Cardio Menu

SCHILLER
Switzerland

CARDIOVIT AT-3

Operating Manual

SCHILLER AG
Altgasse 68
CH-6340 Baar/Switzerland

Telephone: 042 / 33 43 53
Telex: 865 140 sbe ch
Telefax: 042 / 31 08 80

Art. No. 2.510043
Issue 28.1990

CONTENTS

INTRODUCTION

CARDIOVIT AT-3, the intelligent miniature ECG unit from Schiller, is ready for use at any time and anywhere: It is handy, battery powered and equipped with all the know-how of the large ECG recorders. You can program it so that you will be able to record and print an ECG in exactly the way you need by pressing only one key.

With the CARDIOVIT AT-3 you can record resting ECGs and print them in many different formats. Also, there are several printing formats for long-term rhythm recordings at your disposal. If you read the following pages you will very quickly be able to use your new electrocardiograph optimally.

The manufacturer can only be held responsible for the safety, reliability, and performance of the apparatus when:

- **assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by him, and**
- **the electrical installation of the relevant room complies with the IEC requirements, and**
- **the CARDIOVIT AT-3 is used in accordance with the operating instructions.**

About this manual

This manual introduces you to the operation of the CARDIOVIT AT-3. We recommend that the instructions be read first in order to obtain the necessary basis for working with the unit. The manual can later be used for reference.

The operating manual is divided into three main parts:

- The **Brief Operating Instructions** describe in a few sentences the most important procedures (automatic and manual ECG recordings, rhythm recording, replacing the paper). When you are used to working with the unit, these brief hints will serve as an aide-memoire.
- In the second part **Working with the CARDIOVIT AT-3** you will be introduced in detail to the different applications.
- In the **Reference** part you find all the settings, programs and inputs described in detail.

The last chapters contain further information. The general parts of the operating manual apply to the CARDIOVIT AT-3 standard model. Nevertheless, some of the options are included, especially if they are necessary for a particular mode of operation. The other options are described in Chapter 7 .

The most important part is "Working with the CARDIOVIT AT-3". There you learn all the important applications. In order to use you new electrocardiograph optimally we recommend that the whole manual be read carefully.

Safety

This unit is classified CF ( ). This means that the patient connection is fully isolated and defibrillation protected and that the unit is also suitable for intracardiac application. Protection against defibrillation voltages is only ensured, however, if the original Schiller patient cable is used.

For ECG recordings it must be ensured that neither the patient nor the conducting parts of the patient connection nor the electrodes (including the neutral electrode) come into contact with other persons or conducting objects (even if these are earthed).

The original Schiller patient cable is provided with special safety precautions to offer protection against burns from HF surgical equipment. Incorporated protective resistors prevent or reduce the passage of defibrillation or HF currents through the electrode leads.

When using high frequency surgical equipment together with an electrocardiograph, special care must be exercised in all cases: the active surgical electrode should always be placed at least 15 cm from the nearest electrode.

For a defibrillation, the protection against overvoltages fitted in the patient cable is indeed sufficient, but here too, the necessary caution must be observed. If possible, the patient should be disconnected temporarily from the ECG unit during defibrillation.

There is no danger when using the ECG unit for a pacemaker patient or with simultaneous use of other electrical stimulation equipment. A certain caution should however be observed here: the stimulation units should only be used at a sufficient distance from the electrodes. In case of doubt, the patient should be disconnected from the ECG recording unit.

If several units are coupled, there is a danger of summation of the leakage currents. It must be determined in each case before coupling (e.g. by consulting the manufacturer) whether the units are suitable for this purpose.

The CARDIOVIT AT-3 should only be operated together with mains adapter unit MA-3 or MA-4.

Brief Operating Instructions

In this first chapter, the applications are briefly described. Once you are used to working with the CARDIOVIT AT-3, these descriptions will serve as an aide-memoire. Apart from the short lists of operating instructions for automatic and manual ECG recording and long-term rhythm recording, the procedure for replacing the paper is also shown. On a further page, the function keys are listed.

Automatic ECG Recording

1. Place electrodes in standard positions on patient
2. Switch on the CARDIOVIT AT-3 with green key **ON**
   → check recording on screen
3. Enter patient data: press **FNCT** and **1** and input according to table
4. Press **AUTO/START**
   → ECG is printed in the preset format
5. Copies: press **COPY**
6. Switch off electrocardiograph, free patient from electrodes

Manual ECG Recording

1. Place electrodes in standard positions on patient
2. Switch on the CARDIOVIT AT-3 with green key **ON**
   → check recording on screen
3. Select lead group, sensitivity, and paper speed
4. Enter patient date: press key **FNCT** and **1** and input according to table
5. Press **MAN/START**
   → ECG is printed
6. During the recording, you can change lead group, sensitivity, paper speed at any time
7. Stop recording with the **STOP** key
8. Switch off unit, free patient from electrodes

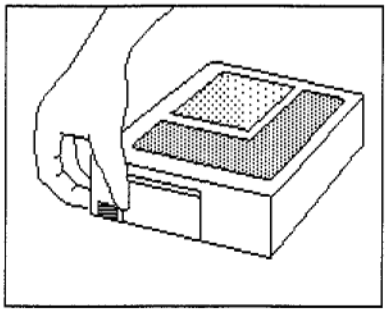
Long-term Rhythm Recording

1. Place electrodes in standard positions on patient
2. Switch on the CARDIOVIT AT-3 with green key **ON**
   → check recording on screen
3. Enter patient data: press key **FNCT** and **1** and input according to table
4. Press **FNCT** and **2**: Select recording format
5. Press **7** to start the recording
   → The rhythm leads are printed in the preset format after 4 to 12 minutes.
6. To stop the recording, press **8**
   → The remainder of the rhythm leads is printed.
7. Switch off electrocardiograph, free patient from electrodes

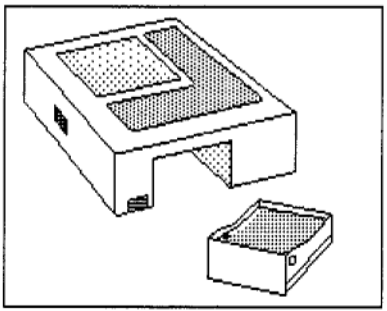
Replacing the Recording Paper

The recording paper should be replaced as soon as the end of the paper is indicated on the lower edge. After the indication first appears, there are about eight pages left.

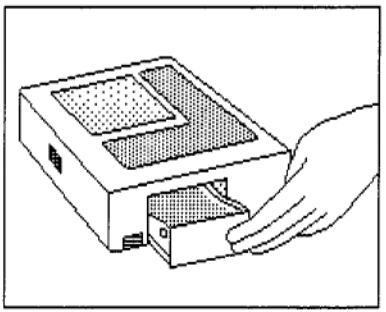
Push paper compartment release and pull out paper drawer.



Put the new paper package into paper compartment. Pull up beginning of paper and place it over guide roller.



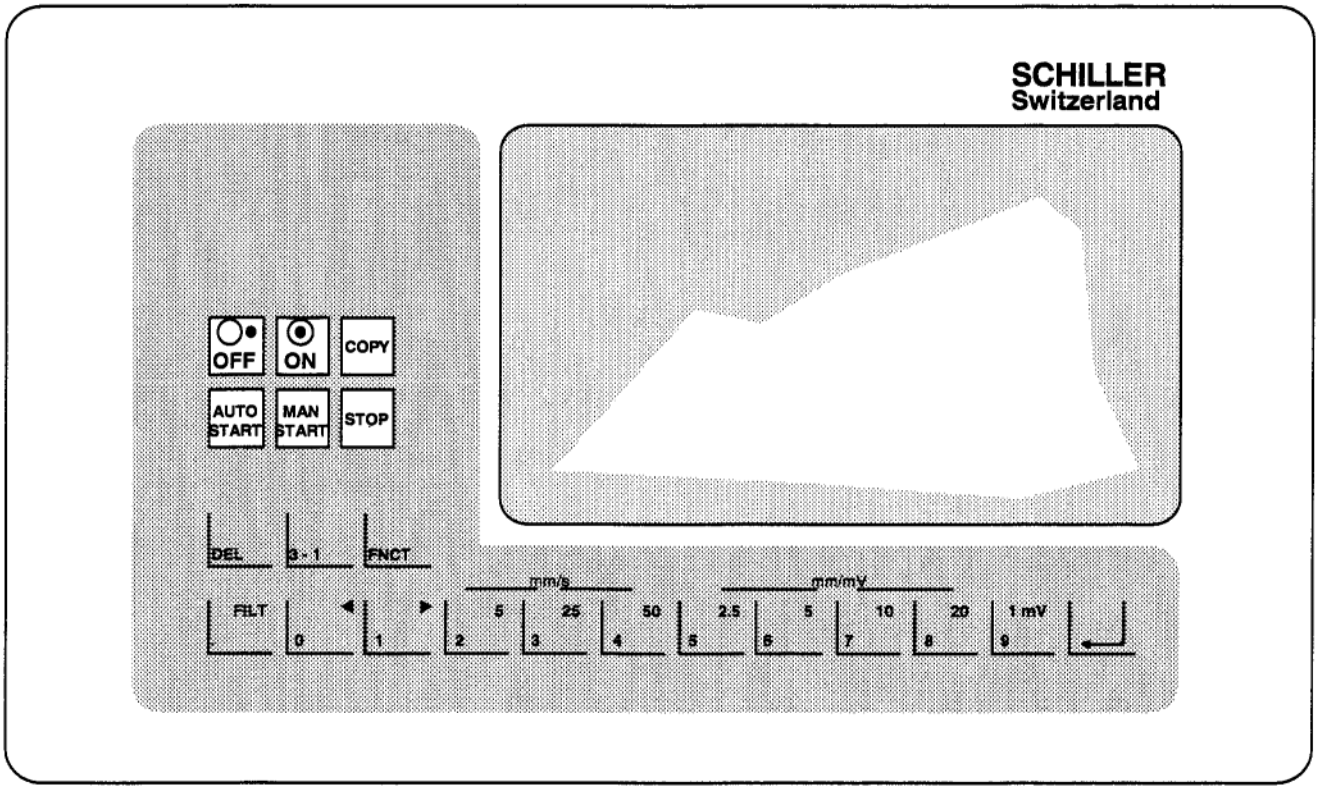
Put in the paper drawer and press firmly until it clicks into place. Check for correct paper alignment.



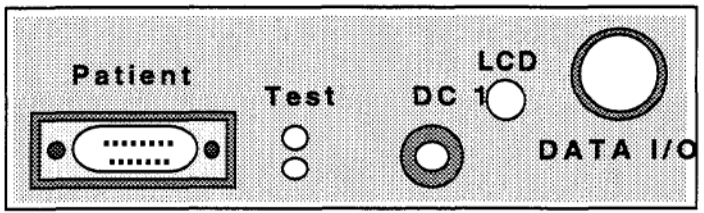
Keyboard Functions

Key	Function
FNCT	switching to operating help or ECG monitor on the screen
FNCT + 1	entering patient data
FNCT + 2	format for rhythm mode
FNCT + 3	storage mode
FNCT + 4	format for automatic mode
FNCT + 5	on/off acoustic QRS indication
FNCT + 6	self-test
FNCT + 7	adjusting clock and calendar
FNCT + 8	program of additional lead group
FNCT + 9	measurement of pacemaker
FNCT + RETURN + 1	storing base setting
FNCT + RETURN + 2	various machine settings
FNCT + RETURN + 3	user identification
FNCT + RETURN + 4	ECG transmission
OFF	switch off
ON	switch on
COPY	copies of ECGs
AUTO/START	start automatic printout
MAN/START	start manual printout

Key	Function
STOP	stop printout
DEL	delete characters
3-1 	ECG monitor: switching from 1-channel to 3-channel representation and vice versa.
FILT	switch on/off myogram filter (muscle tremor filter)
◄ **0**	lead group selector (backward)
► **1**	lead group selector (forward)
5/25/50mm/s	chart speed selector
2,5/5/10/20mm/mV	sensitivity selector
1 mV	key for manual calibration
 **(RETURN)**	moving to next line or to next page


SCHILLER
Switzerland
OFF
ON
COPY
AUTO START
MAN START
STOP
DEL
3 - 1
FNCT
FILT
0
1
mm/s
5
25
50
2
3
4
mm/mV
2.5
5
10
20
1 mV
5
6
7
8
9

Connector Panel (right-hand side of unit)



Patient

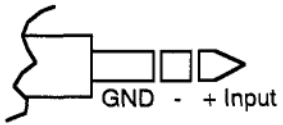
Socket for patient cable
CF rated: fully floating and isolated, defibrillation protected, suitable for intracardiac application
Caution: Defibrillation protected only if used with the original patient cable.

Test

Test socket for electrode leads with control light

DC1

Experimental input (differential input)
sensitivity: 0,5 V
input impedance: > 100 kOhm

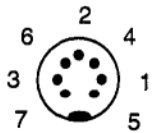


LCD

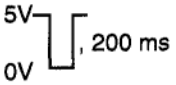
Knob for adjusting the contrast of the screen

DATA I/O

socket for :
- input and output of data
- connecting the footswitch
- transferring a QRS trigger signal



Pin 1 footswitch (contact to GND = START)
Pin 2 GND
Pin 3 QRS trigger



CHAPTER 2

Getting Started

Once you receive your CARDIOVIT AT-3, it is important to set it up properly and to learn the basic manipulations such as switching on and off, changing the paper etc. When you have read this second chapter, you will be able to start working with the CARDIOVIT AT-3.

Setting Up the Apparatus

Do not keep or operate the apparatus in a wet, moist, or dusty environment. Also, avoid exposure to direct sunlight or heat from other sources. Do not allow the unit to come into contact with acidic vapours or liquids, as such contact may cause irreparable damage.

Furthermore, the unit should not be placed near X-ray or diathermy units, large transformers or motors.

Caution: This apparatus should not be operated in areas with danger of explosion.

Power Supply

The unit can either be operated with the in-built rechargeable battery, or by connection to the mains supply by means of the supplied power adapter.

On the lower right of the screen the indication 'BATT' shows the condition of the battery. As soon as the battery voltage reaches a minimum (25%), the indication starts to blink. For recharging the battery, connect the apparatus to the mains supply by means of the supplied power adapter. A totally discharged battery needs 24 hours to be recharged with the MA-3, or 1 1/2 hours with the MA-4.

