for selecting the correct saved setup, when loading a setup. After the name is entered, the box can be closed by pressing <Esc>.

Then activate the choice **SAVE** from the SETTINGS menu. A dialog box appears, in which the filename for the settings file can be entered. The filename will automatically get an extension .SET. If you have entered the filename, the file with the instrument setup is saved on disk.

To make an instrument setting which will be used as a 'quit program' from SELECT SETTINGS (menu SETTINGS from the advance main menu) or MEASUREMENT TYPE (simple menu) any instrument setup will do, but the filename for the settings has to be QUIT. If a file named QUIT is read by one of the two here mentioned menus, the program will quit. Reading that file using RESTORE will not quit the program.

Loading instruments settings

Saved instrument settings can be read in three ways: at the start of the program as a parameter, through the choice **RESTORE** from the SET-TINGS menu and through the choice **SELECT SETTINGS** from the SETTINGS menu. The first method is already mentioned on page 23.

After activating the choice RESTORE a popup menu with a list of the present settings files appears. By means of the $< 6789 >$ keys the file to be loaded can be selected. By pressing $<$ Enter $>$ the selection is accepted. Before loading an extra confirmation is requested. The selection can be cancelled by pressing $<$ Esc $>$.

After activating the choice **SELECT SETTINGS** both a popup menu and a text window appear. In the popup menu the names of the settings, entered with the choice COMMENT FOR SETTINGS, are listed. In the text window, the accompanying text, entered with TEXT FOR SET-TINGS, is shown.

Setting the file type for measurement data

With the choice **SET DATAFILE TYPE** the file type with which the data will be stored on disk can be set.

When the **BYTE** option is selected the data file exists of records of 4 bytes (byte 1 and 2 are the value of CH1 and byte 3 and 4 are the value of CH2).

When the **ASCII** option is selected the data file exists of an ascii file of 4 columns, separated by a comma. Column 1 is the sample number, column 2 the sampling time, column 3 the voltage value of CH1 and column 4 is the voltage value of CH2.

Setting the location of files

With the choice **DEFAULT DIRECTORY** the default directories for the Handyprobe HP2, the print files and the data files can be set. The default directory for the Handyprobe HP2 is the directory containing the files HP2.EXE, HP2_ENG.HLP, HP2_ENG.INF and HP2.FNT.

Setting the printer port

With the choice **DEFAULT PRINTER PORT** the parallel printer ports 1, 2 or 3 to be connected to the printer can be selected.

When only one printer port is available, a conflict arises when a print command is given. In that case the program asks you to disconnect the Handyprobe HP2 from the computer and to connect the printer to the computer. Then the printout is generated. When printing is finished, you are requested to disconnect the printer and to connect the Handyprobe HP2 to the computer again. The Handyprobe HP2 is then ready to measure again.

Setting the printer type

With the **SET PRINTER TYPE** choice you can choose between an **EPSON** compatible matrix printer or an **HP-LASER** compatible printer. This setting is used for printing out data.

Setting the date format

The program uses date indications at several places, like at printer output or on the screen of the transient recorder. There are two ways to represent the date: day-month-year (DD-MM-YY) and month-day-year (MM-DD-YY). The preferable notation can be selected by activating **DATE FORMAT** from the SETTINGS MENU. Behind DATE FORMAT the current setting is indicated.

Default text on the printer output

With **SET USER TEXT** you can fill in three text lines. These text lines are placed at the top on each print out (with the PRINT option). For example, you can fill in your name and address information in these text lines.
The text lines are saved in the HP2.DEF file. At the start of the program the text lines are read automatically.

Setting the screen colors

When an EGA/VGA color monitor is available, the colors of the background, the foreground, Channel, ref channel and the cross hair can be set. While changing, the new color is displayed immediately. The color brightness can be changed using the < 76 > keys or the mouse.

Also a selection can be made between a color or a black and white display.

Storing measurement data on disk

By activating the **WRITE DISK** choice a file name is requested. A file name without extension has to be entered. The data are stored in filename.DAT and the corresponding instrument setting in filename.GEG.
In case the file name already exists, the program asks to overwrite the

existing file. If there is insufficient disk space an error message appears. A file with the extension "DAT" and a file with the extension "GEG" are made during a WRITE DISK. The data format is determined by SET FILE TYPE.

Loading saved measurement data

By activating the choice READ DISK a popup menu appears, giving an overview of the data files contained in the indicated default data directory. With the <7896> keys a file can be selected. When a selection has been made, the data and set files will be read from disk. When the data is not from the measuring instrument only the data file is read, or an error message appears.

The following file operations can be carried out with the function keys:

F2   View the file information (size, date and time)

F3   View the file (only text files)

F4   Delete the file

F5   Rename the file

F6   Copy the file

F7   Enter a new directory mask and/or path and/or disk

When <F4>, <F5> or <F6> is used, both the .DAT file and the .GEG file are acted on.

Printing measured data

There are two ways to print the measurement data.

The first way is pressing <Shift-PrtSc>. A quarter page size screen dump is made, containing only the information that is found on the display.

The second way is activated by the menu choice PRINT. A popup menu appears, displaying 2 choices.
The DISK choice requests for a file name to create the print file. This print file can be sent to the printer using the DOS command: COPY/B `file-name` PRN, where `filename` stands for the file name you entered in the input box.

With the PRINTER option the screen can be printed out on an EPSON, HP-LASER or a compatible printer. What printer type has been installed is indicated at the bottom of the popup menu. This printout is full page, containing extra information like date and time of the measurement, the comment lines and the USER TEXT.

Comments can be added to the printout using the COMMENT choice. When activated, a dialog box appears, in which three lines of text can be entered. These comments entered here are printed together with a prin-tout The comments are stored on disk together with the data. So each data file has its own comments. The key <F1> gives an overview of valid function keys in the editor.

Choosing an instrument

By activating the choice DEVICE, menu a popup menu appears, display-ing 6 choices.
When the QUIT choice is activated, the program will be terminated. The other options activate the indicated measuring instrument.
The measuring instruments (the devices) to be selected are:

LIVE	=	oscilloscope
HOLD	=	storage oscilloscope
SPECTRUM	=	spectrum analyzer
VOLT	=	voltmeter
TRANS	=	transient recorder

This menu can also be activated by means of the <**Esc**> key or the right mouse button (if no other menu is active).

Terminating the program

The popup menu **DEVICE** can be invoked from all program sections by means of the <**Esc**> key or the right mouse button. The **QUIT** option enables you to leave the program and takes you back to the operating system (DOS). The popup menu **DEVICE** can also be invoked with the <**Esc**> key or the right mouse button, if no other menu is active.

Chapter 4
Oscilloscope (device: LIVE)

An oscilloscope is a measuring instrument which displays the changes of a voltage in the time domain.

The Handyprobe HP2 is equipped with an oscilloscope with a fully configurable input (channel). It is a digital sampling oscilloscope. That means that the oscilloscope takes samples at fixed times. From each sample the value is determined and the size is displayed at the screen. The screen is filled with 500 samples per channel. Between two adjacent samples on the screen a line is drawn. The speed at which the samples are taken, is adjustable.

Aliasing

A disadvantage of digital sampling oscilloscopes is the fact that aliasing can occur.

Aliasing occurs when too low and therefore a wrong sampling speed is chosen. In the next illustration is shown how aliasing occurs.
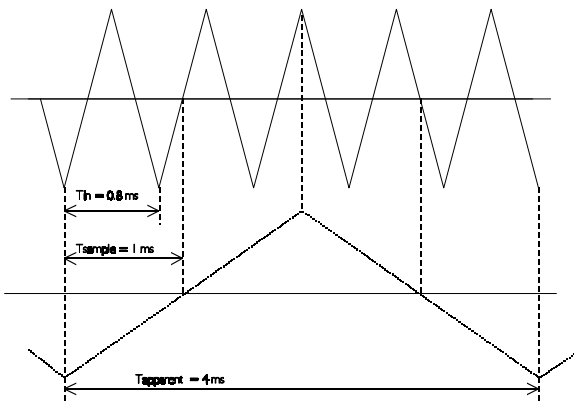
The input signal is a triangular signal with a frequency of 1.25 kHz (upper most in the illustration). The signal is sampled at a frquency of 1 kHz. The dotted signal is the result of the reconstruction. From that triangular signal the periodical time is 4 ms, which corresponds with an apparent frequency (alias) of 250 Hz (1.25 kHz - 1 kHz).

