

FIELD DOSIMETER

System FD3

User Manual

The System FD3 is a professional handheld instrument for capturing and logging data about extremely low frequency magnetic fields. To make best use of the instrument, we recommend that you read this manual carefully.

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Section 1

INTRODUCTION

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1.1 About this Manual

The places in the manual that refer to operating the dosimeter are marked in **bold text**, and those referring to the sections concerning the PC-program for the FD3 dosimeter, are marked in *italics*.

1.2 Magnetic fields in the Environment

Increasing use of electrical equipment has resulted in increased exposure to low frequency magnetic fields.

The presence of such magnetic fields in our environment and the possible risk that this implies, means that there is an increased concern to investigate these fields and to take action to decrease these fields. That is why Combinova developed the System FD3. The dosimeter is a tool used to help determine magnetic field exposure and to verify that the actions taken to reduce the fields gave the desired result.

Strong magnetic fields can also cause electrical interference problems, for example the disturbance of CRT-type displays in computer displays and TV-apparatus by external magnetic fields.

The largest magnetic fields are found around power transmission lines and power supply installations, but the electrical equipment in the home and workplace also generate comparatively strong magnetic fields.

Magnetic flux is measured in Tesla or in some countries in Gauss. The unit Tesla is used in this manual. The conversion factor is $10 \text{ mG} = 1 \mu\text{T}$.

Magnetic fields from power lines are directly related to the phase current. The magnetic field strength decreases with distance from the power line. Seasonal and daily variations in the magnetic fields directly reflect the different power consumption demands. The magnetic flux can reach a maximum of $10 - 30 \mu\text{T}$, close to the line, but decreases to below $1 \mu\text{T}$ at distances of $50 - 200$ meters.

Magnetic fields at home and in our working environment are caused both by internal and external sources. Typical external sources are power lines and power distribution substations close to buildings. Even water pipes can carry stray neutral currents from unbalanced supplies that can create significant magnetic fields. Internal sources are a large variety of electrical equipment and installation wiring.

The usual electrical equipment found at home or in the office generates magnetic fields with dipole characteristics. The field strength decreases rapidly with distance. The field strength can be as high as $10 \mu\text{T}$ close to the source, but this decreases to a background level at a distance of only a few meters. Electrical wiring and lighting also generate local magnetic fields. In general the normal background magnetic fields do not exceed $0.1 \mu\text{T}$, but in certain cases it can be as large as $1 - 3 \mu\text{T}$ throughout a building.

1.3 The dosimeter (Figure 1.1)

The dosimeter is a compact instrument for measuring alternating magnetic fields. The instrument is designed specially for identifying and measurement of the most usual sources of magnetic fields.

The dosimeter offers the following features:

- Handy format
- Three orthogonal coils, which means that the magnetic fields are measured correctly and independently of the dosimeters orientation
- The dosimeter has a frequency range of 20 - 2000 Hz which covers the commonest low frequency magnetic fields with a good margin, as well as a wide dynamic range from 40 nT to 100 μ T
- True RMS measurements independent of the measured fields waveform
- Large, easy to read LED bar graph display

The dosimeter is a robust and reliable instrument, built to simplify measurement in various situations

The dosimeter is constructed using the very latest technology, including surfacemounted electronics and highly optimized mathematical routines in the integral microprocessor. This new technique allowed the dosimeter to contain features that previously had only existed in significantly larger and more expensive instruments.

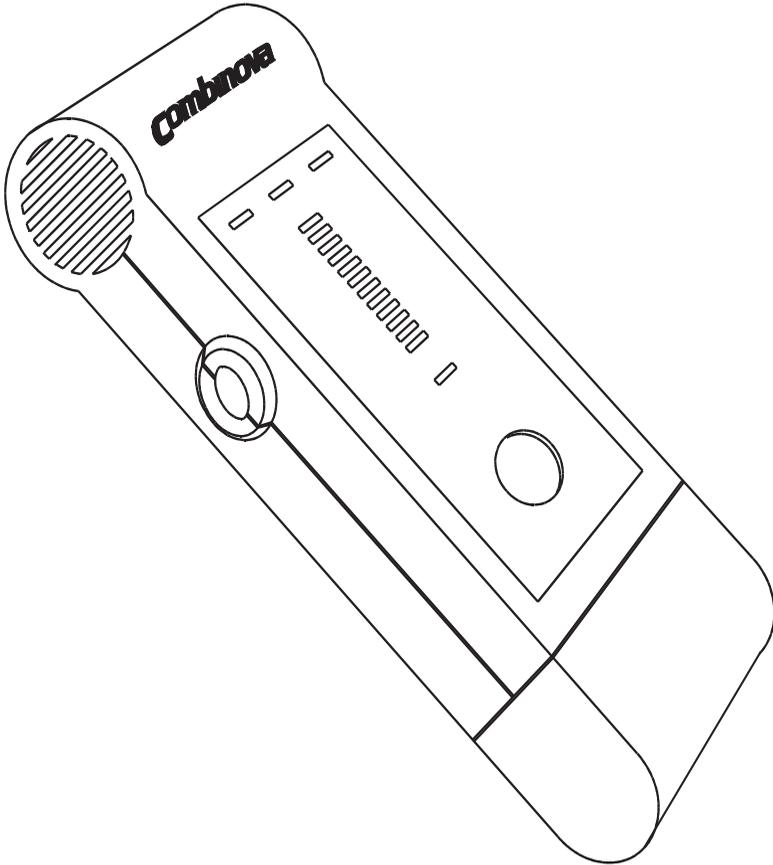


Figure. 1.1 Dosimetern

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1.4 System FD3 - In brief

System FD3 is a powerful and easy-to-use tool for collection and analysis of magnetic field exposure within power distribution, transport, industry, offices and private dwellings.

System FD3 uses the measurement method called mean-value exposure. This method is straightforward in use and provides a good basis to assess the results of the actions taken to reduce magnetic fields.