A fully charged battery will last for approx. 1 1/4 hours of ECG recording and printing. When used for monitoring and long-term rhythm recording, the battery will last for at least 2 1/2 hours. The stored ECGs will be retained in the memory even if the battery voltage is too low to operate the unit.

In order to conserve battery power, an automatic switch-off will occur if the unit is inactive for a period of 5 minutes.

The unit can remain connected to the mains supply all the time without any danger of damage to the battery or the unit.

Mains Adapter/Charger Unit MA-3

Use the connector cable to connect the MA-3 to the CARDIOVIT AT-3, and connect the mains cable to the mains supply. When connected to the MA-3, the AT-3 will be supplied directly from the mains. During battery charging, the green indicator lamp is lit. This lamp is extinguished as soon as the battery is recharged (approx. 24 hours).

Mains Adapter/Charger Unit MA-4

The mains adapter/charger unit MA-4 is a fast-charging unit enabling the accumulator in the AT-3 to be fully recharged in a short time. The MA-4 is connected to the AT-3 either by plugging directly into the socket on the rear of the unit or via the connecting cable supplied. (When connecting directly, first unscrew and remove the potential equalisation connection (⏚) on the rear of the AT-3.) Connect the MA-4 to the mains supply with the power cable (by means of a special cable, it is also possible to operate the MA-4 from a 12 V battery). Switch the MA-4 on and the green "power on" light is illuminated. The yellow light illuminates indicating that the battery is being charged and is extinguished as soon as the battery is fully recharged. A totally discharged battery can be fully recharged within a maximum of 1 1/2 hours.

Caution: The MA-4 mains adapter/charger can only be used with AT-3 units which are equipped with a fast charging accumulator.

Potential Equalisation

The yellow/green ground lead can be connected to the potential equalisation and then to the (⏚) connection either on the rear of the CARDIOVIT AT-3 or on the left-hand side of the MA-4.

Switching On and Off

The CARDIOVIT AT-3 is switched on by means of the green **ON** key and off by means of the red **OFF** key. You can program the CARDIOVIT AT-3 in order to have it in the right setting when switching on. (→ Basic setting).

Please make sure that, during ECG recording, neither the patient nor the conducting parts of the patient connection or the electrodes (including the neutral electrode) come into contact with other persons or conducting objects (even if these are earthed).

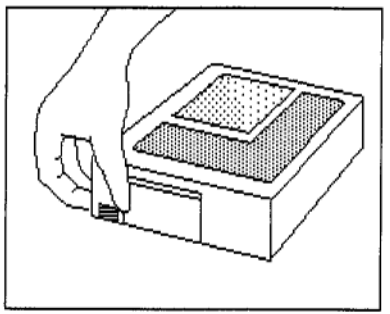
Replacing the Recording Paper

The recording paper must be replaced as soon as the end of the paper is indicated on the lower edge. After the indication first appears, there are about 8 pages left. However, we recommend that the paper be replaced immediately.

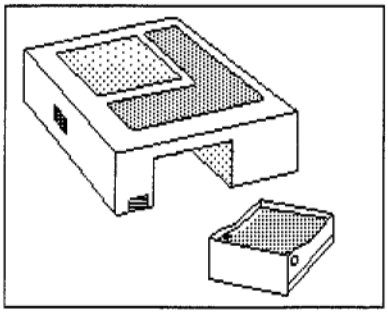
If no paper is left, the printing process is interrupted. On the screen, a corresponding remark appears. After the paper has been replaced, the printout is started again by pressing **COPY**.

SCHILLER can only guarantee an excellent printout, if Schiller original chart paper or a chart paper of the same quality is used.

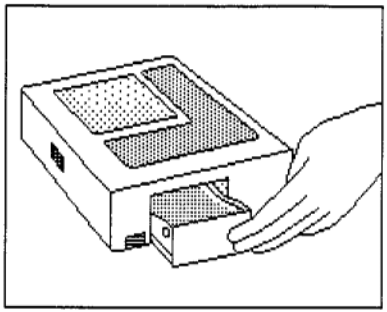
1. Push paper compartment release and pull out paper drawer.



2. Remove the remaining paper by turning the drawer upside-down. Place a new paper pack into the drawer. Check that the printed (grid) side is facing upwards, and place the beginning of the paper over the guide roller.



3. Reinsert the paper drawer and press firmly until it clicks into place.



Working with the CARDIOVIT AT-3

If you have never worked with a SCHILLER unit, it is important to read this chapter carefully. First, the basic functions such as selecting the lead group, entering patient data etc. are described. Further you learn how to record ECGs, which formats are available in automatic mode and what further possibilities the CARDIOVIT AT-3 offers.

ECG Recording

The CARDIOVIT AT-3 always receives all ECG signals simultaneously. Thus, 12 synchronous standard leads are available for measurement and interpretation. The recorded ECG signals are stored for 10 seconds in the input memory. For the further processing of the signals (i.e. formation of average complexes, interpretation) 10 seconds ECG signals are stored in the working memory. The ECG stored in the working memory can be printed as many times as required and in any format. This ECG remains stored until a new ECG is recorded, even if the unit is switched off.

Accordingly, the CARDIOVIT AT-3 has two different memories:

1. The input memory, where the real-time signals are stored for 10s and continually renewed.

2. The working memory for processing and printing of the ECG leads as described in section "Automatic ECG recording".

As an option, the CARDIOVIT AT-3 can be equipped with a long-term memory for up to 15 ECGs. (see Option "*Long-term memory*")

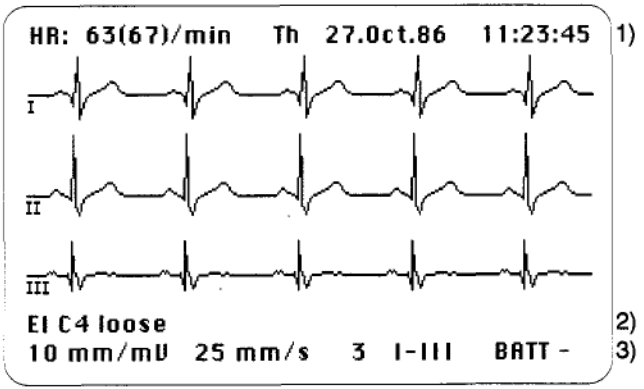
Liquid Crystal Display

As soon as the apparatus is switched on and the patient is connected, three leads are shown on the display together with information about the recording. The LC display is used on the one hand as an ECG monitor and on the other hand as an alphanumeric display for operating help, change of format, input of patient data etc.

To obtain good screen visibility, the contrast can be adjusted by means of knob **LCD** on the right-hand side of the unit.

LC Display as ECG Monitor

On the screen, either one or three leads can be represented. By pressing the key  you can change from 1-channel to 3-channel mode.



(1): Heart rate: mean value of 8 heart beats, in brackets beat-to-beat measurement; day, date, time

(2): Line for system messages: Here for example: Poor or no contact of electrode C4

(3): Sensitivity, recording speed, number of printed leads, indication of selected lead group, power supply

Heart rate (mean value of 8 heart beats and beat-to-beat measurement), day of the week, date and time are listed on the top line of the screen. On the bottom, sensitivity and recording speed and the power source (mains or battery) are indicated. The leads are marked on the left side. If any disturbances occur (e.g. loose electrodes, empty paper compartment), they are indicated on the second lowest line.

The leads can be represented at a speed of 25 or 50 mm/s. In 3-channel mode, the sensitivity is only half the selected value.

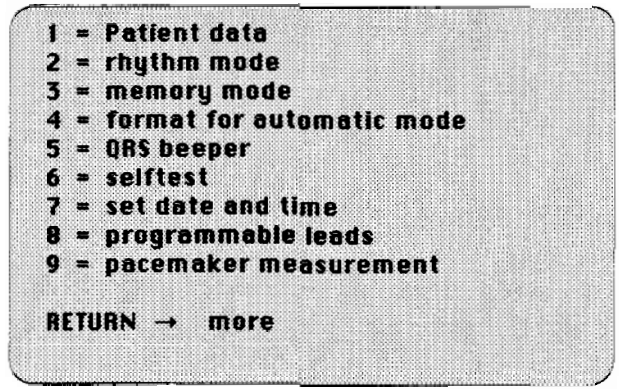
Printing the ECG shown on the screen

The recorded ECG signals are available in the input memory during 10 seconds. At any specific event (e.g. an extrasystole), the ECG can be printed for further examination or for documentation. For this purpose, the AUTO/START key has to be pressed so that the last 10 seconds of the ECG signal are retained in the working memory, analysed, interpreted and, after 2 - 3 seconds, printed.

LC Display as Alphanumeric Screen

For all programs and settings described later, the LC display serves as an alphanumeric input screen. For each application, ready made tables are available which have to be filled in and completed according to instructions. All programs are called up by pressing the **FNCT** key and a **number or FNCT, RETURN** and **a number.** The most helpful facility is the list of the operating instructions to be used.

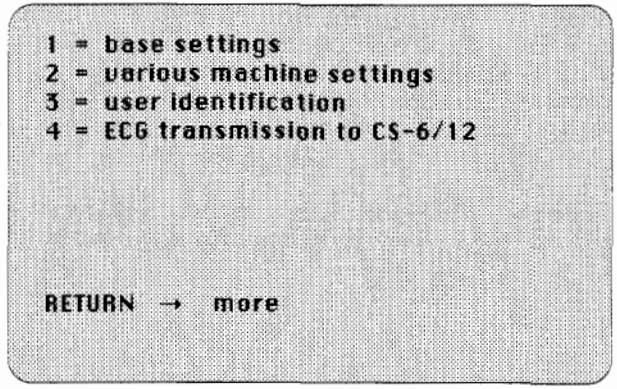
With the key **FNCT** you can switch back to the ECG monitoring.



Operating instructions on the screen

At any time, you can call up an operating help on the screen where all the commands and functions are briefly described. After pressing key **FNCT** a list appears as shown opposite.

By pressing the indicated character on the numeric keyboard, the desired function is called up or the command given is executed.



Selecting Number of Leads

The manual ECG can be printed on one channel or three channels. For one specific automatic format, the number of leads per page is predetermined in the same manner.

The number of printed leads is selected from 1 channel to 3 channels or back again by pressing key  . The setting you normally use will be stored in the base setting (see *Basic Setting*).

On the lower right of the LC display the number of leads is indicated.

Selecting the Lead Groups

The lead groups are selected by means of the keys **< 0** and **1 >**.You can select not only the 12 standard leads, it is also possible to select the Frank XYZ leads and a group of 3 freely programmable leads (PROG 1 - PROG 3). You will find a detailed description of how to select these leads in the reference section(→ *Leads (freely programmable)*).

In **1-channel mode**, you can select and print out all twelve standard leads, PROG1 - PROG 3 and X, Y, Z one by one.

In **3-channel mode**, the lead groups I -III, aVR - aVF, V1 - V3, V4 - V6, PROG, XYZ are selected group by group and printed accordingly.

It is possible to change to another lead or lead group at any time during the printout.

Connecting the Patient Cable

The accessory kit of the electrocardiograph includes a 10-lead patient cable. This cable is plugged into the patient cable socket on the right side of the unit and secured with the screws.

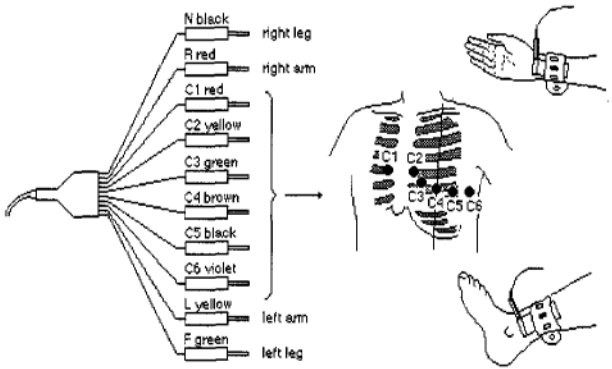
The CARDIOVIT AT-3 is CF (⚕) rated. The patient connection is fully isolated and defibrillation protected. The unit can be used for intracardiac application. Protection against defibrillation voltage is only ensured, however, if the original Schiller patient cable is used.

The lower the resistance between skin surface and electrodes, the better the quality of the ECG recording. The skin areas have first to be cleaned with alcohol and thick hair has to be removed.

The standard accessories include four stainless steel limb electrodes and 6 precordial suction electrodes. The limb electrodes are first spread with electrode gel and then attached with the rubber strings to the arm and foot pick-up sites.

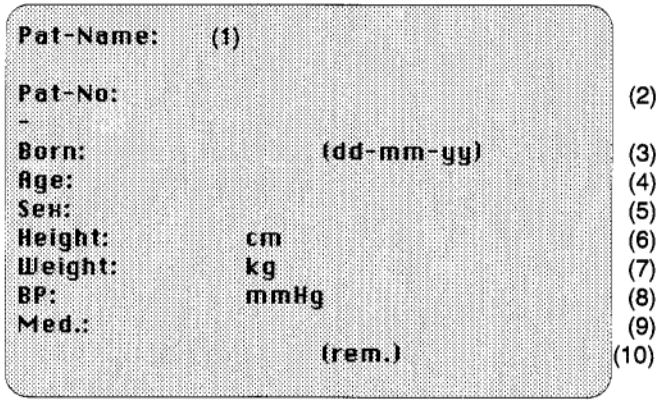
Connecting the electrodes

Apart from the standard leads you can also record other lead groups. In the reference part you find the most commonly used lead systems (see *Lead systems*). Here, we show you the connections for the standard leads.



Input of Patient Data

Each ECG is printed with the number and other information on the patient. Patient name, sex, medication and individual remarks have to be written on the ECG printout. The other data can be entered by means of the numeric keyboard. Press key **FNCT** and **1** in order to call up the following input table:



(1): Patient name: manual input on printout
(2): Patient number: maximum length 22 characters
(3): The date of birth has to be entered in figures in the order day, month, year. Example: for 3rd november, 1936 "3.11.36" or "03.11.36"
(4): The age is calculated by the CARDIOVIT AT-3 on the basis of the date of birth (up to 2 years: number of months; up to 6 years: number of years and months; then: number of years)

The cursor is located on the first input line "Pat-No:". Now the respective entry is made by means of the numeric keyboard. After each entry, the **RETURN** key is pressed. The cursor moves automatically to the next line.

