

Cardiolab[®] II Plus Amplifier Manual

Service Manual

2002938-002

Revision E



GE Medical Systems
Information Technologies

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CE Marking Information



Compliance

The CardioLab II Plus Amplifier bears CE mark CE-0459 indicating its conformity with the provisions of the Council Directive 93/42/EEC concerning medical devices and fulfills the essential requirements of Annex I of this directive.

For devices manufactured in the United States, the CE mark is applied under the authority of Notified Body GMED (0459).

The country of manufacture and appropriate Notified Body can be found on the equipment labeling.

The safety and effectiveness of this device has been verified against previously distributed devices. Although all standards applicable to presently marketed devices may not be appropriate for prior devices (i.e. electromagnetic compatibility standards), this device will not impair the safe and effective use of those previously distributed devices.

The CardioLab II meets the requirements of EN60601-1-2 (1993-04) Medical Electrical Equipment, Part 1: General Requirements for Safety, 2. Collateral Standard: Electromagnetic compatibility - Requirements and tests.

Exception

ECG Parameter

IEC601-1-2 clause 36.202.1 - Immunity: Radiated Immunity –

The level of compliance is less than 1V/m

If operating under the conditions defined in EMC Standard EN60601-1-2 (Radiated Immunity 3V/m), field strengths less than 1V/m may cause waveform distortions and erroneous numeric data at various electromagnetic interference (EMI) frequencies.

Recommendations: –

Review the AAMI EMC Committee technical information report (TIR-18) titled Guidance on electromagnetic compatibility of medical devices for clinical / biomedical engineers - Part 1: Radiated radio-frequency

electromagnetic energy. This TIR provides a means to evaluate and manage the EMI environment in the hospital.

The following actions can be taken:

- managing (increasing) distance between sources of EMI and susceptible devices
- managing (removing) devices that are highly susceptible to EMI
- lower power from internal EMI sources under hospital control (i.e. paging systems)
- labeling devices susceptible to EMI
- educating staff (nurses and doctors) to be aware of, and to recognize, potential EMI related problems

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1 Introduction

Introduction

Revision History

Each page of the document has the document part number and revision letter at the bottom of the page. The revision letter identifies the document's update level.

The revision history of this document is summarized in the table below.

Revision History PN 2002938-002		
A	June 21, 2000	Initial Release of the manual.
B	15 November 2000	Release B of this manual.
C	October 9, 2001	Release C with minor editorial updates.
D	21 July 2006	Revised document.
E	11 December 2007	Updated per GEHmk15561

Manual Purpose

This manual contains the instructions necessary to service the CardioLab II Plus Amplifier safely in accordance with its function and intended use. These instructions include but are not limited to:

- Describing fundamental controls and indicators.
- Operating procedures.
- Connecting and disconnecting detachable parts and accessories.
- Troubleshooting and service procedures.

Intended Audience

This manual is intended for the person who maintains and troubleshoots this equipment.

Intended Use

The CardioLab II Plus Amplifier is intended for use in an electrophysiological catheter laboratory or catheterization laboratory where ECG, direct cardiac, intracardiac and pressure signals need to be recorded from a patient. This device is intended for use under the direct supervision of a licensed health care practitioner.

Chapter Content

This manual is organized into the following chapters:

- **1. Introduction:** Describes the manual contents and provides general information about safety precautions, service requirements, equipment symbols and serial number identification.
- **2. Equipment Overview:** Gives a description of the equipment and components.
- **3. Operation:** Describes how to connect and disconnect cables to the amplifier and provides a list of related user's manuals and update guides. Describes the stimulator bypass connections for emergency pacing.
- **Appendix A: Maintenance and Troubleshooting:** Describes how to maintain the equipment and keep it in good working order with a recommended maintenance schedule, cleaning guidelines, checkout procedure, and safety tests.
- **Appendix B: Technical Information:** Provides a complete table of technical specifications for the CardioLab II Plus Amplifier.

Related Manuals

Below are a list of the related manuals.

Part Number	Document
2027332-100	Mac-Lab Operator's Manual
2027332-101	Cardiolab Operator's Manual
2027332-102	Centricity Cardiology INW Operator's Manual
2027332-103	Mac-Lab/Cardiolab System Security Guide

Part Number	Document
2027332-107	Mac-Lab/Cardiolab System Installation Manual
2027332-109	Mac-Lab/Cardiolab System Service Manual

Manual Conventions

Hardware and Software Terms

The following is a list of conventions used throughout the text of the manual:

- Hardware items shown in **Bold** text are keys on the keyboard.
- *Italicized* items are software terms that identify menu items or options in various windows.

Safety Information

Safety Messages

The terms danger, warning, and caution are used throughout this manual to point out hazards and to designate a degree or level or seriousness. Familiarize yourself with their definitions and significance.

Hazard is defined as a source of potential injury to a person.

DANGER
DEATH OR SERIOUS INJURY — A message which indicates an imminent hazard which, if not avoided, will result in death or serious personal injury or product/property damage.

WARNING
POTENTIAL DEATH OR SERIOUS INJURY — A message which indicates a potential hazard or unsafe practice which, if not avoided, could result in death or serious personal injury or product/property damage.

CAUTION

MINOR INJURY OR DATA LOSS — A message which indicates a potential hazard or unsafe practice which, if not avoided, could result in minor personal injury or product/property damage.

NOTE

A message which provides application tips or other useful information to assure that you get the most from your equipment.

Manufacturer Responsibility

GE Medical Systems Information Technologies is responsible for the effects of safety, reliability, and performance only if:

- Installation operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE Medical Systems Information Technologies.
- The equipment is used in accordance with the instructions for use.
- The user attaches only accessory equipment recommended for interaction with the amplifier.