An exposure measurement using System FD3 can be divided into three stages:

Planning:

It is most helpful if one has decided how the result will be displayed, in order to plan the measurement in the best possible way. System FD3 allows a great deal of freedom in being able to measure according to the many varying needs. One chooses measurement interval, start- and stop time and method, as well as task identification before the measurement is commenced. These parameters are downloaded into the dosimeter from the PC together with the system time in the PC. The measuring start and stop time can be either manual or time-controlled.

Measurement:

If the measurement is time-controlled, then no further action is required.

The dosimeter is measuring when the **B indicator** blinks. The **TAG button** is pressed to mark during measurement. The mark is shown on the time-axis when the results are displayed. It is advisable to make notes if many marks are made.

Analysis:

The measurement data is taken from the dosimeter to the System FD3 in the PC via the serial adapter, when the measurement is complete. There are four methods for direct presentation of data, called thumbnail sketches. Mean exposure per hour is not available for presentation if the measurement is for less than one hour.

The line diagram shows the mean-, maximum-, and minimum curves, and compresses the measurement onto a single screen image. Interesting parts of this image can be expanded to full-screen using the zoom tool.

The dosimeter can store more than 60,000 individual measurements. It is possible to create a database file with each individual value stored, for additional analysis. One should bear in mind that it can be difficult to work with such a large amount of data. Microsoft Excel has a limit of 32,000 rows times 4,000 units for diagram presentation.

1.5 Combinova AB - The company behind System FD3

System FD3 is developed by Combinova AB, who are also responsible for the manufacture, marketing and after-sales service of the instrument.

Combinova has a complete range of measuring instruments for measuring of low frequency magnetic and electrical fields:

Standard MPR instruments

- MFM1000 - Magnetic Field Meter for the Band 2/VLF (2 - 400 kHz) range
- MFM10 - Magnetic Field Meter for the Band 1/ELF (5 - 2000 Hz) range
- MFM1020 - Automatic VDT magnetic field measurement system
- EFM200 - Electrostatic fields and alternating fields measurement system in the Band 1/ELF (5 - 2000 Hz) and Band 2/VLF (2 - 400 kHz) range
- EFM100 - Alternating electric fields in the Band 1/ELF (5 - 2000 Hz) and Band 2/VLF (2 - 400 kHz) range

Field detectors

- FD1 - Field detector for magnetic and electrical alternating fields (20 - 2000 Hz)
- FD2 - Field detector for magnetic and electrical alternating fields(2 - 400 kHz)
- System FD3 - Field dosimeter for magnetic alternating fields (20 - 2000 Hz)

Combinova works with Swedish and International industrial clients in the area of advanced product development.

All phases of a development project can be handled, from idea outlines to the completed product. This is due to the extensive technical experience and knowledge within the company.



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Section 2

UNPACKING AND INSPECTION

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2.1 Unpacking

Commence by inspecting the outer box for damage caused during transportation. If significant damage has occurred to the box, then there is a risk that the instrument is also damaged. In that case, please contact the transport carriers that delivered your instrument.

The System FD3 is delivered in a cardboard box with expanded plastic packaging to protect the instrument during transportation. The box and packaging should be saved for future use, such as calibration or service where the instrument should be sent to Combinova or Your authorised dealer.

All items that are included in a normal delivery are contained in the cardboard box

Supplied items:

- User Manual
- Dosimeter
- 2 batteries - type R6
- Serial-port adapter
- 2 installation diskettes
- Carrying holster

If any item is missing, please contact your dealer.

Important!

Complete the warranty card and return a copy to Combinova AB. The warranty which is for 1 (one) year is valid only if the Warranty Card has been completed and sent to and received by Combinova AB.

Combinova recommends that this manual is read carefully before using the instrument.

2.2 Inspection

Ensure that the dosimeter and supplied accessories were not damaged in delivery.

Two R6 (AA) size 1.5 volts alkaline batteries must be inserted into the instrument before use.

Remove the battery cover (Figure 2.1) and insert the batteries as indicated in the bottom of the battery compartment.

The instrument is ready for use when the batteries and battery cover are in place.

Contact Combinova or the dealer who sold the instrument, if the instrument does not work despite that new batteries were used and were installed correctly.

