

CARDIOVIT CS-6/12

OPERATING MANUAL

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Introduction

The CARDIOVIT CS-6/12 is equipped with a highly sophisticated technology. Thus it can be used as a simple electrocardiograph or as a complex unit for many different applications. The CARDIOVIT CS-6/12 is easy to operate, for despite its versatility the automatic programs are started by pressing one key only. The many options and programs allow the performance of the CARDIOVIT CS-6/12 to be adapted exactly to your particular needs.

With the CARDIOVIT CS-6/12 you can record resting ECGs and print them in many different formats. Stress testing is automatically controlled and documented in detail. There are several printing formats for long-term rhythm recordings at your disposal. The many applications make the present operating instructions very bulky. If you read the following pages you will very quickly be able to use your new electrocardiograph optimally.

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

- **assembly operations, extensions, re-adjustments, 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 CS-6 is used in accordance with the operating instructions.**

About this manual

This manual introduces you to the operation of the CARDIOVIT CS-6/12. We recommend to read first the instructions in order to obtain the necessary basis for working with the unit. Lateron, you can use the manual for references.

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, stress testing, replacing the paper). When you are used to work with the unit these brief hints will serve as aide-memoire.
- In the second part **Working with the CARDIOVIT CS-6/12** you will be introduced in detail to the different applications.
- In the **Reference** part you find all the settings, programs and inputs extensively described.

The last chapters contain further information.

The general parts of the operating manual apply for the CARDIOVIT CS-6/12 standard model. Nevertheless, some of the options are included, especially if they are intrisically connected to a topic. The other options are described in Option 1 to 6 (ECG measuring and interpretation, video monitor, diskette memory, etc.).

The most important part is "Working with the CARDIOVIT CS-6/12" and "Stress testing" where you learn all the important applications. In order to use you new electrocardiograph optimally we recommend to go through the whole manual 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 conducting objects (even if these are earthed) or persons.

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, nevertheless special care must be exercised in all cases: the active surgical electrode should always and only 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 also be observed here, however: 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 lead currents. It must be determined in each case before coupling (e.g. by consulting the manufacturer) whether the units are suitable for this purpose.

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Chapter 1
Brief Operating Instructions

In this first part, the applications are briefly described. These description will serve you as aide-memoire once you are used to working with the CARDIOVIT CS-6/12. Apart from the short lists of operating instructions for automatic and manual ECG recording and stress testing, the few manipulations for replacing the paper are shown. On a further page, the functions of the alphanumeric keys are listed.

Automatic ECG recording

1. Place electrodes in standard positions on patient
2. Switch on the CARDIOVIT CS-6/12 with green power switch
→ check recording on screen
3. Press **P** and enter patient data according to table
4. Press **AUTO**
→ ECG is printed in the preset format
5. Copies: press **START**
6. Switch off electrocardiograph, free patient from electrodes

Manual ECG recording

1. Place electrodes in standard positions on patient
2. Switch on the CARDIOVIT CS-6/12 with green power switch
→ check recording on screen
3. Press **MAN** and select lead group, sensitivity, and paper speed
4. Press **P** and enter patient data according to table
5. Press **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

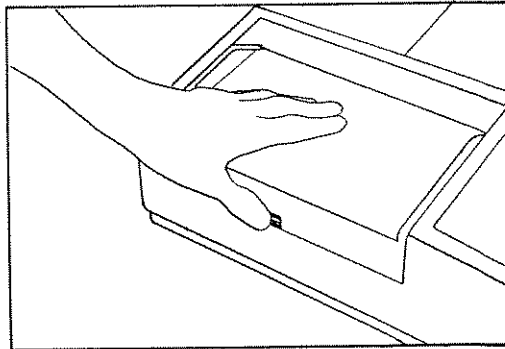
Exercise test

1. Place electrodes on patient, adjust bicycle ergometer to patient's physique (height of seat and handle)
2. Switch on CARDIOVIT CS-6/12 and ergometer.
→ check ECG recording on monitor
3. Press **P** and enter patient data according to form.
4. If possible, record resting ECG (automatically or manually)
5. Press **E** in order to call up stress test program.
Adjust parameters to patient's potential
6. Press **B**
→ exercise test is started
7. During the test, blood pressure measurements can be taken.
Observe the monitor at any time.
8. At heart rate alarm or any other criterion for breaking off: Press **A** or **L**.
→ workload is reduced to 0, the resting phase starts (time and heart rate measurements are continued)
9. At the end of the resting phase: Press key **S**
→ final report is printed out
10. Copies: press **S** again
11. Switch off units, free patient from electrodes

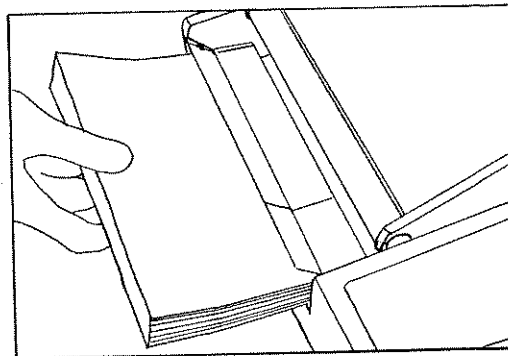
Replacing the recording paper

As soon as the end of the paper is indicated on the lower edge, you have to replace it by a new package. After the indication first appears, there are about four pages A4 (i.e. approx. 120 cm) left.

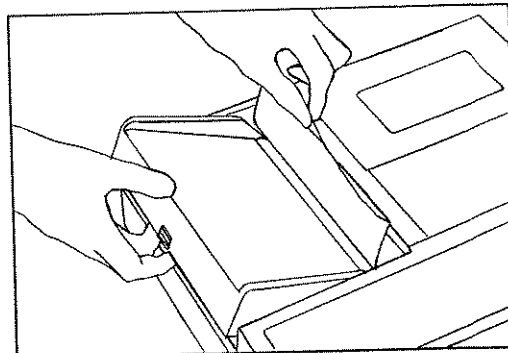
- Push paper compartment release and lift lid



- Fold back top sheet of new paper package by one inch and put it into paper compartment



- Pull up beginning of paper and put it over guiding roll. Check for correct paper alignment
- Close paper compartment by pressing lightly until release catches.

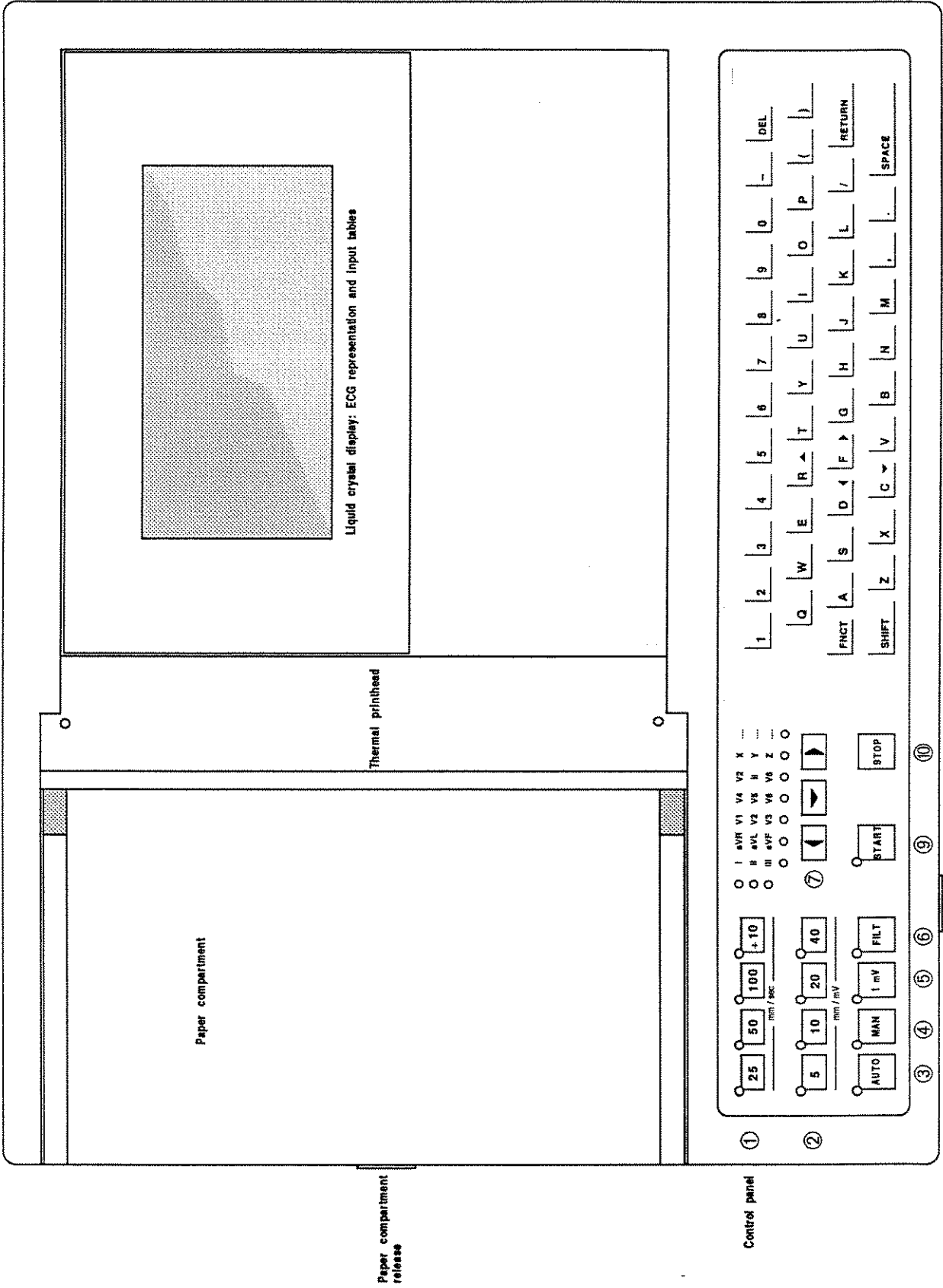


Function characters

<u>Character</u>	<u>Function</u>
E	calling up exercise test program
F	format for automatic mode
G	storing base setting
H	operating help on the screen
I	MTA identification (temporary)
J	user identification (permanent)
L	programming of additional lead group
P	entering patient data
Q	switching on/off acoustic QRS indication
R	format for rhythm mode
T	self-test
U	adjusting clock and calendar
V	various machine settings
Y	stop ECG-monitor (freeze)
Z	calling up diskette / RS-232C program
FNCT	starting or switching to ECG monitor
RETURN	moving to next line or to next page, storing of program
DEL	delete characters
1	ECG monitor: switching from 1-channel to 3-channel representation and vice versa.
6	(format) ECG tracing on 3, 6, (8) or 12 channels

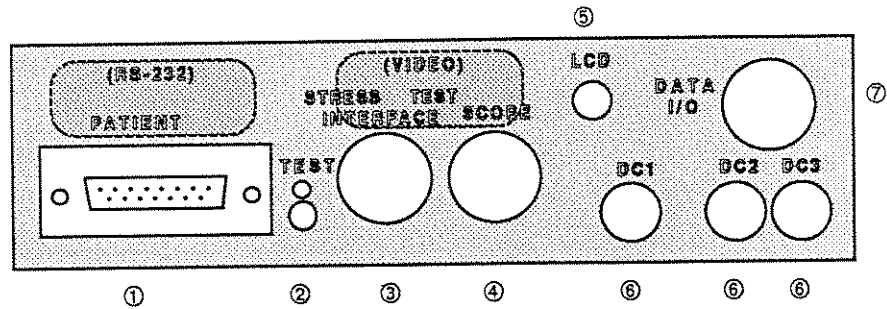
Technical descriptions

- (1) Key for selecting the **recording speed**. The key on the outer right divides by 10 the values of the other keys. For a recording speed of 5 mm/s you have to press the 50 mm/s key as well as the division key.
- (2) Keys for selecting the **sensitivity**.
- (3) **AUTO** key: As soon as this key is pressed 10 seconds of 12 simultaneous standard leads are recorded into the storage and the ECG is printed shortly afterwards. This process is indicated by the blinking red light.
- (4) By means of the **MAN** key you switch to manual mode.
- (5) **1 mV** key for manual calibration
- (6) **FILT** key for switching on and off the myogram filter.
- (7) **Lead selector**: The three lower keys move the selector in the indicated direction. The outer right column stands for the freely programmable lead group. The red control lights indicate the selected lead or lead group. In automatic mode, the first four bottom lights are illuminated. In manual mode, the lead group is selected with the motion keys. The selected lead group is indicated by its light. For the monitor, you can select either a lead group or a single lead. The single lead is selected by first choosing the lead group and then the respective lead with the middle motion key (indication on the outer left).
- (8) **Power switch**
- (9) The **START** key starts the printing of the ECG tracing. With this key you can copy automatic ECG records any number of times.
- (10) The **STOP** key stops the printing of the ECG tracing



Alphanumeric key board: Input of data and programming

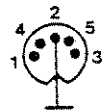
Connector panel (right-hand side of unit)



(1) 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.

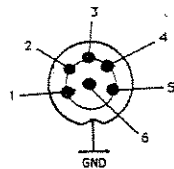
(2) Test socket for electrode leads with control light

(3) Stress test interface



Pin 1 RPM Input: 100 RPM/V
 Pin 2 GND
 Pin 4 Load input: 100 W/V
 Pin 5 Load output: 100 W/V
 Input impedance: > 100 kOhm

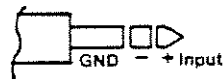
(4) Scope output



Pin 1 Experimental input - (DC4)
 Pin 2 Experimental input + (DC4)
 Pin 3 Output channel 1
 Pin 4 Output channel 3
 Pin 5 GND
 Pin 6 Output channel 2
 Output level: 1 V/cm
 Output impedance: < 100 Ohm

(5) Knob for adjusting the contrast of the screen

(6) Experimental inputs



Differential inputs
 Sensitivity: 0,5 V/cm
 Input impedance: > 100 kOhm
 Maximal voltage: ±5 V

(7) DATA I/O



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

Chapter 2

Getting Started

After you first received your CARDIOVIT CS-6/12 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 CS-6/12.

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 damages.

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 / Grounding

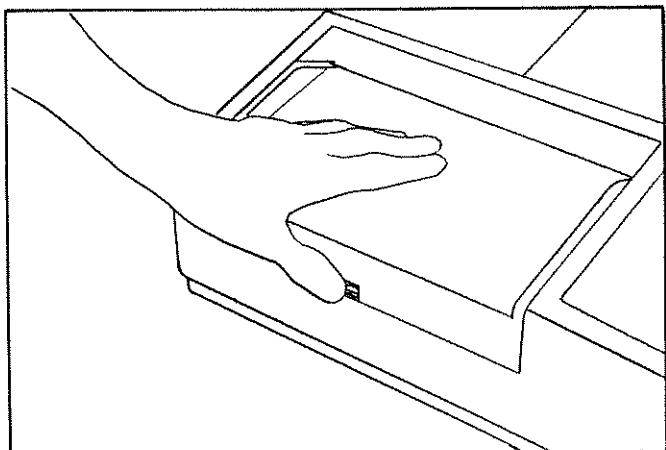
The unit is connected to the mains supply by means of the supplied power cord. At the same time, you have to ground it with the yellow/green ground lead cable. The ground lead has to be connected to the potential equalization if any such is available in the examination room. Else, you can connect the ground lead to a radiator or a water pipe by means of a special clamp.

