Cardio–Aid® 200
Service Manual

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Chapter 1 – Introduction.

This manual covers service and maintenance procedures for the Cardio-Aid® 200. This manual is written for service personnel having the proper training, experience, access to original spare parts, proper tools and tests equipment. We provide this service manual to customer's for their convenience and for the general information purposes only.

The D.F.U. (Directions for Use) contain important notes and warnings, which are intended for the user but are also relevant for service personnel. The technician must be fully acquainted with the operation of the Cardio-Aid® defibrillator prior to any service or calibration of the device.
Artema Monitoring & Emergency Care A/S reserves the right to improve or change our products and manuals. Therefore, certain data is subject to change without notice. This manual reflects the state of the Cardio-Aid® defibrillators at the time of publication. Artema will update earlier production models, if there is a design or production fault, which will have a direct bearing on the safety of the patient or cause a product malfunction. Changes affecting this manual are described in issues of Artema Service News.
See Chapter 11 – Service News., reserved for the purpose

Artema assumes full responsibility for safety, reliability, and performance of this equipment if:

1. Assembly, modifications, or repairs have been carried out by personnel authorized by Artema and the parts and components used are approved by Artema.

2. Electrical installations satisfy local requirements.

3. The equipment is used by qualified personnel in accordance with the Directions for Use.

1.1 Service policy.

The Cardio-Aid® defibrillator line sets a new standard for serviceability. The objective is to exploit a distributed service strategy, where extended servicing of the defibrillator can be handled by either the certified distributor or the biomedical department in the hospital, or by the possibility of remote trouble shooting and downloading of software directly from Artema.

The service policy for the Cardio-Aid® defibrillator can be divided into three levels:

1. Field service (at hospital):

   Replacement of the battery.
   Software and voice prompt update from memory card.
   Calibration via the built-in Service Menu.

2. Service by authorized and certified distributor.

   Software update from memory card, servicing, fault finding and calibration from the built-in Service Menu or remotely from a PC.
   Replacement of spare parts and main components.
   Upgrading with optional features.

3. Factory service.

   Full service at the Artema factory.

The range of service products includes:

1. A PC service kit for certified distributors, for remote servicing, calibration and fault finding. The kit includes software and the necessary hardware for connecting a PC to the defibrillator, see Chapter 9 – Defi program. and Chapter 10 – Spare parts.

2. Memory card for download of software and voice prompts updates.

3. All printed circuit boards, cables, main components, labels and essential cabinet parts. See Chapter 10 – Spare parts..

4. Service kits for updating the defibrillator with the optional printer or change of the defibrillation means (Pads or Paddles)

5. Tools and test equipment that is to be used when servicing the defibrillator. See Chapter 10 – Spare parts.

Thus this manual is developed to support diagnostics and support at system and printed circuit board levels. The distributor and authorized service dealer should keep appropriate stock of spare parts to support this principle. Printed circuit boards, which need repairs, must be returned to Artema.

1.2   The product.

The Cardio-Aid® is a defibrillator intended for use inside a hospital.

Primary use for emergency situations by inexperienced defibrillator operators but also to be used by experienced users for defibrillation, monitoring, in-hospital transport and cardio version.

The Cardio-Aid® is typically mounted on a shelf, emergency trolley or hanging on a wall mount device or at the end of a hospital bed during transport.

The Cardio-Aid® incorporates semi-automatic and manual defibrillation modes.

The Cardio-Aid® can be delivered in two different version.

> V1.0 Manual/Semi automatic defibrillator with pads
> V1.1 Manual/Semi automatic defibrillator with paddles

The Cardio-Aid® has a built-in main power supply and an internal battery for full operation when disconnected from the main supply.

The Cardio-Aid® has a PCMCIA slot for:

> PC remote control via a serial card.
> Software update via a memory card.
> Storing event logs on a memory card (in the future).

Cardio-Aid® includes also (optional):

A built-in thermal paper printer for generation of paper strip documentation, A build-in Pacer module for external pacing.

The accessories for the Cardio-Aid® include internal paddles (spoons), defibrillation electrodes/pads, printer paper, PCMCIA memory cards, accessory bag, Bed hook, Trolley mount, ECG cables, Service kit etc.

1.2.1   Philosophy of the Cardio-Aid®.

The philosophy of the Cardio-Aid® is to fulfil the requirements from two different user groups.

1.2.2   The first responder.

Typically a less experienced person in the resuscitation process e.g. a nurse, hospital technician or other non medical staff. The less experienced users, only trained in basic life support and how to use an AED, need an extremely easy to use defibrillator giving as much guidance and safety as possible.

1.2.3   The experienced

Users from the anesthesiology or cardiology dept. joining the resuscitation team at a later stage of the process. The experts need the more advanced

functions as manual selection of energy levels, synchronized defibrillation for cardioversion, monitoring and external pacing.

The operation is optimized for the two types of users based on the 1–2–3 step approach accepted in the market today.

1.2.4   Semi automatic mode.

Semi automatic mode is intended for the first responder, who will be guided through the resuscitation process using the Cardio-Aid®. This is done through short advisory messages shown in the display assisted by voice prompts. The ECG-signal from the patient is analyzed by the Cardio-Aid®, and the result is presented to the user. The user is guided through the sequence of shocking, checking for signs of circulation and performing CPR.

To use the Cardio-Aid® in Semi automatic mode, the user will only need to press the Power On/Off key (1) to turn the Cardio-Aid® on and the Action (2+3) key to analyze and deliver the shock. See the D.F.U. (Directions for Use) for details.

1.2.5   Manual mode.

Manual mode is intended for the experienced user. The ECG signal is analyzed in the Cardio-Aid® and the result is presented to the user. The user can act on the analysis results, or make a defibrillation whenever it is needed. To use the basic functions of the Cardio-Aid® in manual mode, the user will only need to do the following. Press the Power On/Off (1) key to turn the Cardio-Aid® on, open the cover covering the expert keyboard to get access to the energy selection keys and to select manual mode with the Manual key if not already selected in the configuration menu. Select the desired energy with the Energy up/down on the expert keyboard or on the paddles. Activate the Charge key (2) and the Shock keys (3) on the paddles or the Action (2+3) keys if pads are used to charge and deliver the shock. See the D.F.U. (Directions for Use) for details.

1.2.6   Pacer.

The user will be able to pace the patient externally by placing defibrillation electrodes/pads on the chest of the patient. The ECG is still analyzed by the Cardio-Aid® and a message is presented to the user if a shockable rhythm is detected. To use the Cardio-Aid® in Pace mode, the user will only need to press the Pacing key to enter pace mode, adjust pace rate with the Pace rate keys, adjust the pacing current with the Pace Current key and start the pacer output with the Pacer On/Off key. The pace mode (fixed or demand) can be selected in the user menu. See the D.F.U. (Directions for Use) for details.

1.2.7   Test mode.

Test mode is for the daily check of the Cardio-Aid®. The test can be performed in either semi- automatic mode or in manual mode. The user will

shock internally in the Cardio-Aid® and the delivered energy is measured, compared with the selected energy, and a record is printed.

Furthermore a simulated ECG signal can be shown on the display for demonstration and training purposes. Access to the simulated ECG signal is protected with a secret key to be activated during power on. See the D.F.U. (Directions for Use) for details.

1.2.8 Service and Configuration menus.

The configuration and service menus are dedicated to the technician in equipment set-up and service situations. The configuration and service menu are not used in the resuscitation process.

Accesses to the menus are protected with a secret key to be activated during power on. See the D.F.U. (Directions for Use) and Chapter 7 – Verification and Test. for details.

1.2.9 General user interface principle.

To keep the user interface extremely simple for the inexperienced users, the advanced functions like: Mode selection, Manual energy selection, Alarm system, Synchronization, Pacemaker functions and User set-up menus are hidden underneath a plastic cover. To access the functions the cover is easily opened.

The keys on the Cardio-Aid® are dedicated keys and have only a single function. The Print key can, however, be used in conjunction with Lead key to activate the lead scan function and together with the Event key to make an event report printout. Keys that control parameters with several settings toggle through the possible values, and wraps around when pressed with the last setting of the sequence showed. The menu function is entered and exited through the same key.

1.2.10 The Cardio-Aid® design.

The Cardio-Aid® consists of a cabinet housing the mechanical and electrical parts. The front encompasses a display, a keyboard, High Voltage connector and ECG connector. Display and keyboard are used for implementing the interaction between the user and the Cardio-Aid® supported by an integrated sound and voice-prompt system. The paddle holders with integrated test connection are placed on each side, making access to the paddles easy. The printer is placed on the left side of the cabinet. A PC card slot is placed on the right side of the cabinet. The internal battery compartment is placed behind the sternum paddle holders on the left side. A mains supply connector which includes the mains fuses is placed on the rear of the cabinet. An accessory bag can be mounted on the rear of the cabinet.

The handle can be folded down into the top of the cabinet. An integrated hook for bed mounting can optionally be attached on the rear of the cabinet.

1.2.11 Memory card.

The memory card (also called a PC card) is a is a standard PCMCIA type I SRAM memory card.

The memory card stores (future option) all resuscitation data recorded in the Cardio-Aid®. The data can later be reviewed, displayed, printed and extra notes added via a PC based Windows program like the CodeLog from Artema.

The memory card is also used to contain software and voice prompt updates. See Chapter 9 – Defi program.

1.2.12 Printer (optional).

The printer provides an instant paper record of the ECG trace, or print a record of other data such as the event report, settings or test results. It is an OEM thermal printer containing an Artema character set to allow all specified languages to be printed.

The printer speed is 25/50 mm per second and the width is 50mm.

The ECG trace occupies 40mm.

1.2.13 Pads.

The Cardio-Aid® can detect when pads are connected rather than paddles. The instruction label on the cover (visible when closed) indicates where the pads should be placed on the patient.

For test mode the pad connector can be inserted into the Pad Test Socket located on centre of the right pad holder. (Only available on the variants with pads holders).

1.2.14 External paddles.

The right (Apex) paddle contains the *Charge* and one *Shock* key. The *Charge* key is labelled '2' and is referred to on the screen as "key 2". The shock key is labelled '3' and is again referred to on the screen.

The Left (Sternum) paddle contains a *Shock* key labelled with '3'. There are also *plus* and *minus* buttons, labelled 'Energy' The keys are only active in Manual mode. These keys will change the energy level up or down and the actual value can be seen at the display. If either is pressed, in manual mode, while the unit is charging or is ready to shock, the unit will disarm.

1.2.15 Internal paddles.

Similar to pads, the unit will be able to detect when internal paddles are connected. The energy level will default to a lower value (configured in the service menu). Inserting internal paddles will force the Cardio-Aid$^®$ into manual mode.

1.3 Installation.

The Cardio-Aid$^®$ is intended for In-hospital use. To support the installation of the defibrillator in different environments within the hospital a number of suitable applications are made available to ease the mounting process.

The development of the Cardio-Aid$^®$ was not only aimed at a functional design but also on a mechanical well balanced construction that can be used as is. However, in order to provide the user with suitable mountings solutions there has been developed a Trolley, Wall and Bed mount.

1.3.1 Trolley mount.

Basically 3 types of standard mounting scenarios are seen for mounting a defibrillator on a trolley.

1. On a defibrillator swing arm, that is "raised" approximately 20-30 cm above the main chassis of the emergency trolley.

2. On the top work base of an emergency trolley.

3. On the top plate of an equipment trolley.

Requirements:
It is important that the defibrillator can be secured properly from sliding, tilting or dropping on the floor, while leaving the defibrillator controls unobstructed. Furthermore, it must be easy to detach the defibrillator from the trolley.

Solution:
An easy to use metal plate that can be mounted on any flat surface. When properly mounted the Cardio-Aid® slides onto the plate and uses the cutaway sections for the positioning of the four feet.

1.3.2 Wall mount.

The Cardio-Aid® must be positioned in an upright position as close to the wall as possible.

The wall mount is identical to the trolley mount, without any mechanical or electrical connections. The wall mount will secure the Cardio-Aid® defibrillator from sliding, tilting and dropping on the floor.

1.3.3 Bed mount.

A bed hook is integrated in the Cardio-Aid®,by means of an optional bracket that can be mounted next to the standard handle without obscuring the use of this. By simply place the handle over the bed rail the Cardio-Aid® is secured, leaving the controls unobstructed and the Cardio-Aid®,ready for immediate use during in-hospital transport situations.

1.3.4 Bag.

To facilitate the use of the Cardio-Aid®,a bag is made available (option) fulfilling multiple purposes such as easy storage of accessories and protection of the device.

Chapter 2 – Logbook.

2.1 Logbook.

This Artema Cardio-Aid® should be tested and, if necessary, serviced every 12 months from the date of delivery. This service logbook is included for your convenience.

Date	Initials	Remark

2.2   Goods to repair.

ARTEMA ◣◢

Goods to be repaired by Artema Monitoring and Emergency Care A/S

Date: _____

Company name:	
Your ref.:	Page ____ of ____
Signature:	

Part no.:		Cat no.	
Serial no.:			
Fault description:	*(please always indicate to secure quick repair)*		

Part no.:		Cat no.	
Serial no.:			
Fault description:	*(please always indicate to secure quick repair)*		

Part no.:		Cat no.	
Serial no.:			
Fault description:	*(please always indicate to secure quick repair)*		

Please ship to: Dan Transport A/S, Stenholm 19, DK-9400 Noerresundby, Denmark

Notify: Artema Monitoring and Emergency Care A/S, Aabybro

Destination: Aalborg Airport

To be filled in by Artema						
Goods received on				Initials		
Customer no.				Original packing	Yes	No
Condition of goods	Good	Fair	Poor			

2.3 Complaint form.

ARTEMA ◢◣◤

This form is intended for problem reporting and is to be completed by authorized Artema MEC A/S representatives or distributors, and sent to the:

Complain Manager	Artema MEC A/S Herstedvang 8 DK-2620 Albertslund Phone +45 4386 7474 Fax +45 4362 1001 e-mail: artema@artema.dk

Product:		Serial no.:	
Software version:		PCB/Module serial no.:	
Operating hours:		No of discharges:	

Medical Consequence: Tag as appropriate	Was the unit applied or connected to a patient? *if Yes tag off one of the following statements*	Yes		No	
	Cannot determine Medical Consequence from User Information				
	No Medical Consequence reported by user				
	Minor injury reported by User (give details under 'Nature of problem')				
	Death/serious injury reported by User. (give details under 'Nature of problem')				
	User believes death/serious injury could result if problem/incident reoccurs*				
	* if YES to this question please give the Users name and provide details of User's concern under 'Nature of problem'				

Customer name:	
Address:	
User name:	

Contact name:			
Fax/Telex:		Telephone:	
Form completed by:			
Company:			
Signature:		Date:	

Nature of problem:

For Artema' internal use only		Complaint no.:	
Received:		Signature:	

Chapter 3 – Technical description.

There are two basic standard versions available of the Cardio-Aid® defibrillator.

The only differences between the two versions are the cable/paddle holders mounted on each side of the Cardio-Aid® defibrillator. The remaining part of internal hardware and user interface are common for both versions.

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Paddles version.

Pads version.

As an optional feature the Cardio-Aid® also may be equipped with a thermal printer, as well as build-in pacer module for external pacing.

3.1 Block description.

The Cardio-Aid® electronics is build of the following circuits' boards:

Processor board.
Defi controller board.
Paddle and cable ECG boards.
Power supply board.
Defi test boards.
Printer connection board.
Pacer board.
Cable ECG connector board.
Keyboard.

Cables and board-to-board connectors make interconnections between the different boards and all boards and wiring harness are assembled onto the moulded inner chassis.

```
┌──────────────┐
│ Power Supply │
│    board     │
└──────┬───────┘
       │
       ▼
┌──────────────┐         ┌──────────────┐
│              │◄───────►│ Paddle ECG   │
│              │         │    board     │
│              │         └──────────────┘
│              │
│              │         ┌──────────────┐        ┌──────────────┐
│              │◄───────►│  Cable ECG   │───────►│  Cable ECG   │
│              │         │    board     │        │  Connector   │
│              │         └──────────────┘        │    board     │
│              │                                 └──────────────┘
│              │         ┌──────────────┐        ┌──────────────┐
│              │────────►│    High      │───────►│  HV Socket   │
│   Defi board │         │   Voltage    │        │              │
│(Defi Processor)│       │   harness    │        └──────┬───────┘
│              │         └──────▲───────┘               │
│              │         ┌──────┴───────┐               │
│              │◄───────►│   Option:    │               │
│              │         │ Pacer board  │               │
│              │         └──────────────┘               │
│              │◄──────────────────────────────────────┘
│              │         ┌──────────────┐
│              │◄────────│   HV-Test    │
│              │         │    board     │
│              │         └──────────────┘
│              │                              ┌──────────────┐
│              │◄──────┐                 ┌───►│ Battery Pack │
│              │       │                 │   └──────────────┘
│              │       ▼                 │
│              │     ┌──────────────┐    │   ┌──────────────┐
└──────┬───────┘     │   Printer    │────┘   │   Option:    │
       │             │ connection   │───────►│ Printer unit │
       ▼             │    board     │        └──────────────┘
┌──────────────┐     └──────────────┘
│              │
│  Processor   │     ┌──────────────┐
│    board     │────►│   Display    │
│(Main Processor)│   │    (LCD)     │
│              │     └──────────────┘
│              │
│              │     ┌──────────────┐
│              │◄────│   Keyboard   │
└──────────────┘     └──────────────┘
```
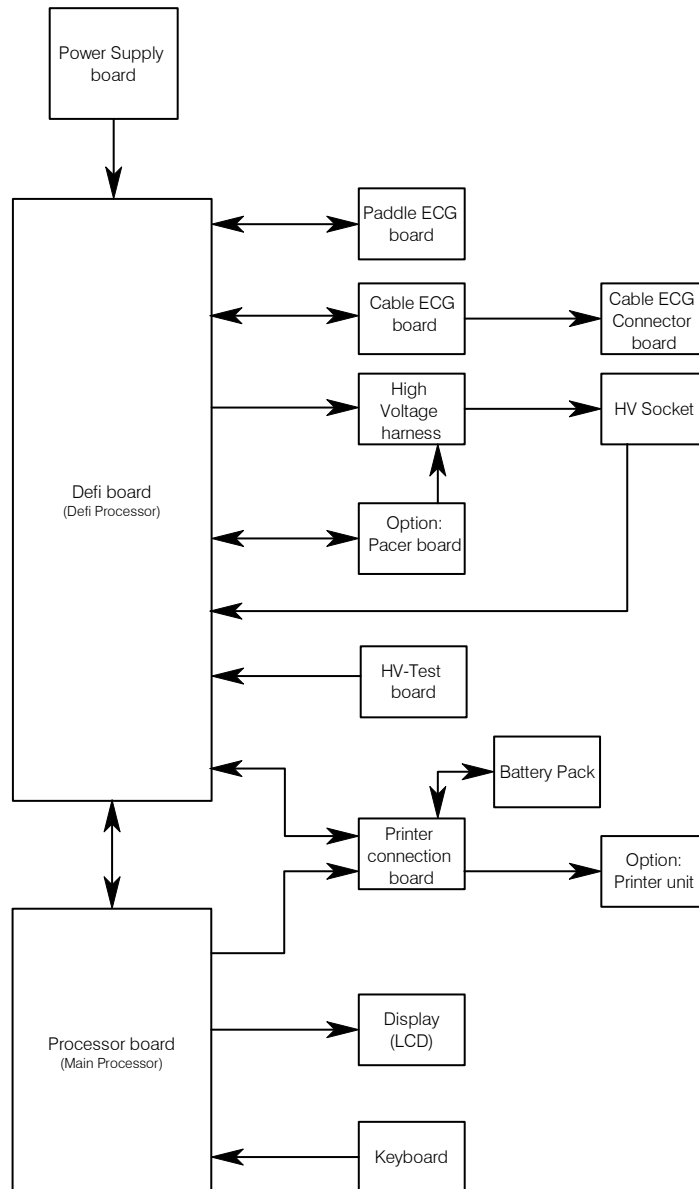
3.1.1 Power management.

The internal Power distribution in the Cardio-Aid® takes place in two ways:

From the AC inlet placed on the rear side.
From a built in battery pack.

3.1.1.1 Power Supply board.

The Power Supply is a combined power factor controller and DC/DC converter.

The Power supply is designed to accept inputs levels from 100-240VAC and to deliver a constant output power up to 60W and a peak power up to 200W.
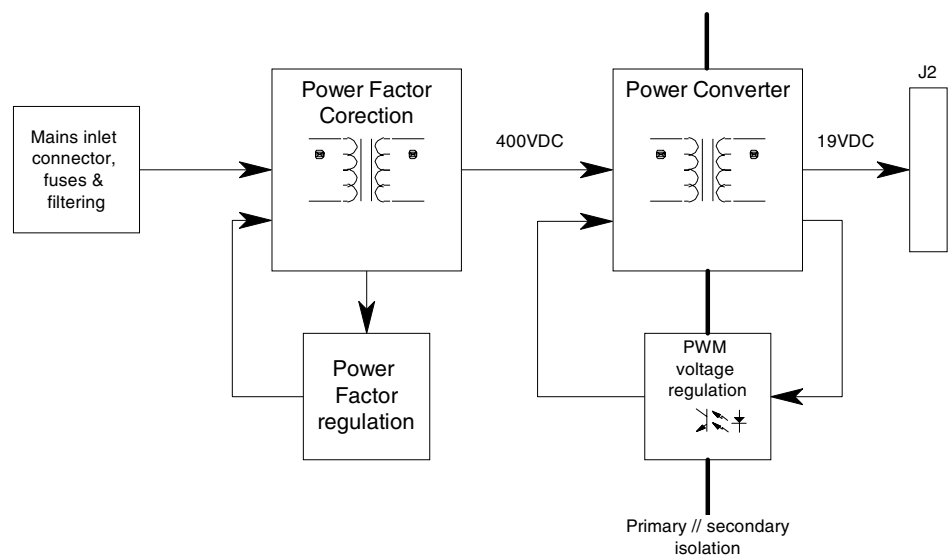
The AC from the inlet is feed via the input filter network to the AC/DC converter, which is a combined power factor controller and rectification circuit.

The converted DC voltage supplies an isolated DC/DC converter, which delivers a regulated 19VDC-output voltage, used as system supply for the different circuits' board inside the Cardio-Aid®.

The Power supply is protected against overload by help of two high breaking capacity fuses placed into the AC inlet connector onto the rear side of the Cardio-Aid®.

Output of the converter is electronically overload and overheat protected. If an over-voltage is detected, the unit automatically will close down. Normal operation is restored when the main voltage has been disconnected from the AC inlet for a few seconds.

3.1.1.2 Battery–pack.

The battery pack are special designed for the Cardio-Aid® and has a capacity of 1,7Ah.
The battery pack comprises 10 accumulator-cells, delivering a total battery voltage of 12 VDC. The cells temperature is readable by an internally thermistor, used by the charge controller placed onto the Defi board.

3.1.2 Defi board.

The Defi board includes following main functions:

A multi-output converter.
A battery charger and monitor system for the built in battery.
Defi controller and safety control logic.
A high voltage generator.
Drain circuit for internal high voltage discharge.
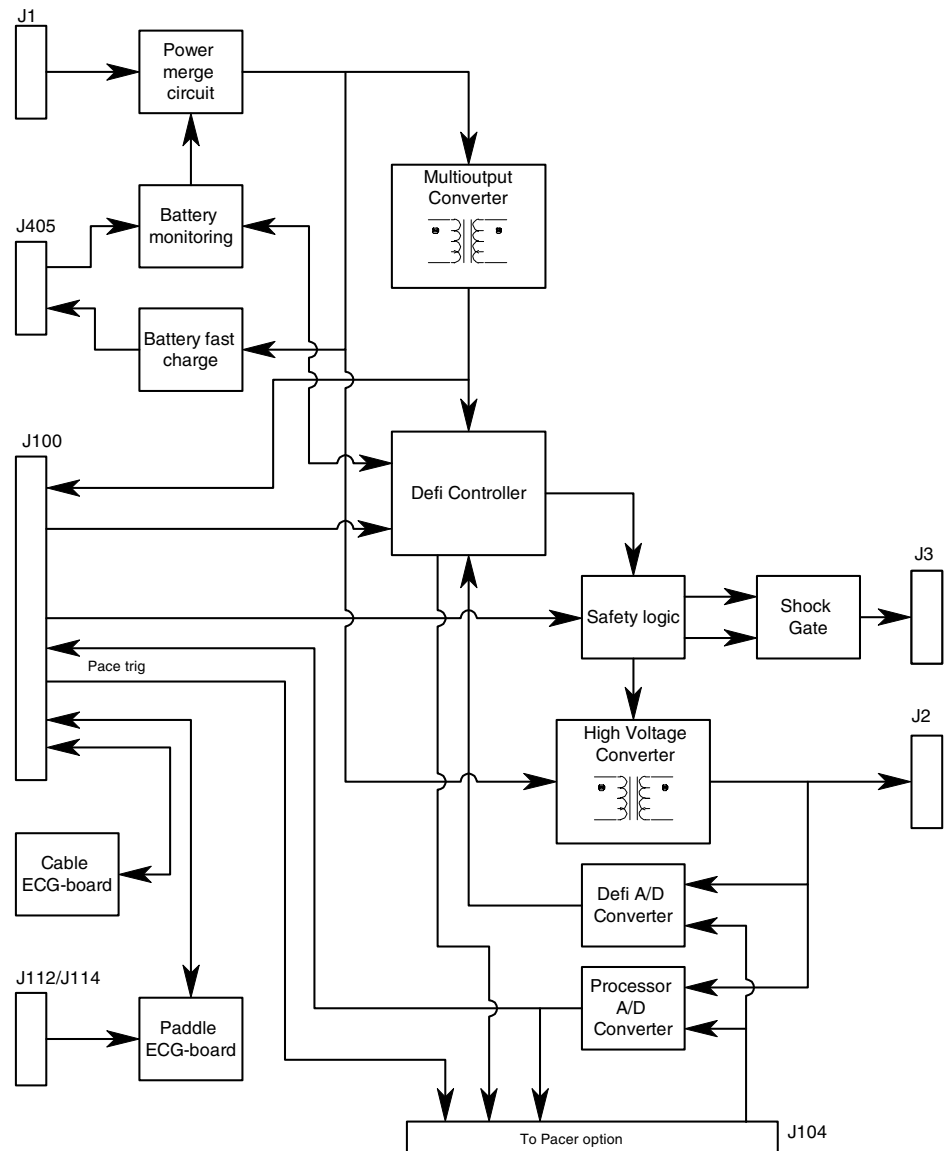
3.1.3 Multi output converter.