Wrongly typed characters can be deleted with the **DEL** key. Whole lines can be typed over. The old contents of the line is deleted as soon as the first character is entered. If a new patient number is entered, all the other patient data are automatically deleted.

(5): Sex: manual input on printout
(6): Height in cm (3 figures)
(7): Weight in kg (3 figures)
(8): Blood pressure in mmHg (7 figures)
(9): Medication: manual input on printout
(10): Line for remarks: manual input on printout

Chart Speed

For the real-time recording and the ECG representation on the LC display, the speed can be selected by pressing the corresponding key (mm/s). The selected chart speed is indicated on each ECG printout.

In automatic mode, the chart speed is selected when defining the format.

Sensitivity

The sensitivity can be set manually by pressing the corresponding key (mV/mm). In automatic mode, the sensitivity is automatically set. However, it can be adjusted manually for special cases (see Automatic Mode).

At each change the calibration signal is printed on the ECG. The calibration signal can be manually triggered by pressing the 1 mV key.

Heart Rate Indication

The heart rate is indicated on the screen (upper left side) as average value of eight heart beats and in brackets as beat-to-beat extrapolation. By pressing **FNCT** and **5**, the acoustic QRS indication is switched on and off.

Automatic ECG Recording

ECG acquisition and printout

For the automatic processing, the ECG signals are taken from the input memory into the working memory. As soon as the AUTO/START is pressed, the last 10s of the current ECG recording are read into the working memory and after a short moment, the ECG is printed in the selected format. The ECG remains available in the memory until a new ECG is recorded, even if the unit is switched off in the meantime.

If there is any disturbance (i.e. loose electrode or end of paper), an acoustic signal is given. As long as the disturbance remains, no ECG can be stored. An indication of where to find the defect is shown on the LC screen. As soon as the defect is eliminated, storage starts (duration: 10s).

The ECG is automatically printed in the selected format (see *Format for automatic mode*). If your CARDIOVIT AT-3 is equipped with software for ECG measurement and interpretation, average cycles, measuring results and interpretation statements will be printed, too. Beginning and end of the page are set to the perforation so that after the end, the ECG strip can easily be removed.

Copies of the ECG

Press the **COPY** key to print out once more the ECG from the memory. Each ECG can be copied as many times as you want. And as the original ECG signals are stored you can print the ECG in different formats and with different contents.

Selection of sensitivity in automatic mode

All leads are recorded with a sensitivity of 10 mm/mV unless amplitudes are too great, in which case the sensitivity is automatically reduced to 5 mm/mV. The **1 mV calibration** signal given at the beginning of each ECG tracing indicates the sensitivity applied.

In exceptional cases it is possible to change the sensitivity manually, i.e. all leads can be printed with 5 mm/mV or 20 mm/mV. Before pressing the **COPY** key, the new sensitivity is selected. The whole ECG is then printed with the new sensitivity.

Manual Recording of ECGs

In manual mode, the number of leads, lead group, chart speed, and sensitivity can be freely chosen.

Press the **MAN/START** key: The one or three selected leads are printed. On the lower edge of the ECG strip, chart speed, sensitivity, indications of possible disturbances, heart rate, patient number as well as date and time of the recording are continually recorded.

During the recording, you can change one or more recording parameters at any time. After each switching to a new lead group the sensitivity is automatically adjusted and the respective 1 mV calibration signal recorded. Whenever baseline drifts occur the ECG is automatically centered again.

Press the **STOP** key in order to interrupt the recording.

Copies of manual ECGs

For copies of the manual ECG tracings or for a detailed analysis of a particular event, the last 10 seconds of the ECG can be stored in the working memory by pressing the **STOP** and **AUTO/START** key. After a short moment, the ECG will be printed in the selected format .

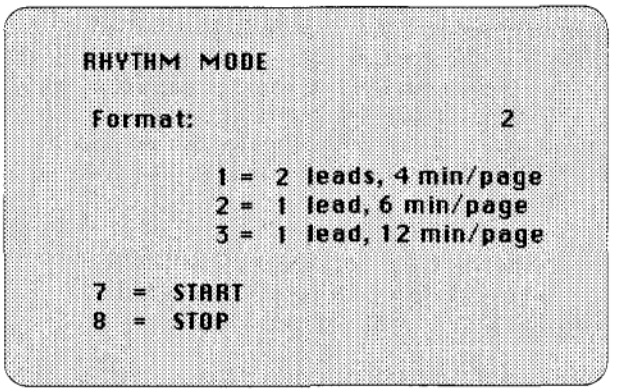
Recording of Long-term Rhythm ECGs

For long-term rhythm recordings, there are several recording formats at your disposal. By pressing keys **FNCT** and **2** the following table for selecting the format appears on the LC display.

As soon as the rhythm recording is started, the indication "R" appears on the LC display.

After 4 to 12 minutes, or when the long-term recording is stopped by pressing 7, the printout of the rhythm leads starts. The patient identification, the leads printed, the chart speed and the date and time of recording are indicated on the lower margin of the paper.

The rhythm leads can be freely selected (see *Leads (freely programmable)*).

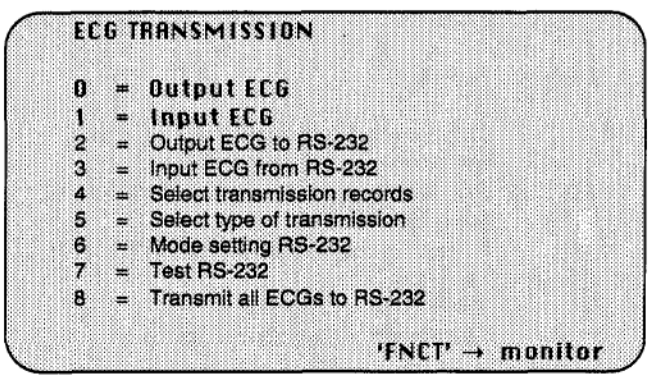


Input:	Result:
1	Printout of programmed leads UR1 and UR2, 4 min on one page (20 cm)
2	Printout of programmed lead UR1, 6 min. per page
3	Printout of programmed lead UR1,12 min. per page
7	The rhythm recording starts.
8	The rhythm recording is stopped.

Transfer to/ from CARDIOVIT CS-6/12

If you wish to transmit data from the CARDIOVIT AT-3 to the CARDIOVIT CS-6/12, firstly press **FNCT**, **RETURN** and **2** to call up the Various Machine Settings menu and set the footsw/QRS trig. setting to OFF. At the same time, the storage mode can be set (if the storage mode is set to COMPRESSED, then the data transmitted will also be compressed).

Insert the special connecting cable into the "DATA I/O" connection on both units. On the AT-3, press **FNCT**, **RETURN** and key **4** to call up the following table:



(*For items 2 to 8 → RS-232 Computer Interface*)

A transmission is possible between two CARDIOVIT AT-3 units, or one CARDIOVIT AT-3 and a CARDIOVIT CS-6/12. It is important that you switch the receiving set to 'Input ECG' and the transmitting unit to 'Output ECG'.

The **output of ECG data is** started with key **0**. If the transmission is successful, you will hear an acoustic signal and a confirmation appears on the LC screen ('sending ECG data' followed by 'ECG is output').

The indication **F** in the lower right corner shows that there is an ECG in the memory. Otherwise, no ECG can be transferred and the message 'No ECG in storage' will appear on the LC display.

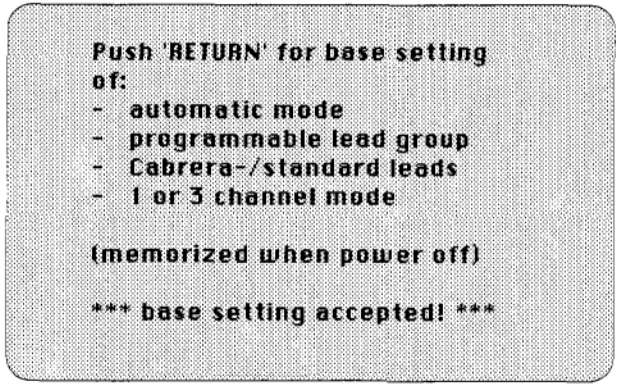
For the **input of ECG data**, switch the CARDIOVIT AT-3 to 'ECG Input'. If the transmission is successful, you will hear an acoustic signal and on the screen, the indications 'receiving ECG data' followed by 'ECG is input' will appear.

If **no ECG data can be sent or received** the message 'transmission error' will appear on the LC display. Please check that the line is properly connected and that the transmitting unit is correctly installed and set, or contact your official SCHILLER service representative.

Basic Settings

It is possible to establish a basic setting of most of the programmable variables so that the CARDIOVIT AT-3 is ready with exactly the right settings whenever you switch it on.

Press **FNCT**, **RETURN** and **1** to call up the base setting program:



By pressing **RETURN**, the present setting of the unit is permanently stored as base setting and an acknowledgement is given on the screen.

Further Settings and Programs

In this chapter we have introduced the most important settings and applications. The CARDIOVIT AT-3 offers many more possibilities. For further settings, we would like to draw your attention to the reference section where you will find more information on the already mentioned programs as well as additional descriptions for further settings (e.g. user identification, setting of date and time etc.).

CHAPTER 4

Care and Maintenance

Disturbances

Due to the digital processing of the ECG signals, the influence of disturbances is reduced to a minimum. 50 Hz and 60 Hz interferences are suppressed by an adaptive, digital, AC interference filter, without attenuating or distorting the ECG. However, when using the unit, make sure that no sources of interference (such as electrotherapy units, X-ray appliances, strong lamps or current conductors) are nearby.

If the ECG recording is disturbed, a message appears on the LC screen (second lowest line). As long as the cause of the disturbance remains, the ECG cannot be stored.

For example, if "EL C4 loose!" appears on the screen, this means that there is insufficient contact at electrode C4 (brown). The cause could be insufficient electrode gel or too much thick hair.

A short-term disturbance of the ECG recording may be caused by defibrillation (overloading of the ECG amplifier).

Self-test

Every time the unit is switched on, a self-test is carried out to check all the functions of the unit.

By pressing keys **FNCT** and **6**, the self-test can be initiated at any time. A table giving information for the service staff appears on the screen. To exit the self-test, press **FNCT**.

Testing the Electrode Cables

The electrode leads can be tested for short-circuit and interruption by means of the test socket on the right-hand side of the unit. For this purpose, the electrode plugs are plugged into the test socket. The CARDIOVIT AT-3 is switched on and the patient cable plugged in. If the control light is illuminated there is no defect.

Care and Maintenance

The **patient cable** should not be exposed to excessive mechanical stress. Whenever disconnecting the leads, hold the plugs and not the cables. Store the leads in such a way as to prevent anyone stumbling over them or any damage caused by the wheels of instrument trolleys.

The cable can be wiped with soapy water. Sterilization, if required, should be done with gas only and not with steam. To disinfect, wipe the cable with one of the following products (do not dip into liquid!):

Incidin GG	Lysoformin
Amocid	Alhydex

The **electrodes** can be cleaned after every use with soapy water. Make sure that no water is left in the suction cup of the suction electrodes. Sterilization can also be performed with gas or with Alhydex or Vygon.

The **casing** of the CARDIOVIT AT-3 should be cleaned with a soft cloth on the surface only. Use conventional detergents or disinfectants which do not contain alcohol. Switch the unit off before cleaning.

Do not, under any circumstances, immerse the apparatus into a cleaning liquid or sterilize with hot water, steam, or air.

At 12 monthly intervals, the unit should undergo a technical safety check. The extent of this check should include the following:

- visual inspection of the unit
- visual inspection of accessories
- accumulator check
- protective earth conductor test
- insulation test
- leakage current test
- calibration test
- check of alarm functions
- check of unit functions

The test results should be documented and entered in the equipment book.

Terms of Warranty

The CARDIOVIT AT-3 is warranted against defects in material and manufacture for a period of one year (from date of purchase). Excluded from this guarantee is damage caused by an accident or as a result of improper handling. The warranty entitles free replacement of the defective part. Any liability for consequential damages is excluded. The warranty is void if unauthorized or unqualified persons attempt to make repairs.

In case of defect, send the apparatus post-paid to your dealer or directly to the manufacturer.

CHAPTER 5

Technical Data and Equipment Configurations

Technical data

CARDIOVIT AT-3

Dimensions (l/w/h) : 250x141x48 mm
Weight : approx. 1.5 kg
Power Supply Requirements : In-built 9.6 V NiCd battery (rechargeable) and/or charging unit 110/220/240 Vac 50/60 Hz
Power Consumption : recording 5W, standby 2W
Leads : Standard / Cabrera / FrankXYZ / Nehb. Further combinations user programmable
Paper Speed : 5 / 25 / 50 mm/s (direct), 100 mm/s (from memory)
Sensitivity : 2.5 / 5 /10 / 20 mm/mV, either automatically adjusted or manually selected
Chart Paper : Thermoreactive, Z-folded, 70 mm wide, 20 m long, perforation 100mm
Printing Process : High-resolution thermal print head, 8 dots per mm
Recording Tracks : 1, 2 or 3 channels, positioned at optimal width on 56 mm, automatic baseline adjustment
Automatic Lead Programs :
- 1 or 3 channel representation of 12 simultaneously acquired standard leads
- Versions M and C : average complexes of the 12 standard leads (25 or 50 mm/s) and 10s rhythm strip (1 or 2 leads)

Data Record :
- Listing of ECG recording data, date and time of examination, patient number, etc
- Version C : ECG interpretation statements
- Versions M and C : ECG measurement results (intervals, amplitudes, electrical axes), average complexes with optional measurement reference markings

Long-term Rhythm Recordings in High-density Report Formats : - 2 leads, 3 min per 20 cm chart paper
- 1 lead, 6 min per 20 cm chart paper
- 1 lead, 12 min per 20 cm chart paper

ECG Storage :
- Output memory for 10s 12-lead ECG
- Circular input memory for 10s 12-lead ECG. The last 10s ECG can be copied from input memory to output memory by pressing one key
- Every ECG can be copied from the output memory any number of times
- Option: Input memory for 15 ECGs with all data

Liquid Crystal Display :
- Liquid crystal display for ECG monitoring (1 or 3 leads) and alphanumeric information
- Resolution : 128x256 dots; viewing angle adjustable

Calendar Clock : Battery powered. Lifetime >6 years, leap-years preprogrammed
Frequency Range of Digital Recorder : 0 Hz to 150 Hz (IEC), 0 Hz to 150 Hz (AHA)
ECG Amplifier :
- Simultaneous, synchronous registration of all 9 active electrode signals (= 12 standard leads)
- Sampling frequency 800 Hz
- Digital resolution 5 µV
- Dynamic range ± 9 mVac
- Max. electrode potential ± 300 mVdc
- Time constant 3.2s
- Frequency response 0.05 to 280 Hz (-3 dB)
- Input impedance >100 MOhm

Myogram Filter (muscle tremor filter) : 25 Hz or 35 Hz, programmable (only effective for printed ECG). The stored ECGs can be printed with or without filter
Line Frequency Filter : Distortion-free suppression of superimposed 50 or 60 Hz sinusoidal interferences by means of an adaptive digital filter
Experimental Inputs : 1 differential input, sensitivity 0.5V/cm. Input impedance >2x100 kOhm.
Test Socket for Patient Cable : For testing of electrode cables for interruptions and short-circuits; if defective, control lamp does not light
Patient Input : Fully floating and isolated, defibrillation protected
Patient Leakage Current : Less than 5 µA
Safety Standard : CF according to IEC
Protection Class : III according to IEC, VDE and SEV
Environmental Conditions :
- Temperature : Operating 10°C to 40°C
  Storage -10°C to 70°C
- Relative humidity: 15 to 85%
- Atmospheric pressure: up to 5000m alt.