Replacing the recording paper

The chart paper can easily be replaced. As soon as the end of the paper is indicated on the lower edge, you have to replace it by a new package. After the indication first appears, there are about four pages A4 (i.e. approx. 120 cm) left. However, we recommend to renew the paper 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 **START**.

Push paper compartment release and lift lid. Lift off the remaining paper by means of the cellophane lash.

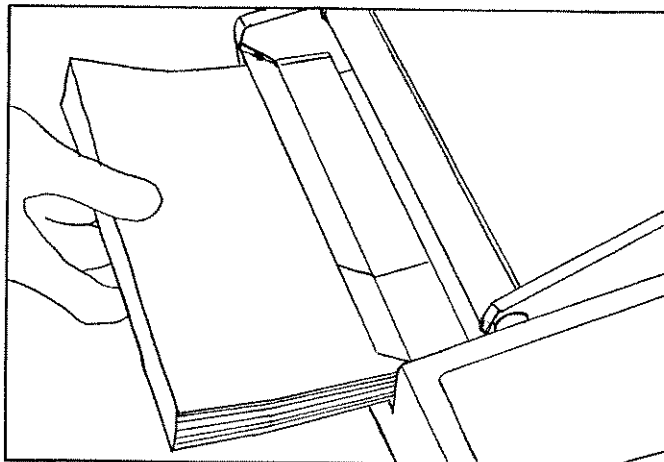


Fold back top sheet of new paper package by one inch.

In order to insert the paper more easily we recommend to fold back the top sheet by one inch. Thus it is easier to seize the paper.

Put new package into paper compartment.

Now you place the new paper into the compartment. Check for the printed grid side to be placed correctly and for the cellophane not to slip under the paper.

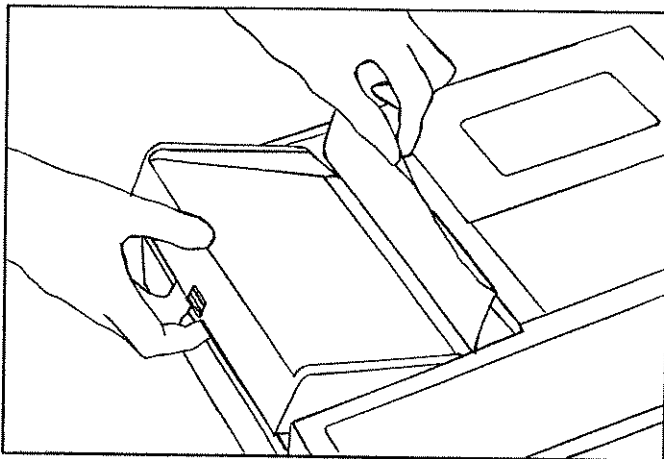


Pull up beginning of paper and put it over guiding roll.

Now you draw up the paper between the guiding roll and the thermal print head. Put the paper around the roll. Please check that the grid side is on top, i.e. visible.

Check for correct paper alignment.

Make sure that the paper can run smoothly. The paper has to be parallel to the guiding edges of the paper table.



Close paper compartment by pressing lightly until release catches.

*Start printout by pressing **START**.*

Switching on and off

The CARDIOVIT CS-6/12 is switched on and off by means of the green O/I button. You can program the CARDIOVIT CS-6/12 in order to have it in the right setting when switching on (→ *Base setting*).

Please make sure that, during the 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 conducting objects (even if these are earthed) or persons.

Chapter 3
Working with the CARDIOVIT CS-6/12

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 CS-6/12 offers. At various places, you will be referred to the reference part.

Stress testing is described in chapter 4. The present part is, however, basis for that application, too.

ECG Recording

As soon as the patient is connected to the patient cable and the unit is switched on, the ECG is recorded and represented on the screen. At the same time, the heart rate (mean value and beat-to-beat), date and time as well as the leads shown are indicated. If an electrode is not sufficiently attached, a hint appears. This disturbance has to be removed before the ECG recording can take place.

The recorded ECG signals are available in the flow memory during 10 seconds. The CARDIOVIT CS-6/12 contains three different ECG memories:

1. The flow 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" below.

Furthermore, the CARDIOVIT CS-6/12 can be equipped with a diskette memory for long-term storage of up to 30 ECGs. (→ *Option 6: Diskette memory*)

Liquid Crystal Screen

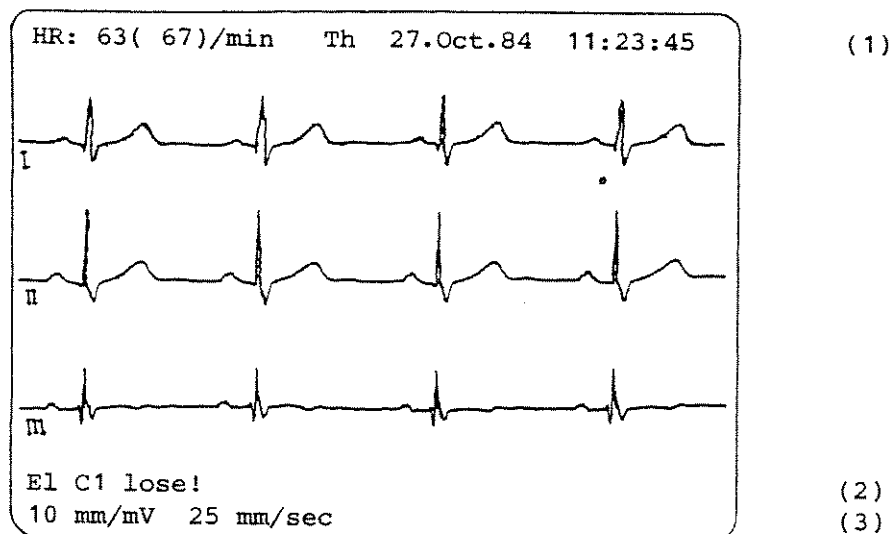
The LC screen is used on the one hand as an ECG monitor and on the other one as an alphanumeric display for operating help, change of format, input of patient data etc. To obtain good visibility of the screen contents, the angle of the display can be adjusted. You can furthermore adjust the contrast by means of knob LCD on the right side of the unit. The screen is best visible if fully illuminated.

LC display as ECG monitor

On the screen, either one or three leads can be represented. By pressing the number 1 on the alphanumeric keyboard you can change from one representation mode to the other.

Together with the ECG tracings, 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 are indicated. The leads are marked on the left side. If any disturbances (e.g. lose electrodes, empty paper compartment) occur, they are signalled on the second lowest line.

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



- (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

Freezing the ECG

The ECG shown on the screen can be frozen: Press letter **Y**. To release it again: press **FNCT**. By this manipulation, the ECG in the memory is not stopped, i.e. it is not possible to print directly the contents of the screen. There is, however, enough time (10 seconds) to retain the event of interest by pressing the **AUTO** key and to print it afterwards.

Printing the ECG shown on the screen

The recorded ECG signals are available in the 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** key has to be pressed so that the last 10 seconds of the ECG signal are retained in the working memory, analysed and interpreted and then printed. This retrospective printing is only possible when first starting from manual mode.

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 that have to be filled in and completed according to instructions. Pressing the **FNCT** key moves you back to ECG representation again.

The most helpful facility is the list of the operating instructions to be used.

Operating instructions on the screen

At any time, you can call up an operating help where all the commands and functions are briefly described. After pressing letter **H** the following list appears:

F	=	format for automatic mode
E	=	stress test mode
I	=	MTA identification
P	=	patient data
Q	=	QRS beeper
R	=	rhythm mode
Y	=	freeze monitor
FNCT	=	restart monitor
RETURN	→	more

FNCT → Monitor

G	=	base setting
J	=	user identification
L	=	programmable leadgroup
T	=	selftest
1	=	1/3 channel monitor
6	=	switch number of traces
U	=	set date and time
V	=	various machine settings
Z	=	floppy/RS-232 control

RETURN → more

FNCT → Monitor

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

Selecting the Number of Leads

Printed leads

The manual ECG can be printed on 3, 6, 12 or an individually chosen number of channels (see *Various Settings*). For one automatic format, you can predetermine the number of leads per page in the same manner.

The number of printed leads is selected by pressing key 6 on the alphanumeric keyboard. The selection changes from 3 to 6 to 12 to the individually chosen number and back again. The setting you want to use normally can be stored in the base setting (see *Base Setting*).

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

Leads on the screen

For the LC display, you can choose between 1 or 3 leads. To switch press key 1.

Selecting the Lead Groups

For the printed ECG

The lead groups are selected by means of the keys < and > of the lead selector. The control lights on the left side and below the lead selector indicate the setting. For the standard leads, the first four lights must be on. By selecting the last column, the freely programmed leads will be recorded (see *Leads (freely programmable)* in the reference part).

In 3-channel mode, the leads are selected group by group as shown on the lead selector.

In 6-channel mode, either the group I-aVF, V1-V6 or the freely programmed leads (1 - 6) are printed. On the lead selector, the first group of three is indicated. The groups V2, H, V6 and X, Y, Z cannot be selected and are therefore skipped.

In 12-channel mode, the groups I - V6 or the programmed leads (1 - 12) are printed. You cannot select groups V2, II, V6 and X, Y, Z.

For the representation on the screen

For the 1-channel representation, you first choose this mode with key 1 and then the lead group that contains the lead to be selected. By means of the center key, the single lead can now be chosen.

Chart Speed

For the real-time recording and the ECG representation on the display, the speed can be selected by pressing the corresponding keys (mm/s). The last key divides the values of the preceding ones by 10, i.e. for a condensed rhythm strip of 5 mm/s you have to press keys 50 and +10. The selected chart speed is indicated on each ECG printout.

In automatic mode, the recording 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 strip. The calibration signal can be manually triggered by pressing the 1 mV key.

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 (1) on the right side of the unit and secured with the screws.

The apparatus is CF (∞) rated. The patient connection is fully isolated and defibrillation protected. The unit can be used for intracardiac application. The protection against defibrillation voltage is only ensured, however, if the original Schiller patient cable is used.

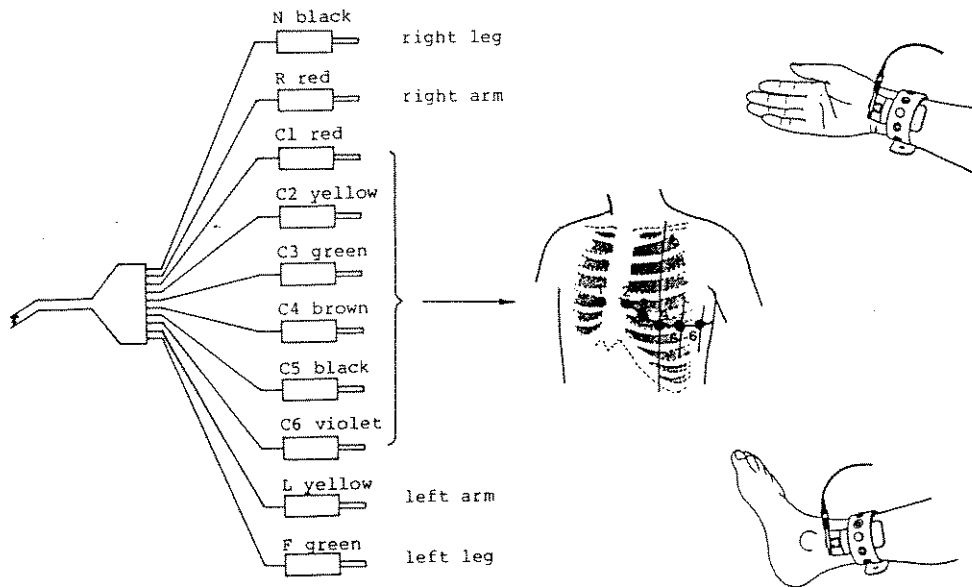
As you know, the quality of the ECG recording is the better the lower the resistance between skin surface and electrodes is. The skin areas have to be first cleaned with alcohol and thick hair has to be removed.

The standard accessory includes four stainless steel limb electrodes and 6 precordial suction electrodes. The extremity electrodes are first spread with electrode gel and then fixed to the arm and foot pick up places. Please make sure that the rubber bands are only tightened to such an extent as to prevent any movement of the electrode without constricting the blood circulation.

The precordial suction electrodes are also first moistened with gel and attached in the right positions.

Connecting the electrodes

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



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 the letter **Q**, the **acoustic QRS** indication is switched on and off.

Input of Patient Data

Each ECG is printed with the name and other information on the patient. The patient data are entered by means of the alphanumeric keyboard. Press letter **P** in order to call up the following input table:

Pat-Name.		(1)
Pat-No:		(2)
Born:	(dd-mm-yy)	(3)
Age:		(4)
Sex:		(5)
Height:	cm	(6)
Weight:	kg	(7)
BP:	mmHg	(8)
Med.:		(9)
	(rem.)	(10)
FNCT → ECG-Monitor		

- (1): Patient name: maximal length 22 characters
- (2): Patient number. maximal 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 CS-6/12 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)
- (5): Sex: maximal length 13 characters
- (6): Height in cm (3 figures)
- (7): Weight in kg (3 figures)
- (8): Blood pressure in mmHg (7 figures)
- (9): Medication: max. 16 characters
- (10): Line for remarks, length max. 22 characters

The cursor () is placed on the first parameter "Pat-Name:". Now the respective entry is done. 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 name is entered, all the other patient data are automatically deleted.

Example of a completed table:

Pat-Name:		
Thomas Sterne		
Pat-No:		
234-689-09		
Born:	03.05.42	(dd-mm-yy)
Age:	45 years	
Sex:	M	
Height:	165	cm
Weight:	75	kg
BP:	80/140	mmHg
Med.:	none	
Angina pectoris		(rem.)

ECG Recording

Now we arrive at the actual application of the CARDIOVIT CS-6/12. As soon as the patient is connected to the patient cable, the ECG is recorded and represented on the screen. At the same time, the heart rate (mean value and beat-to-beat), date and time as well as the leads shown are indicated. If an electrode is not sufficiently attached, a hint appears. **This disturbance has to be removed before the ECG recording can take place.**

Automatic ECG Recording

When switching on, the unit is in automatic mode. To change to manual mode, press key **MAN**.

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** 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.

If there is any disturbance (i.e. lose electrode or end of paper) the **AUTO** control light starts to blink. As long as the disturbance remains, no ECG can be stored. An indication of where to find the defect is shown on the screen. As soon as it is cleared, the storage starts (duration: 10s).

The ECG is automatically printed in the selected format (see *Format for automatic mode*). If you CARDIOVIT CS-6/12 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 be easily removed.

Copies of the ECG

Press the **START** 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.

The number of copies can be preselected (see *Various settings*). This presetting is of great help if you always need the same number of ECG strips.

Selection of sensitivity in automatic mode

All leads are recorded with a sensitivity of 10 mm/mV unless there are too large amplitudes. In this latter 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 **START** key, the new sensitivity is selected. The whole ECG is then printed with the new sensitivity.