The system or battery voltage from the merging circuits supplying the converter.

The converter outputs' supplying the different circuits locally on the Defi board as well the Processor board with following voltages:

+5V dc.
+12V dc.
-28V dc.
2 x ±15V dc.
+ 13V dc. (only used for the printer).

The 15VDC outputs are galvanic isolated from the other outputs to ensure the patient isolation between the ECG amplifier modules and other circuits.

The converter is over voltage protected and will latch the converter off in fault conditions.

3.1.4 Battery fast–charge and energy monitoring.

The charging circuit ensures a comprehensive control of the battery charging process to secure long lifetime for the battery. The circuit controls the charge time and monitor the temperature in the accumulator-cells during charging.

The Defi controller monitors the actual energy supplied to and from the battery pack and data is used to inform the user about battery capacity.

A two-colored LED indicates the battery charge status on the front of the Cardio-Aid®. Green indicates that the battery is fully charged and yellow indicates battery is charging.

3.1.5 Defi Controller and safety logic.

The Defi controller and safety logic is for safety reasons designed as a two-channel system, where the Defi board controls the primary channel and the Processor board the secondary channel.

The Defi controller is based on a single chip processor, which include serial ports for communication locally onto the Defi board, parallel ports for interfacing to the processor board and other digital controls.

Any safety critical parameter analogue as well digital is monitored by the two-channel system. If any of these parameters is exceeding defined limits, the limits is brought into a safe state and an error message will be shown at the display.

3.1.6 Shock gate.

The high voltage relay is switching between charging of the high voltage capacitor and discharging energy to the patient. Both the relay and the capacitor are placed outside the Defi board into the moulded inner chassis.

To control the relay the shock gate merges the shock control signals from the two channels.

For executing a shock discharge both signals must be present at the same time, which secure that both channels must be fully functional to deliver a discharge.

3.1.7 High Voltage Generator.

The system voltage from the power merge circuit supplies the high Voltage Generator, which is controlled by the safety logic.

In monitoring mode the generator is disabled and the high voltage capacitor is shortened by a discharge/drain resistor placed onto the Defi board.

When a high voltage charging sequence is initiated, the primary channel enables the generator and controls the voltage charging of the capacitor. The second channel acts as a safety processor during the whole defibrillation process.

3.1.8 ECG interface.

The Cardio-Aid® has two ECG modules placed onto the Defi board.

The Defi board acts only as a gateway for the serial communication between ECG modules and the processor board. The communication takes place by help of opto-coupler, to secure the patient isolation.

3.1.9 Processor board.

The processor board includes the following main functions:

Microprocessor.
Flash memory and RAM.
Graphics circuit for a LCD.
Real Time Clock circuit.
Voice and sound generator.
Watchdog and reset circuit.
Interface for the Defi board.
ECG boards.
Printer, Memory card and Keyboard.
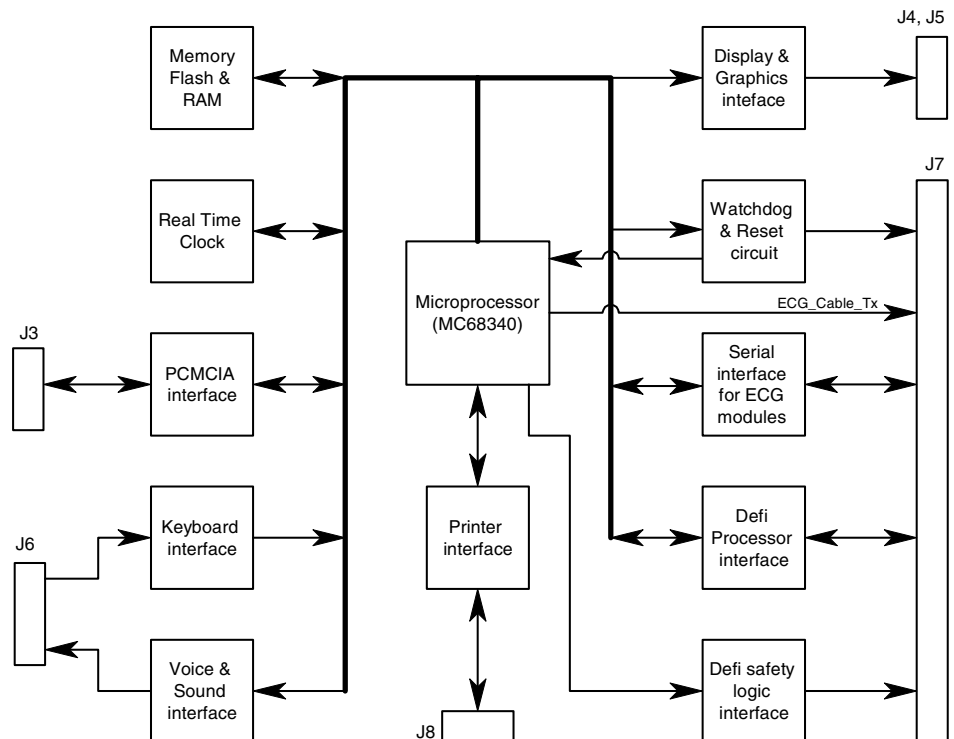
3.1.10 Flash PROM and RAM.

The boot software, programs code and Voice Data are stored in Flash PROM. The program data is stored into static RAM with power back up during stand by mode for data retention.

3.1.11 Controller for Liquid Crystal Display.

The LCD controller consists of a graphics microprocessor with separate video memory. The display resolution is 320X240 pixels.

Communication to the graphic processor is controlled by the main processor and the external display is directly connected to the graphic processor output. Contrast regulation circuitry and power supply for the display is also included on the processor board.

3.1.12 Real Time Clock.

The real time clock is an integrated circuit which also contains a lithium battery and crystal clock. The lifetime of the lithium battery is more than 10 years.

The real time clock is integrated with an intelligent controller, which may initiate a "Wake Up Test" by itself, if specified in the Cardio-Aid® configuration menu.

3.1.13 Voice and sound generator.

The voice table for the voice processor is transferred via the Main processor DMA channel. The converted voice data is merged together with volume and sound data by an electronic potentiometer and fed to the loudspeaker.

3.1.14 Watchdog.

A watchdog circuit ensures that the program execution on the Cardio-Aid® is fail-safe, by supervising the processor.

The processor must address a specific memory location in a certain interval and if not, the Watch dog will time out and generate a global reset to several circuits of the Cardio-Aid®.

A Watch-dog reset caused by an error will power off the Cardio-Aid® and an error code may appear in the display next time the Cardio-Aid® is powered on. After an error occurs, a fault LED placed on the front is flashing as well as a piezo speaker will start beeping.

3.1.15 Defi controller interface.

To communicate with the defi processor, the processor sends and receives command data via an eight-bit bi-directional port. A few additional safety-controlling lines are fed separately to the Defi board.

3.1.16 ECG and Printer interface.

Communications to and from the Paddle and Cable ECG amplifier is implemented as serial signals via the Defi board.

The communication signals are feed to the processor via a separate UART on the board and ECG signals processing takes place by the processor.

3.1.17 PCMCIA interface.

The interface is primarily used for storing obtained patient data onto a memory card.

The interface is also used when updating the Main and Basic software by downloading either from a memory card. See also 4.2.3 PCMCIA connector., and 9.2 Equipment needed..

3.1.18 Keyboard interface.

The keyboard is interfaced directly to the Processors data-bus via a set of buffers and latches. The processor filters keys toggle noise.

3.2 Defi Test board.

The test circuit contains power load resistors and an isolated current sense circuit, for monitoring the discharge voltage when shock is applied into the paddle or pad holders onto the Cardio-Aid®

The voltage is discharged over the load resistors and the measured current is fed to the Defi board for signal processing.

3.3 The ECG amplifiers.

Two independent ECG amplifier modules are used for processing the ECG signals supplied form either the paddles or pads or via an ECG Cable. Both amplifiers are located on the Defi board as two separate plug-in modules:

Cable module handles signals from the ECG cable.

Paddle module handles signals from either Pad or Paddles.

3.3.1 Cable ECG board.

The ECG signal is routed to the pre-amplifier board from the blue ECG connector on the front, via the ECG connection board mounted on the HV socket. The ECG connection board is supplied with spark gabs and EMI filters, to protect the pre-amplifiers input circuits against high voltage surges applied to the ECG cable.

The pre-amplifiers analog circuits control gain for the selected ECG lead, filter characterizations, offset adjustments, pace block and lead off detection.

A single chip microprocessor is used to control the ECG signal amplification and conversion, as well as interface to the serial communication between the ECG board and Processor board.

A coding system inside the ECG cable connector, enables the Cardio-Aid® to select the ECG cable as the ECG signal source because the ECG cable source has higher priority than the paddles or pads source.

3.3.2 Paddle ECG board.

The ECG signal from the HV socket is routed to the pre-amplifier via the Defi board, which also contains necessary protection circuits for reducing high voltage at the pre-amplifiers input circuit during shock.

Functionally on this module identical to the cable ECG module, except that the signal input only supports one lead and is integrated with a circuit for monitoring patient impedance measuring circuit for monitoring the impedance between pads/paddles when connected to a patient.

3.4 Printer (optional).

The printer is an option and is an OEM product equipped with a special character set for the Cardio-Aid®.

The interface to the printer is serial and is directly and fully controlled from the Processor board.

Power for the printer thermal heads is directly supplied from the Defi board via the printer board, which only consists of board-to-board connectors and some EMI filtering components.

3.5 Pacer (optional).

The Pacer board may be mounted onto the Defi board as an option. The module is, when installing, simply interconnected by inserting the module into the high voltage signal path by exchanging the high voltage cabling plugs to the Defi board, no further cabling is required.
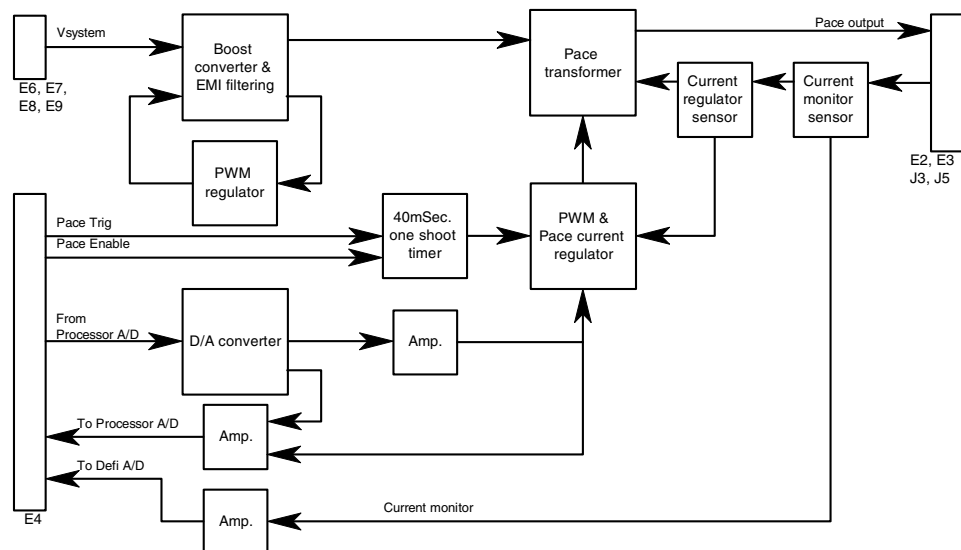
Note!   Updating a unit with a pacer board also requires updating the rubber key mat and labels.

3.5.1 Boost regulator.

To ensure the stability of the supply to the Pacer regulation circuit under all conditions, the input supply is boosted to approximately 32V.

A PWM regulator controls the boost circuit and the system voltage is used to supply the converter.

3.5.2 Pace generator.

The Pacer generator provides a 40ms pulse output, where the repetition rate and amplitude is controlled from the Processor board.

The 40ms pace pulse is generated by a one-shot timer triggered from the Processor board, which as well is setting the pace current, by writing a reference value to the digital to analog converter.

The converted reference value is used for the PWM regulation loop to set the pace current, which is delivered to the patient.

The actual true pace current obtained from the current sensor on the output connectors is used for the regulation circuit and is a part of the regulation loop.

3.5.3 Pace security system.

The Pacer module is for safety reasons designed as a two-channel system, where the Processor board act as the primary channel in pace mode and controls the pacer. The Defi controller controls the secondary channel.

The secondary channel monitors any safety critical parameter analog as well as digital. If a critical value is read, the pacing process immediately stops and an error message will be shown at the display.

The actual true pace current values is monitored at the output connectors and provides very accurate information about the patient current unaffected by the patient impedance variation. The Paddle ECG monitors the patient impedance during pacing.

Chapter 4 – Interconnections.

4.1   Interconnections.

The Printed circuit boards with most connectors are the Defi board and the Processor board. The text is basically made relative to these two boards.

Overview block diagram, see also 3.1.9 Processor board.

The Cardio-Aid® is a stand-alone unit and as such not intended to be inter-faced to other equipment.

The unit is equipped with a PMCIA slot, where a RS 232 serial communica-tion card can be used for communication between the defibrillator and a PC for service purposes.

Furthermore it is possible to connect a remote 1V ECG signal, from another ECG unit, through the normal ECG input connector. Coding in the cable informs the Cardio-Aid® about the means used.

In the following a description is made both on the external connectors, i.e. connectors used for external signals and the internal connectors, i.e. connec-tors used internally in the unit for distribution of signals. All signal distribu-tion is done via cabling or connectors between the various boards. The pin number and signal name remains the same from board to board in a given cable/connector.

By using the configuration tables below and the interconnection diagram the relevant information can easily be found.

4.2   External connectors.

4.2.1   Signal type definition.

A:	Analog
D:	Digital
I:	Input
O:	Output
P:	Power

4.2.2   Front connectors.

1. ECG connector.

2. HV Socket (Defi pads/Defi paddles/Pace electrodes).

4.2.2.1   ECG connector.

Pin no.	Name	Signal type
1	RA	AI (Analog Input)
2	LA	AI
3	RL	AI
4	LL	AI
5	Vx	AI
6	Screen	AO
7	External ECG	AI
8	Cable detect 1	DI
9	Cable detect 2	DI
10 (0)	GND	

ECG connector (front view)
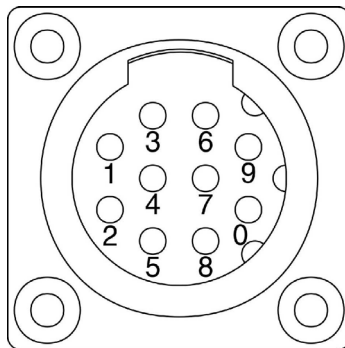
ECG connector coding

Cable type	Pin 8	Pin 9
3 lead	1	0
5 lead	0	0
Ext. ECG	0	1
No cable	1	1

1= open (not connected)
0= connected to pin 10 (GND).

4.2.2.2   HV socket.

Pin no.	Name	Signal type
1	SHOCK APEX	DI
2	CODE 2	DI
3	SHIELD	AO
4	ENERGY –	AI
5	SHOCK STERNUM	DI
6	CHARGE	DI
7	VDD+5V	PO
8	CODE 3	DI
9	CODE 1	DI
10	ENERGY +	AI
S	ENERGY STERNUM	AI/0
A	ENERGY APEX	AI/0
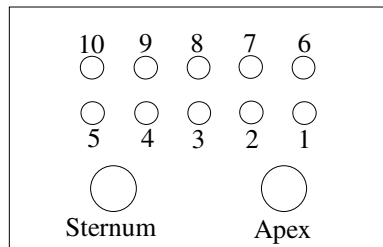
HV-Socket
(front view)

HV Connector, coding in accessory cables

Accessory	Pin 2	Pin 8	Pin 9
External paddles	NC	NC	Short to pin 7
Internal paddles	Short to pin 7	NC	NC
Defi pads	NC	Short to pin 7	NC

4.2.3   PCMCIA connector.

PCMCIA connector is placed on the right side of Cardio-Aid®.

The PCMCIA slot can be used for different applications.

1. Memory card mode (in the future) for logging events and waveforms for later analysis on a PC equipped with Artema's CodeLog program. The memory card is updated during the normal execution of the Cardio-Aid® program.

2. The Cardio-Aid®system software can only be updated via a memory card. A memory card, loaded with system software, can be received from Artema or the system software can be transferred to a memory card from a local PC with a PCMCIA slot.

3. Remote test and fault finding via a PCMCIA to RS 232 adaptor card and a PC equipped with Artema's DEFI TEST program. See Chapter 9 – Defi program..

Memory card function. See 4.3.4 Processor board connectors. J3003

4.2.3.1   RS 232 card serial link to PC.
The purpose of the serial link is twofold.

1. Enables local setup, test and calibration via the Artema's DEFI TEST program.

2. Enables remote access and control from, i.e. Artema's service organisations.

4.2.3.2   Requirements:
Standard PC 486 or higher, with CD ROM supporting, minimum Windows 95 and equipped with the remote control software "NETOP".

PCMCIA to RS 232 adaptor card 2 port. Manufactured by "ARGOSY".

Parity: none
Data bits: 8
Stop bit: 1
Flow control: XON/XOFF
Baud rate: 9600

Note!   It is recommended to use a galvanic isolation between the PC and the defibrillator in form of a RS 232 to RS 232 converter.

The communication port on the PC must be set up to communicate with the proper channel on the serial card. See Chapter 9 – Defi program..

4.3   Internal connectors.

Refer to interconnection diagram. Page 27. Drawing No. 91843.

Module	Connector	Pins	Module	Connector
DEFI board	J4001	6	Power supply board	J202
DEFI board	J4002	7	HV Relay	B3
DEFI board	J4003	4	HV Relay	Coil
DEFI board	J4006	4	Hv Socket	
DEFI board	J4100	50	Processor board	J3007
DEFI board	J4101	10	HV Socket	
DEFI board	J4102	4	Test board	J901
DEFI board	J4103	6	Cable ECG board	J5005
DEFI board	J4104	40	Pacer board	J1201
DEFI board	J4107	6	Paddle ECG board	J605
DEFI board	J4108	6	Cable ECG board	J5004
DEFI board	J4109	6	Paddles ECG board	J606
DEFI board	J4110	6	Paddles ECG board	J601
DEFI board	J4111	6	Paddles ECG board	J604
DEFI board	J4112	2	HV Socket/HV coil (Apex)	
DEFI board	J4114	2	HV Socket/HV relay	
DEFI board	J4405	10	Printer board	J704
DEFI board	E 4101		Processor board	J11
ECG connector board	J801	10	ECG connector	
ECG connector board	J802	4	Processor board	J3010
ECG connector board	E801	10	Cable ECG connector	J5001
Printer board	J705	6	Battery pack	J1
Printer board	J701	50	Printer Assy	
Processor board	J3003	68	PCMCIA	
Processor board	J3004	14	LCD	
Processor board	J3005	4	LCD CCFL	
Processor board	J3006	40	Keyboard board	J1001
Processor board	J3008	9	Printer board	J703

4.3.1   Defi board connectors.

The following connector references are located at the Defi board.

4.3.1.1   J4001 – POWER input from mains supply.

Pin no.	Name	Signal type
1	PSU DC	PO
2	PSU DC	PO
3	PSU DC	PO
4	VSYSTEM RTN	PO
5	VSYSTEM RTN	PO
6	VSYSTEM RTN	PO

4.3.1.2   J4002 – HIGH VOLTAGE – output to HV relay.

Pin no.	Name	Signal type
1	5KV	PO
2	N.C.	
3	N.C.	
4	N.C.	
5	N.C.	
6	N.C.	
7	5KV RTN	PO

4.3.1.3   J4003 – HIGH VOLTAGE RELAY–coil.

Pin no.	Name	Signal type
1	SCHOCK	DO
2	+12V	PO
3	N.C.	
4	GND	PO

4.3.1.4   J4005 – VSYS RTN.

Pin no.	Name	Signal type
1	VSYS RTN	PO
2	VSYS RTN	PO
3	VSYS RTN	PO
4	VSYS RTN	PO

4.3.1.5   J4006 – HV – shield.

Pin no.	Name	Signal type
1	GNDHV	PO
2	GNDHV	PO
3	GNDHV	PO
4	GNDHV	PO

4.3.1.6   J4100 – Communication and supply for the Processor board.

Pin no.	Name	Signal type
1	0VD	PI
2	D0	DIO
3	D1	DIO
4	+5VD	PI
5	D2	DIO
6	D3	DIO
7	0VD	PI
8	D4	DIO
9	D5	DIO
10	+5VD	PI

11	D6	DIO
12	D7	DIO
13	0VD	PI
14	RD	DO
15	WR	DO
16	+5VD	PI
17	CS_CPU	DO
18	CS_HPAD	DO
19	0VD	PI
20	CSDA	DO
21	CS_IN2	DO
22	+5VD	PI
23	CS_OUT1	DO
24	CS_OUT2	DO
25	0VD	PI
26	INT_PROC	DI
27	TX_SPI	DO
28	+5VD	PI
29	ACTION_KEY	DO
30	CLK_SPI	DO
31	CPU_SHOCK	DO
32	PACE_TRIG	DO
33	/RESET	DO
34	RX_SPI	DI
35	/POWER_ON/OFF	DO
36	STB_SUPPLY	PI
37	AC_POWER_C	PI
38	0VD	PI
39	AC_POWER_G	PI
40	AC_POWER_Y	PI
41	+5VD	PI
42	+12V	PI
43	–28V	PI
44	0VD	PI
45	ECGPAD_RX	DI
46	ECGPAD_TX	DO
47	+5VD	PI
48	ECGCAB_RX	DI
49	ECGCAB_TX	DO
50	0VD	PI

4.3.1.7   J4101 – Paddles control.

Pin no.	Name	Signal type
1	ENERGY +	DI
2	ENERGY -	DI
3	SCHOCK ST	DI
4	CHARGE	DI
5	SHOCK AP	DI
6	CODE 1	DI
7	CODE 2	DI
8	CODE 3	DI
9	VDD KEY	PO
10	VDD KEY	PO

4.3.1.8   J4102 – Defi HV–test and supply.

Pin no.	Name	Signal type
1	+12V	PO
2	VDD_ +5V	PO
3	0VA10	PO
4	HV TEST	AI

4.3.1.9   J4103 – Communication for CABLE ECG board.

Pin no.	Name	Signal type
1	ECG CABLE TX	DI
2	ECGCAB Rx	DO
3	VDD +5V	PO
4	VSS 0V	PO
5	NC	
6	NC	

4.3.1.10   J4104 – Communication and supply for PACER board (Option).

Pin no.	Name	Signal type
1	TX SPI	DO
2	CLK SPI	DO
3	CSDA	DO
4	PACE TRIG	DO
5	/RESET	DO
6	NC	
7	PACER RELAY	DO
8	PACER EN2	DO
9	IP OPTO	DI
10	+12V	PO
11	CURRENT MONITOR	AI
12	0VA10	PO
13	+5VD	PO

14	+5VD	PO
15	+5VD	PO
16	0VA	PO
17	0VD	PO
18	0VD	PO
19	0VD	PO
20	0VA	PO
21	VSYS SWITCH	PO
22	VSYS SWITCH	PO
23	VSYS SWITCH	PO
24	VSYS SWITCH	PO
25	VSYS SWITCH	PO
26	VSYS SWITCH	PO
27	0VPA	PO
28	0VPA	PO
29	0VPA	PO
30	0VPA	PO
31	0VPA	PO
32	0VPA	PO
33	NC	
34	DA OUT CNTL	AI
35	0VA20	PO
36	DA REF	AI
37	VDD +5V	PO
38	VDD +5V	PO
39	VSS 0V	PO
40	VSS 0V	PO

4.3.1.11   J4107 – Supply for the PADDLE ECG board.

Pin no.	Name	Signal type
1	P_VSS	PO
2	P_VDD	PO
3	P_VSS	PO
4	P_VEE	PO
5	NC	
6	NC	

4.3.1.12   J4108 – Supply for the CABLE ECG board.

Pin no.	Name	Signal type
1	C_VSS	PO
2	C_VDD	PO
3	C_VSS	PO
4	C_VEE	PO
5	NC	
6	NC	

4.3.1.13   J4109 – Communication for the PADDLE ECG board.

Pin no.	Name	Signal type
1	ECGPAD_TX	DO
2	ECGPAD_RX	DI
3	+5V	PI
4	0V	PI
5	NC	
6	NC	

4.3.1.14   J4110 – Paddle ECG signals to the PADDLE ECG board.

Pin no.	Name	Signal type
1	PAD 0V	PO
2	PAD 0V	PO
3	PAD ST	AO
4	PAD AP	AO
5	PAD 0V	PO
6	PAD 0V	PO

4.3.1.15   J4111 – Patient impedance signals for the PADDLE ECG board.

Pin no.	Name	Signal type
1	NC	
2	+IMP	AO
3	NC	
4	–IMP	AO
5	NC	
6	NC	

4.3.1.16   J4112 – ECG Apex paddles.

Pin no.	Name	Signal type
1	Apex	AI/O
2	Apex	AI

4.3.1.17   J4114 – ECG Sternum paddles.

Pin no.	Name	Signal type
1	Sternum	AI/0
2	Sternum	AI

4.3.1.18   J4405 – Battery power input and printer supply.

Pin no.	Name	Signal type
1	+13V	PO
2	+13V RTN	PO
3	VBAT RTN	PIO
4	VBAT RTN	PIO
5	VBAT RTN	PIO
6	OVL1	PO
7	TCELL S	AI
8	VBATTERY	PIO
9	VBATTERY	PIO
10	VBATTERY	PIO

4.3.1.19   E4101, E4102, E4103, E4104 – EMC shield.

Pin no.	Name	Signal type
1	Shield	PO

4.3.2   ECG connector board.

The following connector references are located at the ECG Connector board.