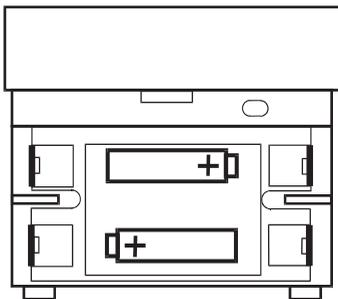


Figure 2.1

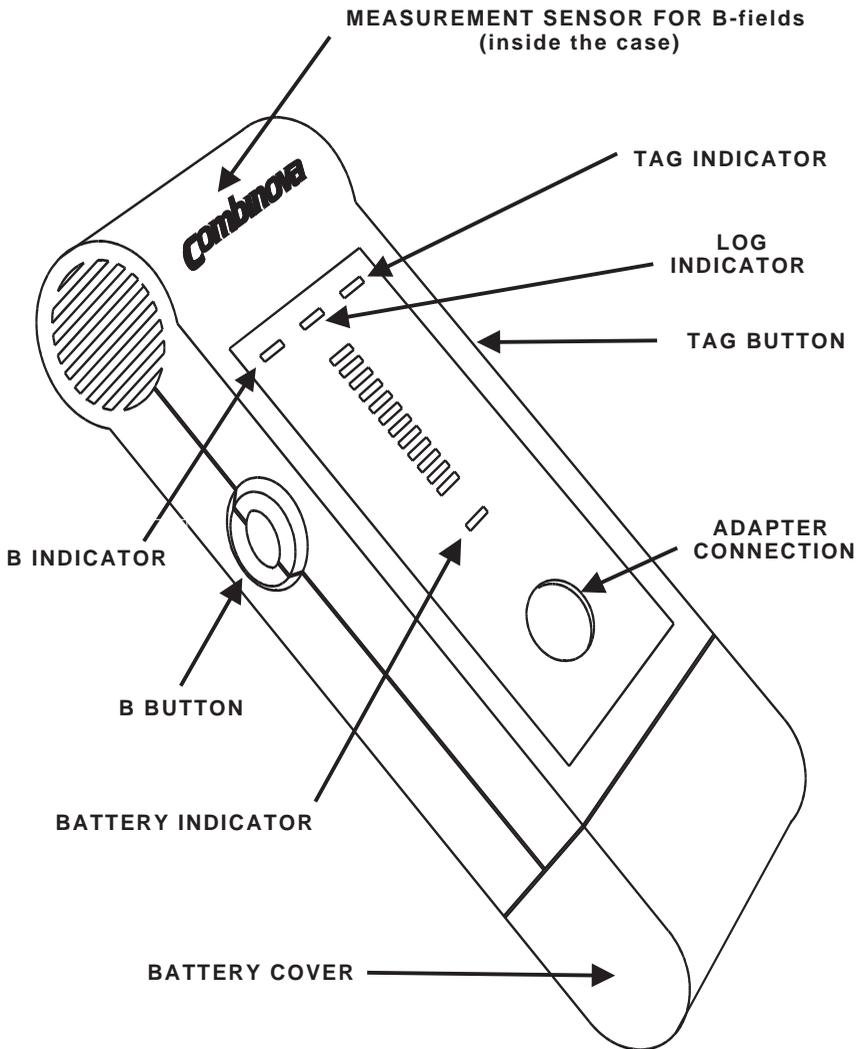
2.3 Battery Check

The dosimeter controls the battery level during measurement. If the combined voltage level of the two batteries together drops below 2.2 0.1 volt, then the **battery indicator** will blink when the **measuring button** is released.

The recommended battery type for the dosimeter is a pair of 1.5 volt alkaline batteries of R6 type (AA). Ensure that the batteries are inserted with the correct polarity according to the diagram. A pair of new batteries should suffice for about 30 hours of measurement, in normal use.

Depress one of the **buttons** until a measurement value is displayed. Release the button and observe the battery indicator at the bottom of the display. **The indicator** will not light up if there is sufficient voltage left in the batteries. If the **indicator** light shows, then it is time to replace the batteries.

Do not leave the batteries in the dosimeter when not in use.



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Figure 2.2 Dosimeter

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INSTALLATION

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3.1 Installation of the PC-program

Start Windows as normal.

Insert diskette labelled 1:2 in drive A.

Open *File handler* and click on A:

Double-click on file *SETUP.EXE* on the right hand side.

The installation program will suggest that a sub-directory is to be created named *C:\FD3*.

System FD3 is supplied on two diskettes. A request will be displayed after a short while to insert the second diskette. The program will be fully installed a short while after that.

Upgrading from an earlier version

When an earlier version is being upgraded, a sub-directory named *C:\FD3PROJ* should be created, if the suggested name by the previous program version was followed, instead of using another name. In the former case, the previous measurements will automatically be entered as a database in the newly installed program.

See also the file *readme.txt* on the installations diskette no. 1.

3.2 Connecting the adapter and dosimeter

The next stage in the installation is to connect the FD3 adapter to a PC serial-port.

The adapter is connected to either COM1 or COM2, the program locates the actual port used. Insert the adapter into the unused port.

The serial-port adapter uses an external power supply, and thus communication between the dosimeter and the computer does not drain the dosimeter batteries.

System FD3 is ready to use when the serial-port adapter and the dosimeter are connected together by the cable.

The menu *Setup* allows the choice of serial-port to be changed. A serial-port that is not reserved for any other use should be the one chosen, to avoid any problems.

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OPERATING INSTRUCTIONS

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4.1 Dosimeter functional description

B button

The left side button (**B button**) has three functions; memory-test, manual measurement and status display of any programmed functions.

Depressing the **B button** will show if the dosimeter is in standby, ready for the next measurement or whether a measurement is in progress. The dosimeter is always able to be used as a direct-reading magnetic field meter.

It is important to remember that manual measurements made during a measurement sequence will be stored as measurement values.

TAG button

The **TAG button**, which is the right side button is used to mark a particular measurement event. This can include a series of measurements outside the planned measurement series, or commencement of measurement on a new floor level in a building, or something that deserves special attention in the results. The next measurement value is tagged by depressing the button for at least four seconds.

Both buttons

The measurements can be started by depressing **both buttons** for four seconds, if the dosimeter is programmed for manual start/stop. Likewise, depressing **both buttons** again for four seconds will stop the measurements. It is possible to start and stop the measurement sequence as often as one wishes, in this manner.

It is possible to start an automatic logging program, with measurements every ten seconds, even if the dosimeter is not programmed at all. The **TAG button** is depressed for at least four seconds until the **LOG indicator** is lit. The measurement is started by depressing both buttons simultaneously.

WARNING!

The date and time can be incorrect when using this ten seconds logging mode. This is due to the fact that time and date can only be downloaded from the PC.

Bar-graph scale

The twelve light-emitting diodes show the current measurement value every time the **B button** is depressed. It also shows how much memory is available for storing the measurement data. After the **B button** has been depressed, a light-emitting diode, on a scale between 0 and 100%, will blink for the first two seconds. If **0%** blinks, then almost all the memory is available for measurement data. If **50%** blinks, then half the memory has been used. If there is no memory available, then **Memory full** diode will blink and in that case, the dosimeter will close itself down. The memory contents are erased whenever a new measurement sequence is downloaded.

B indicator

A steady light means that the dosimeter is being used for manual measurement, and a rapid blink indicates that a measurement value has just been stored.

LOG indicator

A steady light means that the dosimeter is being used for time-controlled (automatic) measurement, and a blinking light indicates that the dosimeter is waiting for a manual measurement sequence to begin.

TAG indicator

The next measurement will be tagged when the blinking **TAG indicator** light changes to a steady light, after approx. four seconds.