To avoid aliasing, the sample frequency must be greater than 2 times the maximum frequency of the input signal.

If you have any doubts about the displayed signal, you can set the timebase of the oscilloscope one step faster or slower and check whether the signal at the display changes accordingly. If that does not give any clearance, you can determine the frequency of the input signal with the spectrum analyzer. Therefore you must set the frequency range of the spectrum analyzer to the maximum, to avoid aliasing with the spectrum analyzer. For more information, see the chapter Spectrum Analyzer

Setting up the channel

The channel of the Handyprobe HP2 oscilloscope is completely configurable.

With the choice **CH SET** from the main menu a popup menu is called.

With the choices from this menu the channel can be configured.

Setting the sensitivity

By activating the choice **VOLTS/DIV** a popup menu appears, displaying 10 voltage ranges.

When e.g. **2** has been activated, a voltage range of 2 volts/div will be set, that is, the maximum voltage to be measured is $\pm$ 8 volt. The **AUTO** option provides for setting the voltage-axis automatically.
The following ranges can be selected: 125mV, 250mV, 500mV, 1V, 2V, 5V, 10V, 20V, 50V and 100V per division

Setting the signal coupling

By activating the choice **COUPLING AC/DC**, the text changes from COUPLING AC to COUPLING DC or vice versa. In the hardware, a capacitor is switched into (AC) or out of (DC) the signal path.

In COUPLING DC the complete signal (AC + DC) at the input is passed through. In COUPLING AC only the AC component of the input signal is passed through. It is then possible to examine e.g. a ± 20 mV ripple on a 30 V DC voltage, since only the ripple is passed through and the DC voltage not. AC voltages with a frequency lower than ± 4 Hz are not coupled correctly.

The current coupling is displayed in the upper part of the vertical axis. For DC the sign **=** is used and for AC the sign **~**.

Setting the vertical position

The vertical position of the channel on the screen can be adjusted.

When doing this, the signal is shifted graphically, **after** sampling. This method only has an effect on the displayed signal. If the signal clipped, because it is larger than the selected input range, and is positioned with the software method, the signal remains clipped, but the clipping is now visible on the display. The signal appears to be 'cut off' at either the upper side or the lower side.

The positioning method is not done by means of a popup menu. At the lefthand side of the screen two small arrows are visible. The small arrow next to the border of the window is for the position of a channel, the outer arrow is for the trigger level, which is discussed later.

```
 5.00        | . . .
             |
             |     .-'
             |   .-'
 0.00      }>|.-'. . .
             |
             |
-5.00        | . . .
```
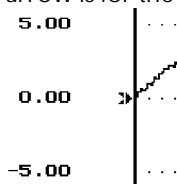
Only one offset (arrow) can be active, displayed normally. The other arrow is displayed inverted. In the latter illustration the channel offset arrow is active.

The arrow indicates the offset, the 0 volt level . The offset can be set as follows:

Q	i	Move the offset level up
Q	k	Move the offset level down
Q	h	Move the offset level to the center
Q	l	Select the next offset or trigger level
Q	j	Select the previous offset or trigger level
Q	e	Move the offset level to the top
Q	r	Move the offset level to the bottom
Q	+	Increase the step size (2 times)
Q	–	Decrease the step size (2 times)
Q	f	Switching between crosshair controll and offset/ trigger level controll.

Note the step size for changing the offset level or trigger level can be changed with <**Shift**-+> and <**Shift**-—>

The offset level can also be changed with the mouse. Place the mouse cursor on top of the arrow of the offset level to be changed and drag it to the correct position. Drag: press the left mouse button and keep it pressed, while moving the mouse. When the arrow is at the correct position, release the mouse button. The mouse cursor will disappear while dragging the arrow and appear again when the button is released.

Enlarging or reducing the vertical axis

The measured values can be enlarged or reduced by software. Because of that it is possible to magnify the vertical axis. It is also possible to invert the measured values. After activation of the choice GAIN in the menu CH SET, a dialog box appears in which a multiplication factor can be entered. The factor must be between -5 .. -0.1 or 0.1 .. 5. The measured factors are multiplied by the factors and then displayed. The numbers along the

vertical axis are also changed.

The GAIN can be used to invert a signal by entering a negative value.

Changing the units of the vertical axis

Along the vertical axis, normally the voltage of the input signal is projected. The unit of measure is then Volt and the numbers along the axis correspond with the size of the input signal.

The Handyprobe HP2 oscilloscope allows you to create another definition of the vertical axis.

By means of the choice **UNIT** from the CH SET menu the units of measure of the vertical axis can be changed.

After activation, a popup menu with 11 choices appears. The unit that is selected, is displayed at the top of the vertical axis. It is also placed on the paper when printed out. The possible choices are:
VOLT, AMPERE, DEGREE F, DEGREE C, WATT, PERCENT, METER, KILOGRAM, NEWTON, COLOMB and BAR.

If you are measuring e.g. with a temperature probe, you can choose **DE-GREE C** for the units.

By activating the choice **UNITS/VOLT** from the menu CH SET, a multiplication factor can be entered for the units of the vertical axis. A dialog box appears in which the factor is entered. The numbers along the vertical axis are multiplied by the factor and replaced by the result.

Another application is the previously mentioned example with the temperature probe. Suppose the temperature probe gives a voltage change of 1 volt at a temperature change of 5 degrees. By entering the factor 5, the temperature change is displayed directly in the number of degrees.

It is also possible to add an offset to the numbers of the vertical axis. In the dialog box called by activating **OFFSET** from the CH SET menu, an offset can be entered. This offset is added to **the numbers along the vertical axis**. Nothing is done to the signal.

An aplication for this is again the temperature measurement. Suppose the output voltage of the temperature probe at 0°C is +10 Volt. By entering a UNITS/OFFSET of -10, the zero level of the axis is changed in a way that the absolute temperature is directly readable.

Setting up the time axis

Along the horizontal axis of the screen the measuring time is projected. The oscilloscope always measures 2 pages of samples. Default the page after the trigger point is displayed (post trigger). Switching between the 2 pages is done by pressing <PgUp> or <PgDn>. <PgUp> gives the post trigger page and <PgDn> gives the pre trigger page. The keys < + > and <-> can be used to adjust the step size.

Setting the timebase

By activating the choice **TIME/DIV**, a popup menu appears, displaying 12 time ranges.
When, for example, the **0.2 sec** choice has been activated, one time division will be equal to 0.2 sec. The screen contains 10 time divisions.
One time division consists of 50 samples. The screen contains 10*50 = 500 sample values. By activating the **0.2 sec** choice one sample is taken every 0.2/50 = 4 msec.
With the **0.2 sec** choice the minimum duration of the sampling process is 10*0.2 sec = 2.0 sec. When a key is pressed within these 2.0 sec, the sampling process will be interrupted and the program will responds to the key press.

Note There are 5 different Handyprobe HP2 models, they differ in the maximum sampling frequency. The available models are: 1MHz, 2MHz, 5MHz, 10MHz and 20MHz.

The following time-axis ranges can be selected:
2.5 Fs, 5 Fs, 10 Fs, 25 Fs, 50 Fs, 100 Fs, 0.2 msec, 0.5 msec, 1 msec, 2 msec, 5 msec, 10 msec, 20 msec, 50 msec, 0.1 sec, **0.2 sec, 0.5 sec, 1 sec, 2 sec, 5 sec and 10** sec/div.

The bold printed values are not available in each Handyprobe HP2 model.

Magnification of the horizontal axis

By activating the **TIME-MAG** choice, a popup menu appears, displaying 6 software time-axis magnification areas.