Control Panel : Water and dust-proof pad keys

Technical data subject to change

Mains Adapter/Charger Unit MA-3

Dimensions (l/w/h): 160 X 115 X 65mm
Weight: 980 g
Voltage: 220Vac / 50Hz / 20VA. Thermal fuse T109°C
Output voltage: 12Vdc / 1A (1 fuse M1.6 A-E)
Charging current: 30mAdc / 12V
Protection class: II according to IEC
Environmental conditions:
- Temperature: Operating 0°C to 50°C
  Storage -10°C to +70°C
- Relative humidity: 15 to 85%
- Atmospheric pressure: up to 5000m alt.

Technical data subject to change

Mains Adapter/Charger Unit MA-4

Dimensions (l/w/h): 250 X 96 X 50mm
Weight: 1.5 kg
Voltage: 220Vac / 50Hz / 35VA (2 fuses T 0.5 A)
DC connection: 12Vdc / 1.5A (only with mains operation)
(1 fuse T 2.5A)
Output voltage: 0.5Adc / max. 14V
Protection class: I according to IEC
Environmental conditions:
- Temperature: Operating 0°C to 50°C
  Storage: -10°C to +70°C
- Relative humidity: 15 to 85%
- Atmospheric pressure: up to 5000m alt.

Technical data subject to change

CARDIOVIT AT-3 Available Configurations

The CARDIOVIT AT-3 is available in three different versions with standard or optional accessories. Additionally, there are a number of software and hardware options available. The various configurations are as follows:

Equipment versions

Standard version : Standard unit with ECG monitoring, recording and print-out capabilities.

Version M: Standard unit with additional ECG measurement program

Version C: Standard unit with additional ECG measurement and interpretation program

All the above versions are available in different languages

Options

- Integral long-term memory for 15 ECGs
- Software for rhythm and heart rate monitoring
- RS-232 computer interface
- Software and finger sensor for pulsoximetry (SaO_2)

Accessories

Standard accessories:

- 10-lead patient cable
- 6 precordial suction electrodes
- 4 extremity electrodes with rubber straps
- 1 flask of electrode gel
- 1 package of recording paper
- mains/charger adaptor
- operating manual

Optional accessories:

- external tripod-electrode for emergency ECGs
- foot switch
- carrying case
- AT-3 ↔ CS-6/12 Data I/O connector cable
- MA-4 mains adaptor/charger unit with RS-232 interface (complete with connecting cables)

CHAPTER 6

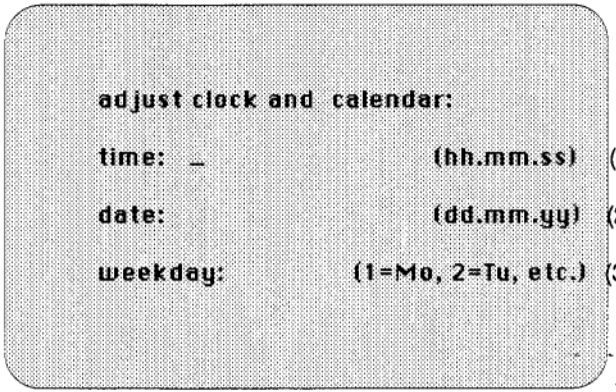
Reference Information

Adjusting Date and Time

The CARDIOVIT AT-3 contains a calendar clock running on its own battery. Thus, the calendar clock works independently from the power supply. The battery will last for approx. 8 years.

The number of days per month and the leap years are already preprogrammed and the time is adjusted to Central European Time (CET). If time or date have to be changed, call up the "Adjusting calendar clock" menu by pressing **FNCT** and key **7**.

As soon as **RETURN** is pressed the entered values are stored and the cursor moves to the next line. Wrongly entered figures can be deleted with the **DEL** key. If a wrong date (e.g. 42.5.85) is entered and **RETURN** is pressed, the whole line is deleted and a question mark appears. The cursor remains on the same line so that a new, correct date can be entered.



(1): The time has to be entered in hours, minutes, seconds. Example: for 11.25 a.m.: "11.25.0", for 6.05 p.m.: "18.05.0". The newly entered time is valid as soon as RETURN is pressed.

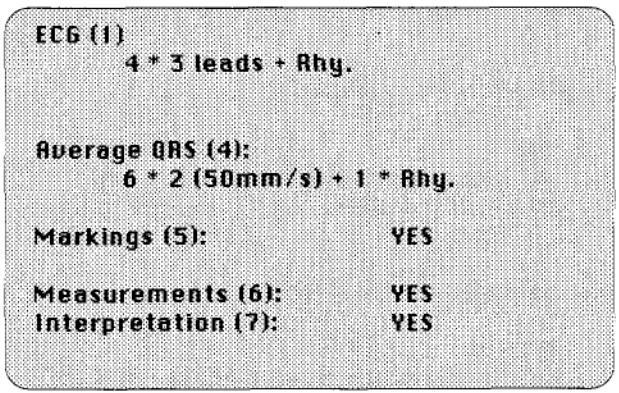
(2): The date is entered as day, month, year. Example: for 11th December, 1987: "11.12.87"; for 2nd May, 1986: "2.5.86".

(3): The day of the week is indicated by the following numbers: 1=Mo, 2=Tu, 3=We, 4=Th, 5=Fr, 6=Sa, 7=Su.

Format for Automatic Mode

The format of the automatic ECG output can be freely chosen. Normally the format will only be programmed once when starting the CARDIOVIT AT-3 for the first time. Nevertheless, it is possible to change the programmed format at any time (some of the format options are valid only for M and C versions).

First step: Press **FNCT** and key **4**. The following table appears on the screen:



In the ECG section, the format of the printed leads can be selected. By pressing key **1**, different format possibilities appear on the screen.

Entry **Output format:**

1 **- - - - - - - - - -**
No leads are printed

4 * 3 leads + Rhy.
On 30 cm, all the 12 standard leads plus one rhythm strip are printed.

1 * 1/3 leads (10 s)
10s of the user programmed leads are printed at a chart speed of 25 mm/s (30 cm).

choose (2) SHORT
(3) 25 mm/s
12 leads are printed as selected on 1 or 3 channels. The length of the leads is selected with key **2** as SHORT (= 30 cm) or LONG (= 60 cm), the chart speed with key **3** (25, 50, or 100 mm/s).

In the Average QRS section, the format of the page with the average ECG cycles can be selected (applies to M or C versions only):

Entry **Output format**

4 **- - - - - - - - - -**
No average cycles are printed.

4 * 3 (25 mm/s)
The average complexes are printed on 10 cm (chart speed: 25 mm/s).

4 * 3 (50 mm/s)
On 20 cm, the 12 average complexes are printed at 50 mm/s.

6 * 2 (50 mm/s) + 1 * Rhy
On 30 cm, the 12 average complexes are printed at 50 mm/s and one rhythm lead at 25 mm/s over 10 s.

12 * 1 (25 mm/s) + 2 * Rhy.
On 30 cm, the 12 average complexes are printed at 25 mm/s and two rhythm leads at 25 mm/s over 10 s.

Markings:

5 **YES/NO**
The reference points (beginning and end of P wave and QRS as well as end of T wave) can be added to the ECG cycles or omitted.

Measurements:

6 **YES/NO**
The detailed table of measuring results can be printed out or omitted. (However, the values of electrical axes, intervals, and heart rate are not suppressed.)

Interpretation (C Version only):

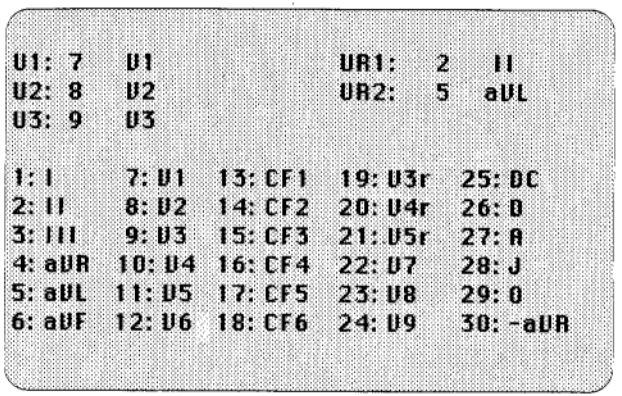
7 **YES/NO**
The interpretation statements can either be printed out or omitted.

Patient data (standard version only):

8 **YES/NO**
To obtain an extra compact ECG, the printout of detailed patient data can be omitted.

Leads (freely programmable)

Use keys **FNCT** and **8** to call up the table for programming leads.



The cursor is on the input line U1. Choose the lead required by entering the corresponding number as shown on the table below. With key **RETURN** you change to the next line and put in the next lead number etc. Up to 3 leads can thus be freely selected which are printed out on a manual ECG recording. In automatic mode, they are recorded, stored and printed out .

In the second column the rhythm leads can be selected. UR1 appears if only one rhythm lead is selected in automatic fomat or in rhythm mode. UR1 and UR2 are printed in the 2-channel rhythm format. UR1and UR2 can be chosen from the standard leads (1 to 12, and 30) only.

The user programmed leads can be stored in the base setting of the unit (see *Basic setting*). The lead group can be selected by pressing keys 0 < and 1 >.

Lead Systems

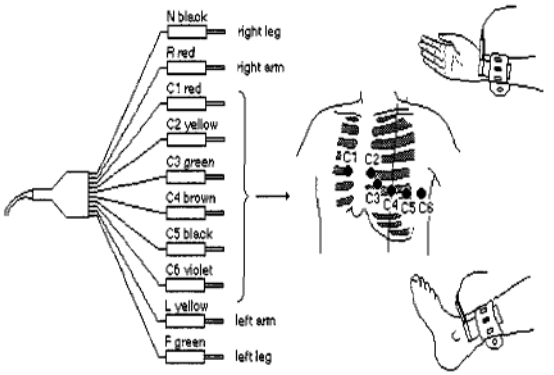
Attaching the electrodes

The smaller the resistance between skin surface and electrodes, the better the quality of the ECG. The skin areas must first be cleaned with alcohol and thick hair should be removed.

The four stainless steel electrodes are used for the extremities. The electrodes are first spread with electrode gel. The rubber straps should only be tightened to such an extent as to prevent any movement of the electrodes, but they should not constrict the blood circulation.

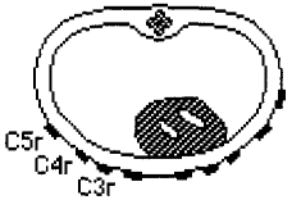
The six suction electrodes are also moistened with gel and attached in their corresponding positions.

Standard leads
I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6



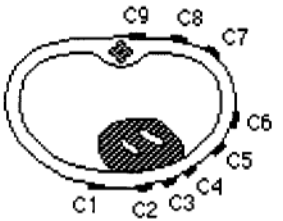
Leads V3r, V4r, V5r

Plug C3 green to electrode C3r
Plug C4 brown to electrode C4r
Plug C5 black to electrode C5r

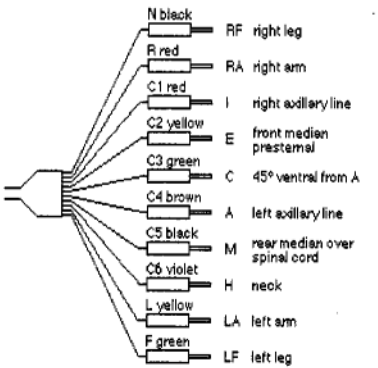


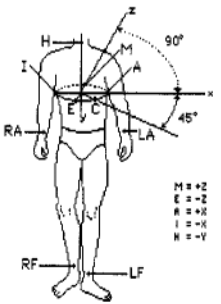
Leads V7, V8, V9

Plug C1 red to electrode C7
Plug C2 yellow to electrode C8
Plug C3 green to electrode C9



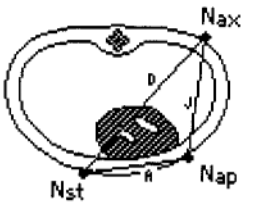
Frank leads X, Y, Z





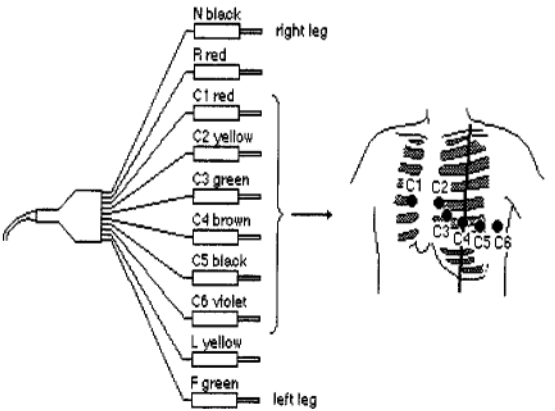
Nehb leads

Plug R red to electrode on N_{st}
Plug L yellow to electrode on N_{ax}
Plug F green to electrode on N_{ap}
Plug N black to electrode on right leg



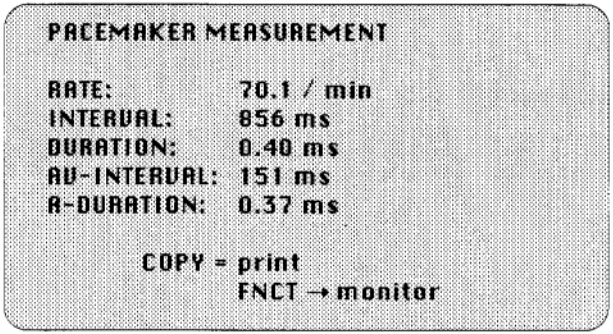
Bipolar leads CF1 - CF6

To record the semithoracic leads CF1 to CF6, electrode F green is usually attached to the left leg. This electrode can however be be located elsewhere, for example when placed on the manubrium of the sternum, CM leads will be measured.



