DESIGNED AND MANUFACTURED IN SWITZERLAND

CARDIOVIT AT-102 plus

ECG Recorder and Spirometry Unit

User Guide

SCHILLER

The Art of Diagnostics

Art. no.: 2.510858 Rev. f

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CE 0123

The Cardiovit AT-102 plus bears the CE-0123 mark (Notified Body TÜV-SÜD Produkte Service GmbH, Ridlerstr. 65, 80339 Munich, Germany), indicating its compliance with the essential requirements of the Annex I of the Medical Device Directive 93/42/EEC regarding safety, functionality and labelling. The requirements apply to patients, users and third persons who come into contact with this device within the scope of its intended use.

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SCHILLER

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Contents

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

1 Safety Notes

1.1 Intended Use

- The CARDIOVIT AT-102 plus is a 12-channel or 16-channel ECG device used for the recording, analysis and evaluation of ECG Recordings. Recordings made with the unit can be used as a diagnostic aid for heart function and heart conditions. It is designed for indoor use and can be used for all patients of both sexes, all races, and all ages.
- The CARDIOVIT AT-102 plus is intended for use in hospitals, cardiology units, out-patient clinical units, and general physicians offices.
- The diagnostic applications for which the unit is intended are the diagnosis of cardiac abnormalities in the general population, detecting acute myocardial ischemia, and infarction in chest pain patients, etc.
- The unit includes a low sensitivity setting. Low sensitivity will suppress certain non-specific ECG diagnoses that can be used for screening low-risk patients. The high sensitivity setting is used for detecting cardiac abnormalities in general and high risk patients including those taking thrombosis medication.
- To prevent pacemaker malfunction, a distance of at least 20 cm must be observed between the antenna of the CARDIOVIT AT-102 plus and the pacemaker as soon as the GSM module is switched on.
- There is no danger when using the device for a patient with a pacemaker fitted.
- Do not use this unit in areas where there is any danger of explosion or in the presence of flammable gases such as anaesthetic agents.
- The device is CF classified. It is defibrillation protected only when the SCHILLER original patient cable is used. However, as a safety precaution, remove the electrodes before defibrillation, if possible.
- The device is not designed for sterile use nor is it designed for outdoor use.
- This product is not designed for internal use. The device is not designed for direct cardiac application.

Spirometry

- The spirometry program is designed to carry out pulmonary function tests on persons of all races and sex, from the age of 6 years. The objective of these tests is to diagnose a lung disease and find the extent of the abnormality by following a patient during the course of his/her disease to determine the efficiency of treatment or the need for supplemental oxygen and mechanical ventilation. It is also useful when determining if pre-operative patients can withstand any intended surgery, to assess disability and to decide whether an individual can perform an occupational task requiring a certain workload.
- Routine pulmonary function tests can be used to determine if a patient complaining of dyspnea (shortness of breath) or fatigue has a lung disease and, if so, whether it is an obstructive, restrictive or vascular disease or a disease of the ventilation control.
- The spirometry option can be used to measure Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), $FEV_{1.0}$ / FVC, $FEF_{0.2\text{-}1.2}$, $FEF_{25\text{-}75\%}$, $FEF_{75\text{-}85\%}$, PEF, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FIVC, $FIV_{1.0}$, $FIV_{1.0}$ / FIVC, PIF, $FIF_{50\%}$, SVC, ERV, IRV, TV, MVV, MV, RR, TV, in patients 6 years of age or older.

Art. no.: 2.510858 Rev. f

1.2 Organisational Measures

- ▲ Before using the unit, ensure that an introduction regarding the unit functions and the safety precautions has been provided by a medical product representative.
- ▲ Keep these operating instructions in an accessible place for reference when required. Make sure that they are always complete and legible.
- ▲ Observe the operating instructions and maintenance instructions.
- ▲ These operating instructions do not override any statutory or local regulations, or procedures for the prevention of accidents and environmental protection.

1.3 Responsibility of the User

- ▲ This device must only be used by qualified physicians or trained medical personnel.
- ▲ The numerical and graphical results and any interpretation given must be examined with respect to the overall clinical condition of the patient and the general recorded data quality.
- ▲ The indications given by this equipment are not a substitute for regular checking of vital functions.
- ▲ Specify the competencies of the personnel for operation and repair.
- ▲ Ensure that personnel have read and understood these operating instructions. In particular this section **safety notes** must be read and understood.
- ▲ Damaged or missing components must be replaced immediately.
- ▲ The operator is responsible for compliance with all applicable accident prevention regulations and safety regulations.
- ▲ The safety, reliability and performance of the device can only be guaranteed when the maintenance intervals, as stated in the Maintenance section of this user guide, are observed.

1.4 Safety Facilities

- ▲ Operating the device without the correctly rated fuse, or with defective cables, constitutes a danger to life. Therefore:
  - – Do not operate the unit if the earth connection is suspect or if the mains lead is damaged or suspected of being damaged.
  - – Damaged cable connections and connectors must be replaced immediately.
  - – The electrical safety devices, such as fuses, must not be altered.
  - – Ruptured fuses must only be replaced with the same type and rating as the original.

Art. no.: 2.510858 Rev. f

1.5 Safety-conscious Operation

- Make sure that the staff have read and understood the operating instructions - particularly this Safety Notes section.
- Do not touch the unit casing during defibrillation.
- To ensure patient safety, none of the electrodes including the neutral electrode, nor the patient or any person with simultaneous patient contact, must come in contact with conductive parts, even when these are earthed.
- Immediately report any changes that impair safety (including operating behaviour) to the person responsible.
- Only operate the device in accordance with the specified technical data.
- Do not place any liquids on the unit. If liquid should be spilled over the device, immediately disconnect the device from the mains and wipe it. The device must be serviced before reusing.
- Do not use the unit if the unit, or any cable assembly or accessory, is damaged.
- Position the device so that there is no possibility of it falling on the patient or floor.
- Only connect the original SCHILLER patient cable to the patient socket.
- If the patient cable should become defective after defibrillation, an electrode becomes displaced, or an electrode resistance is too high, a lead-off indication is displayed in the upper right part of the screen and an acoustic alarm given.
- Only use accessories and other parts recommended or supplied by SCHILLER AG. Use of other than recommended or supplied parts may result in injury, inaccurate information and/or damage to the unit.
- The device can transmit saved ECG recordings via GSM at 850/900/1800/1900 MHz. As soon as the GSM module is switched on, all persons must keep a distance of at least 20 cm from the sending antenna of the CARDIOVIT AT-102 plus.
- The transmission of ECG recordings from the CARDIOVIT AT-102 plus is not permitted in areas in which mobile phones are not allowed.
- Danger of strangulation. Take care, especially when using a cable arm, that the patient cable cannot interfere with the patient's breathing.

Art. no.: 2.510858 Rev. f

1.6 Operation with other Devices

- Ancillary equipment connected to any analogue and/or digital interface of the unit must be certified according to the respective IEC standards (e.g. IEC/EN 60950 for data processing equipment and IEC/EN 60601-1 for medical equipment). Furthermore all configurations shall comply with the valid version of the system standard IEC/EN 60601-1 clause 16. Everybody who connects additional equipment to the signal input part or signal output part configures a medical system, and is therefore responsible that the system complies with the requirements of the valid version of the system standard IEC/EN 60601-1 clause 16. If in doubt, consult the technical service department or your local representative.
- Do not use this unit in conjunction with an MRI scanner or in MRI areas where there is any danger of interference.
- Any other equipment used with the patient must use the same common earth as the CARDIOVIT AT-102 plus.
- Precautions must be observed when using high frequency devices. Use the special high frequency SCHILLER patient cable to avoid possible signal interference during ECG acquisition.
- There is no danger when using the ECG unit simultaneously with electrical stimulation equipment. However, the stimulation units should only be used at a sufficient distance from the electrodes. If in doubt, the patient should be disconnected from the device.
- If the device is part of a medical system, the original SCHILLER patient cable must only be used with, and connected to, the patient connector on the CARDIOVIT AT-102 plus.
- Portable communication devices, HF radios and devices labelled with the  symbol (non-ionic electromagnetic radiation) can affect the operation of this device (see **Electromagnetic Radiation,** page 133).

1.7 Networks and Internet

- When the unit is part of a network (LAN, WLAN, HIS, etc.), transmitting over a telephone network, any other transmission medium, or if exposed to the Internet or other insecure networks, appropriate security measures must be provided to protect the patient data stored.
- Patient security and security of the network is the sole responsibility of the user.

1.8 Maintenance

- Danger of electric shock. Do not open the device. No serviceable parts inside. Refer servicing to qualified technicians authorised by SCHILLER only.
- Before cleaning and to isolate the mains power supply, switch the unit off and disconnect it from the mains by removing the plug.
- Do not use high temperature sterilisation processes (such as autoclaving). Do not use E-beam or gamma radiation sterilisation.
- Do not use solvent or abrasive cleaners on either the unit or cable assemblies.
- Do not, under any circumstances, immerse the unit or cable assemblies in liquid.

Art. no.: 2.510858 Rev. f

1.9 Extra Precautions for Spirometry

- For correct predicted values and diagnosis, it is important that all patient data is entered correctly. In particular gender, date of birth, ethnicity, height and weight must be entered.
- The unit must be calibrated at the beginning of every day, or after a significant change in temperature.
- False measurements can result when the sensor is not held vertically - always ensure that the sensor is held upright at all times.
- If using the **SP-250 sensor** - The disposable mouthpiece of the SP-250 spiro sensor is designed for one-time use to eliminate the danger of cross contamination - do not use the mouthpiece for more than one patient. Do not attempt to clean the mouthpiece.
- If using the **SP-260 sensor** - The mouthpiece of the SP-260 spiro sensor is reusable. Thoroughly disinfect the mouthpiece assembly before using for another patient. Replace the filter after every patient - do not use the filter for more than one patient.

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to both Part 15 of the FCC (Federal Communications Commission) rules and the radio interference regulations of the Canadian Department of Communications. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Art. no.: 2.510858 Rev. f

1.10 Safety Symbols and Pictograms

1.10.1 Symbols Used in this Document

The safety level is classified according ANSI Z535.4. The following overview shows the safety symbols and pictograms used in this manual.

For a direct danger which could lead to severe personal injury or to death.

For a possibly dangerous situation, which could lead to serious bodily injury or to death.

For a possibly dangerous situation which could lead to personal injury. This symbol is also used to indicate possible damage to equipment.

Single patient use only - dispose after use, do not reuse.

For general safety notes as listed in this chapter.

Used for electrical dangers, warnings and other notes in regarding operation with electricity.

Note For possibly dangerous situations, which could lead to damage to property or system failure. **Important** or helpful user information.

Reference to other guidelines.

Art. no.: 2.510858 Rev. f

1.10.2 Symbols Used on the Device

Potential equalization

CF symbol. This unit is classified safe for internal and external use. However, it is only defibrillation protected when used with the original SCHILLER patient cable.

Symbol for the recognition of electrical and electronic equipment.

Equipment, components, battery and accessories no longer required must be disposed of in a municipally approved collection point or recycling centre. Alternatively, you can return the equipment to your supplier or SCHILLER AG for disposal. Improper disposal can harm the environment and human health.

The unit and battery can be recycled.

CE 0123

Notified body of the CE certification (TÜV P.S.).

Read and follow the instructions in the accompanying documentation.

The following applies to CARDIOVIT AT-102 plus units with the SCM module and wireless LAN.

Attention: Non-ionising electromagnetic environment. The device contains an HF transmitter.

The CARDIOVIT AT-102 plus radiates radio frequency transmitting electromagnetic energy and can disturb other devices if not installed and operated in accordance with the user guide. However, there is no guarantee that no interference can occur in certain installations. If the CARDIOVIT AT-102 plus causes interferences, these can be determined by switching the device off/on or by transmitting/not transmitting ECG data. The user can take the following measures to solve this problem:

- Increase the distance between the disturbed device and the CARDIOVIT AT-102 plus. A minimum distance of 20 cm must be kept between the device and a pacemaker.
- Turn the device to change the angle of radiation.
- Connect the device to a different mains connector.

The user is responsible for network security.

Art. no.: 2.510858 Rev. f

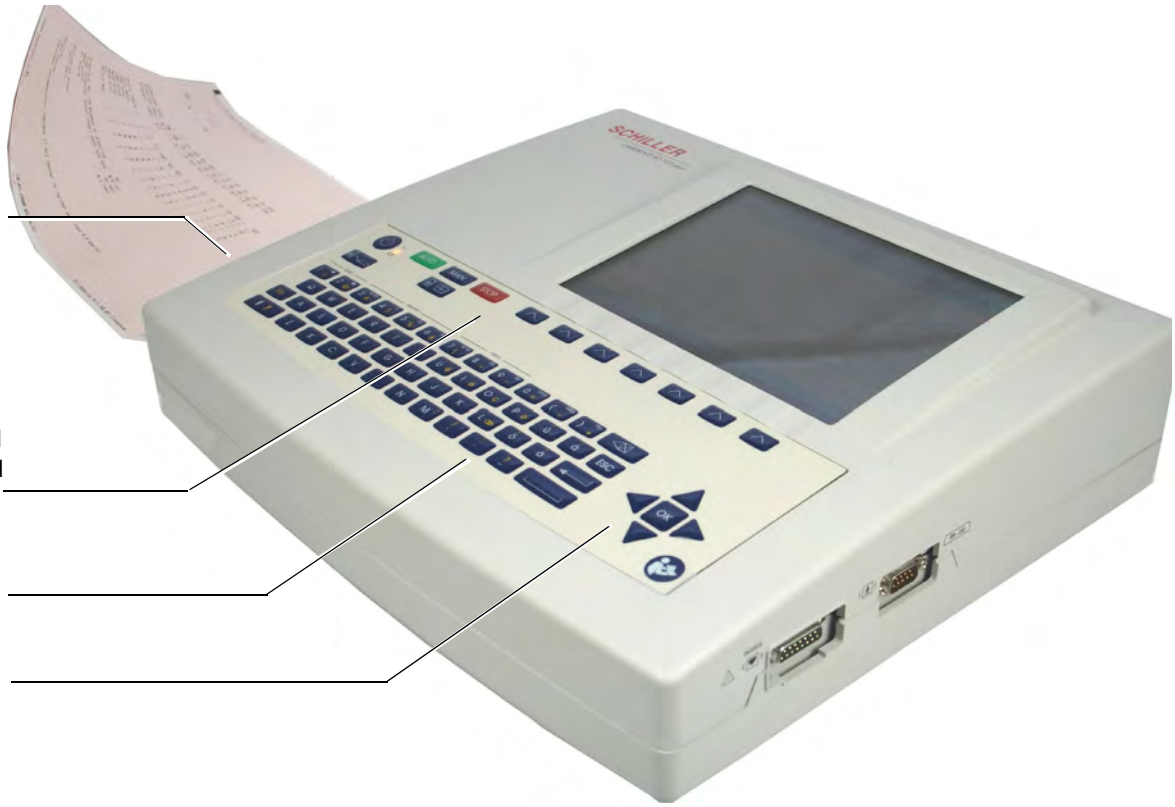
2 Introduction and Operation

The SCHILLER CARDIOVIT AT-102 plus is an ECG unit designed to record, display, and measure resting ECGs. With the addition of a pneumotach sensor, spirometry recordings can also be made. Recordings can be stored locally or when the unit is networked, transmitted to a server for editing and storage.

There are various hardware configurations of the unit affecting the options available. The hardware configuration is stated in the hardware index of the unit given in the software screen (see **Software,** page 108). The hardware configurations are as follows:

Hardware Index	12 lead recording	16 lead recording	GSM trans.	WLAN	LAN	External power supply	Internal power supply
A, B, C, D	✓	✘	(option)	(option)	✓	✓	✘
E	✘	✓	(option)	(option)	✓	✓	✘
F	✘	✓	✘	(option) up-graded mod-ule	✓	✘	✓

For all versions the user interface, operation, keyboard, and screen presentation are the same.



Art. no.: 2.510858 Rev. f

2.1 Features and Options

2.1.1 Standard

- Pacemaker Detection
- Manual (real time) ECG printout - (leads, speed and amplitude can be changed as required)
- Auto mode with user defined presentation formats
- Measurements
- Resting Rhythm recording
- SCHILLER Communication Module (SCM)

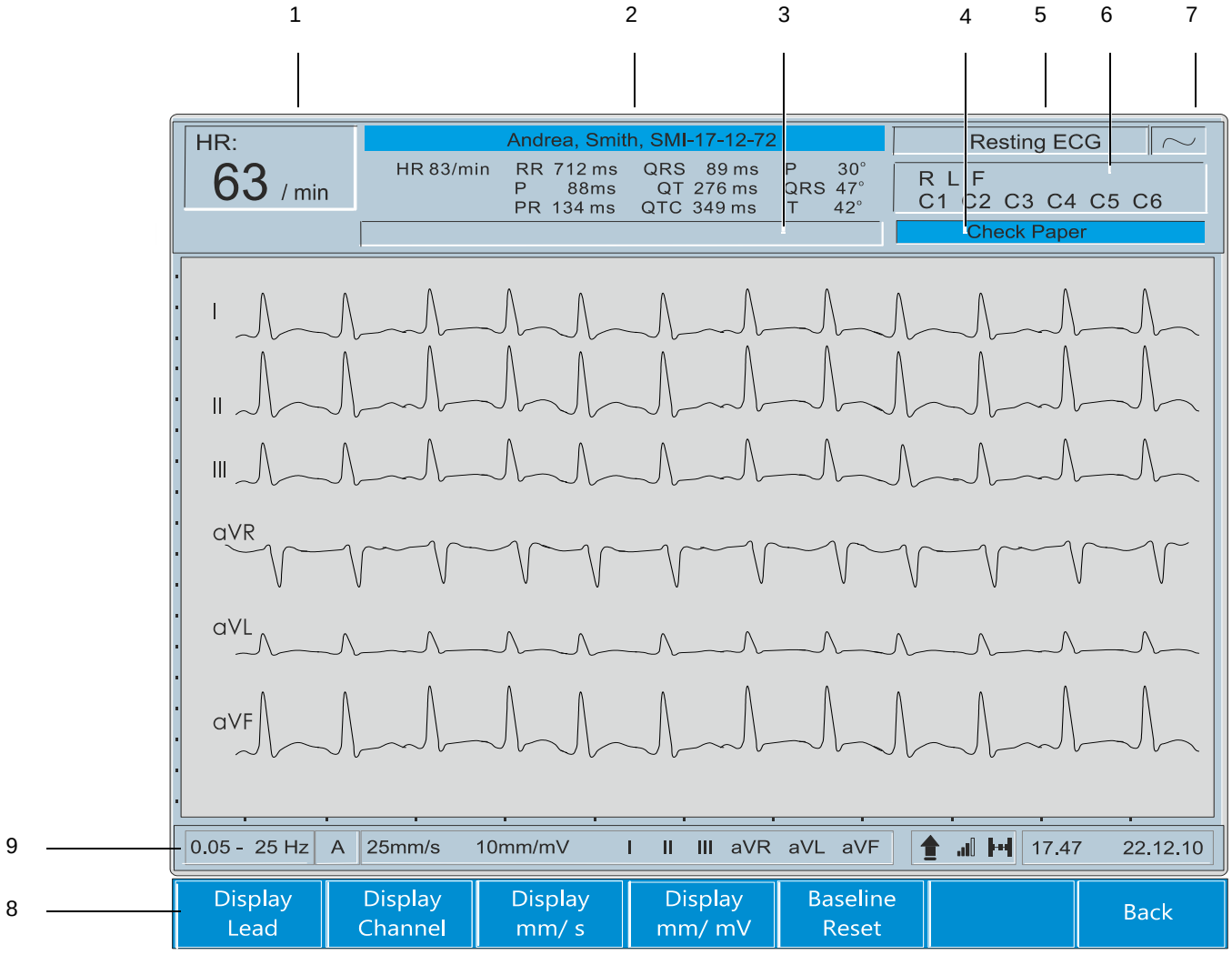
2.1.2 Options

- Interpretation
- Thrombolysis (with C version (interpretation) only)
- Pacemaker measurement
- Culprit Coronary Artery Algorithm - designed to localise an occlusion site in the coronary artery and determine the size of a cardiac area at risk. The program then provides clinical data to help shorten the time interval between the onset of chest pain and restoration of myocardial blood flow.
- Worklist - a worklist for a specific unit can be defined remotely by a hospital information system. The worklist can define specific patients, locations and type of recording to be taken by the unit. Completed recordings are sent back to the hospital information system either individually or collectively.
- Spirometry - the Spirometry software is available when a spiro sensor is attached to the unit.
- Barcode Reader - for reading a patient's ID and accessing the patient data from a database.
- SEMA and SEMA3. A Database for the storage, referencing, analysis and evaluation of ECG, spiro and rescue data. Other types of recording can also be referenced.

Art. no.: 2.510858 Rev. f

2.2 LCD Screen

The display will vary according to the current task being carried out. In all screens however, the top, middle and bottom areas always display the same information groups. The following is an example of a typical resting ECG screen.



The colour theme of the display can be changed in system settings (see **Table of Unit Settings,** page 106).

Art. no.: 2.510858 Rev. f

(1) Heart rate (HR)

Current heart rate averaged over the last 8 beats.

(2) Current patient

Patient name followed by the patient identification number - below is the recording intervals (if an auto mode recording has been taken).

(3) Message field

This area displays any status messages.

(4) Message field

This area displays technical and system error messages.

(5) Current mode of operation

The current mode as follows:

- Resting ECG
- Spirometry

(6) Electrode lead status

When an electrode indication flashes (an audible indication is also given), it indicates that the electrode resistance is too high. The electrode must be re-applied (see **Skin/ Electrode Resistance,** page 46).

(7) Current power source

The current power source as follows:

- Mains connected (~), or
- Internal battery power ( ).

When the unit is running on battery power, the symbol gives an indication of capacity; it flashes when capacity is limited.

When mains is connected and the battery is charging, the battery symbol is displayed ‘filling’.

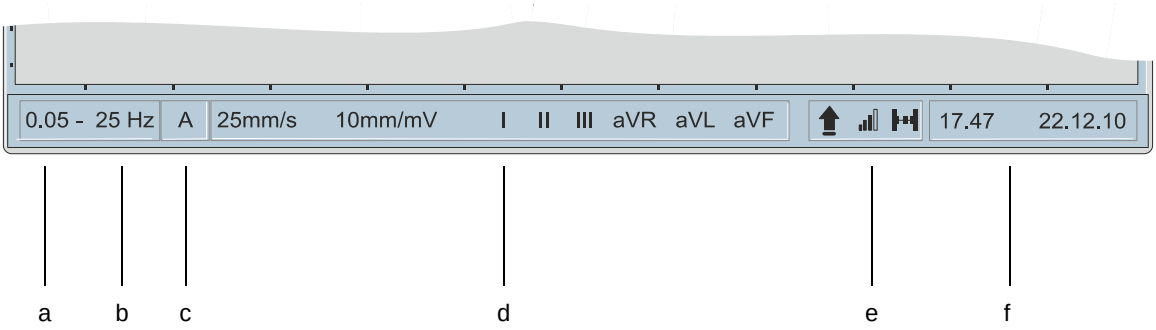
Details of the power source status is given in the Power Supply section (see **Power Supply,** page 29).

(8) Soft key indications

These will change according to the currently displayed screen options(see **Soft-key Menu Overview,** page 21)

Art. no.: 2.510858 Rev. f

(9) Information line as follows:



(a) Baseline cut-off frequency, set to 0.05, 0.15, 0.30, or 0.60 Hz (see **Table of ECG Options and Settings,** page 69)

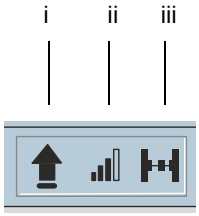
(b) Myogram filter - cut-off frequency for the Myogram filter, set to 25 Hz, 35 Hz or 150 Hz (off) (see **Myogram Filter,** page 63).

(c) Auto sensitivity reduction - Auto sensitivity reduction is used to help reduce overlapping traces. When auto sensitivity is on an A is displayed in the box (see **Table of ECG Options and Settings,** page 69).

(d) Manual Print settings. Current manual printout settings (see **Consider thrombolytic therapy,** page 60):

- speed in mm/s
- sensitivity in mm/mV
- selected leads

(e) System symbols as follows:



(i) This symbol indicates that the caps lock is on (Fn +). Note that caps lock on can be set as default if required (see **System Settings,** page 105)

(ii) This indicates that the wireless network is connected and the strength of the signal.

Poor Signal | Better Signal | Full Strength Signal

(iii) This symbol indicates the SCHILLER communication module status (SCM), and if a (wired) network is connected as follows:

SCM Detected | Network Connected

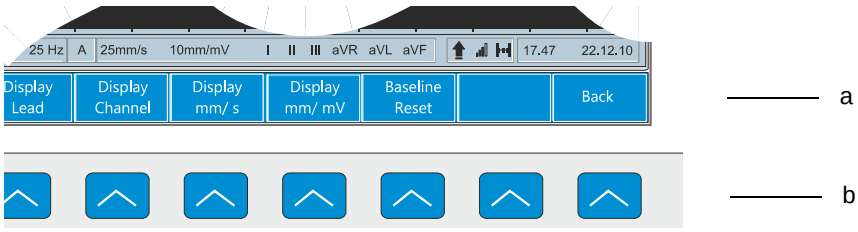
In addition the symbol indicates if the unit is transmitting or receiving as follows:

- Symbol Black - Idle
- Symbol Yellow - Transmitting
- Symbol Green - Receiving

(f) System time and date - Current unit time and date

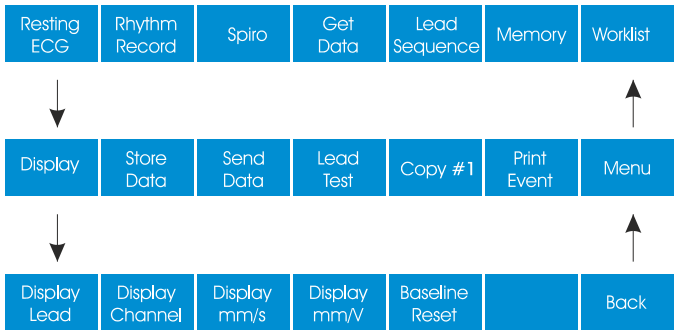
Art. no.: 2.510858 Rev. f

2.3 Soft-key Menu Overview



The soft-key menu options **(a)** change according to the screen displayed. The menu options are selected with the keys below the options **(b)**.

2.3.1 ECG Soft-key Menu Options



Main Menu

- **Resting ECG** - enter the ECG screen (see **Resting ECG,** page 49).
- **Resting Rhythm ECG** - enter the ECG screen (see **,** page 74).
- **Spiro** - enter the spiro screen (only displayed when a spiro sensor is attached to the unit (see **Unit Maintenance,** page 119).
- **Lead Test** - displays the electrode screen (see **Skin/Electrode Resistance,** page 46).
- **Get Data** key - initiates data reception from another location (usually patient data (PDQ) from a patient database) when in the patient screen - the location where the data is received is defined in the system settings.
- **Memory** key - gives access to the stored recordings (see **,** page 74).
- **Worklist** key - gives access to the worklist option (see **Worklist (Option),** page 100).

Art. no.: 2.510858 Rev. f

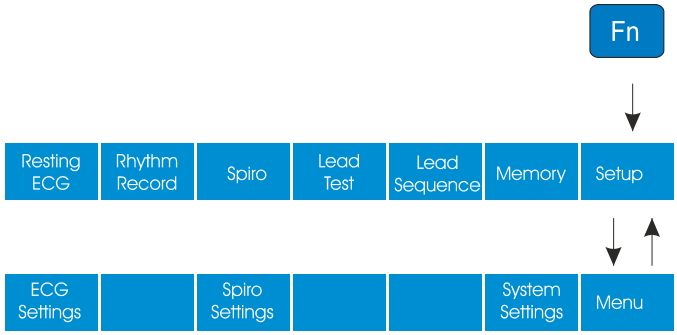
ECG Menu

- **Display** - this changes the screen settings as follows:
  - Display Lead - Standard / Cabrera lead sequence, User Defined or Paediatric lead sequence.
  - Display Channel - 3, 6, 8, 12 leads, 8 leads split in two columns (sequential), 12 leads split in two columns (parallel), with two rhythm leads, 12 leads split in 3 columns simultaneous display.
  - Display mm/mV - 5, 10, or 20 mm/V.
  - Display mm/s - 10 or 20 mm/s.

- **Store Data** key - initiates data storage to internal memory of the current recording - the location where the recording is stored is defined in the system settings.
- **Send Data** key - initiates transmission over the defined interface of the current recording - the location where the recording is sent is defined in system settings.
- **Lead Test** - displays the electrode screen (see **Skin/Electrode Resistance,** page 46).
- **Copy 1** key - print a copy of current recording in format 1. To obtain a printout in **format 2,** press the function key (Fn) followed by the copy key.
- **Print Event** key - prints a rhythm strip of the previous 10 seconds of all 12 leads.

2.3.2 Settings

To enter the settings menus, press the function key (Fn). The end soft-key changes to setup and the settings menu options can be selected.

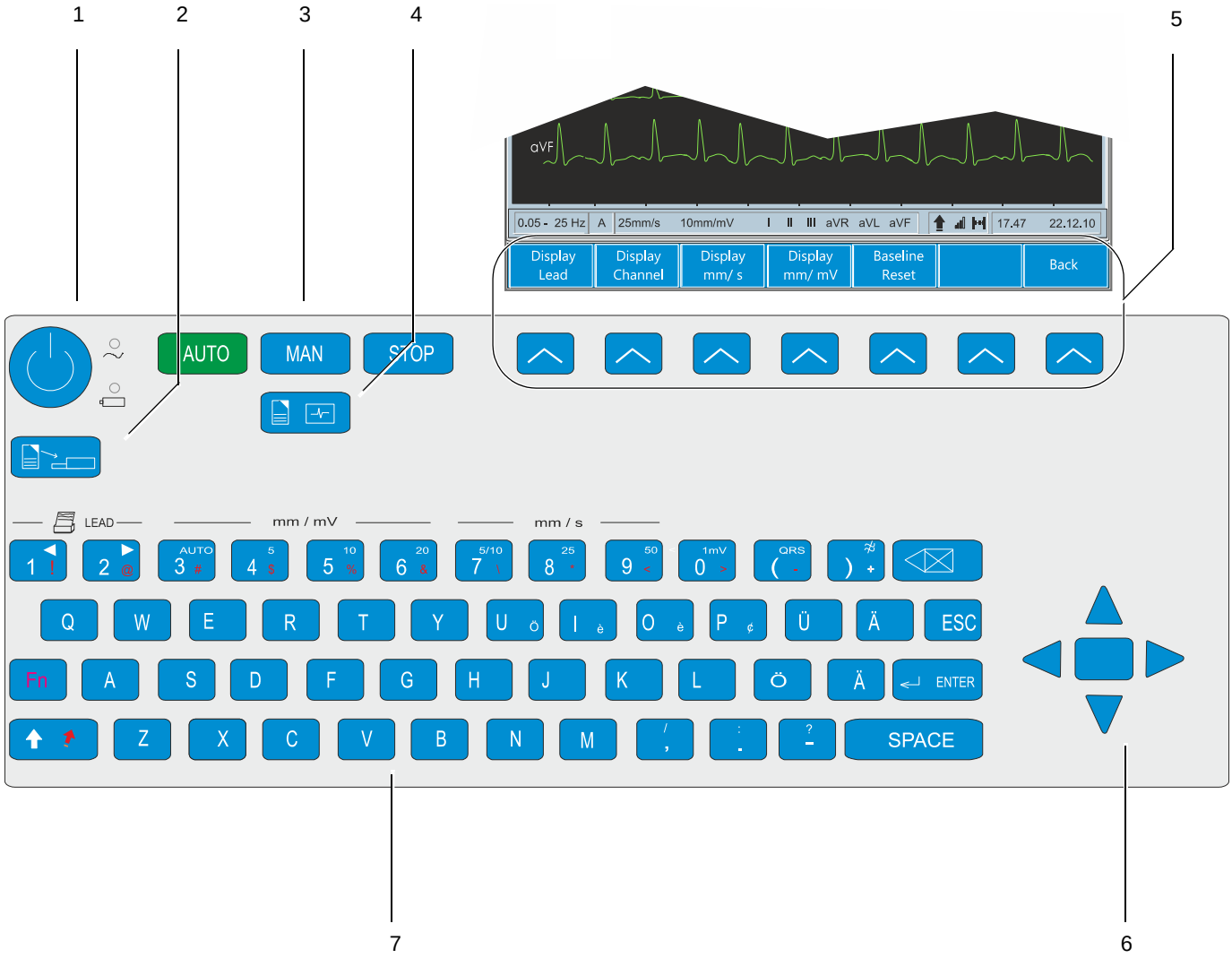


- Details of the **ECG menu options and settings** are given later in this user guide (see **Resting ECG,** page 49).
- Details of the **spiro options and settings** (see **Unit Maintenance,** page 119).
- Details of the **system settings** including time and date settings, network setup, and saving defaults (see **System Settings,** page 105).

Art. no.: 2.510858 Rev. f

2.4 Keypad

The keypad is divided into the following functional areas:



(1) On/Off key and power indicators

Press the on /off key to switch the unit on or off (see **Switching On and Off,** page 28
The power indicator LEDS indicate the power source (see **Power Supply,** page 29).

(2) Replace paper key

Extend or retract the paper tray for paper replacement.

(3) Direct function keys

- **Man Start** key - real time printout
- **Auto Start** key - take auto recording
- **Stop** key - stop printout / advance paper to beginning of new page

(4) Patient data key

Input of patient data (see **Patient Data,** page 32).

Art. no.: 2.510858 Rev. f

(5) soft-key menu options

The menu options will change according to the screen displayed (see **Soft-key Menu Overview,** page 21).

(6) Menu selection and navigation keys including

- **the centre key is the Confirm** key - confirm current / displayed setting
- **Left arrow** key - move cursor to the left / select next menu option
- **Right arrow** key - move cursor to the right / select previous menu option
- **Up arrow** key - move cursor or menu bar up
- **Down arrow** key - move cursor or menu bar down

(7) Alphanumeric and dual purpose keys

The numerical and some character keys are dual purpose as follows (manual **printout** only):

- The following keys change the speed, amplitude and lead group during manual printing:
  - Key **1** and **2** changes to next / previous lead group (on printout).
  - Key **3** sets auto sensitivity. Use this setting to help reduce overlapping traces. When auto sensitivity is on an A is displayed in the information box (see **Table of ECG Options and Settings,** page 69 and previous section).
  - Key **4** to **6** printout amplitude (sensitivity - 5 / 10 / 20 mm/mV)
  - Keys **7** to **9** printout speed (10 / 25 / 50 mm/s)

- Key **0** - reset ECG signal to baseline and insert calibration signal on the screen or on the printout.
- Key **(** - switch QRS beep on / off
- Key **)** - switch myogram filter on or off
- **ESC** key (escape) - exit from the currently displayed settings screen.

Art. no.: 2.510858 Rev. f

2.5 External Connections

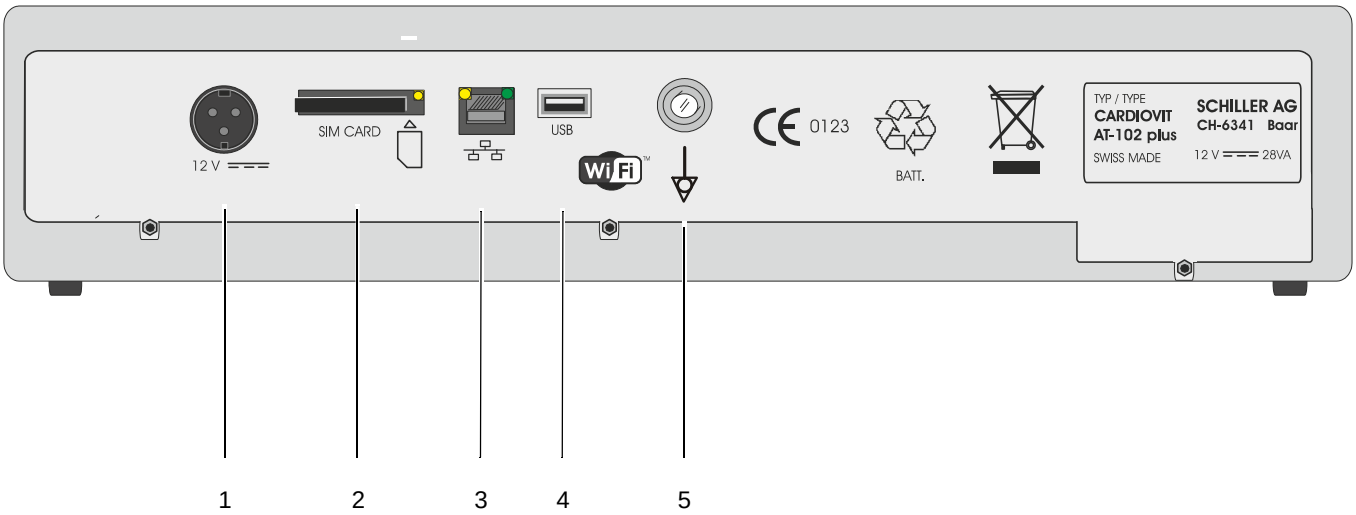
⚠ CAUTION

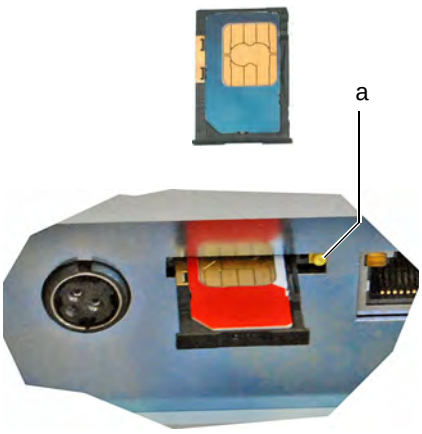
▲ All externally connected hardware must be approved by SCHILLER. Connection of any hardware not approved by SCHILLER is at the owner‘s risk. The unit guarantee may also be invalid.

