

ELECTRIC FIELD METER 200

Operator's Manual

The EFM 200 is a professional instrument to measure electrostatic and alternating electric fields.

To make the best use of this instrument, we recommend that you read this manual carefully.

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Section 1

INTRODUCTION

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The Electric Field Meter 200 (EFM 200) is a professional instrument designed to measure electrostatic and alternating electric fields. The EFM 200 has been developed for self-contained field operation with such features as built-in rechargeable batteries, LCD display and large data logging memory.

1.1 Electric Field Measurements with EFM 200

Electric fields exist over a very wide range of amplitudes and frequencies. The EFM 200 is designed to measure both static and low frequency electric fields, within the following limits:

- » Electrostatic fields from 0.5 - 1,000kV/m
- » Alternating electric fields
 - ELF frequency range (5 - 2,000Hz) from 0.5-10,000V/m (rms)
 - VLF frequency range (2-400kHz) from 0.05-1,000V/m (rms)

Measurements are made using a ground reference technique to reflect the electric field from the source to specific ground reference probe. The instrument has been specifically designed to fully comply with the Swedish MPR test methods for VDU's which is applicable from 1 January 1991. All accessories needed for MPR measurements are delivered with the standard instrument (see Section 2).

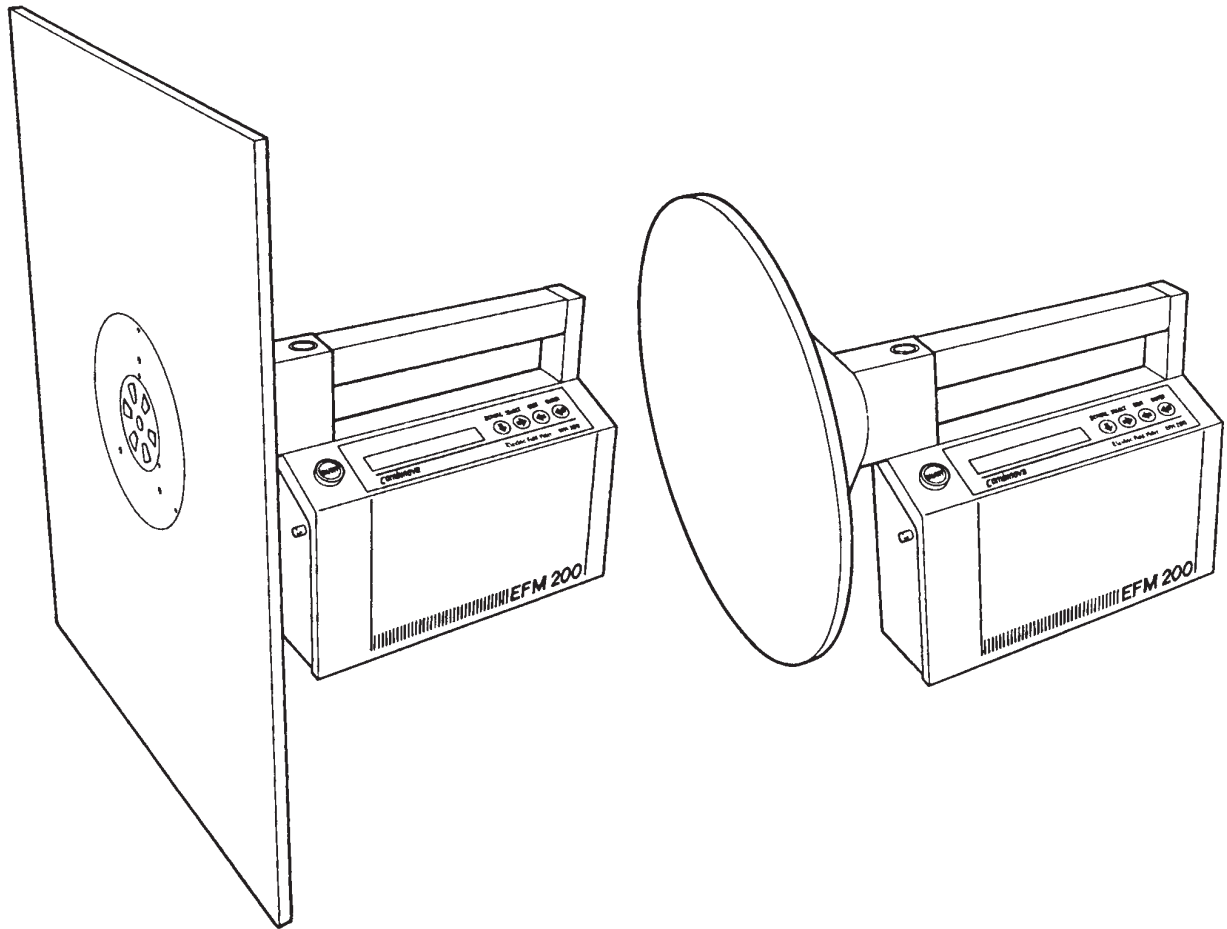
1.2 The Instrument - EFM 200

Electric Field Meter 200 is a professional instrument to measure electrostatic and alternating electric fields. The instrument has a wide dynamic range with automatic gain setting. Electrostatic field measurements are made using a built-in field mill probe. Alternating electric fields are measured using a special probe. Two different frequency ranges are available; ELF (5-2,000Hz) and VLF (2-400kHz). The instrument is powered by a built-in chargeable sealed lead-acid battery. The built-in communication interface (RS232) can be used to transfer stored results to a printer or a computer.

The options available with the instrument are:

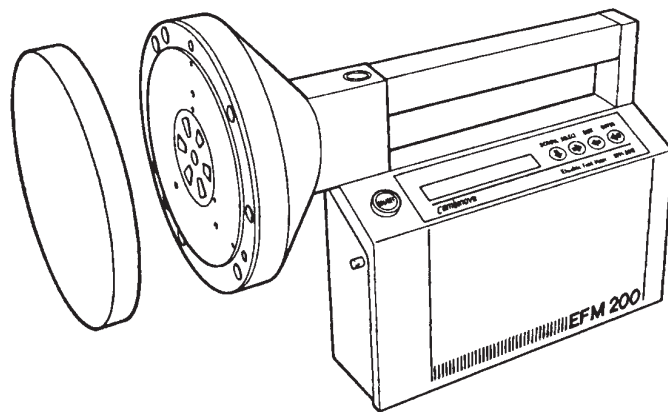
- » Fiber-optic interface kit for remote control operation.
- » Probe to check instrument calibration.

The electronics in the instrument comprise analog amplifiers, a microcomputer with communication peripherals and an alphanumeric LCD-display with back light. A built-in clock and calendar is used in the data logging measurement modes.



Static Field Probe

AC-Field Probe



Basic EFM 200 (with Field Mill)

Fig. 1.1 EFM 200

1.3 Using the EFM 200

The EFM 200 has been designed to be easy to use in the field. A four-key keyboard and LCD display panel allow the instrument operation to be optimized for the particular measurement application. Once the instrument has been set up then measurement is initiated by simply pressing the start button. The display even informs the operator of remaining measurement time until the batteries should be recharged.

The main instrument modes are:

- » **MEASUREMENT**
Measurement mode is used to make the actual measurements. A number of different measurement modes can be selected (single, repetitive and logging).
- » **DATA RETRIEVE**
Data retrieve mode is used to show stored measurement data on the instrument display. Mean period values as well as single measurement data can be accessed in this mode.
- » **PRINT**
Print mode is used to dump stored data to a printer or computer through the built-in RS232 serial interface.
- » **CHECK**
Check mode includes a number of tests to verify different instrument functions.
- » **PARAMETERS**
Parameter mode gives the user a wide variety of possibilities to adapt the instrument for different measurement and communication needs.

Selecting the measurement mode and setting up the EFM 200 is described in Section 3, Operating Instructions.

A technical description of the EFM 200 is given in Section 4.

IMPORTANT!

Do not touch the Field Mill and avoid contaminating the surface of it. When the instrument is not in use, keep the field mill covered with either the AC-field probe or the protective cover.

1.4 Combinova AB - Behind the Product

The Electric Field Meter 200 has been developed by Combinova AB, who are also responsible for the manufacture, marketing and after-sales service of the instrument.

Other field measurement products from Combinova are:

- » MFM 1000 - Magnetic Field Meter for the VLF (2-400kHz) range.
- » MFM 1020 - Automatic VDT magnetic field measurement system.
- » MFM 10 - Magnetic Field Meter for the ELF (5-2000Hz) range.
- » EFM 100 - Alternating electric fields in the ELF (5-2,000Hz) and VLF (2-400kHz) frequency ranges.

Combinova AB works with Swedish and international industrial clients in the area of broad technical development. The principle areas of development expertise are:

- instrument development
- technical trouble shooting
- manufacturing equipment development

This depth of technical experience makes it possible for the company to handle all stages of product development, including project management and technical co-ordination.



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Section 2

UNPACKING AND INSPECTION

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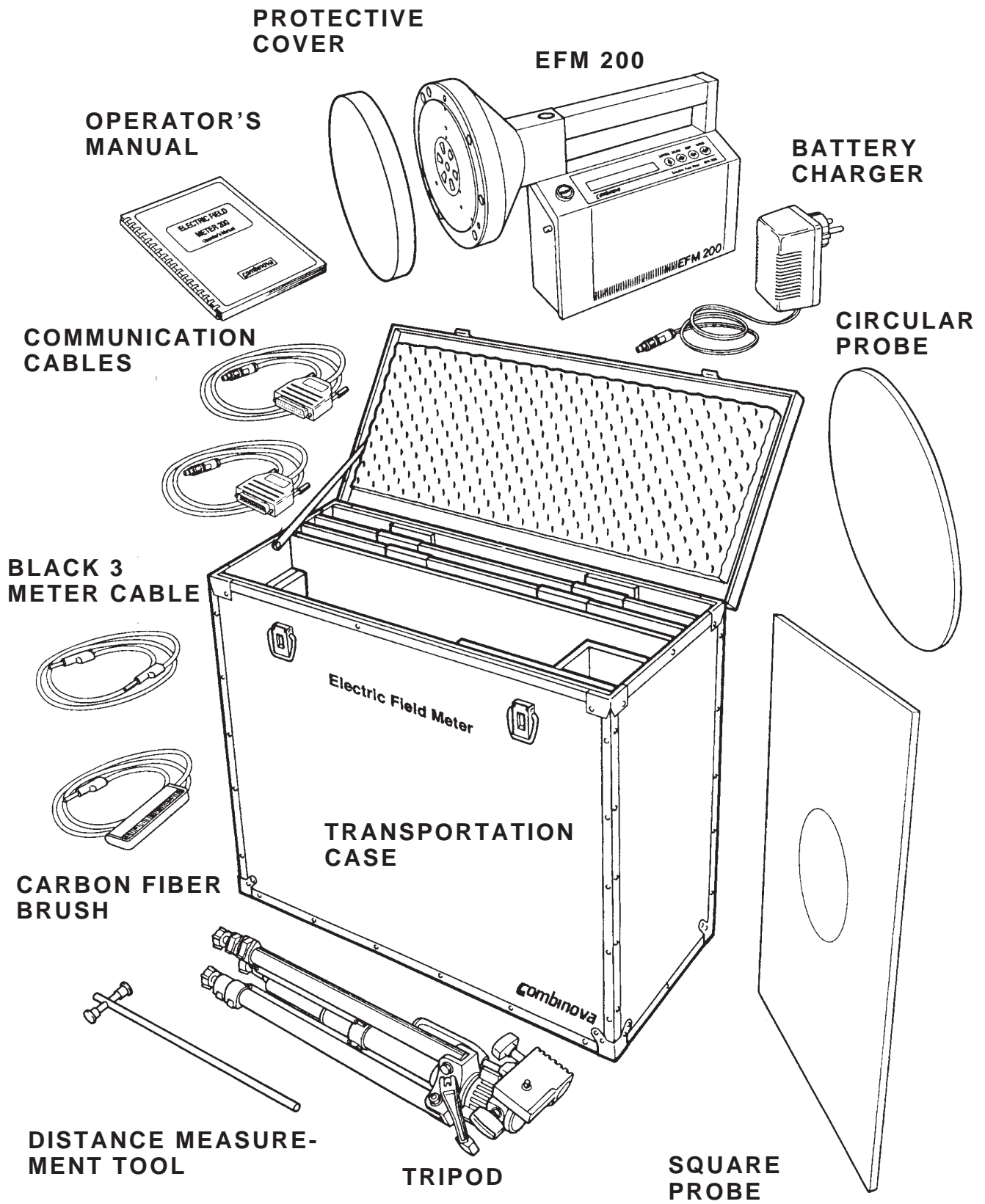


Fig. 2.1 Unpacking the EFM 200

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2.1 Unpacking

The EFM 200 is delivered in a specially designed transport box, which also contains all the accessories that are used with the instrument. Inspect the transport case for any damage caused during transit. If damage has occurred, please contact the shipping company who delivered your instrument.

Open the case and check that the following items have been supplied (see Fig. 2.1):

Standard Instrument

- » EFM 200 instrument
- » Protective cover for field mill
- » Battery Charger PS10 (110V or 220V)
- » Measurement probe for alternating electric fields, Ø0.3m
- » Ground reference plate for electrostatic field measurements, 0.5x0.5m
- » Ground reference cable (black 3m with connection clip)
- » Two Communication Cables (for Printer/Computer)
- » Operator's Manual.
- » Distance measurement tool, 0.500m/0.100m
- » Carbon fiber brush
- » Standard Tripod

Optional Probe for Calibration Test

- » Probe plate 0.5x0.5m
- » Signal cable (red 1m + isolated connection clip)
- » Distance pieces for probe plate positioning (2 pairs)
- » Instrument foot for electrostatic calibration test

Optional Fiber Optic Remote Interface

- » Fiber interface (internal)
- » Fiber Cable (10m) with connectors
- » Fiber Adapter 10, for use with an RS232 25-pin PC serial port

IMPORTANT! Complete the warranty form and return a copy to Combinova AB. The warranty is only valid when the warranty form has been completed and received by Combinova AB.