Pacemaker Measurement

If the patient has a pacemaker, then the CARDIOVIT AT-3 can be used to check and measure it's characteristics. Both single and dual-chamber pacemaker measurements can be made. Press **FNCT** and then key **9** to call the following table to the display:

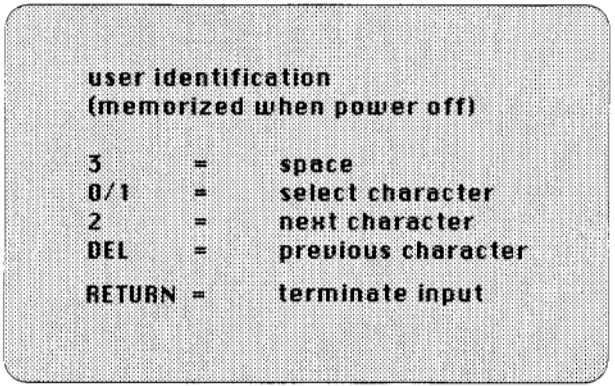


Using lead II, the CARDIOVIT AT-3 measures the pacemaker characteristics and displays the number of stimulations per minute, the time interval between two stimulations and the duration of the stimulation. If a dual-chamber pacemaker is being measured, then the time interval between atrium and ventricle stimulations and the duration of the atrium stimulation are also given.

To produce a print-out of the recording together with the measurement results, press **COPY**.

User Identification

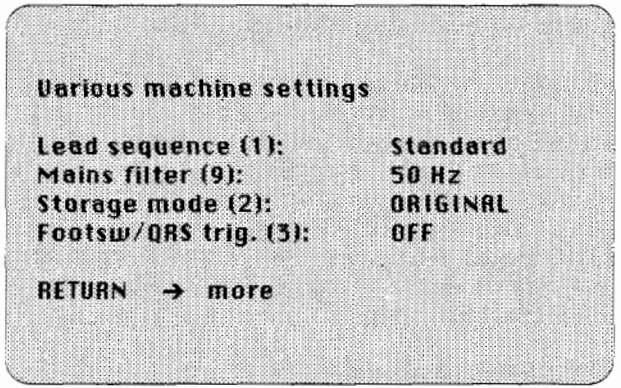
This program is used to enter the name of the physician, clinic or department which will then be printed on each ECG. The input is stored permanently, i.e. it is not deleted when the unit is switched off. Press **FNCT**, **RETURN** and **3** and enter the desired identification according to the instructions on the screen.



Letters are entered by means of the numeric keyboard, press **1>** to move forwards through the alphabet and **0<** to move backwards. When the desired letter appears on the screen, press **2** to move on to the next letter space. To replace or delete a previously entered letter, press **DEL**. A blank space can be entered between two words by pressing key **3**. Once input of the desired identification is completed, press **RETURN** for confirmation.

Various Settings

The Various Machine Settings menu comprises 3 pages of customer programmable parameter settings. To call up the menu, press **FNCT**, **RETURN** and **2**. The first page of settings comprises the following:



The **lead sequence** can be switched from Standard to Cabrera and vice versa by pressing key **1**.

The **mains filter** can be switched from 50 Hz to 60 Hz (necessary for some countries) or switched off by pressing key **9**.

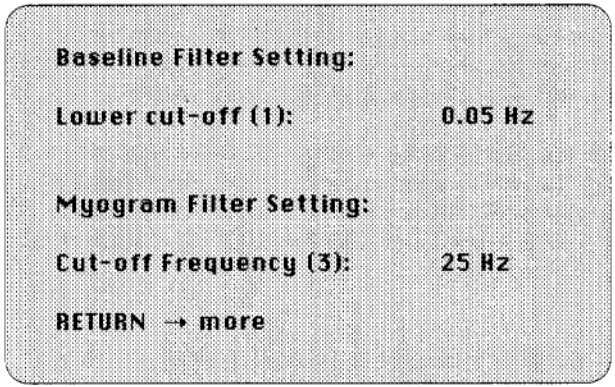
The **storage mode (option)** determines if the data to be memorized will be stored in compressed or in original form. Compressed ECG data enables more ECGs to be stored, but when printed again, a slight deviation from the original waveforms will result. Measurement and interpretation, however, are still the same as in the original. This setting also determines whether the data transferred to a CARDIOVIT CS-6/12 will be in compressed or original form.

The **footswitch/QRS trig.** settings determine whether the DATA I/O interface is to be used as a footswitch and QRS trigger connection (setting = ON), or as a connection to transmit data to another unit (setting = OFF). The setting is altered by pressing key **3**.

Press **RETURN** to change to the second page:

Baseline and myogram filters

The second page of settings contains the parameters for the Baseline and Myogram filters:



The digital **baseline filter** has been designed in order to suppress excessive baseline drifts. By pressing key **1**, the setting can be altered to one of the following values: 0.50, 0.25, 0.12, or 0.05 Hz. The value set is the lower limit of the frequency range and is normally set to 0.05 Hz, ie a frequency range of 0.05 to 100 Hz.

The settings 0.12, 0.25 and 0.50 Hz should only be used when absolutely necessary as the possibility exists that they could affect the original ECG signal, especially the ST segments.

The **myogram filter** suppresses disturbances caused by strong muscle tremor. The filter is switched on and off by means of the **FILT** key. It is possible to print the stored ECG either with or without passing the myogram filter.

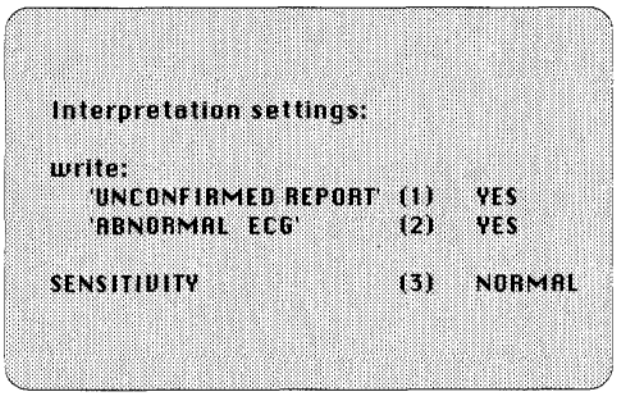
The cut-off frequency can be set by pressing key **3**, which switches the value from 25 to 35 Hz and back again.The value set will be the new upper limit of the frequency range as soon as the **FILT** key is switched on.

Filter ON is indicated by "FI" in the centre of the bottom line of the ECG monitor display.When **FILT** is pressed again, the Myogram filter is switched off and the "FI" indication disappears from the display.

Press **RETURN** to move on to the third page:

Interpretation settings

The third page contains the interpretation settings and is only available in "C" versions of the CARDIOVIT AT-3.



The **interpretation settings** enable the user to determine whether or not the comments 'UNCONFIRMED REPORT' and/or 'ABNORMAL ECG' will be added to the interpretation statements on the print-out. By pressing key **1**, the first comment can be requested (YES) or cancelled (NO). The second comment can be requested or cancelled in a similar manner by pressing key **2**. The required sensitivity 'NORMAL' or 'LOW' can be selected by pressing key **3**.

Selection of 'LOW' sensitivity suppresses certain non-specific ECG findings and is recommended for situations such as mass screening. Selection of 'NORMAL' sensitivity cancels the suppression of non-specific ECG findings and is recommended for situations where a more detailed patient examination is required.

NOTE: For a complete listing of statements at normal sensitivity, and an explanation of statements at low sensitivity, see *Option 2 : SCHILLER ECG Interpretation Program.*

CHAPTER 7

Options

SCHILLER ECG Analysis Program (Versions M & C)

The SCHILLER ECG analysis program forms the basis for analyses using the SCHILLER ECG interpretation program or for diagnosis by a physician. The program measures the ECG signal and presents the results in a clearly arranged form. The measurements are as follows:

Heart rate (HR)

Average heart rate calculated on the basis of the entire recording (10 seconds) and shown as number of beats per minute.

Intervals

RR: Average time interval between two consecutive ventricular complexes, computed on the basis of the average heart rate.

PP: Duration of P wave (interval between markings 1 and 2 of the average ECGs)

PQ: P-Q interval, i.e. period of time between beginning of P wave and beginning of QRS complex (markings 1 and 3 of average ECGs)

QRS: Duration of QRS complex (time interval between markings 3 and 4 of average ECGs)

QT: Interval between beginning of QRS (beginning of ventricular depolarisation) and end of T wave (end of repolarisation phase)

QTC: Normalized QT interval. As the QT interval is dependent on the heart rate, it is often converted into the normalized QTC interval (i.e. the QT the patient would show at a HR of 60/min). Usually, the QTC amounts to 390 ±40 msec. The conversion is achieved according to the following formula:

$$QTC = QT * \sqrt{\frac{1000}{RR}}$$

Electrical axes

The electrical axes of the heart are determined separately for the P, T and QRS waves. They indicate the main spreading direction of the electrical vector in the frontal plane.

The SCHILLER analysis program calculates the axes on the basis of the maximum deflection of the relevant waves in leads I and aVF. The following formula is used for the calculation:

$$\text{axis } \alpha = \arctan [\max (aVF) / \max (I)]$$

Please note that large discrepancies may be found between two measurements if the P and T waves are indistinct. It is also known that breathing and the position (supine or standing) of the patient produce changes in the electrical axes.

Detailed measurements for each lead

The SCHILLER analysis program prints a table with lead-specific measurement results presented in 12 columns, i.e. for each standard lead, the amplitude values of the P, Q, R, S, R', S' T, and T' waves, the J point and the ST integral are listed in millivolts (mV). The amplitude measurements relate to a reference value that correponds to the signal value immediately before the beginning of the QRS complex (marking 3 on the average ECGs). The duration of the Q, R, S, R' and S' waves is indicated in milliseconds (ms).

The measurements are designated as follows:

P:	amplitude of P wave
Q:	amplitude of Q wave
Qd:	duration of Q wave
R:	amplitude of R wave
Rd:	duration of R wave
S:	amplitude of S wave
Sd:	duration of S wave
R':	amplitude of R' wave
R'd:	duration of R' wave
S':	amplitude of S' wave
S'd:	duration of S' wave
J:	amplitude of J point (marking 4 of average ECGs)
ST:	ST integral: averaged amplitude of ST segment (from J point to half the distance between J point and T wave maximum)
T:	amplitude of T wave
T':	amplitude of T' wave (in case of a diphasic T wave)

SCHILLER ECG Interpretation Program (Version C)

Explanation of findings.

The SCHILLER ECG interpretation program is designed to assist the physician in reading and evaluating the ECG print-out. The program produces its findings as the result of a comparison between ECG signal measurements and pre-programmed criteria.

On the following pages is an explanation of the possible findings which can result from the interpretation program. Each explanation is accompanied by one of the following general classification statements:

Normal ECG
Otherwise normal ECG
Borderline ECG
Possibly abnormal ECG
Abnormal ECG

Rhythm

Premature atrial contractions(s)
One or several premature beats of the same shape as the predominant beats were detected in the absence of atrial fibrillation.

Bigeminy will appear in addition to this statement if at least three supraventricular extrasystoles are detected, each separated from the preceding one by a single predominant beat.

Trigeminy will appear in addition to this statement if at least three supraventricular extrasystoles are detected, each separated from the preceding one by two predominant beats.

(OTHERWISE NORMAL ECG)

Atrial escape beat(s)
A pause longer than 1.5 times the predominant R-R interval preceded one or several beats of the same shape as the predominant beats in the absence of atrial fibrillation.

(OTHERWISE NORMAL ECG)

Premature ventricular contractions(s)
One or several premature beats differing in shape and size from the predominant beats were detected.

Bigeminy will appear in addition to this statement if at least three ventricular extrasystoles are detected, each separated from the preceding one by a single predominant beat

Trigeminy will appear in addition to this statement if at least three ventricular extrasystoles are detected, each separated from the preceding one by two predominant beats.

(ABNORMAL ECG)

Ventricular escape beat(s)
A pause longer than 1.5 times the predominant R-R interval preceded one or several beats differing in shape and size from the predominant beats in the absence of atrial fibrillation.

(ABNORMAL ECG)

Beat(s) with aberrant intraventricular conduction
One or several beats were detected differing in shape and size from the predominant beats, but occurring in time, i.e. separated from the preceding and following beats by the predominant R-R interval.

(OTHERWISE NORMAL ECG)

Sinus rhythm
A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the R-R intervals between the predominant beats was no greater than 10%.

(NORMAL ECG)

Sinus arrhythmia
A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the R-R intervals between the predominant beats was greater than 10%.

(OTHERWISE NORMAL ECG)

Supraventricular arrhythmia
A P wave was detected in the averaged ECG cycle, the heart rate was greater than 100 beats per minute, and the difference in the duration of the R-R intervals between the predominant cycles was greater than 10%.

(OTHERWISE NORMAL ECG)

Sinus bradycardia
A P wave was detected in the averaged ECG cycle, and the heart rate was less than 50 beats per minute.

(OTHERWISE NORMAL ECG)

Sinus tachycardia
A P wave was detected in the averaged ECG cycle, and the heart rate was greater than 100 beats per minute.

(OTHERWISE NORMAL ECG)

Supraventricular tachycardia
A P wave was detected in the averaged ECG cycle, and the heart rate was greater than 130 beats per minute.