When, for example, the **2*** choice has been activated, the time-axis will be magnified 2 times. The magnified part of the screen is indicated by two interconnected arrows at the bottom of the screen. The time-axis magnification area can be moved using the <**PgUp**> and <**PgDn**> keys or by mouse. Place the mouse cursor on the interconnected arrows, press the left mouse button and drag the arrows left or right. With the <**+**> and <**-**> keys the step size can be increased and decreased, respectively.

The following time-axis magnification areas can be selected: 1, 2, 4, 5, 10 and 20 times.

Triggering

To be able to examine a signal, the moment of displaying the signal has to be adjustable. Therefore an oscilloscope is equipped with a triggering system. This functions as follows:
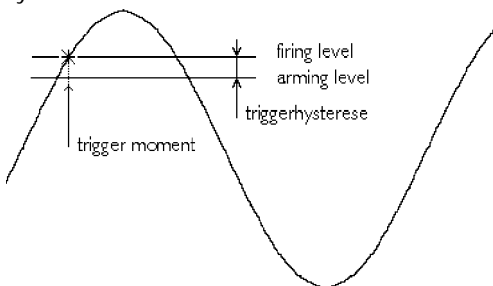
The input signal is compared with two levels in the trigger circuitry: the arming level and the firing level. When the input signal passes the arming level, the trigger system is armed. If the the input signal passes the firing

level, the trigger system becomes active and 'fires' a pulse. This pulse is used to start the display of the signal.

The arming level and the firing level are coupled to each other by the trigger hysteresis and their level is determined by the trigger level. The firing level corresponds to the trigger level. The trigger hysteresis defines at which signal size change can be triggered, the change has to be that large that both levels are passed. With a small trigger hysteresis it is possible to trigger on small signals. If a signal contains a lot of noise, a small trigger hysteresis causes triggering on the noise, instead of the original signal, which gives an unstable display. A trigger hysteresis larger than the noise level is then necessary.

In the latter illustration a signal and the two levels are displayed. In this case it is triggered on the rising slope of the signal. The signal passes the two levels from low to high. When triggering on the falling slope of a signal, the two levels are swapped. Then the signal has to pass the two levels from high to low, to generate a trigger.

Setting the trigger hysteresis

By activating the choice HYSTERESIS, a popup menu appears, displaying 12 trigger hysteresis options.
For example, when the 0.5 DIV option has been activated, the trigger hysteresis will be 0.5 division of the voltage range set. This means that the signal has to come out at a minimum of 0.5 division below the trigger level set (for a positive trigger slope). When the signal has much noise the trigger hysteresis can be set high to ensure that triggering is satisfactory.
When a signal has less noise, the trigger hysteresis can be set low allowing triggering at low signal levels. For setting the trigger level, see: offset and trigger levels. The following trigger hysteresises can be selected: 0, 0.125, 0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 2.25 and 2.5 DIV.

Setting the trigger slope

By activating the choice **SLOPE+ / SLOPE-**, the text in the menu choice changes from SLOPE + to SLOPE- or vice versa.
In the SLOPE + position triggering takes place on a rising slope of the signal to be measured and in the SLOPE- position on a falling slope.

Adjusting the trigger level

The adjustment of the trigger level is not done by means of a popup menu. At the lefthand side of the screen two small arrows are visible. The small arrow next to the border of the window is for the position of a channel, the outer arrow is for the trigger level.

There are two arrows. Only one arrow can be active, displayed normally. All other arrows are displayed inverted. The arrow indicates the trigger level. The trigger level can be set as follows:

q	i	Move the trigger level up
q	k	Move the trigger level down
q	h	Move the trigger level to the center
q	l	Select the next offset or trigger level
q	j	Select the previous offset or trigger level
q	e	Move the trigger level to the top
q	r	Move the trigger level to the bottom
q	+	Increase the step size (2 times)
q	–	Decrease the step size (2 times)
q	f	Switching between crosshair controll and offset/ trigger level controll.

Note the step size for changing the offset level or trigger level can be changed with <**Shift-+**> and <**Shift-—**>

The trigger level can also be changed with the mouse. Place the mouse cursor on top of the arrow of the trigger level to be changed and drag it to

---

the correct position. Drag: press the left mouse button and keep it pressed, while moving the mouse. When the arrow is at the correct position, release the mouse button. The mouse cursor will disappear while dragging the arrow and appear again when the button is released.

Setting the trigger time-out

When the input signal does not meet the trigger conditions, no new measurement data will be displayed and the last displayed signal will remain on the screen. This can be very inconvenient with unknown signals, since it is not known how the trigger circuitry has to be set. To provide in that case for a representation of the input signal on the screen, a trigger time-out setting is available.

With the time-out setting it is determined how long the delay will be for a trigger pulse. If that time expires, the available data will be displayed. This will not result in a stable display, but it will give an impression how the trigger has to be set.

By activating the choice **TIME-OUT** from the main menu, a popup menu appears with 12 choices for the trigger time-out: 0 DIV, 10 DIV, 20 DIV, 50 DIV, 100 DIV, 200 DIV, 500 DIV, 1000 DIV, 2000 DIV, 5000 DIV, 10000 DIV and Infinite.

For example, when the **50 DIV** option has been activated, the signal will be controlled for 50 time divisions maximally. If the signal does not comply with the trigger level set, the trigger slope and the trigger hysteresis within 50 time divisions, it will nevertheless be measured after 50 time divisions.

Stopping the display

By activating the **LIVE/FREEZE** choice, the text in the menu changes from LIVE to FREEZE or vice versa. In the LIVE position the oscilloscope continuously takes 500 samples and displays them on the screen.

In the FREEZE position no samples are taken and the samples last taken are displayed on the screen. A ONE SHOT menu is added in the FREEZE position.

By activating the **ONE SHOT** menu the text in the menu changes from

ONE SHOT to **MEASURE**. After measuring the signal the text changes back to ONE SHOT. When a key is pressed during measuring (MEASURE), the sampling process will be terminated immediately. Samples taken up to the moment the key is pressed can be viewed (the remaining samples are 0).

Magnifying a part of the screen

By activating the choice **ZOOM**, a popup menu appears, displaying 2 options.
The **FULL** choice displays the signal fully. (The x-axis and y-axis magnifications are set at 1 and the offset levels at 0.)
With the **WINDOW** option a rectangular magnification area can be indicated using the < 7896 > keys or the mouse. One corner has to be indicated first, followed by the <**Enter**> key or the left mouse button. Then the second corner has to be indicated, followed by the <**Enter**> key or the left mouse button. Cancelling the zooming can always be done by means of the <**Esc**> key or the right mouse button.

Measuring with the cross hair

After the measured signal is displayed, a crosshair appears. With the crosshair absolute and relative time and voltage measurements can be performed. Controlling the crosshair is done with the following keys:

q	h	Setting the absolute zero
q	y	Setting the relative zero
q	u	Move the crosshair to zero
q	i	Move the crosshair up
q	k	Move the crosshair down
q	j	Move the crosshair to the left
q	l	Move the crosshair to the right
q	e	Mirror the crosshair on the relative x-axis

⊙	Γ	Mirror the crosshair on the relative y-axis
⊙	–	Decrease the step size twice
⊙	+	Increase the step size twice
⊙	Γ	Switching between crosshair controll and offset/ trigger level controll.

Absolute zero is that point at the screen where voltage and time are zero (left most, in the center of the screen). Relative zero is that point set by moving the crosshair to the intended point and subsequently pressing <Shift-Del>.

The time and voltage values according the crosshair position are displayed on the screen, the voltage value in the upper right corner of the screen and the time value at the right most end of the time axis. The values are displayed inverted.

The crosshair can also be moved by means of the mouse. This is done by placing the mouse cursor at the crosshair, press the left mouse button and move the mouse, keeping the left mouse button pressed. While positioning the crosshair with the mouse, the mouse cursor disappears. When the correct position is achieved, the left mouse button can be released and the mouse cursor appears again.