4.3.2.1   J801 – ECG Input.

Pin no.	Name	Signal type
1	RA	AI
2	LA	AI
3	RL	AI
4	LL	AI
5	Vx	AI
6	Screen	AO
7	External ECG	AI
8	Cable detect 1	DI
9	Cable detect 2	DI
0	GND	

4.3.2.2   E801 – ECG Input.

Pin no.	Name	Signal type
1	RA	AI
2	LA	AI
3	RL	AI
4	LL	AI
5	Vx	AI
6	Screen	AO
7	External ECG	AI
8	Cable detect 1	DI
9	Cable detect 2	DI
0	GND	

4.3.2.3   J802 – ECG signal for Cable ECG board.

Pin no.	Name	Signal type
1	RA	AI
2	LA	AI
3	RL	AI
4	LL	AI
5	Vx	AI
6	Screen	AO
7	External ECG	AI
8	Cable detect 1	DI
9	Cable detect 2	DI
10	GND	

4.3.3   Printer board connectors.

The following connector references are located at the Printer board.

J704 – Battery.

Pin no.	Name	Signal type
1	+VBATTERY	PIO
2	Temp1	PO
3	–VBAT RTN	PIO
4	+VBATTERY	PIO
5	Temp2	AI
6	–VBAT RTN	PIO

4.3.3.1   J701 – Printer, data bus and supply.

Pin no.	Name	Signal type
1A	NC	
1B	NC	
2A	TxD	DO
2B	NC	
3A	NC	
3B	NC	
4A	NC	
4B	VLogic	PO
5A	NC	
5B	VLogic	PO
6A	NC	
6B	GND Logic	PO
7A	NC	
7B	GND Logic	PO
8A	NC	
8B	+13V rtn	PO
9A	NC	
9B	+13V rtn	PO
10A	RxD	DI
10B	+13V rtn	PO
11A	/CTS	DI
11B	+13V rtn	PO
12A	NC	
12B	+13V rtn	PO
13A	/RST	DO
13B	+13V rtn	PO
14A	NC	
14B	+13V rtn	PO
15A	NC	
15B	+13V rtn	PO
16A	/SYNC	DI
16B	+13V rtn	PO
17A	NC	
17B	+13V rtn	PO
18A	/RTS	DO
18B	+13V	PO
19A	NC	
19B	+13V	PO
20A	NC	
20B	+13V	PO
21A	NC	
21B	+13V	PO
22A	NC	
22B	+13V	PO
23A	NC	

23B	+13V	PO
24A	NC	
24B	+13V	PO
25A	NC	
25B	+13V	PO

4.3.4 Processor board connectors.

The following connector references are located at the Processor board.

J3003 – Communication for PCMCIA card.

Pin no.	Name	Signal type
1	0VD	PO
2	PCD3	DIO
3	PCD4	DIO
4	PCD5	DIO
5	PCD6	DIO
6	PCD7	DIO
7	/PCCE1	DO
8	PCA10	DO
9	/PCMEMRD	DO
10	PCA11	DO
11	PCA9	DO
12	PCA8	DO
13	PCA13	DO
14	PCA14	DO
15	/PCMEMWR	DO
16	READY//IRQ	DI
17	+5VD	PO
18	+5VD	PO
19	PCA16	DO
20	PCA15	DO
21	PCA12	DO
22	PCA7	DO
23	PCA6	DO
24	PCA5	DO
25	PCA4	DO
26	PCA3	DO
27	PCA2	DO
28	PCA1	DO
29	PCA0	DO
30	PCD0	DIO
31	PCD1	DIO
32	PCD2	DIO
33	PCWR_PROT	DI
34	0VD	PO
35	0VD	PO
36	/PCCARD_DET1	DI

37	PCD11	DIO
38	PCD12	DIO
39	PCD13	DIO
40	PCD14	DIO
41	PCD15	DIO
42	/PCCE2	DO
43	N.C.	
44	/PCIORD	DO
45	/PCIOWR	DO
46	PCA17	DO
47	PCA18	DO
48	PCA19	DO
49	PCA20	DO
50	PCA21	DO
51	+5VD	PO
52	+5VD	PO
53	PCA22	DO
54	PCA23	DO
55	0VD	PO
56	0VD	PO
57	N.C.	
58	PCRESET	DO
59	N.C.	
60	N.C.	
61	/REG	DO
62	boardTT_DET2	DI
63	boardTT_DET1	DI
64	PCD8	DIO
65	PCD9	DIO
66	PCD10	DIO
67	/PCCARD_DET2	DI
68	0VD	PO

4.3.4.1   J3004 – LCD, Data for display.

Pin no.	Name	Signal type
1	D0	DO
2	D1	DO
3	D2	DO
4	D3	DO
5	DISP_ON	DO
6	FRAME	DO
7	N.C.	
8	LOAD	DO
9	CP	DO
10	VDD	PO
11	VSS	PO
12	VEE	PO
13	VO	PO
14	VSS	PO

4.3.4.2   J3005 – LCD CCFL, backlight power.

Pin no.	Name	Signal type
1	HV	PO
2	N.C.	
3	N.C.	
4	HV	PO

4.3.4.3   J3006 – Keyboard, User interface.

Pin no.	Name	Signal type
1	0VD	PO
2	+5VD	PO
3	SEMI AUTO	DO
4	+5VD	PO
5	SYNC	DO
6	PACING ON/OFF	DO
7	SEMI AUTOMATIC	DI
8	CURRENT DOWN	DI
9	CURRENT UP	DI
10	SYNC	DI
11	OK	DI
12	PACING START/STOP	DI
13	MENU DOWN	DI
14	RATE UP	DI
15	MENU UP	DI
16	RATE DOWN	DI
17	MENU	DI
18	ENERGY UP	DI
19	AC_POWER_C	DO

20	ALARM	DI
21	AC_POWER_Y	DO
22	ENERGY DOWN	DI
23	AC_POWER_G	DO
24	MANUAL	DI
24	FAULT+	DO
26	MANUAL	DO
27	FAULT-	DO
28	PACING	DI
29	DISARM	DI
30	PACING	DO
31	SIZE SELECT	DI
32	MEMORY	DI
33	ACTION	DO
34	PRINTER	DI
35	ACTION KEY	DI
36	POWER ON/OFF	DI
37	HT1	AO
38	HT2	AO
39	LEAD SELECT	DI
40	0VD	PO

4.3.4.4 J3008 – Printer, Communication.

Pin no.	Name	Signal type
1	RxD	DI
2	TxD	DO
3	/CTS	DI
4	/RTS	DO
5	/SYNC	DI
6	/RESET	DO
7	+5VD	PO
8	0VD	PO
9	GND	PO

4.3.4.5 J3010 – EMC shield.

Pin no.	Name	Signal type
1	Shield	PO
2	Shield	PO
3	Shield	PO
4	Shield	PO

Chapter 5 – Dismantling & re-assembly.

5.1   Dismantling & re-assembly.

This section provides information about the dismantling and re-assembly procedures for the Cardio-Aid®,on a strict non-electrical basis only.

The Cardio-Aid® is dismantled in steps braking the unit down into its major components.

Note!   All necessary adjustment and setting up procedures following a replacement of a major component are explained in Chapter 7 – Verification and Test..

The necessary precautions against Electro Static Discharge (ESD) must be taken. This applies to all handling of electrical components as well as printed circuit boards and all service involving dismantling the Cardio-Aid®.

Note!   Before handling High Voltage parts such as HV-capacitor, HV-circuit etc., ensure that there is no voltage on the HV-capacitor using a high voltage probe (1000:1). High-voltage parts are identified with the "Danger High-voltage" symbol.

Be very careful when connecting the high voltage probe- avoid touching the terminals and use proper insulation If voltage is present, leave the unit until the HV-capacitor is fully drained. If the capacitor remains charged it can be discharged by connecting a drain resistor e.g. 100kohm, 17W, directly over the HV capacitor terminals for min. 30 sec.

Be very cautious when connecting the resistor and use proper insulation.

When storing an HV-capacitor, always leave it in a short-circuit state.

Re-assembling the Cardio-Aid® taking care that the various rubber seals are seated correctly.

Important!   When ever an operation of dismantling and re-assembly of the Cardio-Aid® is carried out, a safety and performance check must be performed.

See Chapter 7 – Verification and Test. and Chapter 8 – Maintenance..

Tools needed:

Torx TX 10 screwdriver.
Hexagon screwdriver
Phillips screwdriver.
Wire cutter.

5.1.1 Replacing Paddles or Pads holder.

Changing the Cardio-Aid® from Paddle version to Pads version or replacing the Paddle and Pads holders.

Remove the three screws (two Hexagon 3x10 and one Torx) marked with arrows on the Paddle holders and remove two screws on Pads holders.

Note!   Do not remove the screw (white arrow) holding the metal plate on the Paddle holders

5.1.2 Replacing the battery.
The battery is located behind the left paddle/pads holder, seen from the front.

1. Turn off the Cardio-Aid® and disconnect the main cable.

2. Remove the left paddle from the paddle holder.

3. Remove the three Hexagon screws (two 3x10) marked with arrows, on the left paddle holder, Remove two screws on pads version.

4. Slacken the two Hexagon screws on the battery.

Note!   The screws are secured and can not fall out.

5. Remove the battery by pulling the white band.

Re-assemble is in reverse order.

Important!   Following the removal of the battery, the build in battery capacity system is void and must be reset.
Refer to Chapter 7 – Verification and Test.,.

5.1.3 Replacing the printer.

The printer is located below the left paddle holder, seen from the front.

1. Open the door to the printer unit and remove the paper roll.

2. Slacken the two Phillips screws at the bottom of the printer unit.

Note! The screws are secured and can not fall out.

3. Gently pull out the printer unit.

Re-assemble is in reverse order.

Note! Take care not to damage the connector when replacing the printer.

5.1.4 Removing front– and rear covers.

Disconnect ECG cable, pacer cable/Defi cable, main cable and all other accessories.

1. Remove the battery by performing the procedure "Replacing the battery". Remove the printer by performing the procedure "Replacing the printer".

2. Remove three Hexagon screws in the right paddle holder and remove it. remove only two screws on pads version.

Note!   Do not remove the left screw on the metal plate, it is used only to fix the metal plate.

3. Remove two Hexagon screws in the left paddle holder and remove it.

4. Place the Cardio-Aid® with the front cover facing downward.

Note!   To avoid damaging the front panel, place the Cardio-Aid® on a soft fabric or something similar.

5. Remove the eight Torx screws in the rear panel, and remove the rear panel.

6. Remove the seven Torx screws and two Phillips screws in the front panel.

7. Gently remove the memory card door unit by lifting and pushing it carefully up toward the chassis.

8. Disconnect the keyboard cable, placed below the battery slot, by carefully lifting the chassis approx. five centimeter with the right hand and disconnect the keyboard cable with the left hand.
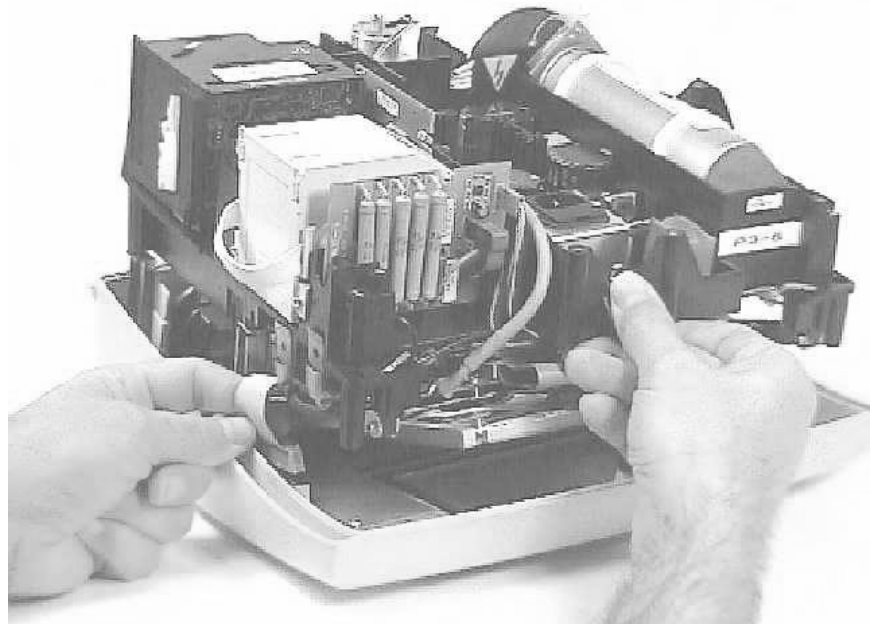
The chassis can now be lifted from the front panel.

Re-assemble is in reverse order.

5.1.5 Replacing the keyboard pcb and keypad panel.
The Keyboard pcb is located on the rear side of the front panel.

Note!   To avoid damaging the front panel, place it on a soft fabric or something similar.

1. Disconnect the speaker cable.

2. Remove the six Torx screws and lift out the keyboard panel.

3. To remove the keypads, gently pull out the keypad panel.
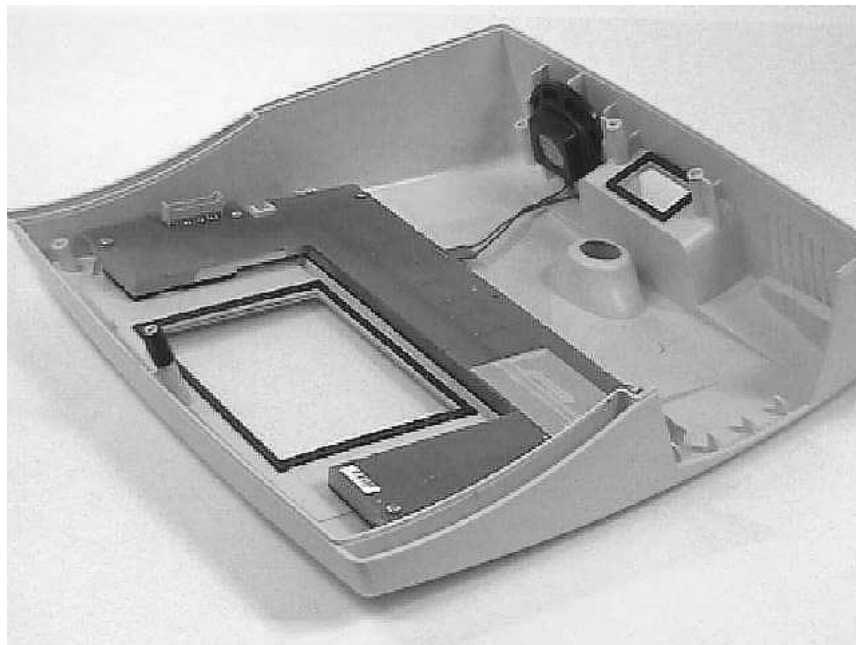
Re-assemble is in reverse order.

Important!   If the keypads is replaced, make sure that water tightening gaskets are replaced.

5.1.6 The Service position, open and closed.

1. Perform the procedure "Removing front- and rear panel"

2. Remove the four Torx screws (3x6) holding the metal frame to the chassis.

Important! Disconnect the green ground connector next to the ECG connector on the processor board of the Cardio-Aid®.
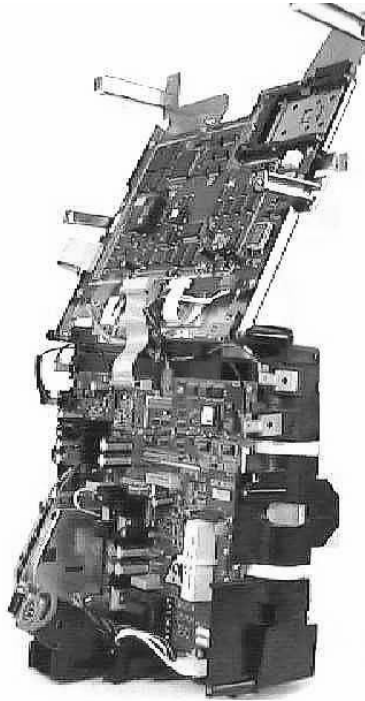
Open Service Position
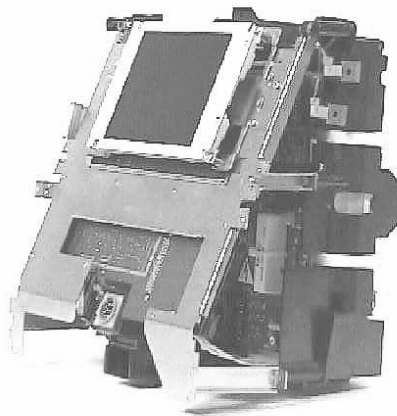
Closed Service Position

5.1.7 Replacing the Processor board

The processor board is located on the metal frame behind the display.

1. Place the Cardio-Aid® chassis in "Open Service Position".

2. Disconnect all cables connected to the Processor board.

3. Remove the eleven Torx screws (3x6) on the processor board.

4. Remove the board
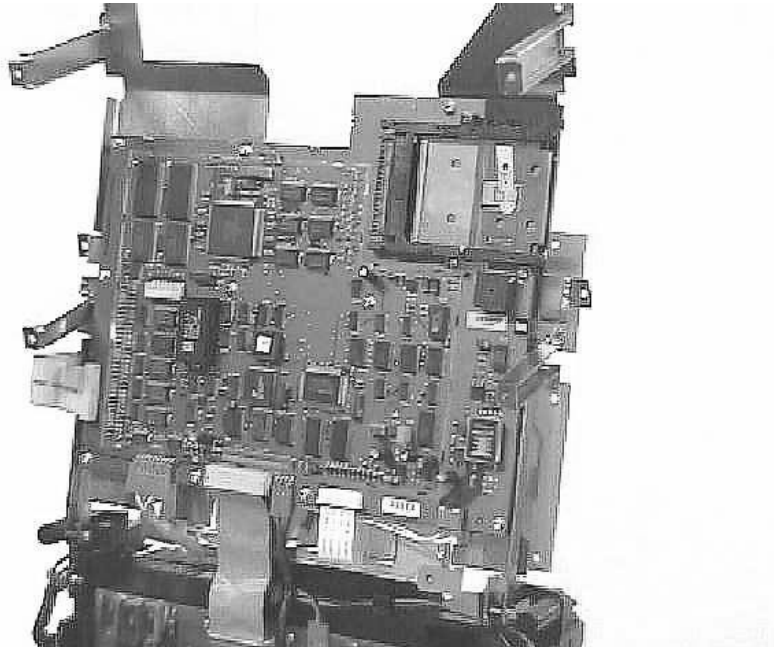
Re-assemble in the reverse order.

Note! DIL-switches and jumpers might need to be set.
See Chapter 7 – Verification and Test., Jumper settings and software update..

5.1.8 Replacing the LCD display

1. Place the Cardio-Aid® chassis in the "Open Service Position".

2. Disconnect the two cables between the processor board and the LCD display
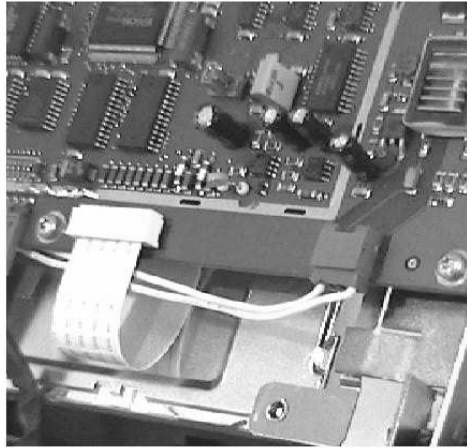
3. Place the Cardio-Aid® chassis in the "Closed Service Position".

4. Remove the four Torx screws (3x6) on the LCD display and slide it away.
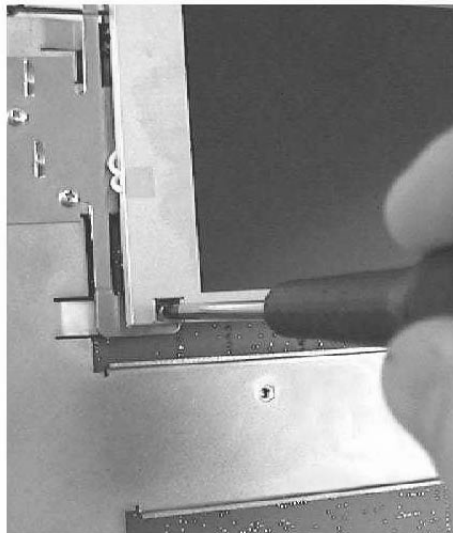
Re-assemble in the reverse order.

5.1.9 Replacing the Power supply board

The power supply board is located on the back of the Cardio-Aid® chassis.

1. Remove the battery by performing the procedure "Replacing the battery"

Important! Following the removal of the battery, the build in battery capacity system is void and must be reset. Refer to "Verification and test".

2. Place the Cardio-Aid® chassis in the "Closed Service Position".
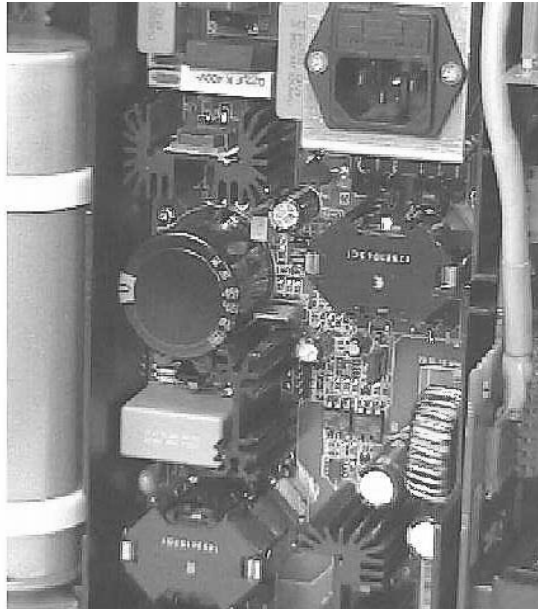
3. Remove the six Torx screws (3x6) from the power supply board.

4. Carefully lift out the power supply. Some force must gently be applied as the power supply board connects directly to the Defi board via a six-pin connector placed on the back of the power supply board.

Re-assembly in the reverse order.

5.1.10 Replacing the ECG connector board

The ECG connector board is located on the front of the Cardio-Aid®,behind the display metal frame.

1. Place the Cardio-Aid® chassis in the "Open Service Position"

2. Disconnect the cable connecting to the ECG amplifier.

3. Remove the foam gasket located on the connector.

4. Remove the two screws on the right side of the connector.
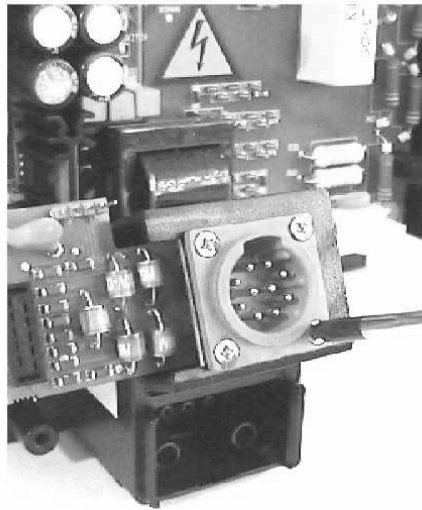
5. Slacken the two Phillips screws on the left side holding the ECG connector.

6. Remove the ECG connector board by sliding it to the left.

Re-assemble in the reverse order taking care not to overtighten the Phillips screws.

Note!   It is important to tighten the two screws to the left first, otherwise it is difficult to mount the two screws to the right.

Important!   Remember to replace the foam gasket.

5.1.11 Replacing the ECG paddle amplifier board

The ECG paddle amplifier board is located on the front of the Cardio-Aid® chassis, behind the display metal frame.

1. Place the Cardio-Aid® chassis in the "Open Service Position"

2. Slacken the two Torx screws accessible through slots in the ECG paddle amplifier's metal shield.

Note!   The screws are secured and can not fall out. Note! Take care not to damage the component inside the metal shield.
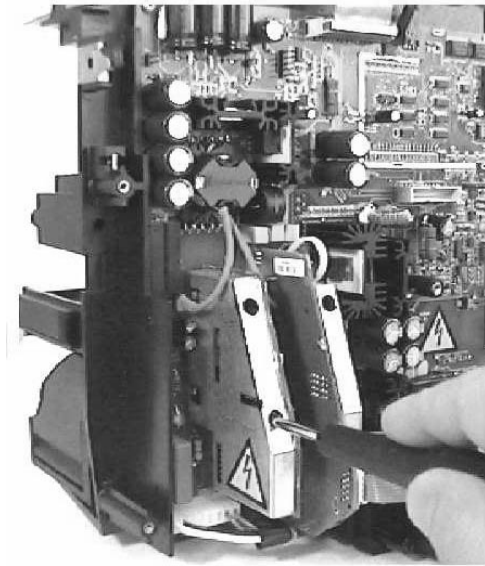
3. Remove the ECG paddle amplifier board taking care not to damage the connectors.