Manual Recording of ECG

Press the **MAN** key in order to switch to the real-time recording of ECG traces. In manual mode, number of leads, lead group, chart speed, and sensitivity can be freely chosen.

Press the **START** key: The three, six or twelve selected leads are printed. On the lower edge of the ECG strip, chart speed, sensitivity, indications of possible disturbances, heart rate, name of patient 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 **AUTO** 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 key **R** the following table for selecting the format appears on the LC display:

RHYTHM MODE		
Format:	2	
1 = 2 leads, 10 min/half page		(1)
2 = 1 lead, 15 min/half page		(2)
3 = 1 lead, 30 min/half page		(3)
S = START		
Q = STOP		
FNCT → Monitor		
RHYTHM		

Input:	Result:
1	Printout of programmed leads R1 and R2 on one page A5 (10 min. per page)
2	Printout of programmed lead R1 on one page A5 (15 min. per page)
3	Printout of programmed lead R1 on one page A5 (30 min. per page)
S	To start the rhythm recording, press key S .
Q	To stop the recording, press key Q .

As soon as the rhythm recording is started, the indication "RHYTHM" appears on the LC display. The printout is started after the information for one half page is available, i.e. after 10 to 30 minutes. If the recording is stopped before that time (by pressing **Q**), the rhythm leads are immediately printed.

On every output, the time is printed in intervals of 1 or 2 minutes on the left-hand margin. Furthermore, the patient identification and name, the printed leads, the chart speed, the date and the name of the user are printed on the lower margin of the paper.

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

Basic Setting for the Unit

The CARDIOVIT CS-6/12 offers many more possibilities: We would like to mention here only one of them. It is possible to establish a basic setting of most of the programmable variables. Thus, your CARDIOVIT CS-6/12 is ready for you in exactly the right setting whenever you switch it on.

Press letter **G** to call up the base setting programm:

**Push 'RETURN' for base setting
of:**

- **automatic mode**
- **programmable lead group**
- **Cabrera-/standard leads**
- **number of channels**

(memorized when power off)

FNCT → Monitor

By pressing now RETURN, the present setting of the unit is permanently stored as base setting.

Further settings and programs

In this chapter we have introduced the most important settings and applications. The CARDIOVIT CS-6/12 offers many more facilities. In the following part the stress testing programs are described in detail. For further settings, we would like to draw your attention to the reference part: There you 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

Stress Testing

For the recording of exercise ECGs there are two programs at your disposal: For stress testing with a bicycle ergometer or with a treadmill. In the present chapter, you first find general information for exercise testing. Afterwards, the two applications are described in detail.

We recommend to use an additional video monitor for stress testing. You find a short description in the present part. For further information refer to Option 5: Video Monitor VIDEO V-1.

It is also possible to perform automatic blood pressure measurements by means of a separate unit. For this purpose, the CARDIOVIT CS-6/12 has to be equipped with a RS-232 interface. (see *Option 6: RS-232 Computer Interface*)

The EXEC analysis program for exercise ECGs is described in detail at the end of this part. When using this program, the video monitor is indispensable.

Exercise Testing: General Remarks

The CARDIOVIT CS-6/12 gives you the possibility to perform stress testing together with a suitable ergometer. The programs are controlled by the CARDIOVIT CS-6/12. You need a bicycle ergometer or treadmill with remote control.

Selecting the ergometer

It is always possible to choose whether to use a bicycle ergometer or a treadmill. The change is done in the program "Various Settings". Press the key **V** and select with key **E** the type of ergometer to be used. Normally, you will always use the same ergometer: So you enter your choice into the base setting (see *Base settings*).

Blood pressure measurement

The automatic measurements of blood pressure can be regularly performed during the stress testing. For further information, we refer you to paragraph "Automatic blood pressure measurement" at the end of this chapter.

If you do the blood pressure measurement manually, you can enter the results of the measurements during the test with help of the alphanumeric keyboard. The results appear on the final report (detailed description below).

Stress Testing with a Bicycle Ergometer

The CARDIOVIT CS-6/12 is equipped with a small step test program that can be changed as you please. As ergometer you can use all types of bicycle ergometers with remote control, especially the following ones: Bosch ERG 550S, Lode Corival, Ergometrics 900.

Preparatory tasks

The ergometer has to be connected to the CARDIOVIT CS-6/12 and to the mains supply. Then switch it on. The height of the seat and of the handle bars have to be adjusted to the patient's physique. Connect the patient to electrodes. We recommend to first record a resting ECG for comparison and to measure the blood pressure.

If you have entered the patient data, you are ready for stress testing.

Calling up the stress testing program

Press key **E**. On the screen, the following table for setting the test parameters appears:

STRESS TEST PROGRAM	
Base load:	50 W
Load step:	25 W
Step interval:	2 min
Writing interval:	2 min
HR alarm	250/min
B = Start of stress test	
A = Stop load	
Q = End of stress test mode	
H = more	
FNCT → Monitor	

STRESS TEST PROGRAM	
N = switch to next stage	
L = stop at end of stage	
M = set load manually	
S = output final report	
Z = switch CRT display	
P = input blood pressure	
U = input of program settings	
H = more	
FNCT → Monitor	

The cursor () is on the first line "base load". By typing over, the given values can be adjusted at choice. The cursor moves to the next line as soon as **RETURN** is pressed.

The base load and the load step can be chosen in steps of 5. You can also fix the duration of the load step. The writing interval indicates, at which interval the complete 12-lead ECG is printed out. If you do not like a periodic printout, put in a zero.

The heart rate alarm, that means the upper limit of the heart rate, will be calculated by the CARDIOVT CS-6/12 based on the age of the patient (formula: 200 minus the age of patient). To change the preset value, just type it over.

Setting the measuring programm (M and C versions only)

In the versions with the ECG measuring programm, the ST segment and the QRS duration are periodically measured. The measuring position for the ST amplitude can be individually selected. After pressing **U**, the following table appears:

Program Settings

ST Amplitude Measurement

- Position of the measurement (D/F)
... ms after J point

FNCT → Monitor

With the keys **D** (backwards) and **F** (forwards) the position of the amplitude measuring point can be selected from values of 0 to 80 milliseconds in intervals of ten.

Starting stress testing

By pressing the key **B** the test is started. On the ergometer, the base load is set. At the chosen interval, a complete ECG will be printed out. You see from the LC display and from the periodical printout the test duration, the duration of the load step, the actually set load and the effective load.

Inputs and manipulations during the test

Blood pressure measurement

If you do a separate blood pressure measurement, you can manually enter the corresponding values. Press key **P** and the following table appears:

BLOOD PRESSURE INPUT
(systolic / diastolic)

.....

terminate input with 'RETURN'

FNCT → Monitor

Manual ergometer control

It is possible to manipulate the test procedure during the test. If you press **N**, the load immediately changes to the next load step. The test course can totally be changed and the load can be increased or decreased. After pressing key **M** the screen changes to the following table:

MANUAL ERGOMETER CONTROL

0 W	(R) load increase
	(C) load decrease

FNCT → Monitor

With key **R** the load is increased by 5 W up to 550 W, with key **C** the load decreases correspondingly. As soon as you press RETURN the load changes to the value entered.

Additional ECG printouts

If you need more ECG printouts than preset or if the writing interval was set to 0, you can always start an ECG printout by pressing key **START**.

Stopping the stress testing

As soon as a criterion for interruption is reached you have two possibilities to interrupt the stress testing:

With **A**, the test is interrupted at once. With **L**, the test is ended after the end of the actual load step. The load returns to 0. You see on the screen the following criteria for interruption:

INPUT END POINT CRITERIA

- 0 = Chest pain**
- 1 = Dizziness**
- 2 = Dyspnea**
- 3 = ECG changes**
- 4 = Arrhythmia**
- 5 = Fatigue**
- 6 = Target HR attained**
- 7 = BP behaviour**
- 8 = Decreased HR during exercise**
- 9 = Decrease of BP**

Printout of final report

After interrupting the test, the heart rate and blood pressure measurements continue. The recovery phase should take at least three to five minutes. For the definite test interruption, the final report has to be printed out: Press key **S**.

All information about the test are documented on the final report, especially:

- trendplots of heart rate and load (if there was a blood pressure measurement it is also documented in a diagram)
- criterion for interruption
- measuring results of ST segment and QRS duration
- PWC 150 and PWC 170

Quitting the stress testing mode

Press key **Q** to return from stress testing mode to the resting ECG mode.

Stress Testing with Treadmill

For stress testing with a treadmill, there are five programmed protocols and another five freely programmable protocols available. At present, we use the SCHILLER treadmill model E-17A.

Preparatory tasks

Before starting the test, connect the treadmill to the CARDIOVIT CS-6/12: Plug the seven pin connector into the DATA I/O socket, the five pin connector into the STRESS TEST INTERFACE. Connect to mains supply and switch on. The patient is now connected to the electrodes. It is useful to record first a resting ECG for comparison purposes and measure the blood pressure.

If you have entered the patient data, you are now ready for the stress testing.

Calling up the stress testing program

Press the key **E**. On the screen, the following table appears for operating the test program:

STRESS TEST PROGRAM

Protocol:	0
Writing interval:	2 min
HF-Alarm	250/min

B = Begin stress test
A = Stop treadmill
S = Write final report
Q = End stress test mode
H = more

FNCT → monitor

STRESS TEST PROGRAM

N = switch to next stage
L = stop at end of stage
M = Set grade/speed manually
D = display protocols
Z = switch CRT-display
P = input blood pressure
U = input program settings
K = more

The cursor () is on the "protocol" input line. At present, five test sequence programs are available, four are fixed and one is freely programmable. You enter the corresponding number here.

The writing interval indicates, at which interval the complete twelve-lead ECG will be printed out. If you do not want a periodic printout, put in a zero.

The heart rate alarm, i.e. the upper limit of the heart rate, is automatically calculated by the CARDIOVIT CS-6/12 on the basis of the age of the patient (formula: 200 - age of the patient). You can change the preset value according to your needs.

Protocols

The protocols available can be called up on the LC display by pressing key **D**. Four preprogrammed and one programmable protocol are at disposal. By pressing RETURN you can move to the next protokoll.

Preset protocols

Nr. 1: **PROTOCOL NO. 1 (BALKE):**

STAGE:	DUR.	SPEED	GRADE
1	2 min	5.0 km/h	02.5 %
2	2 min	5.0 km/h	05.0 %
3	2 min	5.0 km/h	07.5 %
4	2 min	5.0 km/h	10.0 %
5	2 min	5.0 km/h	12.5 %
6	2 min	5.0 km/h	15.0 %
7	2 min	5.0 km/h	17.5 %
8	2 min	5.0 km/h	20.0 %
9	2 min	5.0 km/h	22.5 %
10	2 min	5.0 km/h	25.0 %

Nr. 2:	PROTOCOL NO. 2 (NAUGHTON):			
	STAGE:	DUR.	SPEED	GRADE
	1	3 min	3.0 km/h	00.0 %
	2	3 min	3.0 km/h	03.5 %
	3	3 min	3.0 km/h	07.0 %
	4	3 min	3.0 km/h	10.5 %
	5	3 min	3.0 km/h	14.0 %
	6	3 min	3.0 km/h	17.5 %

Nr. 3:	PROTOCOL NO. 3 (ELLESTAD):			
	STAGE:	DUR.	SPEED	GRADE
	1	3 min	2.7 km/h	10.0 %
	2	3 min	4.8 km/h	10.0 %
	3	3 min	6.4 km/h	10.0 %
	4	3 min	8.0 km/h	10.0 %
	5	3 min	8.0 km/h	15.0 %
	6	3 min	9.6 km/h	15.0 %

Nr. 4:	PROTOCOL NO. 4 (BALKE H):			
	STAGE:	DUR.	SPEED	GRADE
	1	1 min	5.2 km/h	00.0 %
	2	1 min	5.2 km/h	01.0 %
	3	1 min	5.2 km/h	02.0 %
	4	1 min	5.2 km/h	03.0 %
	5	1 min	5.2 km/h	04.0 %
	6	1 min	5.2 km/h	05.0 %
	7	1 min	5.2 km/h	06.0 %
	8	1 min	5.2 km/h	07.0 %
	9	1 min	5.2 km/h	08.0 %
	10	1 min	5.2 km/h	09.0 %

Programmable protocol

Nr. 5:	PROTOCOL NO. 5 (USER):			
	STAGE:	DUR.	SPEED	GRADE
	1	0 min	0.0 km/h	00.0 %
	2	0 min	0.0 km/h	00.0 %
	3	0 min	0.0 km/h	00.0 %
	4	0 min	0.0 km/h	00.0 %
	5	0 min	0.0 km/h	00.0 %
	6	0 min	0.0 km/h	00.0 %
	7	0 min	0.0 km/h	00.0 %

The duration of the stage, the speed and the grade can be filled in as required by the user. The speed can contain values up to 10 km/h, the grade up to 25 %.

The cursor is in the time column on the first line. After input of the stage duration, switch to the next line with RETURN, and so on until the column is completed. Then the cursor moves to the column "SPEED" and at the end to column "GRADE".

By means of the keys **D**, **R**, **F** and **C** on the keyboard, you can move in any direction within the table.

Setting the measuring programm (M and C versions only)

In the versions with the ECG measuring programm, the ST segment and the QRS duration are periodically measured. The measuring position for the ST amplitude can be individually selected. After pressing **V**, the following table appears:

<p>Program settings</p> <p>ST amplitude measurement</p> <p>- Position of the measurement (D/F) ms after J point</p> <p style="text-align: center;">FNCT → Monitor</p>

With the keys **D** (backwards) and **F** (forwards) the position of the amplitude measuring point can be selected from values of 0 to 80 milliseconds in intervals of ten.

Starting stress testing

By pressing the key **B** the test is started. On the treadmill, the first stage is started. At the chosen interval, a complete ECG will be printed out. You see from the LC display and on the periodical printout the test and stage duration, the actually set load and the effective load.

Inputs and manipulations during the test

Blood pressure measurement

If you do a separate blood pressure measurement, you can manually enter the corresponding values. Press key **P** and the following table appears:

BLOOD PRESSURE INPUT
(systolic / diastolic)

.....

terminate input with 'RETURN'

FNCT → Monitor

Manual treadmill control

It is possible to manipulate the test procedure during the test. If you press **N**, the treadmill setting immediately changes to the next stage. The test course can totally be changed and speed and/or grade can be increased or decreased. After pressing key **M** the screen changes to the following table:

MANUAL TREADMILL CONTROL

0.0 %	(R) GRADE UP
	(C) GRADE DOWN
0.0 km/h	(F) FASTER
	(D) SLOWER

FNCT → Monitor

With key **R** the grade is increased by 0.5 % up to 25 %, with key **C** the grade decreases correspondingly. With key **F** the speed is increased by 0.1 km/h, with key **D** it is decreased accordingly. As soon as you press RETURN the load changes to the values entered.

Additional ECG printouts

If you need more ECG printouts than preset or if the writing interval was set to 0, you can always start an ECG printout by pressing key **START**.