2.5.1 Back Panel

Two back panel configurations are available for the CARDIOVIT AT-102 plus as follows:

Hardware Index A to E





(1) DC power supply in 12 V, (30 A max)

(2) SIM card (GSM option). To install a SIM card:
- Press the ejection button (**a**) with a pencil tip or similar instrument
- Pull out the card holder
- Place the SIM card into the card holder with the connector side upwards and the chamfered corner to the left
- Carefully push the card holder into the card bed until it clicks into place.

(3) RJ-45 Ethernet LAN connector (Local Area Network).

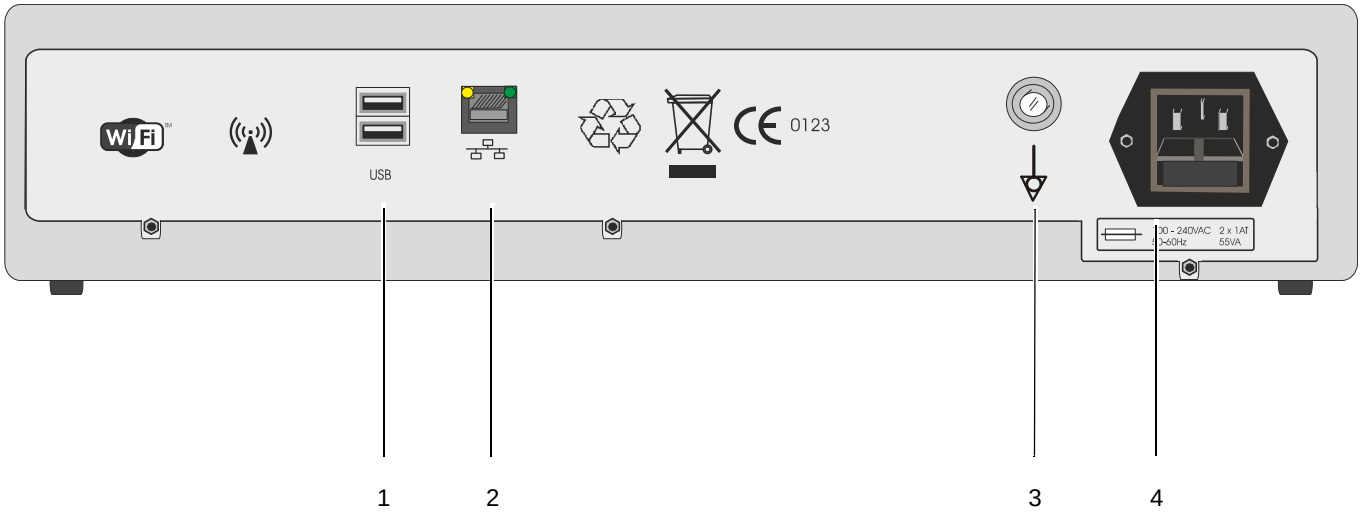
(4) USB connector (USB2) for a barcode reader.

(5) Potential equalisation stud. The potential equalisation stud is used to equalise the ground potential of the unit to that of any nearby mains powered equipment. Use the hospital or building common ground for all mains powered units.

Wi Fi A unit with the WiFi option installed is indicated by the Wi Fi alliance label.

Art. no.: 2.510858 Rev. f

Hardware Index F



(1) USB connector (USB2) for a barcode reader, storage device, etc.
(2) RJ-45 Ethernet LAN connector
(3) Potential equalisation stud.
(4) Mains connector and fuse assembly.

A unit with the WiFi option installed is indicated by the Wi Fi alliance label and the non-ionic electromagnetic radiation symbol

Fuse type

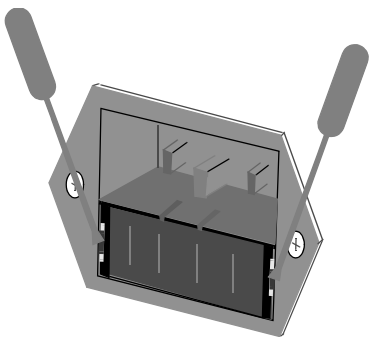
Number	Fuse type
2	T1AL250V (T = slow blow)

Changing a Fuse

DANGER

▲ Before a fuse is changed, the device must be disconnected from the mains supply by removing the mains plug from the wall socket.

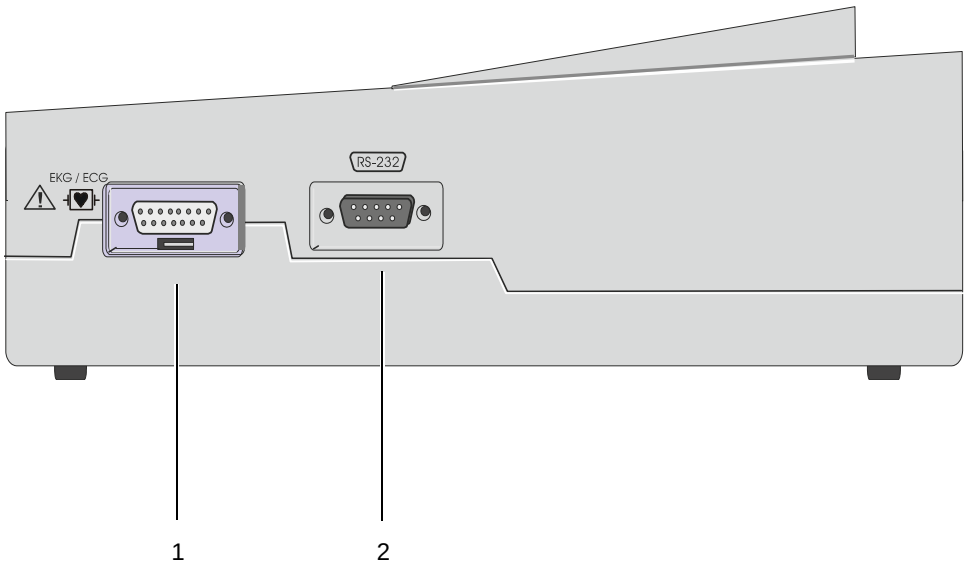
▲ The fuse may only be replaced by the fuse type detailed above.



1. Disconnect the device from the mains and remove the mains plug.
2. Using a small screwdriver gently push the two securing lugs by the side of the fuse inset, and remove the fuse inset.
3. Replace existing fuses with the same type. See table above.
4. Re-insert the fuse inset until it clicks in place.

Art. no.: 2.510858 Rev. f

2.5.2 Side Panel



(1) EKG/ECG patient cable input socket.

▲ Applied part! The patient cable as well as the connector comply with the safety standard CF. That is, fully floating and isolated, defibrillation protected and suitable for intra-cardiac application.

▲ The unit is CF rated and defibrillation protected only when used with the original SCHILER patient cable.

▲ Always secure the connector to the unit by the two screws. Do not remove the connector when electrodes are placed on the patient.

(2) RS-232 connector: used for connecting a pneumotach sensor (SP-250/SP-260) for pulmonary function testing.

Art. no.: 2.510858 Rev. f

2.6 Start-up and Initial Preparation

2.6.1 Location

- Do not keep or operate the unit in a wet, moist, or dusty environment. Avoid exposure to direct sunlight or heat from other sources.
- Do not allow the unit to come into contact with acidic vapours or liquids.
- Do not place the CARDIOVIT AT-102 plus in the vicinity of X-ray or diathermy units, large transformers or electric motors. It must also be positioned at least one metre from the mains supply.

2.6.2 Connection of External Cable Assemblies and Ancillary Equipment

1. Connect power to the unit:
   – **Units with an external power supply:** connect the DC power cable from the external power supply to the rear of the unit. Connect the external power supply to the mains.
   – **Units with an internal power supply:** connect mains power to the rear of the unit.

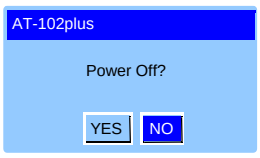
2. The mains indicator LED on the CARDIOVIT AT-102 plus is lit. Leave the CARDIOVIT AT-102 plus connected to the mains for 8 hours overnight to fully charge the battery (see **Power Supply,** page 29).
3. Connect the patient cable (side panel).
4. Connect any ancillary and optional equipment (see **External Connections,** page 25). These may include the following:
   – Spiro sensor (for spirometry)
   – Network cable
   – Insert the SIM card (option - see **External Connections,** page 25).

2.6.3 Potential Equalisation

The potential equalisation stud at the rear of the unit is used to equalise the ground potential of the CARDIOVIT AT-102 plus to that of all mains powered equipment in the vicinity. Use the hospital or building common ground. A yellow/green ground cable is supplied as an option (Article number 2.310005).

2.7 Switching On and Off

The unit is switched on and off with the **On / Off** key. When switching off you are asked to confirm:



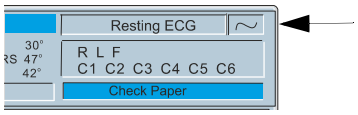
2.8 System and ECG Settings

- The System Settings (time, date, user ID, etc.), network, and other general settings are found in the System Settings section (see **System Settings,** page 105).
- Resting ECG settings (auto format, user defined leads, print options, lead test, QRS beep, interpretation, rhythm lead definition, etc.), are found in the Resting ECG Section (see **ECG Settings,** page 69).

Art. no.: 2.510858 Rev. f

2.9 Power Supply

2.9.1 Mains and Battery LED Indicators



The unit can be operated either from the mains supply (via an external dc power supply for the 12-lead version) or from the built-in rechargeable battery. The power source is indicated on the top line of the LCD and a mains and battery indicator on the unit.

The current power source on the LCD is displayed in the top right corner of the screen when the unit is switched on as follows:

- Mains connected (~) or
- Internal battery power ( ).

Full
Half full
Empty

Battery Capacity

The internal battery provides power for up to four hours. When the unit is running on battery power (mains not connected) the battery symbol indicates the battery status. When the battery is full, the symbol is solid.

When running on battery power and the battery capacity is limited, the battery symbol flashes and an audible indication is given.

Battery Charging

The battery is charged when the unit is connected to the mains supply. The unit can remain connected to the mains supply without damage to either the battery or the unit.

When the battery is not fully charged and the mains supply is connected, the battery symbol 'fills' indicating that the battery is charging.

When fully charged, the mains symbol is shown.

LED Indicators

The LED indicators on the unit casing to the left of the keypad indicate the power operation as follows:

Function	Battery LED	Mains LED
External Power Supply Connected:		
Battery Charging	On	On
Battery Full	Off	On
Battery Working (external power supply not connected):		
Battery Capacity OK	On	Off
Battery Capacity Limited (reconnect mains)	Blinking	Off

2.9.2 Isolating the Mains Supply

To isolate the power supply to the unit and the mains supply to the external dc power supply, remove the mains plug from the wall socket.

Art. no.: 2.510858 Rev. f

2.10 Changing the Printing Paper

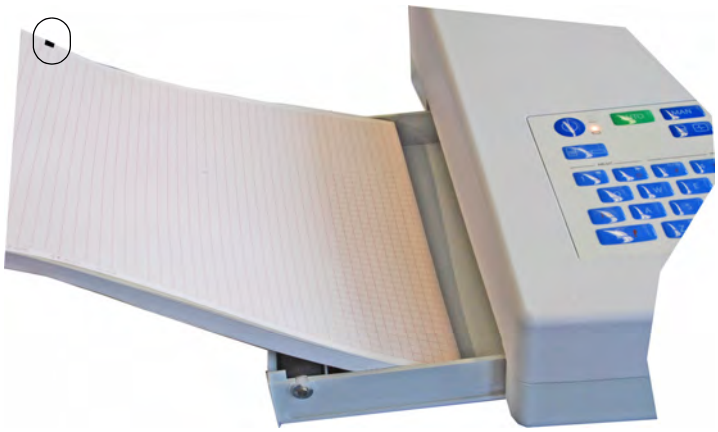
The device is delivered without printing paper installed. The thermo-paper is sensitive to heat, humidity and chemical vapours. The following points apply to both storage, and when archiving the results.

- Before use, keep the paper in its original cardboard cover. Do not remove the cardboard cover until the paper is to be used.
- Store in a cool, dark and dry area.
- Do not store near chemicals e.g. sterilisation liquids.
- In particular do not store in a plastic cover.
- Certain glues can react with the paper - do not attach the printout onto a mounting sheet with glue.

SCHILLER can only guarantee perfect printouts when SCHILLER original chart paper or chart paper of the same quality is used.

▲ Take care not to trap fingers when returning the paper drawer.

1. Press the **Replace Paper** key to open the paper tray (remove any remaining paper from the paper tray if replacing paper.
2. Place a new paper pack into the paper tray with the printed (grid) side facing upwards and the black paper mark to the top of the unit.

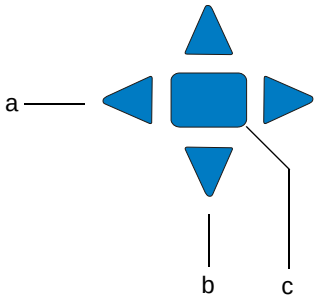


3. Press the **Replace Paper** key to return the paper tray in position.
4. Press the **Stop** key to transport the paper to the start position

Art. no.: 2.510858 Rev. f

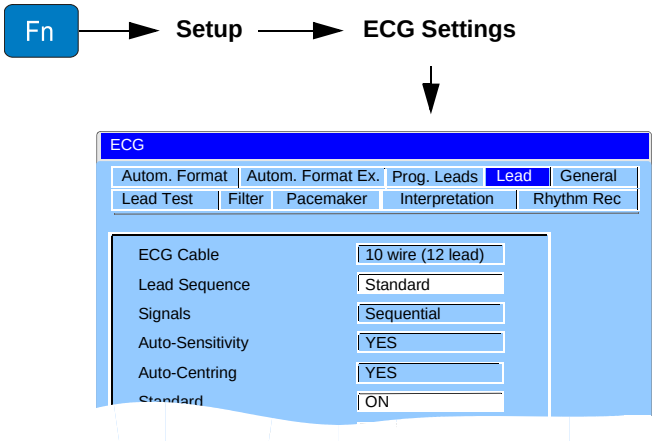
2.11 Selecting Menu Options using the Arrow Keys

When any of the setting options are selected, menu tabs are displayed and menu options shown (as given in the example below when the ECG settings screen is displayed).



The general principal of navigating and option selection is the same for all menu keys as follows:

1. Press the **left /right** keys **(a)** to select (highlight) the tab on the top of the screen. In the example below the **Lead** tab has been selected.
2. Use the **up/down** keys **(b)** to select the field/icon - the entry fields are highlighted when selected (as shown in the example below when the **Lead** option is selected).



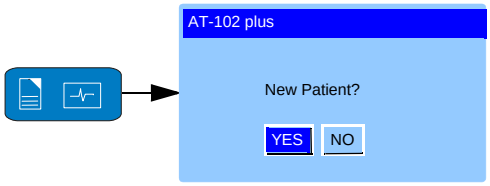
3. Press **Confirm (c)** to select and display the options available in the highlighted selection.
4. Use **up/down** keys to toggle through the options available.
5. Press **Confirm** to set.
6. When all entries have been made, press the **Esc** key to exit and register the entered data.

If you wish to keep the settings when the unit is switched off, the **save as default** setting must be made in system settings (see **System Settings,** page 105).

Art. no.: 2.510858 Rev. f

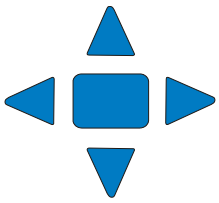
2.12 Patient Data

In the patient data screen, new patients can be entered and previously stored patient data can be edited. Press the **Patient data** key to display the patient screen.

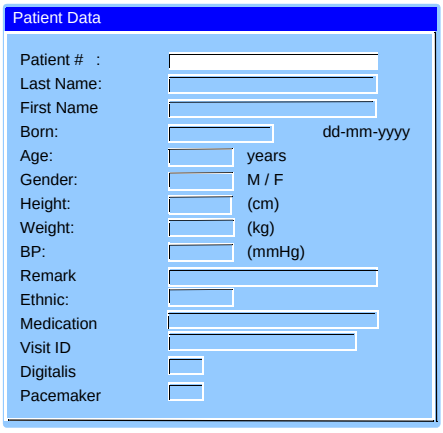


You can edit the current patient (select no), or enter the details of a new patient (select yes).

This screen is only shown when a patient has been entered already. When no patient has been entered previously, the patient screen is displayed directly.



Use the arrow to select an option. Press the middle key **(Confirm)** to display the patient data field:



Patient ID Enter the patient's Identification No.

Patient Name Enter the patient's name (maximum 20 characters).

First Name Enter the patient's first name (maximum 20 characters).

Born Enter the patient's date of birth dd-mm-yyyy.

Age Patient's age calculated from the entered date of birth.

Gender Enter the patient's sex - M or F.

Art. no.: 2.510858 Rev. f

Height Enter patient's height 20 to 250 cm (10 to 80 inches).

Weight Enter patient's weight 0.5 to 250 kg (5 to 500 lbs).

BP Enter the patient's systolic (or diastolic) blood pressure.

Remark Area for entry of any remarks about the patient.

Ethnic The setting made here is used by the Spiro option when calculating norm values. The settings depend on the system language (set in system settings (see **System Settings,** page 105).

- When any language apart from American is set enter:
  - W (White)
  - B (black).
- When American is set, enter:
  - C (Caucasian)
  - H (Hispanic)
  - B (Black)
  - A (Asian)

Details of these settings are provided in the Spirometry section (see **Unit Maintenance,** page 119).

Medication Up to 23 characters can entered for medication notes.

Visit ID An additional field for the Visit ID or, for example, patient ref. data, case no. hospital no., etc. A maximum of 20 characters can be entered.

Digitalis Select Yes or No.

Pacemaker Select On or Off if the patient has a pacemaker. When On is selected and a PM pulse is detected a vertical line is shown on the ECG trace. Note that this pulse is relative to time but is not representative of either pulse amplitude, polarity or duration.

A pacemaker measurement option is also available (see **Display Lead Group, Amplitude and Speed,** page 62).

- Extra/different field combinations can be displayed in the patient data screen. These can be defined by the user and are selected in system settings > **Menu key > Config > Patient Data Input** (see **System Settings,** page 105).

2.12.1 Taking a Resting ECG Directly from the Patient Screen

AUTO

A resting ECG can be taken directly from the patient screen by pressing the **Auto Start** key (see **Automatic Mode Recording,** page 51).

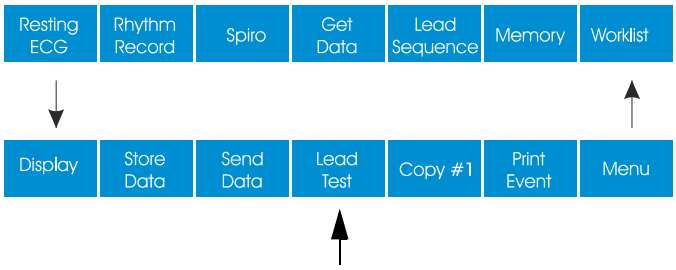
Art. no.: 2.510858 Rev. f

2.12.2 Patient Data Query (PDQ)

When the unit is connected to SEMA or a hospital patient database (via a network or modem), patient data can be filled in when the **Patient ID** or **Patient Ref. No.** is entered. This is called **Patient Data Query** or **PDQ**.

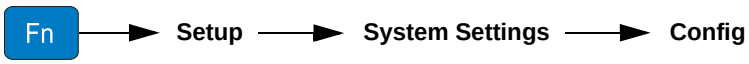
There are two modes as follows:

- **Manual** - The patient data is filled when the **Get Data key** is pressed after the Pat ID/Pat Ref. No. has been entered by the user, or read from a barcode reader (see following).



- **Automatic** - The patient data is filled in automatically after the Pat ID/Pat Ref. No. has been entered by the user or read from a barcode reader (see following).

The PDQ setting options are defined in the **System Settings > Config Tab**.



- **Patient Query** - select between:
  - Ref. No
  - Patient ID
- **Database access** - select between:
  - Off - PDQ disabled
  - **Manual** - database accessed and patient data entered when the **Get Data** Key is pressed.
  - **Automatic** - database accessed and patient data entered as soon as the pat ID or Ref. No, has been entered.

These settings along with other transmission settings are detailed in system settings (see **System Settings,** page 105).

PDQ with Barcode Reader

If a barcode reader is attached (see next page), scan the barcode to enter the Patient ID / Ref. no. The patient data fields are filled similar to described above - if Manual is defined in system settings press the get data key to enter all patient data. If Automatic is set, the patient data is entered automatically when the barcode reader is clicked.

Art. no.: 2.510858 Rev. f

2.12.3 Barcode Reader

A barcode reader can be attached to the USB 2 port on the back panel to facilitate reading of the patient ID / Ref. No. Only one barcode reader has been tested by SCHILLER as follows:

➜ Symbol Model LS 2208, from Symbol Tech N.Y.

When the barcode reader is attached, the patient data is read from the barcode (generated by the hospital system), and all patient data is entered in the patient data fields of the CARDIOVIT AT-102 plus as described on the previous page (PDQ).

A Worklist can also be downloaded from a hospital patient database giving patient data and specifying the type of recording to be carried out. The Worklist is accessed from the memory and is detailed later in this user guide (see **Worklist (Option),** page 100).

Art. no.: 2.510858 Rev. f

3 Electrode Placement

3.1 Cables

- The cable type (10-wire or 14-wire) is defined in system settings (see **Patient Cable, Lead Sequence and Display,** page 47).

10-wire and 14-wire ECG standard cables are available as banana or clip connections as follows:

	Patient Cable	SCHILLER Article Number
14-wire Cable	CODE 2 AHA (banana plug) 3.5 m	2.400141
	CODE 2 AHA (clip type) 3.5 m	2.400139
	CODE 1 IEC (banana plug) 3.5 m	2.400142
	CODE 1 IEC (clip type) 3.5 m	2.400140
10-wire Cable	CODE 2 AHA (banana plug) 2 m	2.400071
	CODE 2 AHA (clip type) 3.5 m	2.400104
	CODE 1 IEC (banana plug) 2 m	2.400070
	CODE 1 IEC (clip type) 3.5 m	2.400095

3.2 Basics

Careful application of the electrodes is important for a good ECG recording. For successful exercise recording, good electrode contact is essential. A minimal resistance between skin and electrode is required to obtain the best ECG signal and ensure the highest quality ECG recording. Therefore please note the following points:

1. Only use electrodes recommended by SCHILLER.
2. Check the expiry date on the electrode packaging. Ensure that the electrodes are within date.
3. To ensure the conductivity and adherence of the electrode:
   - If necessary, shave the application areas.
   - Thoroughly clean the area with alcohol or soap and water before applying the electrodes.
   - Thoroughly dry the electrode area before applying the electrodes.
   - When applying the electrodes, ensure that a layer of gel is between the electrode and the skin.[1]
4. After the electrodes have been applied, the skin electrode resistance can be checked on the screen (see **Skin/Electrode Resistance,** page 46).

1. Electrode gel is integral with single-use electrodes and extra gel does not need to be applied when single-use electrodes are used. For biotab single-use electrodes solid conductive gel is incorporated in the adhesive.

Art. no.: 2.510858 Rev. f

5. If electrode contact is not within tolerance:
   – Remove the electrode and clean the skin area.
   – Use an abrasive pad or proprietary abrasive cleaning gel[1] to remove the upper layer of the epidermis.

6. Reapply the electrode. Always use a new electrode when single-use electrodes are used.
7. Ensure that the patient is warm and relaxed before you start the recording.
8. After the recording, remove the electrodes. Clean suction and vacuum reusable electrodes according to manufacturers' instructions to remove any remaining gel.

3.3 Electrode Identification and Colour Code

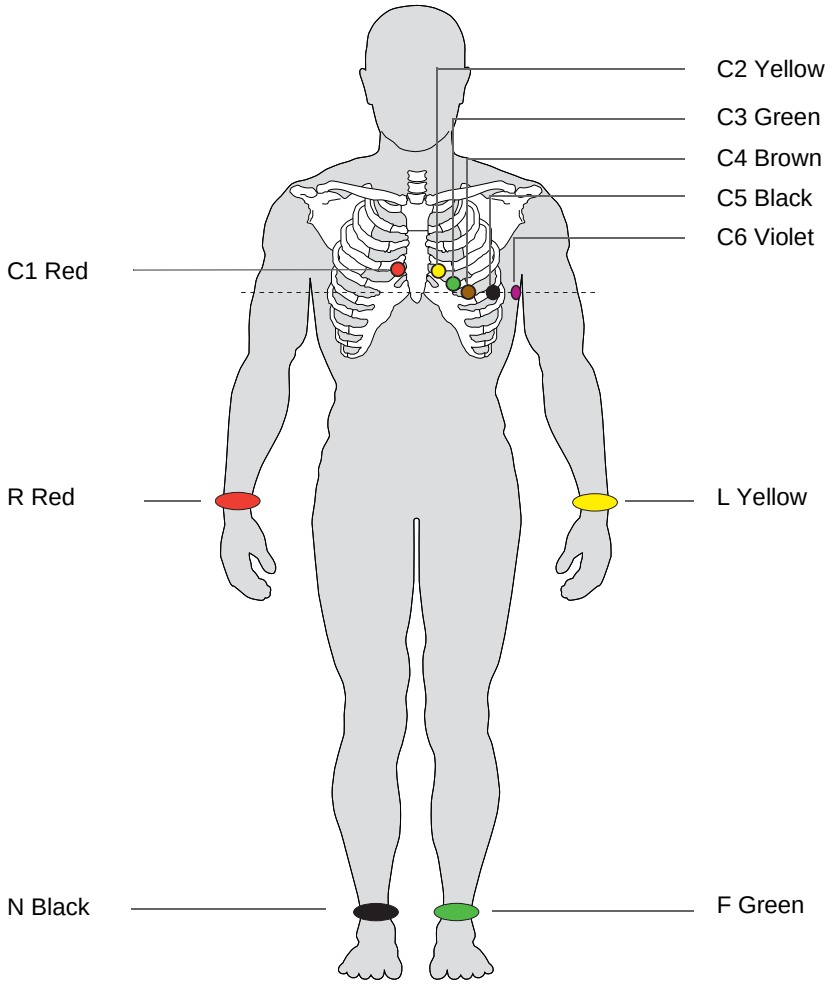
The electrode placements shown in this Section are labelled with the colours according to Code 1 (IEC) requirements. The equivalent Code 2 (AHA) colours are given below.

	Code 1 (IEC)		**Code 2 (AHA)**	
	IEC Label	Colour	AHA Label	Colour
Limb	R	Red	RA	White
	L	Yellow	LA	Black
	F	Green	LL	Red
Chest according to Wilson	C1	White / Red	V1	Brown / Red
	C2	White / Yellow	V2	Brown / Yellow
	C3	White / Green	V3	Brown / Green
	C4	White / Brown	V4	Brown / Blue
	C5	White / Black	V5	Brown / Orange
	C6	White / Violet	V6	Brown / Violet
Neutral	N	Black	RL	Green

1. Abrasive cleaning gel will help reduce skin resistance and achieve good results.

Art. no.: 2.510858 Rev. f

3.4 Standard Resting ECG



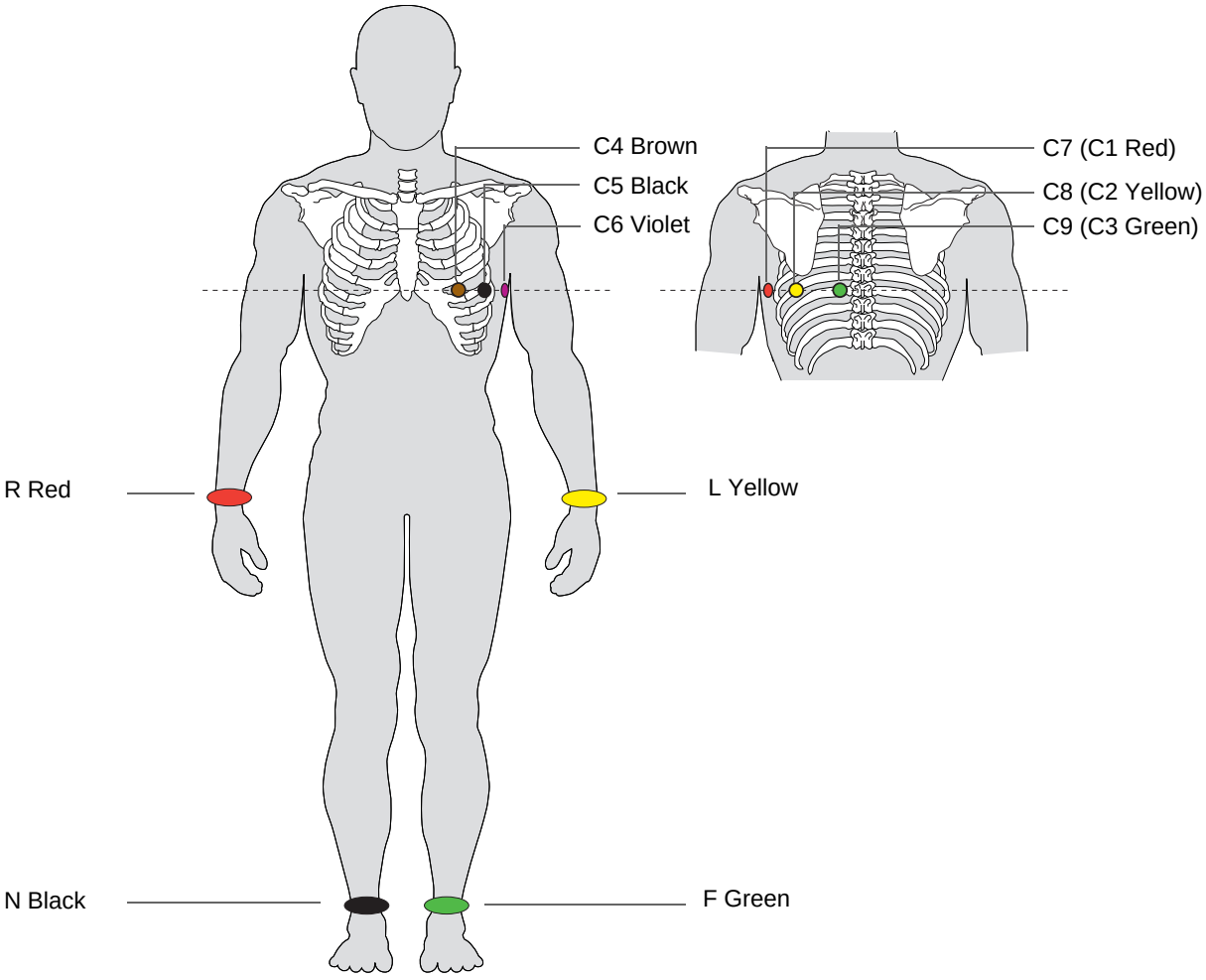
IEC Label	AHA Label		Electrode Placement
C1 white / red	V1 brown / red	→	Fourth intercostal space at the right sternal border
C2 white / yellow	V2 brown / yellow	→	Fourth intercostal space at the left sternal border
C3 white / green	V3 brown / green	→	Midway between C2 and C4
C4 white / brown	V4 brown / blue	→	Left mid-clavicular line in the fifth intercostal space
C5 white / black	V5 brown / orange	→	Left anterior axillary line on the same horizontal level as C4
C6 white / violet	V6 brown / violet	→	Left mid-axillary line on the same horizontal level as C4
L yellow	LA black	→	Left arm
R red	RA white	→	Right arm
F green	LL red	→	Left foot
N black	RL green	→	Right foot

The electrode resistance can be checked in the recording screen (see **Skin/ Electrode Resistance,** page 46).

- When making an ECG with a child it is sometimes physically difficult to place all electrodes. When this is the case electrode C4 can be placed on the right side of the chest.
- Auto Interpretation is only generated when standard electrode placement is set.

Art. no.: 2.510858 Rev. f

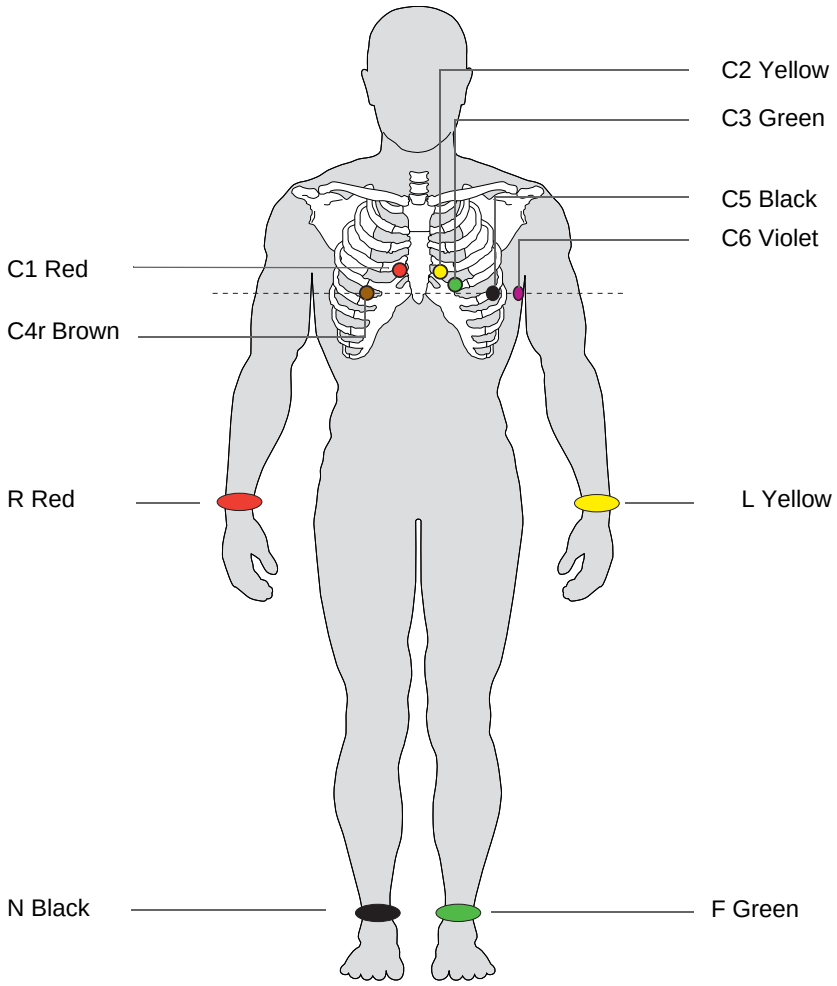
3.5 Left Posterior



IEC Label	AHA Label		Electrode Placement
C7 (C1 white / red)	V7 (V1 brown / red)	→	Left posterior axillary line at the level of C4
C8 (C2 white /yellow)	V8 (V2 brown / yellow)	→	Left midscapular line at the level of C4
C9 (C3 white / green)	V9 (V3 brown / green)	→	Left paraspinal border at the level of C4
C4 white / brown	V4 brown / blue	→	Left mid-clavicular line in the fifth intercostal space
C5 white /black	V5 brown / orange	→	Left anterior axillary line on the same horizontal level as C4
C6 white / violet	V6 brown / violet	→	Left mid-axillary line on the same horizontal level as C4
L yellow	LA black	→	Left arm
R red	RA white	→	Right arm
F green	LL red	→	Left foot
N black	RL green	→	Right foot

Art. no.: 2.510858 Rev. f

3.6 Right Precordial (V4r)

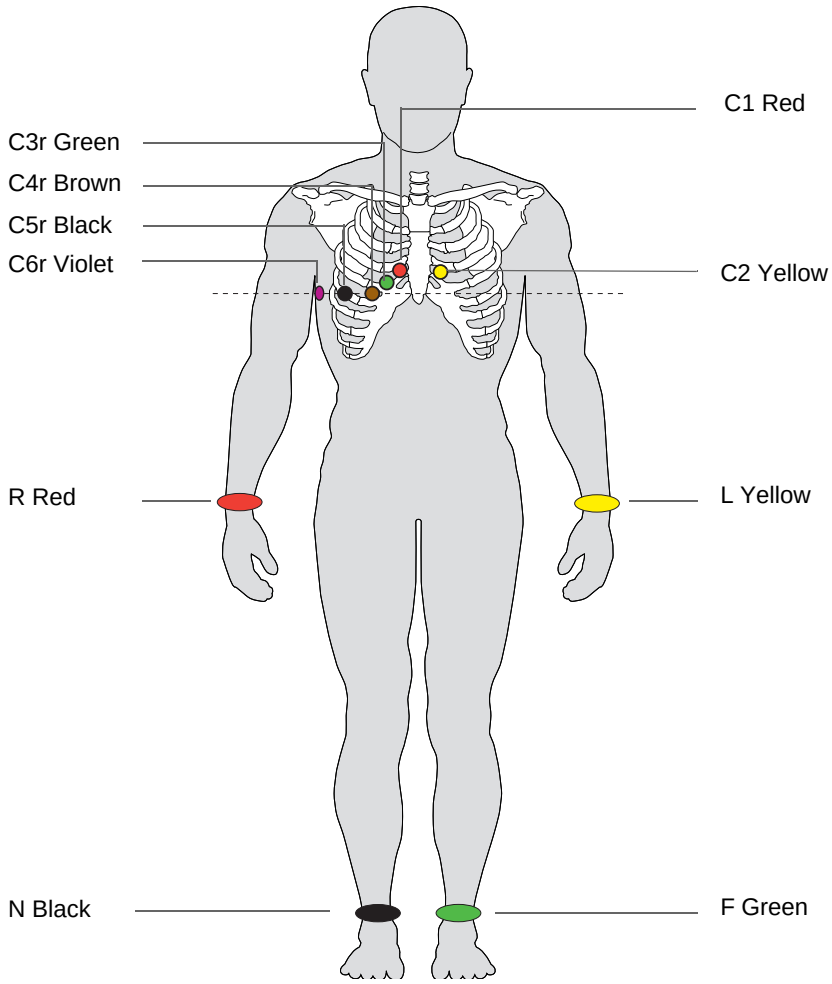


SCHILLER Cable Designation	IEC Label	AHA Label		Electrode Placement
C1	C1 white / red	V1 brown / red	→	Fourth intercostal space at the right sternal border
C2	C2 white / yellow	V2 brown / yellow	→	Fourth intercostal space at the left sternal border
C3	C3 white / green	V3 brown / green	→	Midway between sites C2 and C4
C4	C4r white / brown	V4r brown / blue	→	Fifth intercostal space right mid-clavicular line
C5	C5 white / black	V5 brown / orange	→	Left anterior axillary line on the same horizontal level as C4r
C6	C6 white / violet	V6 brown / violet	→	Left mid-axillary line on the same horizontal level as C4r
L	L yellow	LA black	→	Left arm
R	R red	RA white	→	Right arm
F	F green	LL red	→	Left foot
N	N black	RL green	→	Right foot

The precordial leads must be set in the ECG menu (see **Settings,** page 47).