Re-assemble in reverse order.

5.1.12 Replacing the ECG cable amplifier board

The ECG paddle amplifier board is located on the front of the Cardio-Aid® chassis, behind the display metal frame.

1. Place the Cardio-Aid® chassis in the "Open Service Position"

2. Disconnect the cable connected to the ECG connector board.

3. Slacken the two Torx screws accessible through slots in the amplifier's metal shield.

Note!   The screws are secured and can not fall out.

Note!   Take care not to damage the component inside the metal shield.
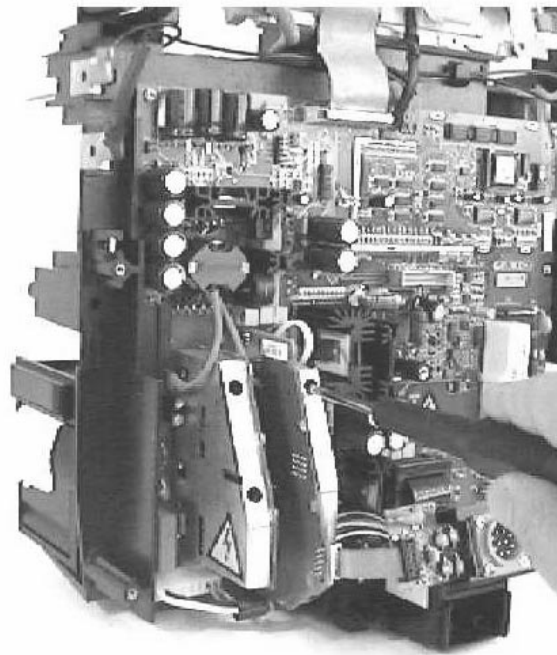
4. Remove the ECG amplifier board taking care not to damage the connectors.

Re-assemble in reverse order.

5.1.13 Replacing the Printer connection board

The Printer connection board is located on the back of the Cardio-Aid® chassis, behind the printer and battery.

1. Perform the procedure "Removing front- and rear cover".

2. Place the Cardio-Aid® chassis in the "Closed Service Position".

3. Remove the battery by performing the procedure "Replacing the battery"

Important! Following the removal of the battery, the build in battery capacity system is void and must be reset. Refer to "Verification and test".

4. Disconnect the cable coming from the processor board.

Important! Note how the cable is guided and locked by the chassis for proper re-assembling.

5. Remove the three Torx screws.

6. Carefully lift out the Printer connection board. Some force must gently be applied as the board connects directly to the Defi board via a 10-pin connector.
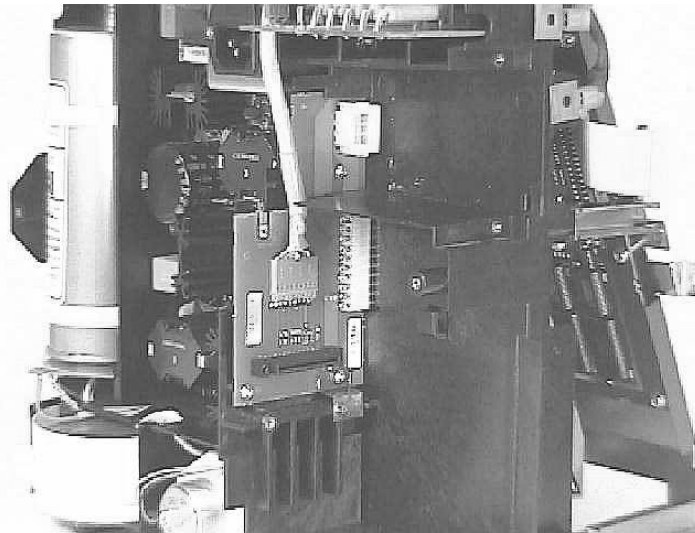
Re-assemble in the reverse order. Note the spring plate position to ease the mounting of the printer.

Important! Guide the cable in the locked position by pressing the connected cable into the slot in the chassis.

5.1.14 Replacing the Defi board

The Defi board is located on the front of the Cardio-Aid® chassis, behind the display metal frame.

1. Place the Cardio-Aid® chassis in the "Open Service Position"

Warning! Before handling the Defi board, ensure that there is no voltage on the capacitor by measuring with a HV probe (1000:1).

2. Remove the battery by performing the procedure "Replacing the Battery".

3. Remove the ECG cable amplifier board by performing the procedure "Replacing the ECG cable amplifier board".

4. Remove the ECG paddle amplifier board by performing the procedure "Replacing the ECG paddle amplifier board".

5. Disconnect all cables connected to the Defi board. Note! It is not necessary to remove the ferrite on the cable to J4101.

6. Remove the seven Torx screws (3x6)

7. Remove the Defi board.

8. Use the plastic strap, next to where the cable amplifier was mounted, to pull out the Defi board.

Important! Some force must gently be applied as the board connects directly to Printer connection board and Power supply board via a connector placed on the backside.
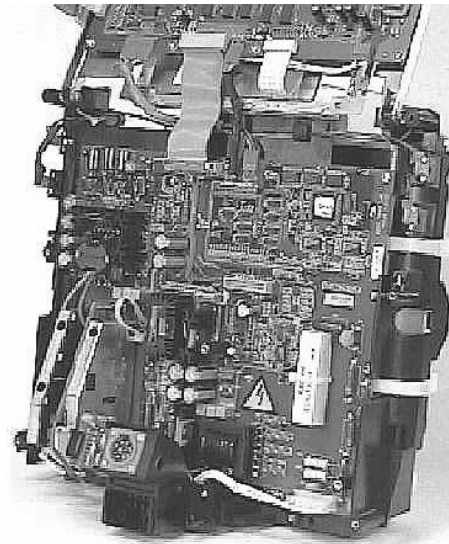
Re-assemble in reverse order taking care not to damage the connectors.

Important! Make sure that all connectors are correctly connected.

5.1.15 Replacing the optional Pacer board.

The optional Pacer Board is located on the front of the Cardio-Aid® chassis behind the display metal frame.
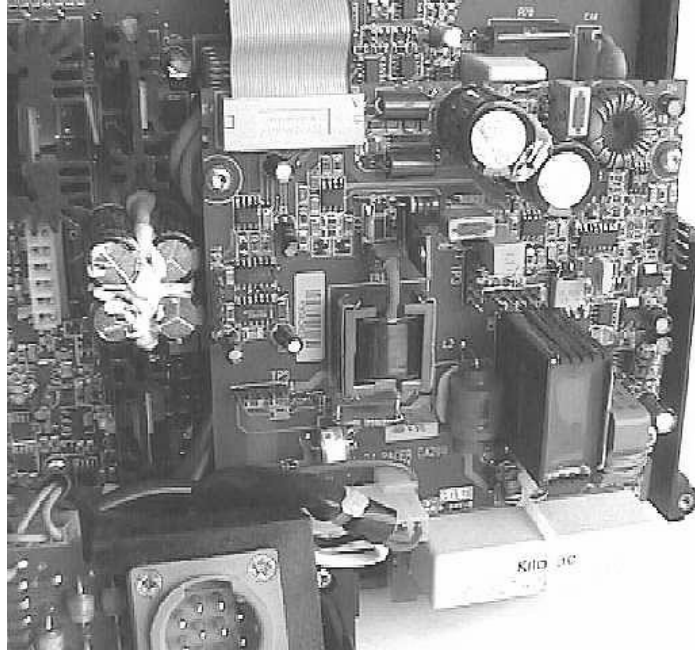
1. Remove the battery by performing the procedure "Replacing the battery"

1. Place the Cardio-Aid® chassis in the "Open Service Position"

2. Disconnect all cables connected to the Pacer board.

3. Remove the four Torx screws (3x6)

4. Remove the Pacer board.

Important!   Whenever the Pacer is replaced or disconnected it must always be calibrated. See Chapter 7 – Verification and Test.

5.1.16 Replacing the Defi test board

The Defi test board are located on the back of the Cardio-Aid® chassis upon the battery.

1. Place the Cardio-Aid® chassis in the "Closed Service Position"

2. Disconnect the cable connected to J901 and cut the single cable tie located behind the display section fixing this cable plus two other cables. Note the position for replacing of the cable tie and the cable in the cable fixation on the chassis.

3. Cut the two cable ties located on upper left and upper right side of the Cardio-Aid® chassis and note the location for replacing.

4. Disconnect the cables connected to the two cable clips located on upper left and upper right side of the Cardio-Aid® chassis.

5. Remove the single Torx screw on the Defi test board.

6. Remove the board. To ease the removal of the board, place a screwdriver between the chassis and the board and gently press out the board.

Important! The safety distance between the five resistors, must be minimum one milli-metre.

Re-assemble in reverse order.

Important! The 3 cable ties must be replaced. Do not tighten the two cable ties, fixing the cables connected to the four cable clips, too much.

5.1.17 Replacing the HV Capacitor.

Warning! Before handling the HV capacitor, ensure that there is no voltage on the capacitor by measuring voltage probe (1000:1).

Be very careful when connecting the high voltage probe, avoid touching the terminals and use proper insulation If voltage is present, leave the unit until the HV-capacitor is fully drained.

If the capacitor remains charged it can be discharged by connecting a drain resistor e.g. 100kohm, 17W, directly over the HV capacitor terminals for min. 30 sec.

Be very cautious when connecting the resistor and use proper insulation.

Important! When storing an HV-capacitor, always short-circuit the capacitor.

1. Place the Cardio-Aid$^®$ chassis in the "Closed Service Position" on the right side, seen from the back of the chassis.

2. To release the HV-capacitor, cut the two cable ties holding the component.

Important! Note the position of the cable ties to ensure proper re-assembly.

3. Remove the HV-capacitor.

4. Remove the HV-Capacitor board from the HV-capacitor, notice the polarizing of the HV-Capacitor board.

5. Remove the short circuit wire from the new HV-Capacitor.

6. Mount the HV-Capacitor board on the HV-C.

Warning! Be sure to polarize the HV-Capacitor board correctly!.

7. Remove the protection from the tape placed on the side of the HV-Capacitor, to fix the capacitor in the chassis.

8. Mount the cable ties on the HV-Capacitor

Re-assemble in reverse order.

Important! The cable ties holding the HV-capacitor must be very tight to secure the mechanical stability.

5.1.18 Replacing keyboard cover (flap).

Remove the keyboard cover by carefully lifting it off the tabs placed on the front part.

5.1.19 Replacing the handle.
Before replacing the handle, perform 5.1.4 Removing front- and rear covers., pt. 1, 2, 3, 4.

Remove the two screws and pull out the handle.
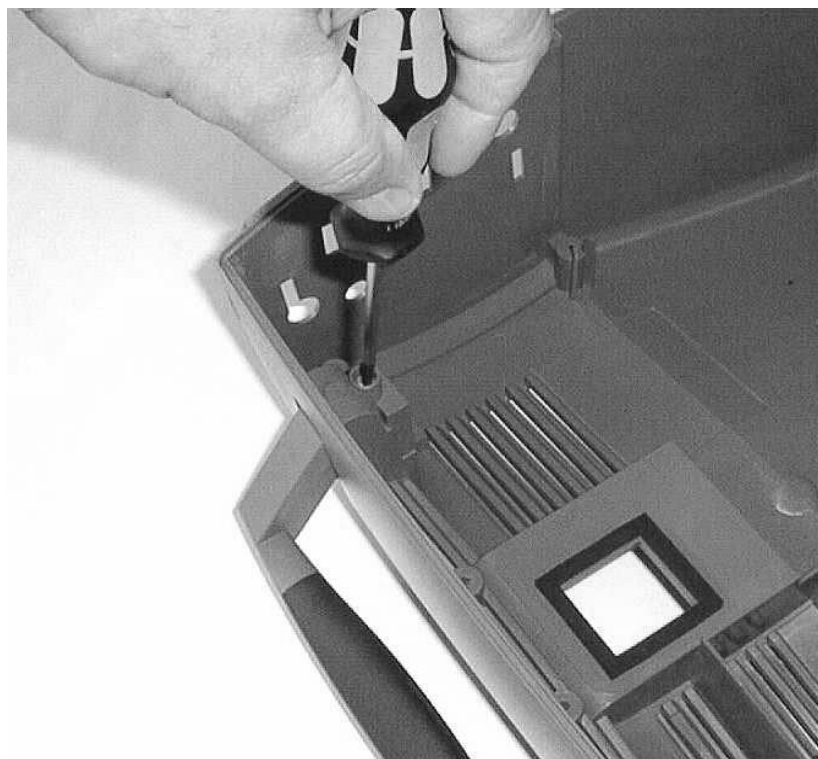
Re-assemble in reverse order.

Chapter 6 – Trouble shooting.

6.1   Self-test.

The automatic self-test is divided into two parts:
Power-on self-test and periodic wake-up self-test.

6.2   Self-test (Power ON).

At power-on the following self-test is made.

1. RAM read-write test

2. PROM (Program code and voice data) check sum test

3. EEPROM (Set-up data) check sum test

4. Battery status and voltage

5. All function keys (short circuit test)

6. Display RAM read-write test

7. Sound system test (short tone)

8. Printer internal self test (no printouts)

9. Memo card test:
   Battery status,
   Write protect,
   Format error,
   Read-write test

10. Check of all calibration values (Range check)

11. Test of RTC clock (and lithium battery)

12. Local controller communication test (ECG I, ECG II, Defi)

13. Lamp test (All lamps tested)

14. The watchdog circuit

If an error has been detected as a result of the self test, or the last wake-up self-test, then the error codes are shown on the display during the power-up sequence.

6.3   Wake-up self-test.

The equipment is able to perform an automatic wake-up self-test at every 24 hours.
Enter the configuration menu to enable or disable the wake-up test system and to set the time where the wake-up test is performed.

Note!   The wake-up test system is by default disabled.

Function:

The wake-up self-test includes the following parts:

1. RAM read-write test

2. PROM (Program code and voice prompt data) check sum test

3. EEPROM (Set-up data) check sum test

4. All function keys (short circuit test)

5. Display RAM read-write test

6. Battery status and voltage

If the battery charge condition is below e.g. 50% capacity and the mains voltage is not connected an error message is given in the next power-up self test.

7. Printer internal self test (no printouts)

8. Memory card test:
   Battery status,
   Write protect,
   Format error,
   Read-write test

9. Check of all calibration values (Range check)

10. Test of RTC clock (and lithium battery)

11. Local controller communication test (ECG I, ECG II, Defi controller)

12. The watchdog circuit

During wake-up self-test of the following circuits are not tested or activated:

   Display back-light,
   Defibrillator High-voltage output and activation of HV-relay,
   Printer running,
   Pacer output,
   Sound system,
   Lamp test.

6.4   Status indicator.

Fault indicator:

A fault indication LED is located on the front panel a. The LED is flashing and a sound is generated (short regular tones), if an error was detected.

OK indication:

At power on of the Cardio-Aid® a bar graph indicates self test is in progress. The label "set up" will show OK as long as no error has been detected, otherwise the error code which caused the fault will show up.

6.5   Error-log.

Technical errors detected by the defibrillator are saved in an error log.

The following errors are retained:

Self-test error found at power on
Self-test error found by the wake-up test
Defi faults
Pacer faults
Other technical errors detected by the defibrillator.

The log contains error type and number together with time and date.

The error log contains the latest 10 errors stored in the EEPROM.

If the same error occurs every time the unit is switched on, it is only stored one time in the error-log.

Access to the error-log is via the service menu or the DEFITEST software application.

The error-log can be shown on the display, printed on the printer and dumped through the serial communication using the defi test program.

Errors related to software problems are grouped according to the part of the execution that failed.

A possible link between the error and the faulty module is presented in the table below.

Software error grouping:

#	Function
1-3	Watchdog
50-51	Task error (software module)
100-	Serial link
200-	Setup error
250-	Self-test error
300-	Mode manager (software module)
400-	Parser (software module)
500-	HW system
600-	User interface error
700-	Remote service
800-	HV security, Over voltage, disarm rate, outside limits, etc.
900-	These corresponds to defi faults
1000-	ECG system
1100	Analyze (software module)
1200	Pacer system

6.5.1 Error log table.

Text in display, possible causes and likely faulty module(s):

Error code	Displayed information	Error cause	User action	Faulty module(s)
0x001	General fault 001	CPU reset status register does NOT contain 0x80	Try to turn the unit on again. If the problem persist, change board.	Processor PCB
0x010	General fault 010	Ram test Basic application failed	Try to turn the unit on again. If the problem persist, change board.	Processor PCB
0x011	General fault 011	Ram test Main application failed	Try to turn the unit on again. If the problem persist, change board.	Processor PCB
0x100	General fault 100	Watch-dog reset: during Basic application at runtime. Possibly a SW error.	Update the Basic SW	
0x101	General fault 101	Watch-dog reset: during Main application at runtime If something goes wrong in the software execution or the Main app. decides it, the application SW will stop to trig the HW watchdog. An other cause could be a power reset due to a complete depleted battery.	Check the condition of the battery. Try to turn the unit on again. If the problem persist, Update Main SW If the problem persist, change board.	Processor PCB
0x102	General fault 102	None initialized IRQ was called OR Bus/Address/Illegal instruction/Zero division Possibly a SW error.	Update Main SW If the problem persist, change board.	Processor PCB
0x103	General fault 103	Last power down detected too long watch-dog reset period	Try to turn the unit on again. If the problem persist, change board.	Processor PCB
0x200	General fault 200	Basic app. Illegal checksum The software will not be updated.	Your Basic SW is corrupted. Require a new version from the manufactor.	
0x201	General fault 201	Main app. is NOT present. The CA200 will not start.	Update Main SW	
0x202	General fault 202	Main app. checksum address illegal.	Update Main SW	
0x203	General fault 203	Main app. checksum reserved value	Update Main SW	
0x204	General fault 204	Main app. illegal checksum The software will not be updated.	Your Main SW is corrupted. Require a new version from the manufactor.	

0x205	General fault 205	Voice Prompts is NOT present.	Update Voice SW	
0x206	General fault 206	Voice Prompts size too big	Your Voice SW is corrupted. Require a new version from the manufactor.	
0x207	General fault 207	Voice Prompts inconsistent size	Your Voice and Main SW are not compatible. Require new versions from the manufactor.	
0x208	General fault 208	Voice Prompts checksum illegal	Your Voice SW is corrupted. Require a new version from the manufactor.	
0x300	General fault 300	Flash programming fail	Update the SW again. If the problem persist, change board.	Processor PCB
0x301	General fault 301	Flash programming time-out	Update the SW again. If the problem persist, change board.	Processor PCB
0x302	General fault 302	Flash programming error	Update the SW again. If the problem persist, change board.	Processor PCB
0x400	General fault 400	Main app. update file too big	Your Main SW is corrupted. Require a new version from the manufactor.	
0x401	General fault 401	Main app. update file missing!	Your Main SW is corrupted. Require a new version from the manufactor.	
0x402	General fault 402	Voice Prompts update file too big	Your Voice SW is corrupted. Require a new version from the manufactor.	
0x403	General fault 403	Voice Prompts update file missing!	Your Voice SW is corrupted. Require a new version from the manufactor.	
0x404	General fault 404	Basic app. update file too big	Your Basic SW is corrupted. Require a new version from the manufactor.	
0x405	General fault 405	Basic app. update file missing!	Your Basic SW is corrupted. Require a new version from themanufactor.	
0x406	General fault 406	Basic app. update file checksum illegal	Your Basic SW is corrupted. Require a new version from the manufactor.	
0x407	General fault 407	Main app. update file checksum illegal	Your Main SW is corrupted. Require a new version from the manufactor.	

0x408	General fault 408	Voice Prompts update file checksum illegal	Your Voice SW is corrupted. Require a new version from the manufactor.	
1	Error log	Watchdog error A SW task is not responding or an unauthorized reset has occurred. Additional information about the task not responding is shown in the error log menu. See also General fault 101.	Check the condition of the battery. Try to turn the unit on again. If the problem persist, Update Main SW If the problem persist, change board.	Processor PCB
2	Error log	Watchdog test The watchdog is activated by purpose (tested)	Try to turn the unit on again.	
3	Error log	Watchdog Illegal Msgid Software error	Update Main SW	
51	Error log	Internal SW error No more delayed timers	Try to turn the unit on again. If the problem persist, Update Main SW	
52	Error log	Internal SW error No more mails to Send	Try to turn the unit on again. If the problem persist, Update Main SW	
100	Error log	Serial communication error	None, implemented for test purposes	
101	Error log	Illegal Message Id received	None	
102	Error log	Illegal write state	None	
103	Error log	Illegal job state	None	
104	Error log	Serial port can not be open	None	
201	Error log	NVRAM CRC error Factory default values in use.	Try to turn the unit on again. If the problem persist, Update Main SW If the problem persist, change board.	Processor PCB
202	Error log	EEPROM not ready Cardio Aid powers off Flashing fault LED/beeps	Try to turn the unit on again. If the problem persist, change board.	Defi PCB
203	Error log	EEPROM, CRC Error	Try to turn the unit on again. If the problem persist, Update Main SW If the problem persist, Update Defi/Pace controller SW. If the problem persist, change board.	Defi PCB

204	Error log	Cable calibration error	Perform calibration. If problem persist perform flowchart D	Defi PCB, ECG cable PCB
205	Error log	Pads calibration error	Perform calibration. If problem persist perform flowchart E	Defi PCB, ECG paddle PCB
206	Error log	Defi calibration error	Perform calibration. If problem persist perform flowchart B	Defi PCB
207	Error log	Tester calibration error	Perform calibration. If problem persist perform flowchart J	Defi PCB, Defi test PCB
208	Error log	Pacer calibration error	Perform calibration. If problem persist perform flowchart G	Pacer PCB, Defi PCB
254	Error log	Self-test function key error. A Paddle or keyboard key is malfunctioning or a key was pressed during self-test.	Try to turn the unit on again. If the problem persist, perform the key test to locate the problem and replace PCB	Keyboard PCB, Paddle key PCB, Processor PCB, Defi PCB
256	Error log	Self-test printer error. Power-on error or communication problem.	Perform flowchart E	Defi PCB, Recorder unit, Processor PCB
257	Error log	Memory card error Reserved		
258	Error log	Self-test calibration range error.	Perform complete calibration	
259	Error log	Self-test RTC error	Set time and date. If problem persists, replace PCB	Processor PCB
260	Error log	Self-test local communication error Additional info available in error message on display.	Check communication line to ECG modules and defi/pace controller. If problem persists, replace PCB	ECG paddle PCB, ECG cable PCB, Defi PCB
261	Error log	Self-test watch-dog error Watch-dog time too long.	Try to turn the unit on again. If the problem persist, Update Main SW and Check jumper on processor PCB. If the problem persist, replace PCB.	Processor PCB
262	Error log	Pacer error Reserved.		
266	Error log	DEFI HV Converter error Cardio Aid powers off Flashing fault LED/beeps	Perform flowchart B	Defi PCB

267	Error log	System voltage out of range	Perform flowchart A	Power PCB, Defi PCB, Processor PCB
303	Error log	SW error Mode manager key object error, Too many key commands.	None, implemented for test purposes Try to turn the unit on again. If the problem persist, Update Main SW	
320	Error log	Mode manger detects battery EDV (end-of-discharge) The battery is completely depleted. The CA200 is turned of to protect the battery and ensure safe use.	Connect to mains Wait until charge LED is orange Power on and charge till the battery symbol indicates full battery	Defi PCB Battery module
322	Error log	Mode manager detects battery reading error from NACH register	Re-calibrate battery monitor system. If the problem persist, replace PCB	Defi PCB
323	Error log	Mode manager detects battery reading error from NACL register	Re-calibrate battery monitor system. If the problem persist, replace PCB	Defi PCB
400-410	Error log	SW errors - Parser task	None, implemented for test purposes Try to turn the unit on again. If the problem persist, Update Main SW	
600-602	Error log	SW errors - User interface task	None, implemented for test purposes Try to turn the unit on again. If the problem persist, Update Main SW	
801	Error log DEFIFAULT 1	HV security error also shown on the display as DEFIFAULT 1. HV security has received an illegal message	Try to turn the unit on again. If the problem persist, Update Main SW and Defi/pace controller SW If the problem persist, replace PCB	Processor PCB
802	Error log DEFIFAULT 2	HV security error also shown on the display as DEFIFAULT 2. HV system does not work.	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
803	Error log DEFIFAULT 3	HV security error also shown on the display as DEFIFAULT 3. Displayed energy and HV capacitor value mismatch	Try to turn the unit on again. If the problem persist, pperformerform flowchart B	Defi PCB