Stopping the stress testing

As soon as a criterion for interruption is reached you have two possibilities to interrupt the stress testing:

With **A**, the test is interrupted at once. With **L**, the test is ended after the end of the actual load step. Speed and grade return to 0. You see on the screen the following criteria for interruption:

INPUT END POINT CRITERIA

- 0 = Chest pain**
- 1 = Dizziness**
- 2 = Dyspnea**
- 3 = ECG changes**
- 4 = Arrhythmia**
- 5 = Fatigue**
- 6 = Target HR attained**
- 7 = BP behaviour**
- 8 = Decreased HR during exercise**
- 9 = Decrease of BP**

Printout of final report

After interrupting the test, the heart rate and blood pressure measurements continue. The recovery phase should take at least three to five minutes. For the definite test interruption, the final report has to be printed out: Press key **S**.

All information about the test are documented on the final report, especially:

- trendplots of heart rate, speed and grade (if there was a blood pressure measurement it is also documented in a diagram)
- criterion for interruption
- measuring results of ST segment and QRS duration
- PWC 150 and PWC 170

Quitting the stress testing mode

Press key **Q** to return from stress testing mode to the resting ECG mode.

Video Monitor VIDEO V-1

If you are using a video monitor, its screen shows you various information on the course of the stress testing:

On the upper left, you can see the heart rate, the total duration of the test and the duration of the actual stage. Underneath, the actual load or grade and speed is indicated. On the lower part of the screen, you can choose between the representation of three leads or the trendplots of heart rate and load or grade and speed. To switch from one representation to the next press key **Z**.

Automatic Blood Pressure Measurement

In order to do automatic blood pressure measurements during the stress testing, a suitable unit (Tonoprint of Speidel & Keller or EBM 502 of Bosch) has to be connected to the RS-232 interface.

The unit used has to be indicated on the table "Various machine settings" (see *Various settings*). Press key **V** and set the right indication by pressing key **P**: The variable changes from TONOPRINT to EBM 502 to manual input (- - - -) and back again. You can store this indication in the base setting.

If a measuring unit is connected to the RS-232 interface, the CARDIOVIT CS-6/12 automatically performs regular blood pressure measurements during the stress testing. The results are always indicated on the periodic ECG printout and on the video monitor. In the final report, the measuring results are represented in a diagram.

Option 4
EXEC Analysis Program for Exercise ECGs

EXEC is a special program for the real time recording and evaluation of all the data accumulated during exercise stress testing. With the help of established signal processing algorithms, EXEC carries out a complete analysis of the ECG (12 simultaneous leads). Furthermore, specific parameters such as blood pressure and subjective symptoms are entered, co-ordinated according to time and finally integrated in the final report.

Main objective of the EXEC program is to accomplish an accurate evaluation of stress testing and to document all relevant information clearly and concisely.

The present documentation will on the one hand describe how the EXEC program works and on the other hand contain brief operating instructions for the EXEC program in the CARDIOVIT CS-6/12. For a more detailed description of the electrocardiographs and the video-monitor refer to the respective paragraphs in the present operating manual.

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Operating Instructions EXEC

The EXEC program does not need any additional commands. The CARDIOVIT CS-6/12 is delivered with a built-in EXEC program. Every time you choose a stress test program, the EXEC is operational. EXEC can be used for stress testing with bicycle ergometer or treadmill.

The stress testing program is called up by pressing key **E**.

Pre-Settings

Before the test some pre-setting has to be done. By pressing key **U** (Input Measuring Program) the type of ST amplitude measurement is determined. The following table appears on the screen:

ST amplitude measurement

- Type of measurement (M):
absolute
- Position of the measurement (D/F)
... ms after J point
- automatic VES-recording (V):
YES

With key **M** you can switch from "absolute" to "normalized R" and vice versa. The ST amplitude can either be shown as absolute value, or normalized for each lead to the maximal R amplitude. This means, that a ST depression in leads with large R amplitudes are of less importance than in leads with small R amplitudes. Conversion is done according to the following formula:

$$J_{xn} = J_x / \frac{R \text{ amplitude}}{1 \text{ mV}}$$

x = amplitude measuring point
 J_{xn} = normalized ST amplitude
 J_x = absolute ST amplitude

With keys **D** and **F** the position of the amplitude measuring point within the ST segment is determined. The given temporal distance is measured from the beginning of the ST segment, i.e. the J point. Values of 0 to 80 milliseconds in intervals of ten are available.

The automatic printout of ventricular extra systoles (VES) can be suppressed by pressing key **V**. The indication is thus changed to 'NO'. When switching on the indication is always on 'YES'.

Starting stress testing

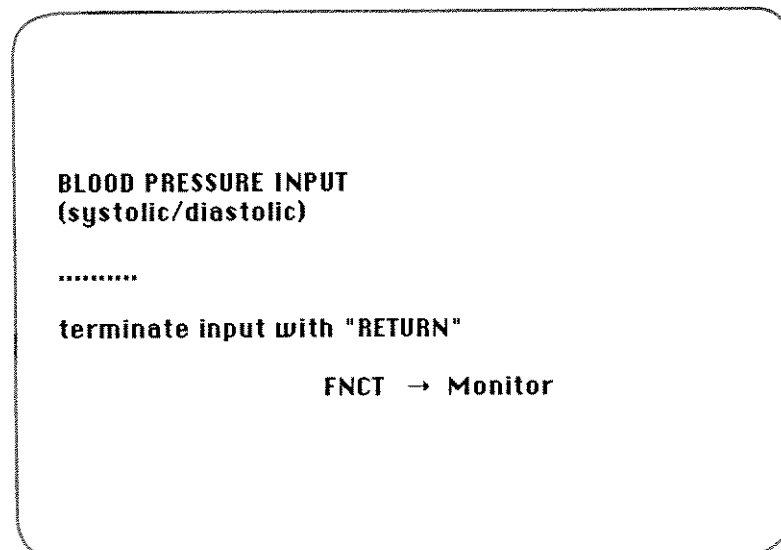
After having started the stress test with key **B**, there is at first a pre-test phase, during which time a resting ECG is being recorded for comparison purposes. The patient should quietly sit on the ergometer (or stand on the treadmill) during this phase. After a minute the first load stage is initiated.

During the test, average complexes are continuously being computed and further analysis made. The results are shown on the monitor (see paragraph Video Monitor in this chapter).

Inputs during the test

During the test, the blood pressure (in case no automatic blood pressure measurement is taking place) and occurring symptoms can be entered.

Input of the blood pressure measurement by pressing key **E** (stress test program) and then key **P**. The following appears on the screen:



```
BLOOD PRESSURE INPUT
(systolic/diastolic)

.....

terminate input with "RETURN"

          FNCT → Monitor
```

Now you can do the corresponding input and confirm with "RETURN". The information entered will appear on the video monitor.

To enter symptoms, first press key **E** (stress testing program) then key **V**. You can choose from the following symptoms:

INPUT OF SYMPTOMS

*** P = CHEST PAIN**
Y = DYSPNEA
D = DIZZINESS

DEL = delete all symptoms

FNCT → Monitor

With keys P, Y or D the respective symptoms can be selected. With the key "DEL" the choice is deleted. The actual entry is indicated on the video monitor. (Input is confirmed with *)

Termination of Stress Testing

After reaching an interruption criteria, the test is discontinued by pressing key **A** or **L**. The monitor shows the list of interruption criteria, where by pressing the corresponding number the applicable information can be selected. The following possibilities are at your disposal:

- 0 = CHEST PAIN**
- 1 = DIZZINESS**
- 2 = DYSPNEA**
- 3 = ECG CHANGES**
- 4 = ARRHYTHMIA**
- 5 = FATIGUE**
- 6 = TARGET HR ATTAINED**
- 7 = BP BEHAVIOUR**
- 8 = DECREASED HR DURING EXERCISE**
- 9 = DECREASE OF BP**

During the recovery phase, which is indicated on the screen with the letter **R**, all the recordings are continued and protocolled.

Final report

You can decide what information the final report should contain: Press key F (in E mode) to get the following table:

FORMAT FINAL REPORT		
ST diagrams	(T):	YES / NO
Average cycles	(M):	- - - /COMPACT/ALL
Speed	(S):	25/50 mm/s
Channels	(C):	6 / 12
VES summary	(V):	YES / NO

With key T, you determine whether the ST diagrams (trend of amplitude and slope) will be printed or not.

The format of the average cycles can be defined by three parameters: With M, you determine whether the average complexes are printed in a condensed format (COMPACT) or all of them in detail (ALL) or whether they are not printed at all (- - -). You can further set the chart speed (with S) and the number of channels on one page (C).

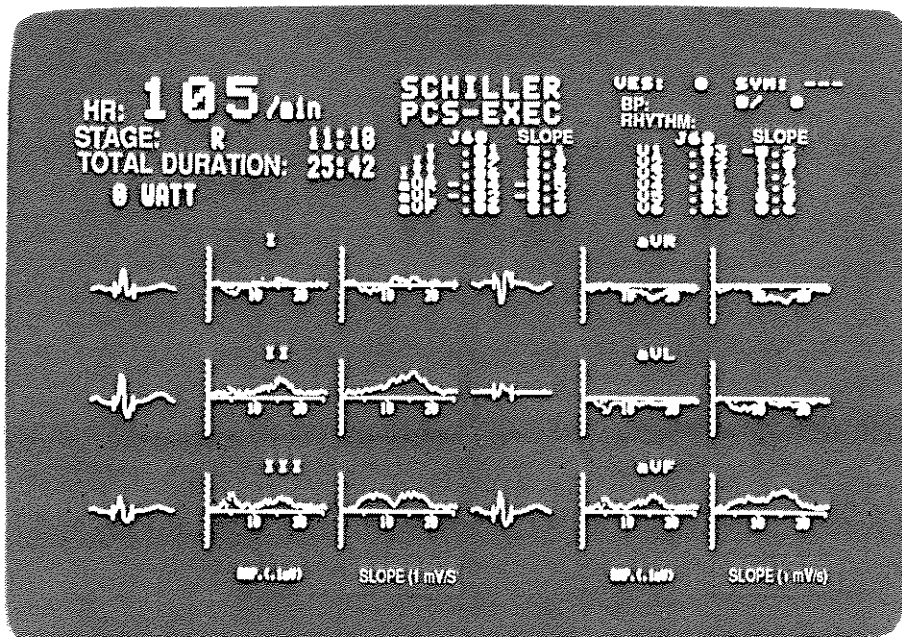
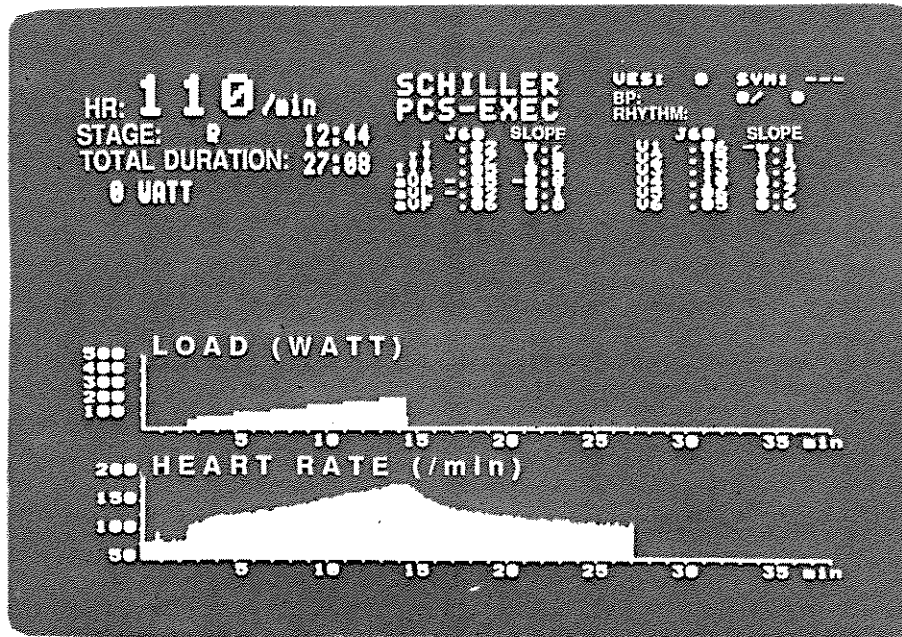
With V, you can finally have the VES summary printed or not.

The printout of the final report is actuated by pressing key S.

In order to conclude a test definitively and to get the CARDIOVIT CS-6/12 ready to start again, the key Q has to be pressed after the printout of the final report.

Video Monitor VIDEO V-1

On the video monitor three freely selectable leads are shown together with their average cycles from the resting ECG and the exercise ECG. The latter is continually renewed. With the help of key Z, the video monitor can be switched to the trend plots of the heart rate and load (see first example below) or a detailed summary of the occurrences in the extremity or chest leads (average complex, ST amplitude trend, ST slope trend; see second example below). The actual analysis results are shown on the upper part of the screen.



On the upper left hand side the heart rate is shown. Below it the test stage. Here the following information appears:

P Pre-Test phase to record resting ECG
 1 - 9 Number of the stage
 R Recovery phase after interruption of the stress test

Next to it the duration of the indicated stage is shown and below it the whole test duration. On the next line the actual load is shown.

On the upper right hand the following information is given:

VES Numer of ventricular extrasystoles
 SYM Symptoms (P = chest pain, Y = dyspnea, D = dizziness)
 BP Blood pressure
 RHYTHM Rhythm classification (ventricular tachycardia, bigeminus, irregular rhythm)

In the table below, the ST amplitude (in mV) and the slope of the ST segment (in mV/s) is indicated for each lead. In addition in the column on the right hand side of the slope a remark appears when there is a significant ST change in the lead concerned. The abbreviations used have the following meaning:

EL = ST elevation
 AS = ST depression with ascending ST course
 SA = ST depression with slowly ascending ST course
 HD = ST depression with horizontal or descending ST course
 CC = ST depression with concaved ST course

	J60*	slope		J60	slope	
I	0.04	0.4		V1	0.04	0.3
II	0.02	- 0.1		V2	0.02	- 0.2
III	- 0.03	- 0.2	HD	V3	- 0.03	0.5
aVR	- 0.04	0.5		V4	- 0.04	1.3
aVL	0.06	1.3	SA	V5	0.06	1.5
aVF	0.09	1.5		V6	0.09	0.8

(* Type of ST amplitude measurement e.g. J40, J80n, etc.)

Description of the EXEC Program

Determination of the dominant QRS cycle

EXEC localizes, measures and classifies each recorded ECG cycle. In order to have an efficient beat classification, precise knowledge of the "normal" QRS type is prerequisite. Hereto a learning process is necessary, which the EXEC carries out immediately after starting a stress test, i.e. during stage P. EXEC informs itself in the first place about the frequency of the occurring QRS patterns. The first five QRS are used for the learning process. From these five complexes a characteristic vector is acquired, which describes the dominant QRS type. This so-called reference vector now serves as a comparison vector for subsequent classification of all the accumulated ECG cycles.

As the shape of the QRS can change continuously during the stress test, the EXEC adapts the reference vector to the changes. When the QRS changes are abrupt - e.g. at an intermittent bundle branch block - a new learning process is automatically initiated.

The duration of the learning process depends on the heart rate. As a rule it lasts for 8 - 12 seconds.