General

The CardioLab II Plus Amplifier maintains leakage currents below medical limits with an isolation transformer, which is incorporated into the design of the amplifier. Amplifier power should be supplied by a dedicated power supply on an isolated circuit for proper behavior of the amplifier.

To ensure patient safety, use only parts and accessories manufactured or recommended by GE Medical Systems - Information Technologies.

This equipment should only be connected as specified by GE Medical Systems - Information Technologies. Installation of the equipment should only be performed by qualified GE Medical Systems - Information Technologies service representatives.

Contact GE Medical Systems - Information Technologies before connecting any device to equipment that is not recommended in this manual. Only cables and accessory equipment purchased from GE Medical Systems - Information Technologies should be used in conjunction with the amplifier.

It is important that all of the instructions in this manual be followed, however, these instructions in no way supersede current medical practices regarding patient care and safety.

Parts and accessories used must meet the requirements of the applicable IEC 601 series safety standards, and/or the system configuration must meet the requirements of the IEC 601-1-1 medical electrical systems standard.

Refer servicing of amplifiers under warranty to GE Medical Systems - Information Technologies authorized service personnel. Any attempt to repair equipment under warranty will void that warranty. It is the responsibility of users of systems needing service to contact GE Medical Systems - Information Technologies for servicing of the equipment.

Failure on the part of responsible individuals or institutions to implement a satisfactory equipment maintenance schedule may lead to undue equipment failure and possible health hazards.

The use of ACCESSORY equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the PATIENT VICINITY; and
- evidence that the safety certification of the ACCESSORY has been performed in accordance to the appropriate IEC 601-1 and/or IEC 601-1-1 harmonized national standard.

The CardioLab II Plus Amplifier is a component/accessory of a Class II medical device.

Electromagnetic Interference

Interference with the operation or signal integrity of this equipment is unlikely as a result of proximity to general equipment. The user should understand that the use of some electrosurgical equipment and medical generators may cause some level of interference of the amplifier.

Users should be aware of known RF sources, such as radio or TV stations and hand-held mobile two-way radios, and consider them when installing a medical device or system.

Be aware that adding accessories or components, or modifying the medical device or system, may degrade the EMI performance. Consult with qualified personnel regarding changes to the system configuration.

The CardioLab II meets the requirements of EN60601-1-2 (1993-04) Medical Electrical Equipment, Part 1: General Requirements for Safety,

2. Collateral Standard: Electromagnetic compatibility - Requirements and tests.

Exception

ECG Parameter

IEC601-1-2 clause 36.202.1 - Immunity: Radiated Immunity –

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Recommendations:

Review the AAMI EMC Committee technical information report (TIR-18) titled Guidance on electromagnetic compatibility of medical devices for clinical / biomedical engineers - Part 1: Radiated radio-frequency electromagnetic energy. This TIR provides a means to evaluate and manage the EMI environment in the hospital.

The following actions can be taken:

- managing (increasing) distance between sources of EMI and susceptible devices
- managing (removing) devices that are highly susceptible to EMI
- lower power from internal EMI sources under hospital control (i.e. paging systems)
- labeling devices susceptible to EMI
- educating staff (nurses and doctors) to be aware of, and to recognize, potential EMI related problems

Equipment Symbols



The following symbols appear on the equipment.

Attention:

Pay attention to the documents delivered with the equipment.

Type CF Equipment

Type CF equipment is specifically designed for applications where a conductive connection to the heart is directly established.

Type CF Equipment



Type CF equipment that is defibrillator proof.

Isolated (floating) applied part suitable for intentional external and internal application to the patient including direct cardiac application. “Paddles” outside the box indicate the applied part is defibrillator proof.

[Medical Standard Definition:] F-type applied part (floating/isolated) complying with the specified requirements of IEC 60601-1/UL 2601-1/CSA 601.1. Medical Standards to provide a higher degree of protection against electric shock than that provided by BF applied parts.

Equipotentiality



A nonessential electrical connection which may be used to connect the chassis to other equipment to achieve the same potential.

Classifications

The CardioLab II Plus Amplifier is classified, according to IEC-60601-1, as:

Type of protection against electrical shock	I
Degree of protection against electrical shock	CF—ECG, BP, CIM, Auxiliary Inputs
Degree of protection against harmful ingress of water	Ordinary
Degree of safety of application in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide	Not suitable
Method(s) of sterilization or disinfection recommended by the manufacturer	Not Applicable
Mode of operation	Continuous operation

I: Class I equipment

CF: Type CF applied part

Ordinary: Ordinary equipment (enclosed equipment without protection against ingress of water)

Not Suitable: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide

Underwriters Laboratories Inc. (UL)

Underwriters Laboratories, Inc.



Classified by Underwriters Laboratories Inc. with respect to electric shock, fire, mechanical and other specified hazards, only in accordance with UL 2601-1, CAN/CSA C22.2 No. 601.1, IEC 60601-1, and, if required, IEC 60601-2-27, IEC 60601-2-30, IEC 60601-2-34, IEC 60601-1-1.

Equipment Safety

The safety statements presented in this chapter refer to the equipment in general and, in most cases, apply to all aspects of the product.

The order in which safety statements are presented in no way implies order of importance.

Dangers, Warnings, and Cautions

There are no dangers that refer to the equipment in general. Specific Danger statements may be given in the respective sections of this manual.

DANGER

EXPLOSION — Do not use in the presence of flammable anesthetics or other flammable gases.

WARNING

EQUIPMENT DAMAGE — Only connect UL 544 or UL 2601-1 listed or IEC certified medical equipment.

If fluid of any kind that should leak into the system, discontinue use of the equipment and contact GE Medical Systems Information Technologies immediately.

Do not allow any foreign materials such as fluids to come in contact with the CardioLab II Plus Amplifier.