Art. no.: 2.510858 Rev. f

3.7 Right Precordials(V3r - V6r)



SCHILLER Cable Designation	IEC Label	AHA Label		Electrode Placement
C1	C1 white / red	V1 brown / red	➜	Fourth intercostal space at the right sternal border
C2	C2 white / yellow	V2 brown / yellow	➜	Fourth intercostal space at the left sternal border
C3	C3r white / green	V3r brown / green	➜	Designated point halfway between C1 and C4r
C4	C4r white / brown	V4r brown / blue	➜	Fifth intercostal space in the right midclavicular line
C5	C5r white / black	V5r brown / orange	➜	Fifth intercostal space in the right anterior axillary line
C6	C6r white / violet	V6r brown / violet	➜	Fifth intercostal space in the right mid-axillary line
L	L yellow	LA black	➜	Left arm
R	R red	RA white	➜	Right arm
F	F green	LL red	➜	Left foot
N	N black	RL green	➜	Right foot

Art. no.: 2.510858 Rev. f

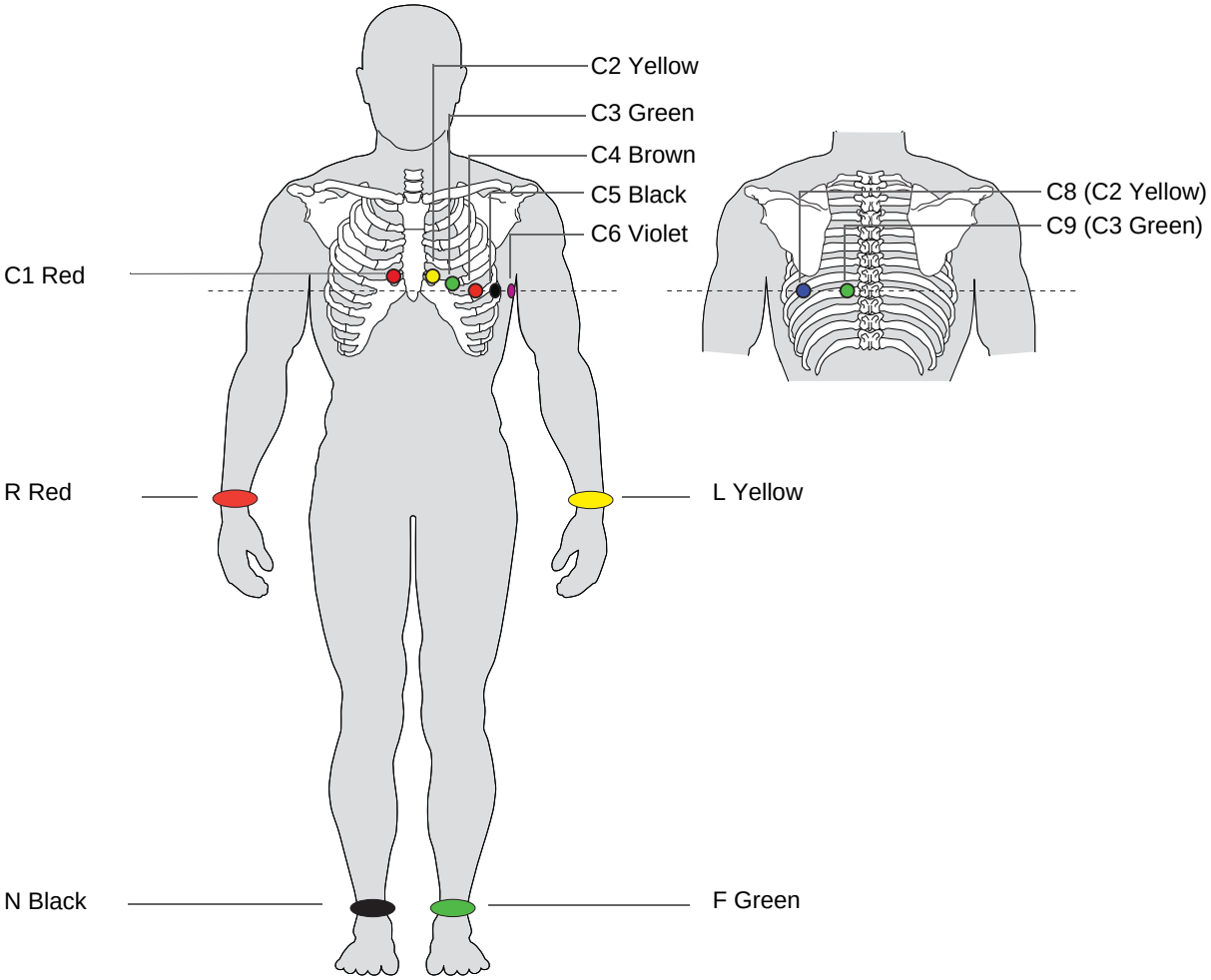
3.8 Right Precordial (only 14-wire Cable)

The precordial leads must be set in the ECG menu (see **Settings,** page 47).

SCHILLER Cable Designation	IEC Label	AHA Label		Electrode Placement
C1	C1 white / red	V1 brown / red	→	Fourth intercostal space at the right sternal border
C2	C2 white / yellow	V2 brown / yellow	→	Fourth intercostal space at the left sternal border
C3	C3 white / green	V3 brown / green	→	Midway between sites C2 and C4
C4	C4 white / brown	V4 brown / blue	→	Mid-clavicular line in the fifth intercostal space
C5	C5 white / black	V5 brown / orange	→	Anterior axillary line on the same horizontal level as V4
C6	C6 white / violet	V6 brown / violet	→	Mid-axillary line on the same horizontal level as C4
L	L yellow	LA black	→	Left arm
R	R red	RA white	→	Right arm
F	F green	LL red	→	Left foot
N	N black	RL green	→	Right foot
C7	C6r (H) Violet	V6r (H) Violet	→	Fifth intercostal space in the mid-axillary line
C8	C5r (E) Yellow	V5r (E) Yellow	→	Fifth intercostal space in the anterior axillary line
C9	C4r (I) Red	V4r (I) Red	→	Fifth intercostal space in the midclavicular line
C10	C3r (M) Black	V3r (M) Black	→	Designated point halfway between C1 and C4r

Art. no.: 2.510858 Rev. f

3.9 Balanced (only 14-wire Cable)



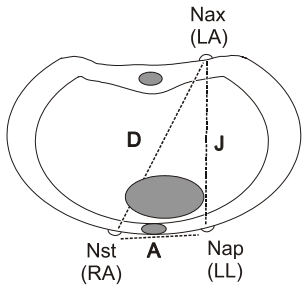
The balanced leads must be set in the ECG menu (see **Settings,** page 47).

SCHILLER Cable Designation	IEC Label	AHA Label		Electrode Placement
C1	C1 white / red	V1 brown / red	→	Fourth intercostal space at the right sternal border
C2	C2 white / yellow	V2 brown / yellow	→	Fourth intercostal space at the left sternal border
C3	C3 white / green	V3 brown / green	→	Midway between sites C2 and C4
C4	C4 white / brown	V4 brown / blue	→	Mid-clavicular line in the fifth intercostal space
C5	C5 white / black	V5 brown / orange	→	Anterior axillary line on the same horizontal level as C4
C6	C6 white / violet	V6 brown / violet	→	Mid-axillary line on the same horizontal level as C4
L	L yellow	LA black	→	Left arm (resting ECG) or left shoulder
R	R red	RA white	→	Right arm (resting ECG) or right shoulder
F	F green	LL red	→	Left foot (resting ECG) or left thigh
N	N black	RL green	→	Right foot (resting ECG) or right thigh
C7			→	Not used
C8	C8 blue	V8	→	C8 - left posterior axillary line opposite C4
C9	C9 green	V9	→	C9 - left posterior axillary line level with C4, opposite C3
C10	EX4 (M) Black	EX4 (M) Black	→	EX4 - this is a V lead and can be placed as required. Usually placed in V4R position.

Art. no.: 2.510858 Rev. f

3.10 Nehb Leads

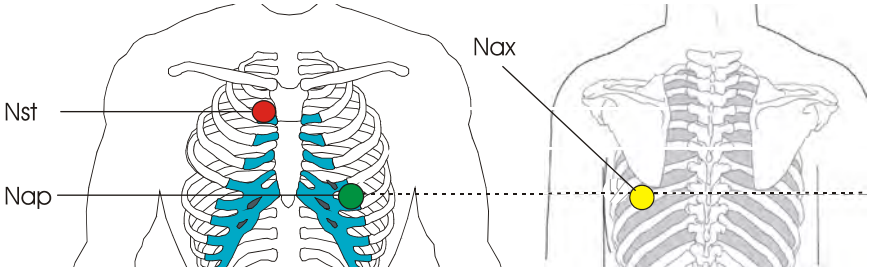
The Nehb leads are bipolar chest leads. They are of special interest for the diagnosis of changes in the posterior ventricle wall. Three leads are arranged in the form of a triangle, also called the “small cardiac triangle”. Nehb dorsal (D) is measured between the electrode positions Nax and Nst; Nehb anterior (A) between Nap and Nst, and Nehb inferior (J) between Nap and Nax.



The Nehb leads (extremities or chest) must be set in the ECG menu (see **Settings,** page 47).

3.10.1 Nehb Leads (Extremities)

When Nehb (Extremity) is set (see **Settings,** page 47), place the extremity electrodes as follows:



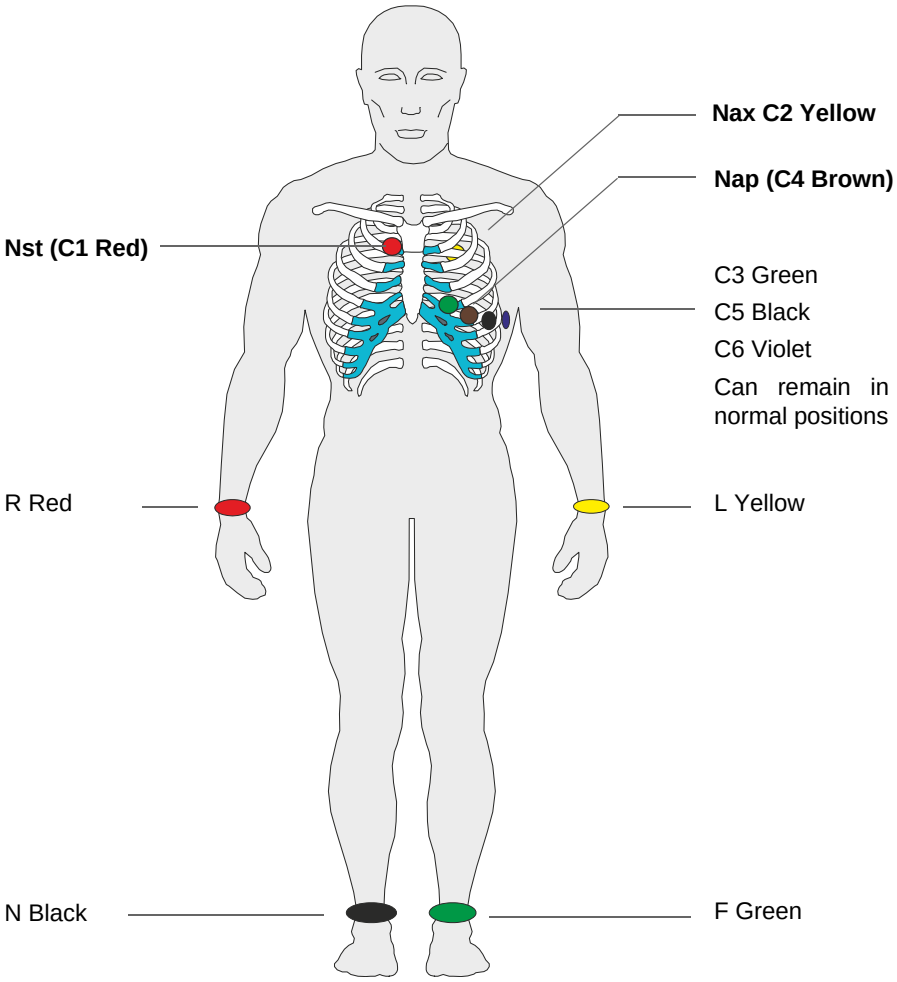
IEC Label	AHA Label	Electrode Placement
R red	RA white	➜ **Nst** - 2nd rib at the right sternal border
L yellow	LA black	➜ **Nax** - The left posterior axillary line directly opposite (on the back) from Nap
F green	LL red	➜ **Nap** - 5th intercostal space mid-clavicular line (cardiac apex equates to V4 / C4)

All other electrodes can be placed in their normal position (see **Standard Resting ECG,** page 38).

Art. no.: 2.510858 Rev. f

3.10.2 Nehb Leads (Chest)

When Nehb (Chest) is set (see **Settings,** page 47), place the electrodes as follows:



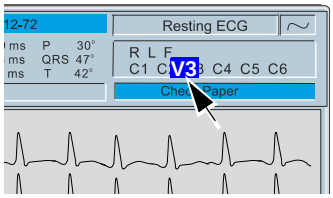
IEC Label	AHA Label		Electrode Placement
C1 white / red	V1 brown / red	➜	**Nst** - 2nd rib at the right sternal border
C2 white / yellow	V2 brown / yellow	➜	**Nax** - The left posterior axillary line directly opposite (on the back) from Nap
C4 white / brown	V4 brown / blue	➜	**Nap** - 5th intercostal space mid-clavicular line (cardiac apex equates to V4 / C4)

All other electrodes can be placed in their normal position (see **Standard Resting ECG,** page 38).

Art. no.: 2.510858 Rev. f

3.11 Skin/Electrode Resistance

The electrode lead status is shown on the LCD in the top right information area.



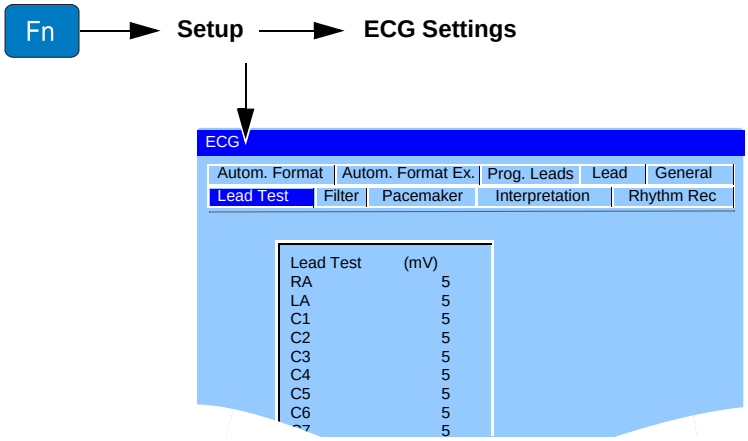
When an electrode indication flashes - an audible indication is also given - it indicates that the electrode resistance is too high. The electrode must be re-applied.

3.11.1 Displaying Electrode Resistance

Electrode and Patient Cable Check (Lead Test)

The electrode resistance check is provided as an integrity check for the electrode resistance and patient cable if suspected of being faulty. The electrode resistance screen is displayed as follows:

➜ The **Lead Test** option in the ECG screen. Press the Function key (FN), Setup, then ECG Settings.



The number of leads displayed will depend on the patient cable connected (see next page).

The result column gives the electrode dc offset and is the voltage drop in the patient cable and electrodes in millivolts measured between the electrode on the left leg and each of the individual electrodes. It can indicate any faults in the patient cable or patient electrode. The voltage readings that can be expected are as follows:

With patient connected ± 100 mV: Good connection, low resistance. An offset of up to ± 150 mV will give an acceptable recording.

With patient simulator connected ± 20 mV: This will depend on the patient simulator used and must be taken as a flexible measurement.

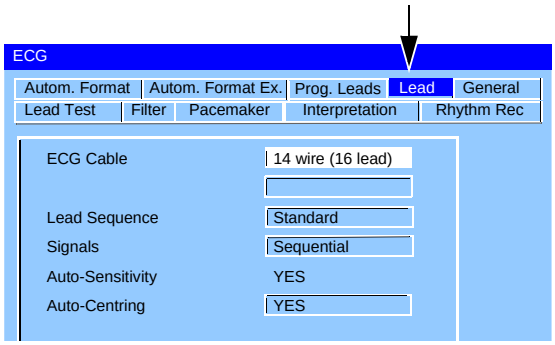
With all electrodes shorted together ± 20 mV.

No patient cable connected -350 to -550 mV.

Art. no.: 2.510858 Rev. f

3.12 Patient Cable, Lead Sequence and Display

3.12.1 Settings



ECG Cable — Define according to the patient cable connected. Select between 10 wire (12 lead) or 14 wire (16 lead).

Lead Sequence — Standard or Cabrera

Signals — Simultaneous or Sequential

Auto Sensitivity — Yes or no

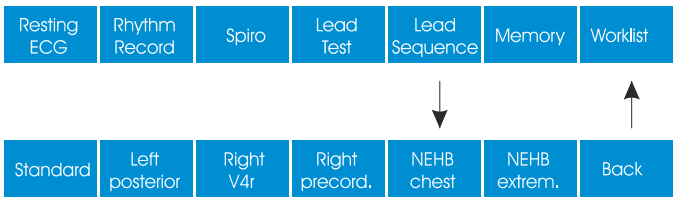
Auto Centring — Yes or no

Standard, right precordial, Nehb, etc., Leads for display — Set to On or Off for Standard, Right precordial (V4r), Right precordial (V3r - V6r), Left Posterior (V7 - V9), NEHB (Chest), NEHB (Extremities), Progr. leads (set following).

Balanced and Right Precordial — Can only be set when 14 wire patient cable is set. Set to ON or OFF.

3.12.2 Lead Sequence

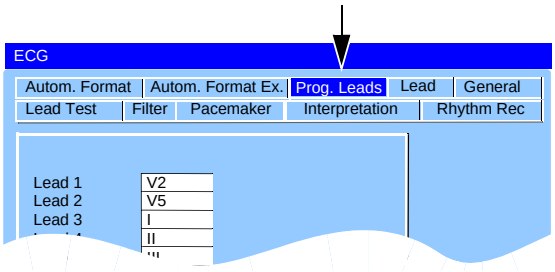
Select Lead Sequence to display the options:



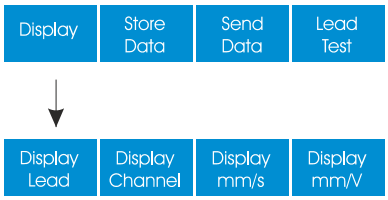
Art. no.: 2.510858 Rev. f

3.12.3 Programmable Leads

A user defined lead order can be set by the user as required. To do this select the **Prog. Leads** tab and define the lead as required.



3.12.4 Changing the leads selection on the display



➜ Toggle the **Display Lead** key to display the next lead group (when 3 or 6 channels are displayed). Note that when 12 channels are displayed, this key has no effect.

➜ Select **Display channel** to change the number and format of leads displayed.

All ECG settings and formats are given in the ECG settings section (see **ECG Settings,** page 69).

Art. no.: 2.510858 Rev. f

4 Resting ECG

⚠ CAUTION

▲ The Safety notices at the beginning of this user guide must be read and fully understood before taking an ECG Recording.

▲ When the mains lead is not connected to the CARDIOVIT AT-102 plus, and any external mains powered units (e.g. monitor) are connected, use the potential equalisation stud for grounding protection.

- Occasionally, the ECG signal acquisition can reset to obtain new reference points. When this occurs no ECG display is given.
- If a reset occurs during the 10 seconds before an auto ECG is requested (AUTO key pressed), the Auto mode ECG is given, however no average cycles are calculated and no interpretation is given.

Note that the auto mode formats are independent of the current screen display. For the two auto mode formats, the following can be freely programmed (before recording).

- Lead Format.
- Chart Speed.
- With the optional interpretation program it is also possible to select the rhythm lead(s), measurement table, average cycles with optional markings and interpretation statements for the printout.

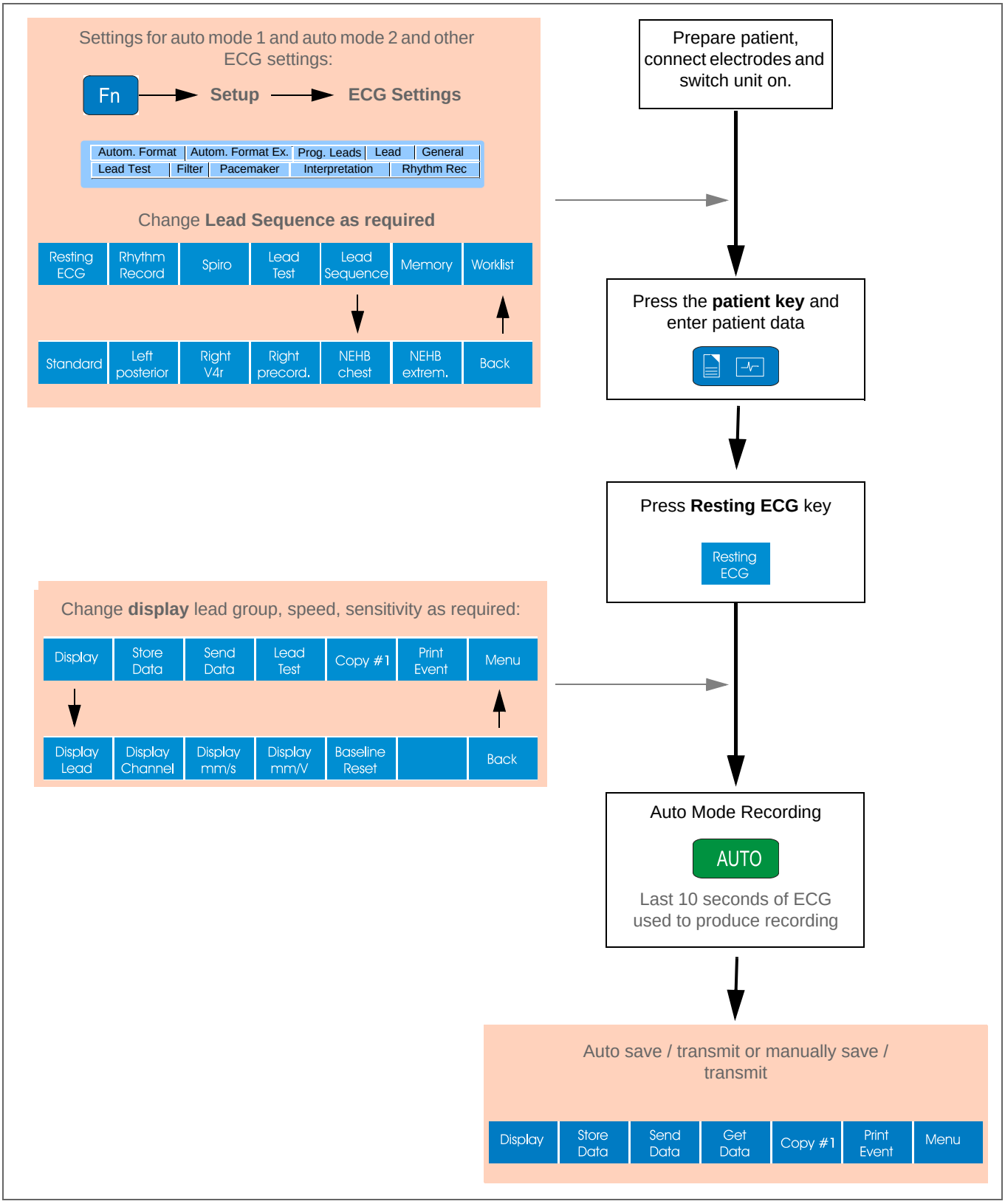
For further information and to define the auto formats (see **ECG Settings,** page 69).

▲ If the screen malfunctions or is not viewable for any reason during recording, a manual printout can still be obtained by pressing the MAN key.

Art. no.: 2.510858 Rev. f

4.1 ECG Recording Procedural Flow Overview

4.1.1 Auto Mode



Art. no.: 2.510858 Rev. f

4.2 Automatic Mode Recording

To take an automatic ECG recording in format 1, press the **Auto** key.

To take an automatic ECG recording in format 2, press the Caps key followed by the **Auto** key.

After approximately 10 seconds the recording is analysed and the result displayed on the screen if set. The interpretation statements can be edited and further printouts obtained in different formats. The ECG data remains in the temporary unit memory until it is overwritten by another recording or the unit is switched off.

A recording can be:

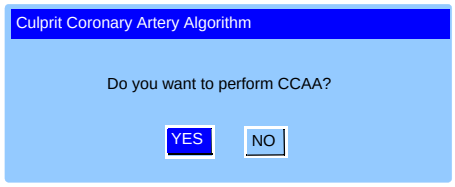
- printed
- saved locally
- transmitted to a remote location (e.g. SEMA3)

The options depend on the user settings and can be carried out manually or automatically after the recording has been made.

Taking a Recording when the Culprit Coronary Artery Algorithm is set

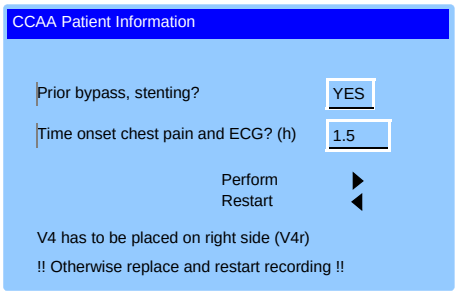
If Culprit Coronary Artery Algorithm analysis has been defined in ECG settings (see **Culprit Coronary Artery Algorithm,** page 57) when **Auto start** is pressed, you are prompted to answer the following questions before the recording is started.

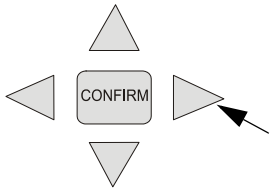
1. Confirm that the Culprit Coronary Artery Algorithm Analysis is to be performed:



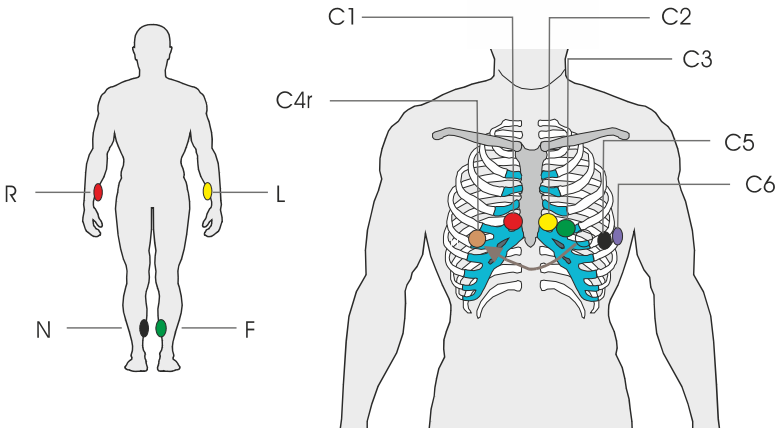
Art. no.: 2.510858 Rev. f

2. Enter the required patient information and press the right arrow key to proceed.



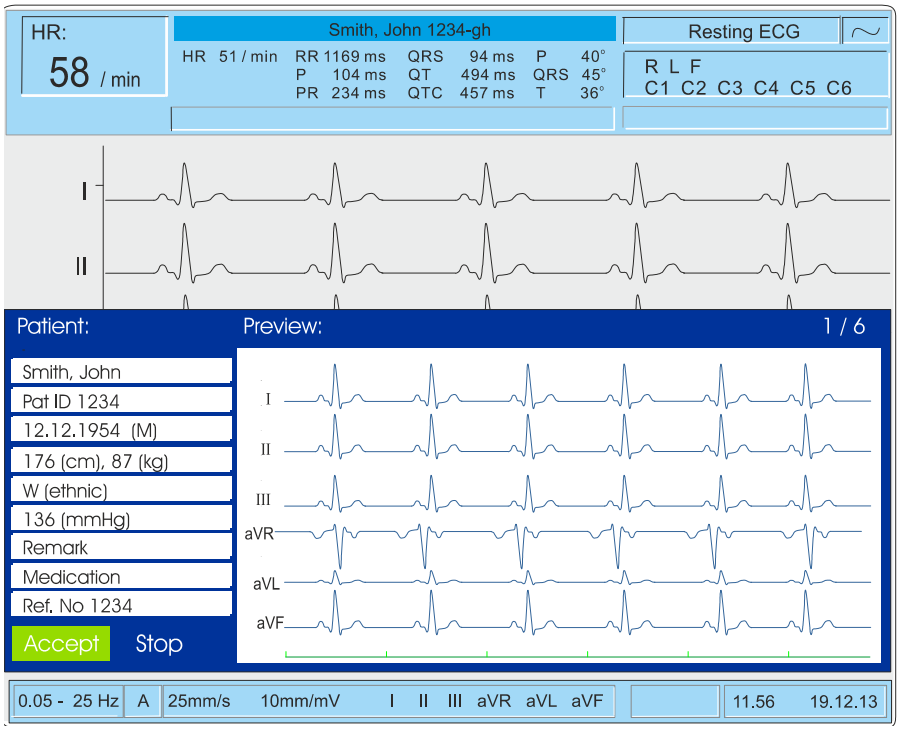


For Culprit Coronary Artery Algorithm, the electrode C4 must be placed in the right precordial (C4r) position.



4.2.1 Print Preview

If preview has been set in ECG settings (see **Print Preview,** page 55) a preview screen is displayed before a recording is printed:



Art. no.: 2.510858 Rev. f

Toggle through the preview screens

Use the **left / right** arrow keys to toggle through the preview screens. The screens are as follows:

- Waveforms (2 pages)
- Averaged waveforms
- Intervals
- Measurements (2 pages)

Printing and Re-Recording Soft Key Options

The soft keys give you the following options:

Accept Prints and saves the recording as shown.

This option will produce the printout only when **autoprint (yes)** is selected in ECG Settings (see **System Settings,** page 105 > general tab). If autoprint is not set, the recording is stored in memory and can be printed manually if required.

Stop Discards the recording and exits without printing.

Record Again Discards the recording and takes another auto mode recording.

Print Preview Prints the recording.

Hard key Options

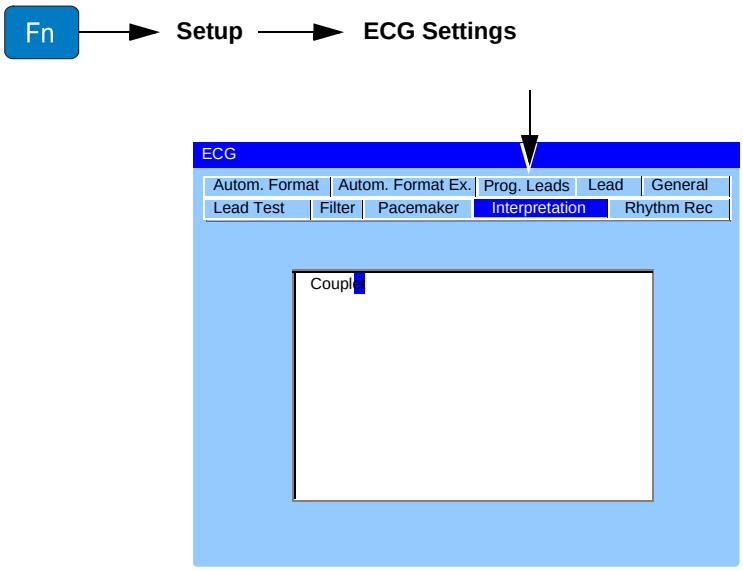
- To print the recording, press the green Auto key.

- To discard the recording without printing, press the blue stop key.

Art. no.: 2.510858 Rev. f

4.2.2 Interpretation

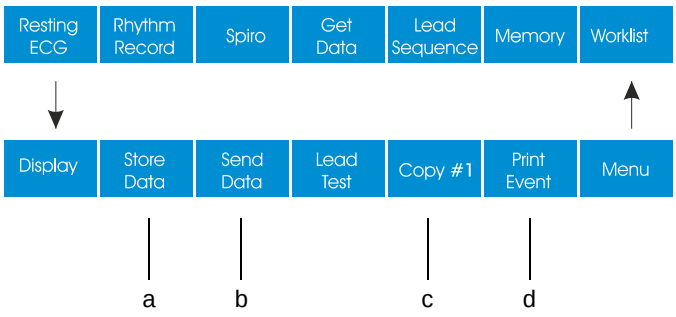
Press the Function key (FN). The last soft-key changes to Setup. Press Setup and then press ECG Settings.



The interpretation from the last recorded Auto mode ECG recording is displayed here. The interpretation can be edited as required using the arrow keys and the keypad (see **Interpretation,** page 70)

- Auto Interpretation is only generated when standard electrode placement is set. (see **ECG Settings,** page 69) and is not generated when a 16 lead configuration is defined. Manual interpretation and editing can be entered for all configurations..

4.2.3 Printing, Storing and Sending - Manually



➜ To obtain a copy in **format 1** press the **Copy #1** key **(c).**

➜ To obtain a copy in **format 2** press the **Caps key** . The **Copy #1** key changes to **Copy #2 (c).**

➜ To store the recording manually press the **Store Data** key **(a)**.

➜ To transmit the recording manually press the **Send Data** key **(b)**.

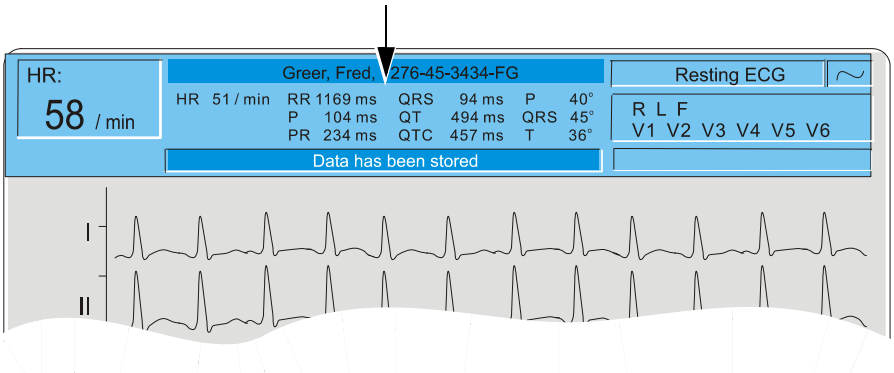
4.2.4 Printing an Event

Press the **Print Event** key **(d)** to print a rhythm strip of the previous 10 seconds of all 12 leads.

Art. no.: 2.510858 Rev. f

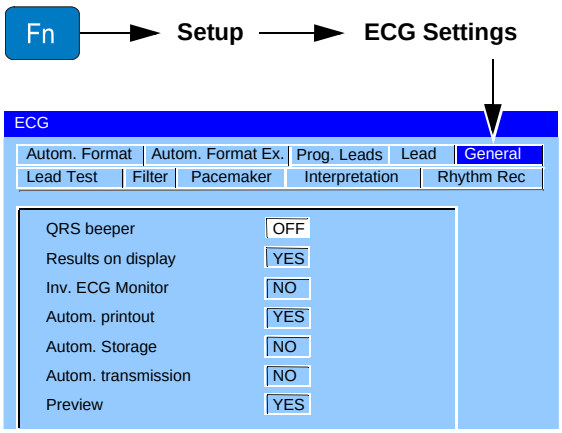
4.2.5 Displaying Measurements

Set the Results on display to Yes to display the ECG measurements after an auto mode recording has been made.



- Communication settings are detailed in system settings (see **System Settings,** page 105).
- Other ECG settings are detailed later in this section (see **ECG Settings,** page 69).
- Printing and transmitting from memory is detailed in the Memory section (see , page 74).
- Settings made will remain until the unit is switched off. The setting can be stored as default if required by setting to Save as Default before the unit is switched off (see **System Settings,** page 105).