QRS classification

After concluding the learning process, EXEC is in a position to process each ECG cycle immediately. With the help of artefact-insensitive measuring algorithms, EXEC determines a characteristic vector that specifies the QRS-complex to be processed and which is structurally identical to the reference vector. Both these characteristic vectors are then compared via a certain decision logic procedure. Through a suitable combination of the measurement results, taking into consideration the empirically determined tolerance range, EXEC classifies the measured QRS.

Each QRS is classified for signal processing and for medical criteria. The possible classes and the respective processing are shown in the tables below:

Signal Processing Classes

Class	Description	Processing
1.1	Dominant QRS type without strong distortion	Averaging/Update reference vector
1.2	Dominant QRS type with strong distortion	
1.3	Non-dominant QRS type	
1.4	Artefact	

Medical Classes

Class	Description	Processing
2.1	Normal beat	Rhythm analysis
2.2	Supraventricular extrasystole	Rhythm analysis
2.3	Ventricular extrasystole	Rhythm analysis / VES typisation
2.4	Bundle branch block picture	Rhythm analysis

The classification from the signal processing view, is essentially determinant whether a beat can be used for averaging or not. The classification according to the medical point of view determines which part the QRS complex has to play in the subsequent rhythm analysis.

Construction of the representative cycles (Averaging)

The aim to reduce the superfluous information and at the same time increase the quality of the interpretation is attained through the computation of representative ECG cycles. The representative cycle (standard cycle) always corresponds to the actual normal cycle.

For the formation of a genuine standard cycle free of artefacts, the established method of beat averaging is provided. This is an efficient method to dispose of artefacts, a method that uses the peculiarities of the ECG signals. On principle one utilizes the characteristics of the ECG as a redundant periodic process. The average complex formed by a multitude of normal beats full of artefacts thus leads in the proximity of the artefact free original signal.

EXEC uses an incremental-averaging-algorithm with base-line correction. This is a method, which allows the recurring parts of the signal only to be fed into the result. The average cycle is always up-to-date and available at any time.

Analysis of the ST segment

On the averaged cycle the ST analysis occurs every 4 seconds. EXEC determines the position of the J point with the help of a pattern recognition process (template method). If the J point, in relation to the resting cycle, is higher by 0.1 mV, the system would then classify it as ST elevation. The analysis of the ST segment shape thus becomes superfluous. The same applies for the J amplitudes which are larger than -0.1 mV. The ST segment is then classified as unobtrusive. In case the J point is lower than -0.1 mV, EXEC identifies an ST depression and carries out an analysis of the shapes of the ST segment in the first 80 milliseconds. It also determines whether the ST segment in this area is fairly rectilinear. Should this be the case, the slope of the regression line in the first 40 milliseconds serves as a measure for classification.

The following table shows the ST classification and their respective criteria:

Degree	Abbr.	Class	J-amplitude (mV)	ST shape (mV/sec)	Slope
0	-	unobtrusive	$0.1 > J > 0.1$		
1	AS	ascending	$J < -0.1$	rectilinear	$s > 1.0$
2	SA	slowly ascending	$J < -0.1$	rectilinear	$1.0 > s > 0.1$
3	HD	horiz/descending	$J < -0.1$	rectilinear	$0.1 > s$
4	CC	concave	$J < -0.1$	basin-shaped	
5	EL	ST elevation relative to resting ECG	$0.1 < J$		

Rhythm Analysis

Aim of the rhythm analysis is a qualitative and quantitative statement about the heart rhythm during the course of the test. The following rhythm disturbances are determined:

Ventricular Extrasystoles (VES)

In order to classify the VES, criteria such as duration and shape of the QRS are drawn upon. At the same time the RR distance has to be shortened.

VES-Types

Beats classified as VES are transferred to a typification algorithm. Up to 5 VES types are differentiated. A VES type is only recognized as such, when at least two matching QRS complexes are identified.

Frequency of VES

VES are counted. Successive VES are identified as chains of two resp. three. At more than three successive VES a ventricular tachycardia is determined.

Arrhythmia

Totally irregular RR distances of normal ventricular complexes are classified as irregular rhythm (absolute arrhythmia).

The following table shows the rhythm disturbances documented by EXEC:

Degree	Abbr.	Description	Data recorded
0	-	No obvious rhythm disturbance	
1	ES	Isolated VES	Number/Temporal distribution
2	BI	VES as bigeminus	Number/Temporal distribution
3	2R	VES as chains of two	Number/Temporal distribution
4	3R	VES as chains of three	Number/Temporal distribution
5	VT	Ventricular tachycardia	Number/Temporal distribution
6	IR	Irregular rhythm	Time of occurrence

Determining the Heart Rate

The heart rate is constantly computed from the last eight RR intervals. A beat is however only taken for the calculation of the heart rate if it is recognized as a normal beat (class 1.2) or if it has the same medical classification as the preceding beat (e.g. with ventricular tachycardia).

Interpretation

The summary report supplied by EXEC will give information about the significance of the test. Apart from the information about the ST and rhythm abnormalities, the subjective symptoms and causes of interruption are shown.

ST Interpretation

EXEC stores during the whole of the stress test for each lead the ST data with the highest significance and the corresponding maximal ST amplitude (selectable: J00 to J80, J00 to J80 normalized). ST changes are classified as significant, when the ST classification of degree 2 (or higher) has occurred at least once in a lead, i.e. a ST depression with slow ascending course is already rated as conspicuous.

Rhythm interpretation

Rhythm disturbances are rated as significant and documented, when at least one of the conditions are fulfilled according to the following table. Always, the statement with the highest degree is given.

Degree	Statement	Condition
1	Ventricular extrasystoles	at least 10 VES
2	Bigeminus	Bigeminus through 4 QRS
3	Polymorphic ventricular ES	at least 2 VES types
4	Ventricular tachycardia	at least 4 sequential VES
5	Irregular rhythm	Irregular RR-intervals

Chapter 5
Care and Maintenance

Disturbances

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

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

Example: On the screen appears: "El C4 lose!"
This means that there is an insufficient contact at the electrode C4 (brown) as for example not enough electrode gel was used or there is too thick hair.

Self-test

Whenever switched on, the unit performs a self test to check all the functions of the unit.

By pressing key T, the self test can be initiated at any time. A table giving information for the service staff appears on the screen.

Testing the electrode cables

The electrode leads are tested on short-circuit and interruption by means of the test socket (18) on the right side of the unit. For this purpose, the electrode plugs are plugged into the test socket. The CARDIOVIT CS-6/12 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 any 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
Amocid
Lysoformin
Alhydex

The **electrodes** are 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 CS-6/12 should be cleaned with a soft cloth on the surface only. Use conventional detergents or disinfectants which do not contain alcohol. Switch off the unit before cleaning.

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

Terms of Warranty

The CARDIOVIT CS-6/12 is warranted against defects in material and manufacture for the duration of one year (as of date of purchase). Excluded from this warranty are damages caused by an accident or as a result of improper handling. The warranty entitles to a free replacement of the defective part. Any liability for consecutive damages is excluded. The warranty is void if nonauthorized 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 6
Technical Data
Available Configurations

Technical Data

Dimensions (l/w/h): 41 x 33 x 12 cm

Weight: approx. 6.5 kg

Power supply requirements:
110/220/240 V AC, 50/60 Hz

Power consumption: recording: 45 W; idling 15 W

Leads: Standard / Cabrera / Frank XYZ / Nehb / V2, II, V6 / a further combination to be programmed by user

Paper speed: 2.5 / 5 / 10 / 25 / 50 / 100 mm/s

Sensitivities: 5 / 10 / 20 / 40 mm/mV, either automatically adjusted or manually selected

Chart paper: thermoreactive, Z-folded, 21 cm wide, 60 m long, perforation for format A4 (21 x 30 cm) and A5

Printing process: high-resolution thermal printhead, 8 dots per mm

Recording tracks: 1–12 channels, positioned at optimal width on 200 mm, automatic baseline adjustment

Automatic lead programs:

- 3-, 6- or 12 channel representation on one or two pages A4 (25, 50, 100 mm/s)
- Versions M and C: average complexes of the 12 standard leads (25 or 50 mm/s) and 10s rhythm strip (1 or 3 leads)
- Version V: graphic representation of ECG vector loops (for M- and C-versions)

Data record:

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

Long-term rhythm recordings in high-density report formats:

- 2 leads, 10 min/page A5 (12 x 15 cm)
- 1 lead, 15 min/page A5
- 1 lead, 30 min/page A5

Exercise ECGs with final report:

- automatic control of bicycle ergometer and treadmill (user programmable); suitable ergometers: Ergometrics 900, Lode Corival, Bosch 501, Bosch ERG 550S etc.; treadmill: SCHILLER E-17 A
- Final report showing trendplots of heart rate, load and blood pressure, pulse working capacity (PWC 150, PWC 170)
- Versions M and C: QRS and ST measurement

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.

Liquid crystal display:

- Backlighted liquid crystal display for ECG monitoring (1 or 3 leads) and alphanumeric information
- Resolution: 128 x 256 dots; viewing angle adjustable

Calendar clock: battery powered; lifetime > 6 years, leap-years preprogrammed

Frequency range of digital recorder:
0 Hz–150 Hz (IEC); 0 Hz–150 Hz (AHA)

ECG amplifier:

- simultaneous, synchronous registration of all 9 active electrode signals (= 12 standard leads)
- sampling frequency: 800 Hz
- digital resolution 5 μ V
- dynamic range: \pm 9 mV AC
- max. electrode potential: \pm 300 mV DC

- time constant: 3.2 s
- frequency response: 0.05–280 Hz (-3 dB)
- input impedance: > 100 M Ω

Myogram filter (muscle tremor filter):
-3 dB at 41 Hz, -6 dB/octave (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: 4 differential inputs, sensitivity 0.5 V/cm, input impedance > 2 x 100 k Ω

Signal outputs: 3 outputs, 1 V/cm, output impedance < 100 Ω , short-circuit proof and overvoltage protected

Test socket for patient cable: for testing of electrode cables for interruptions and short-circuit; defects indicated by the control light

Patient input: fully floating and isolated, defibrillation protected

Patient leakage current: less than 5 μ A

Safety standard: CF according to IEC

Protection class: I according to IEC, VDE and SEV

Environmental conditions:

- temperature, operating: 10 °C – 40 °C
- temperature, storage: -10 °C – 70 °C
- relative humidity: 15–85%
- atmospheric pressure: up to 5000 m alt.

Control panel and alphanumeric keyboard:
waterproof pad keys

Available Configurations

CARDIOVIT CS-6/12	Standard model with automatic stress testing program
CARDIOVIT CS-6/12M	with measurement program for resting and exercise ECGs
CARDIOVIT CS-6/12C	with measurement program for resting and exercise ECGs and interpretation program for resting ECGs
CARDIOVIT CS-6/12VM	M version with vector loops derived from the 12 simultaneous standard leads
CARDIOVIT CS-6/12VC	C version with vector loops derived from the 12 simultaneous standard leads
CARDIOVIT CS-6/12D	with MEDIS interpretation programm (available in German only)

For all these versions, you can choose between several languages.

Hardware options

The above-mentioned units can be equipped or upgraded with the following options:

RS-232 computer interface	necessary for the use of a blood pressure measuring unit and for the transfer of ECG data to the SEMA ECG management system
Built-in diskette memory with RS-232 interface	On one diskette you can store up to 30 ECGs.
Video monitor VIDEO V-1	Indispensable if the EXEC analysis program for exercise ECGs is used, recommended for stress testing
E-17A Treadmill	The ideal treadmill for stress testing

Software options

EXEC analysis program for exercise ECGs	Continual construction of average complexes, analysis, rhythm analysis, comprehensive final report
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References

Format for Automatic Mode

The format of the automatic ECG output can be freely chosen. Usually, you will program the format when starting the CARDIOVIT CS-6/12 for the first time so that this point can be omitted later on. 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 character **F** on the alphanumeric keyboard. The form appears on the screen:

ECG	0: --	1: 4*3 leads + rhy	1
	2: 1*3/6 leads (10s)		
	3: select	E: 1	F: 2 pages
	M: 25	H: 50	J: 100 mm//s
Average QRS	4: --	5: compact	4
	6: 2*6 leads + 3* rhy		
	7: 4*3 leads * 1* rhy		
Markings	K: NO	L: YES	Y
Measurements	R: NO	S: YES	Y
Interpretation	T: NO	U: YES	Y

In the ECG section, the format of the printed leads is determined:

<u>Entry</u>	<u>Output format:</u>
0	No leads are printed but only the page of average QRS.
1	On one page (30 cm), all the 12 standard leads plus one rhythm strip are printed.
2	10s of the user programmed leads are printed.
3	12 leads are printed as selected on 3, 6 or 12 channels. The length and chart speed of the leads are selected as follows:
E	Printout of the 12 leads on one page (30 cm)
F	Printout of the 12 leads on two pages
G	Chart speed: 25 mm/s
H	Chart speed: 50 mm/s
J	Chart speed: 100 mm/s

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

<u>Entry</u>	<u>Output format</u>
4	No average cycles are printed.
5	The average complexes are printed on one half of the page (chart speed: 25 mm/s). There is enough space for patient data, interpretation statements (C), measuring results and one rhythm lead.
6	On one page, the 12 average complexes are printed at 25 mm/s, together with three rhythm leads.
7	On one page, the 12 average complexes are printed at 50 mm/s and one rhythm lead at 25 mm/s.
Markings	<p>K The measurement reference points are not indicated.</p> <p>L The reference points (beginning and end of P wave and QRS as well as end of T wave) are added to the ECG cycles.</p>
Measurements	<p>R The detailed table of measuring results is not printed. (However, the values of electrical axes, intervals, and heart rate are not suppressed).</p> <p>S The detailed table of measuring results is printed.</p>
Interpretation (only C)	<p>T The interpretation statements are not printed.</p> <p>U The interpretation statements appear.</p>

Leads (freely programmable)

You can call up with letter L the table for programming leads at choice:

1: DC1	4: DC4	7: V1	10: V4	R1: V2	
2: DC2	5: II	8: V2	11: V5	R2: II	
3: DC3	6: V2	9: V3	12: V6	R3: aVF	
1: I	7: V1	13: CF1	19: V3r	25: DC1	30: D
2: II	8: V2	14: CF2	20: V4r	26: DC2	31: A
3: III	9: V3	15: CF3	21: V5r	27: DC3	32: J
4: aVR	10: V4	16: CF4	22: V7	28: DC4	33: 0
5: aVL	11: V5	17: CF5	23: V8	29: -aVR	
6: aVF	12: V6	18: CF6	24: V9		

The cursor is on the input line 1. You choose the lead by pressing 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 12 leads can thus be freely selected, which are printed out in manual recording of ECG when the last column of the lead selector is selected or in automatic recording in the ECG format number 2.

In the last column you select the rhythm leads. R1 appears, if only one rhythm lead is selected in automatic format or in rhythm mode. R1 and R2 are printed in the 2-channel rhythm format. R1, R2 and R3 appear, if 3 rhythm leads are chosen. R1, R2 and R3 can be chosen from the standard leads (1 - 12, 29) only.

The user programmed leads can be stored in the base setting of the unit (see *Base setting*).