WARNING

ELECTRICAL SHOCK — DO NOT allow hydraulic fluid from any device to contact any conductive surface. Hydraulic fluid is electrically conductive.

An electrical shock hazard exists between chassis ground and isolated (floating) ground when power is applied. Unplug the unit from the power source before proceeding.

To reduce the risk of electric shock or damage to your equipment, do not disable the power cord grounding feature. This equipment is designed for connection to a earth grounded power outlet. The grounding plug is an important safety feature.

WARNING

ELECTRICAL SHOCK — To reduce the risk of electric shock, DO NOT remove cover or back. This equipment contains no user serviceable parts. Refer servicing to qualified service personnel.

WARNING

BACK-UP MONITORING — Back-up patient monitors should always be available when using the equipment.

WARNING

CONDUCTION HAZARD — Keep the conductive parts of lead electrodes and associated parts away from other conducting parts, including earth.

WARNING

CONDUCTIVE CONNECTIONS — Proper connections to the patient are critical for the proper operation of the CardioLab II Plus Amplifier and patient safety. Use extreme caution when making patient connections.

Do NOT connect non-isolated equipment to the amplifier.

Proper connections to the stimulator are critical for the proper operation of the CardioLab II Plus Amplifier and patient safety. Use extreme caution when making stimulator connections. The stimulator must be a IEC 601-1 certified product

Ablation operations should NOT be executed when a stimulator unit is connected.

WARNING

DEFIBRILLATOR PRECAUTIONS — DO NOT contact the system or patient during defibrillation.

Standby defibrillation equipment is required in the event that the patient needs to be cardioverted or defibrillated.

WARNING

PATIENT/EQUIPMENT SAFETY — The system should be tested yearly for adequate grounding on patient leakage current.

Total system earth leakage current must not exceed 50 microamperes.

When more than two electrical devices are interconnected, the summation of leakage currents must be checked before use and rechecked yearly.

WARNING

IEC — All equipment not complying with IEC 601-1 should be placed outside the patient environment.

WARNING

MAINTENANCE — Use only Catheter Input Module (CIM) #301-00202-08 or #30100203-08 with the CardioLab II Plus Amplifier.

Check the electrical integrity of the signal connections in the catheter input modules and cabling yearly.

WARNING

POWER SUPPLY — Connect the system to a power outlet equipped with emergency power.

The supply line must be fused and capable of delivering 20A.

Route the AC power cable away from moving parts.

Connect only to a properly earth grounded outlet.

WARNING

REPLACEMENT PARTS — Replace only with the same type and rating of fuse.

WARNING

INDICATIONS OF USE — This device is intended for use under the direct supervision of a licensed health care practitioner.

CAUTION

RESTRICTED SALE — Federal USA law restricts this device to sale by or on the order of a physician.

CAUTION

DATA ACCURACY — DO NOT display any channels which are based on unused catheter input modules.

Erroneous values may occur if unused catheter inputs are not properly connected.

CAUTION

CABLING — Route optical cables through conduit in the ceiling or floor to avoid damage to the cables of cable connectors.

CAUTION

TRANSDUCER — Remove air that is trapped in the transducer or associated tubing by flushing the system according to cath lab procedures.

Pressure channels should be calibrated to a known pressure value if the pressure value is in question.

CAUTION

DEFIBRILLATOR PRECAUTIONS — ECG inputs are protected against the use of a defibrillator in conjunction with the use of the ECG cable.

The pressure inputs on the CardioLab II Plus Amplifier are protected against the use of a defibrillator in conjunction with the use of the recommended pressure transducer and reusable cable.

CAUTION

POWER SUPPLY — The CardioLab II Plus Amplifier may be safely powered by line voltages of 100-240 VAC with frequencies of 50-60 Hz.

Service Information

Service Requirements

Follow the service requirements listed below:

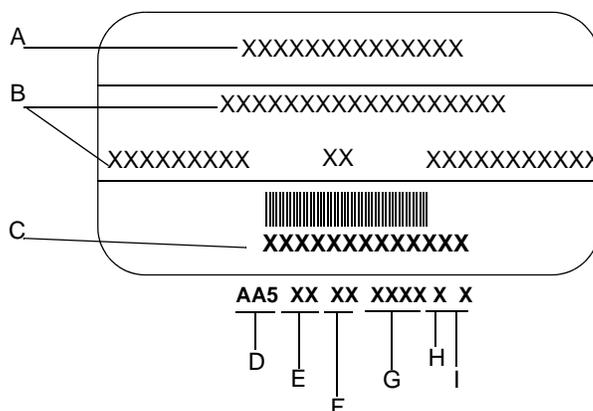
- Refer equipment servicing to GE Medical Systems - Information Technologies authorized service personnel only.
- Any unauthorized attempt to repair equipment under warranty voids that warranty.

- It is the user's responsibility to report the need for service to GE Medical Systems - Information Technologies or to one of their authorized agents.
- Failure on the part of the responsible individual, hospital, or institution using this equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.
- Regular maintenance, irrespective of usage, is essential to ensure that the CardioLab II Plus Amplifier will always be functional when required

Equipment Identification

Every GE Medical Systems - Information Technologies device has a unique serial number for identification. The serial number appears on the back of the CardioLab II Plus Amplifier.