(OTHERWISE NORMAL ECG)

Nodal rhythm
No P wave was detected in the averaged ECG cycle, the heart rate was less than or equal to 60 beats per minute, and the difference in the duration of the R-R intervals between the predominant beats was less than 10%.
(ABNORMAL ECG)

Regular rhythm, no P wave found
No P wave was detected in the averaged ECG cycle, the heart rate was greater than 60 beats per minute, and there was less than 10% difference in the duration of the R-R intervals between the predominant beats.
(POSSIBLY ABNORMAL ECG)

Idioventricular rhythm
No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was greater than 150 ms. The heart rate was less than or equal to 40 beats per minute, and there was less than 10% difference in the duration of the R-R intervals between the predominant beats.
(ABNORMAL ECG)

Ventricular tachycardia
No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was greater than 150 ms. The heart rate was greater than 150 beats per minute, and there was less than 10% difference in the duration of the R-R intervals between the predominant beats.
(ABNORMAL ECG)

Atrial fibrillation/flutter
No P wave was detected in the averaged ECG cycle, the heart rate was less than 95 beats per minute, and there was at least 12% difference in the duration of at least one R-R interval between the predominant beats.
(ABNORMAL ECG)

Atrial fibrillation with rapid ventricular response
No P wave was detected in the averaged ECG cycle, the heart rate was equal to or greater than 95 beats per minute, and there was at least 12% difference in the duration of at least one R-R interval between the predominant beats.
(ABNORMAL ECG)

Pacemaker spikes noted
More than two typical pacemaker spikes were detected in at least two leads of the original ECG data recorded over 10 seconds.
(ABNORMAL ECG)

Electrical axis

The electrical axis is computed on the basis of the algebraic sum of the amplitudes and deflections of the QRS complex in leads I and aVF. The possible findings with their corresponding ranges are as follows:

Abnormal left axis deviation -90° to -30°
(ABNORMAL ECG)

Leftward axis - 30° to 0°
(OTHERWISE NORMAL ECG)

Rightward axis +90° to +110°
(OTHERWISE NORMAL ECG)

Abnormal right axis deviation +110° to +180°
(ABNORMAL ECG)

Abnormal right superior axis deviation
- 90° to -180°
(ABNORMAL ECG)

Indeterminate axis
The algebraic sum of the deflections of the QRS complex in leads I and aVF ranged between -0.20 mV and +0.20 mV.
(BORDERLINE ECG)

Atrial activity

Possible left atrial abnormality
A negative phase of at least 0.08 mV was detected in lead V1, and the duration of the P wave was longer than 130 ms.
(POSSIBLY ABNORMAL ECG)

Left atrial abnormality
A negative phase of at least 0.15 mV was detected in lead V1, and the duration of the P wave was longer than 130 ms.
(ABNORMAL ECG)

Right atrial enlargement
The amplitudes of at least two P waves in leads II, III and aVF were greater than 0.25 mV.
(POSSIBLY ABNORMAL ECG)

Biatrial enlargement
A negative phase in the P wave of at least 0.10 mV was detected in lead V1 and at least two P waves in leads II, III and aVF were greater than 0.25 mV.
(ABNORMAL ECG)

Prolonged P-R interval
The duration of the P-R interval was longer than
$23 \times \sqrt[4]{10 \times \text{R-R interval}}$
(ABNORMAL ECG)

ECG voltages

Low limb lead voltage
The sum of the peak-to-peak QRS amplitudes in leads I, II and III was 0.15 mV or less, but one or several peak-to-peak QRS amplitudes in the chest leads was greater than 0.7 mV.
(BORDERLINE ECG)

Low voltage
The sum of the peak-to-peak QRS amplitudes in leads I, II and III was 0.15 mV or less, and the peak-to-peak QRS amplitudes in the chest leads were all 0.7 mV or less.
(ABNORMAL ECG)

Blocks

Right bundle branch block
The total duration of QRS was at least 130 ms. The R/S ratio in lead V1 was greater than 1, or an S wave deeper than 0.20 mV was detected in leads I and V6. In lead V1 or lead V2 a notched QRS complex or a QRS complex of the RSR' type was found.
(ABNORMAL ECG)

Incomplete right bundle branch block
The total duration of QRS was shorter than 130 ms. In lead V1 or lead V2 a notched QRS complex or a QRS complex of the RSR' type was detected and the R' wave in one of those two leads had an amplitude of at least 0.30 mV.
(OTHERWISE NORMAL ECG)

Left bundle branch block
The total duration of QRS was at least 130 ms. The R/S ratio in lead V1 was less than 1. If an S wave was found in leads I and V6, it was no deeper than -0.2 mV. No Q wave was present in either lead I or lead V6.
(ABNORMAL ECG)

Incomplete left bundle branch block
Same as left bundle branch block, except that the total duration of QRS was shorter than 130 ms and longer than or equal to 120 ms.
(POSSIBLY ABNORMAL ECG)

Non-specific intraventricular block
The total duration of QRS was at least 130 ms. None of the criteria for left bundle branch block, right bundle branch block, left anterior or left posterior fascicular block were fulfilled.

(ABNORMAL ECG)

Non-specific intraventricular delay
The total duration of QRS was shorter than 130 ms but longer than or equal to120 ms. None of the criteria for incomplete left bundle branch block, incomplete right bundle branch block, left anterior or left posterior fascicular block were fulfilled.

(BORDERLINE ECG)

Left anterior fascicular block
No Q wave was present in lead aVF, i.e. the ventricular depolarisation started in a downward direction. The R/S ratio in lead aVF was 0.6 or less, and the electrical axis ranged between -30 and -120 degrees. An S-wave must be present in lead V6.

(ABNORMAL ECG)

Left posterior fascicular block
The electrical axis ranged between +90° and +180°, or between -120° and -180°. The R/S ratio in leads I and aVL was 0.6 or less.

(ABNORMAL ECG)

Bifascicular block
A left anterior fascicular block or a left posterior fascicular block occurred together with a right bundle branch block.

(ABNORMAL ECG)

QRS abnormalities

QRS (T) contour abnormality, cannot rule out antero-septal myocardial damage
There was a pathological start of the ventricular depolarisation. The initial momentary QRS vectors were directed backward and mostly to the left, and remained in this direction during the greater part of the ventricular depolarisation, instead of remaining directed forward for the first 30 ms then turning backwards and to the left.

(BORDERLINE ECG)

QRS (T) contour abnormality, cannot rule out antero-lateral myocardial damage
The ventricular depolarisation started normally, the initial momentary QRS vectors being directed forward and to the right. However, instead of then turning to the left and backwards, the momentary QRS vectors turned further to the right and backwards.

(BORDERLINE ECG)

QRS (T) contour abnormality, cannot rule out lateral myocardial damage
The ventricular depolarisation started normally, the initial momentary QRS vectors being directed forwards and to the right. However, instead of then turning to the left and backwards, the momentary QRS vectors remained directed forwards and more to the right than normal, i.e. the turn to the left was postponed.

(BORDERLINE ECG)

QRS (T) contour abnormality, cannot rule out inferior myocardial damage

The initial 10 to 20 ms momentary QRS vectors were directed upward, which is still normal, but instead of turning immediately downwards, the momentary QRS vectors remained directed upward for at least the first 40 ms of the ventricular depolarisation and often remained directed upwards during the greater part of the ventricular depolarisation.

(BORDERLINE ECG)

CANNOT RULE OUT is substituted by CONSIDER in the above statements if in addition to the QRS contour abnormality pathognomonic inverted T waves were detected in appropriate leads, i.e.

- II and aVF for inferior localisation
- V1, V2 and V3 for anteroseptal localisation
- V4, V5 and V6 for anterolateral localisation
- I and aVL for lateral localisation

Myocardial infarctions

A diagnosis of myocardial infarction requires the detection of at least one pathognomonic Q or QS wave (Q/QS), i.e. a Q-wave which measures at least 25% of the amplitude of the following R wave in leads I, II, aVL, aVF, or V1 to V6.

The ECG interpretation program enables the detection of myocardial infarctions within the following areas:

septal	Q/QS in V2
anteroseptal	Q/QS in V2 and V3, Q/QS in V1 to V3.
anterolateral	Q/QS in V5 or in V5 and V6
anterior	Q/QS in V4, or any combination of Q/QS in V4 with Q/QS in any other precordial lead
lateral	Q/QS in V5 and/or V6 and Q/QS in I and/or aVL
high lateral	Q/QS in I and/or aVL
inferolateral	Q/QS in II and/or aVF and Q/QS in V6
inferior	Q/QS in II and/or aVF

A diagnosis of myocardial injury will be replaced by a diagnosis of myocardial infarction if a Q/QS was detected in the anteroseptal, anterolateral, anterior or high lateral localisation as defined above.

If only one Q/QS was detected in a certain area, the following diagnosis will appear:

QRS (T) contour abnormality, consider.....infarct

If more than one Q/QS was detected in a certain area, the following diagnosis will appear:

QRS (T) contour abnormality, consistent with.....infarct

Exceptions: The high lateral localisation is always associated with "consider", the septal one with "cannot rule out".

The patient however must be at least 30 years old otherwise INFARCT will be substituted by MYOCARDIAL DAMAGE.

When a diagnosis of myocardial infarction is proposed, the program endeavours to determine its age.

Probably old will appear if no specific ST and T changes were detected in the leads defining the infarct localisation.

Possibly recent will appear if a significant ST elevation was detected in the leads defining the infarct localisation.

Age undetermined will appear in all other cases.

A diagnosis of myocardial infarction will always have the classification ABNORMAL ECG.

ST-T morphology

ST abnormality, possible anteroseptal subendocardial injury
ST depressed by at least 0.25 mV in at least one of leads V1, V2 and V3, and no anteroseptal QRS-induced myocardial injury or infarct was detected.
(ABNORMAL ECG)

ST abnormality, possible anterior subendocardial injury
ST depressed by at least 0.25 mV in other precordial lead combinations than those typical for anteroseptal and anterolateral injuries, and no anterior QRS-induced myocardial injury or infarct was detected.
(ABNORMAL ECG)

ST abnormality, possible anterolateral subendocardial injury
ST depressed by at least 0.25 mV in at least one of leads V4, V5 and V6, and no QRS-induced myocardial injury or infarct was detected.
(ABNORMAL ECG)

ST abnormality, possible lateral subendocardial injury
ST depressed by at least 0.25 mV in leads V5 and V6, and at least 0.1 mV in leads I and aVL, and no lateral QRS-induced myocardial injury or infarct was detected.
(ABNORMAL ECG)

ST abnormality, possible inferior subendocardial injury
ST depressed by at least 0.1 mV in leads II and aVF, and no inferior QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

Non-specific ST depression
ST depressions other than those mentioned above were detected.

(BORDERLINE ECG)

ST & T abnormality, consider anteroseptal ischemia or right ventricular strain
ST depressed by 0.05 to 0.09 mV with T diphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, diphasic or negative in at least one of leads V1, V2 and V3, and no anteroseptal QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

ST & T abnormality, consider anterior ischemia or left ventricular strain
ST depressed by 0.05 to 0.09mV with T diphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, diphasic or negative in other precordial lead combinations than those typical for anteroseptal and anterolateral ischemia or left ventricular strain.

(ABNORMAL ECG)

ST & T abnormality, consider anterolateral ischemia or left ventricular strain
ST depressed by 0.05 to 0.09 mV with T diphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, diphasic or negative in at least one of leads V4, V5 and V6, and no anterolateral QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

ST & T abnormality, consider lateral ischemia or left ventricular strain
ST depressed by 0.05 to 0.09 mV with T flat, diphasic or negative in at least one of leads I, aVL and V6 and no lateral QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

ST & T abnormality, consider inferior ischemia or left ventricular strain
ST depressed by 0.05 to 0.09 mV with T flat, diphasic or negative in leads II or aVF, and no inferior QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

ST & T abnormality, consider recent ..... myocardial or pericardial damage
ST elevated at least 0.20mV in at least two V leads or two inferior leads (I, aVF, III) and followed by a flat or negative T-wave, and no QRS-induced myocardial damage or infarct was detected within the same localisation.

(ABNORMAL ECG)

Non-specific ST & T abnormality (elevation)
An ST elevation of at least 0.2 mV was detected accompanied by a T wave in the same lead higher than the normal upper limits as given below in at least two V leads or two arm leads.

(OTHERWISE NORMAL ECG)

T abnormality in anteroseptal leads
T diphasic or negative in at least one of leads V2 and V3, and no anteroseptal QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

T abnormality in anterior leads
T diphasic or negative in other precordial lead combinations than those typical for anteroseptal and anterolateral myocardial injuries was detected.

(ABNORMAL ECG)

T abnormality in anterolateral leads
T diphasic or negative in at least one of leads V4, V5 and V6, and no anterolateral QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

T abnormality in lateral leads
T diphasic or negative in at least one of leads I, aVL and V6, and no lateral QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

T abnormality in inferior leads
T diphasic or negative in lead II or aVF, and no inferior QRS-induced myocardial injury or infarct was detected.

(ABNORMAL ECG)

Non-specific T abnormality
T changes other than those mentioned above were detected.

(BORDERLINE ECG)

T-wave table (amplitudes in mV)

		aVL	I	-aVR	II	aVF	III
NORMAL	Upper limit	0.22	0.35	0.34	0.43	0.31	0.22
	Lower limit	-0.05	0.07	0.09	0.08	0.00	-0.12
FLAT	Lower limit	--	-0.04	-0.04	-0.04	-0.04	--
NEGATIVE	Upper limit	-0.06	-0.05	-0.05	-0.05	-0.05	-0.13

		V1	V2	V3	V4	V5	V6
NORMAL	Upper limit	0.39	1.01	1.07	1.04	0.78	0.49
	Lower limit	-0.13	0.17	0.20	0.16	0.13	0.08
FLAT	Lower limit	--	-0.04	-0.04	-0.04	-0.04	-0.04
NEGATIVE	Upper limit	-0.14	-0.05	-0.05	-0.05	-0.05	-0.05

QT-Interval

Prolonged QT
A QTc duration longer than or equal to 470 ms was detected
(BORDERLINE ECG)

Hypertrophy

For the detection of a **Left Ventricular Hypertrophy**, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

Amplitudes: 2 points if
- the sum of the R-amplitude in lead V5 or V6 and the absolute value of the S-amplitude in lead V1 or V2 exceeds 3.5 mV.

1 point if
- the greatest R or S deflection in the extremity leads was equal to or greater than 2 mV, or
- the greatest S deflection in leads V1 to V3 was equal to or greater than 2.5 mV, or
- the greatest R deflection in leads V4 to V6 was equal to or greater than 2.5 mV.

The maximum number of amplitude points is 3.

ST & T: 1 point if
- an ST depression and a negative or diphasic T wave were detected in leads I, aVL, aVF, V5 or V6.