Before switching on the instrument, read this manual carefully.

2.2 Inspection

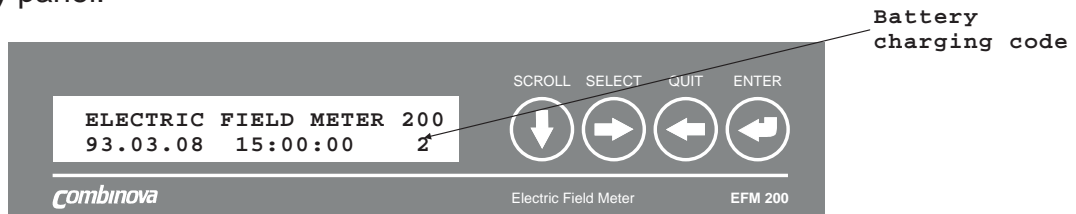
Inspect the EFM 200 and the accessories supplied for any sign of damage.

Before the EFM 200 can be used the voltage of the re-chargeable battery should be checked. The battery is fully charged when it leaves the factory. However, if for any reason it has become discharged then the instrument will not operate correctly, and will need to be recharged.

EFM Checks

- Switch on the instrument, using the ON/OFF button (see figure 2.1).

The EFM carries out a number of checks and then displays the following message in the display panel:



Note: Refer to Section 3.6 to set the correct time and date!

- Check the battery charging code in the bottom-right of the display panel.

When "0" or "1" is indicated then the battery should be fully charged. Check the battery voltage if any of the other codes are shown.

2.3 Checking the Battery Voltage

This procedure is fully described in Section 3.5, but a brief guide is given here.

- Switch on the instrument.
- On the control panel select "CHECK" by pressing the "SCROLL" button (⬇️) **four** times so that the display panel shows:



- Press the "SELECT" button (➡️), and the display panel will show:



where XX.XV is the battery voltage.

- Check that the battery voltage is greater than 11.5V. If it is below this voltage then recharge the instrument (see Section 3.7).

Section 3

OPERATING INSTRUCTIONS

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General

The EFM 200 has been designed to be simple to operate, while still retaining great operational flexibility. This section details how to operate the EFM 200 and how to obtain measurement results. The controls and display panel are described in Section 3.1 together with details of how to select functions and enter parameter values.

The EFM 200 uses a number of main operational modes, which are listed below, together with a reference to the section in which they are fully described.

- **MEASUREMENT (Section 3.2)**
Initiate electric field measurement, select measurement method.
- **DATA RETRIEVE (Section 3.3)**
Display measurement results, either in summarized form or individual results.
- **PRINT (Section 3.4)**
Obtain hard copy of measurement results, either summarized or individually.
- **CHECK (Section 3.5)**
Initiate internal instrument checks.
- **PARAMETERS (Section 3.6)**
Set up the instrument according to requirements.

3.1 General Operation

Figure 3.1 shows the location of the controls and display on the EFM 200. These are described below:

ON/OFF Switches the instrument on or off.

Start Measurement This button initiates measurement, see Section 3.2

The type of probe attached to the instrument automatically switches instrument operation mode between electrostatic and alternating electric field measurements.

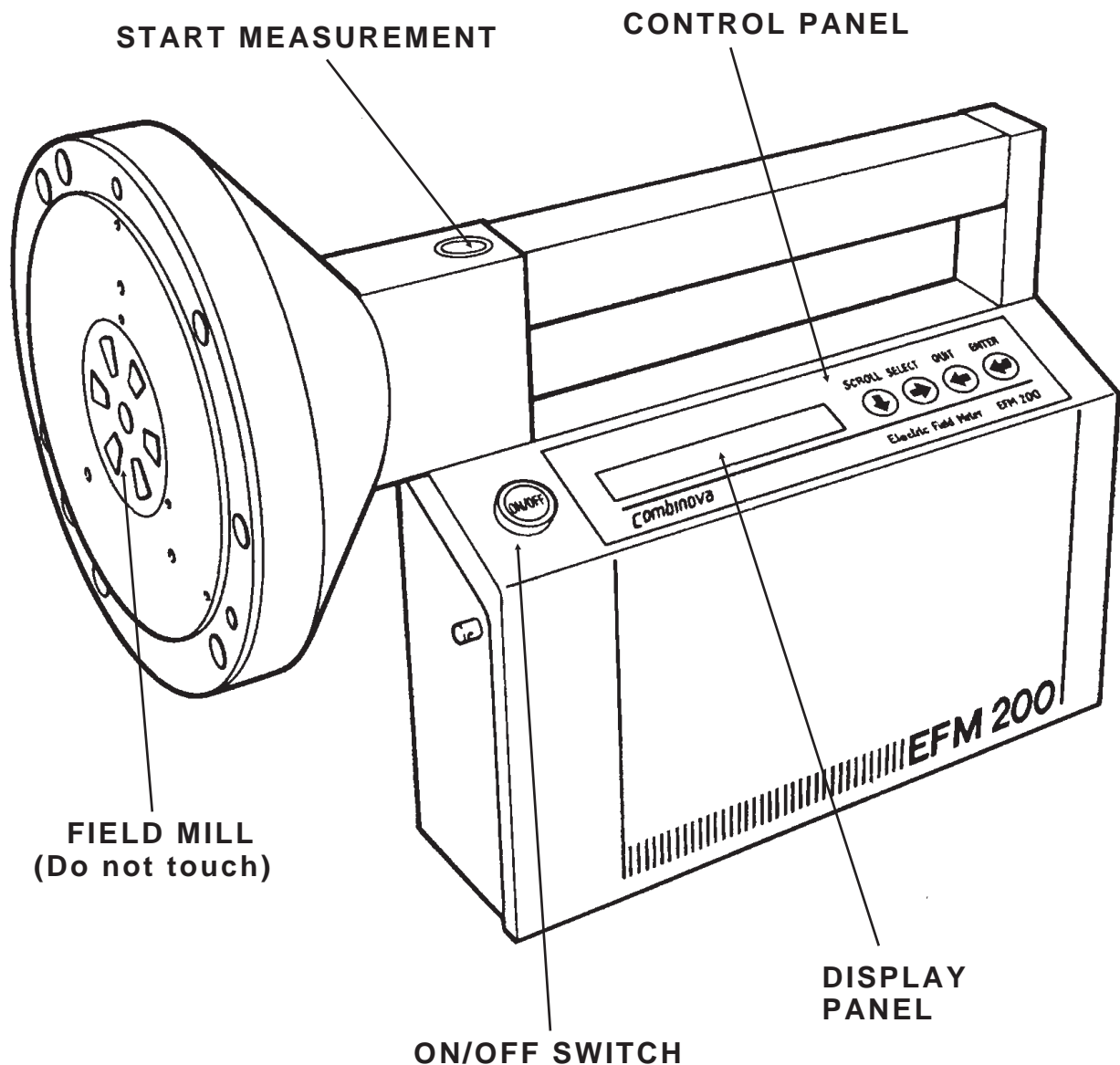


Fig. 3.1 Controls and Indicators

Fig.3.2 shows the control panel with its four function switches, which are described below:

- SCROLL (⬇️) Goto next function, sub-function result or value (see Fig. 3.3)
- SELECT (➡️) Select the displayed function.
- QUIT (⬅️) Quit the selected function and return to the next level (see Fig. 3.3).
- ENTER (↩️) Enter the selected value or parameter on the second line of the display panel.

Use SCROLL key to reach the main functional modes of the instrument. The next section shows how these controls and indicators are used.



Fig. 3.2 Control Panel

EFM 200 Function Modes

The instrument is automatically set to measure either electrostatic or alternating electric fields by the probe type which is attached to the instrument.

By using the four keys on the control panel, all functional modes of the instrument can be accessed. The available functions are shown in the flow diagram, Figure 3.3. The key presses required to select the function or enter values are also shown.

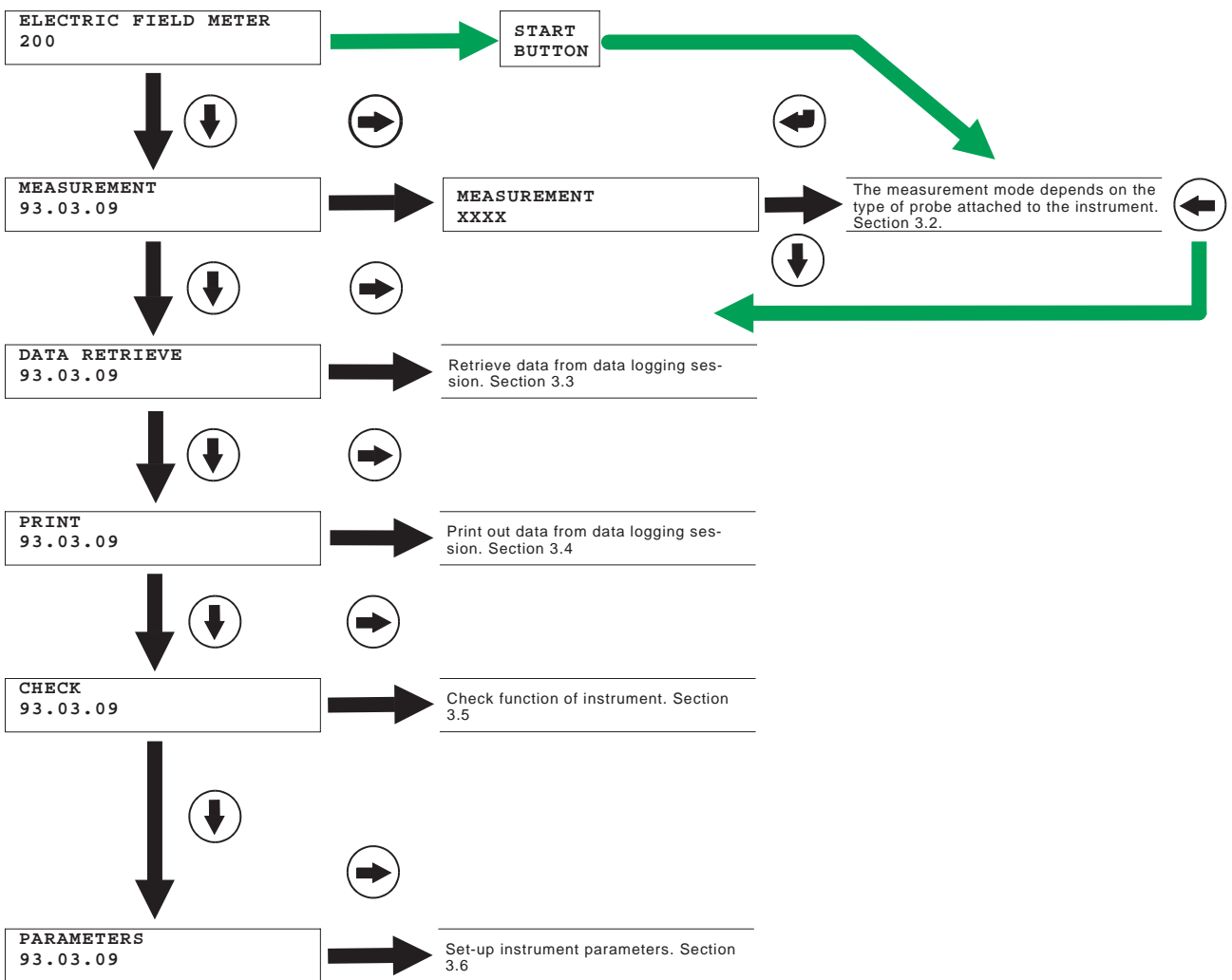


Fig. 3.3 EFM 200 Function Modes

3.2 Measurement

To start measurements switch on the EFM 200.

IMPORTANT: Always connect the ground pin on the EFM 200 to the field source ground (mains ground) reference as shown in Fig. 3.4.

Single Measurement

To carry out a measurement as previously carried out by the instrument, using the same probe type, press the green (START' button. After a short time status information is displayed, followed by a message 'waiting for start'. Press the 'START' button again to initiate the measurement.

Repeated Measurements

To select repeated measurements keep the 'START' button depressed during the first single measurement. To go back to single measurement press the 'START' button again.

Leave measurement mode by pressing 'QUIT'.

General

To ensure that accurate measurements can be made related to a specific field source always remember to measure the background field levels in the laboratory.

During measurements the instrument should be disconnected from the battery charger and electrical communication cables, to avoid interference.