Lead Systems

Attaching the electrodes

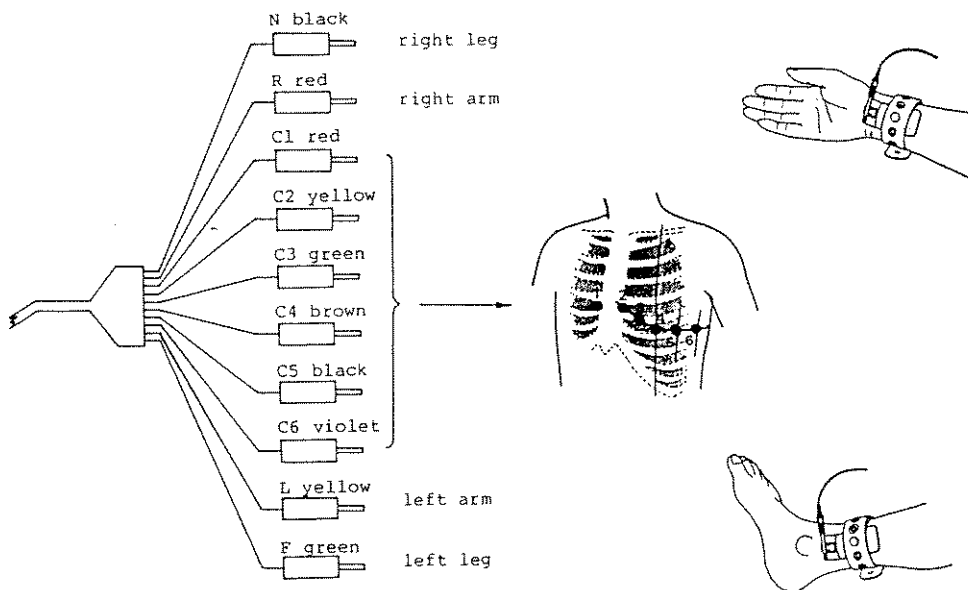
The smaller the resistance between skin surface and electrodes, the better the quality of the ECG. The skin areas have to be first cleaned with alcohol and thick hair has to be removed.

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 the right positions.

Connecting the electrodes

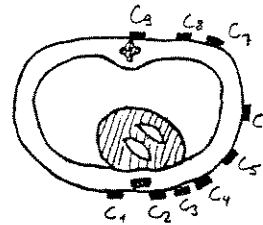
Standard leads I, II, III, aVR, aVL, aVF, V₁, V₂, V₃, V₄, V₅, V₆



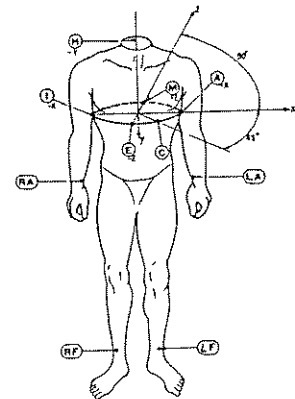
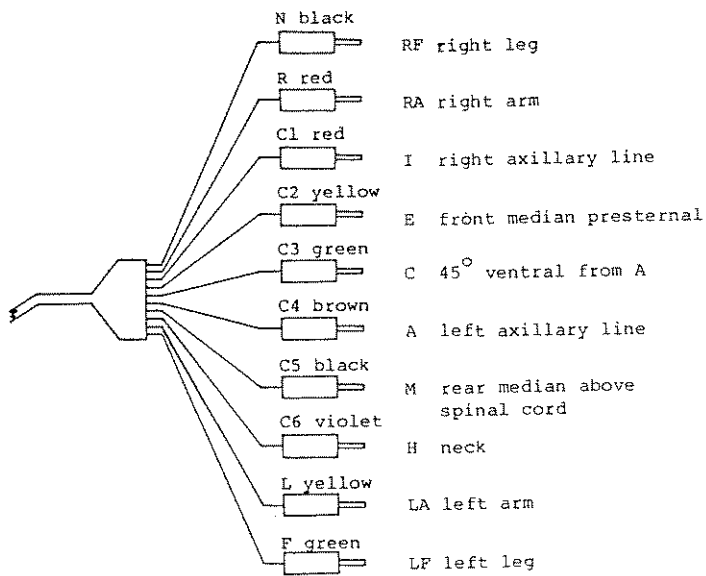
Leads V₇, V₈, V₉

The electrodes have to be connected as follows:

- Plug C4 brown to electrode C₇
- Plug C5 black to electrode C₈
- Plug C6 violet to electrode C₉



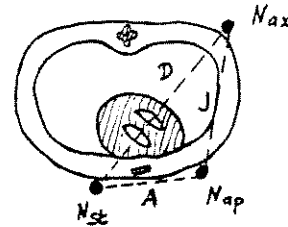
Frank leads X, Y, Z



Nehb leads

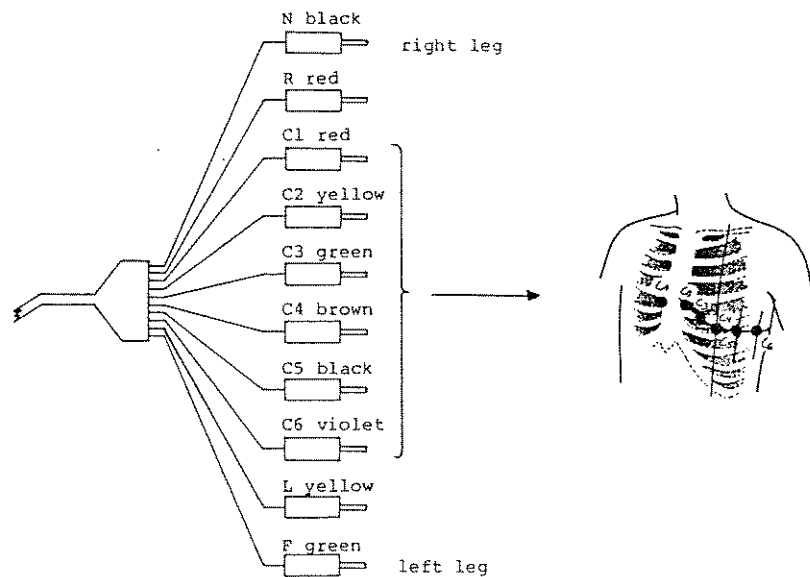
The electrodes have to be connected as follows:

- 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 $CF_1 - CF_6$

These leads are measured between one extremity electrode (F green) and the precordial electrodes $C_1 - C_6$. The electrode F green is usually placed on the left leg. In this way, the semithoracic leads $CF_1 - CF_6$ are derived. The F electrode can also be placed in other positions: if it is placed on the manubrium of the sternum, you will derive CM leads.



MTA Identification

In order to mark the ECG with the name or identification of the person in charge for the recording, you can make a temporary input by means of this program. The entry is stored until the unit is switched off or a new entry is made.

Press letter **I** and enter name or any other identification (up to 22 characters).

Identification of MTA
(stored until power off)

—

FNCT → Monitor

Example:

Identification of MTA
(stored until power off)

Linda Masters

FNCT → Monitor

User Identification

This program is used to enter the name of the physician, clinic or department which then will be printed on each ECG. The input is stored permanently, i.e. it is not deleted when the unit is switched off.

Press letter **J** and enter permanent user identification (e.g. name of physician, clinic, or department), max. length 22 characters. The entry is stored as soon as the RETURN key is pressed. A change is made by simply typing it over and pressing RETURN.

**user identification
(memorized when power off)**

—

(enter id with 'RETURN')

Example:

**user identification
(memorized when power off)**

—

(enter id with 'RETURN')

identification stored!

Adjusting Clock and Date

The CARDIOVIT CS-6/12 contains a calendar clock running on its own battery. Thus, the calendar clock works independently from the mains supply, i.e. it is running even if the unit is switched off. The battery has life of 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, you call up form "Adjusting calendar clock" by pressing letter **U**.

adjust clock and calendar:

time:	_	(hh.mm.ss)	(1)
date:		(dd.mm.yy)	(2)
weekday:		(Mo/Tu/etc.)	(3)

- (1): The time has to be entered in hours, minutes, seconds.
Example: for 11.25 h a.m.: "11.25.0", for 6.05 h p.m.: "18.5.0" or 18.05.00".
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, 1987: "2.5.76".
- (3): The day of the week is indicated by its first two letters: Mo, Tu, We, Th, Fr, Sa, Su for Monday, Tuesday, Wednesday Thursday, Friday, Saturday, Sunday respectively.

As soon as RETURN is pressed the entered values are stored and the cursor (blinking underscore) 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, the whole line is deleted and a question mark appears. The cursor remains on the same line.

Various Settings

Apart from the above mentioned possibilities for the selection of the automatic format, you can also predetermine the number of ECG copies to be printed or whether the leads have to be printed in Cabrera or standard sequence. After pressing V the following table appears:

Various machine settings	
Lead sequence (H):	Standard
Mains filter (F):	50 Hz
Copies (01 - 99):	01
Programm. channels (C):	08
Stress test with (E):	bicycle
BP measurement (P):	EBM 502

The **lead sequence** is switched with key **X**: The parameter changes from Standard to Cabrera and vice versa.

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

The **number of copies in automatic mode** can be selected (enter a number between 01 and 99). This function produces a constant number of ECG copies whenever key **START** is pressed.

The **programmable channels** setting allows you to set an individual number of channels for the printout, e.g. if you want to record additional Doppler or phono waveforms. With **C** you can choose a number between 7 and 11. When printing out, the individual number of printing tracks is selected with key **6**.

With key **E** you can select, if the stress testing will be with bicycle or treadmill (Woodw. only for Woodway-treadmill).

With key **P** will be defined which appliance for automatic blood pressure measurement is connected (Tonoprint, EBM 502 or manual input).

Option 1 and 2 **SCHILLER ECG analysis program**

The new SCHILLER ECG interpretation program was developed in co-operation with leading European cardiologists. This program intends to help the physician read the ECG with utmost care and evaluate it efficiently.

The interpretation provided by the SCHILLER ECG interpretation program does not replace a detailed report by the physician. It offers, however, a reliable basis as it is based on the objective measurement of ECG signals and the comparison with confidence intervals in normal material. However, a machine will never be able to offer a complete diagnosis on the basis of the ECG alone and without a considerable amount of additional information. The comprehensive clinical diagnosis will always be the physician's responsibility and his undeniable privilege.

Before listing the statements, we would like to briefly recall the essential principles of ECG analysis and evaluation.

The ECG evaluation should always be systematic and in a predetermined order. Before each ECG evaluation you should verify whether the recording was done correctly, and whether the patient received any heart-active medicine (digitalis, beta-blockers, antiarrhythmics, diuretics etc.). Clinical findings and diagnosis have to be known to the evaluating person. The following procedure is recommended for the evaluation:

1. Determine rhythm or rhythm disturbances
2. Determine heart rate
3. Measure duration of P, PQ, QRS and QT
4. Systematic examination of P, Q, R, S, T waves and ECG segments (ST segment etc.)
5. Determine electrical axes in extremity leads and evaluate precordial leads (R/S ratio, transitional zone etc.)
6. Brief description of exceptional and abnormal signs within each single section of the waveform
7. At the end, the overall evaluation takes place

In this procedure, you are optimally supported by the SCHILLER ECG interpretation program. It supplies the necessary measuring data and suggestions for interpretation.

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**Option 1:
SCHILLER ECG measurement program**

The basis for an interpretation with the SCHILLER ECG interpretation program or a diagnosis by the physician is the SCHILLER ECG measurement program. It measures the ECG signal and presents the results clearly arranged.

Heart rate (HR)

Average heart rate calculated on the basis of the entire recording (10 seconds) and is 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:

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

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

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

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

Detailed measurements for each lead

The SCHILLER measurement program prints a table with lead-specific measuring results.

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 corresponds 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)

**Option 2:
SCHILLER ECG Interpretation Program**

List of possible statements and criteria

Rhythm statements

Interpolated supraventricular extrasystoles

One or several beats of the same shape as the predominant beats of the ECG were detected between two beats separated by the predominant R-R interval, in the absence of atrial fibrillation.

Supraventricular extrasystoles

One or several premature beats of the same shape as the predominant beats, followed by a R-R interval longer than or equal to the predominant R-R interval were detected, in the absence of atrial fibrillation.

Supraventricular escape beats

A pause longer than 1.2 times the predominant interval preceded one or several beats of the same shape as the predominant beats, in the absence of atrial fibrillation.

Interpolated ventricular extrasystoles

One or several beats differing in shape from the predominant beats were detected between two beats separated by the predominant R-R interval, in the absence of atrial fibrillation.

Ventricular extrasystoles

One or several beats differing in shape from the predominant beats, and followed by a compensatory pause longer than the predominant R-R interval were detected.

Ventricular escaped beats

A pause longer than 1.2 times the predominant R-R interval preceded one or several beats differing in shape from the predominant beats, in the absence of atrial fibrillation.

Sinus rhythm

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

Sinus arrhythmia

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

Supraventricular arrhythmia

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

Sinus bradycardia

A P wave was detected in the averaged ECG cycle. The heart rate was less than 50 beats per minute.

Sinus tachycardia

A P wave was detected in the averaged ECG cycle. The heart rate was greater than 100 beats per minute.

Supraventricular tachycardia

A P wave was detected in the averaged ECG cycle. The heart rate was greater than 130 beats per minute.

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. There was less than 10% difference in the duration of the R-R intervals between the predominant beats.

Nodal rhythm ?

No P wave was detected in the averaged ECG cycle. The heart rate was greater than 60 beats per minute. There was less than 10% difference in the duration of the R-R intervals between the predominant beats.

Idioventricular rhythm

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

Ventricular tachycardia

No P wave was detected in the averaged ECG cycle. The QRS duration of the predominant beats was greater than 150 ms. There was less than 10% difference in the duration of the R-R intervals between the predominant beats. The heart rate was more than 150 beats per minute.

Atrial fibrillation

No P wave was detected in the averaged ECG cycle. There was at least 12% difference in the duration of at least one R-R interval between the predominant beats. The heart rate was less than 95.

Atrial fibrillation with rapid ventricular response

No P wave was detected in the averaged ECG cycle. There was at least 12% difference in the duration of at least one R-R interval between the predominant beats. The heart rate was equal to or greater than 95.

Pacemaker ECG ?

No P wave was detected in the averaged ECG cycle. The QRS duration of the predominant beats was greater than 150 ms. There was less than 5 ms difference in the duration of the R-R intervals between the predominant beats. The heart rate was greater than 40 and less than 150 beats per minute.

Electrical axis

The electrical axis is computed on the basis of the algebraic sum of the QRS amplitudes of leads I and aVF. The individual statements correspond to the following ranges:

Abnormal left axis deviation	- 90°	-	- 30°
Leftward axis	- 30°	-	0°
Rightward axis	+ 90°	-	+ 120°
Abnormal left axis deviation	+ 120°	-	+ 180°
Abnormal right superior axis deviation	- 90°	-	- 180°

Indeterminate axis

The algebraic sum of the deflections of the QRS complex both in lead I and lead aVF ranged between -0.20 and +0.20 mV.

Atrial activity

Prolonged P

The duration of the P wave was 140 ms or longer.

Left atrial enlargement

A negative phase of at least 0.05 mV was detected in lead V1.

Right atrial enlargement

The amplitudes of at least two P waves in lead II, III and aVF were greater than 0.25 mV.