4.2.6 Printing, Storing and Sending - Automatically



Set the Autom. printout, Autom. storage, Autom. transmission setting to Yes to print, store, and transmit automatically after an auto mode recording has been made.

The automatic data transfer via GSM or network is only possible when the network and transmission settings have been activated in the setup (see **Communication Settings,** page 109).

4.2.7 Print Preview

Set the Preview setting (above) to Yes to provide a preview of the data that will be printed. After preview, the printout can be confirmed or cancelled.

Art. no.: 2.510858 Rev. f

4.2.8 The Auto Mode Printout

The printout gives some or all of the following according to the settings defined (see **ECG Settings,** page 69):

- Name, ID and patient details including age, BP, medication and remarks
- Time and Date
- Heart Rate
- Sensitivity and Speed (of the waveforms)
- Filter Settings
- Software version
- ECG recording of all leads in either Standard or Cabrera format according to selection
- Interpretation statements
- Average Cycles according to selection
- Rhythm leads R1 / R2
- Interval measurements. The formula used to calculate the QTc is also given (defined in ECG settings, see **QTc Formula (see note below),** page 74).
- Markings (on the average cycles)
- Thrombolysis
- Axis
- Sokolow Index (ECG index for hypertrophy)
- Detailed Measurement Table

To obtain extra prints (see **Printing, Storing and Sending - Manually,** page 54).

Art. no.: 2.510858 Rev. f

4.3 Culprit Coronary Artery Algorithm

The Culprit Artery Algorithm developed by Professor Hein Wellens, is designed to determine the size of the cardiac area at risk by localising the occlusion site in the coronary artery and to provide clinical data to shorten the time interval between the onset of chest pain and restoration of myocardial blood flow. The algorithm uses the ST segment deviation of 12 ECG leads to indicate the site of occlusion in the culprit artery.

The closer the occlusion site to the origin of the coronary artery, the larger the size of the area at risk. The guidance given provides the location of a possible occlusion and intervention advice based on the ECG recording, patient history and distance from the nearest PCI centre (**Percutaneous Coronary Intervention** Centre). The criteria for advice is based on the following:

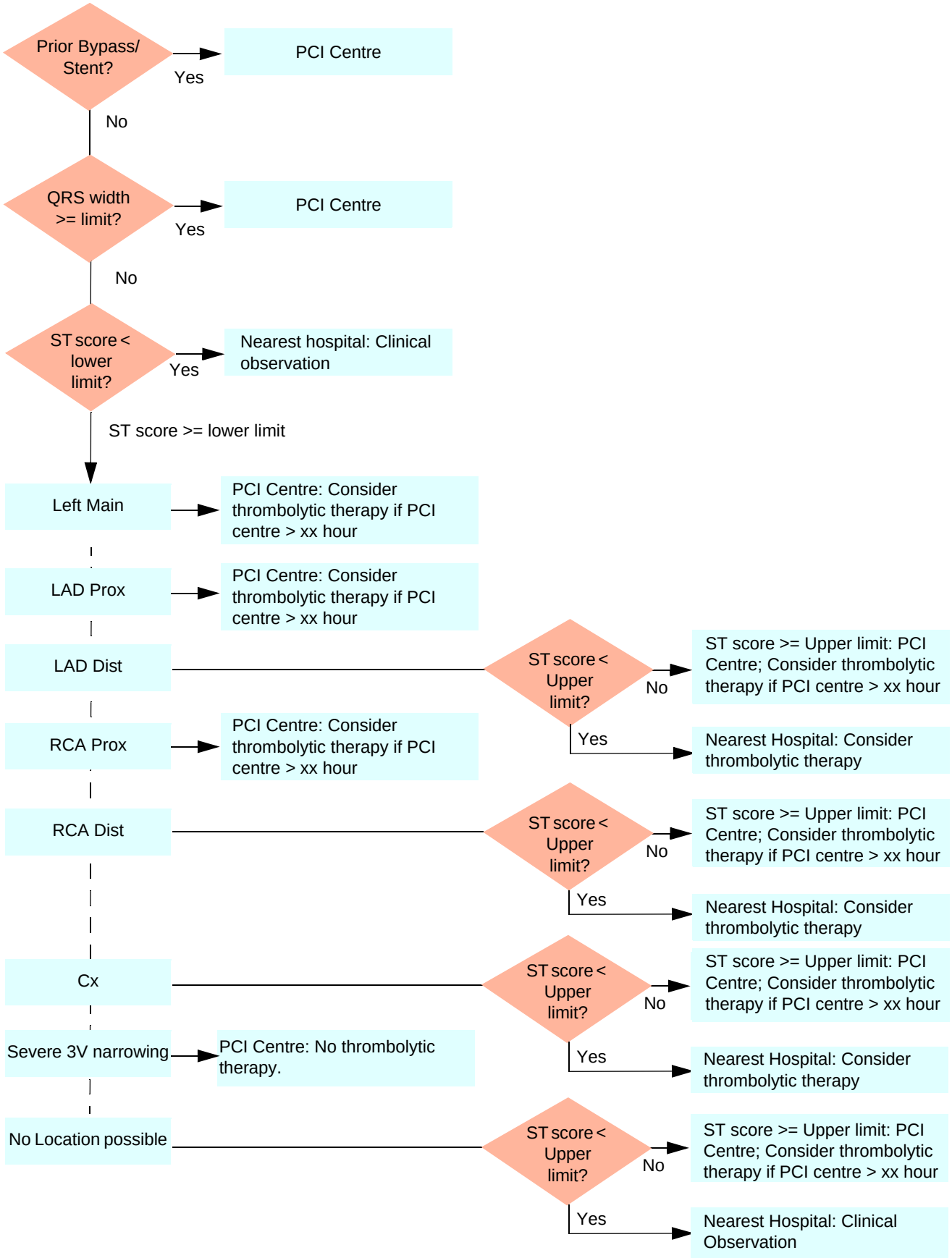
- **Prior bypass/stent history.** This data is entered before the ECG recording is taken. If the patient has had prior bypass or stent, the ECG is not analysed further and the advice **Go to PCI centre** is given.
- **QRS width.** A QRS width is set in the Culprit Coronary Artery Algorithm. If the QRS width is more than defined, the ECG is not analysed further and the advice **Go to PCI centre** is given.
- **Occlusion Site.** The calculated occlusion site.
- **ST score**. The sum of the absolute ST deviations in mm in 12 leads (excluding V4r). That is the total ST deviation (mm) of all leads (I, II, II, aVR, aVL, aVF, and all leads V1 to V6).
- **PCI distance**. The time to travel to PCI centre.

When Culprit Coronary Artery Algorithm analysis is set (see **General,** page 74), the following applies:

- The lead setting is automatically set to Right Precordial V4r. Ensure the C4 electrode placement is in the C4r (precordial) position (see **Right Precordial (V4r),** page 40).
- Before an auto mode recording is taken, you are asked to confirm that Culprit Coronary Artery Algorithm analysis is to be performed and to enter extra patient information (see **Automatic Mode Recording,** page 51).
- An extra page on the printout after an auto mode recording is provided that gives the Culprit Coronary Artery Algorithm ST scores and a statement suggesting actions based on the analysis (see **Culprit Artery Algorithm Printout,** page 60).
- When print preview is set (see **Print Preview,** page 55), the CCAA Culprit Coronary Artery Algorithm ST scores are given on the first two pages and the interpretation and advice given on page three.
- The CCAA interpretation and advice is given in the interpretation statement in the ECG settings (see **Interpretation,** page 54).

Art. no.: 2.510858 Rev. f

4.3.1 Culprit Artery Algorithm Decision Overview



Art. no.: 2.510858 Rev. f

The ST value in mm indicates the ST segment's elevation or depression. The ST score is the sum of the ST values in mm of all the ECG leads.

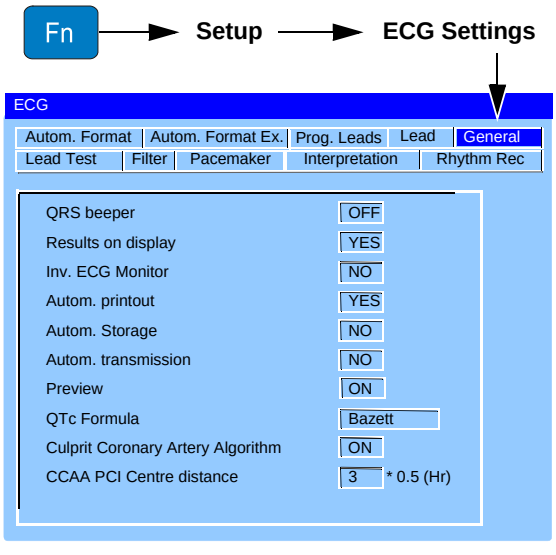
- **QRS widths greater than or equal to the limit**. The ECG is not analysed further and the advice **Transport to PCI Centre** is given.
- **Scores below the lower limit:** Continue monitoring. Further analysis is not performed and a Wellens Analysis statement is not provided when the ST score is less than the lower limit.
- **Scores greater than or equal to the lower limit:** Diagnosis of the occlusion site as one of the following:
  - Left main
  - LAD proximal or distal
  - RCA proximal or distal
  - Cx
  - Severe 3V narrowing
  - No location possible

The method of diagnosing the occlusion site is outlined on the next page.

- After assessment, for the more critical occlusion sites (i.e. LM, LAD prox, RCA prox, 3V/Narr.), the ST score value is not analysed further and the advice **Transport to PCI centre** is given.
- For the less critical occlusion sites (i.e. LAD dist, RCA dist, CX and 'no location possible'), the advice depends on the ST score (see **Culprit Artery Algorithm Decision Overview,** page 58).
- Scores greater than or equal to the upper limit: The advice **Transport to PCI centre** is given. The ST score is not analysed further.

4.3.2 Settings

The settings and criteria for Culprit Coronary Artery Algorithm analysis are entered in the ECG menu > General as follows:



Culprit Coronary Artery Algorithm

Yes or No. When no is selected the other limit options are greyed and cannot be defined.

CCAA PCI Centre distance

Define an estimate of the distance (time) to the PCI centre (Percutaneous Coronary Intervention Centre).

Art. no.: 2.510858 Rev. f

4.3.3 Culprit Artery Algorithm Printout

When CCAA analysis has been set, an extra page is given at the end of the printout detailing the following:

- ST values (µV) and ST values (mm), for every lead.
- ST score (mm)
- Score table detailing the Wellens ST score for each lead and the SUM total for the following values:

  – Left main
  – LAD Prox
  – LAD Dist
  – RCA Prox
  – RCA Dist
  – Cx
  – 3V/LM Nar

This gives a binary value (1 or 0). That is if the ST value suggests an occlusion, 1 is issued, if no occlusion is suggested, 0 is issued.

V4 is not recorded but is simulated from the mean of V3 and V5.

- Previous MI, CA Bypass or stenting (manually entered before the recording was taken)
- Time interval onset of chest pain (manually entered before the recording was taken)
- QRS width (averaged) (ms)
- ST score (averaged) (mm)
- Occlusion Site - assessed area of an occlusion

The site of occlusion is determined by the following:

1. The number of leads that suggest an occlusion (see score table above) are counted (= sum value)
2. The occlusion site with the highest number is chosen as the occluded location.
3. If two locations have an equal value, then the more critical occlusion site (highest in the artery) is selected.

Advice

Statements given at the bottom of the page based on the ST score and entered data are as follows:

First line - where to go

Where to go will be one of the following:

- PCI Centre
- Nearest Hospital

Second line - what to do

What to do will be one of the following:

- Consider thrombolytic therapy if PCI Centre is further away than xx hours.
- Clinical Observation
- Consider thrombolytic therapy

Art. no.: 2.510858 Rev. f

4.4 Manual Mode Rhythm Printout

The rhythm printout mode provides a direct printout of the real-time ECG. During the printout, lead selection, amplitude and speed can be changed as required.

This function provides a printout of the ECG only and it is not possible to store or send electronically. The Rhythm recording function is described later (see , page 74).

MAN

→ To start the manual recording of a real-time ECG, press the **Man Start** key.

STOP

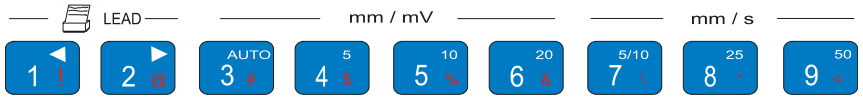
→ To stop the manual recording (printout), press the **Stop** key.

4.4.1 The Printout

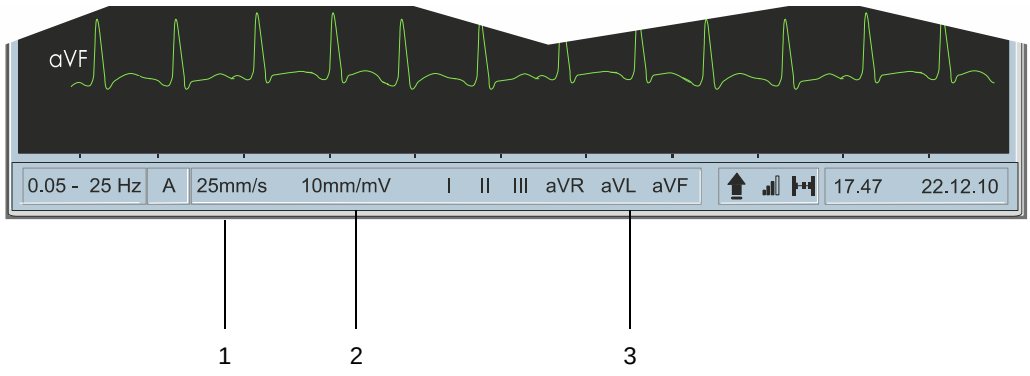
The printout provides you with the following:

- Six or 12 leads with lead identification (see below).
- On the lower edge, the chart speed, user identification and the mains filter setting (50 or 60 Hz) and the Myogram filter cut-off frequency (if filter applied) 25 Hz or 35 Hz.
- At the top, the heart rate as current average of 4 beats, trace sensitivity, and the time and date.

The lead group, sensitivity, and speed of the printout are changed using the printout keys.



The settings that will be/are being printed are displayed in the bottom of the screen:



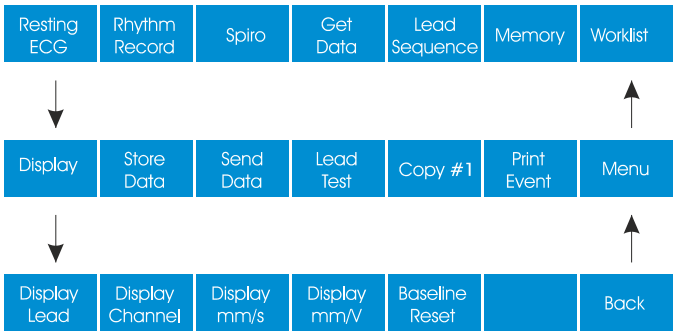
(1) Speed in mm/s (5, 10, 25, or 50 mm/s)
(2) Sensitivity in mm/mV (5, 10, or 20 mm/mV)
(3) Selected leads
  – six leads: I, II,III, aVR, aVL, aVF
  – six leads: V1, V2, V3, V4, V5, V6
  – twelve leads: I, II,III, aVR, aVL, aVF, V1 - V6

Art. no.: 2.510858 Rev. f

4.5 Display Lead Group, Amplitude and Speed

Different lead groups, speed and sensitivity are defined for the display and for the manual printout. The following can be freely changed on the display.

Settings for manual printout are changed with the number keys of the keypad (see previous page).



Display lead

Change the screen presentation to the next lead grouping as follows:

- Standard / Cabrera lead sequence
- User Defined or Paediatric lead sequence

The Standard and Cabrera Lead Groupings are as follows:

Lead Group Type	Lead group 1	Lead group 2
Standard	I, II, III, aVR, aVL, aVF	V1, V2, V3, V4, V5, V6
Cabrera	aVL, I, -aVR, II, aVF, III	V1, V2, V3, V4, V5, V6

The lead group selection is made in ECG settings (see **ECG Settings,** page 69).

Display Channel

Change the screen presentation to one of the following:

12-lead (10-wire Patient cable)

- 3 leads
- 6 leads
- 12 leads
- 12 leads split in two columns simultaneous display
- 12 leads split in 4 columns simultaneous display

16-lead (14-wire Patient cable)

- 16 leads split in two columns simultaneous display
- 16 leads split in four columns simultaneous display

Display mm/mV

Sensitivity (Amplitude) - toggle the screen amplitude between 10 or 20 mm/mV.

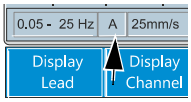
+ **Display mm/mV** Change the screen amplitude to 30, 60 mm/mV.

Display mm/s

Speed - toggle the screen speed to 5, 10, or 20 mm/s.

Art. no.: 2.510858 Rev. f

4.5.1 Auto Sensitivity



If amplitudes are high and the QRS waveforms would overlap, the sensitivity can be reduced automatically to 5 mm/mV. This is set in ECG settings (Lead option > auto sensitivity > on/off) - see **ECG Settings,** page 69. When this is on an A appears in the information line on the bottom of the screen.

4.6 Reference Pulse and Filter Settings

The following settings apply to the screen display and to the manual printout.

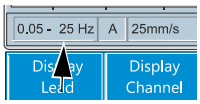
4.6.1 Re-centring the trace, 1mV reference pulse

Occasionally the trace can wonder from the baseline.

To re-centre the ECG trace, and to display / print a 1mV reference pulse, press the **1mV** key.

4.6.2 Myogram Filter

The Myogram filter suppresses disturbances caused by strong muscle tremor. The filter is toggled on/off by pressing the **Filter** key.



When the Myogram filter is on, the cut-off frequency **0.5 - 25 Hz** (or 35 Hz) is displayed in the information box. When the Myogram filter is off, **0.5 - 150 Hz** is displayed.

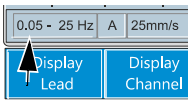
- The cut-off frequency for the Myogram is user defined at 25 Hz or 35 Hz (see settings following).
- An ECG recorded in auto mode is stored unfiltered. It is therefore possible to print the stored ECG either with or without passing the myogram filter.

Art. no.: 2.510858 Rev. f

4.6.3 Other Filters

Further filters can be applied to both resting and exercise ECG recordings as follows:

Baseline



The cut-off frequency (0.05, 0.15, 0.30 or 0.60 Hz) is displayed in the information box. We recommend that the frequency is set to the IEC recommendation of 0.05 Hz.

Smoothing

Suppresses high frequency artefacts between the QRS complexes. SSF is printed on an auto mode printout when this filter is applied.

Baseline Stabiliser

Reduces baseline fluctuations without affecting the ECG. SBS is printed on an auto mode printout when this filter is applied.

Mains

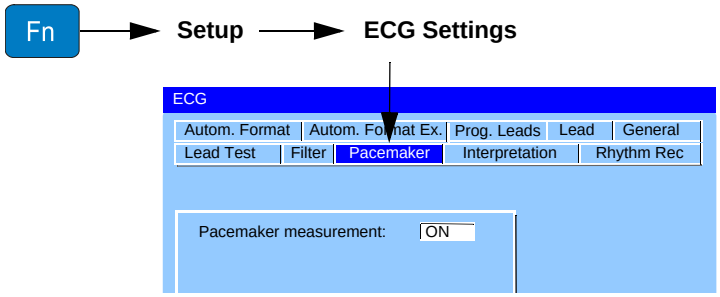
Prevents recording interference due to mains frequency oscillation. F50 (50 Hz) or F60 (60 Hz) is shown on the printout.

The settings for all of the above filters are defined in ECG settings (see **ECG Settings,** page 69).

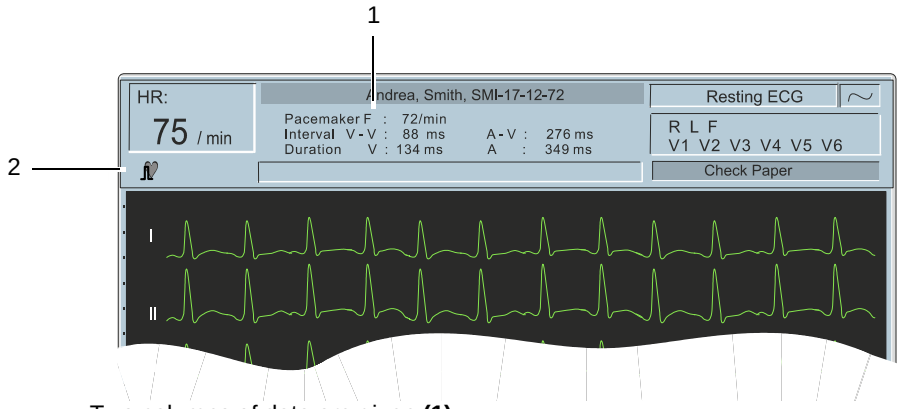
Art. no.: 2.510858 Rev. f

4.7 Pacemaker Measurement (Option)

To display pacemaker measurements, select **On** in the pacemaker menu:



The pacemaker measurements are displayed in the upper part of the screen:



Two columns of data are given **(1)**:

Pacemaker The number of stimulations per minute (pacemaker frequency).

Interval V - V The time interval between two stimulations (V-V).

Duration V The duration of each stimulation.

If a dual-chamber pacemaker is being measured then the right hand column gives the following:

A-V The time interval between atrium and ventricle stimulations.

A The duration of the atrium stimulation.

When the pacemaker option is active and measurements are taken the pacemaker icon is displayed in the top left information bar **(2)**.

When the pacemaker option is on and measurements cannot be taken a crossed pacemaker icon is displayed in the top left information bar. The reasons why a pacemaker measurement cannot be taken includes the following:

- Patient lead or electrodes not connected.
- No pacemaker detected.
- Patient does not have a pacemaker.

Art. no.: 2.510858 Rev. f

4.8 Resting Rhythm Recording

4.8.1 Entering the Rhythm Recording Screen

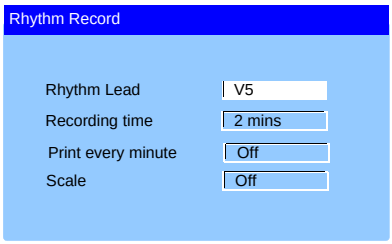
Select **Rhythm Record** from the main menu.

4.8.2 Rhythm Recording Settings

The Rhythm settings defined here are also available in the ECG settings screen (see **ECG Settings,** page 69).

Select **Settings** to enter the rhythm settings screen.

The following settings can be made:



Rhythm Lead

Select between I, II, III, aVR, aVL, aVF, V1 - V6

Recording time

Select between the following:

- 30 seconds
- one minute
- two minutes
- three minutes
- four minutes

Art. no.: 2.510858 Rev. f

Print every minute

When this is set to **On (25 mm/s, 10 mm/mV)**, a printout is given during the recording, at the end of every minute. The previous minute of ECG data is printed and the scale of the printout is fixed.

Scale

The scale setting is for the final printout and can only be set when **Print every minute** is set to **off**. If **Print every minute** is set to **on** this setting is greyed and cannot be set.

Select between the following:

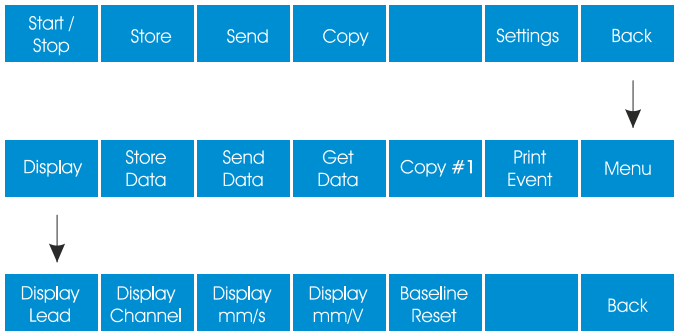
- 12.5 mm/s, 5 mm/mV
- 12.5 mm/s, 2.5 mm/mV

The setting to print directly after a recording has been made is defined in the resting ECG settings (General tab - see **Table of ECG Options and Settings,** page 69).

The lead settings and scale settings above are for the printout only. Lead selection, speed and sensitivity settings during rhythm recordings are set in the display menu (see following).

4.8.3 Display Lead Group, Amplitude and Speed

To change the screen display in the rhythm screen, press the back key and then the display key:



The display lead, channel, and speed and sensitivity can be changed on the screen (see **Display Lead Group, Amplitude and Speed,** page 62).

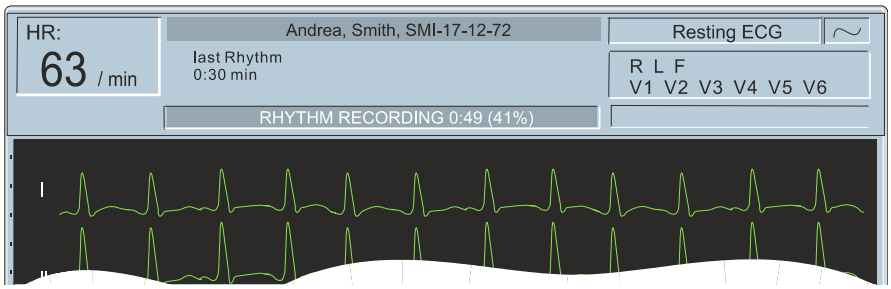
Screen settings cannot be changed when a recording is in progress. If the back key is pressed during a rhythm recording, the recording is stopped without saving.

Art. no.: 2.510858 Rev. f

4.8.4 Rhythm Recording Procedure

Enter patient data if not already entered (see **Patient Data,** page 32) and press the **Start / Stop icon** to start the recording.

The recording starts and the duration and percentage is indicated in the message bar.



The recording continues for the duration defined. Press the **Start / Stop icon** at any time during a recording to stop.

When the time defined has elapsed or the recording is manually stopped, the recording is stored, sent, printed, etc., according to the defined settings.

4.8.5 Printing, Storing, Transmitting the Rhythm Recording

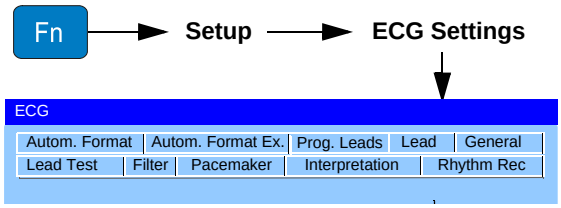
The recording can be sent to a database, stored or printed automatically after the recording has been made. The setting is the same as for the resting ECG (see **Printing, Storing and Sending - Manually,** page 54).

Because rhythm recordings require larger memory space, if rhythm recordings are to be stored locally an SD card must be inserted in the unit. If a request to store a rhythm recording is made without an SD card being inserted, the message **Write error!** is given; insert an SD card and re-save the recording. The memory settings are detailed in the memory section (see **Memory,** page 96).

Art. no.: 2.510858 Rev. f

4.9 ECG Settings

This section gives an overview of all the settings and tabs available in the following table.



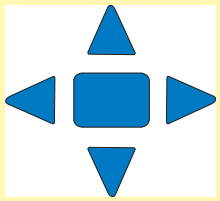
Menu navigation, selection and confirmation is detailed in the Introduction (see **Selecting Menu Options using the Arrow Keys,** page 31).

All changed settings are remembered until the unit is switched off. If you wish to keep the settings as default, the **Save as default** icon (Settings > System settings > Software > Save as Default) must be pressed before switch off (see **System Settings,** page 105).

4.9.1 Table of ECG Options and Settings

Parameter	Options	Description
Lead Test		Displays the resistance of all leads to ensure good electrode contact and the integrity of the cable (see **Skin/Electrode Resistance,** page 46).
Filter	Baseline Filter	The cut-off can be set for **0.05 Hz, 0.15 Hz, 0.30 Hz** or **0.60 Hz**, for both resting and Exercise recording. NOTE: The standard value set is 0.05 Hz. The higher settings should only be used when absolutely necessary because it could affect the original ECG signal, especially the ST segment.
	Myogram Filter	 The Myogram filter suppresses disturbances caused by strong muscle tremor. The filter is applied by pressing the **Filter** key (or programmed on as default when the unit is switched on). The cut off frequency is displayed in the information box (see **Myogram Filter,** page 63). The cut-off frequency is user defined at **25 Hz** or **35 Hz**. **Note**: An ECG recorded in auto mode is stored unfiltered. It is therefore possible to print the stored ECG either with or without passing the myogram filter.
	Mains Filter	The mains filter is an adaptive digital interference filter designed to suppress ac interference without attenuating or distorting the ECG. Set the mains filter in accordance with the frequency of your local mains supply.
	SBS Filter (baseline)	The baseline stabiliser greatly reduces the baseline fluctuations without affecting the ECG signal. The purpose of the stabiliser is to keep the ECG signals on the baseline of the printout. This filter is only effective in auto mode printout. The Baseline Stabiliser is applied to a recording (**on**), or not applied to a recording (**off**). The cut-off frequency is set above.
	SSF Filter (smoothing)	**On** or **Off**. The smoothing filter (SSF: SCHILLER smoothing filter) is a low pass filter to suppress high frequency artefacts between the QRS complexes. When this filter is switched on, **SSF** is shown on the bottom line of the automatic printout.

Art. no.: 2.510858 Rev. f

Parameter	Options	Description
Pacemaker		**On** or **Off.** Displays Pacemaker measurements at the top of the screen when set to On (see **Pacemaker Measurement (Option),** page 65).
Interpretation	Interpretation Screen	Display, and Edit/ Enter interpretation. To edit / enter an interpretation, press the **confirm key** (middle key). The interpretation can then be entered via the keypad. 
	Write Unconfirmed Report	**Yes** or **No**. **Unconfirmed Report** is added/not added to the interpretation statements on the auto ECG printout (if applicable).
	Write Abnormal ECG	**Yes** or **No**. **Abnormal ECG** is added/not added to the interpretation statements on the auto ECG printout (if applicable).
	Sensitivity	**Normal** or **low** sensitivity. Low sensitivity will suppress certain non-specific ECG diagnoses; this may be advisable when carrying out ECGs for screening.
	Thrombolysis (option)	**On** or **Off**. Thrombolysis is the breaking up of a blood clot. When the Thrombolysis option is off, the interpretation text **possible infarct or other abnormality** is disabled.
Rhythm Record	Recording time	Defines the default duration when a rhythm recording is made.
	Rhythm Lead	Select lead for printout.
	Print every minute	**On (25 mm/s, 10 mm/mV)** or **Off** (no printout every minute). This defines the speed and sensitivity of the prinout every minute and for the final printout. If off is selected, the speed and sensitivity of the final printout is defined in the scale setting (next entry).
	Scale	**12.5 mm/s, 5 mm/mV** or **12.5 mm/s, 2.5 mm/mV**. Note this setting is for the final printout and can only be set when **Print every minute** is set to **off**. If **Print every minute** is set to **on** this setting is greyed and cannot be set. The setting to print / not print after a recording has been made is defined in the resting ECG settings (General tab).

Art. no.: 2.510858 Rev. f

Parameter	Options		Description
Autom. Format (Automatic mode for formats 1 and 2)	ECG Printout	No Printout	No printout of the ECG given at the end of an auto mode recording (the recording can be stored in the memory and printed at a later time if required).
		4*3 + 1 Rhythm (R1)	Leads are printed in a 4 * 3 format at 25 mm/s, with the selected rhythm lead (R1) at the bottom of the page at 25 mm/s.
		1*12 at 25 mm/s	Leads are printed in a 1 * 12 format at 25 mm/s.
		8*5 + 4*10s	Five seconds of 8 Leads, and 10 seconds of four leads are printed at 25 mm/s.
		2*6, 25 mm/s, 1 page	Leads are printed in a 2*6 format at 25 mm/s (one page).
		2*6, 25 mm/s, 1 page	Leads are printed in a 2*6 format at 50 mm/s (one page).
		2*6, 25 mm/s, 2 pages	Leads are printed in a 2*6 format at 25 mm/s (two pages).
		2*6, 50 mm/s, 2 pages	Leads are printed in a 2*6 format at 50 mm/s (two pages).
		prog. leads, 25 mm/s, 1 page	User defined leads (see following) are printed at 25 mm/s on one page.
		prog. leads, 50 mm/s, 1 page	User defined leads are printed at 50 mm/s on one page.
		prog. leads, 25 mm/s, 2 pages	User defined leads are printed at 25 mm/s on two pages.
		prog. leads, 50 mm/s, 2 pages	User defined leads are printed at 50 mm/s on two pages.
	Average Cycles	No Printout	No printout of average cycles.
		4*3, 25 mm/s + 2 Rhy	Leads are averaged over the entire 10 second recording and printed in 4 groups of 3 leads at 25mm/s, with the two selected rhythm leads (R1, R2) at the bottom of the page at 25 mm/s.
		4*3, 50 mm/s + 2 Rhy	Four groups of 3 leads at 50 mm/s, with the two selected rhythm leads (R1, R2) at the bottom of the page at 50 mm/s.
		2*6, 50 mm/s + 2 Rhy	Two groups of 6 leads at 50 mm/s, with the two selected rhythm leads (R1, R2) at the bottom of the page at 50 mm/s.
	Rhythm Lead R1	Select lead for the first rhythm lead on the screen and printout.	
	Rhythm Lead R2	Select lead for the second rhythm lead on the screen and printout.	
	Measurements	Select **yes** or **no** to print a detailed table of measurement results.	
	Markings	Select **yes** or **no** to print reference markings on the ECG average cycle print. A vertical marker shows the beginning and end of P wave and QRS, and the end of the T wave.	
	Interpretation	Select **yes** or **no** to print interpretation statement (C version only).	
	Patient Header	Select **yes** or **no** to print patient header and details. Note that this option is **only available when 1*12 or 2*6 is selected** for the ECG printout (above), otherwise is always set to **yes.**	

Art. no.: 2.510858 Rev. f

Parameter	Options	Description	
Autom. Format Extended (Only for 14 wire (16 lead) patient cable)	ECG Printout 16	No Printout 16	No printout of the ECG given at the end of an auto mode recording (the recording can be stored in the memory and printed at a later time if required).
		4*4, 25 mm/s, 1 page	Leads are printed in a 4*4 format at 25 mm/s (one page).
		4*4, 25 mm/s, 2 page	Leads are printed in a 4*4 format at 25 mm/s (two pages).
		4*4, 50 mm/s, 1 page	Leads are printed in a 4*4 format at 50 mm/s (one page).
		4*4, 20 mm/s, 2 page	Leads are printed in a 4*4 format at 50 mm/s (two pages).
	Average Cycles	No Printout	No printout of average cycles.
		4*4, 25 mm/s + 1 Rhy(R1)	Leads are averaged over the entire 10 second recording and printed in 4 groups of 4 leads at 25 mm/s, with the rhythm leads (R1) defined at the bottom of the page.
	Rhythm Lead R1	Select lead for the rhythm lead (R1) on the screen and printout.	
	Measurements	Select **yes** or **no** to print a detailed table of measurement results.	
	Markings	Select **yes** or **no** to print reference markings on the ECG average cycle print. A vertical marker shows the beginning and end of P wave and QRS, and the end of the T wave.	
Programmable Leads	Lead 1 to Lead 12, (1 to 16 when a 14-wire patient cable is defined)	Define the lead order for user leads (see next setting).	
Lead	ECG Cable	Define the patient cable, 10-wire, or 14-wire.	
	Lead Sequence	This sets the lead sequence for manual and auto printouts as well as on the screen. Set to **Standard or Cabrera.**	
	Signals	**Sequential** or **Simultaneous**.	
	Auto Centring	**Yes** or **No**. Printer trace alignment affects both the manual as well as the automatic printout. A change of the current setting is only valid on the printout after a new number of printer channels is selected by pressing the key during or before printing, or after a new lead group is selected by pressing the lead keys during printing.	
	Auto Sensitivity (Reduction)	**Yes** or **No**. In auto mode a default recording sensitivity of 10 mm/mV is set. However, if the amplitudes are high meaning that the QRS peaks would overlap, the sensitivity is reduced automatically to 5 mm/mV. When this is set an A appears in the information line on the bottom of the screen (see **LCD Screen,** page 18).	
	Lead configurations	Define the lead configuration as required - set to On of Off. Lead configurations are as follows: • **Standard** • **Right precordial (V4r)** • **Right precordial (V3r - V6r)** • **Left Posterior (V7 - V9)** • **NEHB (Chest)** • **NEHB (Extremities)** • **Progr. leads** • **Balanced** • **Right Precordia**l Balanced and Right Precordial are only available when a 14 wire (16 lead) patient cable has been defined above.	

Art. no.: 2.510858 Rev. f

Parameter	Options	Description
General	QRS Beeper	**On** or **Off**
	Show Results on Display	At the end of an Auto test, display the results on the screen (**Yes**) or don't display (**No**).
	Inv. ECG Monitor	Inverse the screen display. Select **Yes** or **No**.
	Autom. printout	At the end of an Auto test, print the results (**Yes**) or don't print (**No**).
	Autom. storage	At the end of an Auto test, store the results (**Yes**) or don't store (**No**).
	Autom. transmission	At the end of an Auto test, transmit the results (**Yes**) or don't transmit (**No**). The transmission settings are defined in system settings - menu key > comm. tab (see **System Settings,** page 105).
	Preview	**Yes** or **No**. Give a preview of the recording for conformation before printing.
	QTc Formula (see note below)	This defines the way that the QTc value is calculated. The options are as follows: • Bazett • Fredericia • Framingham • Hodges The formula used is indicated on the printout in the Intervals measurement table, under the QTc value (in brackets).
	Culprit Coronary Artery Algorithm	Select On or **Off** to apply the Culprit Coronary Artery Algorithm for auto mode recordings (see **Culprit Coronary Artery Algorithm,** page 57).
	CCAA PCI centre distance	When CCAA is selected ON, enter the distance to the nearest PCI centre.