804	Error log DEFIFAULT 4	HV security error also shown on the display as DEFIFAULT 4. Too high voltage on HV capacitor in safe state. Drain-relay suspect.	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
805	Error log DEFIFAULT 5	HV security error also shown on the display as DEFIFAULT 5. Too high voltage at HV capacitor in defi state.	Try to turn the unit on again. If the problem persist, Re-calibrate and perform flowchart B	Defi PCB
806	Error log DEFIFAULT 6	HV security error also shown on the display as DEFIFAULT 6. Voltage in security channel out of range in defi state	Try to turn the unit on again. If the problem persist, Re-calibrate and perform flowchart B	Defi PCB
807	Error log DEFIFAULT 7	HV security error also shown on the display as DEFIFAULT 7. Unexpected charge command from HV system	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
808	Error log DEFIFAULT 8	HV security error also shown on the display as DEFIFAULT 8. The Disarm rate is to slow - suspect drain relay.	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
909	Error log DEFIFAULT 9	HV system error also shown on the display as DEFIFAULT 9. Internal communication problem	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
910	Error log DEFIFAULT 10	HV system error also shown on the display as DEFIFAULT 10. HV System unknown state	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
911	Error log DEFIFAULT 11	HV system error also shown on the display as DEFIFAULT 11. HV System charge failure	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
912	Error log DEFIFAULT 12	HV system error also shown on the display as DEFIFAULT 12. HV System shock failure	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
913	Error log DEFIFAULT 13	HV system error also shown on the display as DEFIFAULT 13. HV System refresh failure	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
914	Error log DEFIFAULT 14	HV system error also shown on the display as DEFIFAULT 14. HV System unknown command	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB

915	Error log DEFIFAULT 15	HV system error also shown on the display as DEFIFAULT 15. HV System charge fin-ish in bad state	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
916	Error log DEFIFAULT 16	HV system error also shown on the display as DEFIFAULT 16. HV System HV disabled	Try to turn the unit on again. If the problem persist, perform flowchart B	Defi PCB
1001	Error log	ECG communication error ECGsys frame align	Try to turn the unit on again. If the problem persist, perform flowcharts D or E	Defi PCB, ECG cable PCB, ECG pad-dle PCB
1002	Error log	ECG communication error ECGsys DMA buffer overrun	Try to turn the unit on again. If the problem persist, perform flowcharts D or E	Defi PCB, ECG cable PCB, ECG pad-dle PCB
1003	Error log	ECG communication error ECGsys static imp buffer overrun	Try to turn the unit on again. If the problem persist, perform flowcharts D or E	Defi PCB, ECG cable PCB, ECG pad-dle PCB
1004	Error log	ECG communication error ECGsys no ack from stop ampl.	Try to turn the unit on again. If the problem persist, perform flowcharts D or E	Defi PCB, ECG cable PCB, ECG pad-dle PCB
1005	Error log	ECG communication error ECGsys no ack from start ampl	Try to turn the unit on again. If the problem persist, perform flowcharts D or E	Defi PCB, ECG cable PCB, ECG pad-dle PCB
1006	Error log	ECG communication error ECGsys buffer to resus-citation underflow	Try to turn the unit on again. If the problem persist, Perform flowcharts D or E	Defi PCB, ECG cable PCB, ECG pad-dle PCB
1101–1102	Error log	SW errors - Analyzer task	None, implemented for test purposes Try to turn the unit on again. If the problem persist, Update Main SW	
1201	Error log PACERFAULT 1	Pacer system error also shown on the display as PACERFAULT 1. Pace Pulse too early	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Change PCB	Pacer PCB
1202	Error log PACERFAULT 2	Pacer system error also shown on the display as PACERFAULT 2. Pace pulse too late	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Change PCB	Pacer PCB

1203	Error log PACERFAULT 3	Pacer system error also shown on the display as PACERFAULT 3. Pace pulse too narrow	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Change PCB	Pacer PCB
1204	Error log PACERFAULT 4	Pacer system error also shown on the display as PACERFAULT 4. Pace pulse too wide	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Change PCB	Pacer PCB
1205	Error log PACERFAULT 5	Pacer system error also shown on the display as PACERFAULT 5. Pace current too high	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Re-calibrate pacer If the problem persist, Change PCB	Pacer PCB
1206	Error log PACERFAULT 6	Pacer system error also shown on the display as PACERFAULT 6. Pace current too low	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Re-calibrate pacer If the problem persist, Change PCB	Pacer PCB
1207	Error log PACERFAULT 7	Pacer system error also shown on the display as PACERFAULT 7. Reference voltage out-side limits	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Re-calibrate pacer If the problem persist, Change PCB	Pacer PCB
1208	Error log PACERFAULT 8	Pacer system error also shown on the display as PACERFAULT 8. DA-converter can not be set to the correct value	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Re-calibrate pacer If the problem persist, Change PCB	Pacer PCB
1209	Error log PACERFAULT 9	Pacer system error also shown on the display as PACERFAULT 9. Message queue error	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Re-calibrate pacer If the problem persist, Change PCB	Pacer PCB
1210	Error log PACERFAULT 10	Pacer system error also shown on the display as PACERFAULT 10. Garbage collection - Internal SW error	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again.	

1211	Error log PACERFAULT 11	Pacer system error also shown on the display as PACERFAULT 11. Mismatch between current on display and software measurement	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again.	
1212	Error log PACERFAULT 12	Pacer system error also shown on the display as PACERFAULT 12. Mismatch between rate on display and software measurement	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again.	
1213	Error log PACERFAULT 13	Pacer system error also shown on the display as PACERFAULT 13. Rate change too fast	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again.	
1214	Error log PACERFAULT 14	Pacer system error also shown on the display as PACERFAULT 14. Current detected between pace-pulses	Exit Pacer mode and re-enter pacer mode to clear the fault. Start pacing again. If the problem persist, Re-calibrate pacer If the problem persist, Change PCB	Pacer PCB
1401–1402	Error log	SW errors - DPC Handler task	None, implemented for test purposes Try to turn the unit on again. If the problem persist, Update Main SW	

6.6 Error messages.

The Cardio-Aid® is capable of displaying various messages related to the operating or technical state of the unit and the resuscitation process.

In the following only messages directly caused by technical/electrical problems, or a condition where a technical malfunction might be the reason, are listed.

For a complete overview refer to the Direction For Use.

6.6.1 Error messages and which impact they may have.

Display:	Comment	Impact	Attributes:
"Defi fault no XXX" Note 1!	An internal error has been detected.	The defibrillator is not able to continue to operate	V: S: – P: XX TP: XX T: –
"Pacer fault no XXX"	An internal pacer error has been detected.	The pacer function is inhibited. The fault can be cleared be exiting pace-mode.	V: – S: – P: XX TP: XX T: –
"Defi test Passed" "Delivered Energy: xxxJ"	Shock delivered to the internal test system. Test passed.		V: – S: (5) Attention P: XX TP: XX T: 5
"Defi test Failed" "Delivered Energy: xxxJ"	Shock delivered to the internal test system. Test failed.	Service is needed	V: – S: (5) Attention P: XX TP: XX T: 5
"Printer fault xxx"	An error has been detected in the printer.	Print outs can not be made.	V: – S: (5) Attention P: XX TP: XX T: –
"Card fault"	Memory card is defect.	Resuscitation data can not be saved on the memory card.	V: – S: (5) Attention P: XX TP: XX T: –
"Card format error"	Memory card is not DOS-formatted. Detected at power on or when card is inserted in the defibrillator.	Resuscitation data can not be saved on memory card.	V: – S: (5) Attention P: XX TP: XX T: –

"Set-up memory error" "Call for service"	An error has been detected in the set-up memory. Set-up could not be saved internally	Service is needed.	V: – S: (5) Attention P: XX TP: XX T: –

Note 1!   The Defi Fault XXX covers a wide range of errors or problems in the defibrillation process.

Should a DEFI FAULT occur then refer to the troubleshooting flowchart to locate which module is at fault. See 6.5.1 Error log table.

The errors from 901 – 916 are shown directly on the display without the grouping number '9', i.e. as DEFI FAULT 1 or DEFI FAULT 16.

Note!   The word DEFI FAULT is translated into the relevant language variant.

6.7   Fault finding procedure.

Due to the complexity of the electronic design, the unit being software controlled, the choice of SMD components and multi layer boards, the overall aim for the service technician is to fault find down to module level, which is defined as a PCB or a major component.

The build in self test system provides information about which section of the defibrillator that failed and the table of error messages in section 6.5.1 Error log table. provides information about a possible faulty module

Should, however, a situation occur where a problem still persists it is recommended to separate the Cardio-Aid® in its major parts and process the fault finding flowcharts that fits with the situation.

The flowcharts are grouped in blocks as follows.

A: Power system faults.
B: High voltage defibrillator faults.
C: Display faults.
D: Cable ECG faults.
E: Printer faults.
F: Memory card faults
G: Paddles ECG faults.
H: Pacer faults.
I: Internal defi-test faults.

6.7.1 Flowcharts A1 for power systems faults.

Flowchart A1

```
┌─────────────────────┐
│ With mains ON and the│
│ mains cable connected│
│    to the unit       │
└─────────────────────┘
           │
           ▼
      ◇ Is the battery charge LED      No   ◇ Are the mains fuses    No   ┌──────────────────────┐
        indication at the front  ──────────►  at the mains socket  ──────►│ Replace the fuses to the│
        active?                                ok?                         │ correct type, if fuses still│
                                                                           │ blows replace the       │
                                                                           │ Power supply PCB        │
           │ Yes                              │ Yes                        └──────────────────────┘
           ▼                                  ▼
                                        ┌──────────┐
                                        │ Go to    │
                                        │ flowchart A2│
                                        └──────────┘
```

```
      ◇ Does the LED light      Yellow      ◇ Does the battery symbol in
        green or yellow?    ────────────►     the display show 100%
                                               capacity after a full charge
                                               cycle?
           │ Green                                │ No          │ Yes
           ▼                                      ▼             ▼
```

```
      ◇ Does the battery    No   ┌──────────────┐      ┌──────────────┐  No   ◇ Does the battery
        symbol in the display ──►│ Reinitialize the│     │ Go to flowchart│◄─────  charge LED change to
        show 100% capacity?      │ battery monitor │     │ A3           │          green?
           │ Yes                 └──────────────┘      └──────────────┘              │ Yes
           │                            │
           │                            ▼
           │                     ◇ Is the problem    No   ┌──────────────┐
           │                       solved?        ──────►│ Replace the   │
           │                                              │ battery-pack  │
           │                            │ Yes             └──────────────┘
           ▼                            ▼
      ┌──────────────────────────────────────────────────┐
      │          The power system is ok                  │◄──────────────
      └──────────────────────────────────────────────────┘
```

6.7.2 Flowcharts A2 for power systems faults.

Flowchart A2

6.7.3 Flowcharts A3 for power systems faults.

Flowchart A3

```
                    ┌─────┐
                    │  C  │
                    └──┬──┘
                       │
                       ▼
                   ◇ Is the battery LED          ◇ Remove the
                     indicator        ──No──▶      battery-pack       ──No──▶  ┌──────────────┐
                     green?                         Is the battery LED          │ Replace the  │
                                                    indicator                   │ Defi-PCB     │
                       │                            green?                      └──────────────┘
                      Yes                             │
                       │                             Yes
                       ▼                              │
               ┌──────────────┐                       ▼
               │ The battery  │              ┌──────────────┐
               │ charger is ok│              │ Replace the  │
               └──────────────┘              │ battery-pack │
                                             └──────────────┘
```

6.7.4 Flowchart B for high voltage defibrillator faults.

Flowchart B

```
                    ┌─────────────────────┐
                    │      Problem:       │
                    │ The unit can not charge │
                    │ to the selected energy │
                    └─────────────────────┘
                              │
                              ▼
                         ╱─────────╲
                        ╱ Defi-charging ╲           ┌──────────────┐
                       ╱  is OK when using ╲──Yes──▶│  Replace the │
                       ╲   pads option?    ╱        │ paddles assembly │
                        ╲─────────────────╱         └──────────────┘
                              │ No
                              ▼
                         ╱─────────╲
                        ╱ Is the power ╲             ┌──────────────┐
                       ╱ system check    ╲──No──────▶│  Follow the  │
                       ╲ (Flowchart A) ok? ╱         │ procedure in │
                        ╲───────────────╱            │ flowchart A1 │
                              │                       └──────────────┘
                              ▼
                    ┌─────────────────────┐
                    │ Dismantle the CA200 to open │
                    │   service position  │
                    │ All measurements are made onto │
                    │    the defi-PCB.    │
                    └─────────────────────┘
                              │
                              ▼
                         ╱─────────╲
                        ╱ Is the system ╲
                       ╱ voltage 19VDC+/-5% ╲──No──┐
                       ╲ at TP3 Pin 1 when    ╱     │
                        ╲ charging defi energy.╱    │
                         ╲───────────────╱          │
                              │ Yes                  │
                              ▼                       │
                    ┌──────────────┐                 │
                    │  Replace the │                 │
                    │ defi-controller │              │
                    │    IC106     │                 │
                    └──────────────┘                 ▼
                              │             ┌──────────────┐
                              ▼             │  Replace the │
                         ╱─────────╲        │   defi-PCB   │
                        ╱  Does it  ╲──No──▶│              │
                        ╲ defi-charge now? ╱ └──────────────┘
                         ╲─────────╱              ▲
                              │ Yes               │
                              ▼                    │
                    ┌──────────────┐               │
                    │  Make a new  │               │
                    │ calibration of │             │
                    │   the unit   │               │
                    └──────────────┘
```

6.7.5   Flowchart C for display fault.

Flowchart C

```
┌─────────────────┐
│ Problem:        │
│ No data in the  │
│ display         │
└─────────────────┘
        │
        ▼
┌─────────────────┐
│ Dismantle the   │
│ CA200 to open   │
│ service position│
│ and connect to  │
│ mains.          │
└─────────────────┘
        │
        ▼
┌─────────────────┐
│ Check Display   │
│ wiring &        │
│ connection to   │
│ J4& J5          │
└─────────────────┘
        │
        ▼
   Is there any backlight ──No──► Is the voltage at ──No──► Replace the
   in the display                 Defi-PCB TP2 pin 6        defi-PCB
        │                         within limits.
       Yes                           │
        │                           Yes
        ▼                            ▼
   Is the problem solved ──Yes──►  Is the voltage approx. ──No──► Replace the
        │                          300Vac at the                   processor-PCB
       No                          Processor-pcb J5 pin 1 & 4
        │                              │
        ▼                             Yes
┌─────────────────┐                    ▼
│ Replace the     │              ┌─────────────────┐
│ processor-PCB   │              │ Replace the     │
└─────────────────┘              │ display unit    │
        │                        └─────────────────┘
        ▼
   Is the problem solved ──Yes──► The Cardio-Aid should be OK
        │
       No
        ▼
┌─────────────────┐
│ Replace the     │
│ display unit    │
└─────────────────┘
```

6.7.6 Flowchart D for Cable ECG fault.

Flowchart D

Problem:
No cable ECG signal
in the display

⬦ Is the ECG cable OK — No → Replace the Cable assembly

Yes

Dismantle the CA200 to open service position. All measurements are made onto Defi PCB

⬦ Is the ECG connection PCB & connetion cable OK — No → Replace ECG connection PCB

Yes

Disconnect J100 & the cable ECG module. Connect to mains & place a jumper onto S1

⬦ Is the voltage at J108 within limits. — No → Replace the defi-PCB

Yes

Remove Jumper on S1. Replace the Cable ECG module

⬦ Is the problem solved — No → Update the Main software.

Yes

⬦ Is the problem solved — No → Replace the defi-PCB

Yes

Reassemble the CA200.

6.7.7 Flowchart E for printer fault.

Flowchart E

```
                    ┌─────────────────┐
                    │    Problem:      │
                    │ No printout on the│
                    │     paper        │
                    └─────────────────┘
                             │
                             ▼
                    ╱─────────────────╲                    ╱─────────────────╲                ┌─────────────────────┐
                   ╱  Is paper coming   ╲──Yes──▶         ╱  Is the paper      ╲──No──▶ │ Replace the printer │
                   ╲   out of the printer╱                 ╲  placed correct     ╱        │      paper          │
                    ╲─────────────────╱                     ╲  in the printer   ╱         └─────────────────────┘
                             │                                ╲───────────────╱
                            No                                        │
                             │                                       Yes
                             ▼                                        ▼
                  ┌─────────────────┐                        ┌─────────────────┐
                  │ Dismantle the    │                       │  Update the      │
                  │ CA200 to open    │                       │  Main software.  │
                  │ service positio. │                       └─────────────────┘
                  └─────────────────┘                                 │
                             │                                        ▼
                             ▼                               ╱─────────────────╲
                  ╱─────────────────╲         Yes          ╱  Is the problem    ╲──Yes──▶ Make a test printout.
                 ╱  Measure on the    ╲◀────────           ╲    solved          ╱
                 ╲  defi-PCB           ╱                     ╲───────────────╱
                 ╲  Is the voltage at ╱                              │
                  ╲ TP5 within limits╱                              No
                   ╲───────────────╱                                ▼
                             │                              ┌─────────────────┐
                            No                              │  Replace the     │
                             ▼                              │  printer unit.   │
                  ┌─────────────────┐                       └─────────────────┘
                  │  Replace the     │                               │
                  │  defi-PCB        │                               ▼
                  └─────────────────┘                      ╱─────────────────╲
                                                          ╱  Is the problem    ╲──Yes──▶ Make a test printout.
                                                          ╲    solved          ╱
                                                           ╲───────────────╱
                                                                    │
                                                                   No
                                                                    ▼
                                                          ┌─────────────────┐
                                                          │  Replace the     │
                                                          │  Processor-PCB   │
                                                          └─────────────────┘
```

6.7.8 Flowchart F for memory card fault.

Flowchart F, Memory card faults

```
            ┌─────────────────────┐
            │     Problem:        │
            │  No contact to the  │
            │    memory card      │
            └─────────────────────┘
                      │
                      ▼
            ┌─────────────────────┐
            │   Try using a new   │
            │    memory card      │
            └─────────────────────┘
                      │
                      ▼
                  ◇─────────◇
               Contact to the ──── Yes ──────┐
                memory card                  │
                  ◇─────────◇                │
                      │                      │
                      No                     │
                      ▼                      │
            ┌─────────────────────┐          │
            │  Go to flowchart A2 │          │
            │   and follow this   │          │
            │       chart.        │          │
            └─────────────────────┘          │
                      │                      │
                      ▼                      │
                  ◇─────────◇                │
               Contact to the ──── Yes ──────┤
                memory card                  │
                  ◇─────────◇                │
                      │                      │
                      No                     │
                      ▼                      ▼
            ┌─────────────────┐    ┌─────────────────┐
            │  Replace the    │    │ Update the Main │
            │  Processor Pcb  │    │    software     │
            └─────────────────┘    └─────────────────┘
```

6.7.9   Flowchart G for Paddles ECG fault.

Flowchart G

Problem:
No Paddles ECG
signal in the display

↓

Check cables
Are they OK — No → Replace the
Paddles
assembly

Yes
↓

Dismantle the CA200 to open
service position.
All measurements are made
onto the Defi PCB

↓

Disconnect J100 & the
paddle ECG module.
Connect to mains
& place a jumper onto S1

↓

Is the voltage at
J107 within limits — No → Replace the
defi-PCB

Yes
↓

Remove jumper on S1
Replace the paddles
ECG-module

↓

Is the problem
solved? — No → Update the
software → Is the problem
solved? — No

Yes ↓   Yes ↓   No ↓

Reassemble
the CA200.   Replace the
defi-PCB

6.7.10 Flowchart H for pacer fault.

Flowchart H

6.7.11 Flowchart I for fault in the internal defi-test unit.

Flowchart I

Problem:
No energy is displayed when defi-shock is executed into the Cardio-Aid's internal defi test unit.

Does the message "No Patient Contact" show up when shock — No

Yes

Check Paddles/Pads holder assy. & connection to internal clip onto inner chassis.

Meassure impedanse between the contact brackets into the right & left Paddle holder or into the R2 connector pins in Pads holder.

Is the impedans approx. 50 ohm. — No

Yes

Does the message "No Patient Contact" show up when shock — No

Yes

Dismantle the Cardio-Aid to open service posistion

Check the wiring harness: Is wiring OK. — No → Repair & Check wiring harness.

Yes

Measure the voltage onto Defi-Test PCB at J1 between pin 2 & 3

Is the voltage within 5Vdc+/-5% — No

Yes

Replace the Defi-Test PCB

Execute shock to an external energy-meter.

Is the selected energy delivered to the energy-meter — No → Check or replace Paddles or Pads cables

Yes

Execute Defi Calibration in the service menu

The Cardio-Aid should be OK

Is the selected energy delivered to the energy-meter — Yes

No

Go to flowchart B

6.8   Measurement details at the Defi Board.

6.8.1   Voltage limits for TP2

Pin no.	Output	Min. (V)	Max. (V)
1	Reserved		
2	Reserved		
3	0V (common)	–	–
4	+12V	10,80	13,20
5	+5V	5,25	4,75
6	–28V	–24	–35V

6.8.2   Voltage limits for TP5

Pin no.	Output	Min. (V)	Max. (V)
1	+13V	11,70	15,00
2	+13Vrtn (common)	–	–

6.8.3   Voltage limits for J107

Pin no.	Output	Min. (V)	Max. (V)
1	+0V (common)		
2	+15V	13,50	16,50
3	+0V (common)		
4	–15V	–13,50	–16,50
5	NC		
6	NC		

6.8.4   Voltage limits for J108

Pin no.	Output	Min. (V)	Max. (V)
1	+0V (common)		
2	+15V	13,50	16,50
3	+0V (common)		
4	–15V	–13,50	–16,50
5	NC		
6	NC		