Electrical axis: 2 points if
- QRS axis ranged from -15 to -120 degrees.

Other QRS criteria: 1 point each if
- the interval between the onset of QRS and the maximum QRS vector was longer than 55 ms, and
- the total duration of QRS was longer than 110 ms.

Consider left ventricular hypertrophy
The patient is at least 25 years old and the ECG scored at least 4 points according to the criteria above.
(POSSIBLY ABNORMAL ECG)

Left ventricular hypertrophy
The patient is at least 25 years old and the ECG scored 5 points according to the criteria above.
(ABNORMAL ECG)

Amplitude criteria for left ventricular hypertrophy
The patient is at least 25 years old and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied, and with 3 points.
(POSSIBLY ABNORMAL ECG)

Moderate amplitude criteria for left ventricular hypertrophy
The patient is at least 25 years old, and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied, but only with 2 points.
(BORDERLINE ECG)

For the detection of a **Right Ventricular Hypertrophy**, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

Amplitudes: 3 points if

- the R deflection in lead V1 was greater than 0.7 mV and the S deflection in the same lead was not deeper than -0.2 mV, or
- in the presence of an incomplete right bundle branch block, the R deflection in lead V1 was greater than 1 mV, or
- in the presence of a right bundle branch block, the R deflection in lead V1 was greater than 1.5 mV, and
- an S wave deeper than -0.7 mV was detected in lead V5 or V6, and the R/S ratio was less than 1 in these leads.

ST & T: 1 point if

- an ST depression and a negative or diphasic T wave were detected in leads V1 to V3.

Electrical axis: 2 points if

- The QRS axis ranged from +90 to +180 degrees, or from -120 to -180 degrees.

QRS duration: 1 point if

- the total duration of QRS ranged from 100 to 120 ms.

Consider right ventricular hypertrophy
The ECG scored at least 4 points according to the above criteria.

(POSSIBLY ABNORMAL ECG)

Right ventricular hypertrophy
The ECG scored 5 points according to the above criteria or 3 points in the presence of a right atrial hypertrophy or of a sagittal electrical axis.

(ABNORMAL ECG)

Miscellaneous statements

S1, S2, S3 pattern
An S-wave of at least 0.2 mV was detected in leads I, II and III, and the R/S quotient did not exceed 0.25 in the same leads.

(OTHERWISE NORMAL ECG)

WPW pattern, type A
The duration of QRS was at least 130 ms and the duration of PR shorter than 150 ms. A prolonged ventricular activation time, accompanied by a slope significantly less steep than normal during the first 40 ms of the QRS complex was detected in at least two V leads. The QRS area was positive in lead V1.

(ABNORMAL ECG)

Consider WPW, type B
The duration of QRS was at least 130 ms and the duration of PR shorter than 140 ms. A prolonged ventricular activation time, accompanied by a slope significantly less steep than normal during the first 40 ms of the QRS complex was detected in at least two V leads. The QRS area was negative in lead V1.
(ABNORMAL ECG)

R-S transition zone in V leads displaced to the right
An R/S quotient of at least 3 was detected in lead V2, and the duration of QRS was not longer than 120 ms.
(OTHERWISE NORMAL ECG)

R-S transition zone in V leads displaced to the left
An R/S quotient less than 0.75 was detected in lead V5, and the duration of QRS was not longer than 120 ms.
(OTHERWISE NORMAL ECG)

*** Possible reversal of the arm leads**
The QRS complexes in leads I and V6 were more discordant than concordant, and the P-wave in lead I was negative.

Low sensitivity statements

When 'LOW' sensitivity is selected, the following statements regarding non-specific ECG findings will be suppressed:

- Indeterminate axis
- Low limb lead voltage
- Non-specific intraventricular delay
- Prolonged QT
- Non-specific ST depression
- Non-specific T abnormality
- Cannot rule out myocardial damage
- Moderate amplitude criteria for LVH

If one of the above statements has been suppressed, and no other abnormalities are found, the normal/abnormal classification will be replaced by "No specific ECG abnormalities".

The statement 'Atrial fibrillation/flutter' is replaced with "Irregular rhythm, no P-wave found".

Long-term Memory

The CARDIOVIT AT-3 can be equipped with an additional memory that stores either 10 original ECGs or 15 compressed ECGs as long as the rechargable battery of the unit is not completely discharged.

Before storing the ECGs, it must be determined whether ECG data is to be stored in original or compressed form (→ *various settings*). In either case, the measurement results and the interpretation statements will always be calculated from the original ECG signals.

Press **FNCT** and key **3** to call up the memory mode:

```
MEMORY STORAGE

0/1 = select n
2   = store ECG in any empty file
4   = retrieve ECG from file n
5   = delete ECG from file n
6   = patient data from file n
7   = select page n
8   = list contents of page
RET = display commands

FREE ... %  PAGE  0     n = 0
```

The bottom line of the display indicates the percentage of free storage place and the page and file number activated.

The ECG data are stored in the long-term memory as data files. 10 files numbered from 0 to 9 are contained on one page. There is only one page (0) if the ECG data are stored in original form, when stored in compressed form, there are 2 pages (0 and 1). A data file is clearly defined by the page and file number.

By pressing **RETURN** you can always return to the list of commands. Key **FNCT** will terminate the memory mode.

2 = store ECG in any empty file

Press key 2 to transfer an ECG from the unit memory into an empty file of the long-term memory. An acknowledgement and the remaining available storage space are indicated on the bottom line of the LC display:

```
ECG is stored now
FREE 20 %  PAGE  0  n = 0
```

7 = select page n

In order to execute the following commands, the appropriate page must first be called up (only if there are more than 10 ECGs stored, i.e. if the ECG data are stored in compressed format). With key **7** you can switch from 0 to 1 and vice versa. The actual page is indicated on the bottom line of the LC display.

8 = list contents of page

The list of ECGs contains date and time of recording, and patient identification. The following commands can be executed more easily when referring to this list.

O/1 = select n

The file to be worked on is chosen with keys 0 < (backwards) and 1 > (forwards). The bottom line of the LC display indicates the page and file number selected. The following commands can now be executed:

6 = Patient data from file n

This command will display the complete patient data for the selected ECG. However, no changes can be made.

4 = retrieve ECG from file n

After having selected the number of the file to be worked on, press key 4 to transfer the ECG back to the unit memory. From there it can be printed out by pressing COPY or transferred to another unit (see Transfer to/from CARDIOVIT CS-6/12).

The acknowledgement reads:

ECG is read now

5 = delete ECG from file n

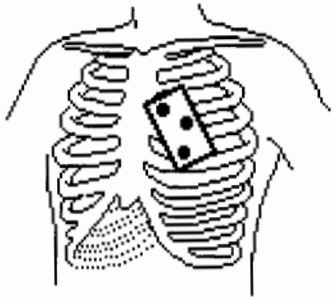
If an ECG is no longer required (e.g. if it has been transferred to a CARDIOVIT CS-6/12), it can be deleted and its file used for a new ECG. Make sure that the ECG to be deleted is from the correct page and that the file number has been correctly selected, otherwise you may lose important information.

Emergency Tripod Electrode

Plug in the tripod electrode at the patient interface. Moisten the contact surfaces of the electrodes with electrode cream, water or, if necessary, saliva.

Place the tripod electrode on the thorax of the patient as shown. All the electrodes must fit tightly as otherwise disturbances may occur in the ECG recording.

We recommend that lead II be used for the recording of emergency ECG.

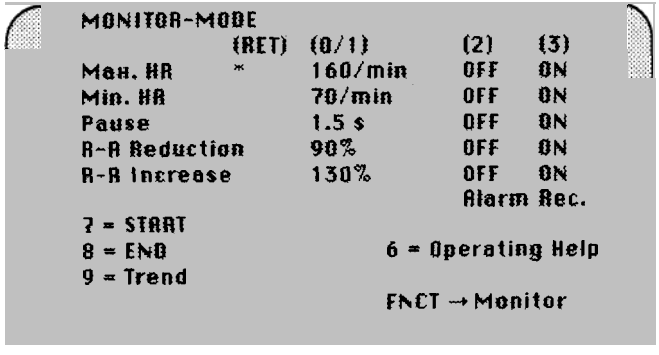


Rhythm and Heart Rate Monitoring

The CARDIOVIT AT-3 can be equipped with rhythm and heart rate monitoring software for the purpose of mobile and stationary patient monitoring. Heart rate, pauses and rhythm variations are recognised and recorded. A trend diagram is produced from the course of the heart rate.

Selecting monitor mode

When a unit is equipped with the monitor mode option, then the second page of the menu list contains the additional item "5 = monitor mode". Press **FNCT**, **RETURN** then key **5** to call up the monitor mode and the following table appears on the display:



The individual limit values can now be set. By pressing **RETURN**, the cursor can be moved to the next line, the current line being indicated by an asterisk.

The limit values are entered into the first column by using keys **0** and **1**. Values can be selected within the following ranges:

Max. heart rate:	70 to 250 beats per minute
Min. heart rate:	20 to 60 beats per minute
Pause:	1.5 to 5.0 seconds
R-R interval reduction:	20 to 90% of normal length
R-R interval increase:	110 to 190% of normal length

In the second column, key **2** is used to determine whether or not an acoustic alarm should sound when each of the set limit values is either reached or exceeded. (When the alarm sounds, it can be cancelled by pressing **DEL**.)

In the third column, key **3** is used to select a print-out of an event recording. The 3 freely selected leads will be printed out over a period of 4 seconds. This print-out comprises 1 page, however an event series will comprise 3 pages (ie 12 seconds).

The Help menu can be called to the display at any time by pressing key **6**.

Starting and termination of monitoring

Rhythm and heart rate monitoring are started by pressing key **7**. At the bottom of the display, the letter "M" appears to indicate that monitoring is in progress.

As soon as a limit value is either reached or exceeded, an acoustic alarm is sounded and/or an event recording is printed out. The acoustic alarm can be acknowledged and cancelled by pressing **DEL**. An ECG print-out can be manually initiated at any time during monitoring.

There is no limit to the duration of patient monitoring. The heart rate trend diagram is produced from the the last 2 hours.

The monitor program can be stopped by pressing key **8**.

Heart rate trend

During the course of the heart rate, a trend diagram is produced which can either be called to the display by pressing key **9** once, or printed out by pressing key **9** twice.

The entered values for maximum and minimum heart rate are indicated on the diagram with dotted lines. The last two hours are shown, whereby the time axis at 30 minutes switches to 60, and at 60 switches to 120.

The trend diagram remains stored in the memory until either the unit is switched off or the monitoring program is re-started.

RS-232 Computer Interface

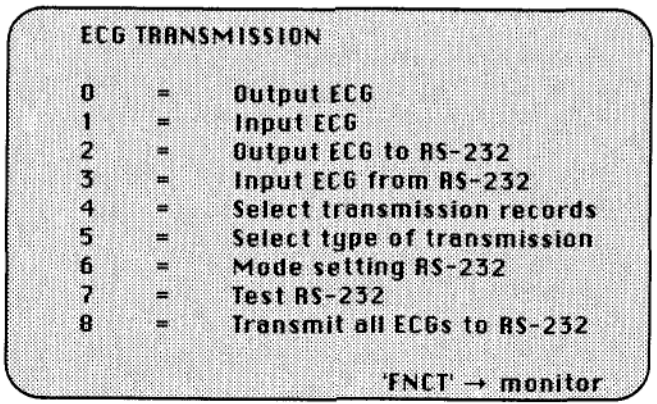
The RS-232 serial interface enables the transfer of ECG data between units. As the CARDIOVIT AT-3 can only process ECG data recorded by a CARDIOVIT unit, the data transfer takes place either between two CARDIOVIT AT-3 units, or between a CARDIOVIT AT-3 and another unit in the CARDIOVIT family, or between a CARDIOVIT AT-3 and a computer (PC or main frame). The ECG data transfer can take place either direct (line), or via a telephone (modem).

Before setting up the AT-3 for data transfer, press **FNCT**, **RETURN** and **2** to call up the Various Machine Settings menu and set the footsw/QRS trig. setting to OFF.

Setting up

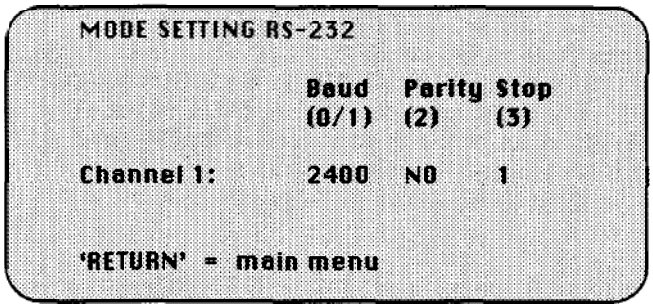
Firstly, connect the mains adapter/charger unit MA-4 to the connection on the rear of the AT-3 either directly or by means of the cable provided. The Data I/O connection on the right-hand side of the AT-3 must now be connected to the corresponding connection on the right-hand side of the MA-4. Connect the transmission cable to the RS-232 connection on both the transmitting and receiving units. Connect the mains adapter to the mains supply and switch on.

The operation and setup of the RS-232 interface is controlled in the ECG Transmission menu. Press **FNCT**, **RETURN** and **4** to call up the following list of commands:



Mode setting

Before an ECG transfer can be made, the technical parameters of the transmitting and receiving units have to be



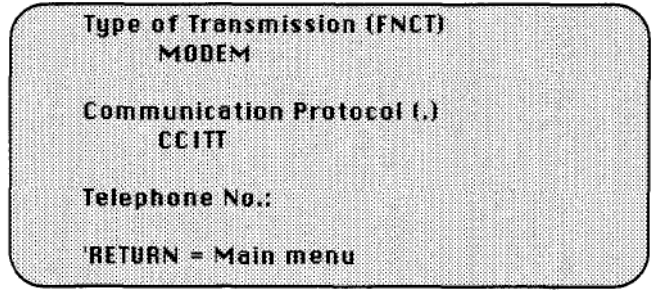
The following settings have to be made separately for the input/output channel:

- **The baud rate is selected with key 1 (increase) or 0** (decrease). The following values can be set: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 baud.
- The **parity bit** is set with key **2**. You can choose between: EVEN, ODD, or NO.
- The **length of the stop bit** is determined with key **3.** Possible are: 1, 1.5, or 2 units.