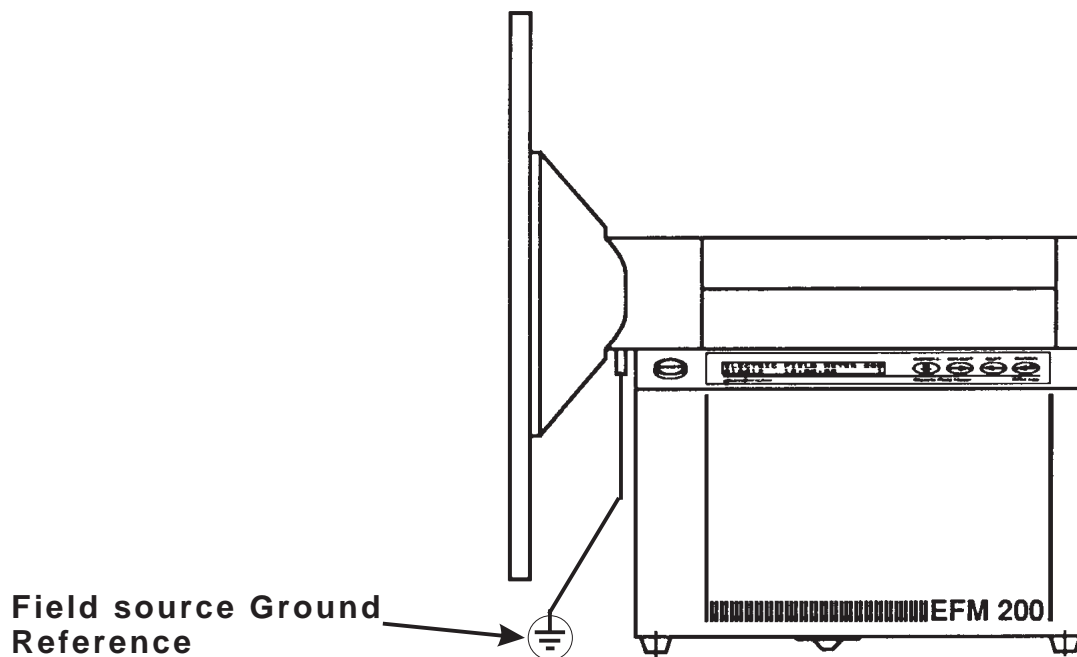


Fig. 3.4 Connecting the Ground Reference

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Measurement Modes

The instrument can be set to measure electrostatic or alternating electric field by fitting the appropriate probe. When a probe is fitted a 'key' system automatically configures the instrument for the selected electric field measurement.

Depending on the probe type attached, there are two measurement menus available which are described below. Once the probe has been attached, select 'MEASUREMENT' to enter measurement mode, see Fig. 3.3.

Static Field Probe

Using the **Static field probe**, two measurement modes are available, see Fig.3.5(a).

Single EP measurement – electrostatic field measurements.

Start MPR-logging of equivalent surface potential following the MPR rules.

$$\text{Potential } U = E * d * [1 + (0.12/D)^3]$$

where: E is the electric field in V/m

d is the distance between VDU screen and probe surface, fixed at 0.1m
 D is the diagonal of the VDU in meters.

The logging will stop when U after more than 1 minute has decreased below the **Limit of U** or when **Time limit** is exceeded.

The values of **D**, **Limit of U** and **Time limit** are selected in PARAMETERS as sub-parameters of **Eq. surface potential**, see Section 3.6.

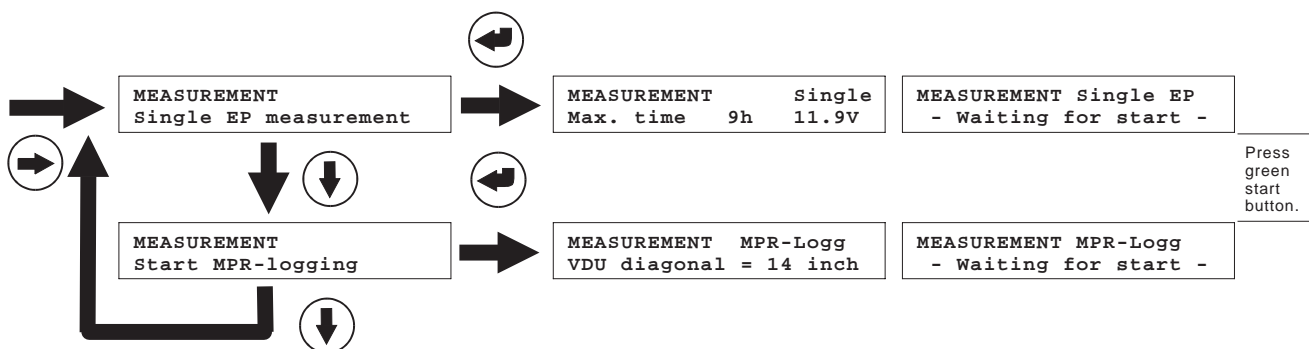


Fig. 3.4 Measurement Modes

Single and Repeated Static Field Measurements

When a measurement mode has been selected using the (ENTER' key the following message appears for approximately two seconds:

Max time Xh Z.YV

where X indicates the number of hours that the EFM 200 can operate before re-charging the batteries and Z.Y is the battery voltage. When the "Waiting for start" message is displayed the EFM 200 is ready to start measurements. Press the green start button to carry out a single measurement. Repeated measurements can be selected by keeping the start button depressed during one measurement cycle. Repeated measurement is stopped by pressing the start button again (return to single measurement mode). The mode will be automatically stopped after approximately 1.5 minutes (400 measurements). Measurement mode is left by pressing the QUIT key.

AC-Field Probe

Using the **AC-field probe** three measurement modes are available, see Fig. 3.5(b).

ELF measurement – alternating ELF electric field measurements. In addition to the result, the fundamental frequency of the signal is displayed.

After choosing ELF, the following modes are available:

- » Single ELF measurement
- » Continue ELF logg (will appear if a previous logging is stored)
- » Start ELF logg
- » Store demo data

Use SCROLL to get to the appropriate choice.

VLF measurement – alternating VLF electric field measurements. In addition to the result, the crest factor (= peak value divided by rms value) is displayed.

After choosing VLF, the following modes are available:

- » Single VLF measurement
- » Continue VLF logging (will appear if a previous logging is stored)
- » Start VLF logging
- » Store demo data

Use SCROLL to get to the appropriate choice.

E+V measurement – alternating ELF+VLF combined electric field measurements. Fundamental frequency of the ELF signal and crest factor of the VLF signal will NOT be displayed.

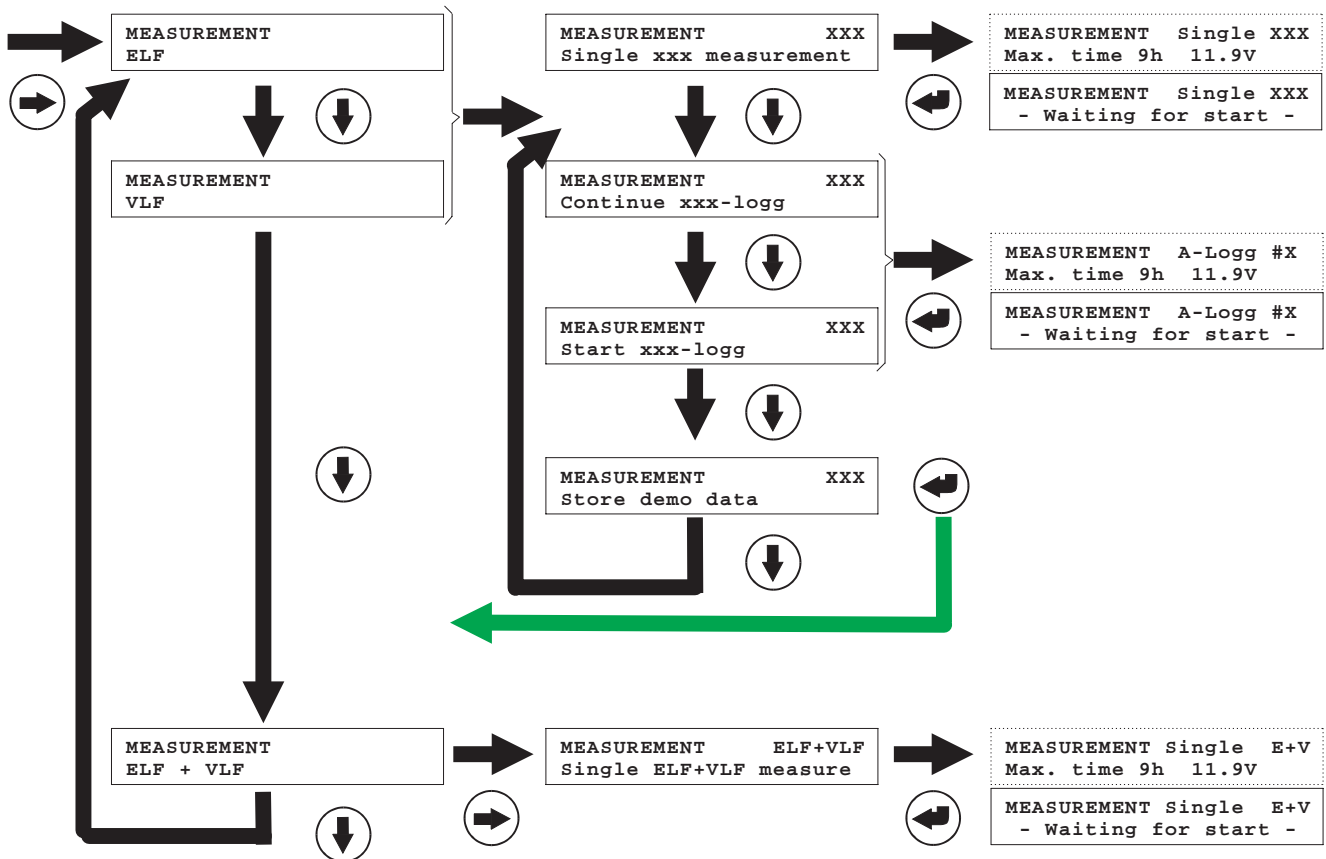


Fig. 3.5(b) AC-Field Probe - Measurement Modes

Single and Repeated AC-Field Measurements

When a measurement mode has been selected using the (ENTER' key the following message appears for approximately two seconds:

Max time Xh Z.YV

where X indicates the number of hours that the EFM 200 can operate before re-charging the batteries and Z.Y is the battery voltage.

When the "Waiting for start" message is displayed the EFM 200 is ready to start measurements.

Press the green start button to carry out a single measurement.

Repeated measurements can be selected by keeping the start button depressed during one measurement cycle.

Repeated measurement is stopped by pressing the start button again (return to single measurement mode). The mode will be automatically stopped after 1.5 minutes (400 measurements).

Measurement mode is left by pressing the QUIT key.

Data Logging Mode

There are two alternate logging modes, 'Start logging' or 'Continue logging'. If 'Start logging' is selected then the instrument's memory is **cleared** and a new logging sequence can be initiated. If 'Continue logging' is selected then the new measurement results are stored, continuing on from the previously stored results. The time break is indicated on the printout.

A "Start VLF/ELF-logging" will never erase a previously stored MPR-logg.

Select the 'logging' mode as shown in Fig. 3.5(b). When the mode is entered using the 'ENTER' key the following message is displayed for approximately two seconds:

Max time Xh (XV if battery is limiting factor)

where X is the maximum time remaining for automatic logging, limited by the size of memory.

The logging parameters, period, sample rate, are selected in the PARAMETERS mode, see Section 3.6. This determines whether manual or automatic logging is selected.

When the "Waiting for start" message is displayed the EFM 200 is ready to start logging measurements. Press the green start button to initiate measurements. Stop logging by pressing the QUIT key.

When manual logging has been selected PARAMETERS" mode, then the instrument should be used as for 'single measurements' except that a "burst" of measurements is taken and the results are stored in the instrument.

The measurement results can be retrieved using the 'DATA RETRIEVE' or 'PRINT' modes, see Sections 3.3 and 3.4.

3.3 Data Retrieve

The DATA RETRIEVE mode enables the results from data logging to be displayed.

Select DATA RETRIEVE as shown in Fig. 3.3, press the SELECT key to enter the mode.

AC-Field Probe Attached

```
DATA RETRIEVE
Periods #a - b
```

where a = first period, and b = last period. The number of periods depends on how long data logging was used.

Press SELECT to display a summary result of each period, the first period is shown:

```
Period #1<
x      Bmean = .....
```

where

- x = number of results in the periods
- < = logging was interrupted.

The mean value from the results in the period is shown. The number of results in the period is set in the PARAMETERS mode, see Section 3.6. To see the mean results from the other periods, use the "SCROLL" key.

Static Field Probe Attached (or no probe)

The following display is shown:

```
DATA RETRIEVE
MPR-Logg
```

Press SELECT to display a summary of results:

```
Period #1      MPR-Logg
U:      -.49kV *      08'22"
```

The summary display above shows that a potential of 490V (limit 500V) was reached in 8 minutes and 22 seconds after power-on. The "*" indicates that logging was terminated when the potential limit was reached.

Individual Results with AC-Field or Static Field Probe Attached

If the individual results from each period are required then these can be displayed. Select the desired period then press SELECT. The following display is shown:

```

Period #a      P-start
90.05.02    10:30
    
```

where

- a = period number
- p-start = time when the period started.

Use the SCROLL key to display the individual results:

```

Period #a      (b - d)
(b xxx)(c xxx )(d xxx)
    
```

where b-d = result number.

Each time SCROLL is pressed three individual results are displayed, press SCROLL again to display the next three etc. When all results have been displayed, the "P-start" display appears so that the results can be scrolled through again.

Use QUIT to return to a higher level.