Biatrial enlargement

A negative phase in the P wave of at least 0.05 mV was detected in lead V1 and at least two P waves in lead II, III and aVF were greater than 0.25 mV.

A-V Block I

The duration of the P-R interval was longer than 210 ms.

QRS statements

Peripheral low voltage

The sum of the peak-to-peak QRS amplitudes in lead 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.

Low voltage

The sum of the peak-to-peak QRS amplitudes in lead 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.

Bundle branch 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 a S wave deeper than 0.20 mV was detected in lead I and in lead V6. In lead V1 or lead V2 a notched QRS complex or a QRS complex of the RSR' type was found.

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. The other criteria for right bundle branch block, except for the duration of QRS, may be fulfilled or not.

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 a S wave was found in lead I and lead V6, this wave was not deeper than -0.2 mV. No Q wave was present in lead I and lead V6.

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 110 ms.

Non specific intraventricular block

The total duration of QRS was at least 130 ms. Neither the criteria for left bundle branch block nor those for right bundle branch block were fulfilled.

Non specific intraventricular delay

The total duration of QRS was shorter than 130 ms but longer than 110 ms. Neither the criteria for incomplete left bundle branch block nor those for incomplete right bundle branch block were fulfilled.

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. The electrical axis ranged between -30 and -120 degrees.

Left posterior fascicular block

The electrical axis ranged between +90° and +180°, or between -120° and -180° degrees. The R/S ratio in lead V6 and aVL was 0.6 or less.

QRS vector abnormalities (defect of myocardium)

QRS contour abnormality suggesting anteroseptal myocardial injury

There was a pathological start of the ventricular depolarisation. The initial momentaneous QRS vectors were directed backward and mostly to the left, and remained directed in this direction during the greater part of the ventricular depolarisation, instead of starting forward, remaining directed forward for the first 30 ms and turning presently backward and to the left.

QRS contour abnormality suggesting anterolateral myocardial injury

The ventricular depolarisation mostly started normally, the initial momentaneous QRS vectors being directed forward and to the right. Instead of turning then to the left and backward, however, the momentaneous QRS vectors turned further to the right and backward.

QRS contour abnormality suggesting localized anterior myocardial injury

The first initial momentaneous QRS vectors were still normally directed forward and to the right, but already after 10 - 20 ms the momentaneous QRS vectors deviated to the left and backward, instead of remaining directed forward for a further 10 - 20 ms.

QRS contour abnormality suggesting anterior myocardial injury

There was an equivocal or uncharacteristic loss of initial momentaneous QRS vectors directed forward.

QRS contour abnormality suggesting inferior myocardial injury

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

QRS contour abnormality suggesting posteroseptal myocardial injury

The initial 10 - 20 ms momentaneous QRS vectors were directed upward, but instead of turning downward immediately hereafter, as would be normal, turning downward was delayed, and occurred only 30 - 40 ms after the beginning of the ventricular depolarisation.

QRS contour abnormality suggesting posterior myocardial injury

There was an equivocal or uncharacteristic initial upward direction of the momentaneous QRS vectors of longer duration than normal.

Non specific QRS abnormality

Minor or isolated deviations from the normal ranges for amplitude and/or duration of the deflections of QRS were detected.

ST-T morphology**ST abnormality, possible anteroseptal subendocardial injury**

ST depressed by at least 0.25 mV in at least 2 of leads V1, V2, V3.

ST abnormality, possible anterior subendocardial injury

ST depressed by at least 0.25 mV in at least 2 of leads V2, V3, V4.

ST abnormality, possible anterolateral subendocardial injury

ST depressed by at least 0.25 mV in at least 2 of leads V3, V4, V5, V6.

ST abnormality, possible lateral subendocardial injury

ST depressed by at least 0.25 mV in leads V5, V6 and at least 0.1 mV in leads I, aVL.

ST abnormality, possible inferior subendocardial injury

ST depressed by at least 0.1 mV in leads II and aVF.

ST & T abnormality, consider anteroseptal ischemia or right ventricular strain

ST depressed by 0.05 - 0.24 mV and T was flat, diphasic or negative in at least 2 of leads V1, V2, V3.

ST & T abnormality, consider anterior ischemia or right ventricular strain

ST depressed by 0.05 - 0.24 mV and T was flat, diphasic or negative in at least 2 of leads V3, V4.

ST & T abnormality, consider anterolateral ischemia or left ventricular strain

ST depressed by 0.05 - 0.24 mV and T was flat, diphasic or negative in at least 2 of leads V3, V4, V5, V6.

ST & T abnormality, consider lateral ischemia or left ventricular strain

ST depressed by 0.05 - 0.24 mV and T was flat, diphasic or negative in at least 2 of leads I, aVL, V5, V6.

ST & T abnormality consider inferior ischemia or left ventricular strain

ST depressed by 0.05 - 0.24 mV and T was flat, diphasic or negative in leads II and aVF.

Non specific ST abnormality

Other ST changes than those named above were detected.

T abnormality, consider anteroseptal injury

T was flat, diphasic or negative in at least 2 of leads V1, V2, V3.

T abnormality, consider anterior injury

T was flat, diphasic or negative in at least 2 of leads V2, V3, V4.

T abnormality, consider anterolateral injury

T was flat, diphasic or negative in at least 2 of leads V3, V4, V5, V6

T abnormality, consider lateral injury

T was flat, diphasic or negative in at least 2 of leads I, aVL, V5, V6.

T abnormality, consider inferior injury

T was flat, diphasic or negative in leads II and aVF.

Non specific T abnormality

Other changes of T than those named above were detected.

Infarct**Cannot rule out anteroseptal infarct**

The patient is at least 35 years old. QRS contour abnormality suggesting anteroseptal myocardial injury was detected.

Possible anteroseptal infarct

will appear instead if moreover specific Q or QS were detected in leads V1 - V4.

Consider anteroseptal infarct

will appear instead if moreover specific repolarization changes were detected in the same leads.

Cannot rule out anterior infarct

The patient is at least 35 years old. QRS contour abnormality suggesting anterior or localized anterior myocardial injury was detected.

Possible anterior infarct

will appear instead if moreover specific Q or QS were detected in leads V1 - V4.

Consider anterior infarct

will appear instead if moreover specific repolarization changes were detected in the same leads.

Cannot rule out anterolateral infarct

The patient was at least 35 years old. QRS contour abnormality suggesting anterolateral myocardial injury was detected.

Possible anterolateral infarct

will appear instead if moreover specific Q or QS were detected in leads V2 - V6.

Consider anterolateral infarct

will appear instead if moreover specific repolarization changes were detected in the same leads.

Cannot rule out inferior infarct

The patient was at least 35 years old. A QRS contour abnormality suggesting inferior, posteroseptal or posterior myocardial injury was detected.

Possible inferior infarct

will appear instead if moreover specific Q or QS were detected in leads II and aVF.

Consider inferior infarct

will appear instead if moreover specific repolarization changes were detected in the same leads.

Hypertrophy

For the detection of a **Left Ventricular Hypertrophy**, points were attributed to different ECG signs possibly caused by this condition according to the following criteria:

Amplitudes: 3 points 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 - V3 was equal to or greater than 2.5 mV and
- the greatest R deflection in leads V4 - V6 was equal to or greater than 2.5 mV.

ST & T: 1 point if

- a ST depression and a flat, 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 maximal QRS vector was longer than 55 ms, and
- the total duration of QRS was longer than 100 ms.

Consider left ventricular hypertrophy

The patient was at least 25 years old and the ECG scored at least 5 points according to the criteria above.

Possible left ventricular hypertrophy

The patient was at least 25 years old and the ECG scored 4 points according to the criteria above.

Amplitude criteria for left ventricular hypertrophy

The patient was at least 25 years old and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied.

For the detection of a **Right Ventricular Hypertrophy**, points were attributed to different ECG signs possibly caused by this condition, according to the criteria below:

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
- a S wave deeper than -0.7 mV was detected in leads V5 or V6, and the R/S ratio was less than 1 in these leads.

ST-T: 3 points if

- a ST depression and a flat, negative or diphasic T wave was detected in leads V1 - 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 5 points according to the criteria above.

Possible right ventricular hypertrophy

The ECG scored 4 points according to the criteria above, or 3 points in the presence of a right atrial hypertrophy or of a sagittal electrical axis.

General classification statements

Normal ECG

Otherwise normal ECG

Borderline ECG

Possibly abnormal ECG

Abnormal ECG

Acquisition of vector loops

On the basis of the calculated orthogonal leads, the vectorial representation of the frontal, sagittal and horizontal planes are computed and printed on an additional page.

On the vector loops, the P, QRS and T parts are clearly distinguishable. The reference points marked with arrows at 10, 20, 30, and 40 ms after the beginning of the QRS indicate the clinically important course of the initial phase of the ventricular depolarisation.

Printout of vector loops

It is possible not to print the vector loops. This is set while selecting the automatic format: First, press key **F** to call up the input table for the format selection. Now you can suppress the printing by pressing key **V** or reactivate it by pressing **W**.

ECG	0: - -	1: 4*3 leads + rhy	1
	2: 1*3/6 leads (10s)		
	3: select	E: 1	F: 2 pages
	M: 25	H: 50	J: 100 mm/s
Average QRS	4: - -	5: compact	25
	6: 2*6 leads + 3* rhy		4
	7: 4*3 leads * 1* rhy		
Markings	K: NO	L: YES	Y
Measurements	R: NO	S: YES	Y
Interpretation	T: NO	U: YES	Y
Vector loops	V: NO	W: YES	Y

Option 3
Vector Loops

The vector software computes three orthogonal leads, i.e. leads perpendicular to each other, on the basis of the 12 simultaneous standard leads. This is possible because the 12 leads are acquired synchronically. Therefore, the electrodes do not have to be moved.

Option 5
Video Monitor VIDEO V-1

For the CARDIOVIT CS-6/12, you can in principle use any video monitor that corresponds to the technical requirements. In any case, the ECG unit has to be equipped with a video interface and video software.

The video monitor VIDEO V-1 can be used for patient monitoring for resting ECGs and exercise tests. If the EXEC analysis program for exercise ECGs is used, you definitely need a video monitor.

Setting up the monitor

The video monitor is connected to the mains supply and to the CARDIOVIT CS-6/12 (video interface on connector panel on righthand side of unit). Secure the connections by fixing the two screws on the plug.

Now switch on by means of the switch at the rear of the monitor.

Contrast and brightness are controlled by a knob on the back of the monitor.

Patient monitoring

On the lower part of the screen, three leads are shown. The actual heart rate can be seen in the upper left corner. The lead group represented are selected on the leadselector of the CARDIOVIT CS-6/12.

Stress testing

For stress testing, the monitor can again be used as patient monitor. On the lower part, three leads are monitored. In the upper part, in addition to the heart rate, the duration of the whole test and the actual stage as well as the actual load or grade and speed are indicated.

In addition, you can call up the trend plots of heart rate and load by pressing key **Z**. While the indications on the upper part remain the same, on the lower part two or three diagrams are shown according to whether you use a bicycle ergometer or a treadmill. The diagrams show the development of heart rate and load during the test.

By pressing **Z** again you can switch back to the ECG representation.

Technical data**Video interface on CARDIOVIT CS-6/12**

1 = GND	6 = NC
2 = GND	7 = (+) VIDEO
3 = NC	8 = (+) H-SYNC
4 = NC	9 = (-) V-SYNC
5 = NC	

Video monitor VIDEO V-1

Dimensions	254 x 294 x 322 mm	
Weight	5.85 kg	
Power supply requirements	200 - 260 V, 50/60 Hz	
Screen size:	12 " diagonal	
Screen colour	Amber	
Resolution	850 x 350 dots	
Input signals	horizontal sync.:	TTL (positive)
	vertical sync.:	TTL (negative)
	video:	TTL (positive)
Scanning frequency:	horizontal	18.43 kHz
	vertical	50 Hz

Option 6
RS-232 Computer Interface

The RS-232 serial interface can be used on the one hand for the transfer of ECG data to a computer and on the other hand for automatic blood pressure measurements during exercise tests.

Transfer of ECG data

The CARDIOVIT CS-6/12 can only process ECG data recorded by a CARDIOVIT unit. Therefore, the data transfer takes place either between two CARDIOVIT CS-6/12 (e.g. via a telephone modem) or between a computer (PC or main frame) and the CARDIOVIT CS-6/12.

The operation and setup of the RS-232 interface is controlled in the diskette mode (menu Z). Press key **Z** and then **RETURN** to call up the list of commands on the second page of Z.

FLOPPY DISK / RS-232 CONTROL

F = Format diskette
I = Input ECG from RS-232
O = Output ECG to RS-232
T = Transmit all ECGs to RS-232
B = Setting up RS-232
U = Test RS-232

'RETURN' → more

'FNCT' → monitor

(line for acknowledgements)

PAGE (0-1):1 n = 0

Setting up the transfer conditions

Before a transfer, the technical parameters of the two units have to be matched. This is done in Z mode by pressing key **B**. The following table appears:

SETTING UP RS-232

	Baud (R/C)	Parity (P)	Stop (S)
Channel 1:	2400	NO	1
Channel 2:	2400	NO	1
ECG channel (A):	1		
Setting channel (H):	1		

'RETURN' = end of input

There are two output/input channels available. For each of them, the following settings have to be made separately:

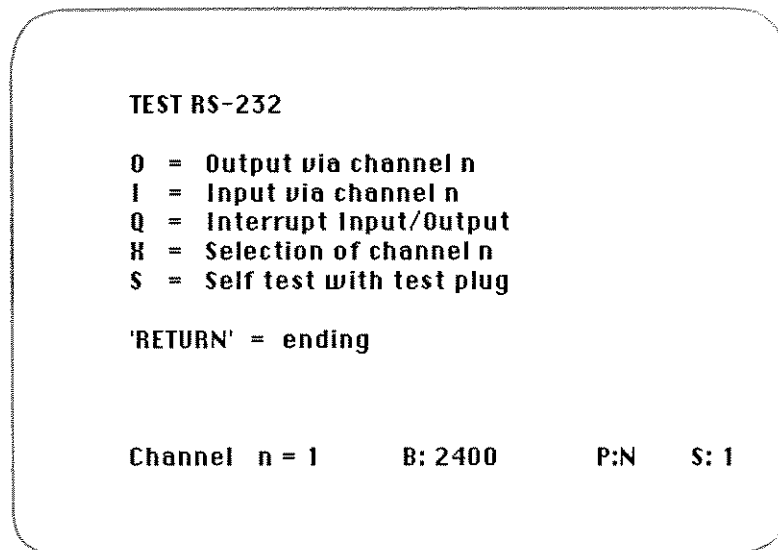
- The baud rate is selected with key **R** (increase) or **C** (decrease). The following values can be set: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 baud.
- The parity bit is set with key **P**. You can choose between: EVEN, ODD, or NO.
- The length of the stop bit is determined with key **S**.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

The channel for the output or input of data is selected with key **A**. For the setting of the two channels press key **X** to switch.

Pressing **RETURN** confirms the technical setting.

Test procedures for the RS-232

If you press key **U**, the RS-232 interface will be tested:



To test the RS-232, connect the CARDIOVIT CS-6/12 to an external unit.