The QT interval is the time from the start of the Q wave to the end of the T wave and represents the time taken for ventricular depolarisation and repolarisation.

The corrected QT interval (QTc) estimates the QT interval at a heart rate of 60 bpm and allows comparison of QT values over time at different heart rates and improves detection of patients at increased risk of arrhythmias.

The formula to calculate the QTc value is based on one of the following:

- Bazett's formula: $QTc = QT / \sqrt{RR}$
- Fredericia's formula: $QTc = QT / RR^{1/3}$
- Framingham formula: $QTc = QT + 0.154 (1 – RR)$
- Hodges formula: $QTc = QT + 1.75 (\text{heart rate} – 60)$

RR interval is given in seconds (RR interval = 60 / heart rate).

Art. no.: 2.510858 Rev. f

5 Spirometry (Option)

5.1 Intended use

The Spirometry option is designed to carry out pulmonary function tests on persons of all races and sex, from the age of 5 years. The objective of these tests is to diagnose a lung disease and find the extent of the abnormality by following a patient during the course of his/her disease to determine the efficiency of treatment or the need for supplemental oxygen and mechanical ventilation. It is also useful in determining if pre-operative patients can withstand any intended surgery, to assess disability and to decide whether an individual can perform an occupational task requiring a certain workload.

Routine pulmonary function tests can be used to determine if a patient complaining of dyspnea (shortness of breath) or fatigue has a lung disease and, if so, whether it is an obstructive, restrictive, or vascular disease or a disease of the control of ventilation.

The Spirometry option can be used to measure Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), $FEV_{1.0}$ / FVC, $FEF_{0.2\text{-}1.2}$, $FEF_{25\text{-}75\%}$, $FEF_{75\text{-}85\%}$, PEF, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FIVC, $FIV_{1.0}$, $FIV_{1.0}$ / FIVC, PIF, $FIF_{50\%}$, SVC, ERV, IRV, TV, MVV, RR, TV, in patients 5 years of age or older.

5.2 Introduction

The spirometry function is available when the spirometry sensor is plugged into the RS-232 connector on the right hand side of the unit. Three pulmonary function testing modes are available for the measurement of inspiratory and expiratory values as follows:

- FVC Forced Vital Capacity
- SVC Slow Vital Capacity
- MVV Maximum Voluntary Ventilation

Measurements are made with one of two open pneumotach sensors - the SP-250 or the SP-260. The SP-250 has a disposable, single patient mouthpiece assembly eliminating the need to clean the sensor after each use. The SP-260 has a disposable filter that must be changed after every patient and the mouthpiece sterilised.

Art. no.: 2.510858 Rev. f

5.3 Pulmonary Test Overview

5.3.1 Forced Vital Capacity (FVC)

For this test the patient must exhale as quickly as possible from the time of starting the test.

The FVC test employs the `Back extrapolation` method. If the extrapolated volume is too large (>0.15 litres or 5% of FVC), then a warning appears on the display.

The patient must exhale as quickly as possible from the time of starting the test so be sure that he/she understands what is required. If inspiratory measurements are required, the exhalation can be immediately followed by a maximum inhalation. The inspiration results will be given on the printout.

The coordinates represent the graph on which the curve will be drawn with the respiratory volume in litres being represented on the vertical axis and the time in seconds on the horizontal axis.

The flow can be shown as a loop if desired (see above). Define loop in the Setup menu (see **Spiro Settings,** page 93).

5.3.2 Slow Vital Capacity (SVC)

The patient should breathe normally 3 times and then inhale as much as possible to maximum lung capacity, and then exhale as fully as possible.

5.3.3 Maximum Voluntary Ventilation (MVV)

The patient should breathe as deeply and as rapidly as possible over a period of 6 to 12 seconds.

⚠ CAUTION

▲ Care should be exercised when performing this test as there is a danger of hyperventilation. Ensure that the patient is sitting down.

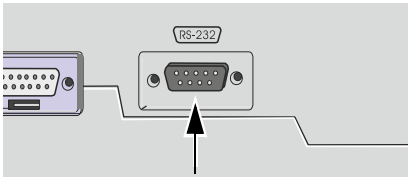
5.3.4 Post-Medication Tests

The post-medication tests are carried out in the same way as the pre-medication tests (three measurements stored). The printout following post-medication tests will give the curves of both pre and post-medication tests. The measurement results are shown as the best results (pre/post), results as a percentage of those predicted (both pre and post), and the percentage change (i.e. difference) between pre and post-medication results.

The diagnosis resulting from the pre-medication test is also given on this printout if set.

Art. no.: 2.510858 Rev. f

5.4 Preparation



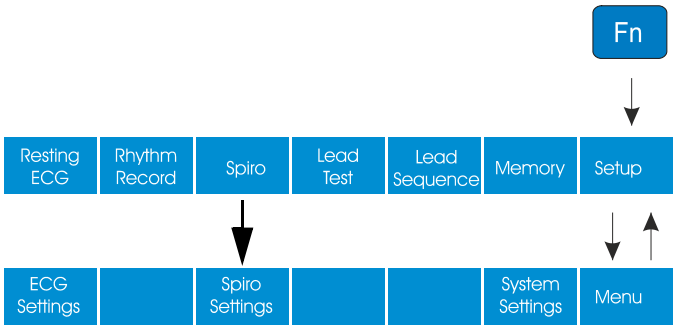
1. Plug the sensor into the RS-232 connector on the right side of the unit.

2. Switch on the unit and press the **Spiro key** to enter the spirometry screens.

▲ Ensure that the connection cable is not exposed to excessive mechanical stress. Whenever disconnecting the sensor, hold the plug and not the cable.

▲ The flow sensor contains a sensitive measuring device. Do not allow the sensor to be dropped or subjected to any sudden blows.

The norm values and the spiro settings are set in the **Spiro Settings screen.** Enter the spiro settings screen at any time by pressing the Function key to display the settings - select Spiro settings:



The spiro settings are detailed later (see **Spiro Settings,** page 93). All settings are stored when the unit is switched off.

Art. no.: 2.510858 Rev. f

5.5 Schiller PFT filter

The SCHILLER Pulmonary Function Test (PFT) filter is a one-time use, bacterial filter designed to help minimise the danger of aerial contamination and the risk of cross infection when performing pulmonary function tests. It is designed to be used with both the SP-250 and SP-260 spiro sensors and fits over the mouthpiece to form an airtight seal.

The PFT filter fully fulfils the latest recommendations from both the American Thoracic and European Respiratory Societies (ATS & ERS).

5.5.1 Why use SCHILLER PFT filters?

Patients and staff are susceptible to the risk of infection when performing pulmonary function tests. Pre-pulmonary function test screening for infection by request form, although helpful, cannot be a substitute for more effective control measures. Most outpatients visiting pulmonary function departments are not routinely screened for infectious diseases prior to performing tests. Even when patients are screened, there may be a significant time interval between obtaining culture results and performing the tests. It is very difficult to identify all the patients with infectious diseases or who have low immune protection. A recent study showed as many as 40% of patients with chronic obstructive pulmonary disease (COPD) had positive sputum cultures to potentially pathogenic microorganisms[1]. Therefore, universal stringent precautions for everyone needing pulmonary function tests are necessary[2]. A paper has shown that ultra-clean techniques should be used when performing most routine pulmonary function tests[3].

The most practical and cost-effective way to ensure that there is no risk of cross-infection between patients is to use SCHILLER PFT filters. Other advantages offered by using SCHILLER PFT filters are as follows:

- Very high-end hygienic protection for patients and staff from inhaling pathogens. (Many centres now use staff to perform pulmonary function tests on the equipment (biological controls), which can be used as part of the quality assurance programme.)
- Protection of flow sensors from contamination by droplets of saliva and mucus that may introduce errors in test measurement and contain microorganisms[4, 5].
- No time delay for disinfection.
- No personal / room needed for disinfection.
- The filter in the SP-260 sensor does not need to be changed after each patient.

Art. no.: 2.510858 Rev. f

1. Banerjee D, Khair OA, Honeybourne D. Impact of sputum bacteria on airway inflammation and health status in clinical stable COPD. Eur Respir J 2004; 23: 685–691.
2. Denison DM, Cramer DS, Hanson PJV. Lung function testing and AIDS. Respir Med 1989; 83: 133–138.
3. Zhang Y. High justification for universal stringent precautions in lung function testing. Letter to editor. Resp Med 2005; 99: 1064–1066
4. Townsend MC, Iiankinson JL, Lindesmith LA, et al. Is my lung function really good? Flow-type spirometer problems that elevate test results. Chest 2004; 125: 1902–1909.
5. Zhang Y. Using barrier filters to protect spirometer sensors from droplet deposition. Letter to editor. Chest 2005; 127: 2294.

5.5.2 Attaching the PFT filter

⚠ CAUTION

Only use bacterial filters approved by SCHILLER. Use of any other filters can cause incorrect measurements.

⚠ CAUTION

- ▲ One-time use only - do not use the PTF filter for more than one patient. Do not attempt to clean the filter.
- ▲ After use, dispose the PFT filter in the clinical waste.
- ▲ The PTF filter can only be positioned in one direction. Attach the round end over the mouthpiece as shown. The filter is tapered and no force is needed to connect the filter to the mouthpiece. Do not over tighten.

SP-250 Sensor

To avoid damage to the sensor, attach the PFT filter to the SP-250 disposable mouthpiece before positioning the SP-250 disposable mouthpiece in the sensor handle (see next page).

SP-260 Sensor

Attach the PFT filter to the mouthpiece. If the SP-260 filter has been changed, the PFT filter can be attached either before or after the mouthpiece is positioned in the handle (see **SP-260 Sensor,** page 81).

5.5.3 Disposal

After use, dispose the PFT filter in the clinical waste.

Art. no.: 2.510858 Rev. f

5.6 Changing the Mouthpiece

5.6.1 SP-250 Sensor

⚠ CAUTION

- ▲ The disposable mouthpiece is designed for one-time use to eliminate the danger of cross contamination - do not use the mouthpiece for more than one patient. Do not attempt to clean the mouthpiece.
- ▲ After use, dispose the complete mouthpiece in the clinical waste.

The disposable mouthpiece must be changed after every patient even when the SCHILLER PFT filter is used. This is because the mouthpiece is designed for one patient use (not less than approximately ten tests) and the metallic filter can return inaccurate results if used for more than one patient.

1. Remove the disposable mouthpiece (if not already disposed) by gently but firmly pulling it away from the handle.
2. Discard the complete mouthpiece.
3. Position a new disposable mouthpiece - align with guide slot in the sensor handle and gently but firmly click it in position.

The disposable mouthpiece can only be positioned in one direction and no force is necessary to insert it on the handle. Ensure that the orientation is correct by checking the guide protrusion in the mouthpiece against the guide slot in the handle.

Art. no.: 2.510858 Rev. f

5.6.2 SP-260 Sensor

⚠ CAUTION

- ▲ The filter is not reusable - replace the filter after every patient (see note below).
- ▲ After use, dispose the filter in the clinical waste.
- ▲ Thtwyllie.stephenhe **mouthpiece is reusable** - thoroughly disinfect the mouthpiece assembly before using for another patient.

The filter must be changed after every patient. However, if the SCHILLER PFT filter is used (see **Schiller PFT filter,** page 78), bacterial cross infection is significantly reduced and the filter can be used for more than one patient. When the PFT filter is employed it is recommended that the filter be changed every quarter (three months).

1. Remove mouthpiece by gently but firmly pulling it away from the handle.

2. Unscrew the mouthpiece counter clockwise, discard the filter and dispose in the clinical waste.

3. Thoroughly disinfect the two parts of the mouthpiece assembly.
4. Position a new filter (Art. No. 2.100123) in the threaded half of the mouthpiece as shown, and screw the two halves of the mouthpiece together. Ensure the filter is firmly held with no air gaps.

5. Insert the mouthpiece in the handle. The mouthpiece can only be inserted in one direction. A moulded lip in the mouthpiece prevents incorrect insertion. The sensor is now ready for the next patient.

Art. no.: 2.510858 Rev. f

5.6.3 SP-260 Mouthpiece Disinfectants

Standard hospital disinfectant can be used to disinfect the mouthpiece (SP-260 sensor). The following disinfectants have been tested and approved.

Disinfectant	Maximum Immersion Time [hours]	Concentration [%]
Sekusept Extra N	1.0	2
	0.5	3
Sekusept Forte	1.0	1
Sekusept Plus	1.0	1.5
Sekusept Powder	1.0	2
Sekudrill	0.25	100
Velicin forte	0.25	25
Aseptisol	0.25	2.5
	0.5	1.5
	1.0	1.0
Gigasept	4.0	10
Lysetol V	4.0	10
Cidex	10.0	100

5.6.4 Non-admissible disinfectants

Never use products containing the following:

- Organic solvents
- Ammonia-based detergent
- Abrasive cleaning agents
- 100% alcohol, Virex, Sani-Master
- Sani-Cloth®, Ascepti® or Clorox® wipes
- HB Quat®
- Conventional cleaner (e.g. Fantastic®, Tilex® etc.)
- Conductive solution
- Solutions or products containing the following ingredients:
  - Acetone
  - Ammonium chloride
  - Betadine
  - Chlorine, wax or wax compound
  - Ketone

Art. no.: 2.510858 Rev. f

5.7 Unit Calibration

▲ The unit must be calibrated with the first pulmonary function test of the day and after every significant temperature change.

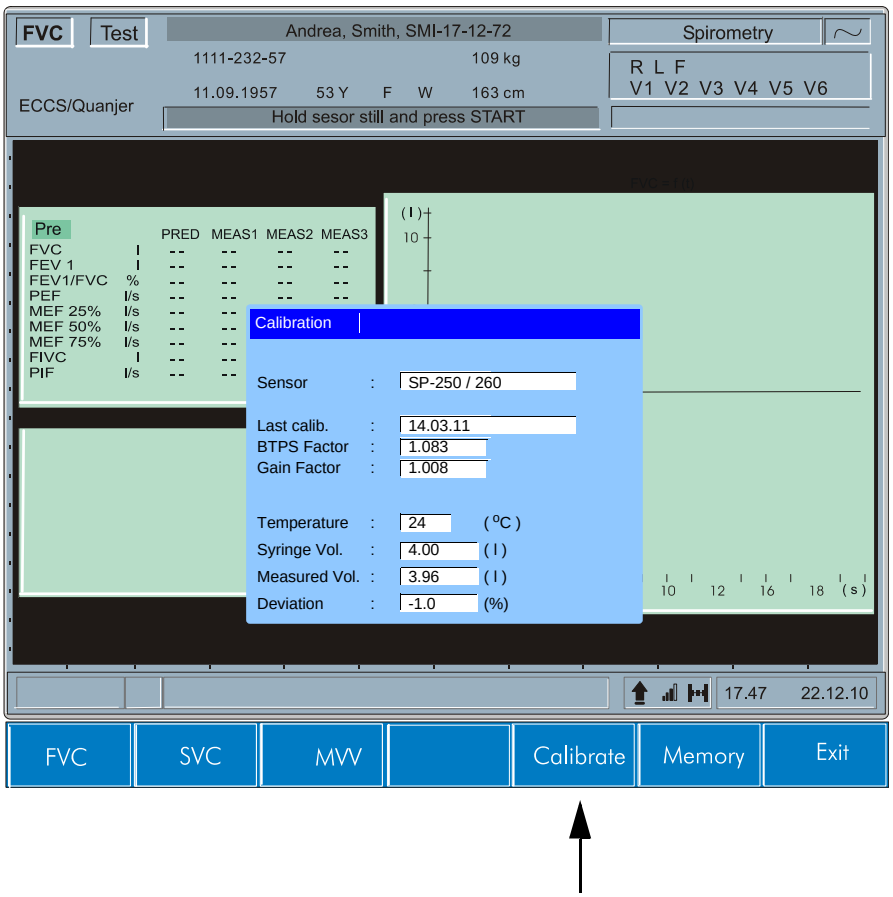
To calibrate the unit proceed as follows:

1. Prepare the sensor (see previous pages).
2. Connect the calibration pump to the mouthpiece. Ensure that there are no air leaks.

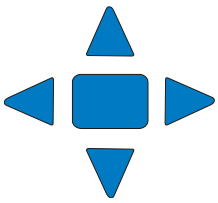
Calibration must be carried out without the PFT filter attached.

Art. no.: 2.510858 Rev. f

3. Select the Calibration icon from the spiro screen. The calibration screen is displayed:



4. Enter the ambient temperature and press the confirm key.
5. Enter the reference volume of air (depending on the size of the calibration pump and times of pumping; e.g. a 2 litre pump pumped 2 times = 4 litres).
6. Press the confirm key (centre arrow).



7. The **Measured Vol** field is now highlighted. Press the **Auto Start** key and pump 3 to 6 litres of air through the sensor.

Make sure that the flow sensor is kept still during the pumping operation.

Art. no.: 2.510858 Rev. f

While pumping, the unit records the volume being pumped through the flow sensor and indicates it on the display.

STOP

8. Press the **Stop** key when finished pumping.
9. The message **Calibration complete** appears on the display in the message bar.

10. Press the **Print** key to obtain a printout of the calibration if required.

ESC

11. Press the **Esc** key to exit the calibration screen.

If the message **Excessive Deviation** or **Change the Filter** appears on the screen after a calibration, it indicates that the difference between the measured volume and the entered volume is too great (>12%). Check the temperature setting, the syringe volume and the entered syringe volume. If these are all correct change the mouthpiece and re-calibrate.

5.7.1 Calibration Information

Last Calibration — Date of last calibration

BTPS Factor — Factor calculated BTPS (=> Body Temperature, Ambient Pressure, Saturated with water vapour) value. This value compensates for the difference in inhaled and exhaled humidity. The unit is set for measuring exhaled volume (100% humidity, Temp 36.8°C), and so when inhaled volume is measured this factor is applied. The CARDIOVIT AT-102 plus uses ambient temperature to calculate the BTPS factor. This is sufficient for accurate FIVC calculation. The formula used is as follows:

$$BTPS = \frac{P_b - P_{H2O}}{P_b - 47} * \frac{273.15 + 37}{273.15 + Tu}$$

Where: $-273.15^oC = 0^o$ absolute (0^o K)

P_b =716 mmHg (at 500 metres above sea level)

P_{H2O} = the vapour pressure of water (mmHg)

Tu = the ambient temperature in degrees centigrade

Gain Factor — Calculated value between measured and effective calibration air volume.

Temperature — Ambient temperature in ^oC (or ^oF) dependent on device setting.

Measured Volume — Air volume measured by the system from the calibration pump.

Reference Volume (syringe) — Entered air volume depending on the size of the calibration pump and times the air was pumped through the sensor; e.g. pumping 2 litres 3 times amounts to 6 litres (the recommended volume with a 2 litre pump is 4 litres and with a 3 litre pump 6 litres).

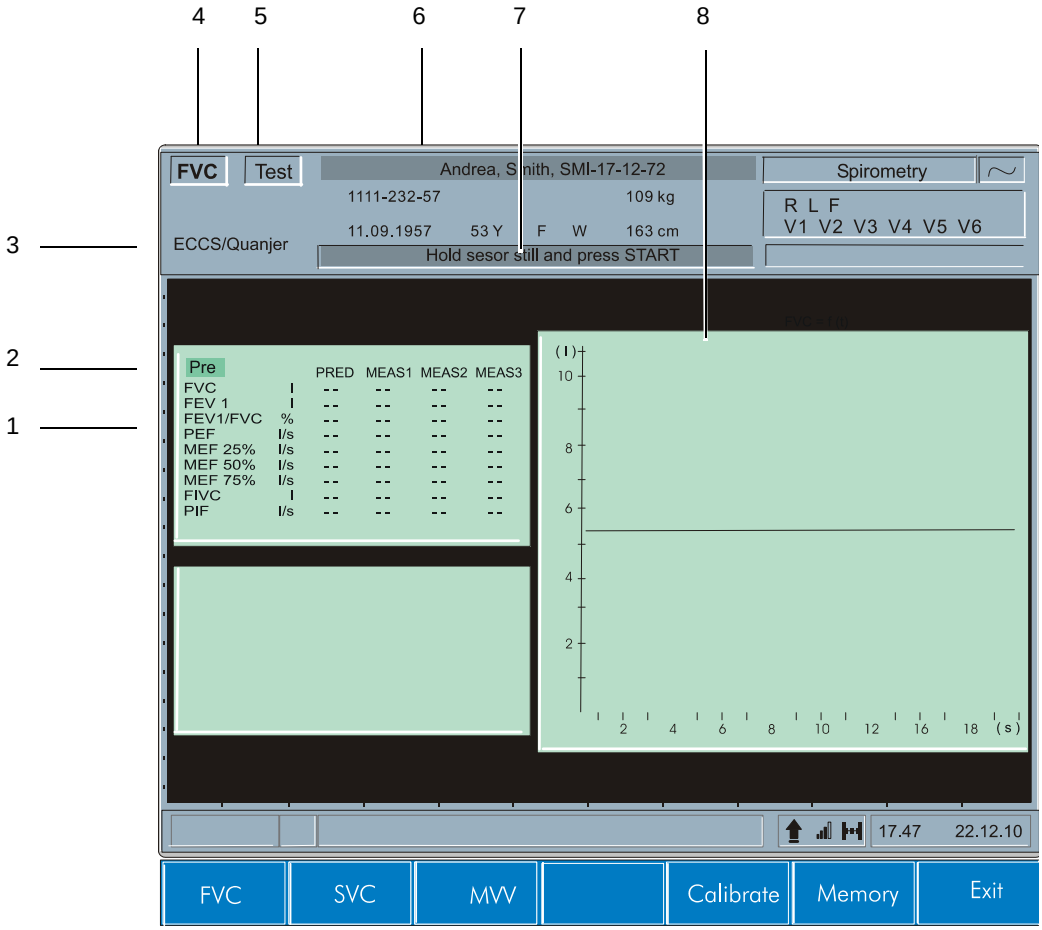
Deviation — Deviation percentage as a factor calculated between measured and effective calibration air volume.

Art. no.: 2.510858 Rev. f

5.8 Taking a Spiro Measurement

⚠ CAUTION

- ▲ It is important that all patient data is entered correctly. In particular gender, date of birth, ethnicity, height and weight must be entered for correct predicted values and diagnosis.
- ▲ False measurements can result when the sensor is not held vertically - ensure that the sensor is held upright at all times during tests.



(1) Result table (last measurement taken)

(2) Pre or Post test selected (see following)

(3) Normal values selected (and used to calculate predicted values)

(4) Current test selected

(5) Test or View mode (from memory).

(6) Patient data

- Last name, first name
- Patient number
- Date of birth
- Calculated age
- Gender: male (M), female (F)
- Ethnic: white (W), black (B)
- Weight (kg)
- Height (cm)

(7) Message / Instruction line

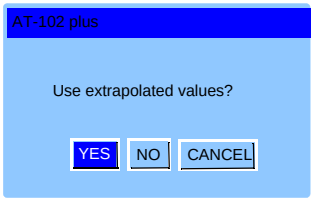
(8) Spiro Graph (real time, last measurement taken, or view mode (from memory)

Art. no.: 2.510858 Rev. f

5.8.1 Procedure

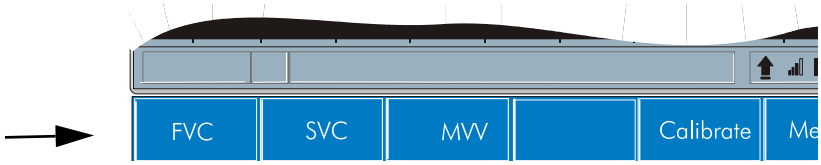
1. Calibrate the unit (see **Unit Calibration,** page 83).
2. Set / change spiro settings and / or Norm values if required (see **Spiro Settings,** page 93). Press the **Spiro** key from the spiro acquisition screen.

3. Enter patient data (see **Patient Data,** page 32) - the Patient data is displayed in the top of the screen.



- **Note:** If the patient data entered is outside the standard range of the selected norm value (i.e. too tall, short, heavy, old, etc.), you are prompted to use extrapolated values.
- When **Yes** is selected, the predicted value is based on extrapolated values using the selected norm value formulae. When **No** is selected, no predicted values are given.

4. Select test - FVC, SVC or MVV.

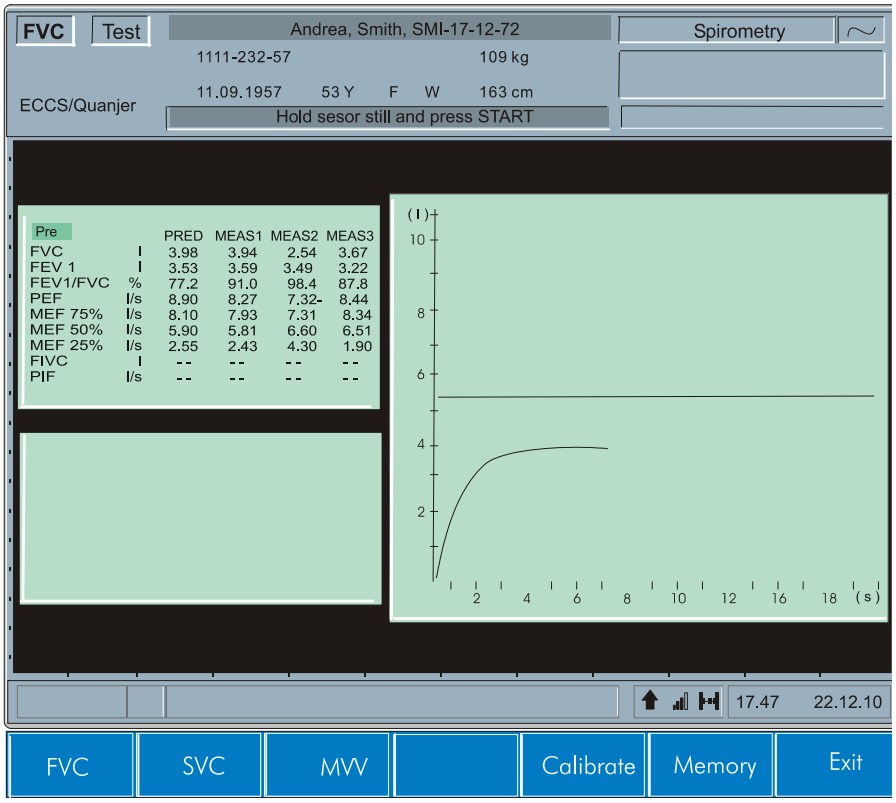


Art. no.: 2.510858 Rev. f

For all tests the procedure is the same:

AUTO

1. Press the **Start** key.
   – The flow sensor must be held quite still and no air should be breathed into the device for at least one second before and after the **Start** key is pressed.
   – Patient blows into the mouthpiece.
   – As soon as the patient starts to breathe into the mouthpiece, the unit begins to record the expiratory flow. The corresponding curve is represented on the display. The break-off point for the expiration measurement is reached automatically (or the Stop key is pressed).



STOP

2. On completion of the test, press the **Stop** key.
   – Once the stop key is pressed, the curve of the last test taken is shown on the centre right of the screen along with the measurement results which are displayed on the centre left of the screen.
3. Repeat as many times as required.

It is recommended that a minimum of three measurements are taken.

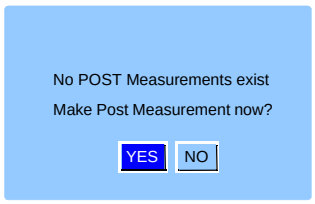
4. Store the recording for future viewing or to take a post recording.

Art. no.: 2.510858 Rev. f

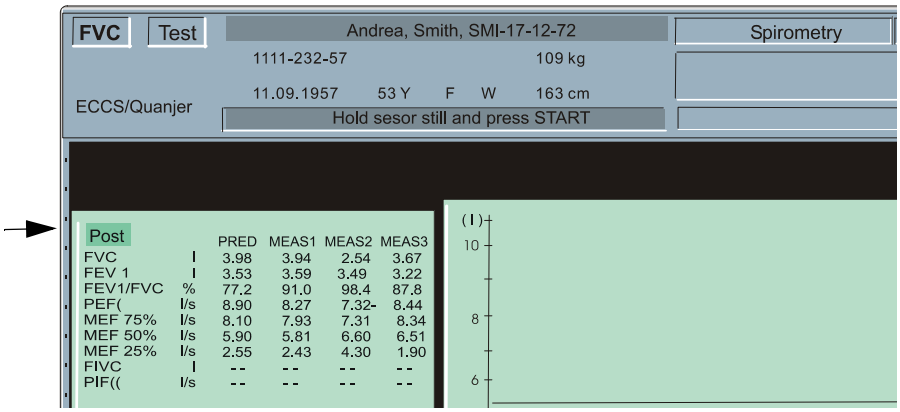
5.8.2 Taking a Post Recording

After a recording has been made, the post option is given in the soft-keys. Press the Post key to record a post spiro recording:

When a spiro recording is open from the memory and no post recording exists, a message is displayed asking if a post recording is to be made:



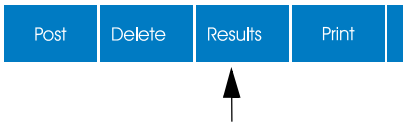
5. When Yes is selected, the Spiro acquisition screen is entered and a Post recording can be made as described earlier.



Art. no.: 2.510858 Rev. f

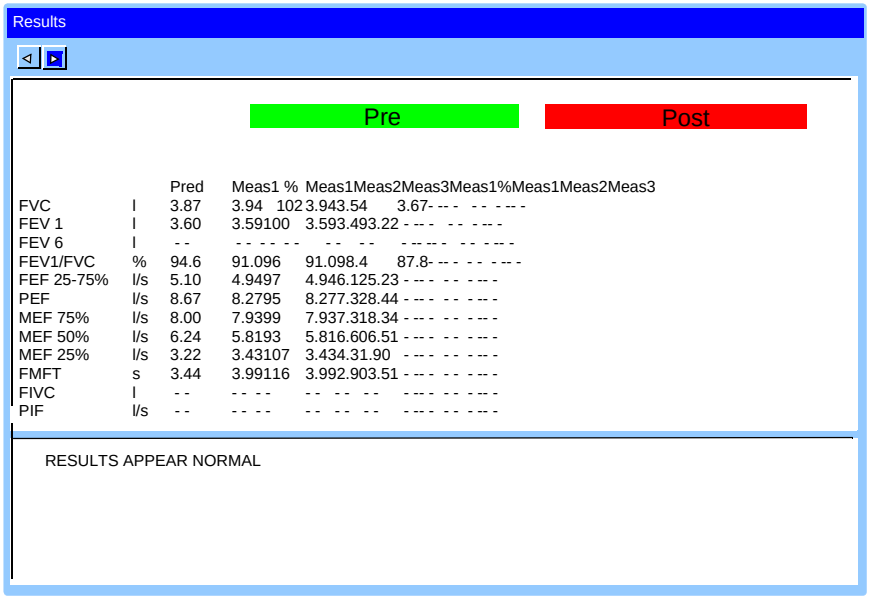
5.9 Displaying the Results

Following a series of patient measurements the best two results are stored along with the last test made. That is, the two measurements with the highest FVC + FEV1 values will be saved and given as MEAS 1 and MEAS 2* along with the last measurement taken (MEAS 3). These three results can then be printed in graphical and tabular form.



The measurement table is displayed with the **Results** icon. This screen gives the three highest measured values from all the tests taken, and the predicted values (calculated from the entered patient data).

The percentage (%) difference column gives the percentage difference between the pre and post values (Meas1).



When the arrows are clicked (top left corner of the results screen) more measurements are given as follows:

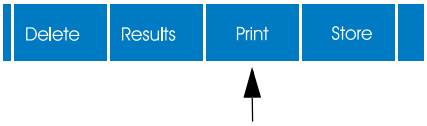
- VC
- ERV
- IRV
- TV
- MVV
- RR
- TV

Best can also be selected for view. This is set in Spiro settings (see **Spiro Settings,** page 93). The definition of best is given later in this section (see **Definition of Best,** page 92).

Interpretation is given below the results table. Details of interpretation and normal calculations are given later in this section.

Art. no.: 2.510858 Rev. f

5.10 Obtaining a Printout



Two different print data formats can be defined; these are defined in Spiro settings (see **Spiro Settings,** page 93).

➜ For **format 1** press the **print** key
➜ For **format 2** press the **Function key** followed by the print key.

When a printout is requested (**format 1 or 2**) either **Best** or **All Measurements** (defined in spiro settings (see **Spiro Settings,** page 93)) are printed along with the following:

- The patient data
- The selected norm values
- The date of last calibration
- The date and time of the printout
- The software version
- PEF

- and a combination of the following when enabled in the settings screen:

- FVC Graph
- Flow graph
- The diagnostic statement

When American/ITS standards are stipulated (see **Spiro Settings,** page 93), the following message is given on the printout if the deviation (as stipulated by the American Thoracic Society) between the best and second best measurements is ≤200 ml.

ATS criteria met

When the difference is greater than 200 ml, the following message is given:

ATS criteria not met

The result displayed is in accordance with ATS recommendations. When subsequent tests are made, the result with the highest value will always be saved and given in the measurement columns.

For definition of best (see **Definition of Best,** page 92).

Art. no.: 2.510858 Rev. f

5.11 Best and Predicted Values

5.11.1 Definition of Best

In accordance with the American Thoracic Society (ATS) Spirometry Standard, the best measurement is defined as the highest value from the calculation:

Best = FVC + FEV1

The Spirometry Program takes the best value from a test according to the above equation and defines this as Meas. 1. When 'Best' is selected (see next page) this definition is also used with the exception of FVC and FEV1 which takes the highest absolute value from the three measurements (Meas 1, Meas 2 or Meas 3).

5.11.2 Predicted Values

The predicted values (%) given on the printout may differ slightly from the values that would be obtained if manually calculated. The reason is that the measured and predicted values on the printout are rounded to two decimal places, the processor however, uses the actual values - measured to three decimal places - to calculate the percentage (%) of predicted value. This can account for a possible variation. Where a difference exists, the values given on the printout are always the more accurate.

The norm values are defined in spiro settings (see next page).

Ethnic Influences on Predicted Norm Values

Predicted values may vary according to the following:

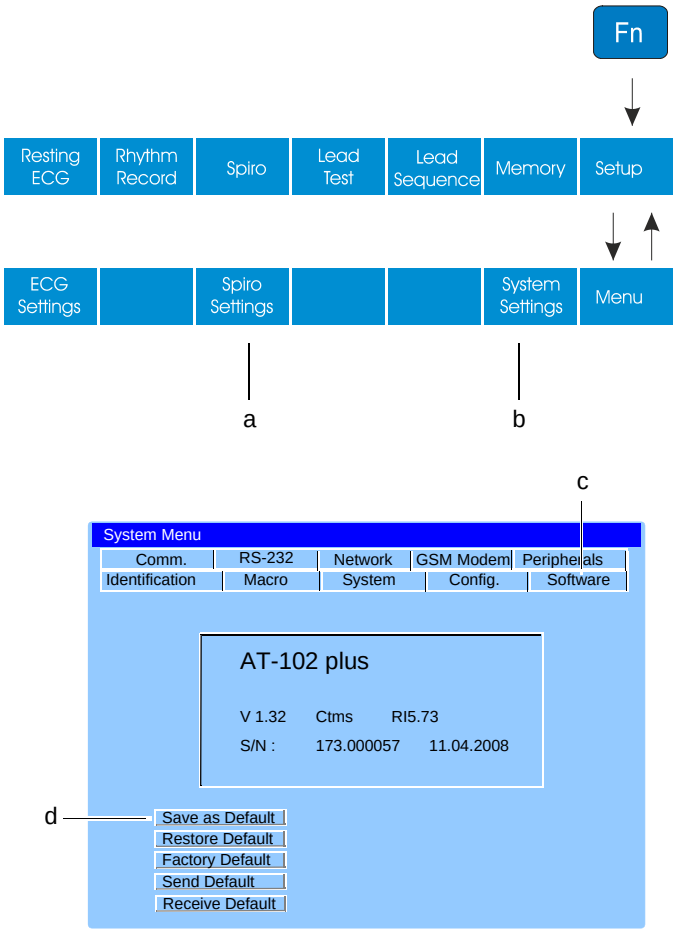
- Language set for the unit
- Norm value selected
- Ethnic origin of the patient

The influence of these factors is detailed later in this section (see **Ethnic Influences on Predicted Norm Value,** page 138).

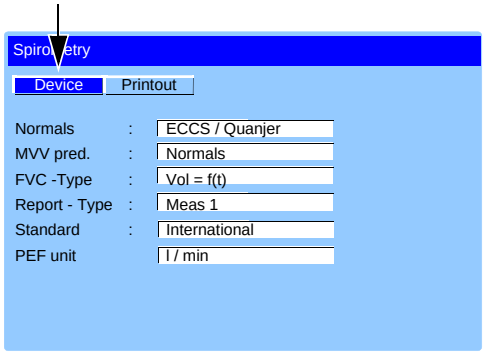
Art. no.: 2.510858 Rev. f

5.12 Spiro Settings

All changed settings are remembered until the unit is switched off. If you wish to keep the settings as default, system settings must be entered **(b)**, the software screen must be entered **(c)**, and the **Save as default** icon **(d)** pressed, before the unit is switched off.