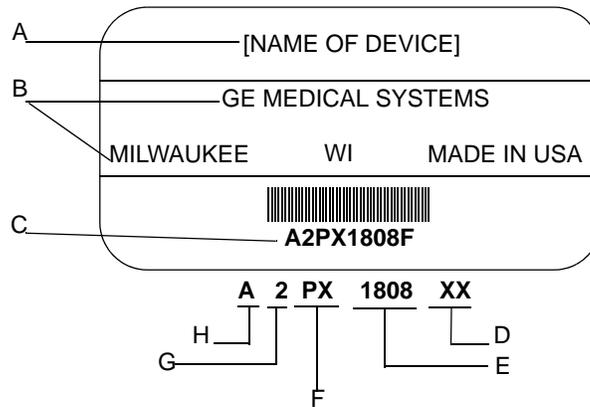
New Identification Tags



Identification Tags	
Item	Name
A	Name of Device
B	Manufacturer

Identification Tags	
Item	Name
C	Serial Number
D	3 digit product code
E	Year Manufactured
F	Fiscal Week
G	Product Sequence Number
H	Manufacturing Site
I	Misc.

Old Identification Tags



Identification Tag		
Item	Name	Description
A	Name of Device	CLABII Plus Amplifier
B	Manufacturer	GE Medical Systems <i>Information Technologies</i>
C	Serial Number	Unique Identifier

Identification Tag		
Item	Name	Description
D	Facility Code	F or G = Milwaukee, P = Bangalore, S = Border Ops (Juarez/El Paso)
E	Product Sequence Number	Manufacturing number of total units manufactured
F	Product Code	Two character product descriptor; XJ= CLAB II Plus Amplifier
G	Year Manufactured	9 = 1999, 0 = 2000 (and so on)
H	Month Manufactured	A = January, B = February, C = March, D = April, E = May, F = June, G = July, H = August, J = September, K = October, L = November, M = December

2 Equipment Overview

General Description

The CardioLab II Plus Amplifier is designed to amplify various types of cardiac signals that are acquired from a patient and transmit them back to the CardioLab/Mac-Lab system, referred to in this manual as the acquisition computer. These signals include 12 Lead ECG, intra-cardiac and pressure signals.

The CardioLab II Plus Amplifier is fully supported by CardioLab EP software versions 3.1 and above and CardioLab Cath software versions 1.0 and above. However, the CardioLab II Plus Amplifier was designed specifically for use with the CardioLab/Mac-Lab system. The following table lists the functionality of the CardioLab II Plus Amplifier with the different software versions.

Table 1. CardioLab II Plus Functionality for Different Versions of CardioLab Software		
CardioLab II Plus Functionality	CardioLab EP 3.1 and Above/CardioLab Cath 1.0 and Above	CardioLab/Mac-Lab System
Intracardiac	Blocks A and B Only	All Blocks Available
Stimulator	CardioLab II Amplifier Equivalent	Enhanced Switching Options
Auxiliary Input	Not Available	RF Filtered and Unipolar Inputs

The CardioLab II Plus Amplifier supports 32, 64, 96 and 128 channel configurations.

The following list illustrates the number of Catheter Input Modules (CIM) used with the four configurations of the CardioLab II Plus Amplifier:

- 32 Channels: 1 CIM
- 64 Channels: 3 CIMs
- 96 Channels: 5 CIMs
- 128 Channels: 7 CIMs

The Catheter Input Modules for the four configurations of the CardioLab II Plus Amplifier connect to the following catheter inputs on the front of the amplifier:

- 32 Channels: Input A
- 64 Channels: Inputs A-C
- 96 Channels: Inputs A-E
- 128 Channels: Inputs A-G

CardioLab II Plus Amplifier Hardware

Amplifier Part Numbers

The part numbers for the CardioLab II Plus Amplifier are as follows:

- 32 Channel: 2003232-001
- 64 Channel: 2003232-002
- 96 Channel: 2003232-003
- 128 Channel: 2003232-004

If international users need to order a power cord, the following part numbers can be ordered separately.

The following table lists the options for each configuration of the Acquisition system:

Part Number	Description
422845-001	Power cord for Continental Europe 10 Amp.
422845-002	Power cord for Britain 10 Amp.
422845-003	Power cord for Italy 10 Amp.
422845-004	Power cord for Swiss 10 Amp.
422845-005	Power cord for India 10 Amp.
422845-006	Power cord for Australia 10 Amp.

Accessory Parts List

GE Medical Systems - Information Technologies recommends the following accessory parts be used with the CardioLab II Plus Amplifier:

Accessory Name	Part Number
Abbott Transpac IV Disposable Transducer with 4 ft. extension Cable*	Abbott #42582-08
Abbott Transpac Reusable Cable*	Abbott #42661-04-42
3M Disposable Electrode for ECG Monitoring*	3M Red Dot #2256
* This accessory is not stocked by GE Medical Systems Information Technologies.	

Required Tools and Supplies

The following is a list of tools needed to service the CardioLab II Plus amplifier:

- Adjustable wrench with a capacity of 1/2 inch
- Phillips screwdriver
- Physiologic signal simulator with ECG and pressure outputs
- 2 mm pin-jack to ECG jumper wires
- Bourn's potentiometer tool
- Adapter cable to interface pressure simulator to amplifier inputs
- Torx T10 driver