Chapter 5
Storage oscilloscope (device: HOLD)

Differences with the oscilloscope

The storage oscilloscope HOLD is quite similar to the oscilloscope LIVE. there are a few differences, which will be described here. For the rest is referred to the chapter Oscilloscope (LIVE).

C   The HOLD scope only works in ONE SHOT mode and does not measure 2 but 30 pages of 500 samples. With the <**PgUp**> and <**PgDn**> keys, the pages are selected. The step size can be set using the <**+**> or <**-**> keys.

C   The HOLD scope can store data on disk while measuring.

The main menu of the HOLD device differs slightly from the main menu of the LIVE device. At the position where in the LIVE device the LIVE / FREE-ZE choice is found, the HOLD device has a choice ONE SHOT.

Automatic storage of measurement data

The storage oscilloscope can store measurement data automatically on disk. This is set by activating the choice **NO DISK** from the main menu. The text changes from NO DISK to **AUTO DISK**. As soon as a measurement is started using ONE SHOT, entering a filename for the data is requested.

```
        Syntax: drive:\path\filename (no .ext !)

 DATA_1

                    F1: Help   Enter: Accept   Esc: Exit
```

For the name, 5 characters are accepted, the rest is ignored. The software adds three characters for a file serial number. When the name is entered, measuring can start. There is a delay until the input signal meets the trigger conditions. When the trigger conditions have been met and a signal is measured, the data is written on disk. This is indicated by a text window, in the lower left corner of the screen.

When the data (measurement data, time and date of measuring) are written, the storage oscilloscope will wait for the next signal to meet the trigger conditions. If that occurs, new samples are taken and stored on disk in a new file. The file serial number will be increased by one from the previous number. The measuring and storing of data can be stopped by pressing <Esc>. READ DISK is used to load stored data for examination.

This system is very usefull when e.g an interference glitch has to be measured. Suppose at unpredictable times a glitch occurs. By setting the trigger delay to INFINITE and selecting AUTO DISK, the storage oscilloscope may wait days for the glitch, but when it occurs, it is measured and stored. The time and date of the occurrence are stored and appear on a printout.

Note When the sensitivity of the channel is set to AUTO ranging, the oscilloscope uses 1 to 10 measurements, depending on the input signal, to find a suitable sensitivity.

Chapter 6
Spectrum analyzer (device: SPECTRUM)

The (storage)oscilloscope measures and displays signals in the time domain: the voltage is plotted against the time. It is also possible to display measurement data in the frequency domain, the data is then plotted against the frequency. For this method the spectrum analyzer is used.

Description of FFT

The spectrum analyzer is using the Fast Fourier Transform (FFT) principle. For this transform, 1024 samples are taken with a previously set sample speed. With these 1024 samples, here called FFT-block, the spectrum is calculated. Therefore the FFT places an infinite number of FFT-blocks behind each other, in the positive and negative direction. Each FFT-block forms 1 period of the created periodic signal.
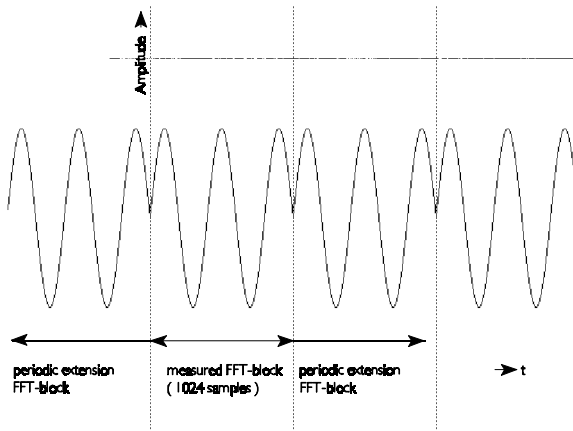
From the signal obtained like this, the spectrum is calculated. The FFT calculation results in 512 spectral components. These spectral components together form the frequency spectrum of the input signal. 500 of the 512 spectral components are displayed, in 12 divisions of 40 spectral components each.

The Handyprobe HP2 spectrum analyzer displays an amplitude spectrum, which means that a 2 volt peak-peak sine wave is displayed with a 1 volt spectral component.

Aliasing

Like the oscilloscope, the spectrum analyzer needs a high enough sampling frequency to avoid aliasing. The result of aliasing when using FFT is that the frequency curve is folded back on itself. See also the next illustration.
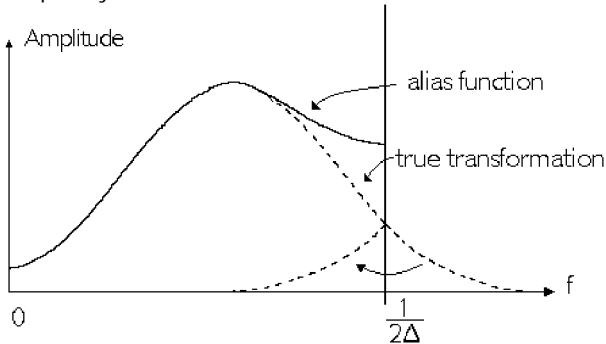
The original signal is sampled at a sample time Δ. The critical frequency (Nyquist frequency) is $(1/2\Delta)$ Hz.

Windowing

FFT treats the FFT-block of 1024 samples like it is one period of a periodic signal. If the sampled signal is not periodic, harmonic distortion can arise, since the periodic waveform, 'created by the FFT', can have sharp discontinuities. See also the following illustration. These discontinuities are also called calculation errors.
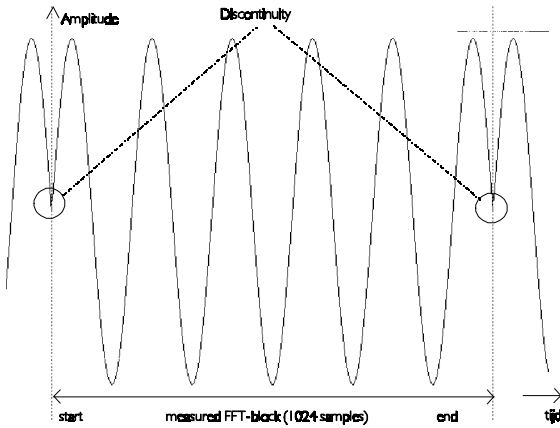
This means that because of the calculation errors extra frequency compo-
nents are generated around the true frequency. Because of this 'smearing'
the amplitude of the true frequency decreases, since the area under the
curve remains the same.

The smearing, caused by the calculation errors, can be decreased by pla-
cing a window on the FFT-block of 1024 samples, in such a way that the
ends of the FFT-block are smoothly tapered to zero and discontinuities do
not occur when the FFT treats the windowed block as one period of a
periodic signal. Each sample of the FFT-block is therefore multiplied by a
factor, whose size is dependent on the position of the sample in the FFT-
block. See also the following illustration.
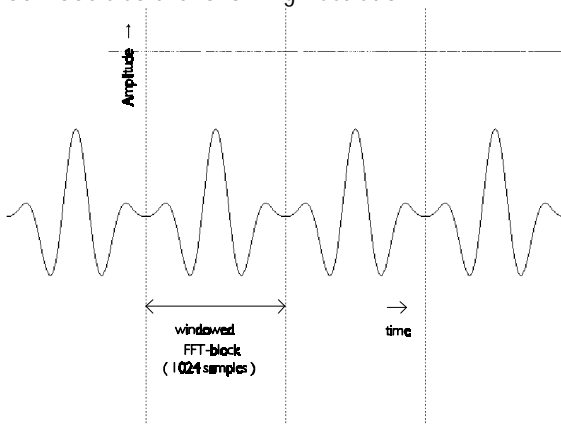
The software supports five different windows:

C   rectangular (all data remains the same)
C   Hanning
C   Hamming
C   Blackman
C   Bartlett