The Spiro settings are entered by pressing the **Spiro settings (a).**



Art. no.: 2.510858 Rev. f

Normals

Select between:

- Nhanes III (Hankinson)
- Knudson / ITS
- Knudson 76/ ITS
- Crapo / ITS
- Morris / ITS
- Polgar/ ITS
- Composite
- ECCS / Quanjer
- Forche 97 (Austria)
- Berglund
- Finland
- India

The Normal value standards are given later in this section.

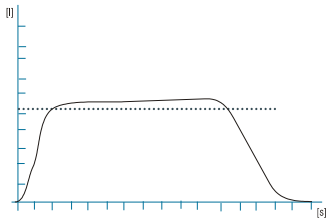
MVV Pred.

Select between:

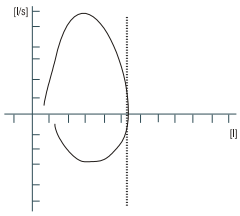
- Normals - The MVV predicted value is calculated by the selected norm value.
- 25 * FEV1 - The MVV predicted value is given as 25 times the FEV1 predicted value (calculated by the selected norm value).
- 35 * FEV1 - The MVV predicted value is given as 35 times the FEV1 predicted value (calculated by the selected norm value).

FVC Type

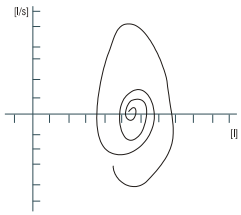
This defines how the FVC graph is displayed and printed. The options are:



FVC Volume = f(t)



FVC Flow = f(V)



FVC Flow = Loop

Report Type

This defines the measurement on which the interpretation is to be based. When **Meas1** is set, the interpretation is based on the measured values when FVC + FEV1 is the maximum value. When **Best** is selected, the values are again defined from the FVC + FEV1 formula above except when the FVC, FEV1 to FEV6 value is higher in either Meas 2 or Meas 3. When this is the case, the highest individual value (from the three measurements) is taken.

Standard

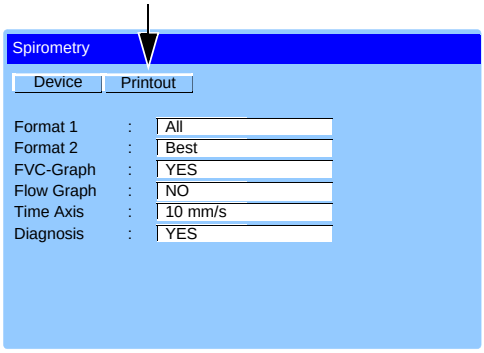
Select between **International and American/ITS**. When American/ITS standards are stipulated the result displayed is in accordance with ATS recommendations and a message is given on the printout if the deviation (as stipulated by the American Thoracic Society) between the best and second best measurements is ≤200 ml (ATS criteria met) or > 200 ml (ATS criteria not met).

PEF

Peak Expiratory flow calculation given in **litres/minute** or **litres/second**. Note that this setting also applies to the printout.

Art. no.: 2.510858 Rev. f

5.12.1 Spiro Printout Settings



This defines the format and content of the printout (when **Copy 1** or Co**py 2** key is pressed).

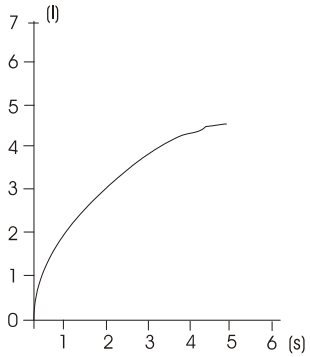
The settings are as follows:

Format 1 and Format 2

This refers to the printout obtained when **Copy 1** or **Copy 2** keys are pressed. Print **Best** or **All** measurements.

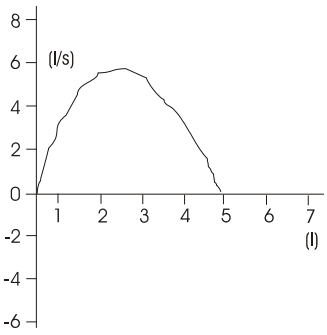
FVC Graph

Print (**Yes**) or don't print (**No**)



Flow Graph

Print (**Yes**) or don't print (**No**)



Time Axis

Select between **10 mm/s** or **20 mm/s**

Diagnosis

Print diagnosis (**Yes**) or don't print (**No**)

Art. no.: 2.510858 Rev. f

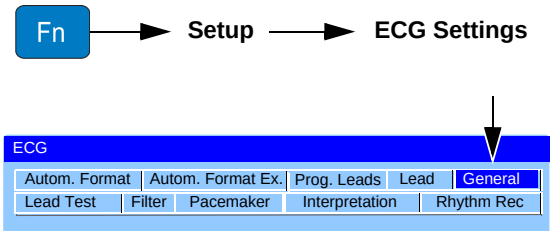
6 Memory

Recordings can be stored locally, and/or transmitted to a PC. This can be carried out either automatically or manually after a recording has been taken. Recordings stored in memory can also be transmitted at any time.

6.1 Storing a Recording

6.1.1 Automatic Storage

The auto storage setting is defined in ECG settings (for both **ECG and Spiro recordings**):



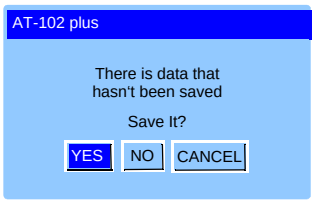
- **ECG Key > General tab** - **Autom**. **storage** (yes/no - see **ECG Settings,** page 69).

When a screen is left after a recording has been made, you are prompted to save the recording.

6.1.2 Manual Storage

To store an auto mode recording (resting ECG or Spiro) manually, press the **Store Data** icon at any time.

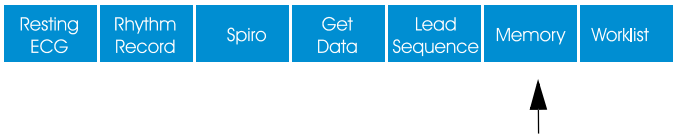
When another screen is selected after a recording has been taken in a different mode and not saved, the following prompt is given to enable the user to save.



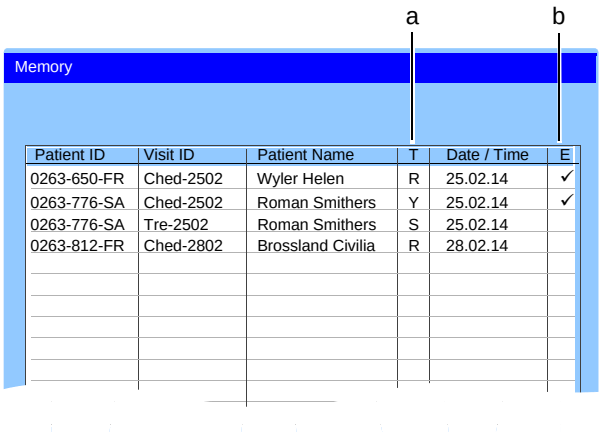
Art. no.: 2.510858 Rev. f

6.2 Using the Memory

Up to approximately 350 recordings in total (memory and worklist) can be stored by the CARDIOVIT AT-102 plus. Note that a maximum of 30 rhythm recordings can be stored and that worklist entries take two entries.



When the **Memory** key is pressed the memory screen is entered and stored recordings displayed:



The recordings are listed by Patient ID. The type of recording is indicated in the T column **(a)**, as follows:

- R = Resting (ECG)
- S = Spiro
- Y = Resting Rhythm

Because rhythm recordings require larger memory space, rhythm recordings are stored on an SD card that must be inserted in the unit.

Export

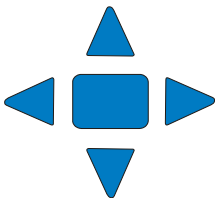
- E = Exported - a tick in the status column **(b)** means that the recording has been exported.

Patient Data

At any time when the memory screen is displayed, press the **patient key** to display the patient data for the highlighted patient. Note that this is for information only and no editing functions are available.

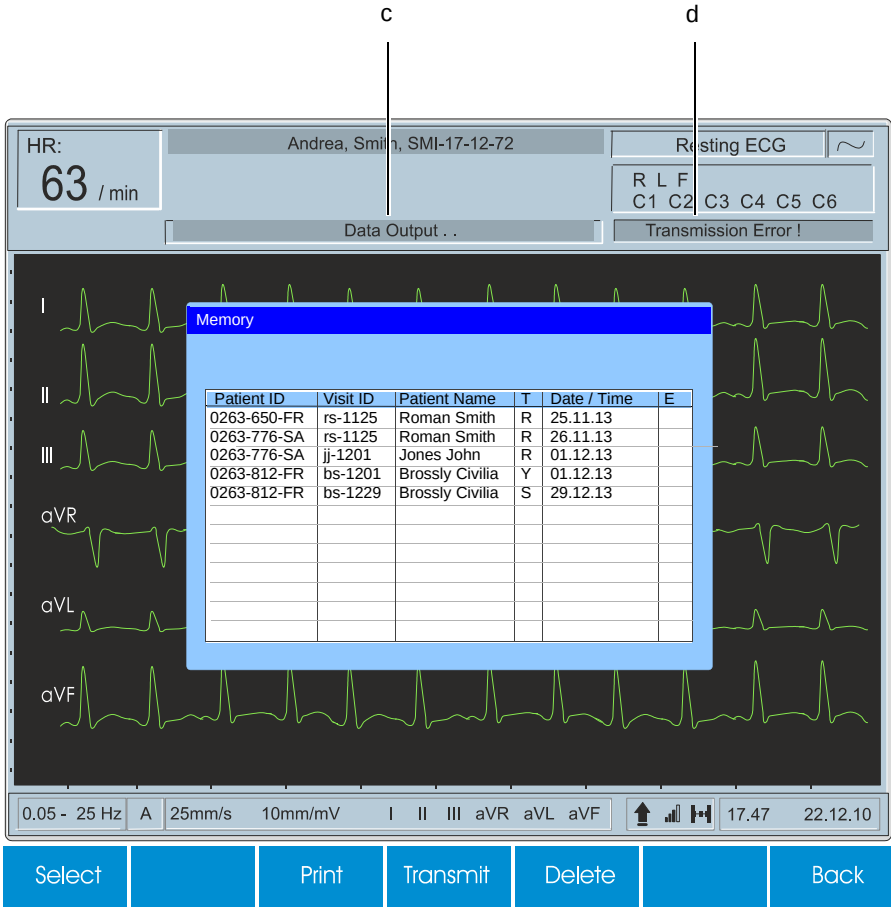
Art. no.: 2.510858 Rev. f

6.2.1 Transmitting, Printing and Deleting Stored Recordings



1. Highlight the selected file by moving the cursor with the **up/down arrow keys**.
2. Press the **Confirm key (**middle key) to select the recording. The recording is highlighted with a black background when selected (deselect a recording by pressing the confirm key again).
3. Repeat steps 1 and 2 to select further recordings.
4. use the soft-keys to carry out required function:
   - Transmit
   - Print
   - Delete

When the option has been selected a message is displayed in the message bar **(c)** indicating that the requested operation has been completed. If an error occurs or the selected operation cannot be carried out, an error message is given in the message field **(d)** (see **Transmission Error Messages,** page 117).



Transmit options are given in system settings (see **Table of Unit Settings,** page 106).

Art. no.: 2.510858 Rev. f

6.2.2 Selecting Recordings in Memory / Worklist

Selecting all Files

To select all recordings press the **function key (** Fn **) and key A**.

To deselect all, press Fn + A again.

Selecting all Unsent files

Press **Fn** Fn **+ V,** - all files that have **not been sen**t will be tagged.

Use this function for example to transmit all the files that have not been transmitted yet by selecting with Fn + V and then clicking the transmit icon.

Selecting all files that have been sent

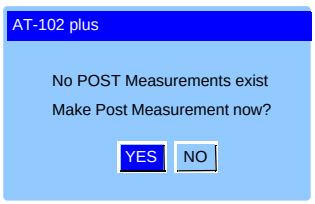
Press **Fn** Fn **+ T**, - all files that have **been sent** will be tagged.

This function is useful, for example, to delete all sent files.

6.2.3 Extra Options for Spiro Recordings

To view spiro recordings (and make post recordings), the unit must be in spiro mode before displaying the memory screen.

When the unit is in the spiro acquisition screen and the Memory key is pressed an extra icon (read) appears. When the read icon is pressed, you are prompted to view the highlighted recording or to make a post recording. Viewing and making a post spiro recording are detailed in the spiro section (see **Taking a Post Recording,** page 89).



Art. no.: 2.510858 Rev. f

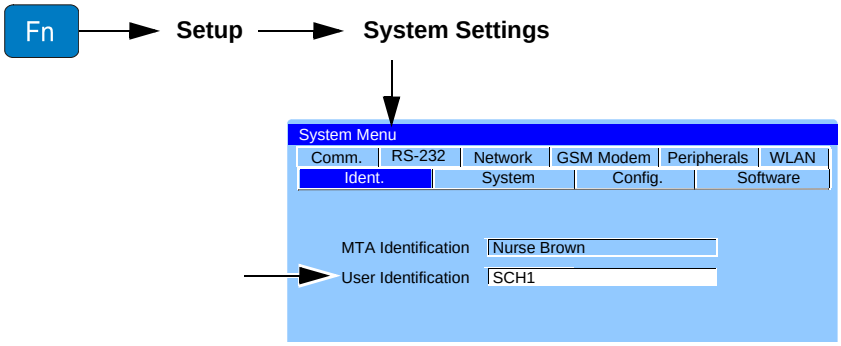
7 Worklist (Option)

7.1 What is a Worklist?

The Worklist function enables a Doctor / Administrator to define a Worklist of patients that require recordings to be made. The Doctor can define the patient, room / department, and specify the type of recording to be made. The Worklist is defined directly from the Hospital information system (HIS) and after the recording has been made by the CARDIOVIT AT-102 plus, the recordings are sent back to the HIS for examination, validation and storage.

The HIS can also specify the recording type to be made or can state ‘undefined’. When this is the case only the patient demographics are sent to the unit.

- To use the worklist function the unit must be setup to communicate with the SEMA as defined in system settings (see **Network Setup,** page 110).
- SEMA has options to send a worklist to a specific unit or to all units on the system. To receive a joblist, the User Identification (unit ID) of the CARDIOVIT AT-102 plus (Device ID in the system) must be the same as that defined for the HIS. This is usually set when the unit is first commissioned.
  - Note that the ID must not be more than four characters, for example EMR1 or DEV1.
  - The user identification can be checked in the settings menu:



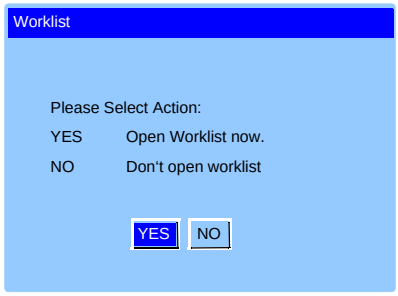
Art. no.: 2.510858 Rev. f

Notes

When in the Worklist mode, it is indicated in the information line on the display.

At any time when the Worklist screen is displayed, press the **patient key** to display the patient data of the highlighted patient. Note that this is for information only and no editing functions are available.

- It is possible to open the worklist directly on power-up or to have the unit prompt if you wish to open the Worklist directly on power-up.



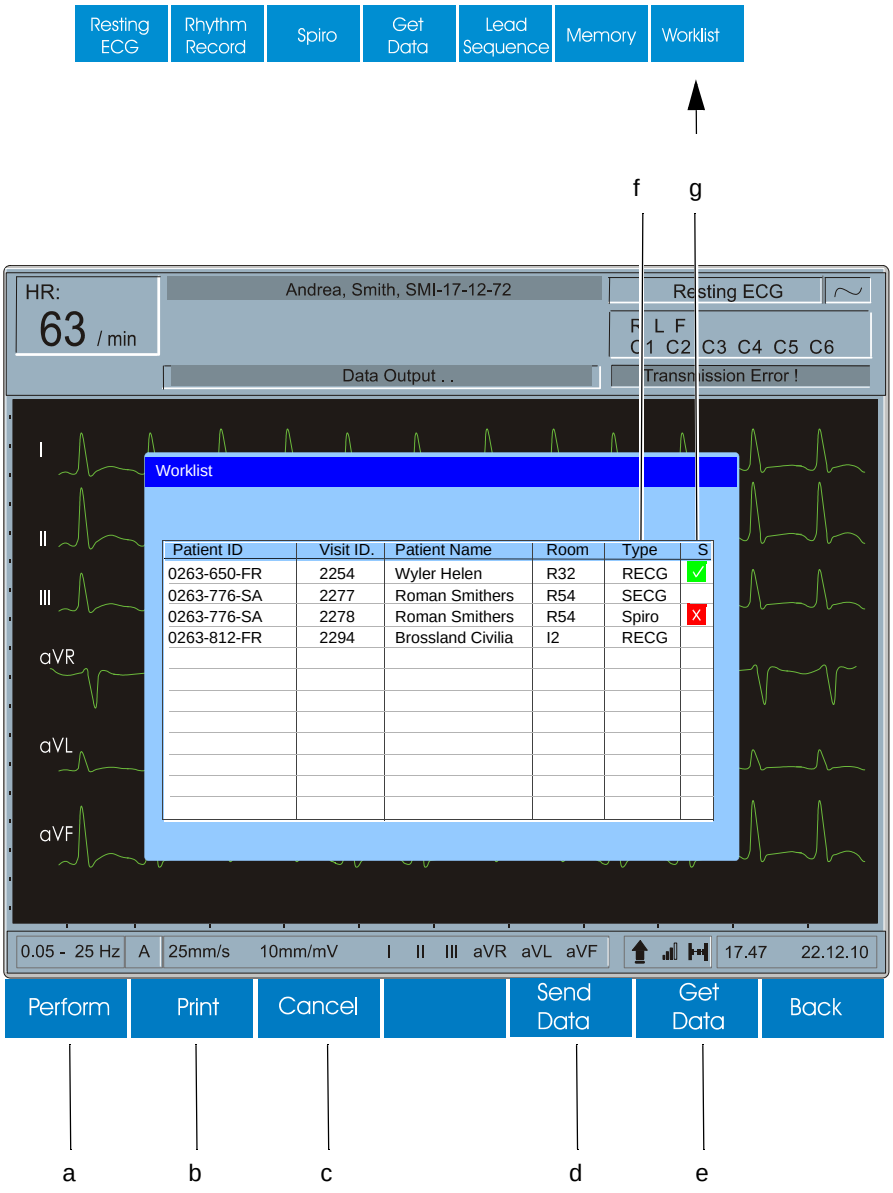
- It is also possible to retrieve a worklist automatically or have the unit prompt if you wish to upload a worklist when the worklist is opened.

These settings are defined in system settings (config. tab see **Confg.,** page 107).

Art. no.: 2.510858 Rev. f

7.1.1 Receiving a Worklist

- To open the Worklist select **Worklist** from the main menu.



To receive a worklist from a HIS, press the **Get Data** (e) key to download the Worklist from the Server. Wait (up to a few minutes) for the Worklist to be populated.

All patients entered on the Worklist along with number and room number, etc., are displayed. The type of recording **(f)** to be made is as follows:

- **RECG** - Resting
- **RHY** - Rhythm ECG
- **Spiro** - Spirometry recording

Art. no.: 2.510858 Rev. f

7.1.2 Printing the Worklist

Click the print key (**b),** to print the worklist.

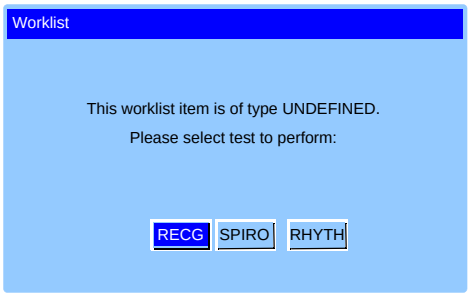
7.1.3 Taking a Worklist Recording

1. Prepare patient and using the up / down arrows **(a)**, highlight the patient and then select **Perform (a).**
   – The patient screen is displayed. Confirm / edit the patient data as required.
   – The data acquisition screen is entered for the defined recording type **(f)**.

Note that the acquisition screen for the defined recording type is defined and cannot be changed.

2. Take the recording:
   – Resting ECG (see **Automatic Mode Recording,** page 51)
   – Spiro (see **Pulmonary Test Overview,** page 76)

If a recording type has not been specified, you are prompted to define:

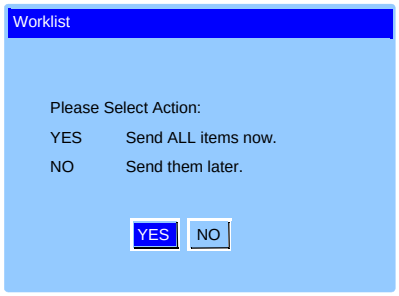


3. After the recording has been made the status line shows that the recording has been made. Status signs shown in the **S (Status) (g)** column are as follows:
   – ✓ recording made
   – X recording could not be carried out for whatever reason and has been cancelled by the CARDIOVIT AT-102 plus user by selecting **Cancel icon (c)**.
   – When no status symbol is shown it means that the recording is waiting to be taken.

Art. no.: 2.510858 Rev. f

7.1.4 Sending Worklist Recordings to the HIS

- It is possible to send performed recordings on a worklist automatically or to have the unit prompt if you wish to send worklist items. This setting is defined in system settings (config. tab see **Confg.,** page 107).

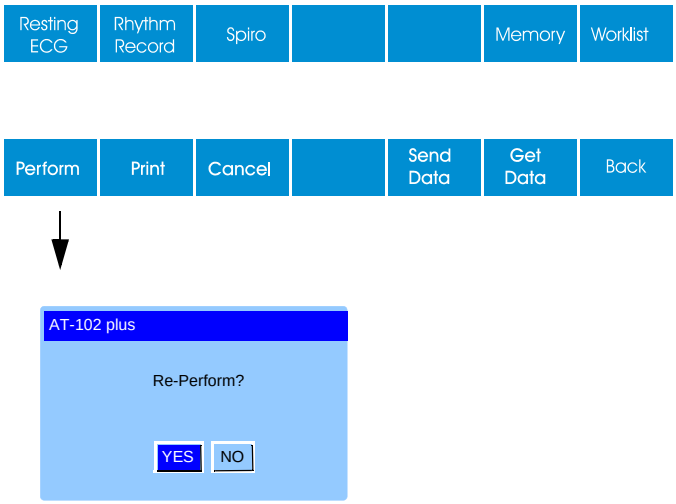


1. Press **Send Data (d)** to upload to the database.
2. Wait (up to a few minutes) while the recordings are sent - the Worklist will go blank after the files have been sent.

Any Worklist requests that have been recorded (✓ in the status column), or cancelled (X in status column), remain in the Worklist. This means that completed recordings can be sent at any time without losing other Worklist requests that have not been recorded.

7.1.5 Retaking a Worklist Item

If an ECG has been performed and for any reason you wish to perform it again, select the item and again click on the **Perform** soft-key. You are prompted to confirm. The previous recording will be overwritten.



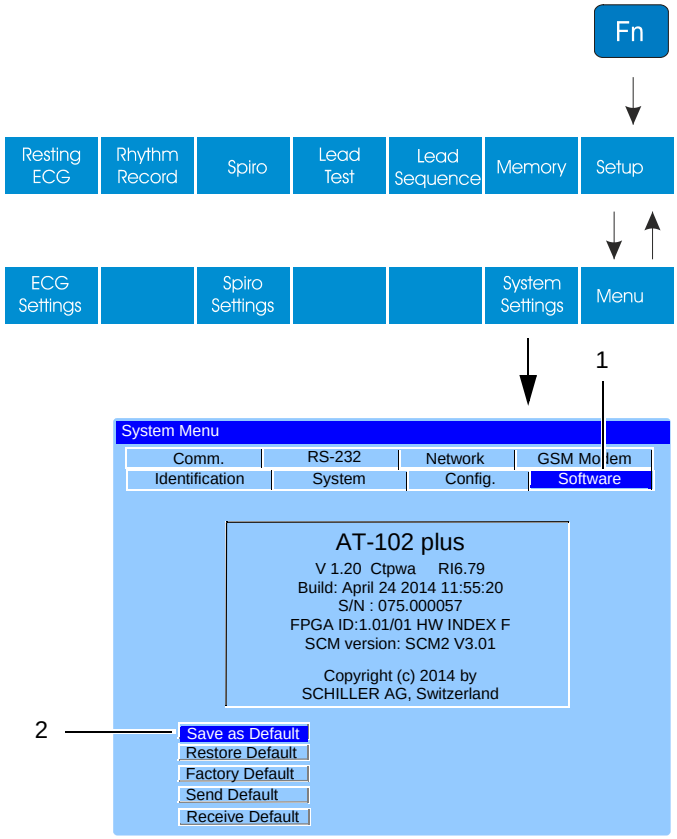
Art. no.: 2.510858 Rev. f

8 System Settings

To display the system settings press the Function key **(Fn)**. The end soft-key changes to **Setup**.

8.1 Saving Settings as Default

All changed settings are remembered until the unit is switched off. To keep the defined settings as default, the software screen must be entered **(1)**, and the **Save as default** icon **(2)** pressed before the unit is switched off.

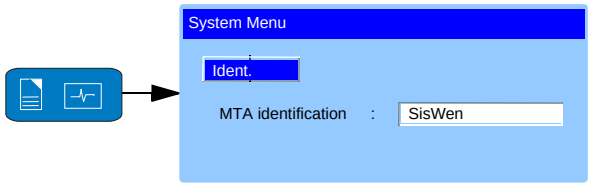


The Restore Default, Factory Default, Send Default and Receive Default icons on this screen are detailed in the following unit settings table.

Art. no.: 2.510858 Rev. f

8.2 Table of Unit Settings

Parameter	Options	Description
Identification	MTA Identification	This function is to register the name of the medical assistant or doctor carrying out the recording. The MTA is identified on each automatic printout. The maximum number of characters is 20.
	User Identification	This function is to register the name and identity of the unit (for example of the department, section, etc.). It is identified on each automatic printout. This also identifies the device in a system when requesting a worklist from SEMA (see **Worklist (Option),** page 100). Note that when this is used for worklist with SEMA, the maximum number of characters is 4, for example EMR1 or DEV1.
System	Language	Select required language between German, English, French, Swedish, American, Italian, Spanish, Portuguese, Russian, Dutch, Finnish, or Danish. Note that the difference between English and American is that some of the designations used on the display and printout are different. For example, American use V1-V6 lead designation, and the heart rate is BPM. Additionally, ethnic, predicted values and norm equations can be different with more options when American is selected. Note: When the language is changed it should be ensured that the appropriate keypad is used (for example the EN and DE keyboards have the Y and Z characters swapped and different language versions have different characters). When the language is changed it must be saved (see previous page) and the unit switched off and on again for the setting to be stored.
	Time	Set current time.
	Date	Set current date.
	Date Format	Set required date format.
	Time Format	Set required time format.
	Take server time	Set time from the server time (networked units only).
	Colour	Set the display colour to **Cyan**, **Grey**, **Black** or **Blue**. The colour must be confirmed as default as follows: 1. Set colour in this menu option. 2. Click the **software tab**, and in the software screen confirm **Save as Default.** Exit the menu**.** 3. Switch the unit off, and then on again to confirm. Note that the screen can also give a reverse image. This is defined in ECG > General tab (see **Table of ECG Options and Settings,** page 69).
	Volume	Select between **Low, Middle** or **Loud**. This sets the volume for system beeps, QRS beeps, etc. The volume must be confirmed as default as follows: 1. Set volume in this menu option. 2. Click the **software tab**, and in the software screen confirm **Save as Default.** Exit the menu**.** 3. Switch the unit off, and then on again to confirm.
	Caps Lock	Tick to set the default caps lock on. The caps lock is indicated in the information line and switched on/ off by pressing Fn Caps key  +  . 

Parameter	Options	Description
	Power Up Screen	This defines the first screen displayed when the unit is switched on. Select between: • ECG display • Patient data screen The save settings as default (see **Saving Settings as Default,** page 105) must be set to remember this setting for the next switch on.
	Prompt for MTA ID	Select between **Off, At Startup,** or **At new Patient**. When set, the MTA ident screen is displayed for the MTA to enter his/her ID at startup (when the unit is switched on), or every time a new patient is selected. 
	Erase after send	Off or On. Erases a resting ECG recording from the memory after it has been successfully sent.
Confg.	Patient Data Input	Add an additional data field in the patient data input menu as follows: • Med./Rem. (Medication / Remarks). • Med./Doc. (Medication / Doctors' Name). • Med./Room (Medication / Room No.). • Room/Doc. (Room No. / Doctors' Name). • Room/Rem. (Room No. / Remarks). • Doc./Rem. (Doctors' Name / Remarks). The selected field will be displayed in the patient data entry (see **Patient Data,** page 32).
	Units	Define units in **cm/kg** or **inch/lbs**.
	Temperature Unit	**Celsius** or **Fahrenheit**.
	Unit Pressure	**mmHg** or **hPa**.
	Patient Query	Select between **Pat ID** or **Ref. No**. This determines the patient field that must be entered to enable PDQ (patient data query). This can be entered via the keypad or via a barcode reader (see **Barcode Reader,** page 35).
	Database Access	Select between **Off, Manual** or **Automatic**. • **Off** means that PDQ is disabled. • **Manual** means that patient data is imported when the **Get Data key** is pressed. • **Automatic** means that the patient data is imported as soon as the Pat ID / Ref. No. is entered.
	Worklist Retrieve	This defines when worklists should be retrieved. Select between **Manual, Ask** or **Automatic**. • **Manual** means that a worklist is imported when the **Get Data key** is pressed. • **Ask** means that the unit will prompt if worklist items should be retrieved when the worklist opens. • **Automatic** means that the worklist items are imported directly when the worklist opens.

Art. no.: 2.510858 Rev. f

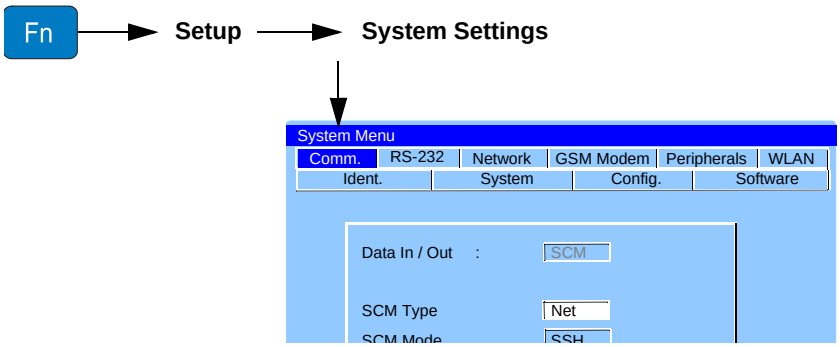
Parameter	Options	Description
	Worklist Send	This defines when worklist items are sent back to the HIS. Select between **Manual, Ask** or **Automatic**. • **Manual** means that worklist recordings are transmitted when the **Send Data key** is pressed. • **Ask** means that the unit will prompt to send after a test has been made. This setting will also prompt if there are unsent recordings when the worklist is opened. • **Automatic** means that the worklist recordings are sent automatically after they have been taken or the worklist opens.
	Worklist Start	This defines how the worklist will be opened when the unit is switched on. Select between **Manual, Ask** or **Automatic**. • **Manual** means the worklist is opened from the memory screen (see **Worklist (Option),** page 100). • **Ask** means that you are prompted to open the worklist on power-up. • **Automatic** means the first screen entered on power-up is the worklist screen.
	PDF Export	This defines the location of PDF files, select between the following: • **Off** - normal printing with the thermo printer. • **USB printer** - print on an USB printer. • **USB Stick** - export the PDF on an USB Stick.
Software	Software Version Display	The current software version for the CARDIOVIT AT-102 plus. Also displayed is the serial number of the unit and any options that are installed as follows: Base configuration (upper case) C = Interpretation Options (lower case) t = thrombolysis p = pacemaker measurement w = worklist a = CCAA (Culprit Coronary Artery Algorithm) for example Cpw is a C unit (interpretation), with pacemaker measurement and worklist. The FPGA ID is the firmware identification and version. The Hardware Index indicates the hardware build as follows: • Hardware index A, B, C and D, indicates a 12 lead (channel) unit. • Hardware index E indicates a 16 lead (channel) unit. • Hardware index F and later indicates a 16 lead (channel) unit with enhanced WLAN module. The SCM version is the software version of the SCHILLER communication module that controls external communication.
	Save as default	Save current settings as default.
	Restore default	Restore settings to the defined default.
	Factory default	Restore settings to the factory default.

Art. no.: 2.510858 Rev. f

Parameter	Options	Description
	Send default	Store current default setting to a PC (usually a service technician will carry this out). The unit must be connected to a computer with the SCHILLER communication tool (SCOT) installed. When the **send default** icon is clicked **all unit settings** (ECG and exercise settings, data format, language, communication, etc.) are sent to the SCOT program where they are stored and can be edited. These settings can then be copied to other units so that all units have the identical settings.
	Receive default	The unit must be connected to a computer with the SCHILLER communication tool (SCOT) installed. When the **Receive default** icon is clicked **all unit settings** in the SCOT program are transferred to the connected CARDIOVIT AT-102 plus.

8.2.1 Communication Settings

The following settings are available when the Comm. tab is pressed in the System menu:



The settings are as follows:

Parameter	Options	Description
Data In / Out	SCM	Data transmission using the SCHILLER communication module. This is the only mode of transmission with the CARDIOVIT AT-102 plus.
SCM Type	Net GSM	Select **Net** for data transmission over a network, i.e. Ethernet or WLAN. Select **GSM** for transmission over the mobile phone network (12-lead version only).
SCM Mode	---	• No encryption and data compression selected.
	SSH+ZIP	• Encryption and data compression.The SSH server certificate is provided by SCHILLER.
	ZIP	• Only data compression.
	SSH	• Only encryption.

The network and the GSM settings are detailed on the next pages

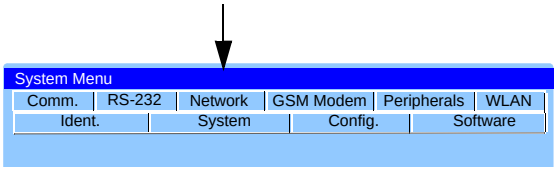
Art. no.: 2.510858 Rev. f

RS-232 Settings

The RS-232 interface is used for connection of a spiro sensor and for servicing purposes only. The Baud rate settings given in this screen are only applicable for software update (see the service handbook for details).

Network Setup

These settings are only applicable when **SCM** and **Net** have been selected (see **Comm** tab, previous page).



Parameter	Options	Description
IP address	0.0.0.0.	Identifier address of the device in the TCP/IP network. If set 0.0.0.0 the IP address will be set by the DHCP server.
Net mask	255.255.255.0	Network sub-net mask.
Gateway	192.016.040.254	Gateway IP address. If you have no gateway use the defined IP address.
Server	192.016.040.001:8080	Server IP address.
Page	/SCS/SCSServlet	Storage address at the Server.
User Name	user name	User name entry (Server).
Password	password	Password entry (Server).
WLAN - SSID		The network name.
WLAN - Key[a]		Network encryption key (password).
WLAN - Code[b]		Authentication (encryption) method - select for the router configuration. Select between OFF (open network), WEP[c], WPA / WPA2 (protected network), WPA / WPAE (protected network) or AEP/TLS (certified network with code provided by server - see **WLAN,** page 112).

a. Key here means the network password.
b. Code here means encryption technology (the standard WLAN encryption is called WPA or WPA2).
c. WEP is a weak encryption method and is also not recommended as a form of encryption. It is strongly recommended that CARDIOVIT AT-102 plus is never used with an open network.

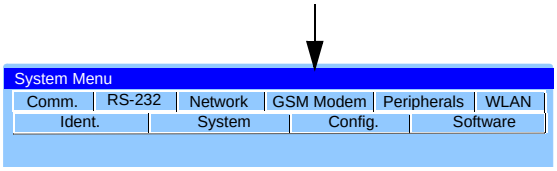
A unit with the wireless LAN option installed is indicated by the WiFi alliance symbol on the rear of the unit.

Contact your system administrator for details of the network setup. Typical setups are given in the SCHILLER communication book (Art. No. 2.520036).

Art. no.: 2.510858 Rev. f

GSM Modem

These settings are only applicable when **SCM** and **modem** have been selected.



Parameter	Options	Description
Phone No.	00,41,417664242	Enter telephone number to be dialled. If it is necessary to enter a pause in the dialling sequence enter a comma (,) in the number. The comma gives a one second pause. If a longer pause is required, two or more commas can be entered. This may be required for example, if you have to wait for an outside line. It is also a good idea to insert a pause after a national or international code. It is also possible to give a gprs address, for example gprs.swisscom.ch
Phone User Name	User name	User name entry (modem dial up)
Phone Password	Password	Password entry (modem dial up)
Country ID	Country ID	The country ID codes are a requirement to meet international telephone line interface requirements. The codes are for modem use only and are unrelated to the international telephone numbers. The Country ID's specified in the current version are as follows: Country IDCountry 0 United States America 32 South Africa 37 Australia 38 Austria 44 France 45 Germany 62 Sweden 63 Switzerland For European countries not in the list use the German code, i.e. **Country ID = 45** For other countries not listed use the default modem setup i.e. Country ID = 0

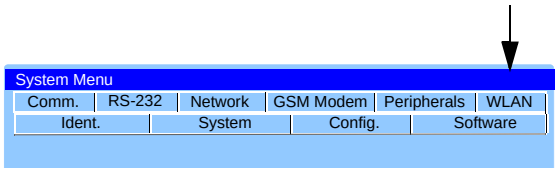
Art. no.: 2.510858 Rev. f

Peripherals

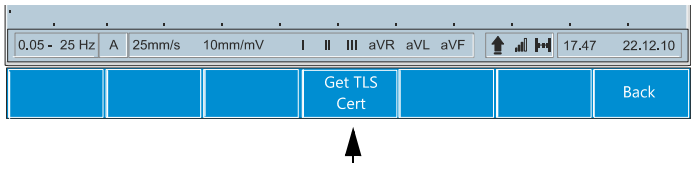
The peripherals tab is not applicable for the AT-102 plus.