Front View

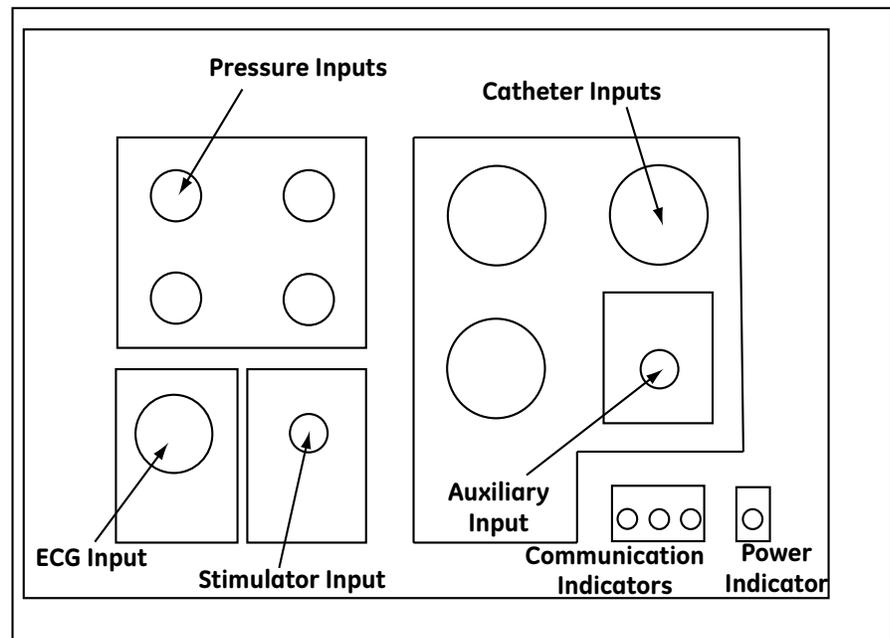


Table 4. Front View 64/32 Channels- CardioLab II Plus Amplifier

Name	Description
Pressure Inputs	Four pressure inputs will each accept a pressure transducer that is calibrated to 5uV/V/mmHg. See the Accessory Parts List for GE Medical Systems - Information Technologies recommended pressure transducers.
ECG Input	The ECG input connector will accept a 10 lead ECG input cable.
Stimulator Input	The stimulator input will accept a stimulator input cable. Use the 3 ft., 15 ft. or 30 ft. Touchproof Stimulator Cables (part numbers , 301-00204-03, 301-00204-15, 301-00204-30, respectively) with the CardioLab II Plus Amplifier.
Catheter Inputs	Up to three catheter inputs will each accept a 32 pole catheter input module. Use the CardioLab II Plus Catheter Input Modules (part number 301-00202-08) with the CardioLab II Plus Amplifier.

Table 4. Front View 64/32 Channels- CardioLab II Plus Amplifier	
Auxiliary Inputs	The auxiliary input will accept the Auxiliary Input Cable (part number 301-00205-08).
Power Indicator	The power indicator is on as long as the CardioLab II Plus Amplifier is turned on.
Communication Indicators	<p>Three communication indicators show the status of the communication between the acquisition computer and the CardioLab II Plus Amplifier.</p> <ul style="list-style-type: none"> ■ When the XMT indicator is on, the CardioLab II Plus Amplifier is transmitting data to the acquisition computer. The XMT indicator should remain on as long as the power indicator is on. ■ When the RCV CMD indicator is on, the CardioLab II Plus Amplifier is receiving data from the acquisition computer. The RCV CMD indicator will turn on as long as an instruction is being received by the amplifier. ■ When the RCV ERR indicator is on, the CardioLab II Plus Amplifier may not be receiving data from the acquisition computer in a valid format or there may be a problem with the fiber optic cable.

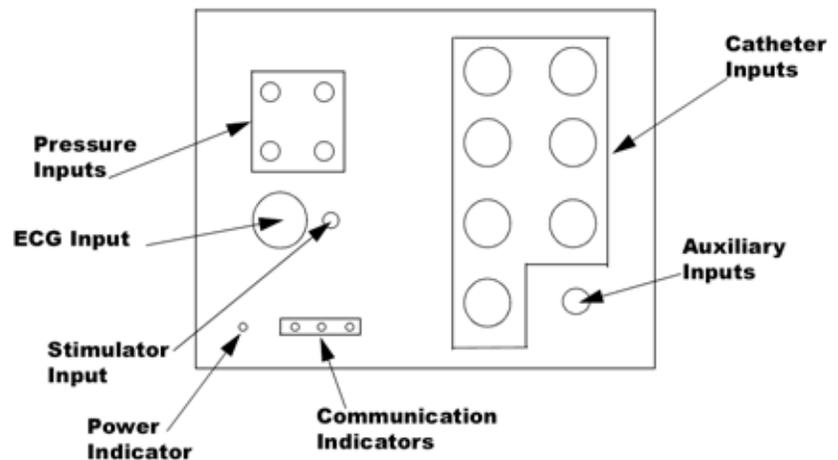


Table 5. Front View 128/96 Channels- CardioLab II Plus Amplifier

Name	Description
Pressure Inputs	Four pressure inputs will each accept a pressure transducer that is calibrated to 5uV/V/mmHg. See the Accessory Parts List for GE Medical Systems - Information Technologies recommended pressure transducers.
ECG Input	The ECG input connector will accept a 10 lead ECG input cable.
Stimulator Input	The stimulator input will accept a stimulator input cable. Use the 3 ft., 15 ft. or 30 ft. Touchproof Stimulator Cables (part numbers , 301-00204-03, 301-00204-15, 301-00204-30, respectively) with the CardioLab II Plus Amplifier.
Catheter Inputs	Up to seven catheter inputs will each accept a 32 pole catheter input module. Use the CardioLab II Plus Catheter Input Modules (part number 301-00202-08) with the CardioLab II Plus Amplifier.
Auxiliary Inputs	The auxiliary input will accept the Auxiliary Input Cable (part number 301-00205-08).

Table 5. Front View 128/96 Channels- CardioLab II Plus Amplifier	
Power Indicator	The power indicator is on as long as the CardioLab II Plus Amplifier is turned on.
Communication Indicators	<p>Three communication indicators show the status of the communication between the acquisition computer and the CardioLab II Plus Amplifier.</p> <ul style="list-style-type: none"> ■ When the XMT indicator is on, the CardioLab II Plus Amplifier is transmitting data to the acquisition computer. The XMT indicator should remain on as long as the power indicator is on. ■ When the RCV CMD indicator is on, the CardioLab II Plus Amplifier is receiving data from the acquisition computer. The RCV CMD indicator will turn on as long as an instruction is being received by the amplifier. ■ When the RCV ERR indicator is on, the CardioLab II Plus Amplifier may not be receiving data from the acquisition computer in a valid format or there may be a problem with the fiber optic cable.