Battery indicator

The **battery indicator** starts to blink when the battery voltage is low, and the batteries are to be replaced. About 30 hours of active measurement are possible with new alkaline batteries. Fully charged NiCd or NiMH batteries are sufficient for 8 to 10 hours of active measurement. The logging is interrupted if the batteries become low, with the reason for stoppage being given as *Battery*.

Dosimeter memory management

There can be occasions when it is desirable to empty the dosimeter of its memory contents. For example, the dosimeter may have been programmed in such a way that the measurements cannot be carried out, or the ten second measurement mode is chosen instead. There are however, several ways that are available for this emptying. The dosimeter can be reprogrammed, which erases the previous setup values and data. The batteries can be removed and the entire memory is empty after 10 - 15 minutes. It is also possible, providing that the dosimeter is not actually measuring, to erase the memory completely. **Both buttons** are depressed for a period of 10 seconds, then released, and then **both buttons** are depressed again for a further 10 seconds. In addition to the memory being erased, a light-emitting diode test will begin which blinks each diode in turn until the buttons are released.

4.2 Getting started with System FD3

Five complete measurements, parameter settings and presentations are supplied with the System FD3 so that it is easy to get acquainted with the system.

System FD3 is started by double-clicking on the *FD3 symbol*. An initial figure of the dosimeter is shown when the program is run in the PC.

There are several functions in the *File menu* in the left-hand top corner. These are *Open, Export, Import, Setup* and *Exit*.

Open is used for everything connected with measurements. Here, one can choose to define and then start a new measurement with *New Measurements*, examine measurements in progress with *Measurements in progress*, or that have already been carried out with *Completed Measurements*. Some examples are found in *Completed Measurements*.

The function *Setup* in the *File menu* is used to insert the limits required for the two graphs *Distribution* and *Spectrum*. These values are to be defined before the measurement parameters are downloaded to the dosimeter. There is a description in section 4.6 Export of measurement data on how the limits can be changed after the measurements are done. The unit chosen can be freely selected at presentation, and is not a parameter that is required beforehand.

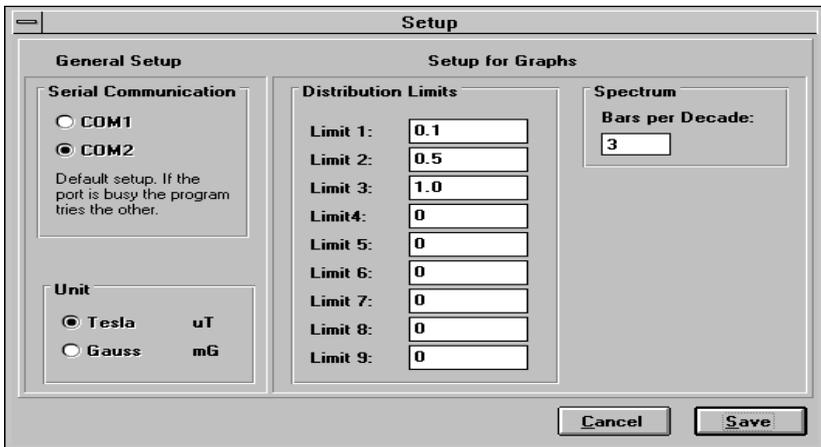


Figure 4.1

4.3 Measuring in practice

System FD3 can be used both as a direct-reading magnetic field meter and as a programmable dosimeter. There are five methods of logging measurement data in System FD3, one of which can be started directly from the dosimeter. The other methods are selected in *Measurement Parameters* in the System FD3 program. One of the programmable methods logs the actual displayed value. The other three are time-controlled and thus mean-value measurements are possible. The time-controlled measurements are initiated by date and time, manual control, or for the same time period every 24 hours.

Direct-reading magnetic field meter

The dosimeter is always able to be used as a direct-reading magnetic field meter by depressing the **B button** and reading the result from the bar graph. The measurement value is updated once a second whilst the button is depressed. Immediately after the **B button** has been depressed, an internal test of the dosimeter takes place and one of the light-emitting diodes will blink. This test shows how much memory is remaining to store the data in. Section 4.1 Dosimeter functional description, contains more information about the memory test.

Initialising a new measurement

New Measurements is chosen or *New...* is clicked on to program the dosimeter for a new measurement. The measurement information is inserted here that applies to the measurement, to which project it will be a member of, and other information that is included in the report identification. Click on *Project ...* if a new project is to be defined.

Figure 4.2

Manual logging is similar to the direct-reading method. A measurement result is logged every time the **B button** is depressed. The number of repeated measurements in every occasion can be chosen to between 1 and 30 repeated measurements in succession. The result will be the mean-value of these. As each individual measurement takes one second, a measurement with 10 repeats will take 10 seconds.

It is important that the dosimeter is stationary for the whole of the measurement period, when separate X-, Y-, and Z-axes values are being stored. A fourth RMS value is calculated as if normal measurement data storage was selected. It should be remembered that separate measurement value storage occupies much more memory and that the measurement time is reduced. The light-emitting diode **B indicator** blinks with each individual measurement. Select from *Method* whether *Clock*, *manual Start / Stop* or *Repeat every 24 hours* is required.