WLAN

The WLAN tab and settings are only applicable to hardware index F versions. The Hardware index is displayed on the software tab (see **Software,** page 108).



Parameter	Options	Description
IP address	0.0.0.0.	Identifier address of the device in the TCP/IP network. If set 0.0.0.0 the IP address will be set by the DHCP server.
Net mask	255.255.255.0	Network sub-net mask.
Gateway	192.016.040.254	Gateway IP address. If you have no gateway use the defined IP address.
User Name	user name	User name entry (network hub).
Password	password	Password entry (network hub).
Encryption	AES, TKIP	This is the authentication used for WPA or WPA2 systems. Select between TKIP or WPA systems and AES for WPA2 systems. Please consult the router configuration.
Authentication	LEAP, PEAP	This is the authentication used for WPA or WPAE systems. Authentication algorithm used for some setups. Select between **Lightweight Extensible Authentication Protocol (LEAP)** or **Protected Extensible Authentication Protocol (PEAP)**. Please consult the router configuration.
Certificate and Password		This is the authentication used for AEP/TLS systems.The certificate and password must be obtained from the server that the unit is to be connected. When the certificate and password is obtained, it is copied to a USB stick and inserted in the USB connector on the back panel. The **Get TLS CERT tab** that is present when in the WLAN screen, must be pressed and the certificate and password entered. No other authentication is required.



The type of encryption, authentication, certification and password is selected in network settings (see **Network Setup,** page 110).

Art. no.: 2.510858 Rev. f

Authentication WLAN Configurations

Authentication	Required Configuration	Notes
None	• None	
WEP	• Settings > System > Network > WLAN-Key	
WPA / WPA2 Personal	• Settings > System > Network > WLAN-Key	
WPA / WPA2 - Enterprise	• Settings > System > WLAN > User-name • Settings > System > WLAN > Password	
TLS	• Settings > System > WLAN > User-name (=username linked with the certificate)	Prior steps: 1. Certificate on USB stick in folder ‘cert’. 2. Connect USB stick on device. 3. Enter certificate password in Settings > System > WLAN > Password Cert. 4. Press softkeys ‘Get TLS cert’. 5. Message ‘Certificate OK’.

Art. no.: 2.510858 Rev. f

9 Transmission Overview

9.1 Transmission Options

Transmission is possible over a network or GSM. Wireless transmission is possible when the optional WLAN module is installed. The options are as follows:

- When the unit is part of a network (LAN, WLAN, HIS, etc.), transmitting / receiving over any other transmission medium, or exposed to the internet, appropriate security measures must be provided to protect patient data.
- Data security is the sole responsibility of the user.

Wireless LAN

CARDIOVIT AT-102 plus to / from HIS server using a wireless LAN.

Network LAN (SCM)

CARDIOVIT AT-102 plus to / from a HIS server using an (ethernet) wired LAN. For an ethernet (network) connection, connect the cable assembly to the RJ-45 connector (see **Back Panel,** page 25).

GSM (not all hardware variants)

This function is transmit only. The GSM SIM card is inserted in the GSM slot at the rear of the unit.

The SCHILLER Communication Server (SCS) is required for communication with SEMA for PDQ and worklist. Details of communication setups are available in the SCHILLER Communication Guide.

Art. no.: 2.510858 Rev. f

9.2 Setup Overview

9.2.1 Network

To setup to transmit recordings over a network and/or receive worklists and patient data, proceed as follows:

1. Enter the setup menu and click the Comms tab. Set the SCM Type to Net:
   – **Setup > Comm. > SCM type > Net**
2. Set the transmission parameters:
   – **Setup > Network > network address, passwords and other parameters (**see **Network Setup,** page 110**)**

Connect the network cable to the RJ4 on the back panel (if connected to a wired network).

Wireless Network

1. Enter the setup menu and click the Comms tab. Set the SCM Type to Net:
   – **Setup > Comm. > SCM type > Net**
2. Set the transmission parameters:
   – **Setup > Network > network address, passwords and other parameters**
   – **Setup > WLAN > network address, passwords and other parameters (**see **WLAN,** page 112**)**

9.2.2 GSM

To setup to transmit recordings over the mobile phone network, proceed as follows:

1. Enter the setup menu and click the Comms tab. Set the SCM Type to GSM:
   – **Setup > Comm. > SCM type > GSM**
2. Enter the phone number and other parameters:

Setup > GSM Modem > telephone number, passwords and other parameters

➜ The transmission settings are defined in the setup (see **Communication Settings,** page 109).
➜ Inserting the SIM card is described in the introduction (see **Back Panel,** page 25).

Art. no.: 2.510858 Rev. f

9.2.3 Automatic Transmission

The auto transmission setting is defined in ECG settings:

ECG Key > General tab - **Autom**. **transmission** (yes/no - see **ECG Settings,** page 69).

When auto transmission is defined a recording is transmitted automatically after it has been taken.

9.2.4 Manual Transmission

To transit an auto mode recording, press the **Send Data** key.

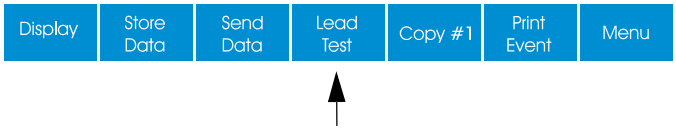
9.2.5 Transmission from Memory

The transmission options from the memory are defined in the Memory section (see **Transmitting, Printing and Deleting Stored Recordings,** page 98).

9.2.6 Receiving Data from SEMA (HIS)

Patient data can be received from a remote location and automatically entered on the CARDIOVIT AT-102 plus. This is called patient data query (PDQ). To do this the patient ID is entered in the patient data screen manually or via a barcode reader (see **Patient Data Query (PDQ),** page 34).

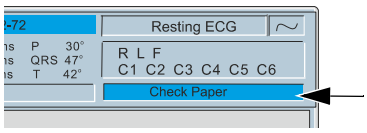
To receive patient data press the **Get Data** key.



- When transmitting to SEMA-200 the SEMACOMM program must be installed on the computer.
- When transmitting to SEMA3 the SEMA3 Server must be installed on the computer.
- For PDQ the SCHILLER SCS must be installed on the remote system.
- The Baud rate, telephone number, interface definition, TCP/IP addresses, etc., and all other communication settings are defined in system settings (see **Communication Settings,** page 109).
- A communication overview is given in the SCHILLER Communication Guide

Art. no.: 2.510858 Rev. f

9.3 Transmission Error Messages



The following transmission error messages may be displayed when working with the memory. These messages are shown on the message area.

Message	Extra Information
SCM setup error	• Check system settings (see **Table of Unit Settings,** page 106).
Network interface error	• Check network settings (see **Table of Unit Settings,** page 106). • Check network connections.
Error sending file	• General error message
Network connection down	• General error message
Server rejected request	• General error message
SSH server not running	• Check encryption settings and server
Invalid SSH server key	• Check system settings (see **Table of Unit Settings,** page 106).
SSH server time out	• Check system settings (see **Table of Unit Settings,** page 106).
Modem has no dial tone	
Modem has no carrier	
Unknown modem error	• General error message
Modem received no answer	
Modem is busy	
No answer from server	• Check network settings (see **Table of Unit Settings,** page 106). • Check network connections.
Invalid server response	• Check network settings (see **Table of Unit Settings,** page 106). • Check network connections.
Server time out	• Check network settings (see **Table of Unit Settings,** page 106). • Check network connections.
Server replied no data	General error message
HTTP error xxx	General error code for service personal. If this message consistently appears contact the SCHILLER service department.
No file available	
No barcode scanner av.	• Check barcode reader connected • Check system settings (see **Table of Unit Settings,** page 106).
Undefined error	General error message
Unknown server error	General error message
Modem rejected config.	General error message

Art. no.: 2.510858 Rev. f

Message	Extra Information
Network conn. time out	• Check network settings (see **Table of Unit Settings,** page 106). • Check network connections.
No physical network link	Check network connections.
Error modem config.	General error message
GSM Module not present	
Invalid File	
Error printing record	General error message Check system settings (see **Table of Unit Settings,** page 106)
WLAN Connection failed	Check system settings (see **Table of Unit Settings,** page 106)
No WLAN Info available	Check system settings (see **Table of Unit Settings,** page 106)
No WLAN Module avail.	Check system settings (see **Table of Unit Settings,** page 106)
SCS error	General error message

Additionally to these error messages, there are some error messages that come directly from the SCHILLER communication server (SCS). These messages are detailed in the SCHILLER Communication Guide.

Art. no.: 2.510858 Rev. f

10 Unit Maintenance

All maintenance work must be carried out by a qualified technician authorised by SCHILLER AG. Only maintenance procedures given in this book, for example, visual inspection, may be carried out by the user.

The following table indicates the maintenance intervals, the maintenance requirement, and the person authorised to carry out the procedure.

Interval	Service	Responsible
Every 6 months	• keypadtest. • Visual inspection of the unit and cables (see below).	➜ User
Every 12 months	• All maintenance work performed at the six monthly interval. • Functional tests according to the Service Handbook. • Electrical safety test and recurrent test according to EN 60601-1, Clause 18 and 19 according to the manufacturers instructions. The safety tests can be carried out at longer periods if local regulations allow.	➜ SCHILLER AG authorised technician
circa. every 48 months	• Replacement of accumulator of running time substantially less than one hour. Dependent on use / manufacture, the battery life may be longer or less than 48 months.	➜ SCHILLER AG authorised technician

10.1 Visual Inspection

Visually inspect the unit and cable assemblies for the following:

➜ Device casing not broken or cracked.
➜ LCD screen not broken or cracked.
➜ Electrode cable sheathing and connectors undamaged.
➜ No kinks, abrasion or wear in any cable assembly.
➜ Input/output connectors undamaged.

In addition, at the same time as the visual inspection, the CARDIOVIT AT-102 plus should be switched on, the menu scrolled through, and some sample functions tested. Ensure a beep is heard when a key is pressed. This will:

- Provide a basic software integrity check
- Check the LCD display
- Check basic keypadfunction

▲ Do not use the unit if the unit, or any cable assembly or accessory, is damaged.
▲ Defective units, damaged cables, or damaged accessories must be replaced immediately.

Art. no.: 2.510858 Rev. f

10.2 Cleaning the Casing and Cable Assemblies

⚠WARNING

▲ Switch off the unit before cleaning and disconnect from the mains by removing the plug. Do not, under any circumstances, immerse the apparatus into a cleaning liquid or sterilise with hot water, steam, or air.

⚠ CAUTION

▲ Do not autoclave the unit or any accessories.

▲ Do not immerse in liquid when cleaning.

▲ Use of cleaning solutions which have a high acid content or are otherwise inappropriate can cause damage to the equipment, including cracking and deterioration of the plastic case.

▲ Always follow the mixing/diluting instructions provided by the manufacturer of the cleaning solution.

▲ Never use any of the following solutions or similar products to clean the equipment: ethyl alcohol, ethanol, acetone, hexane, abrasive or scouring powder or material, any cleaning material that damages plastic.

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

▲ When cleaning, ensure that all labels and safety statements, whether etched, printed or stuck to the unit, remain in place and remain readable.

Before cleaning the unit or any accessories, thoroughly inspect them.

- Look for any signs of damage and any improper mechanical function of buttons or connectors.
- Gently bend and flex cables, inspecting them for damage or extreme wear, exposed wires, or bent connectors.
- Confirm that all connectors engage securely.

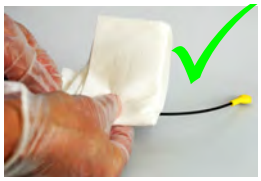
The casing of the CARDIOVIT AT-102 plus and the cable assemblies can be cleaned with a cloth slightly moistened (not wet) on the surface only. Where necessary a domestic non-caustic cleaner or 70% alcohol solution can be used for grease and finger marks. Wipe the equipment with a cloth slightly moistened (not wet) with one of the approved cleaning solutions listed below.

Thoroughly wipe off any excess cleaning solution. Do not let the cleaning solution run into or accumulate in connector openings, latches, or crevices. If liquid gets into connectors, dry the area with warm air, and then check the equipment to confirm that it operates properly.

Art. no.: 2.510858 Rev. f

10.2.1 Cleaning Cable Assemblies

1. Before cleaning, inspect the cable for damage. Gently bend and flex all parts of the cable. Inspect for splits in the sheathing, damage or extreme wear, exposed wires, or bent connectors.
2. Wipe the equipment with a cloth slightly moistened (not wet) with one of the approved solutions listed below.
3. Gently grip the cable with the damp cloth in the centre of the cable and slide the cable through the cloth 20 cm at a time until clean. Do not clean the whole length in one single action as this may cause bunching of the insulation sheathing.
4. Wipe off any excess cleaning solution. Do not let the cleaning solution run into or accumulate in connector openings, latches, or crevices. If liquid gets into connectors, dry the area with warm air.



10.2.2 Approved Cleaning Solutions

- 70% solution isopropyl alcohol
- Neutral mild detergent solution
- All products designed for cleaning plastic.

10.2.3 Cleaning Materials that must not be used

Never use products containing the following:

- Ethyl alcohol
- Acetone
- Hexane
- Abrasive cleaning powder
- Plastic-dissolving products

Art. no.: 2.510858 Rev. f

10.3 Disinfection

Disinfection removes certain bacteria and viruses. Please refer to the manufacturer's information. Use commercially available disinfectants intended for clinics, hospitals and practices to disinfect the device.

Disinfect the units in the same way as described for cleaning the units (previous page).

10.3.1 Admissible Disinfectants

- Isopropyl alcohol 70%
- Propanol (70-80%)
- Ethyl hexanal
- Aldehyde (2-4%)
- Ethanol (70-80%)
- all products that are suitable for ABS plastic

10.3.2 Non-admissible Disinfectants

Never use products containing the following:

- Organic solvents
- Ammonia-based detergent
- Abrasive cleaning agents
- 100% alcohol, Virex, Sani-Master
- Sani-Cloth®, Ascepti® or Clorox® wipes
- HB Quat®
- Conventional cleaner (e.g. Fantastic®, Tilex® etc.)
- Conductive solution
- Solutions or products containing the following ingredients:
  - Acetone
  - Ammonium chloride
  - Betadine
  - Chlorine[1], wax or wax compound
  - Ketone
  - Sodium salt

The disinfectants that can be used to clean the spirometry mouthpiece are specified in the Spirometry section (see **SP-260 Mouthpiece Disinfectants,** page 82).

1. *Disinfectants that contain small amounts of chlorine or that separate chlorine (less than 1200 ppm) may be used.To prevent excessive ageing of the patient cables due to chlorine, the disinfectant needs to be wiped off with a neutral detergent or with water once the specified application duration has elapsed.*

Art. no.: 2.510858 Rev. f

10.4 Cleaning the Thermal Print Head

A residue of printers ink (from the grid on the paper) can build up on the print head over a period of time. This can cause the print quality to deteriorate. We recommend therefore that every month the print-head is cleaned with alcohol as follows:

Extend the paper tray and remove paper. The thermal print-head is found under the paper tray. With a tissue dampened in alcohol, gently rub the print-head to remove the ink residue. If the print-head is badly soiled, the colour of the paper grid ink (i.e. red or green) will show on the tissue.

10.5 Battery Maintenance

- The battery requires no maintenance during its life.
- Replace the battery approximately every 4 years (depending upon application) when the battery running time falls substantially under one hour.
- The battery should remain charged during storage. If the storage period exceeds three months, recharge the battery.

10.5.1 Charging the Battery

A totally discharged battery requires approximately 4.5 hours to be 90% charged, and approximately 15 hours to be 100% charged. It is possible to use the unit when the battery is being charged, however the charging time may be extended.

No harm will be done to the battery by leaving the unit connected to the mains supply.

1. Connect the device to the mains supply.
2. The green mains LED is lit.
3. Charge the battery for at least 4.5 hours.

10.5.2 Battery Disposal

The battery must be disposed of in municipally approved areas or sent back to SCHILLER AG.

⚠WARNING

- ▲ Danger of explosion! Battery must not be burned or disposed of in domestic rubbish.
- ▲ Danger of acid burns! Do not open the battery.

Art. no.: 2.510858 Rev. f

10.6 Inspection and Check List Report

In accordance with the maintenance interval detailed previously, the following check list should be copied and followed.

Unit Serial Number:

10.6.1 Every Six Months

Inspection	Results	Inspection				
General Examination						
➜ Visual inspection of the unit.	• Device casing not broken or cracked.	❒	❒	❒	❒	❒
➜ Visual inspection of the LCD.	• LCD screen not broken or cracked.	❒	❒	❒	❒	❒
➜ Visual inspection of all cable assemblies and sensors.	• Electrode cable sheathing and connectors undamaged.	❒	❒	❒	❒	❒
➜ Plug and socket connectors.	• No kinks, abrasion or wear in any cable assembly.	❒	❒	❒	❒	❒
	• Input/output connectors undamaged.	❒	❒	❒	❒	❒
Self-test (initiated when the device is switched on)						
➜ Switch the device on by pressing the On key.	• The standard screen is displayed.	❒	❒	❒	❒	❒
	• Check the LCD display for response.	❒	❒	❒	❒	❒
Basic Functional Check						
➜ Scroll though some menus	• Check basic keypad function.	❒	❒	❒	❒	❒
Safety checks and inspections						
➜ Confirm the date of last factory inspections and test.	• If the unit is due for the factory inspections and tests (every 12 months or according to local regulations), return the unit to your nearest authorised SCHILLER agent.	❒ ❒ Not required on this inspection	❒ ❒ Not required on this inspection	❒ ❒ Not required on this inspection	❒ ❒ Not required on this inspection	❒ ❒ Not required on this inspection
	Date Of Inspection:					
	Inspector:					

10.6.2 Lifed Item Replacement Every 3 - 5 years

Inspection	Results	Replacement				
Internal Accumulator						
➜ Replace Internal Accumulator if operation falls substantially under one hour.	• Unit sent to SCHILLER service centre for accumulator replacement.	❒	❒	❒	❒	❒
	Date Of Replacement:					
	Inspector:					

Art. no.: 2.510858 Rev. f

11 Trouble Shooting

11.1 Trouble Shooting Table

Fault	Possible Causes and indicators	Remedies and Fault Location
Unit does not switch on, blank screen	• No mains supply, Green mains indicator off.	➜ Check mains supply, check fuses. ➜ If mains indicator is lit it indicates that power is reaching the unit and the internal power supply should be OK. Press and hold the On/Off key for 5 seconds. Wait a few seconds and switch on again.
	• Mains supply OK, but the screen is still not lit.	➜ Check / change the battery. If the battery is faulty it is possible that sometimes the unit cannot be switched on even if the mains supply is connected. ➜ If the screen is still not lit it indicates a software fault, monitor problem or internal power supply. Call your local SCHILLER representative.
QRS traces overlap	• Incorrect settings for Patient.	➜ Change sensitivity setting. ➜ Ensure that the automatic sensitivity reduction is not switched off. ➜ Reset signals to baseline - press the 1mV key.
	• Bad electrode contact.	➜ Check electrode contact - Replace electrodes. ➜ If traces still overlap: Call your local SCHILLER representative. ➜ Note: Some patients have very high amplitudes and even on the lowest sensitivity settings, the QRS traces can overlap.
'Noisy' traces	• High resistance electrode contact.	➜ Check electrode contact > ECG key > Lead Test. Resistance readings should be ± 200 mV. ➜ Re-apply electrodes.
	• Patient not relaxed.	➜ Ensure that the patient is relaxed and warm.
	• Incorrect settings.	➜ Check all filter settings > ECG key > Filter. ➜ Activate Myogram filter - press key 1, change cut-off frequency. ➜ Ensure mains filter is correct for mains supply. ➜ If the trace is still noisy call your local SCHILLER representative.
No printout obtained after an auto mode recording	• No paper.	➜ Ensure that paper is loaded.
	• Paper incorrectly loaded.	➜ Reload Paper.
	• Paper jam.	➜ Ensure that the paper has been installed correctly with the paper mark at the top.
	• Incorrect settings.	➜ Check Settings - ensure that at least one item is selected for print after an auto ECG is recorded. ➜ If the printer still doesn't work: Call your local SCHILLER representative.
Printout fades, is not clear, or the printout is 'patchy'.	• Old paper inserted.	➜ Ensure that fresh SCHILLER paper is installed. ➜ Note that the thermal paper used for the CARDIOVIT AT-102 plus is heat and light sensitive. If it is not stored in its original seal, stored in high temperatures or is simply old, print quality can deteriorate.
	• Dirty print-head.	➜ Over a period of time, the printing ink from the grid on the paper can form a film on the thermal print head. Clean the thermal print head.
	• Print-head out of adjustment.	➜ Adjust the print-head tension according to the CARDIOVIT AT-102 plus service handbook. ➜ If the problem persists call your local SCHILLER representative.

Art. no.: 2.510858 Rev. f

Fault	Possible Causes and indicators	Remedies and Fault Location
No printout of interpretation statement average cycles or measurements	• Incorrect setting.	➜ Check that the interpretation and measurement options are enabled for the printout.
Battery Load indicator seems inaccurate.	• Battery recharge circuit inaccurate.	➜ Disconnect the mains and leave the unit on until it switches off. ➜ Reconnect the mains and leave for 8 hours (with the unit switched off) to fully charge the battery (and reset the charge circuit).
Battery Capacity low	• Battery recharge cycle not optimal - when a battery is not fully charged it may loose capacity.	➜ Disconnect the mains and leave the unit on until it switches off. ➜ Reconnect the mains and leave for 8 hours (with the unit switched off) to fully charge the battery (and reset the charge circuit).
	• Old or defective battery.	➜ Repeat the fully discharge, fully charge cycle twice. ➜ Replace battery.
No key response, LCD locked	• Software hangs up.	➜ Switch off, and switch on again after a few seconds. ➜ Disconnect the mains and leave for 2 hours to force switch off. Reconnect mains and switch on. ➜ If the unit is still not working call your local SCHILLER representative.

Art. no.: 2.510858 Rev. f

12 Technical Data

12.1 System

Dimensions	• 378 x 326 x 108 mm
Weight	• Units with external power supply approx. 4.4 kg including thermal paper • Units with internal power supply approx. 4.5 kg including thermal paper
Screen	• Backlit LCD screen for graphic and alphanumeric representation • Resolution: 800 x 600 dots, 8.4 inches
Power supply	
Device power requirement	
Units with external power supply	• 12 VDC 28 VA
Units with internal power supply	• 100 - 240 VAC, 50 / 60 Hz
Devices with external power supply unit	Medically approved switching power supply with protection class I according to IEC/EN 60601-1
Input	• 100 - 240 VAC, max. 1.0 A(100 V) - 0.6 A(240V), 50-60 Hz
Output	• 12 VDC, max. 2.5 A Note: Because the protective earth (PE) terminates in the external power supply, the unit protective earth resistance test does not need to be performed.
Devices with mains supply	Protection class I with the built-in power supply according to IEC/EN 60601-1
Mains voltage	• 100 - 240 VAC (nominal), 50 / 60 Hz
Power Consumption	• 55 VA
Fuse Rating	• 2 x 1 AT
Battery	Lithium polymer 7.4 V, 31 Wh
Capacity	• 3 hours of normal operation without printing
Battery life	• Under normal operating conditions, 4 years
Charging time	• 100% approx. 3 hours when the device is switched off
Printer	High-resolution thermal head printer; 8 dots/mm (amplitude axis); 40 dots/mm (time axis) @ 25 mm/s
Frequency range	• 0.05 Hz to 150 Hz (IEC/AHA)
Chart paper	• Thermo-reactive, Z-fold, 21 x 29.7 cm (DIN A4; letter size), optimal positioning on 200 mm;
Chart speed	• 5 / 10 / 25 / 50 mm/s (manual printout)
Sensitivity	• 5 / 10 / 20 mm/mV (manual printout), automatic baseline adjustment
Interfaces	• RS-232 interface for pneumotach sensor • ECG cable connection • Potential equalisation • Network connection • USB
Memory	Storage for up to 350 ECG recordings.

Art. no.: 2.510858 Rev. f

12.2 ECG

Patient input	Fully floating and isolated, defibrillation protected (only with original SCHILLER patient cable)
Leads	• 12 or 16 simultaneous leads • Standard • Cabrera
Display	
Leads	• 3, 6, 12, or 16 channel display of the selected leads – selectable speed: 5, 10, 25 or 50 mm/s – selectable amplitude: 5, 10 or 20 mm/mV
Status	• Filter status (on/off) • Power source • Leads • Electrode contact status • Heart rate (30 to 300 bpm) • Date and time • Patient name and number
Filters	
Myogram filter (muscle tremor)	Adjustable at 25 or 35 Hz
Mains filter	Distortion-free suppression of superimposed 50 or 60 Hz sinusoidal interferences by means of adaptive digital filtering
SSF	SSF (SCHILLER Smoothing Filter)
SBS	SBS (SCHILLER Baseline Stabiliser). Filter that suppresses or significantly reduces baseline fluctuations without distorting the measured values.
Automatic lead programs	12 or 16 channel presentation of 12/16 simultaneously recorded leads
Data record	• Patient data (name, age, height, weight, BP), user ID • Listing of all ECG recording conditions (date, time, filter)
With optional interpretation (C) program	• ECG measurement results (intervals, amplitudes, electrical axes) • Average complexes with optional measurement reference markings • Guidance on interpreting adult and paediatric ECGs
ECG amplifier	Simultaneous recording of all 9 active electrode signals (= 12 leads)
Sampling frequency	• 4000 Hz
Resolution	• 5 µV/18 bit
Pacemaker detection	• ≥ ± 2 mV / pulse width ≥ 0.1 ms
Frequency range adults	• 0.05 Hz to 150 Hz (IEC/AHA)
Frequency range children & SAECG	• 0.05 Hz to 300 Hz (IEC/AHA)
Measuring range	• Dynamic ±10 mV, DC ±300 mV
CMRR	• >100 dB
Input Impedance	• >100 MΩ
Defibrillation protection	• 5000 VDC
Patient leakage current	• < 5 µA

Art. no.: 2.510858 Rev. f

12.3 Spirometry

12.3.1 Sensors

Sensors	SP-250 / SP-260
Measurement method	Pneumotachometer
Measurement ranges	Flow: 0 to ± 16 l/s Volume: 0 to ± 15 litres
Measurement accuracy	Flow: ± 5% or 200 mL/s Volume: ± 3% or 50 ml
Temperature drift	Max: ± 2%
Flow impedance	< 0.5 mbar / (l/s) at 6 l/s
Standards compliance	ATS, OSHA, NIOSH

12.3.2 SCHILLER PTF Filter

Electrostatic filter	Bacterial / viral protection, single patient use
Casing	white polypropylene
Protection	99.9999 % bacterial / viral filtration efficiency
Resistance	@ 12 L/s 0.7 cm H_2O/L/s (0.07 kPa/L/s)
Effective dead space	50 ml

Art. no.: 2.510858 Rev. f

12.4 Safety Standards

Safety standard	IEC/EN 60601-1 IEC/EN 60601-2-25
EMC	IEC/EN 60601-1-2
Protection class	
Units with external power supply	Class I according to IEC/EN 60601-1 (with internal battery)
Units with internal power supply	Class I according to IEC/EN 60601-1
Conformity/classification	CE/IIa in accordance with directive 93/42/EEC
Ingress Protection	This device is not designed for outdoor use (IP 20)

12.5 Environmental

Environmental conditions (operating)	
Temperature	• + 10°C to + 40° C (+ 50° F to + 104 °F)
Relative humidity	• 15 to 95% (non-condensing)
Pressure	• 700 to 1050 hPa
Environmental conditions (storage and transport)	
Temperature transport	• - 10°C to + 50° C (+ 14°F to + 122° F)
Temperature storage	• + 5° C to + 50° C (+ 41° F to + 122° F)
Relative humidity (storage and transport)	• 10 to 95% (non-condensing)
Pressure (storage and transport)	• 500 to 1060 hPa
Disposal	
Electrical and electronic equipment	• Equipment/components and accessories no longer required must be disposed of in a municipally approved collection point or recycling centre. Alternatively, you can return the equipment to your supplier or SCHILLER AG for disposal. Improper disposal can harm the environment and human health. • The unit/components can be recycled.

Art. no.: 2.510858 Rev. f

12.6 WLAN (Option)

Transmission standards	IEEE802.11 a/b/g/n WiFi certified
Type module	CB-OWS451 i-04
Encryption	WPA, WPA2, WEP
Frequency range 2.4 GHz	• 2.412 - 2.462 GHz, channel 1 - 11 (FCC domain) • 2.412 - 2.472 GHz, channel 1 - 13 (ETSI, TELEC domain) • 5 MHz channel separation
Frequency range 5 GHz	• 5.180 - 5.240 GHz, U-NII-1 Channel 36, 40, 44, 48 (FCC, IC, ETSI domain) • 5.260 - 5.320 GHz, U-NII-2 Channel 52, 56, 60, 64 (FCC, IC, ETSI domain) • 5.500 - 5.700 GHz, U-NII-2e Channel 100, 104, 108,112, 116, 120, 124, 128, 132, 136, 140 (FCC, ETSI domain) • 5.500 - 5.700 GHz, U-NII-2e Channel 100, 104, 108,112, 116, 132, 136, 140 (IC domain) • 5.745 - 5.825 GHz, U-NII-3* TPC and DFS slave/client operation on 5.260 - 5.320 GHz, 5.500 - 5.700 GHz 20 MHz channel separation
RF output power 2.4 GHz	• 802.11b (DSSS): +17dBm (typ.) • 802.11g (OFDM): +15dBm (typ.) • 802.11n (OFDM): +15dBm (typ.)
RF output power 5 GHz	• 802.11a (OFDM): +9dBm (typ.) • 802.11n (OFDM): +9dBm (typ.)
FCC identification IC	
Regulatory ID:	• cB-0941
FCC ID:	• PVH0941
IC ID:	• 325A-0941
MIC ID:	• 204-310005

Art. no.: 2.510858 Rev. f

12.7 Telecommunication GSM (Option)

Frequency range	Quad band GSM 850/900/1800/1900 MHz
Supported SIM cards	3 and 1.8 V
Data transmission	GPRS class B
Max. transmitting power	2 watts @ 850...900 MHz 1 watt @ 1800...1900 MHz
FCC identification **IC**	QIPMC75I 7830A-MC75I
Directives	• 99/05/EC (CE 0682) • 89/336/EC • 72/23/EC • 2002/95/EC
EU standards	• 3GPP TS 51.010-1 • ETSI EN 301 511 V9.0.2/301 489-1 V1.4.1/301 489-7 V1.2.1 (2000-09) • GCF-CC V3.28 • IEC/EN 90950-1 (2001)
North American standards	• CFR title 47 • UL 60950 • NAPRD 03 V3 V3.1.3 • RSS 133 (Issue2)

Art. no.: 2.510858 Rev. f

12.8 Electromagnetic Radiation

The user can help avoid electromagnetic disturbances by keeping the minimum distance between portable and mobile HF telecommunication devices (transmitters) and the CARDIOVIT AT-102 plus unit. The distance depends on the output performance of the communication device as indicated below.

HF source	Transmitter frequency [MHz]	Power [W]	Distance [m]
Radio telephone (micro cellular) CT1+, CT2, CT3	885-887	0.010	0.23
Cordless DECT telephone, WLAN, UMTS phone	1880-2500	0.25	1.17
Mobile phone USA	850/1900	0.6	1.8
Mobile phone - GSM900, - GSM850, NMT900, DCS 1800	 900 850, 900, 1800	 2 1	 3.3 2.3
Walkie-talkie (rescue service, police, fire brigade, service)	81-470	5	2.6
Mobile telephone system (rescue service, police, fire brigade)	81-470	100	11.7

As a general rule do not use **portable** HF telecommunication transmitting devices within a radius of 3 metres from the device and its cables.

The user can take the following measures to prevent electromagnetic interferences:

- Increase distance to the source of interference.
- Turn the device to change the angle of radiation.
- Connect the potential equalisation cable.
- Connect the device to a different mains connector.
- Only use original accessories (especially patient cables).

For more information on the use in an electromagnetic environment in accordance with IEC/EN 60601-1-2, tables 201, 202, 204 and 206, please consult the service handbook.

12.9 Accessories and Disposables

WARNING

▲ Always use SCHILLER replacement parts and disposables, or products approved by SCHILLER. Failure to do so may endanger life and invalidate the guarantee.

The patient cable part numbers are given electrode section (see **Cables,** page 36).

Your local representative stocks all the disposables and accessories available for the CARDIOVIT AT-102 plus. A full list of all SCHILLER representatives can be found on the SCHILLER website (www.schiller.ch). In case of difficulty contact our head office. Our staff will be pleased to help process your order and provide any details for all SCHILLER products.

Art. no.: 2.510858 Rev. f

13 Annex - Spiro Diagnostic Tables

13.1 International

The diagnostic interpretation is dependent upon the country. The factors used in the evaluation for diagnosis are automatically included in the respective language software.

The following Diagnosis Criteria are applicable for all unit language settings apart from ‘American’.

Possible respiratory problems are diagnosed on evaluation of the following factors:

Diagnosis	%FVC or %SVC	FEV1%
Normal Condition	80%	>70%
Restrictive	<80%	-
Obstructive	-	<70%
Combined	<80%	<70%

The measurement FEV1/FVC or FEV1/VC is adapted on the screen and on the printout.

The diagnostic settings are selected in spirometry settings.

Diagnostic norms are predicted using the VC value (if taken). If VC values are not recorded, FVC is used. That is:

$$\%VC = 100 ¥ \frac{VC}{VC_{Predicted}}$$

otherwise:

$$\%FVC = 100 ¥ \frac{FVC}{FVC_{Predicted}}$$

otherwise:

$$FEV1\% = 100 \times \frac{FVC1}{VC} \text{ or } 100 \times \frac{FVC1}{FVC}$$

Art. no.: 2.510858 Rev. f

13.2 American

For the USA and Canada, diagnosis of possible respiratory problems is based on the ITS interpretation standard which uses the LLN (Lower Limits of Normal) calculations. These calculations apply to patients between the ages of 5 and 85. The LLN FEV1% value is calculated as shown on the following pages.

The following diagnosis criteria are applicable when the unit language is set to 'American'.

13.2.1 Air Obstruction Categories

Predicted Value Minus Measured Value (%):

Category	Women		Men	
	FEV1/FVC	FEV3/FVC	FEV1/FVC	FEV3/FVC
Normal	<9.1 and..	<5.4	<8.3 and ..	<4.6
Airway Obstruction Suggested	<9.1 and..	≥5.4	<8.3 and ..	≥4.6
Mild	9.1 to ..	18.1	18.3 to.	16.5
Moderate	18.2 to ..	36.3	16.6 to..	33.1
Severe	≥36.4		≥33.2	

- If FEV 0.5/FEV 1 < 0.60, then state:
  Upper airway obstruction suggested
- If SVC/FVC> 1.10 or FIVC/FVC > 1.10 then state:
  Air trapping may be present
- If obstruction and expiration time < 5 sec, then state:
  Airway Obstruction may be underestimated
- If FEV0.5/FVC < 0.56 sec, then state:
  Poor initial effort suggested

Art. no.: 2.510858 Rev. f

13.2.2 Chest Restriction Categories

Predicted VC Minus Measured VC (Litres)

Category	Women	Men
Normal	<0.68	<1.12
Mild Restriction	0.68 to 1.18	1.12 to 1.95
Moderate Restriction	1.19 to 1.69	1.96 to 2.79
Severe Restriction	≥1.7	≥2.80

- If FVC > SVC, then SVC = FVC
- If FIVC > SVC, then SVC = FIVC

13.2.3 Ratio of Post (Pre/Post)

Category	FVC Post / Pre	or FEV 0.5 Post/ Pre [a] or FEV 1.0 Post/Pre	or FEF25-75%Post/Pre[b]
Markedly Improved	≥1.25	≥1.25	≥2
Improved	1.15 to 1.24	1.12 to 1.24	1.45 to 1.99
Not clearly Improved	1.05 to 1.14	1.05 to 1.11	1.10 to 1.44
Not Improved	<1.05	<1.05	<1.10

a. If expiratory time post/pre is > 1.10, then FVC is not used because increased FVC may be due to the increased expiratory time, and not increased flow.

b. If expiratory time post/pre is < 0.90 and the FVC post/pre is not between 0.96 and 1.04, then the FEF25-75% is not used because reduced expiratory time and reduced FVC can increase the FEF25-75% without change in the flow itself.