Back View

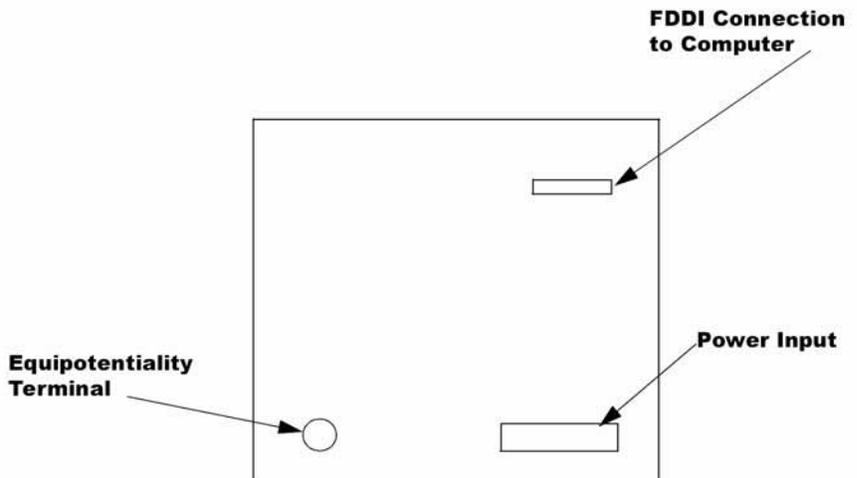


Table 6. Back View - CardioLab II Plus Amplifier

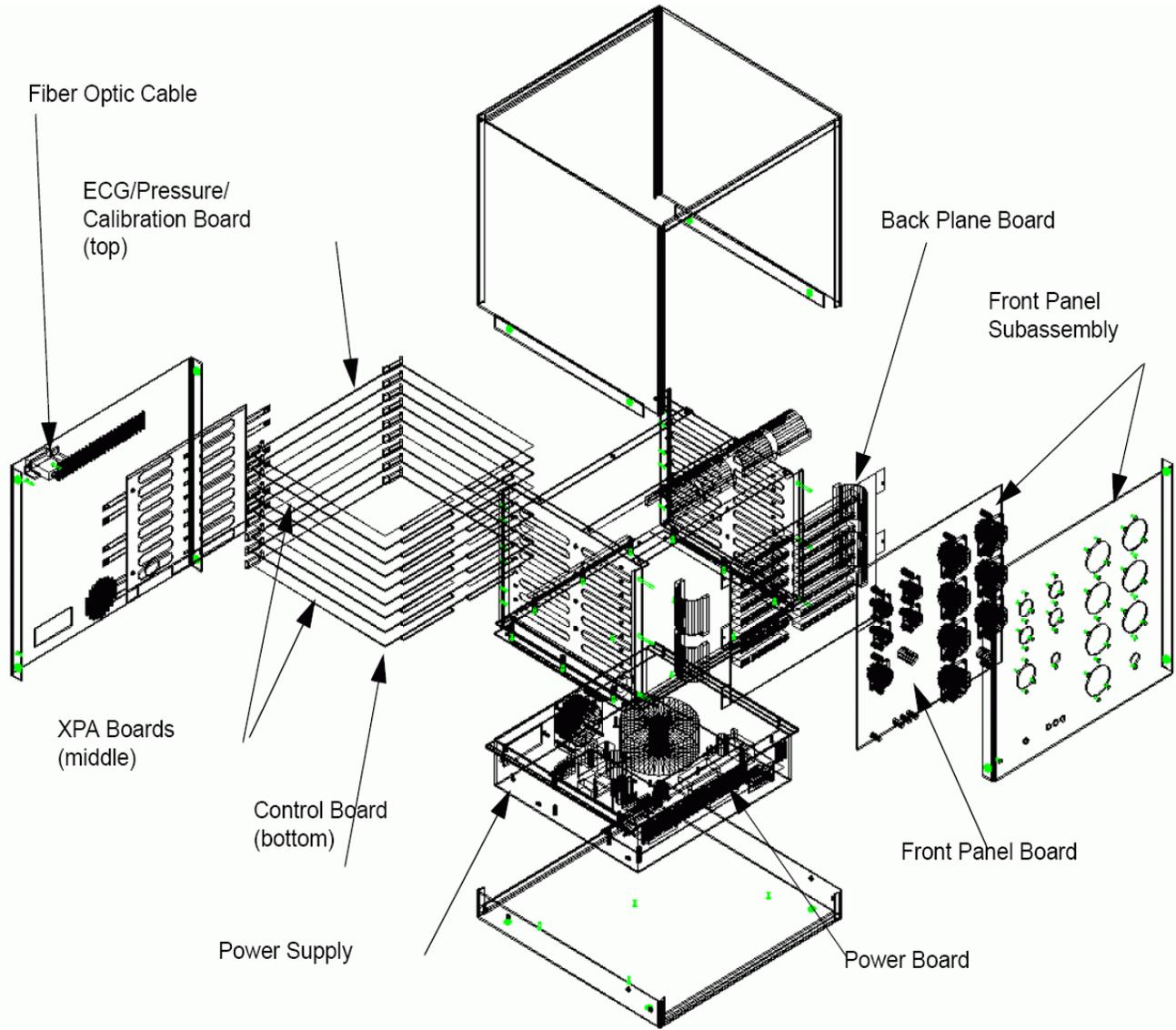
Name	Description
FDDI Connection to Computer	This connector will accept a FDDI type fiber optic cable. The fiber optic cable allows for two-way communication between the amplifier and the CardioLab system.
Power Input	The GE-supplied power cord connects to the Power Input.
Equipotentiality Terminal	The Equipotentiality Terminal is connected to earth ground.