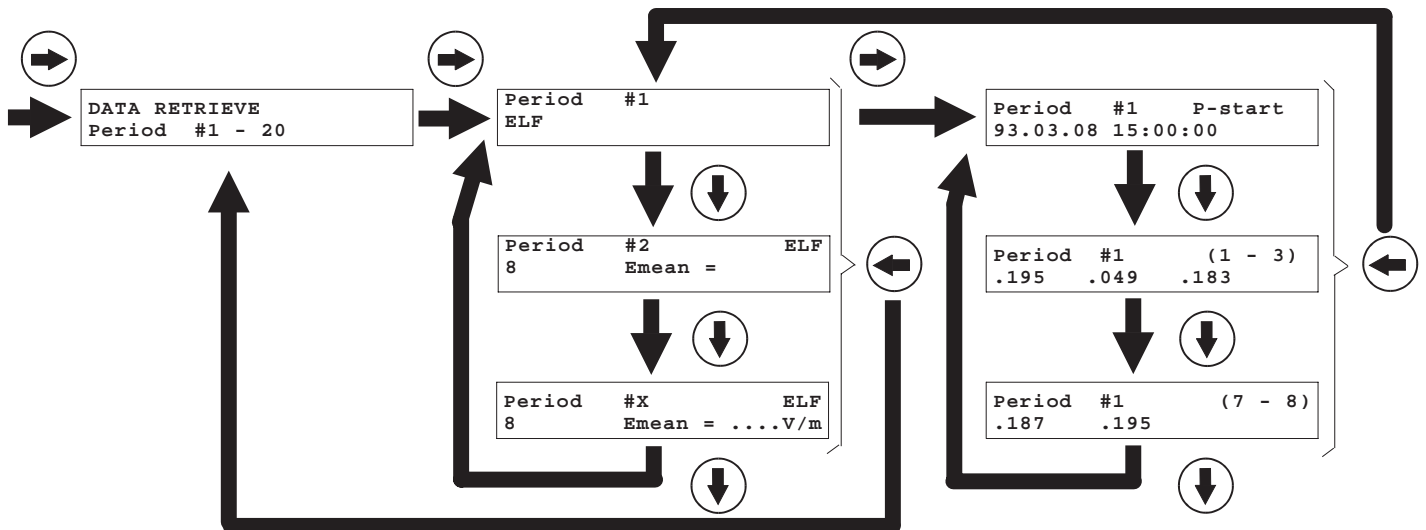


Fig. 3.6 Data Retrieve Mode

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3.4 Print

The measurement data stored in the EFM 200 can be printed out on a printer with an RS232 interface or sent to a PC (which has suitable software). Contact Combinova or your local representative for product information about Combinova's specially designed PC software.

Connect the printer to the printer terminal on the EFM 200. Refer to Section 4 TECHNICAL DESCRIPTION, for details.

There are three print modes, see Fig. 3.7:

Static Field Probe Attached

A MPR-logg print-out is made (see Fig. 3.8). There is a second interval between each data.

AC-Field Probe Attached

These types of print-outs can be made:

Reduced - A summary of results from each logging period, together with a protocol header (see Fig. 3.9).

Complete - An individual result from each logging period, together with a protocol header (see Fig. 3.10).

Last ELF (printer) - All waveform samples comprising the last measurement. Total 3 x 1024 per each measurement value.

Note: All of the print modes can output data either to be printed out or to be sent to a PC, see "TECHNICAL DESCRIPTION" Sec. 4.

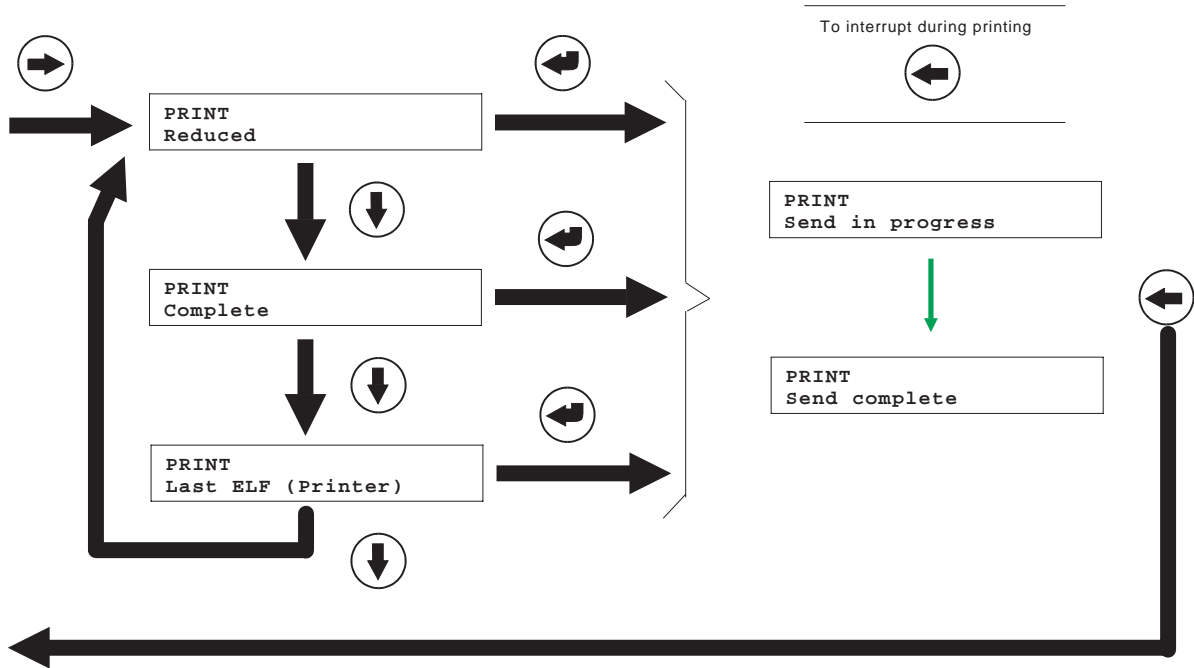
Check that the parameters for printing, see PARAMETERS mode, Sec. 3.6, are correctly set for the printer. Press ENTER to start printing.

If a 'P' is shown in the bottom-right of the display, then this indicates that the data has already been printed out.

When transferring data to the printer the message 'Printing' is displayed, and when the last data of the selected sub-mode has been transferred 'Print complete' is displayed.

To stop the print at any time, press the QUIT key. Use QUIT to exit the print function.

AC-Field Probe Attached



Static Field Probe Attached (or no probe)

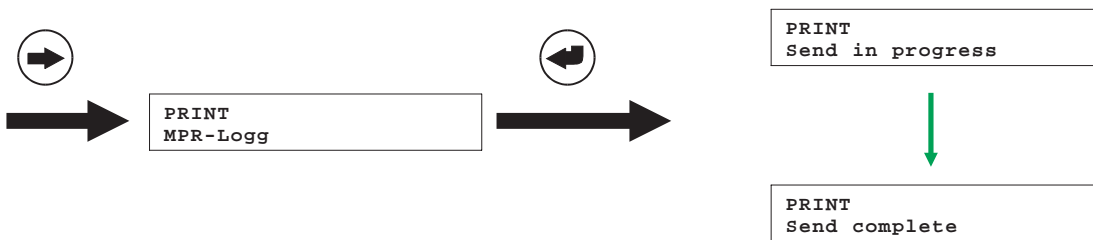


Fig. 3.7 Print Mode

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```
#1 MPR LOGG OF EQUIVALENT SURFACE POTENTIAL

Comments: .....

.....

VDU diagonal = 14 inch Limit of U = 500 V Distance d = 0.1 m
Time of start = 91.06.13 12:14          Time limit = 20'00"

U inkV
  .03          53.27          39.39          29.47          21.39
16.23         11.75          8.79           6.37           4.82
  3.63         2.57          1.98           1.39           1.07
  0.79         0.59          0.44           0.32           0.24
  0.19
Measurement time = 01'00"
Truncated period, U Umax after 1'

End
```

Fig. 3.8 Example of MPR-Logg Print-out

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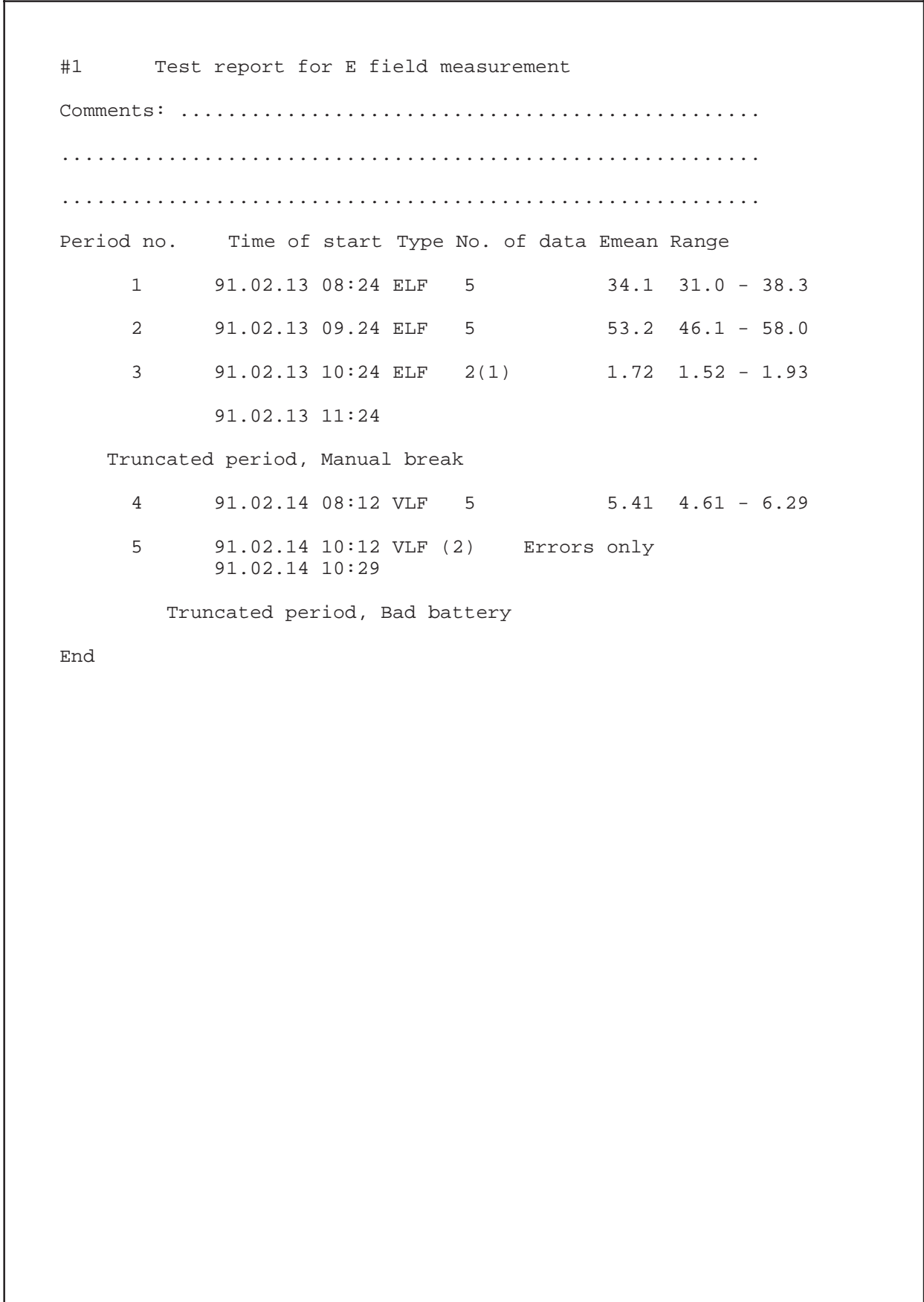


Fig. 3.9 Example of Reduced Print-out

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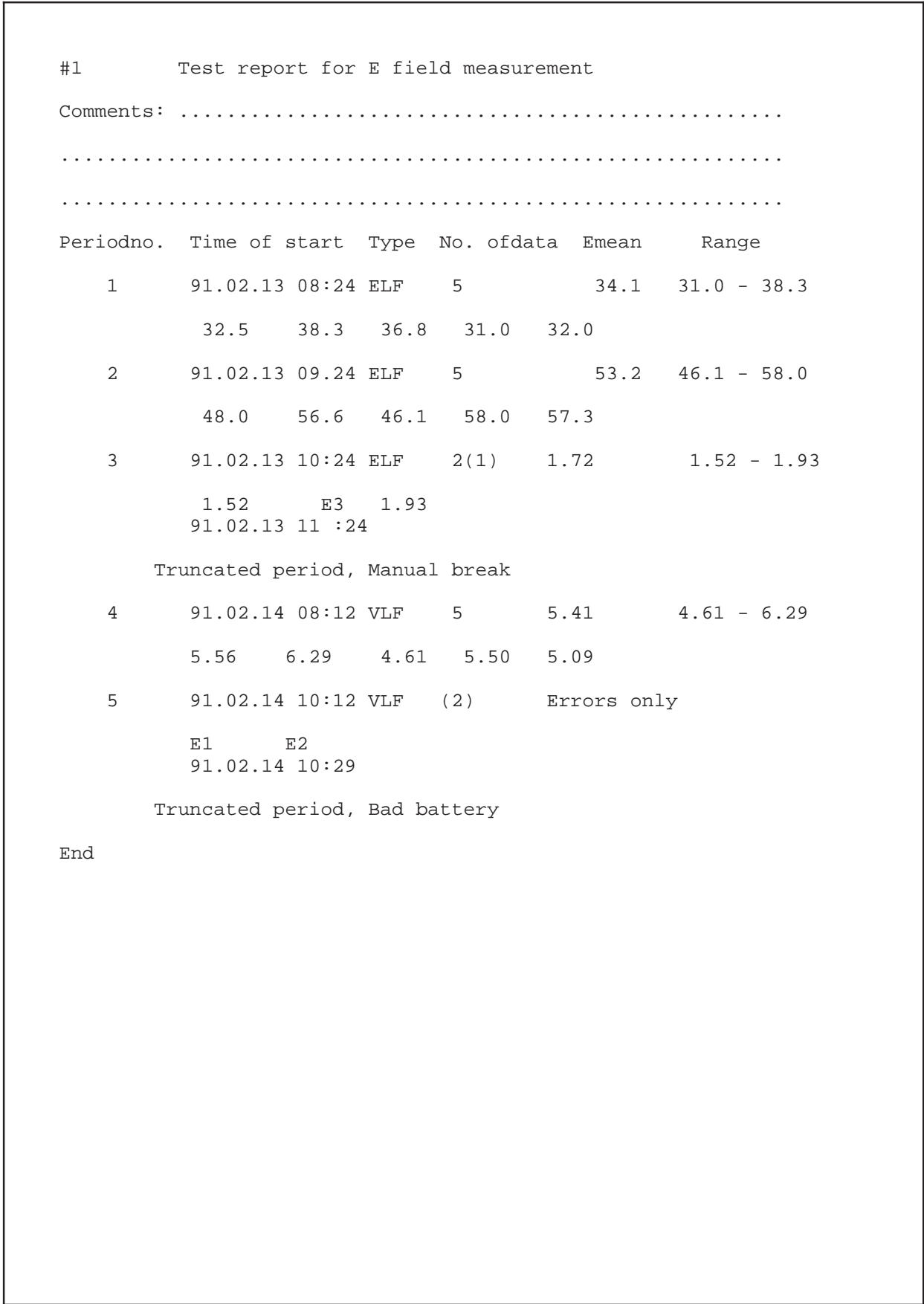


Fig. 3.10 Example of Complete Print-out

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3.5 Check Mode

A number of checks are available to check the operation of the EFM 200.

Each check is selected using the SCROLL key and initiated by pressing the SELECT key. The following checks are available (see Fig. 3.11):

Battery

The display will show:

```

CHECK
Battery           X.XV
    
```

where X.X is the battery voltage.

The instrument will only operate properly if the voltage is greater than 11.0V. Be sure to keep the battery in good condition by regular charging.

IMPORTANT! The instrument should be recharged if the battery voltage is below 11.5V or if the instrument is not to be used for a long period of time.

Transmit

When this function is selected the text string 'TRANSMIT' is sent out to the printer or PC to check the communication link. The text string is transmitted when the ENTER key is pressed. Ensure that 'TRANSMIT' is printed out.

```

CHECK
Transmit
    
```

Receive

This function is used to check characters received from the communication interface. The mode is initiated by pressing SELECT, and the first received character is displayed. Following characters can be displayed using the SCROLL key.

```

CHECK
Receive

CHECK   'A'           01(22)
Receive.... 41H
    
```

- where:
- A = received character
 - 41 = HEX-code for the received character
 - 01 = character position in the character string
 - (22) = number of received characters.

Program

The software program version installed in the instrument can be checked using this function. The following message is displayed:

```

CHECK
Software version  X.YY
    
```

where X = Program version and YY = Release number

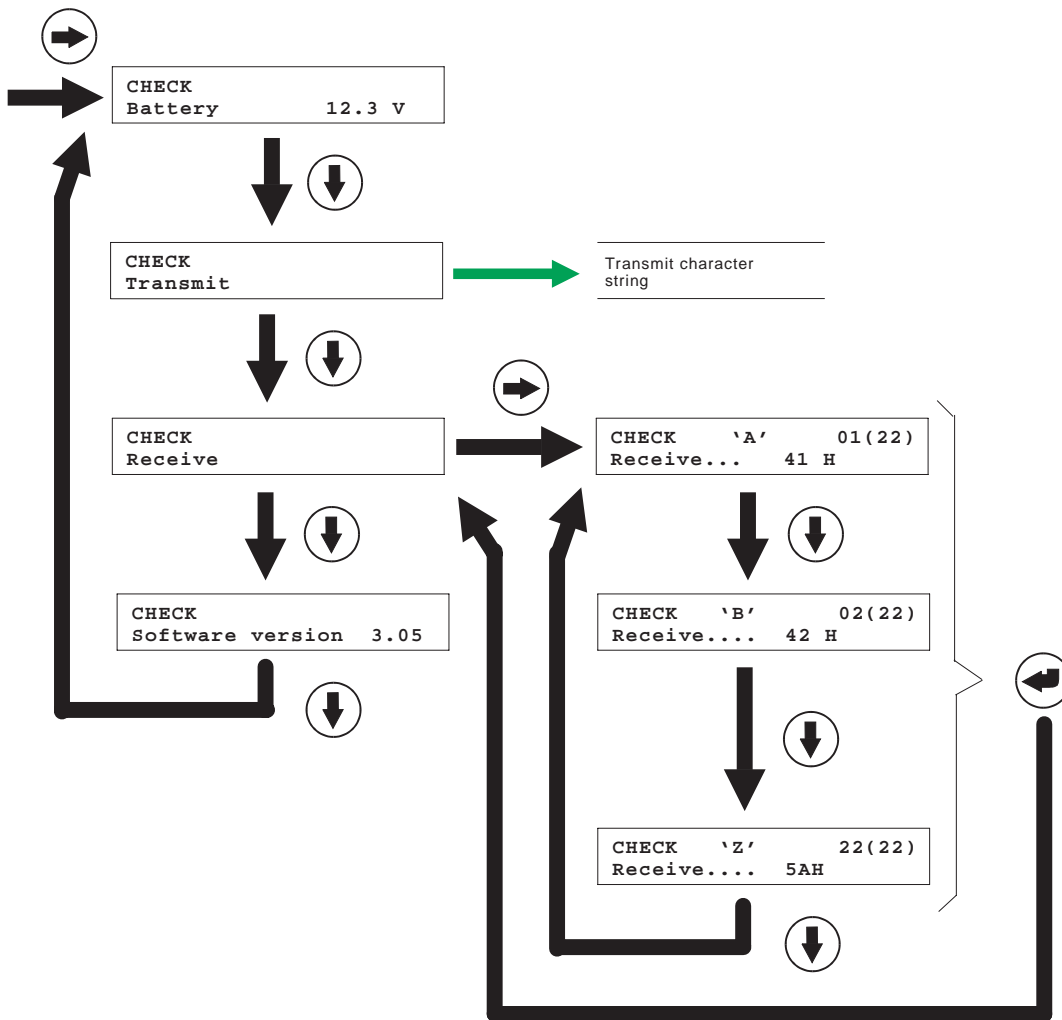
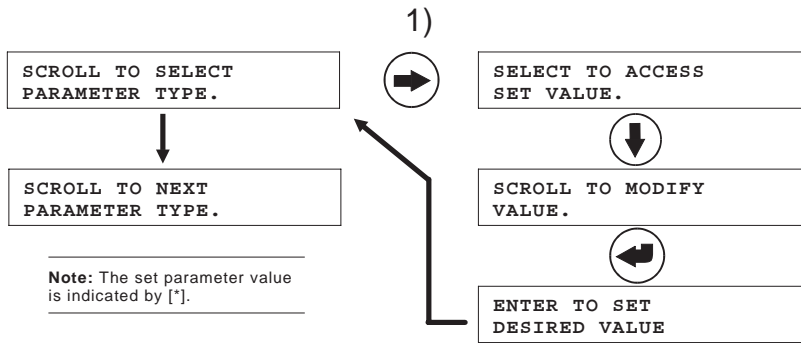


Fig. 3.11 Check Mode

3.6 Parameters

The Parameters mode allows the user to set up the EFM 200 for a wide range of measurement and communication possibilities. The parameter functions are shown in Fig. 3.12, which also shows examples of changing parameters. A full list of the parameter values for each parameter function is given in this section.

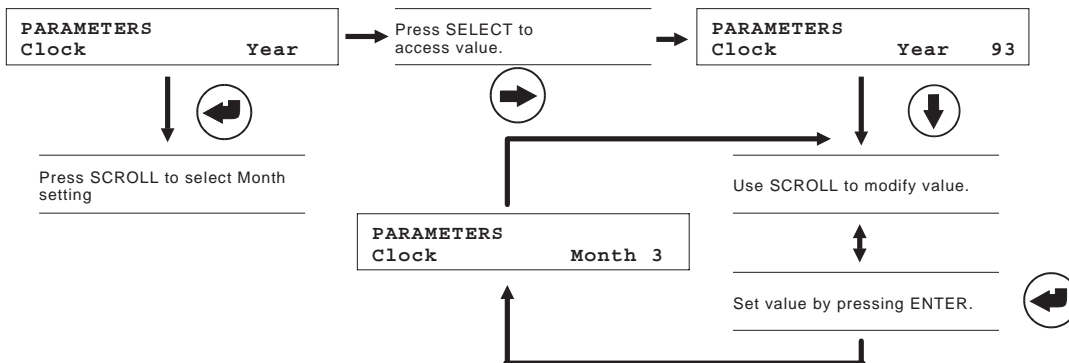
A comprehensive description of setting a parameter, date and time is given below, while the other parameters are listed. The principle of parameter setting is the same for all parameters.



1) For parameter Equivalent Surface Potential press SELECT two times

Clock

Set the correct date and time. Select “clock” and press the SELECT key. The following will appear on the display:



When the modified value has been set, press ENTER to get to the month setting. Set each date and time value, to the correct date and time.

When setting date and time all values must be selected, otherwise the newly entered value will not be set. If a value is correct then simply press ENTER, without modifying the value.

Data Logging

The frequency of measurements for automatic data logging depends on the set values of the “Period” and “Sample Rate” parameters. For example if the period is set to 120 seconds and the sample rate to 5 the five measurements are made every 120 seconds, which is a measurement every 24 seconds. These parameters should be set according to the requirements of what is to be measured. The higher the measurement rate then the shorter the time that data logging can be used. When data logging mode is selected the time available is shown on the display.

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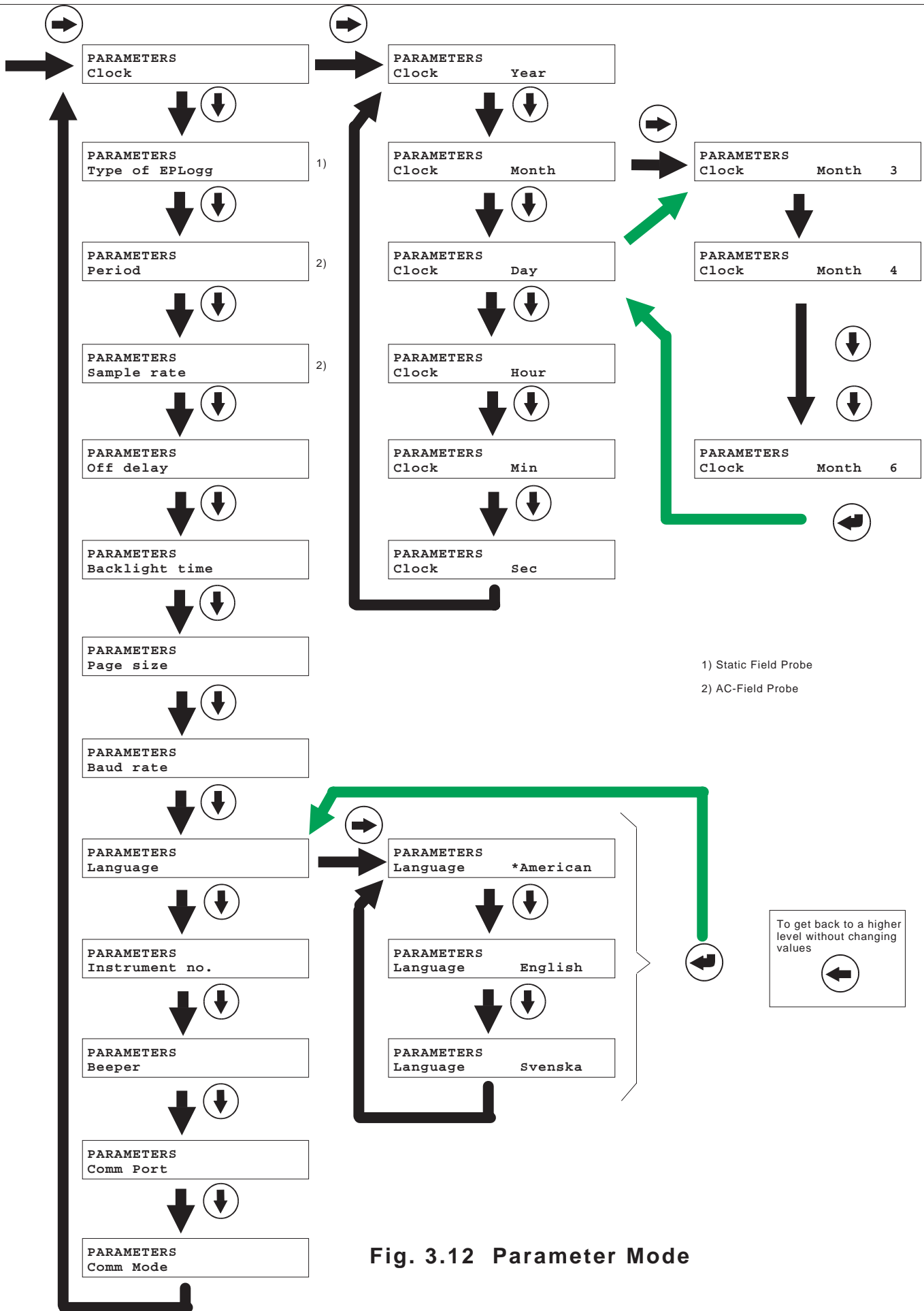


Fig. 3.12 Parameter Mode

When the period parameter is set to manual, then measurements are initiated manually, by pressing the green start button. A measurement cycle in this case is a number of measurements, determined by the "Sample Rate" parameter, being taken in a "burst". The "burst" of measurements is taken at the instrument's fastest possible rate, and the results are logged, as for automatic data logging.

Period (VLF and ELF only)

This parameter defines the length of each logging period, and if manual or automatic logging is to be used. The values that can be selected are shown below. Each period is time stamped on the print-out.

Values = Manual, 120, 360, 900, 1800 or 3600 seconds.
Default = 3600.

If "Manual" is selected then measurement is initiated by pressing the green start button, and a "burst" of measurements is taken. The number of measurements depends on the "Sample Rate" parameter setting.

Sample Rate (VLF and ELF only)

This parameter defines the number of samples to be taken in each logging period.

Values = 2, 5, 10, 20 or 30 samples/period.
Default = 5.

Type of EPLogg

Type of electrostatic measurements, choose **SS** to measure according to SS 436 1490 or **MPR** to measure according to the older MPR-guidelines.

When choosing **MPS**, the following sub-parameters are available:

VDU – diagonal, in inches.

Values = 10 to 24 inch.
Default = 14.

Limit of U, maximum voltage in the time interval $1 < t < \text{time limit}$.

Values = 0, 100, 200, 300, 400, 500V.
Default = 500V.

Time limit, maximum logging time.

Values = 10, 15, 20 minutes.
Default = 20 minutes.

Distance d, 0.1 meters (cannot be changed).

When choosing **SS**, the following sub-parameters are available:

Limit of U

Values = 3.0, 4.0, 5.0 kV/m.

Time limit, maximum logging time.

Values = 5, 10, 20 minutes.

Off Delay

If the EFM 200 is left alone for some time then it will switch itself off to conserve the batteries. The delay from the last operation to when the EFM 200 switches itself off can be set by this parameter. The instrument is switched off if the low battery or memory full warnings have been displayed. When automatic data logging and recharging the instrument the 'off delay' is disabled, as the instrument must remain on during data logging and charging. If manual data logging is selected then the off delay is set to 1 hour.

Values = 1, 2, 5 or 10 minutes.

Default = 2.

Backlight Time

To assist in viewing the EFM 200 display panel in poor lighting conditions a backlight can be used. Each time a key is pressed then the backlight is lit for a time. This parameter defines whether to switch on the backlight and the time it will remain lit.

If it is too dark to see the display and the backlight parameter is selected off the backlight can be switched on by holding down the ON/OFF switch for 3 seconds when switching on the instrument. The backlight will then remain lit so that this parameter can be set to switch the backlight on.

Values = OFF, 1, 2, 5, 10, 20 or 30 seconds.

Default = OFF.

When "OFF" is selected then the backlight is not used so that running time is prolonged.

Page Size

This parameter is used to set the page size, in number of lines, of the printer connected to the EFM 200. The value entered depends on the printer used (see Section 4, TECHNICAL DESCRIPTION for a detailed description). If a PC is connected to the EFM 200 then the 'computer' value should be entered, because this removes the header data and extra line feed commands from the measurement data sent out from the EFM 200.

Values = Computer, 46, 66, 70 or 72 lines/page

Default = 72.

Baud rate

Sets the baud rate for the communication between the EFM 200 and printer (or PC).

Values = 300, 600, 1200, 2400 or 4800 bits/second.

Default = 4800.

Language

The language in which the display messages are presented can be selected by this parameter.

Values = Svenska, English, American.

Default = English.

Instrument No.

Where several EFM 200's are being used together, they can be given a number so that their results can be identified after they have been printed out.

Values = 1,2,3,4,5,6,7,8,9,10.
Default = 1.

Beeper

A beeper can be enabled to indicate end of measures, errors etc.

Values = Enabled, disabled.
Default = Enabled.

Fiber Optic Function

If the fiber option is installed then the following parameters are additionally available:

Commport

Select the communication port type to be used for the option. When **RS232** is selected the fiber option is disabled and the instrument uses the normal (electrical) RS232 interface for printing. Remote control cannot be used in this option. This mode does not result in increased current consumption.

When **FIBER** is selected the RS232 port is disabled, and one-way communication through the fiber transmitters is possible. Remote control cannot be used in this option. However when the transmitter is on, the receiver is also on so that handshake characters can be responded to. A small increase in current consumption occurs when printing (compared to RS232).

When **FIBER 2-WAY** is selected the RS232 port is disabled and full two-way communication is possible. Remote control can be used with this mode. The receiver is active as long as the instrument is switched on, resulting in increased current consumption.

Values = RS232, Fiber, Fiber 2 way, Fiber System.
Default = RS232.

Comm Mode

These parameters are only used for remote control.

When **TERMINAL** is selected, all control characters are converted into readable ASCII strings.

COMPUTER mode is used when the instrument is controlled by a computer. All control characters are ASCII control codes.

Values = Terminal, computer.
Default = Terminal.

See Section 4 "TECHNICAL DESCRIPTION" for further details of the fiber option.

3.7 Calibration Test

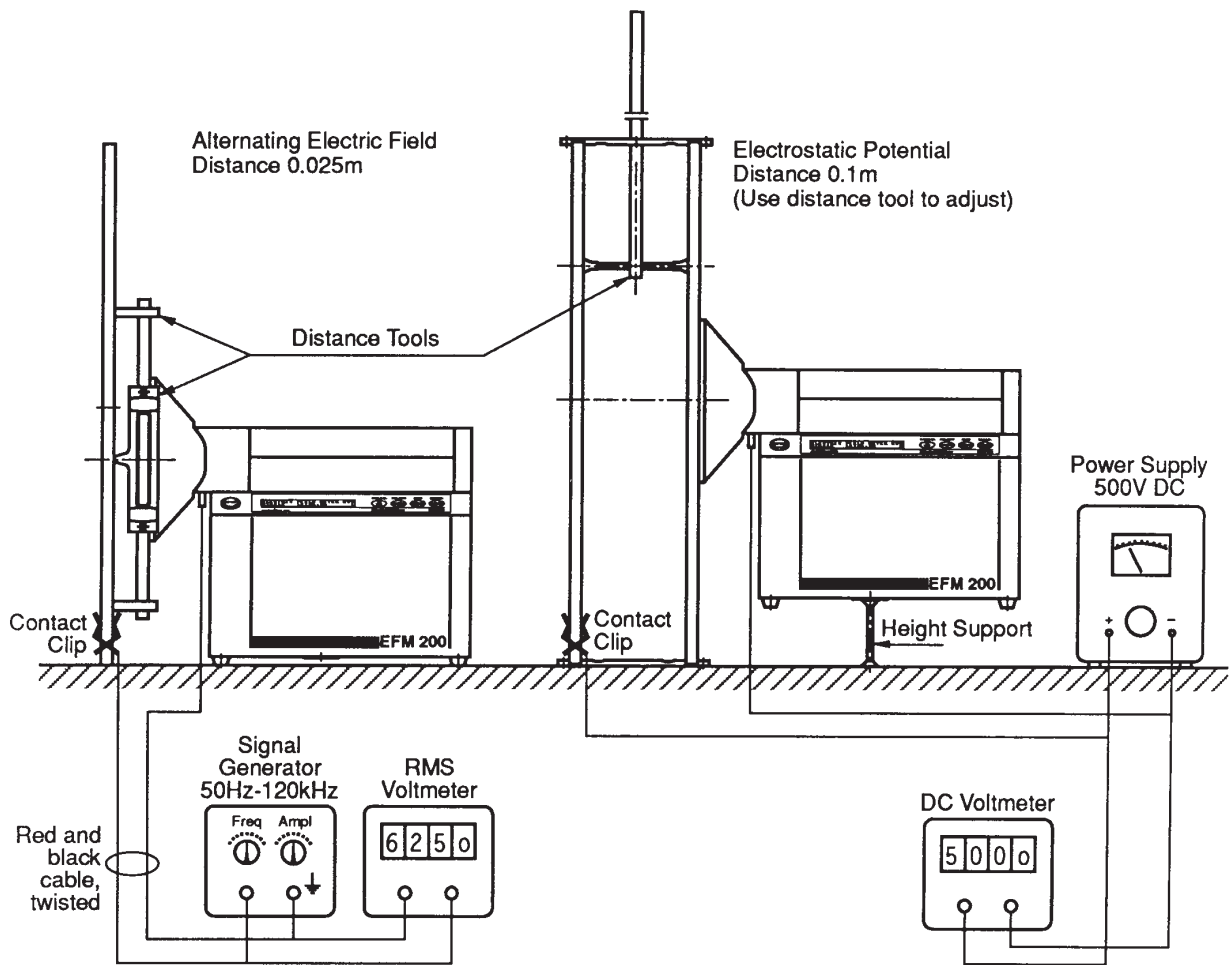


Fig. 3.13 EFM 200 - Calibration Test Setup

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For a calibration test of the EFM 200 the calibration option kit, a signal generator, a true rms voltmeter, a 500V power supply and a DC voltmeter are required.

Using the calibration test probe, a set up according to the figure is made (left part is for alternating electric fields and right part is for electrostatic potential).

To avoid influences from possible fields in the environment it is recommended to check a zero reading with the calibration probe connected to the ground reference input of the EFM 200.

Any value within the measurement range of the instrument can be generated, but for calibration test according to MPR 2 test methods the tabled values should be used.

		Frequencies	Level rms	Amplitude (rms)	Distance
AEF	BAND I ELF	50, 100, 500 1000Hz	25, 250V/m	0.625, 6.25V	0.025m
AEF	BAND II VLF	15, 30, 60 120kHz	2.5,10, 25V/m	62.5, 250, 625mV	0.025m
EP		DC-Signal	5.00kV/m	500V	0.100m

Note that a deviation from the specified levels at the two higher frequencies 1000kHz and 120kHz should occur due to the specified frequency response of the instrument (details in the MPR test methods). The EP calibration level corresponds to an equivalent surface potential of 500V.

3.8 Battery Charging

The EFM 200 instrument incorporates a rechargeable battery which normally provides at least 30 hours of operation between chargings. Be sure to keep the battery in good condition by regular charging.

Charging Code

When the instrument is switched on a code is given in the bottom right of the display panel. This code indicates the state of the last charging of the instrument.