Art. no.: 2.510858 Rev. f

13.3 Measured Values

Parameter	Unit	Explanation
FVC	[l]	**Forced** (expiratory) **Vital Capacity**. Volume achieved by the quickest possible exhalation after a maximal inhalation.
FEV0.5, FEV1, FEV3, FEV6	[l]	**Forced Expiratory Volume.** Lung volume in litres, measured after 0.5, 1, 3, or 6 seconds forced expiration.
FEV0.5 / FVC	[%]	Forced expiratory air volume measured in the first half second as a percentage of forced vital capacity.
FEV1 / FVC	[%]	Forced expiratory air volume measured in the first second as a percentage of forced vital capacity.
FEV3 / FVC	[%]	Forced expiratory air volume measured in the first three seconds as a percentage of forced vital capacity.
FEF	[l/s]	**Forced Expiratory Flow.** Flow in terms of differing lung volumes measured in litres per second.
FEF25-75%	[l/s]	Flow speed of the expired air at 25 to 75% of the forced vital capacity (FVC).
FEF75-85%	[l/s]	Flow speed of the expired air at 75 to 85% of the forced vital capacity (FVC).
FEF0.2-1.2	[l/s]	Averaged flow between 0.2 and 1.2 litres of the forced vital capacity (FVC)
PEF	[l/s]	Peak Expiratory Flow.
MEF75%	[l/s]	Flow speed of the expired air at 25% of the forced vital capacity (FVC).
MEF50%	[l/s]	Flow speed of the expired air at 50% of the forced vital capacity (FVC).
MEF25%	[l/s]	Flow speed of the expired air at 75% of the forced vital capacity (FVC).
		MEF75% = FEF25%
		MEF50% = FEF50%
		MEF25% = FEF75%
ERV	[l]	**Expiratory Reserve Volume**. Possible further expiration starting from the normal expiration level.
IRV	[l]	**Inspiratory Reserve Volume.** Possible further inspiration starting from the normal inspiration level.
TV	[l]	**Tidal Volume.** Expiration and inspiration volumes during normal respiration.
SVC	[l]	**Slow Vital Capacity.** Lung volume measured from a complete expiration following a deep inspiration.
MV	[l/min]	**Expired or Minute Ventilation.** Volume of expired air in litres per minute measured over a minimum of one minute.
MVV	[l/min]	**Maximum Voluntary Ventilation.** Maximum volume of air which can be moved on expiration while breathing as deeply and as rapidly as possible.
RR	[l/min]	**Respiration Rate.** Number of breaths per minute.
FIVC	[l]	**Forced Inspiratory Vital Capacity.** Inspiration volume achieved between a maximal expiration and a maximal inspiration.
FIV 1	[l]	Forced inspiratory air volume in litres measured in the first second.
FIV 1 / FIVC	[%]	Forced inspiratory air volume measured in the first second as a percentage of forced inspiratory vital capacity.
FIV1 / FVC	[%]	Forced inspiratory air volume measured in the first second as a percentage of forced expiratory vital capacity.
PIF	[l/s]	**Peak Inspiratory Flow.** Maximum inspiratory flow speed in litres / second.
FIF50% (=MIF50%)	[l/s]	Flow speed by 50% of the forced inspiratory vital capacity.

Art. no.: 2.510858 Rev. f

13.4 Norm Values

The norm values used for the calculation of predicted values are dependent upon the country.

- For Great Britain, Italy, Spain and Switzerland, the ECCS and Quanjer standards are used.
- For Sweden, the Swedish (Berglund) and Quanjer standards are used.
- In Finland the Finnish and Quanjer standards are used.
- In Austria the Austrian standards are used.
- In India the Indian norm values are used.
- In America and Canada the norm values that are used are Knudson, Knudson76, Crapo, Morris, Composite and Polgar. The American norm values are extended with values taken from the ITS (Intermountain Thoracic Society) recommendations.

The factors used in the evaluation for diagnosis and the specific norm values are included in the software and are described on the following pages.

Due to great differences in the size of the lungs of children, there are no standard values for children under 6 years of age.

13.4.1 Ethnic Influences on Predicted Norm Value

Predicted values may vary according to:

- Language set for the unit
- Norm value selected
- Ethnic origin of the patient

All languages except American

When any language is set in the system settings (see **System Settings,** page 105) apart from American, the ethnic setting in the patient data is **White** or **Black** (or none). The settings influence the predicted norm value as follows:

Choice		Influence
W or B	W (White)	values are calculated according to the given formulas (= 100%)
	B (Black)	85% of the given formulas

Art. no.: 2.510858 Rev. f

American Language Set

When American language is set in the system settings (see **System Settings,** page 105) the ethnic setting in the patient data is **Caucasian, Hispanic, Black, Asian or Mexican**. The settings influence the predicted norm value (according to Intermountain Thoracic Society (ITS) recommendations) as follows:

Caucasian / White

Values are calculated according to the given formulae (= 100%) except when Nhanes III (Hankinson) is selected and the compensation is calculated according to the Nhanes III (Hankinson) table (see **Nhanes III Compensation Factors,** page 144).

Black (African)

85% of the given formulae except when Nhanes III (Hankinson) is selected and the compensation is calculated according to the Nhanes III (Hankinson) table (see **Nhanes III Compensation Factors,** page 144).

Hispanic

Values are calculated according to the given formulas (= 100%)

Asian

85% of the given formulae.

Mexican

Values are calculated according to the given formulas (= 100%), except when Nhanes III (Hankinson) is selected the compensation is calculated according to the Nhanes III (Hankinson) table (see **Nhanes III Compensation Factors,** page 144).

C (Caucasian), **H** (Hispanic), **B** (Black), **A** (Asian) or **M** (Mexican) can only be selected when American language is selected (see **System Settings,** page 105). When any other language is selected the ethnic options are W (white = 100%) or B (Black = 85%).

The ethnic compensation is calculated only when the following norm values are selected:

- Nhanes III
- Composite
- Knudson
- Crapo
- Morris
- Polgar

Art. no.: 2.510858 Rev. f

13.5 International Norm Standards

13.5.1 ECCS

The safety standards of the European Coal and Steel Community Standards (ECCS) are valid for adults of at least 25 years of age. Patients between the ages of 18 and 25 are calculated on the basis of a 25 year old. The calculation equations are as follows:

	Male	Female
VC	6,103H - 0,028A - 4,654	4,664H - 0,024A - 3,284
FVC	5,757H - 0,026A - 4,345	4,426H - 0,026A - 2,887
FEV1	4,301H - 0,029A - 2,492	3,953H - 0,025A - 2,604
FEV1/VC	-0,179A + 87,21	-0,192A + 89,10
MEF	1,944H - 0,043A + 2,699	1,252H - 0,034A + 2,924
PEF	6,146H - 0,043A + 0,154	5,50H - 0,030A - 1,106
MEF75	5,459H - 0,029A - 0,470	3,218H - 0,025A + 1,596
MEF50	3,794H - 0,031A - 0,352	2,450H - 0,025A + 1,156
MEF25	2,605H - 0,026A - 1,336	1,050H - 0,025A + 1,107

H = Height in metres A = Age in years

13.5.2 Quanjer and Tammeling

The Quanjer and Tammeling comparison is valid for children between the ages of 6 and 17 as follows:

	Boys	Girls
VC = FVC	1,00 $H^{2,7}$	0,95 $H^{2,7}$
FEV1	0,84 $H^{2,7}$	0,81 $H^{2,7}$
FEV1/VC	0.84	0.84
MEF = PEF	8,2H - 6,8	6,6H - 5,3
MEF50	5,6H - 4,4	4,6H - 3,3

H = Height in metres

Art. no.: 2.510858 Rev. f

13.5.3 Forche 97 (Austrian Standard)

Boys 5 - 17.99 years (1.09 - 1.96 m)	Males 18 - 91 years (1.44 - 2.00 m)
$\ln(FVC) = -1{,}142 + 1{,}259H + 0{,}004070A\sqrt{W}$	$FVC = -11{,}606 + 8{,}172H - 0{,}0339A \times 1{,}2869\ln(A)$
$\ln(FEV1) = -1{,}178 + 1{,}221H + 0{,}003841A\sqrt{W}$	$FEV1 = -8{,}125 + 6{,}212H - 0{,}0300AH + 0{,}9770\ln(A)$
$\ln(PEF) = -0{,}214 + 0{,}921H + 0{,}0467A + 0{,}0020W$	$\sqrt{PEF} = 1{,}798 + 2{,}311\ln(H) + 0{,}0159A - 0{,}000248A^2$
$\ln(PEF75) = -0{,}077 + 0{,}770H + 0{,}0373A + 0{,}0025W$	$\sqrt{PEF75} = 1{,}581 + 1{,}854\ln(H) + 0{,}0213A - 0{,}000283A^2$
$\ln(PEF50) = -0{,}322 + 0{,}843H + 0{,}0300A + 0{,}0035W$	$\sqrt{PEF50} = 1{,}490 + 1{,}290\ln(H) + 0{,}0125A - 0{,}000218A^2$
$\ln(PEF25) = -1{,}576 + 1{,}166H + 0{,}0219A + 0{,}0021W$	$\sqrt{PEF25} = 1{,}314 + 0{,}898\ln(H) - 0{,}0083A - 0{,}000026A^2$
$FEV1/FVC = 101{,}99 - 1{,}191H^2 - 3{,}962\ln(A)$	$FEV1/FVC = 101{,}99 - 1{,}191H^2 - 3{,}962\ln(A)$

Girls 5 - 15.99 years (1.10 - 1.82 m)	Females 16 - 91 years (1.40 - 1.90 m)
$\ln(FVC) = -3{,}842 + 4{,}1632\sqrt{H} + 0{,}1341\sqrt{A} - 1{,}614Fi$	$FVC = -10{,}815 + 6{,}640H - 0{,}0408AH + 1{,}7293\ln(A)$
$\ln(FEV1) = -3{,}877 + 3{,}9809\sqrt{H} + 0{,}1485\sqrt{A} - 1{,}322Fi$	$FEV1 = -6{,}995 + 5{,}174H - 0{,}0314AH + 1{,}0251\ln(A)$
$\ln(PEF) = 0{,}411 + 1{,}793\ln(H) + 0{,}4251\ln(A) - 0{,}910Fi$	$\sqrt{PEF} = 1{,}832 + 1{,}838\ln(H) + 0{,}0078A - 0{,}0001722A^2$
$\ln(MEF75) = 0{,}455 + 1{,}616\ln(H) + 0{,}3738\ln(A) - 0{,}861Fi$	$\sqrt{PEF75} = 1{,}779 + 1{,}421\ln(H) + 0{,}0096A - 0{,}000179A^2$
$\ln(MEF50) = 0{,}256 + 1{,}643\ln(H) + 0{,}3481\ln(A) - 1{,}089Fi$	$\sqrt{PEF50} = 1{,}561 + 1{,}177\ln(H) + 0{,}0045A - 0{,}000140A^2$
$\ln(MEF25) = -0{,}772 + 2{,}002\ln(H) + 0{,}3063\ln(A) - 0{,}409Fi$	$\sqrt{PEF25} = 1{,}372 + 0{,}938\ln(H) - 0{,}0152A - 0{,}000036A^2$
$FEV1/FVC = 92{,}33$	$FEV1/FVC = 118{,}993 - 3{,}0320H^2 - 6{,}9053\ln(A)$

H = Height in metres A = Age in years

W = Weight in Kg $Fi = \text{Body fat index} = \frac{H}{\sqrt[3]{W}}$

Art. no.: 2.510858 Rev. f

13.5.4 Swedish Standard (Berglund)

The Swedish (Berglund) standard is valid for adults between the ages of 18 and 75 years as follows:

	Male	Female
FEV%	91,79 - (0,373A)	92,11 - (0,261A)
VC	1,09 [(4,81H) - (0,020A) - 2,81]	1,09 [(4,04H) - (0,022A) - 2,35]
FEV	1,09 [(3,44H) - (0,033A) - 1,00]	1,09 [(2,67H) - (0,027A) - 0,54]

H = Height in metres A = Age in years

13.5.5 Finnish Standard

The Finnish standard is valid for adults from the age of 18 years as follows:

	Male	Female
VC	$e^{(-0,00833A) + (0,6309 \times \log A) + (-1,4750/H) + 0,9047}$	$e^{(-0,01016A) + (0,6995 \times \log A) + (-1,4518/H) + 0,7763}$
FEV1	$e^{(-0,00587A) + (0,2756 \times \log A) + (-1,1655/H) + 1,0980}$	$e^{(-0,00920A) + (0,4772 \times \log A) + (-1,3284/H) + 0,9296}$
FVC	$e^{(-0,00827A) + (0,5860 \times \log A) + (-1,4468/H) + 0,9461}$	$e^{(-0,00982A) + (0,6358 \times \log A) + (-1,4137/H) + 0,8320}$
MEF50	$e^{(0,00041A) + (-0,30870 \times \log A) + (-0,0148/H) + 1,34150}$	$e^{(0,00741A) + (-0,34710 \times \log A) + (-0,8581/H) + 0,9336}$
MEF25	$e^{(0,00771A) + (-0,28190 \times \log A) + (-0,0252/H) + 1,05970}$	$e^{(0,01548A) + (-0,34310 \times \log A) + (-0,8498/H) + 0,7966}$
FEV1/FVC	$e^{(0,00240A) + (-0,3104 \times \log A) + (0,2813/H) + 2,1519}$	$e^{(0,00062A) + (-0,1586 \times \log A) + (0,0853/H) + 2,0975}$
PEF	$e^{(-0,00211A) + (0,1049 \times \log A) + (-0,6774/H) + 1,3255}$	$e^{(-0,00677A) + (0,4017 \times \log A) + (-0,7422/H) + 0,9661}$

H = Height in metres A = Age in years
log = Logarithm to base 10

Art. no.: 2.510858 Rev. f

13.5.6 Indian Standard

The Indian equations are valid for patients from the age of 7 years as follows:

	Male	Female
	<30 years old:	
FVC	0,055H + 0,019 A - 6,058	0,030H + 0,006A - 2,284
FEV1	0,039H - 0,010A - 3,266	0,025H - 0,011A - 1,424
	≥30 years old:	
FVC	0,054H - 0,018A - 4,832	0,043H - 0,010A - 3,755
FEV1	0,037H - 0,022A - 2,650	0,032H - 0,012A - 2,580
	≥30 years old:	
FEV1/FVC	-0,1756H - 0,2457A + 119,346	-0,0334H - 0,2146A + 94,8867
VC	0,0522H - 0,0114A - 4,859	0,0587H - 0,0296A - 5,927
FEV3	0,0485H - 0,0183A - 4,138	0,0533H - 0,0105A - 5,660
FEF25-75%	0,0173H - 0,0407A + 1,6108	0,0245H - 0,0336A + 0,1399
PEF	0,0850H - 0,0187A - 6,2083	0,0497H - 0,0018A - 2,7154
FEF50%	0,0195H - 0,0365A + 1,7383	0,0272H - 0,0279A + 0,2704
FEF75%	0,0088H - 0,0301A +1,0402	0,0113H - 0,0288A + 0,5012
MVV	1,3052H - 0,5228A - 93,2102	0,7149H - 0,3624A - 25,0208

H = Height in metres A = Age in years

Art. no.: 2.510858 Rev. f

13.6 Norm Values for the USA and Canada

13.6.1 Nhanes III Compensation Factors

The following tables give the compensation factors when **Nhanes III** (Hankinson, Odencrantz and Fedan) is selected as the norm value.

The Ht_{PRD} coefficient is used for prediction equation and Ht_{LLN} is used (replaces Ht_{PRD}) for the lower limit of normal equation. The formula is as follows:

Lung Function Parameter = $b_0 + b_1 * \text{age (years)} + b_2 * \text{age}^2 + b_3 * \text{height}^2$ (cm)

For example, to calculate the FEV_1 predicted value for a Caucasian male under 20 years of age the equation would be:

- $FEV_1 = b_0 + (b_1 * \text{age (years)}) + (b_2 * \text{age}^2) + (b_3 * \text{height}^2 \text{ (cm)})$
- $FEV_1 = (-0.7453) + (-0.04106 * \text{age}) + (0.004477 * \text{age}^2) + (0.00014098 * \text{height}^2)$

If the subject was 19 years of age with a height of 182 cm the predicted value would be:

- $FEV_1 = (-0.7453) + (-0.04106 * 19) + (0.004477 * 19^2) + (0.00014098 * 182^2)$
- $FEV_1 = (-0.7453) + (-0.78014) + (0.004477 * 361) + (0.00014098 * 33124)$
- $FEV_1 = (-0.7453) + (-0.78014) + (1.616197) + (4.66982152)$
- = 4.76 litres

Art. no.: 2.510858 Rev. f

Nhanes III Prediction and Lower Limit of Normal Equations for Spirometric Parameters for Male Subjects

Male Subjects	Intercept	Age	Age^2	Ht_{PRD} $(cm)^2$	Ht_{LLN} $(cm)^2$	R^2
Caucasian < 20 years of age	b_0	b_1	b_2	b_3		
FEV_1	-0.7453	-0.04106	0.004477	0.00014098	0.00011607	0.8510
FEV_6	-0.3119	-0.18612	0.009717	0.00018188	0.00015323	0.8692
FVC	-0.2584	-0.20415	0.010133	0.00018642	0.00015695	0.8668
PEF	-0.5962	-0.12357	0.013135	0.00024962	0.00017635	0.7808
FEF_{25-75}	-1.0863	-0.13939		0.00010345	0.00005294	0.5601
Caucasian ≥ 20 years of age						
FEV_1	-0.5536	-0.01303	0.000172	0.00014098	0.00011607	0.8510
FEV_6	-0.1102	-0.00842	0.000223	0.00018188	0.00015323	0.8692
FVC	-0.1933	-0.00064	0.000269	0.00018642	0.00015695	0.8668
PEF	1.0523	-0.08272	0.001301	0.00024962	0.00017635	0.7808
FEF_{25-75}	2.7006	-0.4995		0.00010345	0.00005294	0.5601
African - American < 20 years of age						
FEV_1	-0.7048	-0.05711	0.004316	0.00013194	0.00010561	0.8080
FEV_6	-0.5525	-0.14107	0.007241	0.00016429	0.00013499	0.8297
FVC	-0.4971	-0.15497	0.007701	0.00016643	0.00013670	0.8303
PEF	-0.2684	-0.28016	0.018202	0.00027333	0.00018938	0.7299
FEF_{25-75}	-1.1627	-0.12314		0.00010461	0.00004819	0.4724
African - American ≥ 20 years of age						
FEV_1	0.3411	-0.02309		0.00013194	0.00010561	0.8080
FEV_6	-0.0547	-0.02114		0.00016429	0.00013499	0.8297
FVC	-0.1517	-0.01821		0.00016643	0.00013670	0.8303
PEF	2.2257	-0.04082		0.00027333	0.00018938	0.7299
FEF_{25-75}	2.1477	-0.04238		0.00010461	0.00004819	0.4724
Mexican - American < 20 years of age						
FEV_1	-0.8218	-0.04248	-0.04291	0.00015104	0.00012670	0.8536
FEV_6	-0.6646	-0.11270	0.007306	0.00017840	0.00015029	0.8657
FVC	-0.7571	-0.09520	0.006619	0.00017823	0.00014947	0.8641
PEF	-0.9537	0.19602	0.14497	0.00030243	0.00021833	0.7530
FEF_{25-75}	-1.3592	0.10529		0.00014473	0.00009020	0.5482
Mexican - American ≥ 20 years of age						
FEV_1	0.6306	-0.02928		0.00015104	0.00012670	0.8536
FEV_6	0.5757	-0.02860		0.00017840	0.00015029	0.8657
FVC	0.2376	-0.00891	-0.000182	0.00017823	0.00014947	0.8641
PEF	0.0870	0.06580	-0.001195	0.00030243	0.00021833	0.7530
FEF_{25-75}	1.7503	-0.05018		0.00014473	0.00009020	0.5482

Art. no.: 2.510858 Rev. f

Nhanes III Prediction and Lower Limit of Normal Equations for Spiro metric Parameters for Female Subjects

Female Subjects	Intercept	Age	Age^2	Ht_{PRD} $(cm)^2$	Ht_{LLN} $(cm)^2$	R^2
Caucasian < 20 years of age						
FEV_1	-0.8710	0.06537		0.00011496	0.00009283	0.7494
FEV_6	-1.1925	0.06544		0.00014395	0.00011827	0.7457
FVC	-1.2082	0.05916		0.00014815	0.00012198	0.7344
PEF	-3.6181	0.60644	-0.016846	0.00018623	0.00012148	0.5559
FEF_{25-75}	-2.5284	0.52490	-0.015309	0.00006982	0.00002302	0.5005
Caucasian ≥ 20 years of age						
FEV_1	0.4333	-0.00361	-0.000194	0.00011496	0.00009283	0.7494
FEV_6	-0.1373	0.01317	-0.000352	0.00014395	0.00011827	0.7457
FVC	-0.3560	0.01870	-0.000382	0.00014815	0.00012198	0.7344
PEF	0.9267	0.06929	-0.001031	0.00018623	0.00012148	0.5559
FEF_{25-75}	2.3670	-0.01904	-0.000200	0.00006982	0.00002302	0.5005
African - American < 20 years of age						
FEV_1	-0.9630	0.05799		0.00010846	0.00008456	0.6687
FEV_6	-0.6370	-0.04243	0.003508	0.00013497	0.00010848	0.6615
FVC	-0.6166	-0.04687	0.003602	0.00013606	0.00010916	0.6536
PEF	-1.2398	0.16375		0.00019746	0.00012160	0.4736
FEF_{25-75}	-2.5379	0.43755	-0.012154	0.00008572	0.00003380	0.3787
African - American ≥ 20 years of age						
FEV_1	-0.3433	-0.01283	-0.000097	0.00010846	0.00008456	0.6687
FEV_6	-0.1981	-0.00047	0.000230	0.00013497	0.00010848	0.6615
FVC	-0.3039	0.00536	-0.000265	0.00013606	0.00010916	0.6536
PEF	1.3597	0.03458	-0.000847	0.00019746	0.00012160	0.4736
FEF_{25-75}	2.0828	-0.03793		0.00008572	0.00003380	0.3787
Mexican - American < 20 years of age						
FEV_1	-0.9641	0.06490		0.00012154	0.00009890	0.7268
FEV_6	-1.2410	0.07625		0.00014106	0.00011480	0.7208
FVC	-1.2507	0.07501		0.00014246	0.00011570	0.7103
PEF	-3.2549	0.47495	-0.013193	0.00022203	0.00014611	0.4669
FEF_{25-75}	-2.1825	0.42451	-0.012415	0.00009610	0.00004594	0.4305
Mexican - American ≥ 20 years of age						
FEV_1	0.4529	-0.01178	-0.000113	0.00012154	0.00009890	0.7268
FEV_6	0.2033	0.00020	-0.000232	0.00014106	0.00011480	0.7208
FVC	0.1210	0.00307	-0.000237	0.00014246	0.00011570	0.7103
PEF	0.2401	0.06174	-0.001023	0.00022203	0.00014611	0.4669
FEF_{25-75}	1.7456	-0.01195	-0.000291	0.00009610	0.00004594	0.4305

Art. no.: 2.510858 Rev. f

13.6.2 Morris

The Morris equations are valid for women between 56 and 72 inches tall and within the age range 20 to 90 years, and for men between 58 and 80 inches tall and within the age range 20 to 90 years.

	Male	Female
FVC	0,1480H - 0,0250A - 4,241	0,1150H - 0,0240A - 2,852
FEV1	0,0920H - 0,0320A - 1,260	0,0890H - 0,0250A - 1,932
FEV1/FVC	-0,3118H + 0,2422A - 107,120	-0,0679H + 0,1815A + 88,700
FEF0.2-1.2	0,1090H - 0,0470A + 2,010	0,1450H - 0,0360A - 2,532
FEF25-75	0,0470H - 0,0450A + 2,513	0,0600H - 0,0300A + 0,551
FEF75-85	0,0130H - 0,0230A + 1,210	0,0250H - 0,0210A + 0,321

The Morris normals are extended with the following ITS equations:

	Male	Female
FEV0.5	0,0831H - 0,0152A - 1,914	0,0605H - 0,0185A - 0,809
FEV3	-0,1359H - 0,0271A - 3,512	-0,1123H - 0,0257A - 2,745
FEV3/FVC	-0,1593H - 0,1450A + 112,090	-0,2380H - 0,1630A - 118,160
MVV	3,4040H - 1,2600A - 21,400	2,0500H - 0,5700A - 5,500

H = Height in inches A = Age in years

13.6.3 Crapo

The Crapo equations are valid for men between 61 and 77 inches tall and within the age range 18 to 89 years, and for women between 57 and 71 inches tall and within the age range 18 to 89 years:

	Male	Female
FVC	0,1524H - 0,0214A - 4,650	0,1247H - 0,0216A - 3,590
FEV1	0,1052H - 0,0244A - 2,190	0,0869H - 0,0255A -1,578
FEV3	0,1359H - 0,0271A - 3,512	0,1123H - 0,0257A - 2,745
FEV1/FVC	-0,3302H - 0,1520A + 110,490	-0,5131H - 0,2520A + 126,580
FEF25-75	0,0518H - 0,0380A + 2,133	0,0391H - 0,0460A + 2,683
MVV Vol.	3,4040H - 1,2600A - 21,400	2,0500H - 0,5700A - 5,500

The Crapo normals are extended with the following ITS equations:

	Male	Female
FEV0.5	0,0831H - 0,0152A - 1,914	0,0605H - 0,0185A - 0,809
FEV3.0/FVC	-0,1593H - 0,1450A + 112,090	-0,2380H - 0,1630A - 118,160

H = Height in inches A = Age in years

Art. no.: 2.510858 Rev. f

13.6.4 Morris and Crapo Norm Values for Children

The following equations are valid for children within the age range 7 to 17.99 years:

Boys 7 - 17.99 years 43 - 77 inch (1.09 - 1.96 m) White / Caucasian / Hispanic	Girls 7 - 17.99 years 43 - 77 inch (1.09 - 1.96 m) White / Caucasian / Hispanic
FVC (ml) = $3{,}58 \times 10^{-4} \times H^{3{,}18}$ SD = 13%	FVC (ml) = $2{,}57 \times 10^{-3} \times H^{2{,}78}$ SD = 14%
FCV1 (ml) = $7{,}74 \times 10^{-4} \times H^{3{,}0}$ SD = 13%	FCV1 (ml) = $3{,}79 \times 10^{-3} \times H^{2{,}68}$ SD = 14%
PEF (l/min) = $3{,}35 \times 10^{-4} \times H^{2{,}79}$ SD = 13%	PEF (l/min) = $2{,}58 \times 10^{-3} \times H^{2{,}37}$ SD = 18%
FEF25-75% (l/min) = $7{,}98 \times 10^{-4} \times H^{2{,}46}$ SD = 13%	FEF25-75% (l/min) = $3{,}79 \times 10^{-3} \times H^{2{,}16}$ SD = 28%

Boys 7 - 17.99 years (1.09 - 1.96 m) Black / Asian	Girls 7 - 17.99 years (1.09 - 1.96 m) Black / Asian
FVC (ml) = $1{,}07 \times 10^{-3} \times H^{2{,}93}$ SD = 17%	FVC (ml) = $8{,}34 \times 10^{-4} \times H^{2{,}98}$ SD = 15%
FCV1 (ml) = $1{,}03 \times 10^{-3} \times H^{2{,}92}$ SD = 17%	FCV1 (ml) = $1{,}14 \times 10^{-3} \times H^{2{,}89}$ SD = 15%
PEF (l/min) = $1{,}74 \times 10^{-4} \times H^{2{,}92}$ SD = 22%	PEF (l/min) = $5{,}51 \times 10^{-4} \times H^{2{,}68}$ SD = 20%
FEF25-75% (l/min) = $3{,}61 \times 10^{-4} \times H^{2{,}60}$ SD = 36%	FEF25-75% (l/min) = $1{,}45 \times 10^{-3} \times H^{2{,}34}$ SD = 30%

H = Height in inches A = Age in years

Art. no.: 2.510858 Rev. f

13.6.5 Knudson

The Knudson equations are valid for both children and adults in specific groups according to age and height:

	Male	Female
	H = 44 to 61 inches, A = 6 to 11 years	**H = 42 to 58 inches, A = 6 to 10 years**
FVC	0,1039 * H + 0,0 * A -3.376	0,1092 * H + 0,0 * A -3,749
FVC0.5	0,0760 * H + 0,0430 * A -3.050	0,0480 * H + 0,0610 * A -1,740
FEV1	0,0884 * H + 0,0 * A - 2.814	0,0853 * H + 0,0 * A - 2,758
FEV1/FVC	-0,2065 * H + 0,0 * A + 100.439	-0,4849 * H + 0,6655 * A + 109,974
FEF25 - 75	0,0859 * H + 0,0 * A - 2.320	0,0559 * H + 0,0 * A - 0,812
PEF	0,1980 * H + 0,1660 * A - 8.061	0,1240 * H + 0,1570 * A - 3,920
FEF50	0,0960 * H + 0,0 * A - 2.545	0,0 * H + 0,1846 * A + 0,736
FEF75	0,0434 * H + 0,0 * A - 1.015	0,0277 * H + 0,0 * A - 0,166
MVV	4,6800 * H - 1,8 * A - 192.32	2,7600 * H + 3,4000 * A - 108,120
	H = 55 to 76 inches, A = 12 to 25 years	**H = 52 to 72 inches, A = 11 to 20 years**
FVC	0,1499 * H + 0,0739 * A - 6,887	0,1057 * H + 0,0699 * A - 4,447
FVC0.5	0,0760 * H + 0,0430 * A - 3,050	0,0480 * H + 0,0610 * A - 1,740
FEV1	0,1318 * H + 0,0636 * A - 6,118	0,0892 * H + 0,0694 * A - 3,762
FEV1/FVC	-0,2065 * H + 0,0 * A + 100,439	-0,4849 * H + 0,6655 * A + 109,974
FEF25 - 75	0,1369 * H + 0,0749 * A - 6,199	0,0709 * H + 0,1275 * A - 2,801
PEF	0,1980 * H + 0,1660 * A - 8,061	0,1240 * H + 0,1570 * A - 3,920
FEF50	0,1379 * H + 0,1150 * A - 6,385	0,0732 * H + 0,1111 * A - 2,304
FEF75	0,1008 * H - 0,0057 * A - 4,242	
MVV	4,6800 * H + 1,8000 * A - 192,320	2,7600 * H + 3,4000 * A - 108,12

For patients over 18 years the following equations apply:

	Male	Female
FEV3	0,1359 * H - 0.0271 * A - 3.512	0,1123 * H - 0,0257 * A - 2,745
FEV3/FVC	-0,1593 * H - 0.1450 * A + 112.090	-0,2380 * H - 0,1630 * A + 118,160
	H = 62 to 77 inches, A = 26 to 91 years	**H = 58 to 71 inches, A = 21 to 91 years**
FVC	0,1524 * H - 0,0214 * A - 4,650	0,1247 * H - 0,0216 * A - 3,590
FVC0.5	0,0831 * H - 0,0152 * A - 1,914	0,0605 * H - 0,0185 * A - 0,809
FEV1	0,1052 * H - 0,0244 * A - 2,190	0,0869 * H - 0,0255 * A - 1,578
FEV3	0,1359 * H - 0,0271 * A - 3,512	0,1067 * H - 0,0257 * A - 2,745
FEV1/FVC	0,0 * H - 0,1050 * A + 86,686	-0,4704 * H - 0,1896 * A + 121,678
FEF.2 - 1.2	0,1090 * H - 0,0470 * A + 2,010	0,1450 * H - 0,0360 * A - 2,532
FEF25 - 75	0,1471 * H - 0,0363 * A - 4,518	0,0531 * H - 0,0344 * A + 1,128
FEF75 - 85	0,0130 * H - 0,0230 * A + 1,210	0,0250 * H - 0,0210 * A + 0,321
PEF	0,2390 * H - 0,0350 * A - 5,990	0,1240 * H - 0,0250 * A - 0,740
FEF25	0,0900 * H - 0,0200 * A + 2,726	0,0690 * H - 0,0190 * A + 2,147
FEF50	0,1737 * H - 0,0366 * A - 5,409	0,0681 * H - 0,0289 * A + 0,609
FEF75	0,0787 * H - 0,0230 * A - 2,483	0,0244 * H - 0,0259 * A + 1,118
MVV	3,0300 * H - 0,8160 * A - 37,900	2,1400 * H - 0,6850 * A - 4,870

In addition there are the following ITS equations:

	Male	Female
FEV3/FVC	-0,1593 * H - 0,1450 * A + 112,090	-0,2380 * H - 0,1630 * A + 118,160

Art. no.: 2.510858 Rev. f

13.6.6 Knudson 76

The Knudson 76 equations are valid for both males and females in specific age groups as follows:

	Male	Female
	Age <25 years	Age <20 years
FVC	0,1270H + 0,078A - 5,508	0,0838H + 0,092A - 3,469
FVC0.5	0,0762H + 0,043A - 3,054	0,0483H + 0,061A - 1,738
FEV1	0,1168H + 0,045A - 4,808	0,0686H + 0,085A - 2,703
FEV3	0,1321H + 0,066A - 5,531	0,0838H + 0,086A - 3,417
FEV1/FVC	-0,2210H - 0,140A + 103,64	-0,2819H - 0,109A + 107,38
FEF25-75	0,1499H + 0,0A - 5,334	0,0635H + 0,121A - 1,893
PEF	0,1981H + 0,166A - 8,060	0,1245H + 0,157A - 3,916
FEF25	0,1778H + 0,147A - 7,054	0,1118H + 0,144A + 3,365
FEF50	0,1295H + 0,081A - 4,975	0,0864H + 0,120A + 2,531
FEF75	0,0813H + 0,0A - 2,455	0,0H + 0,139A - 0,692

	Age >25 years	Age >20 years
FVC	0,1651H - 0,029A - 5,459	0,0940H - 0,022A - 1,774
FVC0.5	0,0940H - 0,017A - 2,746	0,0483H - 0,014A - 0,406
FEV1	0,1321H - 0,027A - 4,203	0,0686H - 0,021A - 0,794
FEV3	0,1600H - 0,031A - 5,245	0,0889H - 0,023A - 1,633
FEV1/FVC	-0,2210H - 0,140A + 103,64	-0,2819H - 0,109A + 107,38
FEF25-75	0,1143H - 0,031A - 1,864	0,0533H - 0,024A - 1,171
PEF	0,2388H - 0,035A - 5,993	0,1245H - 0,025A - 0,735
FEF25	0,2235H - 0,035A - 5,618	0,1092H - 0,025A + 0,132
FEF50	0,1753H - 0,015A - 5,400	0,0889H - 0,013A - 0,444
FEF75	0,1118H - 0,012A - 4,143	0,0H - 0,014A - 3,042

H = Height in inches A = Age in years

13.6.7 Composite Norm Values

Selection of the Composite normals provides selected equations taken from other tables as follows:

Value	Equation Reference
FVC	Knudson
FEV1	Knudson
FEV3	Crapo
FEF25-75	Knudson
FEF75-85	Morris
FEF0.2-1.2	Morris
MVV	Crapo
VC	Knudson (same as FVC)

Art. no.: 2.510858 Rev. f

13.6.8 Polgar Norm Values

The Polgar equations are valid for both children and adults in specific groups according to age as follows:

	Male Age under 18 years	Female Age under 18 years
FVC	$0{,}0000071H^3 + 0{,}00057H^2 - 0{,}0123H + 0{,}14$	$0{,}0000076H^3 + 0{,}00048H^2 + 0{,}0112H + 0{,}13$
FVC0.5	0,076H + 0,043A - 3,05	-
FEV1.0	$0{,}00000087H^3$ + 0,00035H2 - 0,0086H + 0,1	$0{,}0000086H^3 + 0{,}00035H^2$ - 0,0086H + 0,1
FEF25-75%	0,1109H - 3,46	0,1109H - 3,46
PEF	0,2219H - 7,09	0,2219H - 7,09
MVV	4,68H - 1,8A - 192,32	2,76H - 3,4A - 108,12

	Age 18 to 25 years	Age 18 to 20 years
FVC	0,1499H + 0,0739A - 6,887	0,1057H + 0,0699A - 4,447
FVC0.5	0,0760H + 0,0430A - 3,050	0,0480H + 0,00610A - 1,740
FEV1,0	0,1318H + 0,0636A - 6,118	0,0892H + 0,0694A - 3,762
FEF25-75	0,1369H + 0,0749A - 6,199	0,0709H + 0,1275A - 2,801
PEF	0,1980H + 0,1660A - 8,061	0,1240H + 0,1570A - 3,920
FEF50	0,1379H + 0,1150A - 6,385	0,0732H + 0,1111A - 2,304
FEF75	0,1008H - 0,0057A - 4,242	0,0617H + 0,2923A - 4,401
MVV	4,68H + 1,8A - 192,32	2,76H + 3,4A - 108,12

	Age over 25 years	Age over 20 years
FEF3.0	-	0,1067H - 0,0257A - 2,745
FEF0.2-1.2	0,1090H - 0,0470A + 2,010	0,1450H - 0,0360A - 2,532
FEF25-75%	0,1471H - 0,0363A - 4,518	0,0531H - 0,0344A + 1,128
FEF75-85%	0,0130H - 0,0230A + 1,210	0,0250H - 0,0210A + 0,321
PEF	0,2390H - 0,0350A - 5,990	0,1240H - 0,0250A - 0,740
FEF25	0,0900H - 0,0220A + 2,726	0,0690H - 0,0190A + 2,147
FEF50	0,1737H - 0,0366A - 5,409	0,0681H - 0,0289A + 0,609
FEF75	0,0787H - 0,0230A - 2,483	0,0244H - 0,0259A + 1,118
MVV	3,03H - 0,816A -3,79	2,14H - 0,685A - 4,87

H = Height in inches A = Age in years

The remaining values are taken from the ITS equations.

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

Art. no.: 2.510858 Rev. f

Index

Art. no.: 2.510858 Rev. f

T

U

W

Art. no.: 2.510858 Rev. f