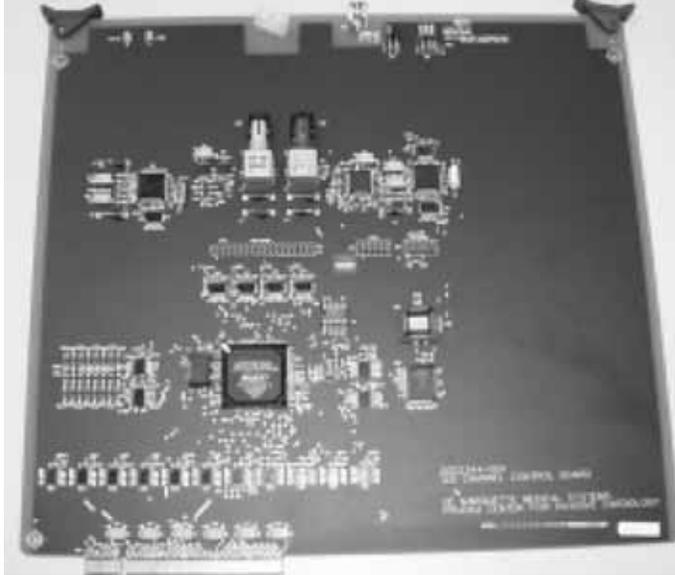
Internal Assembly

Board Identifications

Control Board (PN: 2002344-001)

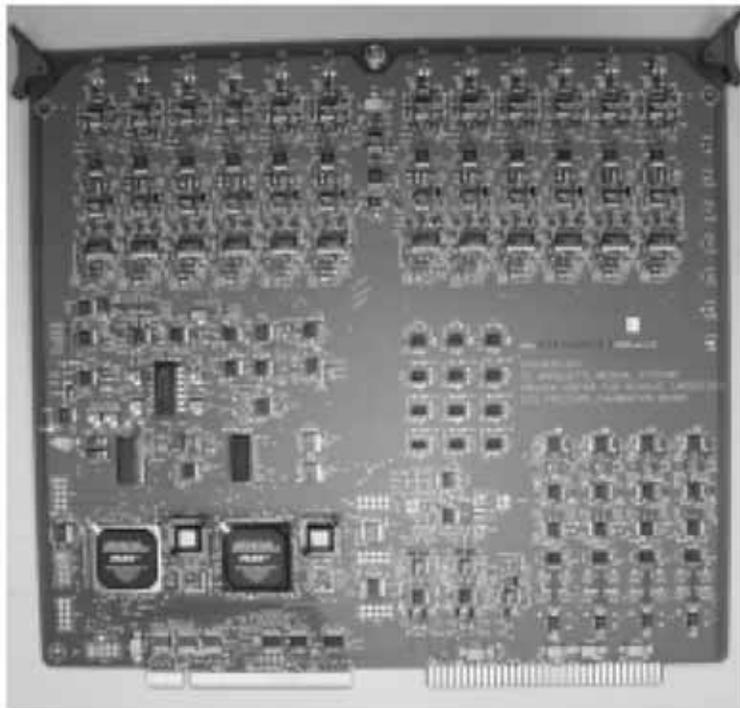
- Provides communications between the amplifier and the CPU.
- Transmits all real-time data.
- Receives all amplifier setup information from the CPU and sends commands to other boards





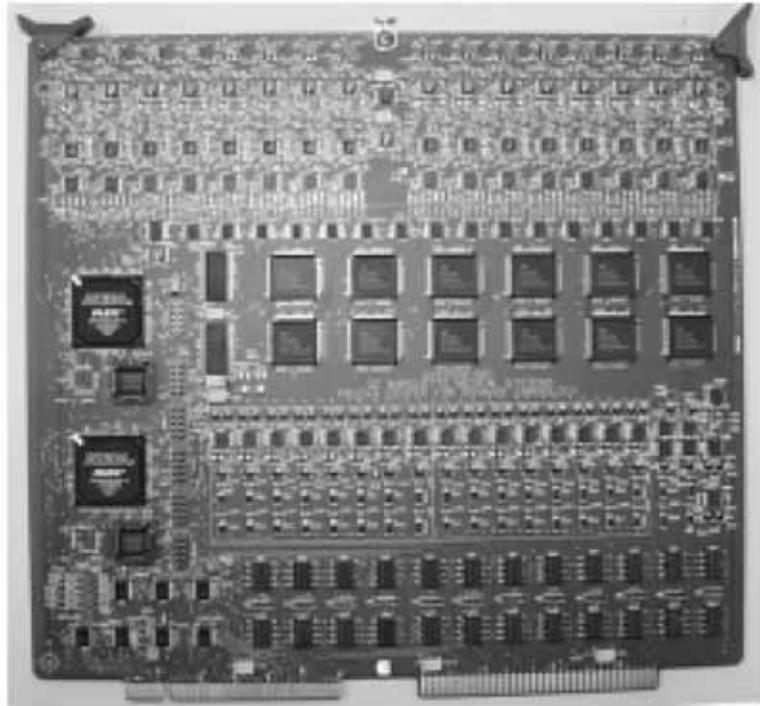
ECG/Pressure/Calibration Board (P/N 2002834-004)

- Processes ECG leads and calculates augmented leads using the Wilson Central Terminal.
- Contains high and low pass filters, gains, and notch filters.
- Contains four-strain, gauge pressure transducers.
- Protects defibrillation.



Cross-Point Amplifier Board (XPA)(PN: 2002506-004)

- Contains high and low pass filters, gains, and notch filters.
- Performs A/D conversion and sends information to the control board.
- Contains 32 inputs/16 channels per board.
- Identifies switches used to assign addresses when swapping boards.
- Relays route stim inputs to correct catheter inputs.