Select transmission mode

Press **5** to call up the following table:

The **parameter Type of Transmission** is **switched with** :1 to 'f line" two directly. If the transmission is executed via telephone, then "modem", has to be selected here. The display changes to the input table for the phone number which will be dialled automatically when the connection is demanded:



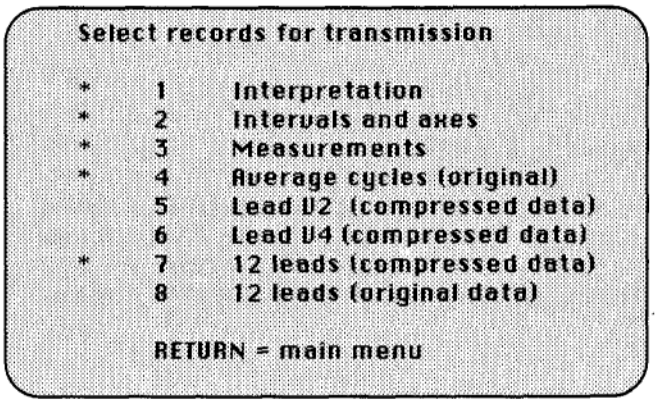
This menu also enables the Communication Protocol (either CCITT or BELL) to be selected. Press **FNCT** to return the menu to the first page.

The **Format of Transmission** is selected with **1**. There are two possibilities: The transmission of records is faster and easier to implement in the receiving unit. The transfer of blocks is, on the other hand, more secure, as the transmitted data is checked for errors and corrected accordingly.

NOTE: "BLOCKS" is always selected when the type of transmission is set to modem.

Selecting the ECG data to be transmitted

On the menu "ECG Transmission", press **4** to call up the menu for selection of the contents of the data to be transmitted.



By pressing the indicated characters (1 to 8), the data to be transferred can be freely combined. The choice is indicated by an asterisk (*).

Press **RETURN** to return to the main menu.

Input ECG from RS-232

By pressing key **3** the input of an ECG is started. The external data are transferred to the memory, from where the ECG can be printed out. When the input of data is complete, the following message appears: "ECG IS INPUT FROM RS-232!"

Output ECG to RS-232

In order to send ECG data, i.e. the contents of the memory, press key **2.** At the bottom left of the menu is the message "TRANSMITTING". At the end of the transmission, the following message appears: "ECG IS OUTPUT TO RS-232!"

Output all ECGs to RS-232

If the unit is equipped with a memory extension (Long-term Memory), then all the ECGs can be transferred in one lot by pressing key **8**. When the transfer is complete, the following message appears: "ECGs OUTPUT TO RS-232!"

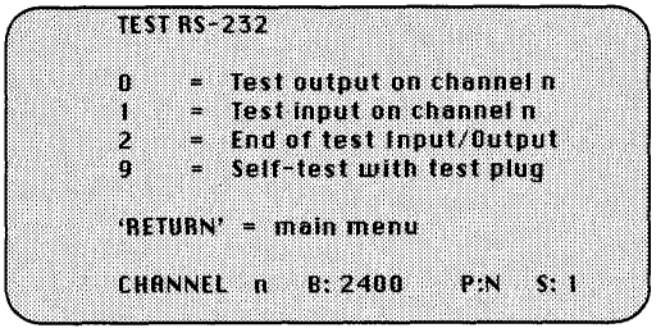
Error messages

If one of these commands cannot be executed for any reason, an error message appears instead of an acknowledgement:

SERIAL LINK TIME-OUT	This indication appears if no signal is received for approx. 30 seconds (e.g. if the connecting cable is not plugged in or not correctly plugged in).
RECEPTION ERROR (PARITY)	Either the parity is not set correctly or there is actually a parity error.
RECEPTION ERROR (OVERRUN)	This concerns a system error Please contact the service organization.
RECEPTION ERROR (FRAMING)	Either there is a transmission error or the baud rate is set incorrectly.
TRANSMISSION ERROR	The connecting cable is not plugged in or not correctly plugged in.
NO ECG IN MEMORY	It has been attempted to transmit an ECG, but no ECG is stored in the unit´s memory.

Test procedures for the RS-232

Press key **7** to carry out tests on the RS-232 interface.



To test the RS-232, connect the CARDIOVIT AT-3 to an external unit.

With **0**, you can test the output of data. With **1** the data input is tested. If an error is detected, an acoustic signal is given. The output or input test is interrupted by pressing key **2**.

The Self-test must be performed using a special test plug and can therefore only be carried out by authorised service personnel.

The channel settings are listed on the bottom of the LC display.

Technical data RS-232 (V24) serial interface

Baud rates:	300 - 38400 Baud
Byte format:	1 start bit, 8 data bits, 0 or 1 parity bit (+ or -), programmable 1 / 1.5 / 2 stop bits, programmable
Transfer control:	by means of DTR, DSR, CTS, RTS
Connection socket:	D subminiature (25 poles), wired as DTE (data terminal equipment)

Pin connections:

2	TxD	O	(output data)
3	RxD	I	(input data)
4	RTS	O	(request for output)
5	CTS	I	(ready for output)
6	DSR	I	(transfer unit ready)
20	DTR	O	(AT-3 ready)
1			GND
7			GND (signal)

Pulsoximetry (SaO_2)

With this option, the CARDIOVIT AT-3 can be used to monitor and measure the peripheral pulse and the percentage oxygen saturation by means of a finger sensor.

The Pulsoximetry program cannot be called up when either Rhythm mode, Automatic ECG Recording, Heart Rate Monitoring or ECG Transmission is active. Similarly, non of the above can be activated when the Pulsoximetry program is running.

Connecting the finger sensor

Remove the SaO_2 sensor kit from the pouch and plug the module into the "DATA I/O" socket on the right-hand side of the AT-3.

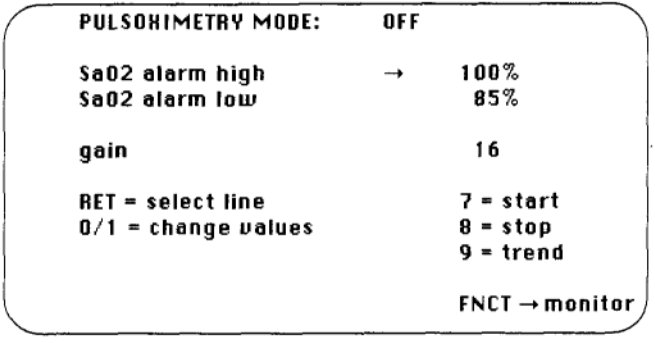
Take the finger "hook" sensor and place it over the patient's finger so that the cable runs along the back of the finger.

Holding the hook in place, take one of the plasters provided, remove the backing and place it securely over the hook and finger so that no external light sources can access the sensor.

Select the Various Settings menu (press **FNCT**, then **RETURN** then **2**) and check that the Data I/O configuration is set to SaO_2. If this is not the case then, when it is attempted to call up the SaO_2 menu, the message "Set Data I/O to SaO_2" will appear on the display.

Selecting the settings

The Pulsoximetry option, when installed, is located on the second page of the main menu. Press **FNCT** to enter the main menu, then **RETURN** to move to the second page. The Pulsoximetry menu can now be called up by pressing the full stop key (also marked "FILT") and the following appears on the display:



To the top of the menu is the pulsoximetry mode status, either "ON" or "OFF".

There are three settings which can be made, namely alarm high and low and the gain setting. An arrow indicates which setting is selected. In the above example the arrow is on the line for the alarm high setting. This arrow can be moved by pressing the **RETURN** key.

Once the desired line has been selected, the setting can be altered by using the **1** and **0** keys. The indicated value will be decreased by pressing the **0** key and increased by pressing the **1** key.

The high alarm can be set to any value between 85 and 100% in steps of 1%. Once set, when the detected SaO_2 value exceeds this limit, then an audible alarm will be initiated. This is not the case however when the limit is set to 100%.

The low alarm can be set to any value between 50 and 90% in steps of 1%. Once set, when the detected SaO_2 value falls below this limit, then an audible alarm will be initiated.

Both high and low alarms can be acknowledged and silenced by pressing the **DEL** key. If a further alarm condition arises, then the audible alarm will again sound. Should the alarm condition be rectified, then the audible alalrm is automatically silenced.

The gain factor influences the size of the displayed pulse curve. This can be set to either 1, 2, 4, 8, 16, 32, 64, 128 or 256.

Starting SaO_2 recording

Once the desired alarm settings have been made, SaO_2 recording can be started by pressing key **7**. Activation of the SaO_2 recording mode is confirmed by the mode status "ON" at the top of the menu .

By pressing **FNCT**, the actual pulse curve can be observed on the screen. To the right of the screen is the pulse rate and below this is the percentage SaO_2 value presented in large figures between the selected high and low alarm limits.

When the ECG patient cable is connected, then the ECG lead is presented above the pulse curve and the heart rate derived from the ECG leads is presented in the top left-hand corner of the screen as normal.

NOTE: Should the ECG recording be too large and thus overwrite the pulse curve, then adjust the sensitivity of the ECG trace (**mm/mV** keys) until a satisfactory presentation of both curves is achieved.

When the ECG cable is not connected, then only the pulse curve will be shown.

To obtain a printout of the actual pulse curve, press the **MAN START** key. To stop this printout, press the **STOP** key.

Trend curves

A trend representation of both the SaO_2 and the pulse rate can be brought to the display by either pressing key **9** when in the Pulsoximetry menu or by pressing **RETURN** when in Monitor mode.

This trend graph is shown on a scale of 0 to 30 minutes. When the recording period reaches 30 minutes, then the scale automatically changes to one of 0 to 60 minutes. When the recording period exceeds 60 minutes then the scale automatically changes to one of 0 to 120 minutes.

The SaO_2 trend curve is located at the top of the graph and horizontal dotted lines indicate the positions of the selected high and low alarm limits. The scale for the SaO_2 is on the left-hand side. At the bottom of the graph is the trend curve for the peripheral pulse. The scale for the pulse is on the right-hand side.

To obtain a printout of the trend curves, press **COPY**. To return to the Monitor mode, press the **RETURN** key.

Interrupting SaO_2 recording

To stop an SaO_2 recording, press **FNCT** then the full stop key to enter the Pulsoximetry menu then press key **8**. Interruption of the recording is confirmed with the mode status "OFF" at the top of the menu.

The recorded trend curves can still be accessed by pressing key **9**, so long as a new recording has not been started.

Acoustic beeper

If the QRS beeper is switched on (**FNCT** then **5**), then each pulse will be indicated by an acoustic beep. The tone varies according to the oxygen saturation detected. The higher the percentage SaO_2, the higher the tone (increments of 2%).

If an acoustic alarm is initiated, then the QRS beep is silenced until the alarm is acknowledged or the alarm condition rectified at which point the QRS beeper will again sound.

Error messages

If the Pulsoximetry program is entered before the sensor is connected to the AT-3 then the following message will appear on the screen:

```
**************************************
*                                    *
*          SaO2 - Sensor             *
*        not connected ! ! !         *
*                                    *
**************************************
```

Connect the sensor to the "DATA I/O" connection on the right-hand side of the AT-3 and the error message is removed from the display. This message will also appear should the sensor become disconnected during recording. Reconnect the sensor and the program continues.

If the finger sensor is receiving too much light, then the following message will be given on the display:

```
**************************************
*                                    *
*    SENSOR out of range !           *
*         reposition ! ! !           *
*                                    *
**************************************
```

Move the sensor to a position with more tissue and ensure that the plaster is correctly preventing the access of light from external sources. Once the sensor restarts measurement, the program continues and the error message is removed from the display.

Technical data

Amplifier:	fully isolated
Band width:	0.5 to 6 Hz
Measuring range:	50 to 100%
Resolution:	1%
Accuracy:	±2% (80 to 100%) ±3% (60 to 80%)
Alarms:	upper limit: 85 to 100% lower limit: 50 to 90%

Real time recording:

- 1 channel:	pulse waveform
- 2 channel:	ECG lead and pulse waveform
Measured values:	SaO_2 and pulse rate
Trends:	SaO_2 and pulse rate up to 120 minutes

(Technical data subject to change without notice)

Test Results

Technical Safety Check
Test Results

Equipment Number:	Type:

Date: Checked by:	Date: Checked by:	Date: Checked by:
Mains / Current	Mains / Current	Mains / Current
Volt amp. Measurement current: amp.	Volt amp. Measurement current: amp.	Volt amp. Measurement current: amp.
Measurement Results	Measurement Results	Measurement Results
Protective earth conductor: Ω	Protective earth conductor: Ω	Protective earth conductor: Ω
Earth leakage current:	Earth leakage current:	Earth leakage current:
NC mA	NC mA	NC mA
SFC mA	SFC mA	SFC mA
Enclosure leakage current:	Enclosure leakage current:	Enclosure leakage current:
NC mA	NC mA	NC mA
SFC mA	SFC mA	SFC mA
Patient leakage current:	Patient leakage current:	Patient leakage current:
NC mA	NC mA	NC mA
SFC mA	SFC mA	SFC mA
Mains voltage on applied part:	Mains voltage on applied part:	Mains voltage on applied part:
SFC mA	SFC mA	SFC mA
Patient auxiliary current:	Patient auxiliary current:	Patient auxiliary current:
NC mA	NC mA	NC mA
SFC mA	SFC mA	SFC mA

Technical Safety Check
Test Results

Equipment Number: Type:

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Technical Safety Check
Test Results

Equipment Number:	Type:

Date: Checked by:	Date: Checked by:	Date: Checked by:
Mains / Current Volt amp. Measurement current: amp.	Mains / Current Volt amp. Measurement current: amp.	Mains / Current Volt amp. Measurement current: amp.
Measurement Results Protective earth conductor: Ω Earth leakage current: NC mA SFC mA Enclosure leakage current: NC mA SFC mA Patient leakage current: NC mA SFC mA Mains voltage on applied part: SFC mA Patient auxiliary current: NC mA SFC mA	Measurement Results Protective earth conductor: Ω Earth leakage current: NC mA SFC mA Enclosure leakage current: NC mA SFC mA Patient leakage current: NC mA SFC mA Mains voltage on applied part: SFC mA Patient auxiliary current: NC mA SFC mA	Measurement Results Protective earth conductor: Ω Earth leakage current: NC mA SFC mA Enclosure leakage current: NC mA SFC mA Patient leakage current: NC mA SFC mA Mains voltage on applied part: SFC mA Patient auxiliary current: NC mA SFC mA