6.8.5 Defi board test point indentification.
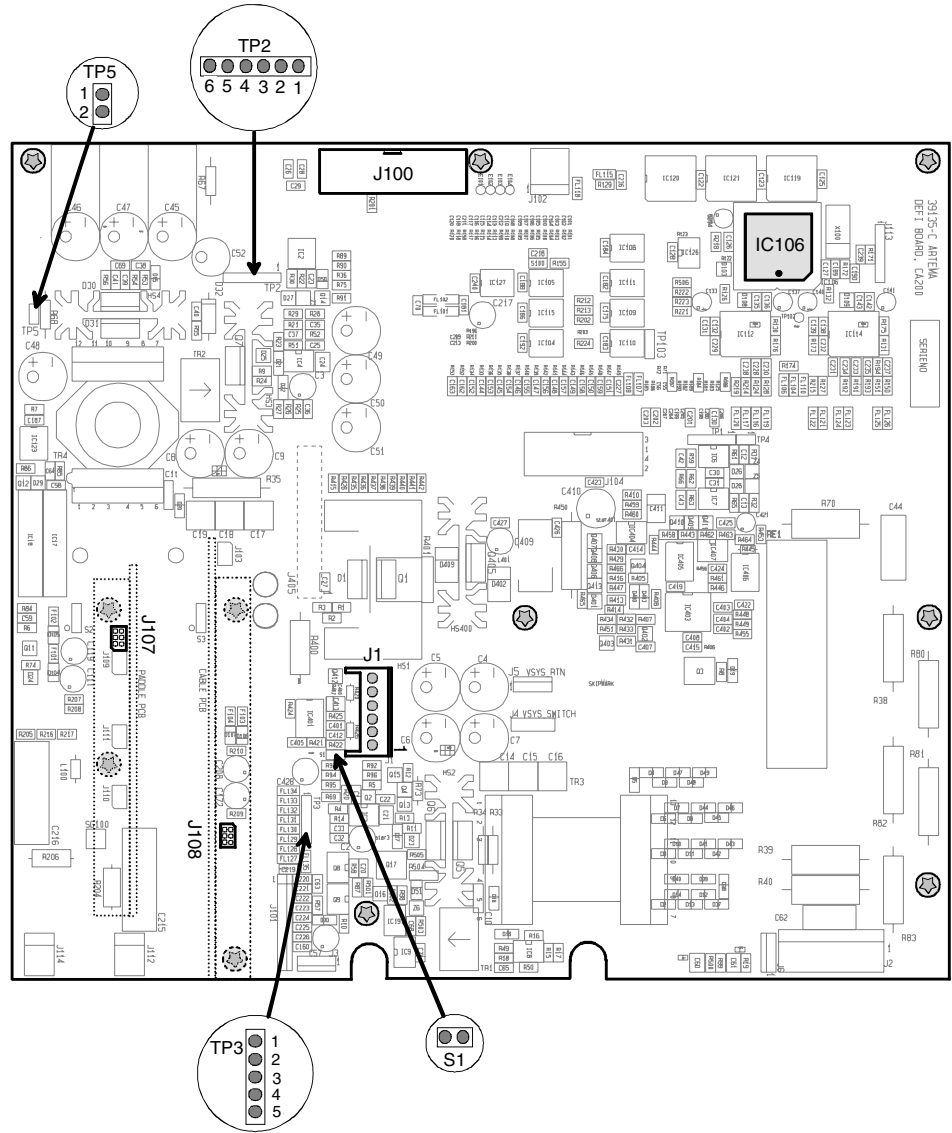
6.8.6 Processor board test point identtification.
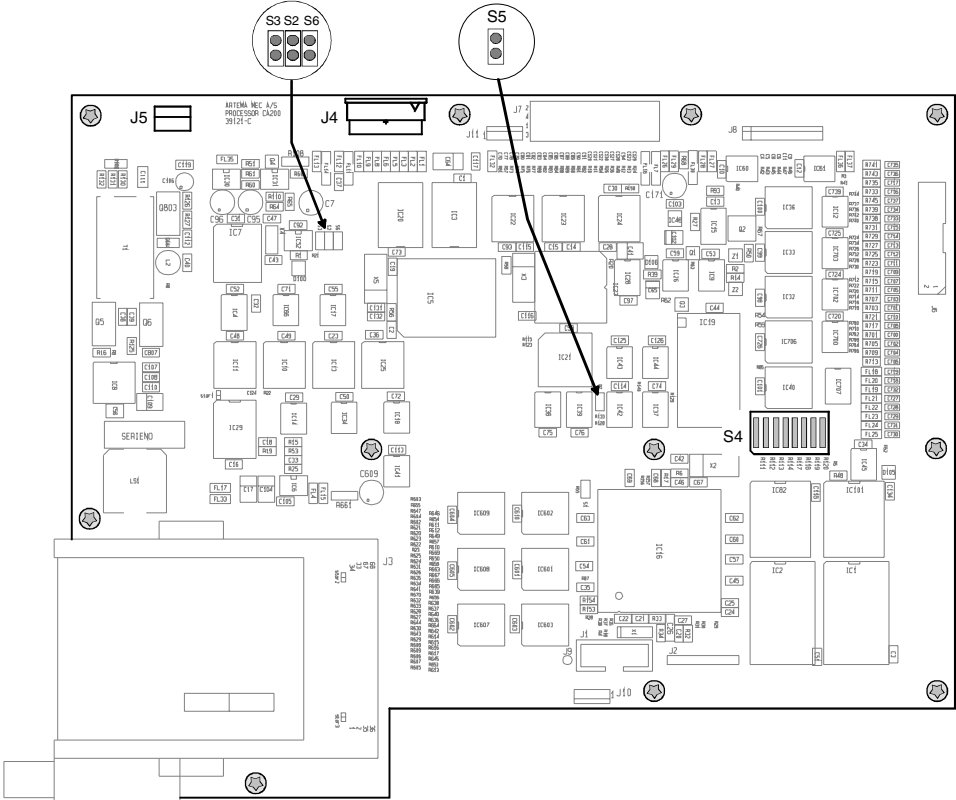
6.8.7 Power suply board test point identtification.
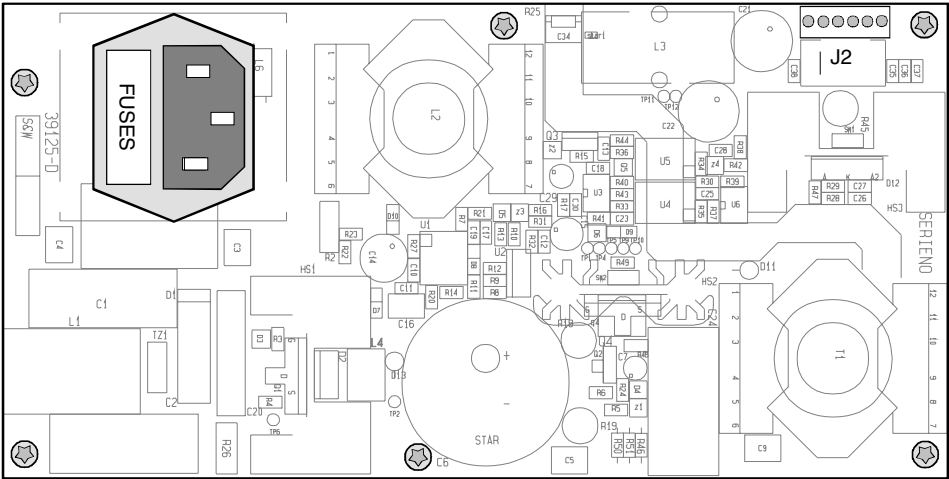
6.8.8 Defi test board test point identtification.
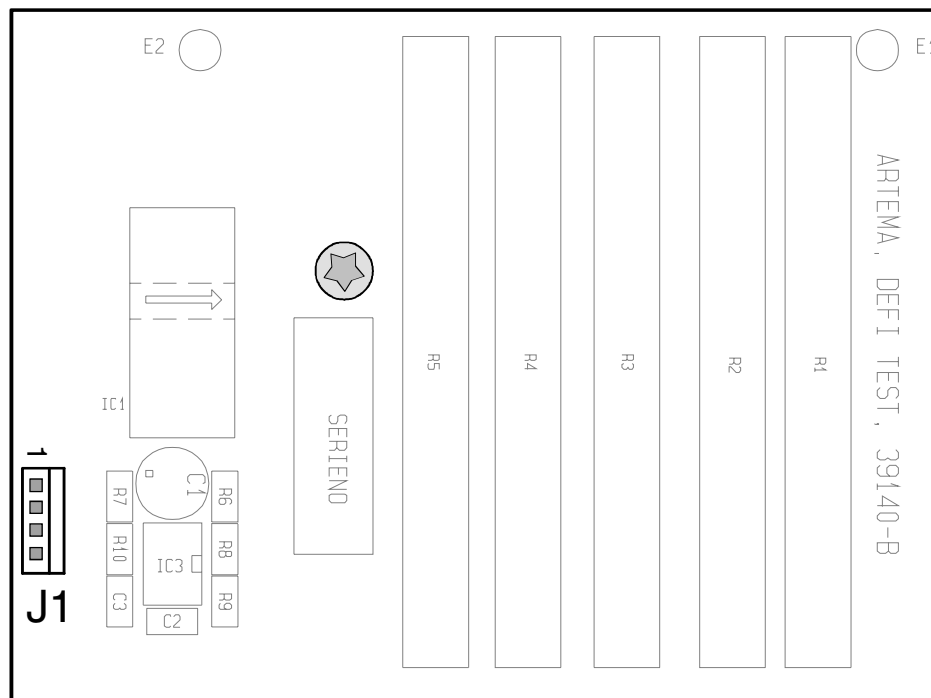
Chapter 7 – Verification and Test.

This section provides information about the necessary steps to be taken following a replacement of a module or component in the Cardio-Aid® and annually checks, regardless of actual use of the defibrillator.

Following a repair it is essential that the unit is properly calibrated.

The DEFI TEST program described in Chapter 9 – Defi program., is dedicated to this purpose. It might, however, occur that the required computer hardware is not always available. In this case the procedures described in the following can be carried out with the Cardio-Aid® in service mode and some essential test equipment alone.

Artema recommends the use of test equipment from Metron in connection with servicing the Cardio-Aid®, and the test procedures described are specifically carried out with the use of:

Metron Safety tester QA 90
Metron Defibrillator tester QA45
Metron Patient simulator PS-420

The information about these is available at the website:

http://www.metron-biomed.com/biomedical_testing_equipment.htm.

See also Artema Service News #108.

7.1 Jumper & DIL switch settings.

Jumpers on processor board:

Jumpers		
S2	Watchdog trig., normal mode	must be on
S3	Manual reset	must be off
S5	For factory use only.	must be off
S6	Watchdog trig., debug (test) mode	must be off

DIL-switch S4 on processor board:

Switch	
D1	Printer (ON=Printer mounted, OFF=not mounted)
D2	Pacer (ON=Pacer mounted, OFF=not mounted)
D3	Not used, must be off.
D4	Not used, must be off.
D5	Not used, must be off.
D6	Not used, must be off.
D7	Not used, must be off.
D8	Not used, must be off.

7.2 Configuration menu.

The Cardio-Aid® has a configuration menu that enables changes to be made to a number of settings. The Configuration Menu also gives access to the Service menu (see 7.3 Service menu.) which is intended for the service technician during i.e. calibration.
Navigation in the menus can be done either with the buttons "Menu",

"Up+/Down–" and "OK" or remote from a PC connected to the Cardio-Aid® through a serial card in the plugged in PCMCIA slot. The optional Service Kit contains the needed equipment. See 10.6 Accessories.

To access the Configuration Menu, press the "Menu" key when the power up self-test display appears. The only way to leave the Configuration Menu is by switching off the Cardio-Aid®.

The table shows the various entries and the options to choose between.

Note! The configuration menu is subject to frequent update, and the content only reflects the configuration menu as it was found during the preparation of the manual. Default values are shown in parenthesis.

Entry, option

Language	DK, E, I, PL, F, D, GB, NL, P,SF, N, S (GB)
Use factory default	Load and use the Artema standard configuration.
Mains frequency	50, 60 (50Hz)
Start-up defi mode	Semi Auto, Manual (Semi Auto)
Pulse check 1	On, Off (On)
Pulse check 2	On, Off (Off)
Protocol Reset	First level, Last level (Last level)
Energy/Charge on keyboard	Disabled, Enabled (Disabled)
Manual Energy-External	2, 5, 7, 10, 20, 30, 40, 50, 60, 80, 100, 150, 200, 300, 360J, (200J)
Manual Energy-Internal	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 40, 50J (20J)
Semi-auto energy 1. shock	2, 5, 7, 10, 20, 30, 40, 50, 60, 80, 100, 150, 200, 300, 360J, (200J)
Semi-auto energy 2. shock	2, 5, 7, 10, 20, 30, 40, 50, 60, 80, 100, 150, 200, 300, 360J, (200J)
Semi-auto energy 3. shock	2, 5, 7, 10, 20, 30, 40, 50, 60, 80, 100, 150, 200, 300, 360J, (360J)
Defi sync	Latching, Non-latching (Latching)
Pace mode	Demand, Fixed (Demand)
QRS volume	Off, 1, 2, 3, 4, 5 (3)
Voice volume	1, 2, 3, 4, 5 (3) - (Off is not possible)
Volume	1, 2, 3, 4, 5 (3) - (Off is not possible)
Realtime clock format	12 hour, 24 hour (24 hour)
Set realtime clock...	Sub-menu, YYYY:MM:DD:HH:MM:SS (Year, Month, Day, Hour, Minute, Second)
Wake-up self-test	Enabled, disabled (Disabled)

Wake-up start time	HH:MM (00:00 to 23:00)
Show elapsed time	Yes, No (Yes)
Show shock count	Yes, No (Yes)
VF detection in manual mode	Enabled, Disabled (Enabled)
HR alarm - Low limit	30 to 299 (40)
HR alarm - High limit	31 to 300 (140)
Automatic print out	Enabled, Disabled (Enabled)
Printout time	15, 20, 30, Continuos (15sec.)
Printer speed	25, 50 (25mm/sec.)
Print event report	Enabled, Disabled (Enabled)
Print defi test result	Enabled, Disabled (Enabled)
Memory Card test	Enabled, Disabled (Disabled) - (enable=test for a memory card)
Default ECG lead	I,II,III (II)
Default ECG size	x0,25 x0,5, x1, x2, x4, Auto (x1)
External ECG gain	x100(0,1V/mV), x1000(1V/mV) (x1000)
User ID	24 chars (Artema MEC)
Service menu...	Access to Service Menu

7.3   Service menu.

The Service Menu is accessed from the Configuration Menu.

Serial number menu example:

Serial Numbers Menu	
Serial number	**12345678**
Processor PCB	
Serial number	**0101010101**
Pcb version	**A**
SW interface	**1.00**
Defi PCB	
Serial number	**0101010101**
Pcb version	**A**
SW interface	**1.00**
Menu key=Exit.	

The following items can be selected in the service menu:

Serial numbers...	Gives access to a sub-menu with serial numbers for Processor- and Defi board versions and software interface numbers. See also 7.13.3 Serial number.
Software versions...	Gives access to a sub-menu with software versions.
Service Log...	Gives access to a sub-menu showing the service log with the last 3 service events. The technician can 'type' in his initials and select a location to update the log with a new entry.
Service Report...	Operation time: 10hours Table of number of shocks/energy level i.e. 10J: 2
Error Log...	Gives access to a sub-menu with the last 10 error codes logged in the Cardio Aid.
Defibrillator calibration...	Gives access to a sub-menu where the delivered energy can be calibrated.
Defi tester calibration...	Gives access to a sub-menu where the defi test circuit can be calibrated.

Impedance calibration...	Gives access to a sub-menu where the patient impedance measuring circuits on the ECG boards can be calibrated. See 7.5.5 Adjusting and testing the ECG amplifiers.

Pacer calibration...	Gives access to a sub-menu where the optional Pacer circuit can be calibrated (only visible if Pacer is mounted). See 7.5.1 Calibration the Pacer board.

Contrast calibration...	Gives access to a sub-menu where the display contrast can be adjusted and select between black or white text/back ground. See 7.5.2 Adjusting and testing the LCD display.

Self test...	Gives access to a sub-menu of self test functions. See 7.4 The Self test menu.

The next two menu items will only appear in the Service Menu when a memory card or a serial card is inserted in the PCMCIA slot.

See also 4.2.3 PCMCIA connector. and 7.14 Memory card, format and delete data.

1. Memory card loaded with software updates inserted.

Software update...	Selecting this menu item enables the user to update different software components through a PCMCIA memory card loaded with new software. The memory card must be inserted the PCMCIA slot at power on.

2. Serial card inserted.

Remote Control...	Selecting this menu item enables the user to access the service menu from a PC connected to the unit through a serial PCMCIA card inserted PCMCIA slot. With remote access it is possible to up-load equipment set-up, download new software, download new voice prompts etc. Remote control can only be stopped by turning off the unit. The serial card must be inserted the PCMCIA slot at power on.

7.4   The Self test menu.

The tests in this menu must be manually performed.
Use "Menu +up/-down" key to select and "OK" key to perform the tests.

Most of the tests must manually be reported: "OK" or "Fault" by use of the key "Menu +up/-down". Use the "OK" key to confirm the test result.

Display test...	A sequence of 4 test screens are shown: Vertical lines, horizon lines, squares and Artema logo while contrast is adjusted up and down. "OK" key to start the Display test. "Menu up/down" key to report "OK" or "Fault". "OK" key to confirm and exit the Display test. "Menu" key to exit without confirming.
Key test...	A list of keys are shown on the screen. Keys on connected paddles are also shown in the list and must be activated to complete the test. "OK" key to start the Key test. Press ALL keys one by one to perform the Key test. The keys in the list are high lighted when pressed. "OK" key to confirm and exit the Key test. The test result is saved automatically.
Lamp test...	All LED's, except the "Battery Charge" LED, is turned on one by one and flashing in sequence. The test ends with the "Fault" LED flashing/beeping 4 times. "OK" key to start the Lamp test. "Menu up/down" key to report: "OK" or "Fault". "OK" key to confirm and exit the Lamp test.
Sound test...	Test of sound generated from the unit. "OK" key to start the Sound test. Sequense: 'Defi charge' sound', 'Defi ready sound', 'Alarm sound', 'QRS beep', 'Attention sound', 'Key click sound'. "Menu up/down" key to report: "OK" or "Fault" "OK" key to confirm and exit the Sound test. "Menu +up" key to repeat a sound. "Menu -down" key to go to the next sound. "OK" key to terminate the test.
Voice test...	Test of the voice prompts generated from the unit in the language version available. "OK" key to start the Voice test. "Menu up/down" key to report: "OK" or "Fault" "OK" key to confirm and exit the Voice test. "OK" key while the test is running will terminate the test. The progress bar shown while the test is running does not indicate the length of the voice prompts. Note!. If the language is changed in the Configuration Menu, matching voice prompts must be loaded from a memory card.
Printer test...	The test is only active if a printer is installed. The test will run for approx. 20 sec. The print-out shows the date and time, the char set, a black box and diagonal lines. A sound is heart if the printer is out of paper. "OK" key to start the printer test. "Menu up/down" key to report: "OK" or "Fault"
Battery test...	The unit must be running on battery to perform the test. The Battery test will run for approx. 1 min. and estimate the remaining capacity. The progress bar indicates the test in progress. The test result is saved automatically. The test will fail if less than 60 minutes remaining capacity is calculated.

7.4.1 Recommended position.

The most convenient position for the Cardio-Aid® during service is the Service position, open or closed.
It enables the technician to both operate the unit and gives easy access to all major components and thereby facilitates the use of test equipment during a faultfinding scenario.

For details, see Chapter 5 – Dismantling & re-assembly., 5.1.6 The Service position, open and closed.

7.4.2 Battery system.

The built in battery is a multi cell 12V NiCd battery with a capacity of 1.7 Ah, which normally will provide either 2 hours of monitoring time or up to 50 shocks at 360J with a new battery.

The battery system includes a charge circuit capable of charging the battery to full capacity within 1 hour and an intelligent battery monitor. The charge circuit will alter the battery charge current between "quick" and "trickle" charge currents to ensure that the battery always is kept fully charged and at maximum capacity. The charge mode is indicated on the Charge/Batt. LED. Orange for quick charge and green for trickle charge.

The battery monitor will continuously estimate the capacity of the battery based on measured current to and from the battery compensated for temperature, self discharge etc. The remaining battery capacity is indicated with the battery symbol on the display.

The battery monitor must be initialized to the actual battery when a battery is replaced or disconnected during a service situation.

To assure an accurate capacity indication the battery monitor should be re-calibrated every 12 month.

Note! When a field service is carried out, and the battery pack has been removed, the battery capacity calibration might not be necessary, when the original battery is reinserted, as the battery monitor has a power back up that retain data for up to 24 hours.

You can determine if the battery needs re-calibration after the field service by

1. Ensure that the battery is 100% charged prior to the service

2. Switch on the unit prior to the service and confirm the battery status to read "Battery capacity 100%"

3. Carry out your service and reinsert the original battery

4. Switch on the unit and if you can confirm that the battery still reads "Battery capacity 100%" the unit can be put into operation again.

5. Otherwise your service caused the battery monitor to loose it's content and you must re-calibrate the battery. This condition can also cause the defibrillator to display "Battery Fault". A message that will disappear when the battery is properly charged.

7.4.3 Resetting the battery monitor.

Every 12 months, the battery must be discharged and charged in a specific way to ensure that the battery capacity is maintained at an optimal level over time and to ensure that the battery management system and thereby the battery capacity indicator gets re-calibrated to match the actual battery characteristics.

The following procedure must be followed:

1. Disconnect the defibrillator from the mains power

2. Turn on the defibrillator in configuration mode (press the menu key during the self-test)

3. Leave the defibrillator turned on until it runs out of power and turns itself off

4. Connect the defibrillator to mains power

5. Let the defibrillator charge for 3 hours (continue even after the battery charge indicator turns green)

6. Disconnect the defibrillator from mains power

7. Turn on the defibrillator in configuration mode (press the menu key during the self-test)

8. Leave the defibrillator turned on until it runs out of power and turns itself off

9. Connect the defibrillator to the mains power

10. Let the defibrillator charge until the battery charge indicator on the front turns green

The battery management system is now calibrated and the battery is charged to its maximum capacity.

11. Turn on the defibrillator and check the battery capacity indicator on the display. If the indicator shows 50% or less, the battery must be replaced by the Artema service center.

Note! The battery conditioning will work only if the defibrillator discharges in the configuration mode. Discharging must be carried out without any interruptions. The sudden loss of power that is intentionally provoked by the special discharge in the configuration mode, may occasionally cause an error message to be displayed when the unit is powered on the next time. This may happen in step 7 and 11 in the above procedure.

The error message will look like:

> Cardio-Aid$^{®}$ 200

<- Power off

> General fault xxxxxxxx

If this message appears, simply turn the unit off and on again and continue the procedure.

Important! The maintenance procedure must be performed every 12 months or when a new battery is inserted.

7.5   Test procedure.

1. Connect the patient lead from the monitor to the ECG output from the Metron QA 45 defibrillator tester.

2. Perform a synchronized defibrillation.

3. Check that the sync delay does not exceed 60mS.

Note! The following adjustments and testing procedures are carried out from the Service Menu.

7.5.1   Calibration the Pacer board.
Requires calibration of impedance measurement to be performed in advance See 7.5.5 Adjusting and testing the ECG amplifiers.

Calibration equipment:

1. A Metron QA-45 tester with its "snap to banana" adaptor is recommended as load and calibration-reference.

2. One 3-lead ECG cable.

3. One Defibrillation electrode cable.

4. One special Pacer calibration cable (type CA191, see Directions For Use, accessories).

Calibrating protocol with a Metron QA-45:

1. Connect Cardio-Aid® to the calibration equipment.

2. Insert the 3-lead ECG cable into the ECG-socket. Connect the 3 leads to the Metron QA-45 tester or short-wire them to each other.

3. Connect the Defib-electrode-cable between the HV-connector socket and the pacer-calibration-cable.

4. Connect the Pacer calibration cable to the "Pacer input" of the Metron QA-45 tester via two "snap to banana" adaptors.

5. Adjust the Metron QA-45 to 300 ohm.

In the Cardio-Aid® Configuration menu, select: Service menu > Pacer calibration.

Perform the Pacer calibration as shown in the table:

No.	Description	Conditions	Test limits
1	Enter measured pace current at 50 mA	Imp=300ohm	
2	Enter measured pace current at 200 mA	Imp=300ohm	
3	Repeat calibrate pacer current at 50 mA	Imp=300ohm	
4	Repeat calibrate pacer current at 200 mA	Imp=300ohm	No calibration error observed
5	Repeat and check calibration for pacer current at 50 mA	Imp=300ohm	Current=50mA +/-5% Pulse width=40msec +/- 10%
6	Repeat and check calibration for pacer current at 200 mA	Imp=300ohm	Current=200mA +/-5% Pulse width=40msec +/- 10%

Note!   "Use factory defaults" sets the gain and offset to default values.

7.5.2   Adjusting and testing the LCD display.
The contrast level for the LCD display can be set in the Service Menu to a level between 0 – 255

No additional adjustments are required.

Note!   Before adjusting the contrast level, select display mode Black and white text.

7.5.3   Testing the Battery charge system.
1. Turn off the Cardio-Aid®.

2. Disconnect the defibrillator from mains power for more than 10 seconds and check that the battery charge indicator on the front turns off.

3. Connect the defibrillator to mains power.

4. Check the battery charge indicator turns on yellow.

5. Check the battery charge indicator turns on green within an hour (within 10 minutes on a fully charge battery).

No additional adjustments are required.

7.5.4   Adjusting and testing the defi processor board.
The energy levels during the discharge sequence must be calibrated, which is achieved by means of software. A set of defibrillation shocks are delivered to an external calibrated energy meter i.e. the Metron QA 45 and the actual value/displayed reading is manually entered via the service menu. The CPU system is thus aware of both the selected and delivered energy and is now able of calculating any necessary change to the voltage generation in order to obtain a correct energy.

The calibration is done at 50 and 360 Joule in a 50 ohm load.

Important!   Energy discharge must be performed immediately after the defibrillator enters ready mode.

From Service Menu:

Defibrillator calibration:

> Last calibration   29-NOV-2001.
> Deliver shock to test equipment.
> Charge to energy   50, 360.
> Enter delivered energy XXX.

When the energy level is properly calibrated by means of the external energy meter it is necessary to calibrate the built in defi tester as well.

This is also achieved via a software calibration. An energy of 50, 200 or 360 Joule is delivered to the built in defi tester as a reference for the CPU when calculating the delivered energy.

Defib tester calibration:

> Last calibration   29-NOV-2001.
> Deliver shock into test connector.
> Charge to energy   50, 200, 360.

Perform calibration at both 50, 200 and 360 J.
Energy selection can be changed by using the up/down menu key. Charging is started by activating "OK".
It is important that energy discharge into defi-tester is performed immediately after the defibrillator enters ready mode.

7.5.5 Adjusting and testing the ECG amplifiers.

The ECG amplifiers support the patient impedance measuring system. Both the cable and the paddle amplifier must be calibrated at 200 and 1000 ohm.

The Cardio-Aid® specifies impedances between 0-200 ohm as "Good contact", Impedances between 200-1000 ohm is specified as "Poor contact" and impedances >1000 ohm is specified as "No contact"

The Metron QA 45 facilitates an adjustable output impedance.

From Service Menu: – Impedance calibration:

Important! Wait 30 sec. after each impedance change before calibration is performed.

> ECG cable impedance applied between RA and LL.
> Connect 200 ohm impedance: OK
> Connect 1000 ohm impedance: OK
> Last calibration: 29-NOV-2001

> Defi output impedance
> Connect 200 ohm impedance: OK
> Connect 1000 ohm impedance: OK
> Last calibration: 29-NOV-2001.

7.5.6 Retrofitting printer option.

Printer option can be fitted to the Cardio-Aid®. The option necessitate hardware changes and a re-configuration of the software.
The Printer option consist of:

1. Printer bezel to fit to the rear cabinet

2. Printer module

See Chapter 4 – Interconnections.
See Chapter 5 – Dismantling & re-assembly. for the hardware installation
See 7.1 Jumper & DIL switch settings.
See 7.13 Printer test (optional). for adjusting and testing procedure.

7.6 Final test of the Cardio-Aid®

7.6.1 Safety test.

Perform a safety test in accordance with IEC 60601 standard.

The below safety tests should be performed by your Artema service center according to IEC 1288-2 "Maintenance of cardiac defibrillators".

Measurement according to IEC 1288-2 Earth leakage current (IEC 1288-2 section 5.3.2)
Max. allowed current - normal condition: 0.5 mA
Max. allowed current - single fault condition:1 mA

Patient leakage current (IEC 1288-2 section 5.3.3)
Type CF equipment: Max. allowed current - normal condition: 0.01 mA
Type CF equipment: Max. allowed current - single fault condition: 0.05 mA
Type BF equipment: Max. allowed current - normal condition: 0.1 mA
Type BF equipment: Max. allowed current - single fault condition: 0.5 mA

Patient leakage current, mains voltage on applied part
(IEC 1288-2 section 5.3.4)
Type CF equipment: Max. allowed current: 0.05 mA

Note!   For internal paddles: 0.1 mA
Type BF equipment: Max. allowed current: 5 mA

7.6.2 Battery test.

See 7.4 The Self test menu. and 7.4.2 Battery system..