```

ELECTRIC FIELD METER 200
92.02.01 12:34:56      1
    
```

The codes which can be displayed are:

- 0 = Charging completed after more than 30 min. of charge
- 1 = Charging completed within 30 min.
- 2 = Charging interrupted
- 3 = Charging failure. Voltage rise too fast
- 5 = Charging failure. Voltage rise too slow

Charging codes "0" or "1" indicate a successfully charged battery. If codes "3" or "5" are displayed, this indicates a bad battery or a charging circuit failure. If any code is displayed other than "0" or "1" (charging completed) then check the battery voltage. Refer to Section 3.5 for details of checking the battery voltage. If the voltage is below 11.5V then the instrument should be recharged.

When the battery voltage reaches the minimum operational level a message is displayed and the instrument automatically stops any measurements to avoid erroneous results.

```

MEASUREMENT Single      ELF
Charge battery

MEASUREMENT A-logg      #1
Truncated, bad battery
    
```

Before using the instrument for data logging over a long period of time, the battery should be charged.

Recharging Procedure

Connect the battery charger (standard accessory) as shown in Fig. 3.13. Before connecting the power supply ensure that the charger is the correct type for the local mains supply.

Switch on the EFM 200 and charging will start. The instrument must be left on during charging, as the microprocessor controls the charging process. The following message is displayed:

```

CHARGING BATTERY
92.02.01 10:02:00
    
```

If the battery voltage is below the minimum operational level then recharging will take approx. 10 hours. 'CHARGING DONE' will appear on the display when recharging is complete, and the instrument will switch itself off after the set delay (see Section 3.6).

CHARGING DONE
92.02.01 14:56:16 0

Disconnect the charger. Switch on the instrument to check that the battery charging code is either "0" or "1". Otherwise check the battery voltage, which should be approximately 12.5V for a fully charged battery.

IMPORTANT!

Always charge the battery:

- » If the voltage is below 11.5V.
- » If the instrument is not being used for a long period of time.
- » If the instrument is to be used for a long data logging period.

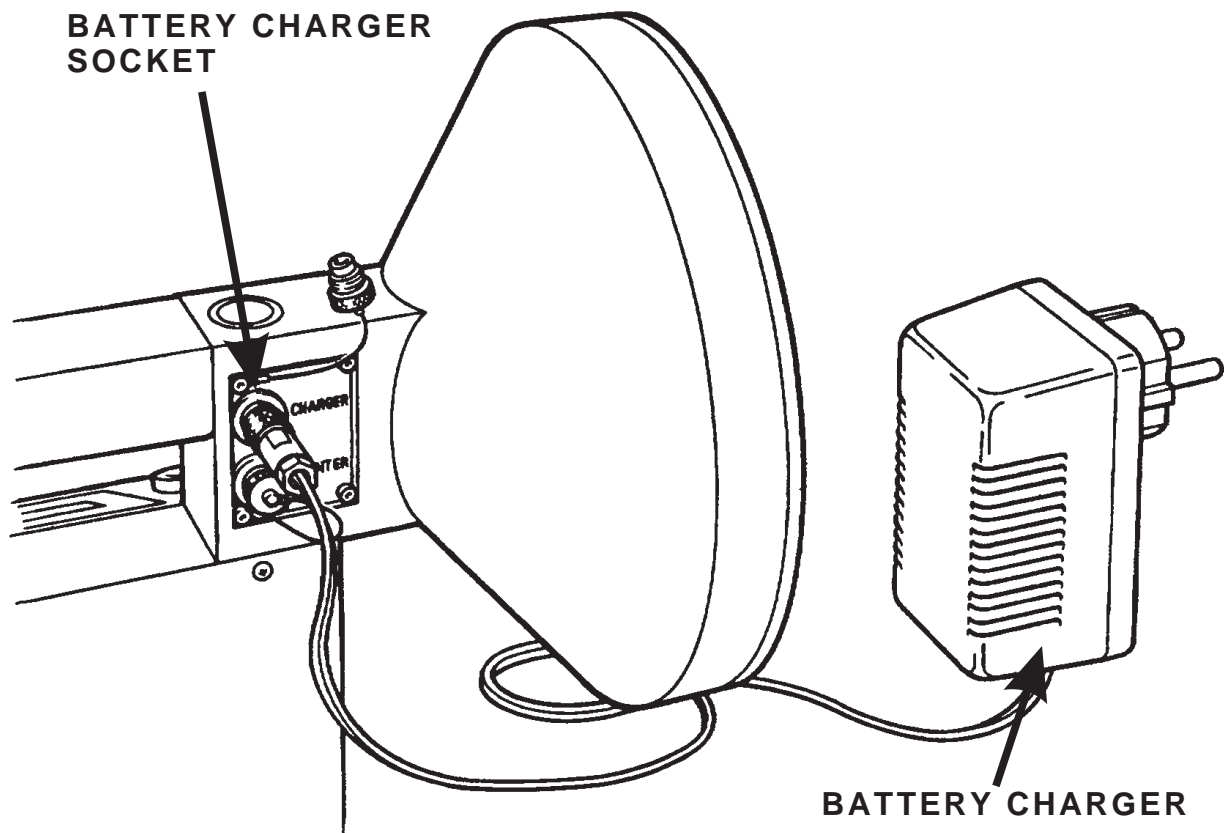


Fig. 3.14 Battery Recharging

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Section 4

TECHNICAL DESCRIPTION

	Page
4.1 General	4.2
4.2 Field Measurement Principle	4.2
4.3 Printing with the EFM 200	4.4
4.4 Fiber Optic Remote Operation	4.5
4.5 Fiber Adapter 10	4.8

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4.1 General

The EFM 200 is a combined instrument for measurement of electrostatic and alternating electric fields. A block diagram for the complete instrument is shown in Fig. 4.1.

The instrument is powered by a built-in sealed lead-acid 12V battery. Individual circuit blocks are switched off automatically when not used, to reduce power consumption. The battery charging is controlled by the instrument's microcomputer.

Data and operating modes are displayed on a LCD panel. The operator keys and the LCD are connected to the microcomputer.

The instrument measurement principles are based on the amplification, filtering and then digital sampling of the measurement signal by sample and hold circuits followed by a 12-bit A/D-converter. Data is fed into the microcomputer where the instrument software takes care of result calculations and digital signal processing.

There is no adjustable analog components for measurement calibration purposes. All calibration is carried out by the instrument's software with the different calibration factors stored in a non-volatile memory.

4.2 Field Measurement Principle

Electrostatic Fields (EP)

Electrostatic field measurements are made with a built-in field mill. For VDT measurement (using the MPR rules) an electrostatic measuring plate (0.5*0.5m) is delivered as a standard accessory. The field mill uses an optical encoder to control rotation speed and as control input to the phase locked signal amplifiers. The instrument has 4 different automatic gain ranges which are factory calibrated to achieve high accuracy.

Alternating Electric Fields

For measuring alternating electric fields the EFM 200 uses a special ground reference probe (defined in the MPR rules). The probe has a diameter of 300mm and in the center a circular measurement area with a radius of 50mm. The probe is fitted to the instrument using magnetic lock. The instrument identifies the probe and is automatically switched over to alternating electric field measurements.

By using separate amplifier stages a measurement can be performed for the two frequency ranges specified in the MPR rules (ELF 5-2,000Hz and VLF 2-400kHz).

The measurements are done with true RMS sampling technique using a combination of analogue and digital signal processing. For the VLF frequency range an electronic rms converter is used. To ensure that correct gain is used independent of signal wave shape, a separate peak detector is used.

For the two frequency ranges the instrument has 4 different independent automatic gain ranges, which are factory calibrated to achieve high accuracy and a wide dynamic range.

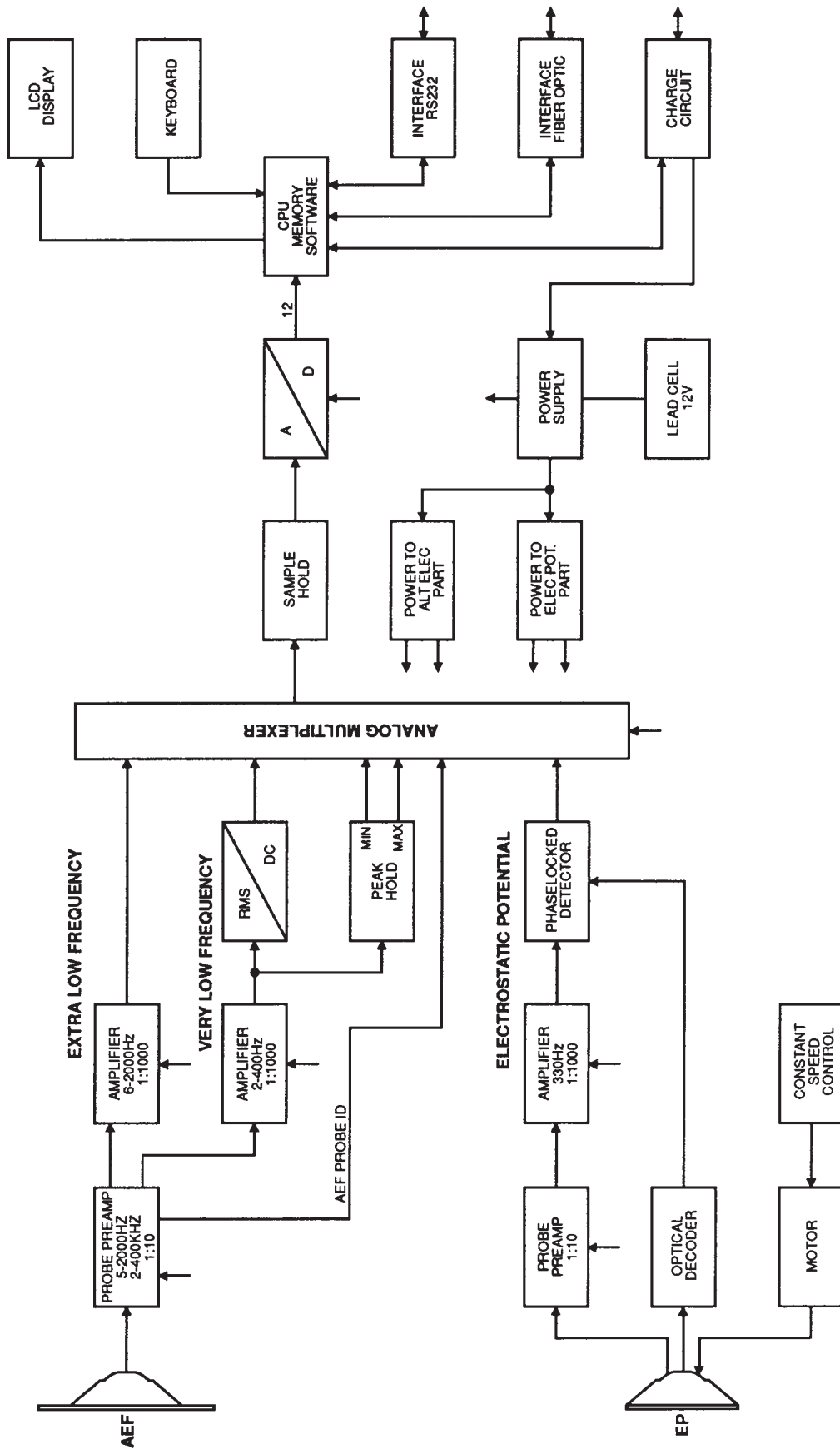


Fig. 4.1 EFM 200 Block Diagram

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4.3 Printing with the EFM 200

There are two cables supplied with the instrument, one 25-pin female DSUB and one 25-pin male DSUB. The cable with the female connector is used when data from the EFM 200 is sent to a computer and the cable with the male DSUB should be used when sending the data to a printer.

The cables are wired as shown in Fig. 4.2:

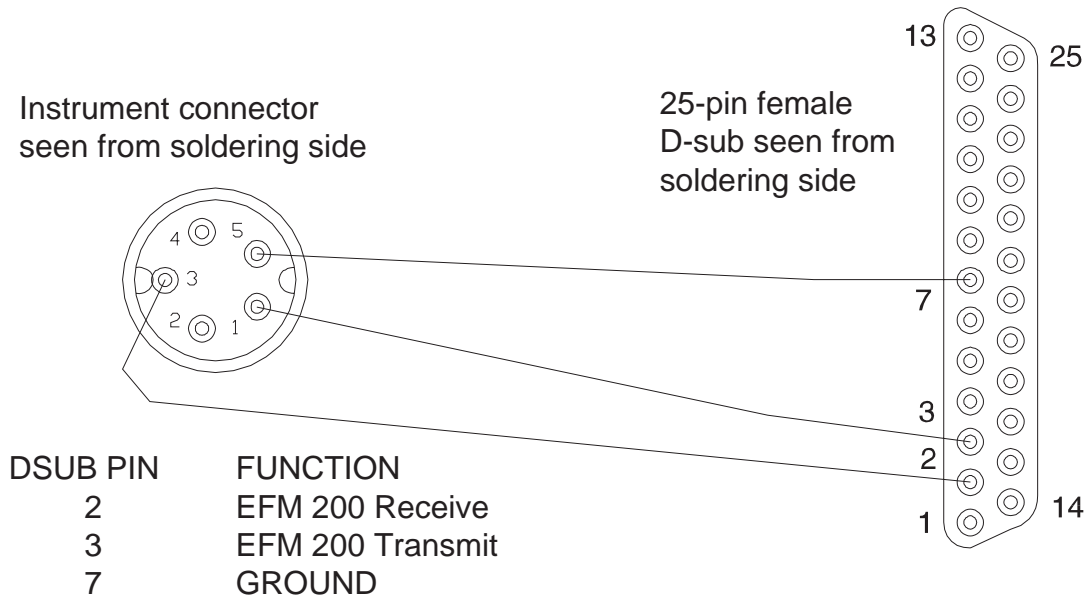


Fig. 4.2(a) Computer Cable

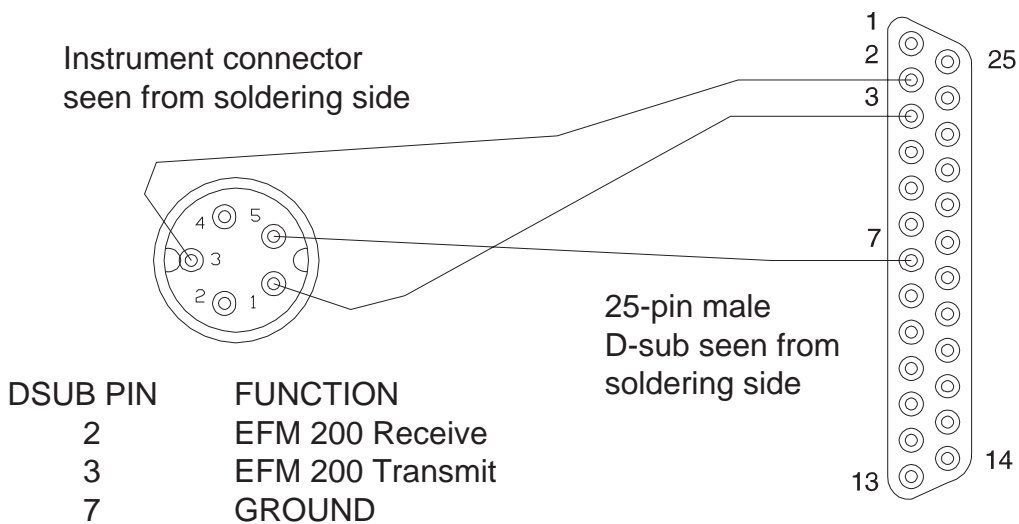


Fig. 4.2(b) Printer Cable

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Note that no electrical handshaking is used. Electrical levels are standard RS232 and the data flow is controlled by sending XON and XOFF characters to the instrument.

- » Sending XOFF (ASCII 013H) to the EFM 200 disables transmission.
- » Sending XON (ASCII 011H) to the EFM 200 enables transmission.

All printouts start with the SOH (ASCII 001H) character and ends with the EOT (ASCII 004H) character.

The parameter **page size** is used to control the printout format. Page length can be selected between **46, 66, 70** or **72** lines per page. The formfeed character (ASCII 00CH) is not used to advance to the next page. Instead, carriage return, line feed (ASCII 00DH and ASCII 00AH) codes are used to advance to the next form.

There is also the selection **Computer** under Page size. Selecting **Computer** will disable the form feed function as described above and send the data without page formatting, suitable for reception by a computer.

4.4 Fiber Optic Remote Operation

The fiber option card is mounted inside the instrument and two holes at the rear of the EFM 200 are used to access the fiber connectors. The fiber option for the EFM 200 contains:

- » EFM 200 fiber option card (placed inside the EFM 200)
- » 10 meter's of plastic fiber, ready to use
- » Software for the instrument to support fiber option.
- » One Combinova Fiber Adapter 10 (separate order)

The Combinova Fiber Adapter 10 is designed to use the EFM 200 charger as the power supply. The power connector at the rear of the Fiber Adapter 10 is the same type as the charger connector on the EFM 200.

Remote Controlling the EFM 200

To enable the remote control of the EFM 200 select **Fiber 2 way** in PARAMETERS COMM PORT (see Sec. 3.6). If the instrument is set to **FIBER 2 WAY**, it will automatically go into MEASUREMENT mode when the instrument is turned on. This is to make sure that the instrument can be talked to immediately. Leaving MEASUREMENT mode will cause the instrument to respond with NAK (Command not accepted). The only way to re-establish remote control is to return to MEASUREMENT mode.

Remote control of the EFM 200 is carried out by sending a valid command character to the instrument and wait for the reply.

- 1: Transmit the command character to the instrument (A, B or C).
- 2: The instrument will immediately reply with 'ACK' if the command was accepted or a 'NAK' if it was not.
- 3: After the command has been executed the result will be sent by the instrument.

Result Description

The result string is divided into result fields. The fields are separated with one or more spaces (ASCII 020H).

Ex: '2.34V/m 100Hz 3.123V/m 1.4'

↑ ↑
 Field 1 Field 2 Field 3 Field 4

The 'V/m' and 'Hz' can be ignored since the result is always in volts/meter and hertz. The results of command A also contain the frequency of the ELF signal. If the frequency cannot be determined, the result is 'Mixed' or 'Noise'.

Ex: '.2.34V/m Mixed'

If the frequency is below 10Hz, the result is '<10Hz'.

Ex: '.2.34V/m <10Hz'

If the frequency is over 1000Hz, the result is '>1kHz'.

Ex: '2.34V/m >1kHz'

Always wait for the result before sending any more characters to the instrument, otherwise the behavior of the instrument may be unpredictable.

Command Descriptions

There are three commands available in the remote mode. These are:

Command A

ASCII character 'A' (Hex 41):

This command starts a measurement in the EFM 200.

This is the alternating electric field measurement. The result consists of ELF field and frequency, VLF field and crest factor..

Ex: SOH, 1.23V/m 50.1Hz 2.345V/m 1.4, EOT

↑ ↑ ↑ ↑
 ELF total ELF frequency VLF total VLF crest factor

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Command B

ASCII character 'B*' (Hex 42):

This command starts an EP measurement in the EFM 200. This is the electrostatic field measurement. The result consists of the measured fields:

Ex: SOH, '6.78kV/m', EOT
 ↑
 EP Total

Command C

ASCII character 'C' (Hex 43):

This command orders the instrument to return its battery voltage, estimated remaining operating time and identification characters.

Ex: SOH, 12.5V 50H 20', EOT
 ↑ ↑ ↑
 Voltage Time ID

The first digit in the ID section is '2'. This informs the controller that the responding instrument is an EFM 200. The second digit '0' is the mode character. This character is always set to '0'.

Selecting 'COMPUTER' or 'TERMINAL' under COMM MODE [see Section 3.6)

COMPUTER selected

The result transmission starts with the 'SOH' character followed by the string which is ended by an 'EOT' character. The special ASCII control characters 'ACK', 'NAK', 'SOH' and 'EOT' have the following codes:

- » ASCII character 'ACK' has the hex code 006H
- » ASCII character 'NAK' has the hex code 015H
- » ASCII character 'SOH' has the hex code 001H
- » ASCII character 'EOT' has the hex code 004H

TERMINAL selected

The control characters 'ACK' and 'NAK' will be replaced with the ASCII string 'ACK' or 'NAK'. All messages are terminated with carriage return, linefeed (ASCII 00DH, 00AH). The control codes 'SOH' and 'EOT' are not used.

4.6 Fiber Adapter 10

The Combinova Fiber Adapter 10 is used to establish RS 232 communication via fiber optic cable for improved transmission range and noise immunity.

The Fiber Adapter10 has a 25-pin DSUB female connector for direct connection to a standard PC RS 232 serial communication port.

The fiber optic is of low cost plastic type with simple single action connections, giving an effective range depending on the selected data speed of up to 100 meters.

The fiber connections are colour coded with a gray connector being the transmitter and a blue connector being the receiver.

The adapter is normally powered by the EFM 200 battery charger. However, the adapter is able to operate with voltages between 18 and 36 volts DC.

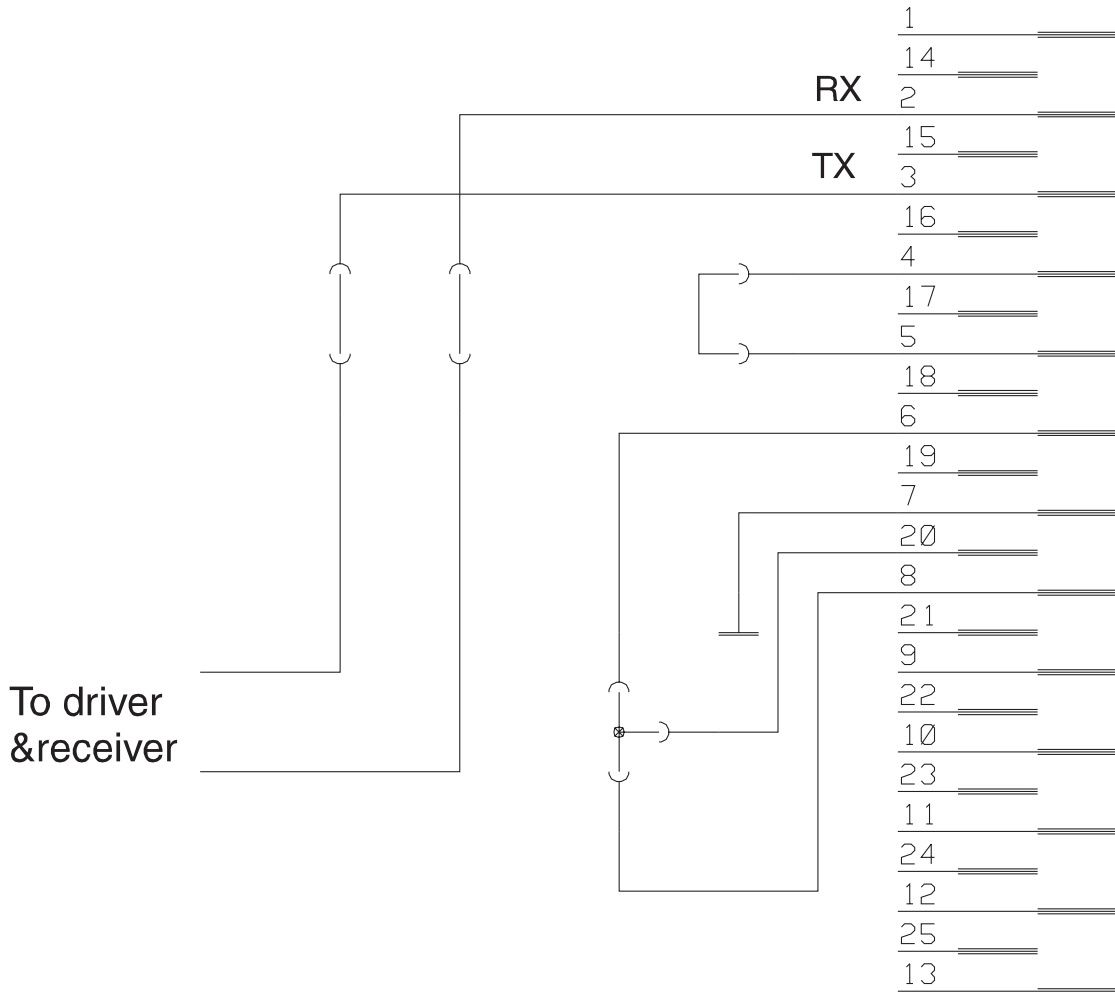
The unit is a small and slim metal box, making it possible to connect it to the computer without using extension cords.



Fig. 4.3 Fiber Adapter 10

Connections

The 25-pin D-SUB connector has the following pin-out:

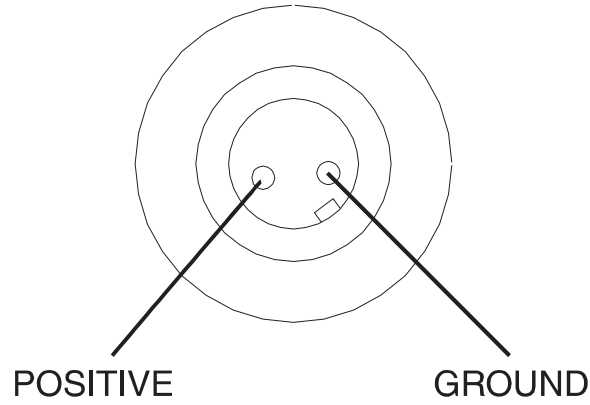


Pin	Function
2	Adapter Receiver (Rx)
3	Adapter Transmitter (Tx)
4	PC Request To Send (RTS)
5	PC Clear To Send (CTS)
6	PC Data Set Ready (DSR)
7	Ground
8	PC Carrier Detect (DCD)
20	PC Data Terminal Ready (DTR)

Fig. 4.4 Fiber Adapter 10 Pin-out

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The power connector has the following pin-out:



Pin	Function
1	Positive (18-36 Volts DC)
2	Ground

Fig. 4.6 Power Connector Pin-out

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Section 5

SPECIFICATIONS

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Individual data given in the technical data are subject to change without prior written notice. Specifications are given at the temperature $T_{amb}=23\pm 5^{\circ}$ centigrade.

1. Electrostatic Potential, EP

Measurement range:	$\pm(0.5-1000)$ kV/m DC automatic range selection
Accuracy:	$\pm(4\%$ of reading + 0.3kV/m)
Display resolution:	Better than 0.5% of reading or 0.01kV/m

2. Alternating Electric Fields, ELF

Frequency range:	5-2000Hz (-3dB)
Filter attenuation:	80dB/decade below 5Hz and 40dB/decade above 2kHz
Measurement range:	0.5-10,000V/m rms automatic range selection
Accuracy:	$\pm(3\%$ of reading + 0.2V/m)
Display resolution:	Better than 0.5% of reading or 0.01kV/m

3. Alternating Electric Fields, VLF

Frequency range:	2-400kHz (-3dB)
Filter attenuation:	80dB/decade below 2Hz and 40dB/decade above 400kHz
Measurement range:	0.05-1000V/m rms, automatic range selection
Accuracy:	$\pm(3\%$ of reading + 0.03V/m)
Display resolution:	Better than 0.5% of reading or 0.001kV/m

Display

Liquid crystal display with backlight, on/off selectable by the operator.

Result Storage

Up to 4,000 results, identified by date and time of measurement, can be stored in the result memory for later printing or transfer to a PC for further analysis. Data storage is maintained also when the instrument is turned off.

Parameter Storage

Instrument parameters and calibration constants are stored in a non-volatile memory (EEPROM).

Power

Rechargeable battery. Operating capacity exceeding 30 hours.

Communication

RS232 serial communication by standard 25-pin D-sub contact.

Weight and Size

Instrument weight 3.5kg. Size 325mm x 155mm x 265mm (L*W*H).

Environment

-10 - +50 Degrees Celsius.

Remote Control Option

A special remote option is available using a fiber optic serial link and instrument software to support remote control of the instrument.

Calibration Test Option

The instrument is designed to give long term stability and accuracy based on factory calibration. As an option the instrument can be supplied with a calibration test fixture for Electrostatic and Alternating Electric fields. An accurate DC voltage power supply and a signal generator is needed at the laboratory to generate control signals.

Section 6

ERROR CODES

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6.1 Instrument Errors	6.2
6.2 Measurement Errors	6.3
6.3 Data Retrieve Errors	6.3
6.4 Print Errors	6.3

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6.1 Instrument Errors