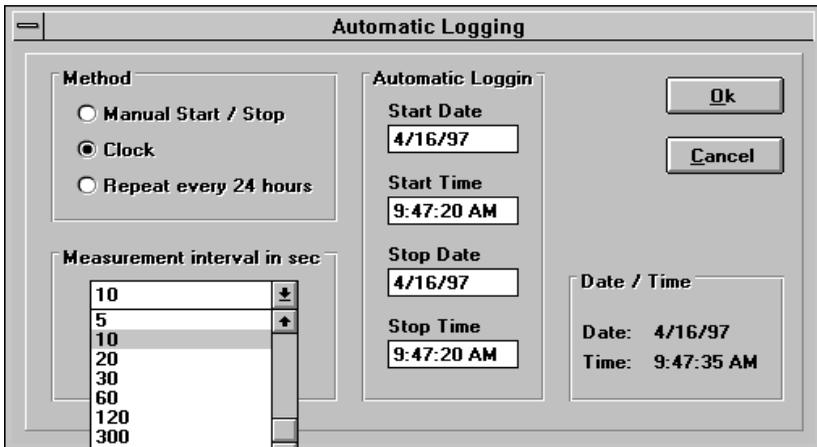


Figure 4.3

Logging with manual start commences when **both buttons** are depressed for 4 seconds. During this time, the **TAG** and **LOG** light-emitting diodes will blink. When the **LOG** light shines steadily, then the logging begins according to the previously defined time-interval, which can be from once a second to every 10 minutes. The measurement sequence can be interrupted and restarted again by depressing **both buttons** together. Every sequence between a start and a stop will be displayed as a separate measurement.

The dosimeter is programmed, with the time-controlled method, to start logging at a given time and date. The dosimeter ceases logging at the defined point in time. System FD3 uses the integral system clock in the PC, and it is therefore very important that it is correct.

The method called *Repeat every 24 hours* logs measurement data between two points in time, repeating this time window on the following day. The dosimeter measures according to the programmed interval which can be from once a second to every 10 minutes. The measurement must begin by depressing **both buttons** for 4 seconds.

When the setup values for a new measurement are complete, they can either be downloaded to the dosimeter or stored for later use. Setup values are stored in *New Measurements* using *Save*. The setup values can be changed by clicking on *Edit ...*. At a later date, the setup can be selected by double-clicking on it and choosing *Download* in the window *Configure Dosimeter*. The measurement information is moved to the *Measurements in progress* field in conjunction with the downloading of the setup to the dosimeter. If several dosimeters are used, then it is naturally possible to have several measurements in progress simultaneously.

The screenshot shows a dialog box titled "Information" with a close button in the top-left corner. It is divided into three main sections:

- Automatic Logging:** Contains seven input fields:
 - Start Stop: Clock
 - Interval: 1 Sec
 - Start Date: 10/11/95
 - Start Time: 5:59:34 PM
 - Stop Date: 10/12/95
 - Stop Time: 11:03:33 AM
- Manual Logging:** Contains one input field:
 - Count:
- Result:** Contains six input fields:
 - Stop Reason: Memory full
 - Mean Value: 0.087 uT
 - Max Value: 10.6 uT
 - Min Value: 0.01 uT
 - Count: 61.440
 - Data File: LOG10007

An "Ok" button is located in the bottom-right corner of the dialog box.

Figure 4.4

The measurement after completion is moved to *Completed measurements*. More information about the measurement is shown by clicking on *Show ...* This window shown the reason that the measurement stopped, which can be time-controlled, manual, cable, or memory full. A time-controlled measurement can be interrupted by connecting the dosimeter to the PC via the cable and uploading the measurement data

Ten seconds logging without PC downloading

This measurement method is integral in the dosimeter and means that it is possible to start logging even if no PC is accessible. A requirement is that there is no measurement sequence stored in the dosimeter. Ten seconds logging is started by depressing the **TAG** button for 4 seconds. The **TAG** indicator will immediately start blinking, and the dosimeter is initialised when the **LOG** indicator begins to light up continuously. The logging is started in the same way as manual logging, that is by depressing **both** buttons simultaneously for 4 seconds. The interval between two measurements is 10 seconds.

4.4 Data presentation as thumbnail sketches

The maximum number of measurements that the dosimeter is able to store is over 60,000. This is equivalent to one measurement per second for almost 17 hours. A data file in the library *C:\FD3BIN* contains all the measurement values as well as the information about measurement time, place, and tag markings. A number of thumbnail sketches are calculated to ease evaluation and presentation of all this measurement data. It is just one of the thumbnail sketches that is shown when a line diagram is selected. Thumbnail sketches are calculated whenever the measurement results are uploaded from the dosimeter to the PC.

System FD3 automatically calculates four thumbnail sketches for every measurement. Clicking on *Diagram ...* shows the thumbnail sketches in the window *Completed Measurements*. The four diagrams can be printed, using *Print*, or copied using *Copy* to the clipboard in the PC.

The measurement result is inserted in a report using Word by simply selecting *Paste* after having selected *Copy* in System FD3. The *diagram Information* can be included in the report by pressing *Alt* and *Print Scrn* together and then selecting *Paste* in the report program.

Line Diagram

The first thumbnail sketch is *Line Diagram* that converts the measurement data to a hundred display groups. Suppose that a measurement consisted of 2,632 measurement results. The thumbnail sketch will calculate the mean values as required for the 100 measurement display groups. The value 2,632 is not exactly divisible by 100, which results in a scale adjustment in the diagram. Rapid changes in the magnetic field will not be lost however. The actual highest and lowest values in each of the display groups will also be shown as a separate maximum and a minimum curve. These two auxiliary curves can be removed by clicking in the boxes *Max Value* and *Mean Value* and then on *Redraw*.

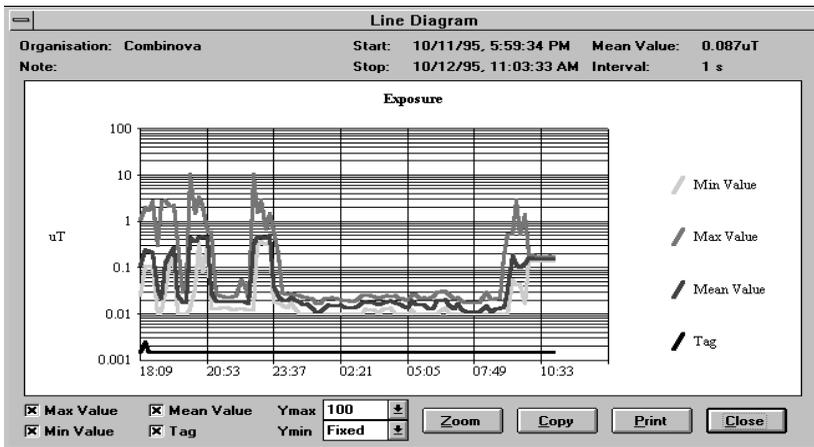


Figure 4.5

All the measurements will be displayed where measurements with less than 100 measurement results. The maximum/minimum curves are not required and are not displayed.