A graphical representation of the different windows is given in the next illustration.
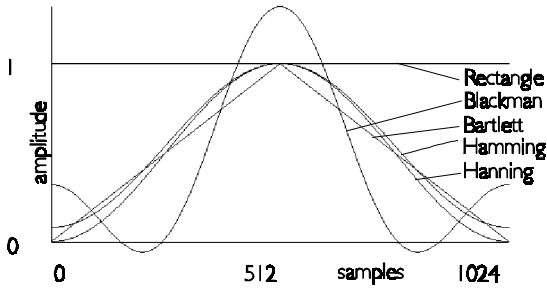
The effects of the different windows are displayed next, together with the sinewave signal the spectrum is taken from. The sinewave does not fit in the FFT-block and will therefore cause calculation errors.
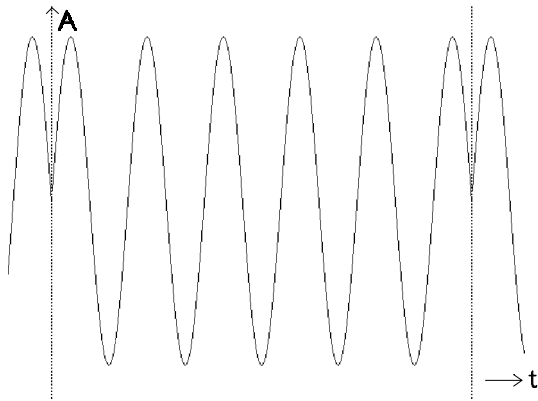
The measured sine wave
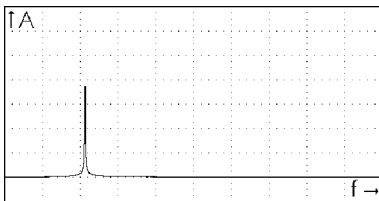
Rectangular window
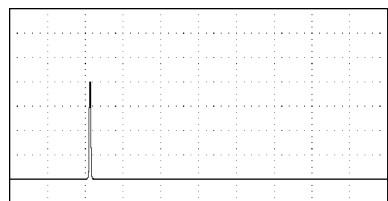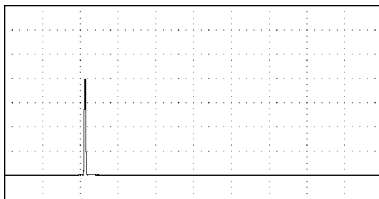
Hanning window

Hamming window
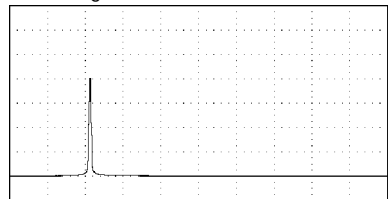
Blackman window
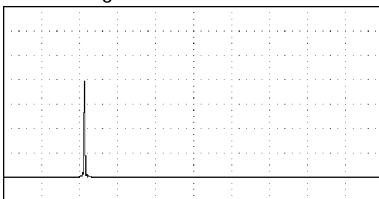
Bartlett window

When using the rectangular window, the amplitude of the spectrum is lower than with the other windows. Smearing is larger with the rectangular window.

Again some example illustrations, now with a sine wave exactly fitting in the FFT-block.
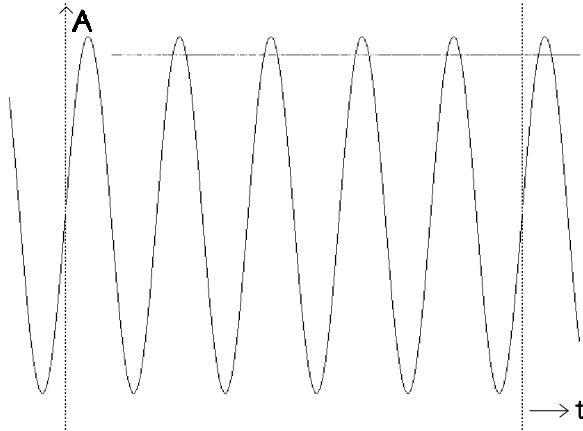
The measured sine wave
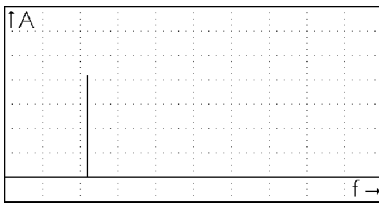
Rectangular window
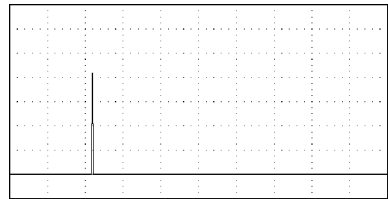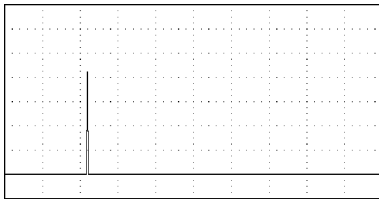
Hanning window

Hamming window
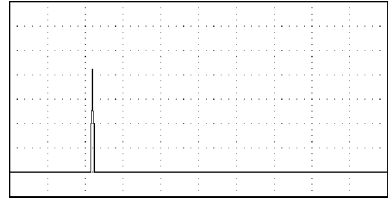
Blackman window
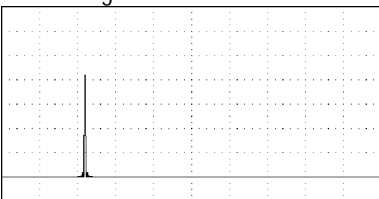
Bartlett window

Similarities with the oscilloscope

The spectrum analyzer has some similarities with the oscilloscope. The bottom row in the main menu contains choices that are similar to the ones in the oscilloscope devices. They will not be discussed here.

Setting up the channel

The channel of the spectrum analyzer can be set up to your own demands. The available settings are equal to the settings for the oscilloscope channel, except for a few points. These points will be discussed here, the other points will be referred to the chapter about the oscilloscope.

Activating the choice CH SET from the main menu, gives a popup menu which is almost equal to that of the oscilloscope, except for the last line. The oscilloscope provides for a choice UNIT, the spectrum analyzer for a choice LINEAR/dB.

Setting the sensitivity

The sensitivity of a channel can be set in exactly the same way as with the oscilloscope. It can be done by means of the choice VOLTS/DIV.

Adapting the vertical axis

With the spectrum analyzer you can decide whether the vertical axis will be linear or logarithmic. This is done with the setting LINEAR or dB from the menu CH SET. The current setting is displayed by the text of the choice. Activating the choice will make the text and setting change.

On a logarithmic axis, 0 dB corresponds with 1 Volt.

Setting up the frequency axis

By activating the choice FREQUENCY, a popup menu appears, displaying 15 frequency ranges.
For example, when the 1000 Hz option is activated, the maximum frequency displayed by the spectrum analyzer will then be 1000 Hz. The resolution is (1000Hz/500) 2.0 Hz.

The following frequency ranges can be selected: **10 Hz, 25 Hz, 50 Hz, 100 Hz**, 250 Hz, 500 Hz, 1 kHz, 2.5 kHz, 5 kHz, 10 kHz, 25 kHz, 50 kHz, 100 kHz, 250 kz, 500 kHz, **1 MHz, 2.5 MHz, 5 MHz and 10 MHz.**

Magnifying the frequency axis

By activating the **FREQ-MAG** choice, a popup menu appears, displaying 6 magnification areas.

When, for example, the **2*** option has been activated, the frequency-axis will be magnified 2 times. The magnified part of the screen is indicated by two interconnected arrows at the bottom of the screen.

The frequency-axis magnification area can be moved using the <**PgUp**> and <**PgDn**> keys or the mouse by placing the mouse cursor on the interconnected arrows and clicking the left mouse button (while moving the mouse button must be kept pressed). With the <**+**> and <**-**> keys the step size can be increased and decreased, respectively.

The following frequency-axis magnification areas can be selected: 1, 2, 4, 5, 10 and 20 times.

Selecting the window

By activating the choice **WINDOW**, a popup menu appears, displaying 5 window types.