7.7   ECG cable amplifier test.

7.7.1   Noise Zero line.
1. Connect to mains.

2. Connect Ecg cable to the Metron QA 45. Select "ECG off"

3. Select Lead = I

4. Select Size = x2

5. Check that the zero line is straight across the display and with not more than one pixel noise.

7.7.2   ECG gain.
1. On the QA 45 set the ECG signal to 1mV, triangle waveform

2. Select Size = x2

3. Check with a ruler the size to be approximate 20mm

Note!   Be careful not to scratch the screen

7.7.3   Heart Rate read out at 60bpm.
1. Set the QA 45 to Ecg waveform, 60bpm.

2. Check the Cardio-Aid® to display 60bpm, +/- 2 bpm.

7.7.4   QRS beep.
1. Check the Cardio-Aid® beeps in correspondence with the QRS signal.

7.7.5   Volume.
1. Press Manual Mode first.

2. Press MENU, choose QRS VOLUME with the arrows, and press the OK button.

3. Check the volume can be adjusted in 5 steps + off.

4. Press the MENU twice to leave the menu.

7.7.6   Inop.
1. Set the QA 45 waveform to 60bpm. ECG signal

2. Disconnect in sequence the RA, LL and LA electrodes and check that "No ECG contact" appears in the display.

7.7.7   VF detector.
1. Select manual mode (make sure that "VF Detection in manual mode" is enabled in the Configuration Menu. See 7.2 Configuration menu.)

2. Set the Cardio-Aid® to lead II.

3. Set the QA 45 waveform to vfib.

4. Check that "SHOCKABLE RHYTHM" appears in the display.

7.7.8 Lead P.

1. Disconnect the ECG cable.

2. Check the Cardio-Aid® selects lead P.

7.7.9 External ECG.

Using External 1V ECG for synchronization during a Cardio version procedure.

1. Connect the external ECG cable. See Chapter 4 – Interconnections. for the ECG connector pin configuration.

2. Check the Cardio-Aid® display EXT as lead selection for external ECG.

Note! AAMI DF2 defibrillator standard does not recommend that an independent monitor is used for synchronization because of the delay in the signal processing in the monitor.

Should, however an external ECG signal be used it is important to check that the overall delay does not exceed 60mS from the peak of the R-wave to the peak of the defibrillator discharge pulse.

7.8 ECG paddle amplifier test.

Note! Disconnect ECG cable or EXT ECG cable if applicable.

7.8.1 Noise zero line.

1. Connect the paddles to the Cardio-Aid®

2. Attach the paddles to the QA 45, Select "ECG off"

3. Select Size = x1

4. Check that the zero line is straight across the display and with not more than one pixel noise.

7.8.2 ECG gain.

1. On the QA 45 set the ECG signal to 1mV, triangle waveform

2. Select Size = x2

3. Check with a ruler the size to be approximate 20mm.

Note! Be careful not to scratch the screen

7.8.3 Heart Rate read out 60bpm.

1. Set the QA 45 to ECG waveform, 60bpm.

2. Check the Cardio-Aid® to display 60bpm. +/- 2bpm.

7.8.4 QRS beep.

1. Check that the Cardio-Aid$^{\circledR}$ QRS beeps in correspondence with the QRS signal.

7.8.5 Electrode "short".

1. Press APEX and STERNUM plates firmly against each other.

2. Check that a flat line is displayed.

Note!   (The flat line must <u>not</u> be dotted - - - - - - - - - - - -)

Note!   If you are in semi-automatic mode the device will ask you to connect the ECG-cable.

7.8.6 Electrodes "open".

Manual mode:

1. Hold the Apex and Sternum plates apart.

Note!   (The flat line must be dotted - - - - - - - - - - -)

7.8.7 Paddle ECG signal.

Manual mode.

1. Place the paddles on the QA 45's corresponding defib plates. Sternum to the left.

2. Select an ECG wave at 30 bpm and confirm the R wave to be positive.

7.9 Defibrillator part test.

Caution!   The following tests are carried out with High Voltage generated.

7.9.1 Sync mode.

1. Mount the external Paddles on the Cardio-Aid$^{\circledR}$.

2. Place the paddles on the QA 45's corresponding defib plates.

3. Connect an ECG cable to the QA 45 and select 60bpm.

4. Select lead I on the Cardio-Aid$^{\circledR}$.

5. Select MANUAL MODE and SYNC.

6. Check that the LED's for Manual mode is on and Sync LED flashes upon detection of QRS and an ECG signal at 60bpm is displayed with associated sync pulses "S".

7.9.2 Sync-delay.

1. Select "Sync" mode.

2. Place the paddles on the QA 45's corresponding defib plates.

3. Select 5J on the Sternum paddle.

4. Press CHARGE on the APEX handle and when the Cardio-Aid® displays "ready" press both Shock keys till the shock is delivered.

5. Check on the QA45 that the delay did not exceed 60mS.

7.10 External Paddles test.

7.10.1 Discharge in open air.

1. Hold the paddles in the air.

2. Select 5J and Charge

3. Attempt to discharge and confirm it is not possible

   Display: "No patient contact"

4. Press "DISARM" on the Cardio-Aid®

7.10.2 Defi tester.

Deliver a shock of 50J into the built-in defi tester. The delivered energy is measured and displayed on the screen and on a printout (if selected in configuration menu). Confirm that the delivered energy is in accordance with the selected energy and that "PASS" is displayed as the result of the test. Approximate tolerance shown in table below.

7.10.3 Sound check.

1. Place the paddles on the QA 45

2. Select 2J and charge

3. Check that the sound is swept during the charge sequence and ends with a steady tone when the defibrillator is ready.

7.10.4 Defibrillator safety.

Note!   Make sure that both paddles are connected to the bulit-in defi tester or to an external energy meter (50 Ohm load).

1. Select 2J and charge

2. Press one Shock button and then the other (one at a time) and confirm that no energy is discharged. Press disarm.

7.10.5 Accuracy of delivered energy.

Select the listed energy levels and perform a discharge to the energy

meter. Confirm that the delivered energy is within the tolerances.

Note: Energy discharge shall be performed immediately after the defibrillator enters ready mode.

Selected energy	Measured energy	Tolerances
2J	2J	+-1J
5J	5J	+-2J
10J	10J	+-3J
20J	20J	+-3J
50J	50J	+-5J
80J	80J	+-7J
100J	100J	+-8J
200J	200J	+-15J
300J	300J	+-24J
360J	360J	+-30J

7.10.6 Defi Ready time-out.

1. Charge to 5J.

2. Check that the energy is available for 30 sec. +/-2 sec.

3. Check that the Cardio-Aid® automatically disarm.

7.10.7 Disarm.

1. Charge to 360J

2. When "Ready" is displayed press "Disarm"

3. Check that "Disarm" is displayed and a charge sequence can be restarted.

7.10.8 Max. charge time on mains supply.

1. Charge to 360J

2. Check the charge time does not exceed 7sec.

3. Discharge via the QA 45

7.10.9 Max. charge time on battery (@25deg.C).

1. Disconnect the power cord

2. Charge to 360J

3. Check the charge time does not exceed 7sec. (typically) with a fully charged battery.

4. Discharge via the QA 45

7.11 Internal paddles test.

1. Mount INTERNAL PADDLES on the Cardio-Aid®

2. Attach the Paddles to the QA 45

3. Select the energy by means of the energy selector behind the front cover

4. Use the action key on the right side of the display for controlling the charge and discharge sequence.

5. Select the listed energy levels and perform a discharge. Confirm that the delivered energy is within the tolerances.

Selected energy	Measured energy	Tolerances
1J	1J	+-1J
5J	5J	+-2J
8J	8J	+-3J
15J	15J	+-3J
30J	30J	+-4J
50J	50J	+-5J

7.12 Test of the SEMI Automatic function.

Note! This test can only be carried using a defib electrode adapter cable (CA282). See Cardio-Aid® directions for use, "Accessory and reorder information".

1. Connect the defib electrode cable to the Cardio-Aid®.

2. Connect the defi cable to the QA 45 using a suitable adapter (e.g. the connector from an old sets of pads can be used or CA190 / CA191 adaptor cable for manikin. See directions for use).

3. Connect an ECG cable to the QA 45, and select the Vfib waveform.

4. Select the SEMI AUTOMATIC MODE.

5. Check that the corresponding LED is on.

6. Check that the Cardio-Aid® displays "Analyse".

7. Press ANALYSE or await automatic analysis start.

8. Check that shockable rhythm is detected, that Cardio-Aid® starts charge to 200J and that the Cardio-Aid® prompts for activating shock.

9. Press SHOCK and check that the energy is delivered.

7.13 Printer test (optional).

7.13.1 Printer offset.
1. Connect the ECG cable to the QA 45 and select a sine wave of 10Hz/1mV (see QA45 manual page 20 §7- §9)

2. Make a print out and check that the trace is placed in the centre of the print out area +/-1mm.

7.13.2 Printer gain.
1. Set the ECG gain to x2

2. Make a print out and check the peak-to-peak amplitude to be 20mm. +/-1mm.

7.13.3 Serial number.
1. Press "Print" + "event" key to make a event report print out

2. Check that the unit's Serial Number appears on the event report print out.

7.14 Memory card, format and delete data.

See also 4.2.3 PCMCIA connector..

7.14.1 Delete data from memory card.
1. Select manual.

2. Select User menu.

3. Select memory card "delete" and confirm.

Message is "done".

7.14.2 Format the memory card.
1. Select manual.

2. Select User menu.

3. Select memory card "format" and confirm.

Message is "done".

Note! The Memory cards must conform with JEIDA 4.0 standard. If the memory card is formatted on PC with a PCMCIA slot, the format must be FAT12 to be compatible with Cardio-Aid$^{®}$.

7.15 Final check sheet.

Tests shall be performed following a replacment of a module or component in the unit. Test shall be also be performed every 12 month regardless of the actual usage of the Cardio-Aid$^®$.

Safety Test.

Subject	Min.	Test result	Max.	Units
Safety test	-		-	OK

Battery Test.

Subject	Min.	Test result	Max.	Units
Battery test	-		-	OK

Cable ECG amplifier.

Subject	Min.	Test result	Max.	Units
Noise zero line	-		1	Pixel
ECG Gain x2	19		21	mm peak to peak
HR read out 60bpm	58		62	bpm
QRS beep	-		-	OK
Volume function	-		-	OK
Alarm on	-		-	OK
Alarm off	-		-	OK
Inop	-		-	OK
VF Detector	-		-	OK
Lead P selection	-		-	OK
EXT. ECG selection	-		-	OK

Paddle ECG amplifier.

Subject	Min.	Test result	Max.	Units
Noise zero line	-		1	Pixel
ECG Gain x2	19		21	mm peak to peak
HR read out 60bpm	58		62	bpm
QRS beep	-		-	OK
Electrode"short"	-		-	OK
Electrode"open"	-		-	OK
Paddle ECG signal	-		-	OK

Defibrillator part.

Subject	Min.	Test result	Max.	Units
Sync mode	-		-	OK
Sync delay	0		60	MS

External Paddles.

Subject	Min.	Test result	Max.	Units
Discharge in open air	-		-	OK
Defi tester	-		-	OK
Sound check	-		-	OK
Defibrillator safety	-		-	OK
Accuracy of delivered energy:				
Energy 2 Joule	1		3	Joules
Energy 5 Joule	3		7	Joules
Energy 10 Joule	7		13	Joules
Energy 20 Joule	17		23	Joules
Energy 50 Joule	45		55	Joules
Energy 80 Joule	73		87	Joules
Energy 100 Joule	92		108	Joules
Energy 200 Joule	185		215	Joules
Energy 300 Joule	276		324	Joules
Energy 360 Joule	330		390	Joules
Defi ready time	28		32	Sec.
Disarm	-		-	OK
Max charge on mains supply	-		7	Sec.
Max charge time on battery	-		7	Sec.

Internal Paddles.

Subject	Min.	Test result	Max.	Units
Energy 1 Joule	0		2	Joules
Energy 5 Joule	3		7	Joules
Energy 8 Joule	5		11	Joules
Energy 15 Joule	12		18	Joules
Energy 30 Joule	26		34	Joules
Energy 50 Joule	45		55	Joules

Semi Automatic.

Subject	Min.	Test result	Max.	Units
Semi automatic mode	–		–	OK
Manual mode	–		–	OK

Recorder Option.

Subject	Min.	Test result	Max.	Units
Recorder offset	–1		+1	mm
Recorder gain	19		21	mm peak to peak
Serial number	–		–	OK

Memory Card.

Subject	Min.	Test result	Max.	Units
Memory card	–		–	OK

Intentionally blank

Chapter 8 – Maintenance.

Note!   IEC 1288-1 an international guide explains the application of defibrillators and IEC 1288-2 prescribes a maintenance scheme. A minimum maintenance program is required.

8.1   Operator's inspection after use.

8.1.1   Cleaning.

The defibrillator may be cleaned with a slightly damp cloth. Care should be taken to prevent liquid from entering the defibrillator. The unit and the patient cable should be cleaned with a non-aggressive solution. Particular care should be taken to clean the metal and insulating parts of the paddles using soapy water.

8.1.2   Visual checks.

1. Inspect the paddles- adult as well as pediatric- for damage. Clean or replace if necessary.

2. Inspect the cables, paddles or connectors for mechanical damage, and replace if necessary.

3. Inspect the text labels on the defibrillator. Are they intact and legible? Replace if necessary.

4. Inspect the accessories (e.g. electrode jelly, ECG cable, ECG electrodes, defib cables, gloves, recording paper) for damage and replace if necessary.

8.1.3   Functional test of paddle version.

1. Ensure the unit is connected to mains voltage.

2. Switch the defibrillator on.

3. Connect the paddles to a known ECG test signal.

4. Check that an ECG trace is shown.

5. Check that the Heart rate in the display correspond to the rate on the simulator.

6. Connect the ECG cable to the ECG input.

7. Connect the ECG leads to a known ECG test signal.

8. Check that an ECG trace is shown.

9. Check that the Heart rate in the display correspond to the rate on the simulator.

10. Activate the "Print" key and check the recorder print out of the ECG test signal.

11. Ensure the paddles are seated in the paddle holders.

12. Set the mode to "Manual" and select 360J via the Sternum paddle.

13. Press the charge button and await the "Ready" signal.

14. Press both "Discharge" buttons simultaneously.

Note! The built in test system will compare the selected energy to the actual energy measured during the discharge. The result is shown on the display and a receipt is printed. If a discrepancy is found an error message will appear.

8.1.4 Functional test of pads version.

1. Switch the defibrillator on

2. Connect the ECG cable to the ECG input

3. Connect the ECG leads to a known ECG test signal

4. Check that an ECG trace is shown

5. Check that the Heart rate in the display correspond to the rate on the simulator

6. Activate the "Print" key and check the recorder print out of the ECG test signal

7. Ensure the defi cable is connected to the test input in the left "Pads" holder

8. Set the mode to "Manual" and select 360J via the keyboard

9. Press the charge button and await the "Ready" signal

10. Press the "Discharge" button.

Note! The built in test system will compare the selected energy to the actual energy measured during the discharge. The result is shown on the display and a receipt is printed. If a discrepancy is found an error message will appear.

8.1.5 Pacer test.

1. Switch the Cardio-Aid$^\circledR$ on.

2. Connect the ECG leads to a known ECG test signal or use the build-in train mode to simulate the ECG signal.

3. Check that the ECG signal is shown.

4. Enter Pace-mode.

5. Adjust "pace rate" to 80 ppm and "pace current" to 80 mA

6. Ensure that the defi cable is connected to the test input in the left pads holder or to an external ECG/Pace tester.

7. Start pacing.

8. Check the ECG signal for capture (heart rate = pace rate), observe the ECG signal for pace-annotations (squared pulse and P-marker).

Note!   If a discrepancy is found an error message will appear.

8.2   Routine inspection.

8.2.1   Daily.
1. Check that the "Fault" led is off.

2. Check that the "Battery charge" led is lit when connected to mains.

3. Switch on the Cardio-Aid® and check that the self test is passed.

4. Check that the Battery symbol indicates a fully charged battery.

5. Switch off the unit.

8.2.2   Every two weeks.
Ask the operators if they have experienced any problems when using the defibrillator. If a written log-book is available, check for notes. Perform the above mentioned section 8.1 Operator's inspection after use.

8.2.3   Complete annual inspection.
1. Inspect the cables, paddles and connectors for wear and tear and replace if necessary.

2. Perform an electrical safety test of the unit.

3. Check the capacity of the battery according to the description in "Verification and test".

4. Perform a full calibration according to the description in Chapter 7 – Verification and Test..

5. Perform a final test according to the description in Chapter 7 – Verification and Test..

6. Enter date and initials in the "service menu" under "Service history".

Note!   IEC 1288-1 an international guide explains the application of defibrillators and IEC 1288-2 prescribes a maintenance scheme. A minimum maintenance program is required.

8.3   Updates and modifications.

Artema publishes updates and modifications effecting the Cardio-Aid® as Service News. Chapter 2 – Logbook. is provided to organize these.

The Service News provides detailed information about product improvements and correction, which should be implemented in the Cardio-Aid®. The Service News are graded according to rules put forward by the FDA and European Vigilance guide.

Following either a software or hardware change a complete annual service routine should be carried out.

8.4 Software updates.

New software releases are available as software/voice-prompts files on i.e. e-mail or floppy disk. These files are to be copied to the service kit memory card allowing service technicians, biomeds and technicians in hospitals to update software for the Cardio-Aid®.

To update the software See Chapter 7 – Verification and Test., 7.3 Service menu., 7.14 Memory card, format and delete data.

Thus the new software is installed in the Cardio-Aid®.

Full software update or partial software update is possible.

Full update is new Basic software, new Main software and new Voice-prompt software.

Partial update is one or two parts of a full update.

Software updates for the paddles ECG, cable ECG or defi/pace processor require replacement of the pre-programmed microprocessor component.

Prior to any software update take note of the present software versions using the Defi-test program or by looking into the Service Menu, where all software versions are listed. See Chapter 7 – Verification and Test., 7.3 Service menu..

8.5 Hardware changes.

Hardware modifications are generally restricted to board replacement and the exchange of a few large components.

Hardware corrections should be implemented, by highly skilled personal, only with the necessary tools and requirements for SMD technology.

Chapter 9 – Defi program.

9.1   Introduction.

The DEFITEST program is developed as a special tool for authorized service technicians. The program is intended for use during field service operation, fault analysis, adjustment and calibration of the Cardio-Aid® 200 defibrillator.

The DEFITEST program is distributed on a CD to be installed on a standard PC with Microsoft Windows.

The DEFITEST program will run on the PC. The PC is connected to the PC card connector in the Cardio-Aid® 200 Defibrillator with a serial PCMCIA PC card, a serial cable and optionally with a safety adaptor for galvanic isolation between the PC and the Cardio-Aid® 200.

Most test and necessary adjustments can be performed directly from the service menu in the Cardio-Aid® 200.

With the DEFITEST program additional tests, adjustments and set-up functions will be available and tests and adjustments can be automated. During replacement of the processor PCB or the Defi PCB the DEFITEST program can be used to read and store settings and calibration values on the PC. The values can be written back to the unit after replacement of the boards.

The DEFITEST program saves a log of all operations, tests and adjustments made with the defibrillator. The user can add comments and observations to the log. The log-file can be saved and printed from the PC.

When the DEFITEST program is started the user has to sign in. A user can sign in as a normal user or as administrator.

If signed in as a normal user the following functions are available:

1. Activation of all manual tests

2. Calibration (ECG Impedance, Defibrillator, Internal defib. Tester, Pacer)

3. Reading the service log and error log from the defibrillator

4. Reading the configuration values and service statistics

5. Reading the software versions and serial numbers

6. Adjustment of the clock in the defibrillator

7. Reading of ECG data to the PC as comma separated file.

If signed in as administrator the following additional functions are available:

1. Changing configuration values and down loading of the same configuration values from a file on the PC to several Cardio-Aid® 200 defibrillators.

2. Run automated test/commands from a script-file.

3. Change serial numbers

4. Delete the error log, shock statistic and operation timer

5. Remote controls all function in the Cardio-Aid® 200.

6. Write directly to memory and I/O ports for fault diagnosis.

9.2 Equipment needed.

You will need the following items to use the DEFITEST program:

1. A standard PC.

2. The DEFITEST program will run on a PC with Microsoft Windows 95/98 or 2000.

3. The PC must have a spare serial communication port. We recommend that the PC include a PCMCIA PC card interface. This will be needed during software upgrade of the Cardio-Aid® 200.

4. Service kit. See chapter 10.6 Accessories.. The service kit contains: a standard NULL-modem serial cable and a PCMCIA serial card.

Optionally a safety adaptor for galvanic isolation between the PC and the Cardio-Aid® 200.
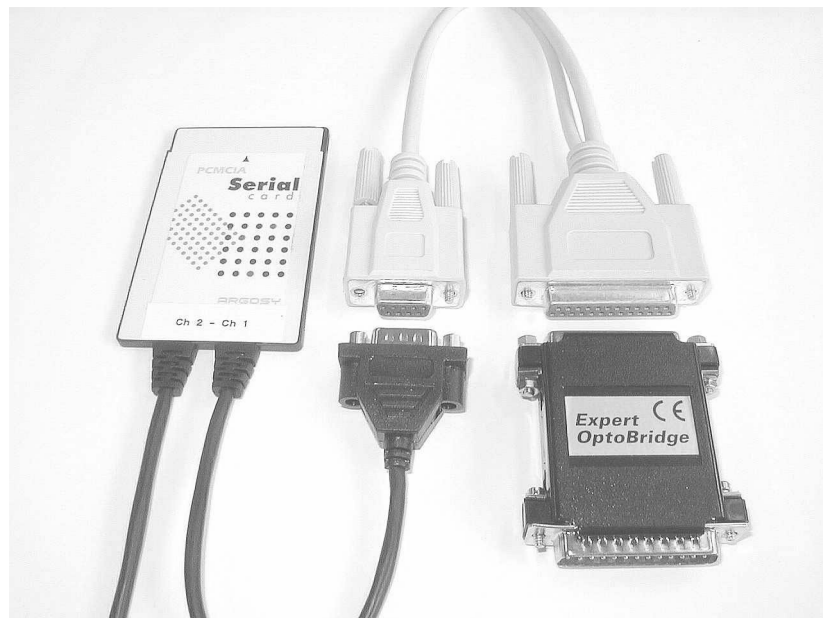
Service Kit.

9.3   Installation.

On the CD-Rom you can find a standard set-up. Use setup.exe to start the installation. (The generated installation set-up applies the Install Shield generation of an install package, which should be familiar to most users).

Follow the guides and accept all default values and you will finish installation with the defitest.exe installed on the "Program Files\Artema\Remote test" path.

The file defitest.ini holds default values to the program. If needed, change settings to match your PC hardware. E.g. change the port number [COM1 or COM2].

The program is available in different language variants. UK English is the standard.

Example of the defitest.ini file:

[Option]
ResourceDll=DefiUK.DLL

[Communication]
Port=COM1
Protocol=BINAR
ProductName=ACE
ScriptCmdDelay=0

9.4   Setting up the equipment.

Before use! Make sure the Cardio-Aid® 200 is turned off.

Insert the serial PC card into the PC card connector on the Cardio-Aid® 200.

Connect the serial cable and the safety adaptor between the serial PC card in the Cardio-Aid® 200 and the selected serial port on the PC.

Turn on the Cardio-Aid® 200

Enter the configuration and service menu by activating the MENU key when the self test picture is displayed.

Use the MENU UP/DOWN keys to select "Remote control..." in the service menu.

Now the Cardio-Aid® 200 is in remote control mode.

Start the DEFITEST program on the PC. The program can be found in the folder "Remote test".

The program will start with the sign in screen.

Enter service organization and your initials. This information is used to update the service log in the Cardio-Aid® 200 and as identification in the log file on the PC.

Accept with OK and the DEFITEST program will start as a normal user.

As normal user it is only possible to activate the self-tests and to read settings from the Cardio-Aid® 200.

If you have been on the certified training course, you have received a password needed to sign in as administrator.

As administrator you have access to write information to the Cardio-Aid® 200 and control the defibrillator remotely.
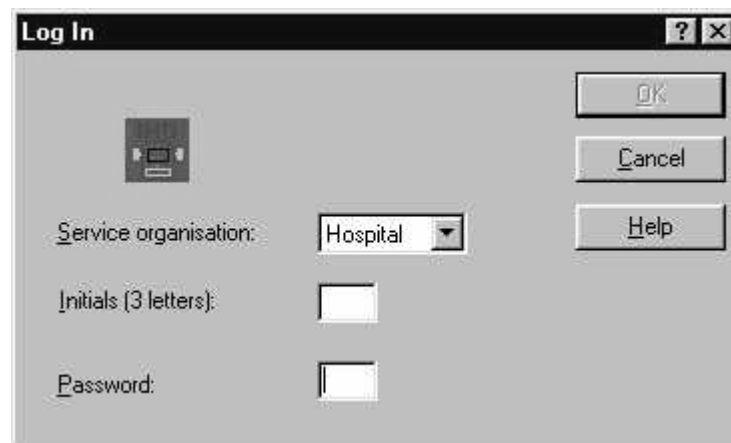
The DEFITEST program will now try to communicate with the Cardio-Aid® 200.

An error message is displayed if communication fails.

Accept with OK and check if cables are connected properly.

You can also change the communication port under the menu item File and COM port.