Ymax and *Ymin* are *Y-axis* scale factors. This facility is applicable when comparing measurement data with different kinds of measurement. *Fixed* sets the *Y-axis* lowest value to 0.001 μT . The *Tag* function is described in section 4.1 Dosimeter Functional Description.

The zoom function allows detailed examination of an event, down to individual measurement values. The start time and stop time are marked by clicking on the *X-axis* at the time interval that is to be zoomed. The start time is shown as a blue line, and the stop time by a red line. A new line diagram is drawn when *Zoom* is clicked. Start- and stop time can also be defined by entering values on the keyboard. There is only one way to save a zoomed diagram, and that is by clicking on *Copy* and then *Paste* in a document or as a file saved in a suitable graphics program. Zooming can take up to several minutes.

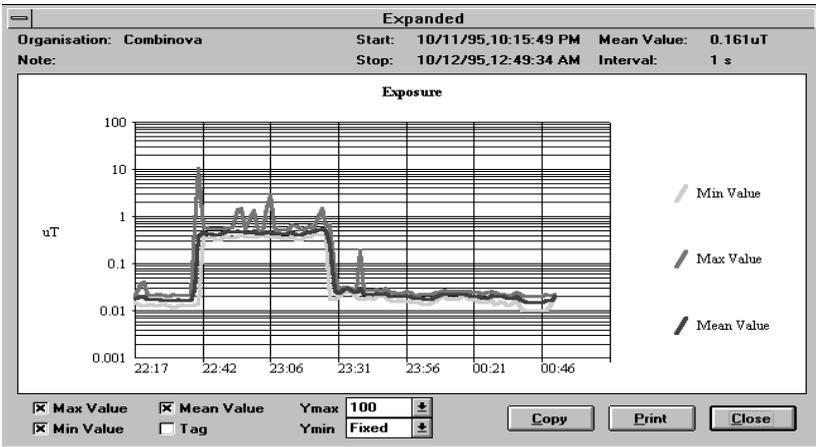


Figure 4.6

Bar diagram

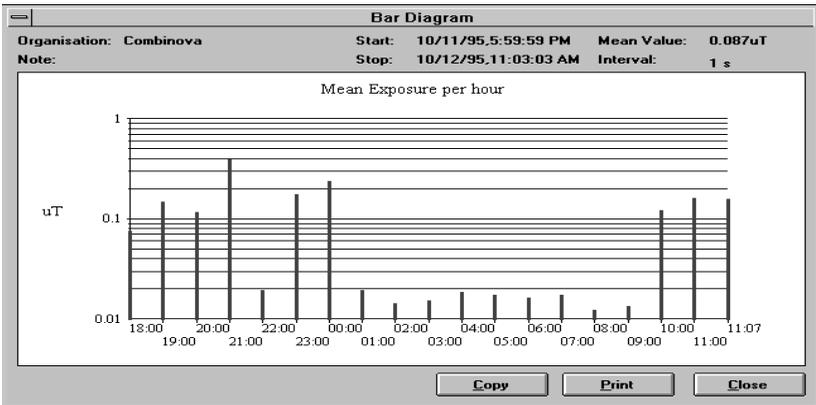


Figure 4.7

The second thumbnail sketch is a bar diagram, which shows mean exposure per hour. The bar diagram is not shown for measurements less than one hour. The maximum number of bars that can be shown is 48 hours or two 24-hour periods. There are no maximum or minimum values in the bar diagram.

Spectrum diagram

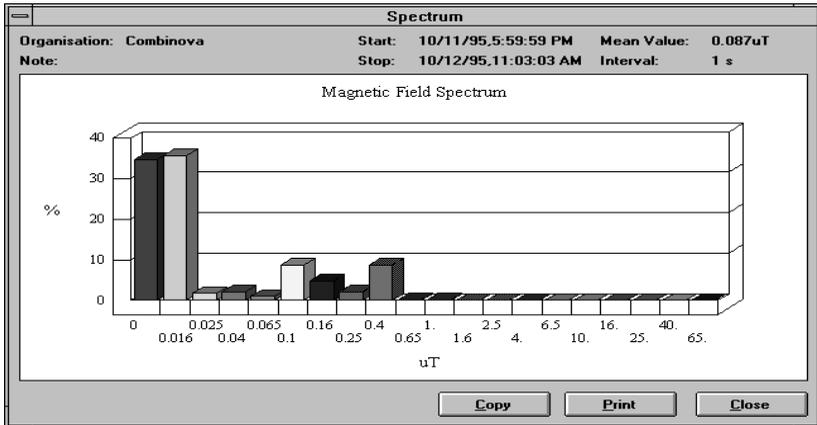


Figure 4.8

This thumbnail sketch shows the exposure as a 3D-bar diagram over the whole of the measurement range, which spans four decades, 0.1 μT , 1 μT , 10 μT and 100 μT . The number of bars per decade are defined as shown in figure 4.2 *Setup* before the measurement takes place. The X-axis has a logarithmic scale to enhance the display resolution of the smaller measurement values.