These windows are used to reduce calculating errors during the FFT transformation. See at the beginning of this chapter for an explanation about FFT and windows.

The following window types can be selected: rectangle(= no window), Hanning, Hamming, Blackman, Bartlett.

Averaging of spectra

When the spectrum of a non-periodic signal (for example noise) is measured, AVERAGE can be used.

By activating the choice **AVERAGE**, a popup menu appears, displaying 8 options. When AVERAGE is set to 10, 10 spectra will be measured, calculated and averaged. After calculating each spectrum the results are displayed immediately. The averaging process can be interrupted by pressing the <**Esc**> key or the right mouse button.

The following choices for averaging are available: 1, 2, 5, 10, 20, 50, 100 and 200.

Starting a spectrum measurement

The sampling process is started by activating the choice **MEASURE**.

On the screen the text "MEASURING, PLEASE WAIT ... " appears. After the sampling process the spectrum is calculated using FFT and the message "CALCULATE SPECTRUM 1, PLEASE WAIT ... (Esc; Exit)" appears on the screen. When there are more calculations set by means of the AVERAGE menu, the first text will be displayed on the screen followed by the second one.

Measuring a harmonic distortion

By activating **DISTORTION**, a frequency can be indicated by means of the <**7896**> keys or the mouse.
The indicated frequency is considered the fundamental frequency.
The total harmonic distortion relative to this fundamental frequency is determined on the basis of the formula:

$$20 * \log \frac{\sqrt{(V_2^2 + V_3^2 + V_4^2 + V_5^2 + V_6^2 + V_7^2 + V_8^2 + V_9^2 + V_{10}^2)}}{V_1}$$

V_1 is the RMS amplitude of the fundamental frequency. V_2 ... V_{10} are the RMS amplitudes of each harmonic. The RMS amplitude of each harmonic is shown in a table.

Calculate the spectrum from the HOLD signal

By activating **HOLD->FFT**, the spectrum of the first 1024 measuring points of the signal measured with the HOLD device is calculated. The frequency-axis and the voltage-axes are adjusted to the value of the HOLD device.

Chapter 7
Voltmeter (device: VOLT)

The Handyprobe HP2 is equipped with a voltmeter with digital display.
The voltmeter functions as follows:

C   200 points are sampled.
C   The measured data is processed, e.g. for calculating the RMS value
        or the mean value. 9 options can be carried out.
C   The calculated values are displayed, e.g. add the values of display1
        and display2 and display on display1. 16 different display modes are
        available.

Because of the computations and display modes there are many options
($\pm$ 100) to measure a signal with the voltmeter.

Setting up the channel

As noticed, the channel can be configured in many ways. Activating the
choice CH SET brings up a popup menu in which the settings for the
channel are available.

Setting the input range

By activating the VOLTS/DIV choice, a popup menu appears, displaying
10 voltage ranges.

When e.g. 10 has been activated, a voltage range of 10 volts full scale will
be set, that is, the maximum voltage to be measured is $\pm$ 10 volt. The
AUTO option provides for setting the voltage-axis automatically.
The following ranges can be selected: 500 mV, 1 V, 2 V, 5V, 10 V, 20 V,
50 V, 100 V, 200 V and 400 V.

Setting the signal coupling

By activating the choice **COUPLING AC/DC**, the text changes from COUPLING AC to COUPLING DC or vice versa. In the hardware, a capacitor is switched into (AC) or out of (DC) the signal path.

In COUPLING DC the complete signal (AC + DC) at the input is passed through. In COUPLING AC only the AC component of the input signal is passed through. It is then possible to examine e.g. a ± 20 mV ripple on a 30 V DC voltage, since only the ripple is passed through and the DC voltage not. AC voltages with a frequency lower than ± 4 Hz are not coupled correctly.

Displaying the measured value

By activating the **DISPLAY CHx** choice, a popup menu appears, displaying 16 options. For both column of displays there is a menu.

Note The voltmeter can have up to six displays, to represent values of the input signal. The displays are divided in two columns, one on the left and one on the right. In the following description ch1 and display1 mean a display in the left column and ch2 and display2 mean a display in the right column, at the same row.

The option choosen determines how the data of display 1 or display 2 will be displayed. The options are:

CH1:   Display data of display 1.
CH2:   Display data of display 2.
CH1*CH2:   Display data of display 1 multiplied with data of display 2.
CH1/CH2:   Display data of display 1 divided by data of display 2.
CH2/CH1:   Display data of display 2 divided by data of display 1.
CH1-CH2:   Display data of display 1 minus data of display 2.
CH2-CH1:   Display data of display 2 minus data of display 1.
CH1+CH2:   Display data of display 1 plus data of display 2.

> then: The data is compared with the HIGH VALUE. When the data is higher than HIGH VALUE, **PASS** is displayed. When the data is smaller than HIGH VALUE, **LO** is displayed.

< then: The data is compared with the LOW VALUE. When the data is lower than LOW VALUE, **PASS** is displayed. When the data is higher than LOW VALUE, **HI** is displayed.

>< COMP: The data is compared with the LOW VALUE and the HIGH VALUE. When the data is higher than HIGH VALUE, **HI** is displayed. When the data is lower than LOW VALUE, **LO** is displayed. When the data is lower than or equal to HIGH VALUE **AND** higher than or equal to LOW VALUE, **PASS** is displayed.

<> Hi Lo: The data is compared with the LOW VALUE and the HIGH VALUE. When the data is higher than HIGH VALUE, **PASS** is displayed. When the data is lower than LOW VALUE, **PASS** is displayed. When the data is lower than or equal to HIGH VALUE **AND** higher than or equal to LOW VALUE, **LO** is displayed.

MAX: Display the maximum value of the data.

MIN: Display the minimum value of the data.

LOG(1/2):
$$20 * \log \frac{measured\ value\ CH1}{measured\ value\ CH2}$$

LOG(2/1):
$$20 * \log \frac{measured\ value\ CH2}{measured\ value\ CH1}$$

Displaying the measured values

The voltmeter can display the measured valyes in several ways, on 2 to 6 displays. By selecting **DISPLAYS** from the main menu, a popup menu appears in which the number of displays and the display settings can be set.

Set the number of displays

By selecting **NUMBER OF DISPLAYS** a popup menu appears with the choices 2 DISPLAYS, 4 DISPLAYS and 6 DISPLAYS. When 6 DISPLAYS is selected, 6 displays are available, all individually configurable. The left hand side displays are numbered 1, 3 and 5, the right hand side displays are numbered 2, 4 and 6.

Selecting the possibilities of the displays

With the choices **SET DISPLAY1** to **SET DISPLAY6** the properties of the displays can be set.

Processing the measured data

By activating **MEASURING**, a popup menu appears, displaying 9 calculations.

The option choosen determines how the data will be calculated.

The following options can be selected:

True RMS: The true RMS value of the sampled data is calculated. The true RMS value (Root Mean Square) is the value of a casual voltage form, identical to a DC voltage dissipating the same power in a resistance.
An AC voltage of 1 volt (RMS) is identical to a DC voltage of 1 volt. (Most -cheap- voltmeters only point the right value at a true sine voltage when an AC voltage is measured. The Handyprobe HP2 always points the correct value at the true RMS handling.)

PEAK TO PEAK The peak to peak voltage of the sampled data is determined. The peak to peak voltage of a DC voltage is zero. The peak to peak voltage of a true sine with a RMS value of 1 volt is 2.828 volt.

MEAN: The mean value of the sampled data is determined. The mean value of the DC voltage of 1 volt is 1 volt. The mean value of a true sine with a RMS value of 1 volt is 0 volt.

MAX: The maximum value of the sampled data is determined. The maxi-

mum value of a DC voltage of 1 volt is 1 volt. The maximum value of a true sine with a RMS value of 1 volt is 1.41 volt.

MIN: The minimum value of the sampled data is determined. The minimum value of a DC voltage of 1 volt is 1 volt. The minimum value of a true sine with a RMS value of 1 volt is -1.41 volt.

dBm: The value of the sampled data is converted into decibels. Converting is done by means of the formula:

$$dBm = 10 * \log \frac{1000 * value^2}{reference\ resistance}$$

With "value" the RMS value of the measured data is meant. The reference resistance can be set with the SET IMPEDANCE option.