```
ELECTRIC FIELD METER 200
93.03.09 15:00:00 1
```

Start-up checks complete,
instrument OK.

```
ELECTRIC FIELD METER 200
Logged data lost
```

Message displayed if battery has
been disconnected.

The message can be canceled by
selecting "Start logging"

```
ROM-Error
Call Service
```



```
RAM-Error
Call service
```



```
ELECTRIC FIELD METER 200
EEPROM error
```



Use the SCROLL key to
cancel the error message.

Calibration and parameter settings
are lost. Default values will be used.

Measurement accuracy $< \pm 10\%$.
Call for service.

```
ELECTRIC FIELD METER 200
Program error #xx
```

Program execution has stopped
for some reason. Use the
SCROLL key to cancel the error
message.

Report the fault to Combinova AB.

NOTE: If program error #26 occurs
then this indicates a Watchdog time-
out. This could appear due to an ex-
ternal disturbance such as:

- A cable is connected during mea-
surements
- A strong external discharge

Acknowledge this code by pressing
SCROLL or SELECT to recover nor-
mal operation.

Normally there is no problem with
the instrument if this code would ap-
pear, but stored data may be lost,
because of this fault.

6.2 Measurement Errors

Measurement E1	Fading signal
Measurement E2	Overrange
Measurement E6	Offset too large (transient signal)
Measurement E8	Charge battery
Measurement E9	Measurement mode error

6.3 Data Retrieve Errors

Data retrieve - - - No data - - -	This message will be the result of a loss of logged data
--------------------------------------	---

6.4 Print Errors

Print - - - No data - - -	This message will be the result of a loss of logged data
------------------------------	---