With **O**, you can test the output of data via channel 1 or 2. (The bottom line of the LC screen indicates which channel is tested and its actual setting.) With **I**, the data input is tested. If a blood pressure measuring unit is connected, you can only test the input of data! If an error is detected, an acoustic signal is given.

The output or input test is interrupted by pressing key **Q**.

The channel to be tested is selected with key **X**. The number of the channel and its settings are listed on the bottom of the LC screen.

The selftest has to be executed with a special test plug and is, therefore, only done by authorized service personnel. If there are any problems, please contact our technical staff.

Input ECG from RS-232

By pressing key I, the input of an ECG is started. The external data are transferred to the memory, from where the ECG can be printed or stored on a diskette.

Input: " I " Acknowledgement: "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 letter O.

Input: " O " Acknowledgement: "ECG IS OUTPUT TO RS-232!"

Output all ECGs to RS-232

If the unit is equipped with a diskette memory, you can transfer all the ECGs on this diskette in one lot. Press letter T.

Input: " T " Acknowledgement: " ... 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 or not properly 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.
DATA SET NOT READY!	The ECG data cannot be fed out since the receiving unit is still not ready for operation after 30 seconds.

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:

Channel 1: (for blood pressure measurement)	2	TxD	O	(output data)
	3	RxT	I	(input data)
	4	RTS	O	(request for output)
	5	CTS	I	(ready for output)
	6	DSR	I	(transfer unit ready)
	20	DTR	O	(CS-6/12 ready)
	1			GND
	7			GND (signal)
Channel 2:	14	TxD2	O	
	16	RxD2	I	
	19	RTS2	O	
	13	CTS2	I	
	12	DSR2	I	
	24	DTR2	O	

Option 7
Diskette Memory

Each model of the CARDIOVIT CS-6/12 family can be equipped with a diskette drive and/or an RS-232C interface. Up to 30 ECGs (unprocessed data from 12 standard leads of 10 seconds duration and patient data) can be stored on one diskette.

These units are at the same time equipped with a RS-232 serial interface. The entire contents of a diskette can be transferred to a computer and a single ECG transmitted and received by means of this computer interface.

Handling the diskettes and the disk drive

- Inserting:** Insert diskette with metal part in front and label on top into diskette drive until it engages.
- Withdrawing:** Press ejector button on diskette drive: The diskette is released and can be removed by hand.
- Storing diskettes:** The diskettes are protected in optimum manner from dust and mechanical damage by the protective jacket. They should be stored at normal room temperature and humidity. It should be ensured that they are not stored near to magnets or loudspeakers. Place them preferably in an upright position.
- Write protection:** If a diskette is provided with write protection, it can neither be used for storage nor deleted. The diskette contents can therefore only be read. This write protection is activated or cancelled by a simple operation. A movable rectangle is placed at the bottom right on the back of the diskette. If this is moved down with the aid of a pointed object (e.g. a pencil) the contents are protected against writing and deletion. The protection is removed again by returning the rectangle to its initial position.

Calling up diskette program

The diskette program is initialized after pressing the letter **Z**. The following table appears on the screen:

```

FLOPPY DISK / RS-232 CONTROL

nS = Store ECG in file n
M  = Store ECG in any empty file
nR = Retrieve ECG from file n
nD = Delete ECG from file n
nP = Patient data from file n
nX = Select page n
L  = List contents of page
H  = Display commands

      'RETURN' = more
                        'FNCT' Monitor

(Line for acknowledgements)
PAGE (0-1): 0                n = 0

```

FLOPPY DISK / RS-232 CONTROL

F = Format new diskette
I = Input ECG from RS-232
O = Output ECG to RS-232
T = Transmit all ECGs to RS-232
B = Setting up RS-232
U = Test RS-232

'RETURN' = more

FNCT' Monitor

(Line for acknowledgements)

PAGE (0-1): =

n = 0

The ECG data are stored on the diskette in the form of data files. 10 files are contained in one page. On each page the files are numbered from 0 to 9. A data file is therefore clearly defined by the page number and file number.

The lowest line gives the number of the activated page (0, 1 or 2) and the number of the file processed (n = 0 - 9). In addition, the letter of the command keyed in is shown on the right by the file number.

In order to carry out the individual commands the correct page is selected and the corresponding combination of characters fed in. Each command is confirmed if it was executed properly. An error message appears if the command could not be executed. An acoustic signal sounds at the same time: a rising series of notes indicates a successful operation, a falling series indicates an error. The information 'SYSTEM IS BUSY - PLEASE WAIT' appears during execution of the command.

The **RETURN** key is used to switch to the other side of the command list. Changeover to monitor operation can be made with the **FNCT** key.

The red lamps on the lead selector indicate the status of the unit memory: If the first four lamps (standard leads) are lit, an ECG is present in the memory. If the last two lamps are on, the memory is empty.

<p>Caution: Each new diskette must be formatted before using for the first time.</p>

Format new diskette

Each new diskette must be formatted before use. This command can also be used to delete an entire diskette.

Caution: Any data possibly present on the diskette are deleted by formatting.

Input: 'F'	Precautional query: 'FORMAT NEW DISKETTE (Y/N)?'
Input: 'Y' = yes	Answer: 'FORMATTING - PLEASE WAIT'
	Acknowledgement: 'DISKETTE SUCCESSFULLY FORMATTED'
or 'N' = no	Process is interrupted

Select page n

This command is used to select the page (0, 1 or 2) to be processed, so that access to the data files on this page is possible.

Input: '1X'	Acknowledgement: The page number is set to 1 on the lowest line.
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List contents of page

When a specific page has been selected with the command 'Select page n', the list of ECGs contained on this page (date and time of recording, name of patient) is displayed with the command 'L'. The following commands can be executed more easily with the aid of this list.

Patient data from file n

This command is used to display the complete patient data of a stored ECG on the screen. No changes can be made however.

Input: '2P'	Acknowledgement: The patient data appear on the screen.
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Store ECG in file n

With this command an ECG from the unit memory is filed at a specific position on the page selected (e.g. file 9).

Input: '9S'	Acknowledgement: 'ECG IS STORED NOW'
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If there is already an ECG in this file, the following remark appears on the screen: 'FILE ALREADY USED'. The process is interrupted.

Store ECG in any empty file

If it is not known exactly where there is an empty data file, this command is used to file the ECG from the unit memory in the first empty memory location. It is not necessary to select the page previously.

Input: 'M' Acknowledgement: 'ECG IS STORED NOW'

The page and file number are shown on the lowest line.

Retrieve ECG from file n

Each ECG can be fetched from the diskette and read into the unit memory to be available for further print-out in any desired format.

Input: '1R' Acknowledgement: 'ECG IS READ NOW'

Copy ECG from one file to another

As a combination of operations mentioned above, it is possible to copy the ECG data from one file to another file (possibly on another diskette): The ECG is first read from the data file to the unit memory (nR). The data are then stored in any other desired data file (nS) after the diskette has been changed if necessary.

Delete ECG from file n

If an ECG is no longer required (e.g. because it has been copied in another data file), this ECG can be deleted.

Input: '3D' Acknowledgement: 'ECG IS DELETED NOW'

Make sure that the correct ECG is deleted from the correct page, since otherwise important data may be lost.

Call up operating assistance

The list of commands can be called up again on the screen at any time during the above procedures.

Input: 'H' Acknowledgement: The list of commands appears.

**Setup of CS-6/12
with ergometrics 900**

1. Settings on CS-6/12 for external control of ergometrics 900

- Press **V**
- Screen 'various machine settings' appears
select 'Stress test with (E): bicycle' by using key **E**
- Select 'Bloodpressure (P): EMB 502 by using key **P**
- Press **FNCT**
- Press **G**
- Press **RETURN** for saving this setting permanently.


2. Connection of CS-6/12 with ergometrics 900

Control of the blood pressure measurement device is made through the RS-232 serial link. Connect the supplied cable between CS-6/12 (RS 232) and ergometrics 900 (RS-232).

Control of the bicycle load is made through a two way analog control, with 1V = 100W. Connect the supplied cable between CS-6/12 (STRESS) and ergometrics 900 (analog output).

3. Set Ergometrics to external control

Press **Monitor**

Press  until 'Load INT/EXT'

Press **Monitor**

Screen A:

Load	INT-EHT	M
INT	(J)	
EHT	(J)	

appears.

Set cursor with arrows to EXT (J)

Press **RETURN**

Press **RETURN**

4. Adjust load input of ergometrics 900

Press **Monitor**

Press  until 'Adjustment load input'

Press **Monitor**

Screen B:

Adjustment load input
Zero load
load ext

Set Cursor to 'Zero load'.

Press

Monitor

Screen C: **Zero load ext**
Input 999 ...

Start Stresstest on CS-6/12 with 'B'.

During 1 minute, CS-6/12 is in pre-exercise mode and outputs 0 W.
Check on bottom line of LCD:

0 / 0W 0:00

Now press on ergometrics 900:

9 **9** **9**


Screen D: **Zero load ext.**
Input 999 999
load Zero = 000 W

Press

RETURN

You are again in screen B.

Adjustment load input
Zero load
load ext

Move cursor with  to 'load EXT'

Press

Monitor

Press

9 **9** **9**

Screen E: **Adj. load input**
Input 999 999
= 000 W ← →

Select on CS-6/12, by pressing 'N' several times, a load of 250 W.
Adjust ergometrics 900 by pressing the arrow keys until a value of 250 W appears on its display.

Press

RETURN

Press

RETURN

5. Adjustment of load output

Press

Monitor

Move Cursor with



until 'Adj. output'

Press

Monitor

Cursor is at position 'Load'.

Press

Monitor

Press

9

9

9

Screen F: **Adj. load output**
Input 999 999

300 W = ← →

Adjust output voltage until CS-6/12 shows feedback load of 300 W on bottom line of LCD:

250 / 300 W 1:35

Press

RETURN

Press

RETURN

Press

RETURN

6. Setup of the program

Press

Monitor

Cursor is at 'Program setup'

Press

Monitor

Press

1

to select program 1

Set all values to 0 0 0

Exception: *base load is limited to 20 W
max. load is set to 999*

Press

RETURN

Press

RETURN

You should now see:

Screen F: P = ext n = 000/min
HF = 000/min E = 00/min
S = 000 mmHg D = 000 mmHg
PRG1 BPM-OFF PR.INT

Press

PROGR

You should now see:

Screen G: PRG1 GEW = 080 HF < 000
S < 000 mmHg D < 000 mmHg
Po = 020 W Pmax = 999 W
INTERU. BPM = 00 min

Attention:

Make sure, the BP-measurement interval is set to 00 min

SCHILLER LATE POTENTIAL ANALYSIS PROGRAM FOR CARDIOVIT CS-6/12

1. INTRODUCTION

Late potentials are high frequency signals having an extremely low amplitude which may indicate the risk of sustained or reentrant ventricular tachycardia and thus the danger of cardiac insufficiency.

The SCHILLER Late Potential Analysis program has been specially developed to detect and analyse these signals based on the data from 12 simultaneous standard leads. The program is so designed that late potentials can be detected using either the Frank X, Y, Z lead configuration or the same standard lead configuration as for a normal resting ECG recording.

2. LATE POTENTIAL ANALYSIS

In order to reliably detect late potential signals, a series of cardiac cycles (a minimum of 100 is recommended) have to be recorded for the purposes of analysis and comparison. It is therefore important that the patient is aware that the process demands a certain amount of time and that during the recording he remains as still and calm as possible.

Once the electrodes are attached in their correct positions on the patient and the required lead configuration (ie standard or Frank) has been selected, the ECG traces are shown on the screen. Press key **M** and the following menu is displayed:

LATE POTENTIAL ANALYSIS		
High pass filter	(1):	25 Hz
Target noise level	(2):	-- μ V
AUTO	=	Start signal acquisition
E	=	End signal acquisition
Q	=	Quit late potential mode
FNCT → monitor		

Once in this menu, the cut-off frequency of the high pass filter can be selected by pressing key 1. This cut-off frequency can be set to 25, 40 or 80Hz.

The approximate noise level below which data acquisition should automatically end can also be set here by pressing key 2. This noise level can be set to any level between 0.2 μ V and 2.8 μ V in steps of 0.2 μ V. The setting normally selected would be between 0.6 and 1.0 μ V. If automatic interruption of data acquisition is not required, then - μ V (ie a setting of 0 μ V) should be selected here.

Once the desired settings have been made, signal acquisition can be started by pressing the **AUTO** key. During data acquisition, the number of cardiac cycles accepted for averaging (QRS acc) and those rejected (QRS rej) together with the actual noise level (Noise μ V) are continually updated and displayed at the bottom of the screen.

Signal acquisition is stopped automatically when the noise level falls below the set target or can be manually stopped at any time by pressing key **E**. If, after approximately 250 average cycles, the preset noise level is not achieved, press **E** to stop the process manually. As soon as data acquisition is stopped, the message "Signal acquired - processing" appears at the bottom of the display indicating that the automatic process of data analysis has begun. This process is concluded with a print-out of the precise analysis results.

As long as the data remains in the unit memory, it can be re-evaluated at different filter settings by selecting a new cut-off frequency and then pressing **START**. A new print-out of the results with the newly selected filter setting will now be printed out.

3. LATE POTENTIAL ANALYSIS REPORTS

The print-out at the end of the signal acquisition process comprises two A4 reports.

The first report provides the standard late potential results and shows the averaged QRS complex for each of the actual or derived XYZ leads with their high frequency content according to the selected high pass filter cut-off setting. The vector magnitude of the entire high frequency content of the signal is given to the right and is plotted on a larger scale for greater clarity. Vertical markers indicate the start and end of the high frequency activity associated with the QRS complex as well as the point where the signal drops below 40 μ V.

At the bottom of the report is the patient data, the measured parameters and the measurement results including the duration of the late potentials and the noise levels for each of the actual or derived XYZ leads. The measurement results given are as follows:

- **QRS duration** - the duration of QRS given in ms as determined from the high frequency portion of the signal
- **RMS (40ms)** - the root mean square value of the high frequency signal of the last 40ms of the ventricular activation
- **RMS (50ms)** - the root mean square value of the high frequency signal of the last 50ms of the ventricular activation
- **LAHFd (40 μ V)** - the duration of the high frequency, low amplitude portion at the end of the QRS cycle

These results should be evaluated in conjunction with the high frequency averaged QRS complex curves and not in isolation.

The second report provides the individual late potential results for each of the 12 leads. The averaged QRS complex together with the high frequency content is shown for each lead in a similar manner to that for the standard XYZ report. This report will be useful for the purposes of verifying whether or not the late potential duration is markedly longer in one of the leads than in the vector magnitude.

4. QUIT LATE POTENTIAL MODE

To exit the Late Potential Analysis program, press key **Q** and the display returns to the Monitor mode. Please note, however, that once **Q** has been pressed, the recorded late potential data is immediately erased from the unit memory and is therefore no longer available for further processing or print-outs.

5. DATA EVALUATION

As a guide, the following factors can be considered as indicating the presence of late potentials in a vector magnitude (ie length of ECG vector) signal with a bandwidth of 25Hz to 250Hz:

- The duration of the late potentials (LAHFd) is longer than 30ms
- The total ventricular activation time is greater than 110ms
- The mean (RMS) amplitude of the last 40ms of the QRS activity is less than 25 μ V.