Distribution diagram

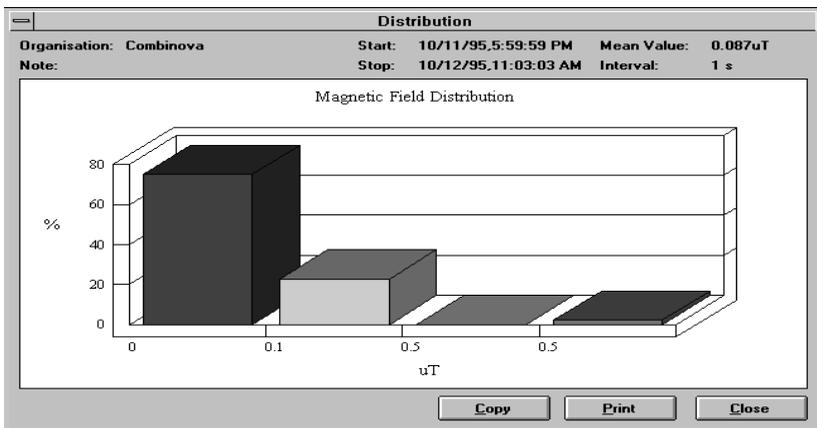
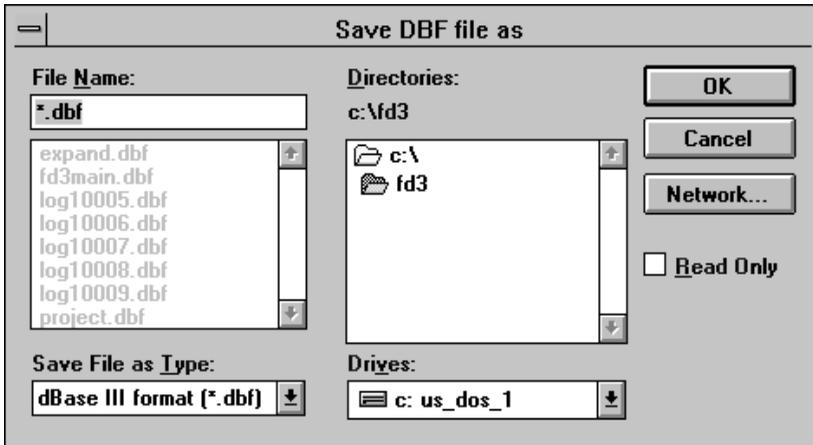


Figure 4.9

The limits on the X-axis for the distribution diagram are defined as shown in figure 4.2 *Setup* before the measurement takes place.



Figur 4.11

The DBF-file that is created can naturally be stored in any directory or on diskette.

Excel

	A	B	C	D	E	F	G	H	I	J	K	L
1	SEGI	DATATYP	DATE	TIME	MARKE	MINVALU	MAXVALU	MEANVALU				
2	10008	M	14/10/95	14:17:00	0.015	0.015	9.900	0.562				
3	10008	M	14/10/95	14:18:00	0.015	9.200	80.000	30.635				
4	10008	M	14/10/95	14:19:00	0.015	9.700	58.000	21.485				
5	10008	M	14/10/95	14:20:00	0.015	9.800	50.000	21.550				
6	10008	M	14/10/95	14:21:00	0.015	0.035	99.900	29.665				
7	10008	M	14/10/95	14:22:00	0.015	0.032	99.900	47.962				
8	10008	M	14/10/95	14:23:00	0.015	0.031	38.000	12.275				
9	10008	M	14/10/95	14:23:24	0.015	0.031	38.500	22.557				
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Figure 4.12

The measurement data can be further analysed, calculated in another way, or presented in another manner than the four thumbnail sketches in System FD3, by using a spreadsheet program, such as Excel. This program can then use the measurement that has been expanded to DBF-format in the directory C:\FD3DBF or a user-defined directory.

The field *DATATYPE* contains *V* for line diagram, *M* for mean value per hour (time-bars), *B* for spectrum diagram and *D* for distribution diagram. The Microsoft user handbook on Excel contains more information on how the spreadsheets filter function can select the thumbnail sketch that is required for use.

Warning!

If the original file is used by a spreadsheet program, then the data format may have been changed. System FD3 will not then be able to use the file. Always use a copy of a DBFfile if Excel or Lotus 123 will use the file.

4.6 Export of measurement data

The measurement can be sent to another PC user on a local area network by choosing *Export measurement* instead. The measurement that will be copied and sent is selected in the usual way. *Export* is clicked on and then the desired address where copying will take place.

It is possible to modify the limits and the number of bars per decade for the distribution- and spectrum diagrams of a completed measurement. This is done by inserting the new limits in *Setup* in the *File* menu. The completed measurement is then expanded into the directory *C:\FD3DBF*, replacing the existing file by using the same name.

4.8 Some general advice

It is easier to understand measurement results taken over a shorter period, by taking a number of shorter measurements at first. The earth's static magnetic field will affect the result if the dosimeter is logging and simultaneously shaken violently. This phenomenon is more apparent with lower background levels. A normal office environment has a field of about 100 - 200 nT, this value being often double so high in a petrol-driven car.

It should be borne in mind that, with manual measurement, the diagrams have a display resolution of about 100 points. The program will calculate the mean value and display 100 points, even if the measurement contains more than 100 measurement results.

4.9 Checking the dosimeter programming status

The **B button** is used to see how and if the dosimeter is programmed.

An internal test program starts directly after the B button is depressed. This shows how much of the memory is available for use by a light-emitting diode that blinks on the bar graph scale. The test program lasts one second. The dosimeter programming status will be shown by holding the B button down after this time.

The dosimeter is not programmed if only the **B indicator** and the bar graph scale light up.

The dosimeter is programmed for manual start if the **B indicator** is lit up and the **LOG indicator** is lit up but blinking.

If both the **B indicator** and the **LOG indicator** is lit up but constant, then the dosimeter is programmed for time-controlled measurement. The light-emitting diodes light up constantly irrespective of whether a measurement is going to start or is in progress. The B indicator blinks each time that the dosimeter logs a measurement value.

4.10 Checking the System FD3 program version

The function ? is clicked on the initial window followed by *Program versions*.

System FD3 consists of four program modules, each with its own version and number.

FD3 is the program module that contains the Windows program.

Dosimeter is the program located in the dosimeter.

Transmit and *Receive* are communication and calculation program modules.