If the communication with the Cardio-Aid® 200 is OK, the DEFITEST program will show the activity log on the screen. It is now possible to send a range of commands to the Cardio-Aid® 200 from the menu items Calibration, Test and Defi info.
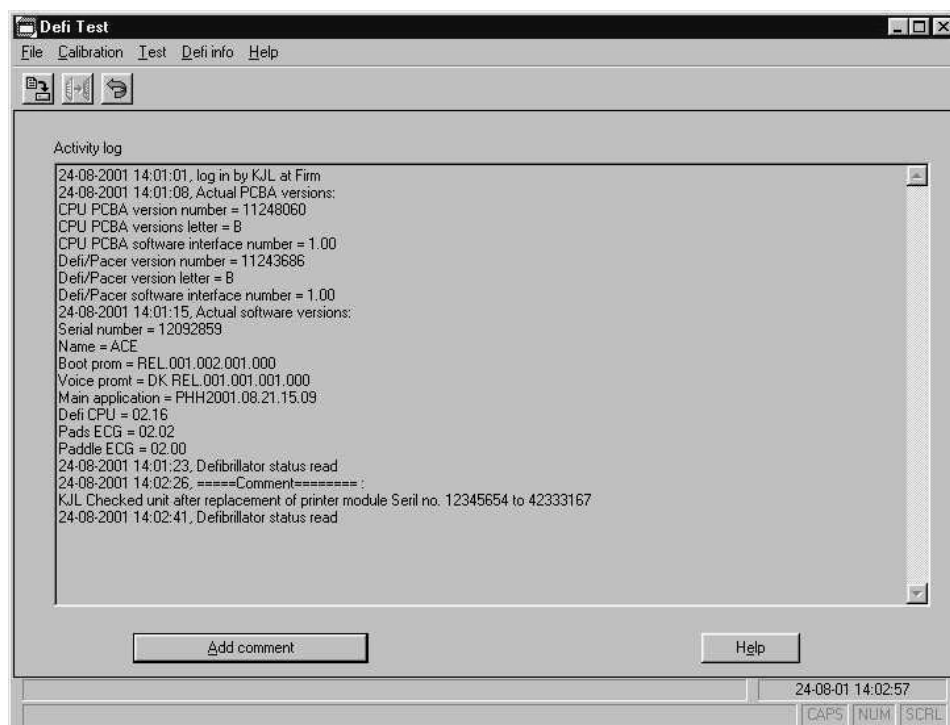
During the use of the DEFITEST program a user can add comments and observation to the activity log file on the PC. The activity log can be saved as a text file on the PC under the menu item File and Save activity log.

The activity file is saved with the name Activity.log.

It is possible to save settings read from the Cardio-Aid® 200 to a file on the PC. This file can be loaded back to the Cardio-Aid® 200. The same settings can be loaded to several Cardio-Aid® 200 if the same settings are needed for the whole hospital. Settings are saved under the menu item File, Download/upload and Configuration. The file is saved under the name DefiCon.con.

Example:

[General]
MemoryCard=Enable
AutoPowerOff=Enable
WakeUpTest=Enable
Language=S
Mainsfreq=50
WakeUpTime=13:00

[Volume]
Qrs=1
Sound=1
Voice=1

[AlarmLimit]
High=140
Low=40

[Display]
UserID=Artema AB
RTCFormat=24 hour
ShowElapsedTime=Disable
ShowShockCount=Disable

[Printer]
AutoEventReport=Enable
PrinterAutoStart=Enable
DefiTestResult=Enable
PrintTime=15

[Defibrillation]
Mode=Semi Auto

[DefiSemiAuto]
Protocol=AHA
FirstShock=200
SecondShock=360
ThirdShock=360

[DefiManual]
latchingSync=Enable
internalPaddels=50
ExternalPaddels=200
EnergySelectOn=Pad/Paddles

[ECG]
Gain=x1
Lead=II
ExtSyncGain=x1000

It is possible to save the service statistic read from the Cardio-Aid® 200 to a file on the PC. The service statistic is saved under the menu item File, Down-

load/upload and Service statistics. The file is saved under the name DefiStat.sta.

Example:

[General]
Serialno=12083557

[ServiceLog]
Entry1=21-05-2000 11:27:10,JEN,HOSPITAL
Entry2=24-09-2000 20:19:52,ADM,HOSPITAL
Entry3=02-10-2000 12:57:20,KJL,FACTORY

[ErrorLog]
Entry1=18-09-2000 11:48:15,267,ERROR
Entry2=18-09-2000 11:54:42,258,ERROR
Entry3=18-09-2000 11:54:43,267,ERROR
Entry4=18-09-2000 11:55:15,258,ERROR
Entry5=18-09-2000 11:55:16,267,ERROR
Entry6=25-09-2000 14:58:07,261,ERROR
Entry7=25-09-2000 16:10:51,254,ERROR
Entry8=25-09-2000 18:19:30,320,WARNING
Entry9=25-09-2000 19:46:18,261,ERROR
Entry10=02-10-2000 11:52:25,254,ERROR

[EnergyLog]
1J=0
2J=3
3J=0
4J=0
5J=1
6J=0
7J=5
8J=0
9J=3
10J=11
15J=0
20J=5
30J=4
40J=5
50J=7
60J=3
80J=2312
100J=5
150J=271
200J=72
300J=6
360J=43

[OperationTime]
Time=00002:14:17.

Note! The service log will only hold the last 3 service events. Older events are over-written.

9.5 Defitest Help program.

To assist the user of the Defitest program a help program has been attached and bound to the program.

The help system is context sensitive. In the different menus a button marked with "?" can be pressed. Then press the expression or field you would like to get more information about and the help system will show you appropriate information.

You can also use F1 to activate the Contents page of the Help.

The help system includes guidance and pictures to support the users and to make sure all the capabilities are exploited by the user.

9.6 Reporting a failure or call for service.

When you are about to report a failure or call for service please make sure you record all pertinent and relevant information to help our internal service to analyze the symptoms and the cause of failure.

The DefiTest program makes this easy for you.

From the program you can save:

Activity.log
DefiStat.sta
DefiCon.con

These three logs contain all the important information about the unit.

9.7 Verification.

If you have used your password and allowed yourself to download new set-tings you should go back to the unit and verify the settings in the Configura-tion menu as final safety measure before you release the product for normal use.

Warning! In particular you should inspect the impedance calibration and the energy calibration and default settings.

See Chapter 7 – Verification and Test. for details.

Chapter 10 – Spare parts.

Spare part overview.
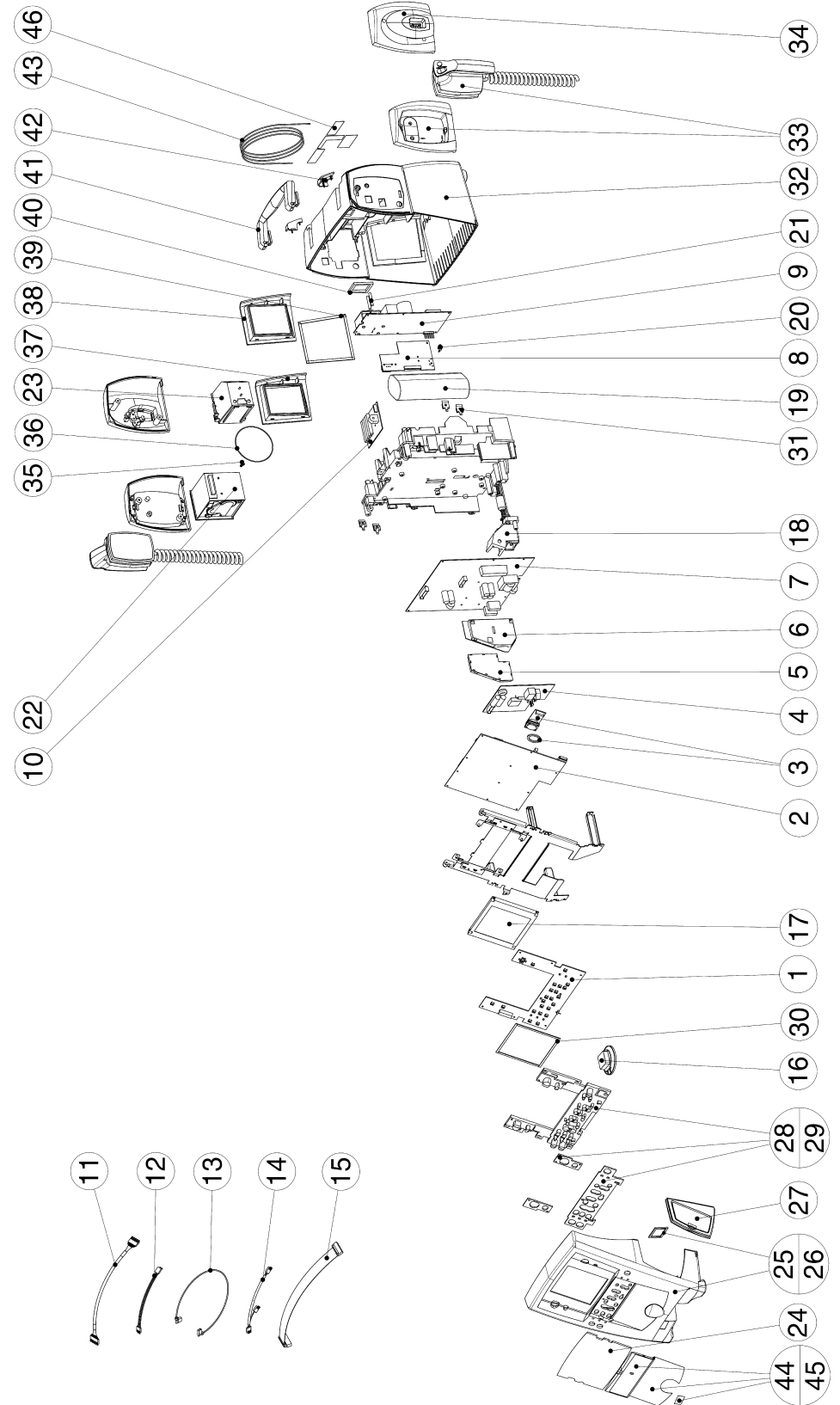
10.1 Printed Circuit boards.

Printed circuit boards are shown as placed in the Cardio-Aid®

For replacing, see Chapter 5 – Dismantling & re-assembly..
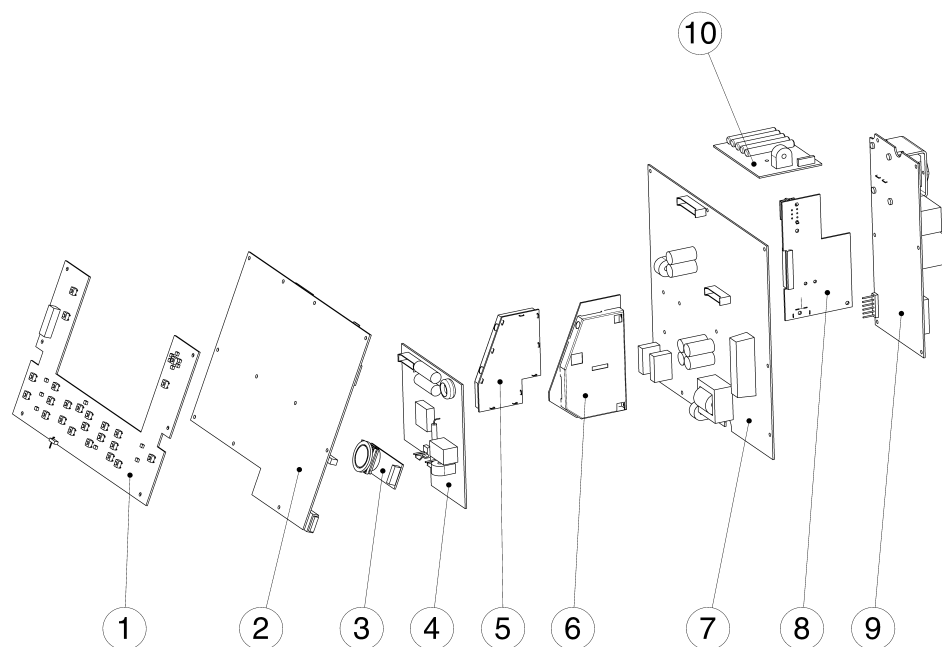
P/N	Description	Pos. no.
70409-0	KEYBOARD BOARD	1
70406-6	PROCESSOR BOARD	2
70492-6	ECG CONN. BOARD	3
70498-3	PACER BOARD (optional)	4
70403-3	ECG PADDLE BOARD	5
70404-1	ECG CABLE BOARD	6
70405-8	DEFI BOARD	7
70407-4	PRINTER/BATTERY CONNECTION BOARD	8
70410-8	POWER BOARD	9
70408-2	DEFI TEST BOARD	10

10.2 Cables.

See also Chapter 4 – Interconnections..
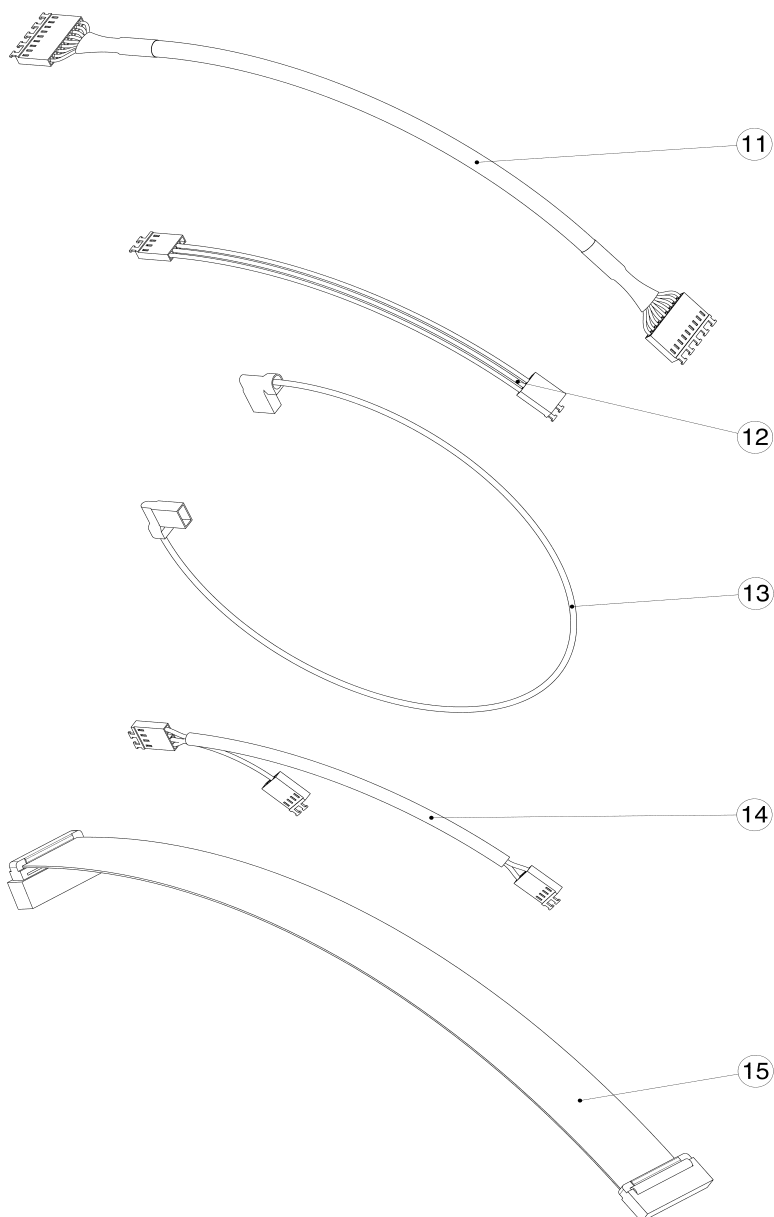
P/N	Description	Pos. no.
70479-3	Processor board to Printer/battery board	11
70480-1	Defi board to Defi Test board	12
20470-3	Cable test connector R2	13
20620-8	Processor board to ECG connector board	14
70482-7	Front cover to Processor board (keyboard extension)	15

10.3 Electrical components.

Spare parts shown without pos. no. in this illustration can be found in section 10.4 Mechanical items..
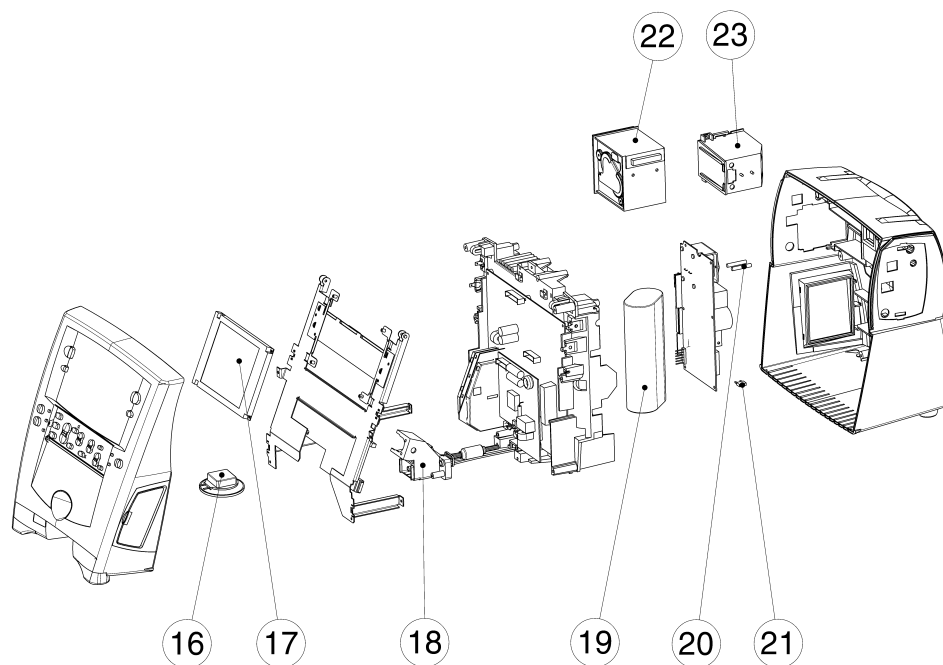
P/N	Description	Pos. no.
70432-2	Loudspeaker with cable	16
70431-4	Display LCD kit	17
70489-2	HV/ECG bracket	18
70433-0	HV capacitor, 45uF, 4.6KV with strap	19
70434-8	Fuse for printer connection board (5 pcs.)	20
48301-3	Main Fuse 5X20 2A HBCT	21
70477-4	Printer and necessary parts for installation	22
20417-1	Battery pack	23

10.4 Mechanical items.
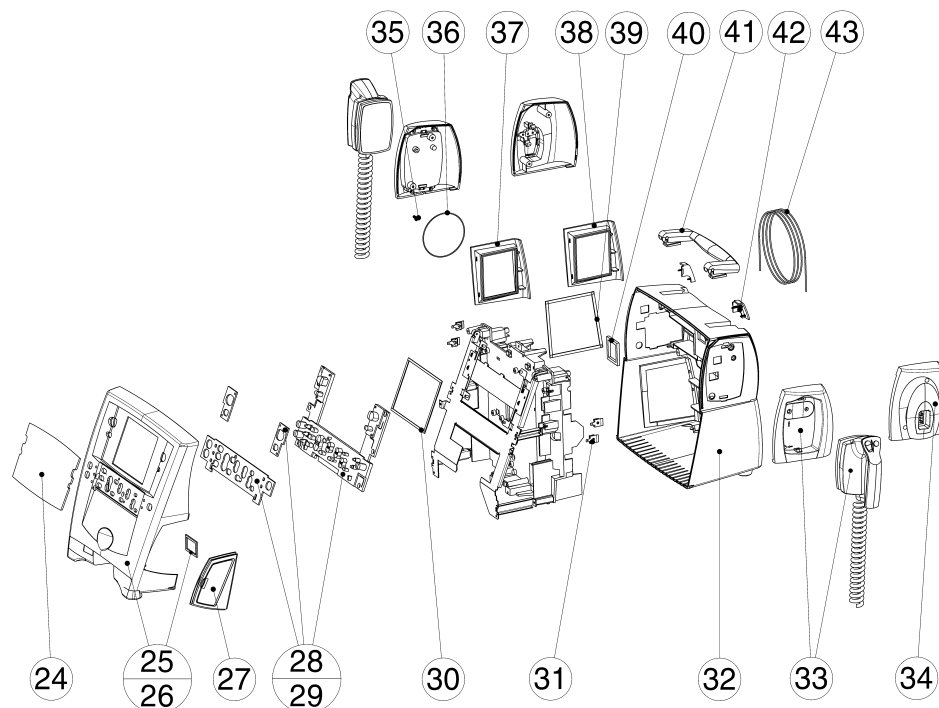
P/N	Description	Pos. no.
70417-3	Display window	24
70413-2	Front part complete with key mat and without pacer	25
70412-4	Front part complete with key mat and pacer	26
70418-1	Memory slot kit	27
70416-5	Key mat complete without pacer	28
70415-7	Key mat complete with pacer	29
70429-8	Window dust gasket	30
70428-0	Test contact (4 pcs.)	31
70411-6	Rear part casting complete	32
25523-5	Paddles holder	33
25522-7	Pads holder	34
70427-2	Spring for recorder	35
70423-1	Printer cover seal	36
70422-3	Printer bezel moulding	37
70421-5	Printer bezel dummy moulding	38
70425-6	Printer bezel seal	39
70424-9	Power supply aperture gasket	40
70414-0	Comp. handle with pivot	41
70430-6	Bed hook cover (left and right)	42
70426-4	Silicone packing (1,65 m)	43

10.5 Labels.

The front- and rear part can only be acquired without labels. Labels can be acquired in different languages. See the table later in this chapter.

10.5.1 Front part labels.

Front part labels shown with Pacer option (pos. no. 44).
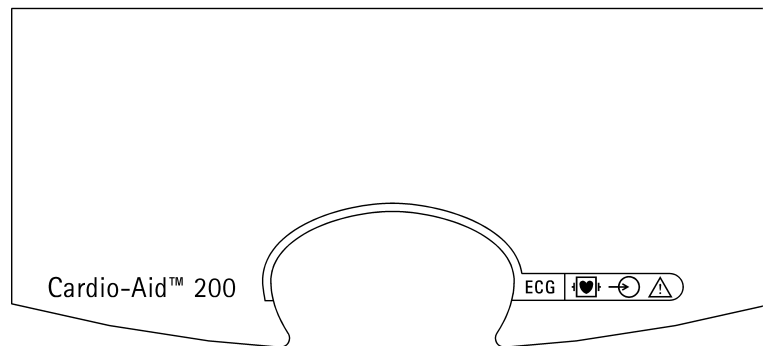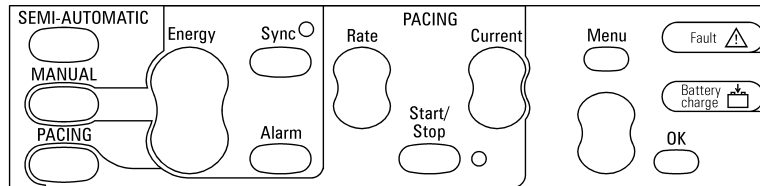
Keyboard cover (flap) labels shown with Pacer option (pos. no. 45).
The labels comes mounted on a keyboard cover.
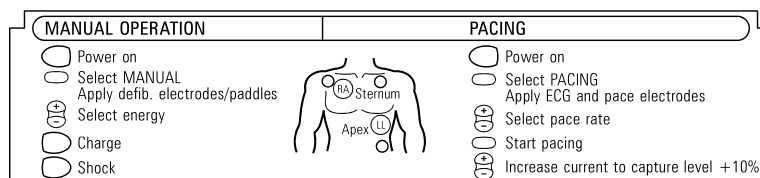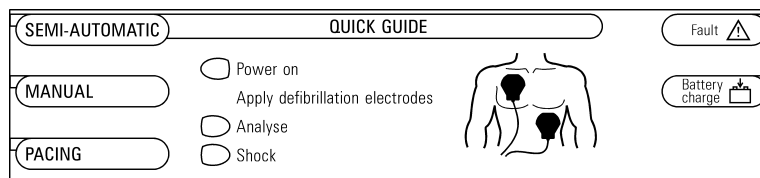
10.5.2 Rear part label kit.

Rear part label kit is used with or without Pacer. (Pos. no. 46).

| DANGER!
Possible explosion hazard if used in
the presence of concentrated oxygen. | Made in Denmark by Artema MEC A/S
Cardio-Aid™ 200

100-240V~
50/60Hz 270W
2xT 2AH 250V~

CE 0123

IP 22

SN: | CAUTION!
HAZARDOUS ELECTRICAL OUTPUT
This equipment is for use only by qualified personnel.
Do not touch patient during defibrillation.
Read and comply with directions for use. |

Class 1 / Internally powered equipment

To charge the internal battery:
Connect the power cord to a mains outlet.
The Battery charge ( ) lamp lights green
when the battery is fully charged.

CAUTION: ELECTRIC SHOCK HAZARD
Do not remove cover.
Refer servicing to qualified service personnel.

10.5.3 List of all available labels.

Front part label kit includes keyboard cover (flap) with labels mounted.
Front part label kit must be ordered with or without Pacer.

Language	Complete front part label kit. With Pacer option Pos. no. 44	Complete front part label kit. Without Pacer option Pos. no. 45	Complete rear part label kit. Pos. no. 46
GB, English	70436-3	70437-1	70435-5
D, German	70439-7	70440-5	70438-9
N, Norwegian	70442-1	70443-9	70441-3
S, Swedish	70445-4	70446-2	70444-7
DK, Danish	70448-8	70449-6	70447-0
PL, Polish	70451-2	70452-0	70450-4
F, Franchise	70454-6	70455-3	70453-8
P, Portuguese	70457-9	70458-7	70456-1
I, Italian	70460-3	70461-1	70459-5
E, Spanish	70463-7	70464-5	70462-9
NL, Dutch	70466-0	70467-8	70465-2
TR, Turkish	70469-4	70470-2	70468-6
RU, Russian	70472-8	70473-6	70471-0
SF, Finnish	70475-1	70476-9	70474-4

10.6 Accessories.

10.6.1 Accessory and reorder information.

See Cardio-Aid$^®$ 200, Directions For Use.

Chapter 11 – Service News.

Artema Service News can be placed in this section.

Chapter 12 – Index