POWER: The value of the sampled data is converted into a power. Converting is done by means of the formula:

$$POWER = \frac{value^2}{reference\ resistance}$$

With "value" the RMS value of the measured data is meant. The reference resistance can be set with the SET IMPEDANCE option.

CREST: The value of the sampled data is converted into a crest factor. Converting is done by means of the formula:

$$CREST = \frac{peak\ value}{RMS\text{-}value}$$

The "peak value" is the peak voltage relative to the zero line of the signal.

FREQ: The frequency of the offered signal is determined.

Changing the units of measure

The units of measure displayed, can be configured to your own demands. By activating the choice **UNIT**, a popup menu with the choices.
When the requested option is activated, this unit will be placed under the display behind the MEASURING mode. At an ACQUIRE TO DISK (or an ACQUIRE TO PRINTER) the unit is placed behind the MEASURING mode as well.

Changing the units per volt

By activating the choice **UNITS/VOLT**, you can enter a factor for the display. The value filled in will be multiplied with the measured value.
Example: A thermocouple generating 1 volt per 5 degrees is measured. Then the number of UNITS/VOLT can be set at 5 allowing the direct reading of the correct number of degrees.

When an oscilloscope probe which attenuates 10 times is used, the value 10 can be entered with the UNITS/VOLT option, so the correct voltage values can be read directly.

Relative measurements

By activating the **RELATIVE = ON/OFF** choice, the text changes from RELATIVE = ON to RELATIVE = OFF or vice versa.

The RELATIVE = ON option results in decreasing the displayed value with the value given at the SET REL. VALUE option.

Example: MEASURING is set on MEAN and DISPLAY is set on CH1. When a DC voltage of 10 volt is offered, the voltmeter will point at 10 volt. When the value 10 is filled in with the SET REL. VALUE option and RELATIVE = ON is set, the voltmeter will point at 0 volt.

With the RELATIVE = OFF option the measured value is not influenced.

Comparison measurements

For displaying the measured and calculated values, 16 methods are available. Four of those methods are comparison measurements:

> then HI
< then LO
>< COMP
< > LO HI

These measurements require a HIGH and a LOW value. With the choices **SET HIGH VALUE** and **SET LO VALUE** the two values can be set. Activating the choices will bring up a dialog box in which the size of the level can be entered in volts.

Setting the impedance

The dBm and POWER measurements require a reference resistance. The value of the resistance can be set by activating **SET IMPEDANCE** from the CH SET menu.

The value has to be entered in Ohm. The default value is 600 Ω.

Setting the frequency range

The voltmeter has a limited frequency range in which the measurements are performed correctly. This is caused by the fact that the voltmeter takes 200 samples, using a certain sampling frequency.

If the periodical time of the input signal is much larger than the measuring time, a wrong value is measured. See the next illustration.
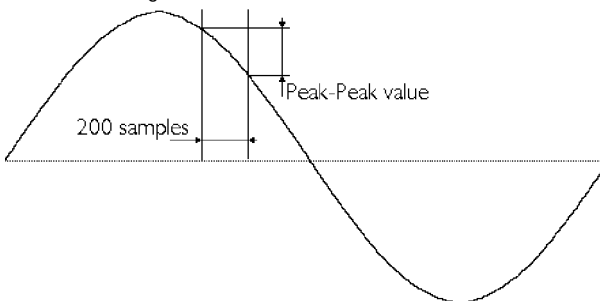
If the time in which the 200 samples are taken is too short in relation to the periodical time of the input signal, **aliasing** can occur (see also the chapter about the oscilloscope).

To avoid errors like the one mentioned above, the frequency range of the voltmeter has to be set properly. The sampling frequency is then changed. By activating the **FREQUENCY** choice, a popup menu appears, displaying 7 center frequencies. A frequency range is determined from 0.2 x f_{center} to 10 x f_{center}.

For example, when **50 Hz** is choosen, signals with a frequency between 10Hz to 500 Hz will be calculated correctly.

The following center frequencies can be selected: 10 Hz, 50 Hz, 100 Hz, 500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz and 100 kHz.

Perform measurements

By activating the **MEASURE/FREEZE** choice from the main menu, the text in the menu changes from MEASURE to FREEZE or vice versa.

In the MEASURE position 200 sample values are taken and from that a determined quantity will be calculated. The quantity to be determined can be set with the CH SET menu, MEASURING option.
The last measured values are displayed in the FREEZE position.

By activating the choice **ONE SHOT** from the main menu one measurement is taken and from that the data will be calculated and displayed.
This menu is only available when the MEASURE/FREEZE choice is in the FREEZE position.

Note A measurement consists of three succuessive measurements which are averaged. In between these measurements the display is updated. If the voltmeter has to perform an auto range while measuring in one shot, as much as nesessary measurements are taken until three measurements are taken in the final input range.

Storing measurement values on disk or paper

The voltmeter can store measurement values on disk or print them on paper. This is done in a different way than the other instruments.

The voltmeter can be set to measure (acquire) at fixed times. The measured value will then be stored on disk or sent to the printer.

Note When only one printer port is available, it is not possible to send the measurements to the printer

Setting the time between two measurements

By activating the choice **TIME** from the main menu, the time between two measurements can be set. A dialog box appears in which the time can be entered, in seconds. The time has to be between 0 and 300 seconds.

Note When a time **shorter than 0.5 seconds**is entered, the acquisition speed is determined by the changes of display 1 or display 2. Each time a measurement value at the screen changes, the measured value is stored on disk or printed.

Start an acquisition

By activating the choice **ACQUIRE**, a popup menu is displayed, from which a selection can be made whether the data has to be stored on disk or sent to the printer.
The choice **DISK** will cause the measurement data to be stored on disk. After activating the choice, a dialog box appears in which a name for the file has to be entered. If a file with that name exists, you will be asked whether that file can be overwritten. The data in that file will be lost. After confirmation, measuring starts. At the fixed times a measurement is taken and stored on disk. Measuring can be cancelled by pressing <**Esc**>.

The choice **PRINTER** will cause the measurement data to be sent to a printer. After activating, measuring starts. At the fixed times a measurement is taken and the value is sent to the printer. Measuring can be cancelled by pressing <**Esc**>.

In both modes, the measurement values are preceded by a block of information. In that block is indicated how the channel is set and how the HIGH, LOW and RELATIVE LEVELS are set. Each measurement is preceded by the time and date of the measurement.

If a measured value is higher than the selected input range, '-----' is displayed. This will also be stored on disk or printed.

Changing the display characters

By activating the DIGIT SET choice, a popup menu appears, displaying 5 digit thicknesses.

For example, when the 4-PIXELS choice has been activated, the digit thickness will be 4 pixels.

The following digit thicknesses can be selected: 2, 4, 6, 8 and 10 pixels.

Chapter 8
Transient recorder (device: TRANS)

The transient recorder is direct registering measuring instrument, displaying the changes of the input signal graphically on the screen or on paper.

The transient recorder measures at settable, fixed times and processes the measured value if necessary. The number of measurements to be taken is also settable.

Note The transient recorder displays a measured sample immediately, the oscilloscope takes all samples and then displays the complete page.

The transient recorder main menu has several items that are similar to the oscilloscope, therefor they are not discussed in this chapter.

Setting the measuring type

By activating **MEAS. MODE**, a popup menu appears, displaying 5 measuring methods.

MOMENTAL	the momentary value will be measured
true RMS	the true RMS (= effective) value will be measured
MEAN	the mean value will be measured
MAX	the maximum value of the signal will be measured
MIN	the minimum value of the signal will be measured

The true RMS, MEAN, MAX and MIN values are calculated from $\pm$ 200 samples. To avoid measuring errors the frequency of the measured signal must be around the center frequency set (See also Setting the frequency range in the chapter Voltmeter).