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Section 5

TECHNICAL DESCRIPTION

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5.1 Measurement Principles

The dosimeter uses true RMS measurements of low frequency magnetic fields. Measurements are made by a sampling technique with multiple samples to give a complete representation of the signal. The samples measurement values are A/D converted and the microprocessor calculates the true RMS value.

Magnetic field measurements are made using three orthogonal coils and the microprocessor calculates a direction independent measurement result (three axis measurement).

The frequency response of the amplifiers in the dosimeter are adapted to avoid any influence from movement of the instrument in the earths static magnetic field. The amplifiers have a six-pole high-pass filter with a lower cut-off frequency of 20 Hz. The normal fundamental frequencies of sources used with the dosimeter are either power frequencies (50/60 Hz) or vertical deflection frequencies from VDTs. The modified frequency response will not cause problems for these applications.

The frequency response will cause an attenuation of the signal for measurement situations where the source frequency is substantially lower than 50 Hz. For railways with a supply of 16.7 Hz, the measurement values are attenuated to around 50% and the results should be multiplied by 2.

The magnetic field measurement coils in the dosimeter are significantly smaller than the ones defined for VDT measurements. In a homogeneous field this has no difference on the measurement result. In an inhomogeneous field, there can be a small difference between the dosimeter and instruments with the standardised coil size. The dosimeter can read some 2 - 3% lower than the standardised instruments at normal measurement distances to VDTs.

5.2 Electronics

The electronics in the dosimeter are divided into two printed circuit boards. One contains the analog amplifiers for the measurement signals, and the other is for the digital part and display. Figure 5.1 shows the block diagram that describes the dosimeter function.

The analog parts of the dosimeter have the following main functions:

- Integrator stages for the magnetic field sensors
- Three-pole low-pass filter with a cut-off frequency of 2.000 Hz
- Six-pole high-pass filter with a cut-off frequency of 20 Hz
- Full-wave rectifiers for the measurement signals
- Compressors with a linear to logarithmic characteristic
- power supply for converting the battery supply to suitable voltages for the working electronics.

The digital parts of the dosimeter have the following main functions:

- A microprocessor with on-chip A/D converter, (Motorola 68HC11).
- An 8 Kbytes EEPROM memory for software storage and correction factors for all the measurement channels. This enables the instrument to have software updates on site without having to replace any sensitive electronic components.
- 128 KB RAM memory for storage of measurement data
- A multiplex driven bar graph display with 16 light-emitting diodes (LEDs)
- Battery voltage monitor
- Push buttons for operator controls

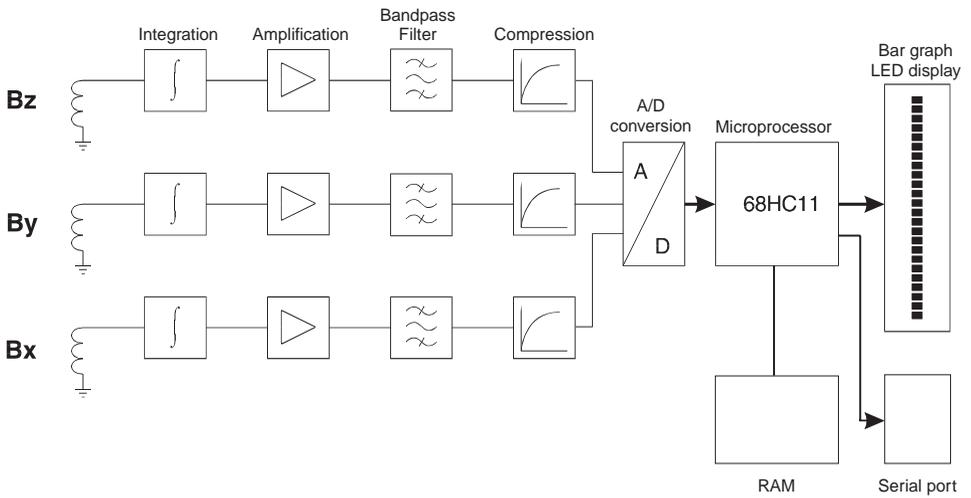


Figure 5.1 Dosimeter blockdiagram

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Section 6

SPECIFICATIONS

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6.1 Dosimeter

Measurement range:	40 nT - 100 μ T (RMS)
Sensor system:	3 axis coil system
Frequency response:	20 Hz - 2.000 Hz (-3dB)
Measurement uncertainty:	\pm (5% of value + 0.01 μ T) at 18 - 28°C
Temperature coefficient:	max. 1%/°C (at temperatures outside 18 - 28°C)
Memory capacity:	60.000 measurement results
Communication:	RS232 via serial adapter
Display type:	16 light-emitting diodes (LEDs)
Batteries:	Two R6 (AA) size alkaline batteries with operating time of 30 hours active measurement in normal use
Dimensions:	Length: 205 mm Width: 70 mm Height: 35 mm
Weight:	290 g (including batteries)
Operating temperature:	-10 to +40°C

Combinova AB reserve the right to amend specification without prior written notice. The specifications are given at the ambient temperature $T_{amb} = 23 \pm 5$ degrees centigrade.

6.2 Program

Manual measurement:	1-30 measurements per measurement result Mean-value is calculated for each result
Automatic measurement:	1-600 seconds measurement interval Manual Start/Stop Time-controlled by date/time Repetition every 24 hours (manual start)
Integral automatic measurement:	One measurement every 10 seconds
Result presentation:	Time-axis line diagram with min. max. and mean value Bar diagram with mean value per hour Magnetic field spectrum over the measurement range Magnetic field distribution Measurement export to another PC user Measurement export to program via DBF-format
Result storage:	3-axis summation Separate X-, Y-, and Z-axis
System requirements:	Windows 3.1, PC or compatible (80386 or later), with at least 4 MB RAM memory an unused serial port (COM1 or COM2) Windows 95, PC or compatible (80486 or later), with at least 16 MB RAM memory an unused serial port (COM1 or COM2)

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