Setting the frequency range

By activating the **FREQUENCY** choice, a popup menu appears, displaying 7 center frequencies. A frequency range is determined from 0.2 x f_{center} to 10 x f_{center}.

For example, when the **50 Hz** option has been activated, the signals with a frequency of 10 Hz to 500 Hz will be calculated correctly.
The frequency setting is only effective when True RMS (= effective), MEAN, MAX or MIN values are measured.

The following center frequencies can be selected: 10 Hz, 50 Hz, 100 Hz, 500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz and 100 kHz.

Setting the sampling time

By activating **SAMPLE TIME** the sampling time between two measured values can be given.

For the sampling time a value between 0.01 and 300 sec can be given. Then the total measuring time can be $300*30,000 = 9,000,000$ sec (= 104.16 days).

Setting the number of samples

By activating the SAMPLES menu, the number of samples can be given. For the number of samples a value between 1 and 30,000 can be given. Then the total measuring time can be $300*30,000 = 9,000,000$ sec ($= 104.16$ days).

Clear the screen

By activating the **CLEAR SCR** choice, the screen of the transient recorder is erased.

Start a measurement

When all settings are set, a measurement can be started, by activating **MEASURE** from the main menu. First a name has to be entered for the file the data will be stored in. If the name of an existing file is entered, you will be asked whether this file can be overwritten by the new data. The old data will be destroyed.

When the name is entered, sampling starts. This is indicated by a win-dow with the text:

```
MEASURING..., Esc: interrupt measuring      .
```

At fixed times a sample is taken, until the number of samples to be taken is reached. While sampling, the sample number, the time and the measured value are displayed inverted.

Note When the Handyprobe HP2 is connected to a relative slow computer, it may occur that, depending on the selected sampletime, the sample number, time and value are not being displayed. Only if enough time is available, the items are displayed.

When the total measurement time is completed, the window with the text disappears and the data is saved on disk.

A crosshair, used for measuring, now appears. See the chapter oscilloscope HOLD for information about controlling the crosshair. During measuring with the crosshair, the value, the sample number and the time of the selected sample are displayed.

When more than 500 samples are taken, the keys <**PgUp**> and <**PgDn**> provide switching between the pages with data. The current page number is displayed in the upper right corner of the screen. With <**+**> and <**-**> the step size can be changed, <**+**> increases the step size, <**-**> decreases the step size.

As with the oscilloscope, the data can be shifted up and down on the screen. This is done in the same way as with the oscilloscope.

Note When switching between pages of data, or shifting the signal, each time the complete signal is read from disk, which may take some time.

Go to a specific sample

By activating the **GO TO** choice a sample number to be jumped to can be given. For example, when a measurement has been made involving 15,000 values, then the 15,000th sample value can be jumped to straight away by entering 15,000.

Chapter 9
Specifications

Hardware

A/D convertor

sampling frequency   1, 2 , 5, 10 or 20 MHz
input sensitivity full scale

500	mvolt	(resolutie	3.91	mvolt)
1	volt	(resolutie	7.81	mvolt)
2	volt	(resolutie	15.6	mvolt)
5	volt	(resolutie	39.1	mvolt)
10	volt	(resolutie	78.1	mvolt)
20	volt	(resolutie	15.6	mvolt)
50	volt	(resolutie	391	mvolt)
100	volt	(resolutie	781	mvolt)
200	volt	(resolutie	1.56	volt)
400	volt	(resolutie	3.91	volt)

maximum overload voltage   500 volt AC 50 Hz
input impedance   1 Mohm/30 pF
coupling   AC/DC
resolution   8 bits 0.39 %
accuracy   1 % $\pm$ 1 LSB
bandwidth   DC to 2 MHz

General

operation temperature   15EC .. +25 EC
dimensions h x l x w   22 x 125 x 43 mm
weigth   approx. 260 gram
cable length   approx. 67 inch (1.7 m)

Software

Common

hardcopy	matrix, deskjet and laser printer

Oscilloscope

timebase					
2.5	usec	(Sample frequency	20	MHz)
5	usec	(Sample frequency	10	MHz)
10	usec	(Sample frequency	5	MHz)
25	usec	(Sample frequency	2	MHz)
50	usec	(Sample frequency	1	MHz)
100	usec	(Sample frequency	500	kHz)
200	usec	(Sample frequency	250	kHz)
500	usec	(Sample frequency	100	kHz)
1.0	msec	(Sample frequency	50	kHz)
2.0	msec	(Sample frequency	25	kHz)
5.0	msec	(Sample frequency	10	kHz)
10.0	msec	(Sample frequency	5	kHz)
20.0	msec	(Sample frequency	2.5	kHz)
50.0	msec	(Sample frequency	1.0	kHz)
100	msec	(Sample frequency	500	Hz)
0.20	sec	(Sample frequency	250	Hz)
0.50	sec	(Sample frequency	100	Hz)
1.00	sec	(Sample frequency	50	Hz)
2.00	sec	(Sample frequency	25	Hz)

accuracy of time base	0.01 %
time-axis magnification	2..20 times
setting accuracy time-axis magnification	0.25 %
y-axis magnification	-5 .. 5 times
triggering	positive slope, negative slope
trigger sensitivity	0.25..2.25 DIV
trigger resolution	0.01 times full scale
trigger time-out	0 .. Infinite
external triggering	keyboard
offset range	0..100 %
offset resolution	0.01 times full scale
invert	yes
compare	yes

Spectrum analyzer

frequency range					
0.0195	-	10	Hz (res.	0.0195	Hz)
0.0488	-	25	Hz (res.	0.0488	Hz)
0.0977	-	50	Hz (res.	0.0977	Hz)
0.195	-	100	Hz (res.	0.195	Hz)
0.488	-	250	Hz (res.	0.488	Hz)
0.977	-	500	Hz (res.	0.977	Hz)
1.95	-	1000	Hz (res.	1.95	Hz)
4.88	-	2500	Hz (res.	4.88	Hz)
9.77	-	5000	Hz (res.	9.77	Hz)
19.5	-	10000	Hz (res.	19.5	Hz)
48.8	-	25000	Hz (res.	48.8	Hz)
97.7	-	50000	Hz (res.	97.7	Hz)
195.3	-	100000	Hz (res.	195.3	Hz)
488.3	-	250000	Hz (res.	488.3	Hz)
976.5	-	500000	Hz (res.	976.5	Hz)
1953.1	-	1000000	Hz (res.	1953.1	Hz)
3906	-	2000000	Hz (res.	3906	Hz)
9765	-	5000000	Hz (res.	9765	Hz)
19531	-	10000000	Hz (res.	19531	Hz)

frequency-axis magnification   2 ... 20 times
y-axis   linear/dB
windows   rectangle, Hanning, Hamming, Blackman, Bartlett window
distortion   measuring 10 harmonics of the ground frequency

True RMS voltmeter

measuring method   true RMS, mean, min, max, momentary,
                        dBm, power, crest factor and frequency values
display abilities: CH1, CH2, CH1*CH2, CH1/CH2, CH2/CH1,
                        CH1-CH2, CH2-CH1, CH1+CH2, > then,
                        < then, >< COMP, <>HI LO, MAX, MIN,
                        LOG (CH1/CH2) and LOG (CH2/CH1)
display height   ±1..2 inch (±25..50 mm) depending on the monitor
frequency range   10 Hz, 50 Hz, 100 Hz, 500 Hz, 1 kHz, 5 kHz, 10 kHz
voltage range   500 mvolt .. 400 volt full scale

maximum overload voltage	500 volt peak to peak
data acquire	to disk and to printer

Transient recorder

measuring time between two measuring points	0.01..300 sec
	at a PC-XT the minimum time is 0.05 sec
maximum number of measuring points to be taken	30,000
time-axis magnification	2..20 times
gain factor	-5..5 times
offset factor	-10,000..10,000
measuring method	true RMS, mean, min, max and momentary

Notes

If you have any suggestions and/or remarks regarding the program, the Handyprobe HP2 or the manual, please contact:

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