Front Panel Board

The part numbers for the front panel boards are as follows:

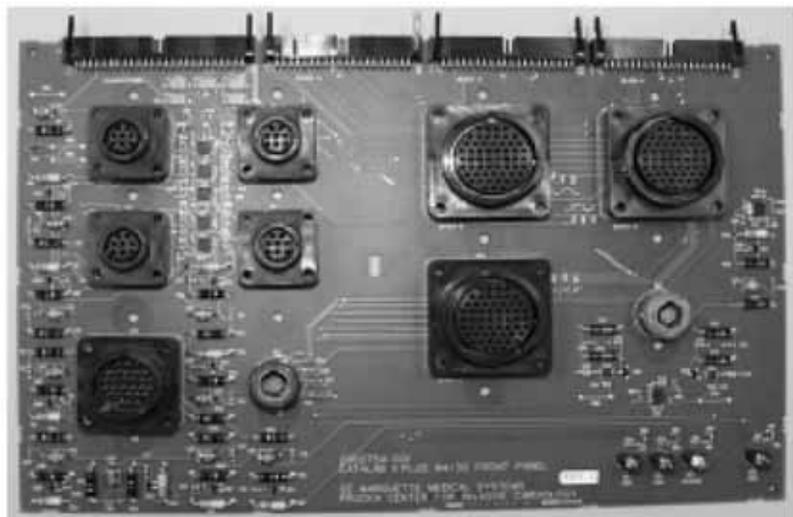
32 Channel: PN: 2002754-004

64 Channel: PN: 2002754-003

96 Channel: PN: 2002758-004

128 Channel: PN: 2002758-003

- Allows RF filtering.
- Protects defibrillation for ECG inputs.
- Allows stim inputs to pass through.
- Allows signals to pass through catheter inputs.
- Contains ribbon cables that connect to the back plane board.
- Provides four LEDs:
 1. XMT DATA (Transmit Data) - Always green indicating real time data being sent to CPU.
 2. RCV CMD (Receive Command) - Only flashes when the amplifier receives commands from the CPU.
 3. RCV Error (Receive Error) - Lights when the amplifier recess incomprehensible command from the CPU.
 4. Power Indicator - Lights as long as the amplifier is turned on.



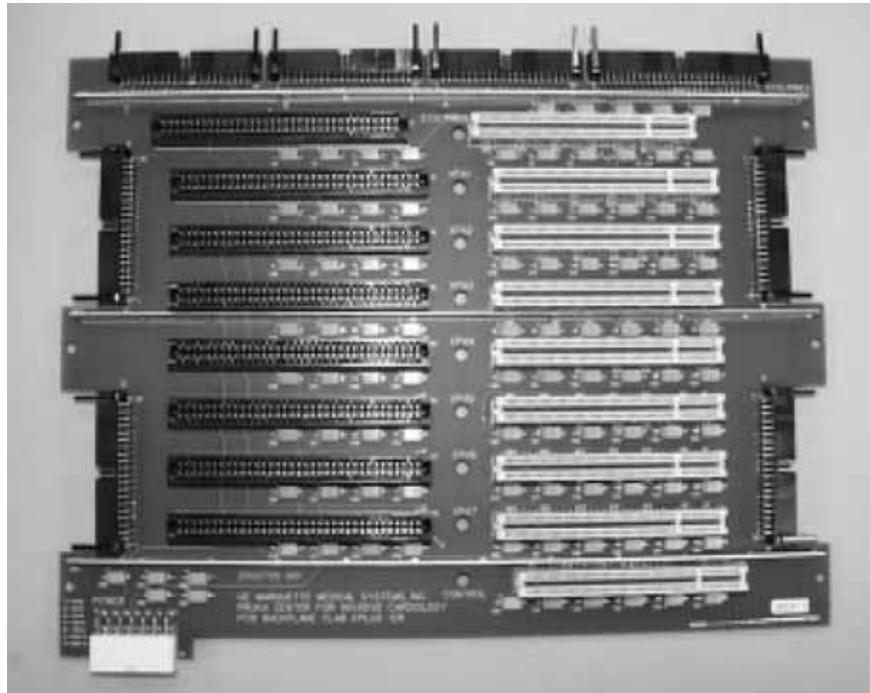
Back Plane Board

The part numbers for the back plane boards are as follows:

64/32 Channel: PN: 2002604-001

128/96 Channel: PN: 2002705-001

Provides the interface for the ECG/Pressure/Calibration Board, XPA boards, and the control board.



Power Board (PN: 2002648-001)

- Converts +15 V to +/- 15 V and +/- 5 V.
- Supplies power to the power subassembly fan.
- Sends a TTL signal equivalent (50 or 60Hz)



Components

The CardioLab II Plus Amplifier comes with the following components:

Table 7. CardioLab II Plus Amplifier Components	
Component Name	Part Number
CardioLab II Plus Catheter Input Module	301-00202-08
3 ft. Touchproof Stimulator Input Cable	301-00204-03
15 ft. Touchproof Stimulator Input Cable	301-00204-15
30 ft. Touchproof Stimulator Input Cable	301-00204-30
Auxiliary Input Cable	301-00205-08
ECG 10 Lead Set	2003421-001
10 Lead ECG Cable	2003419-001
Power Cord	80274-006 405535-013 (Japan)
75ft. ST to FDDI Fiber Optic cable	2003434-001

CardioLab II Plus Catheter Input Module



The equivalent to the Stimulus Inputs 1-4 on the Stimulator Input Cable are labelled on the CardioLab II Amplifier as Stimulus Inputs A1, A2, B1 and B2.

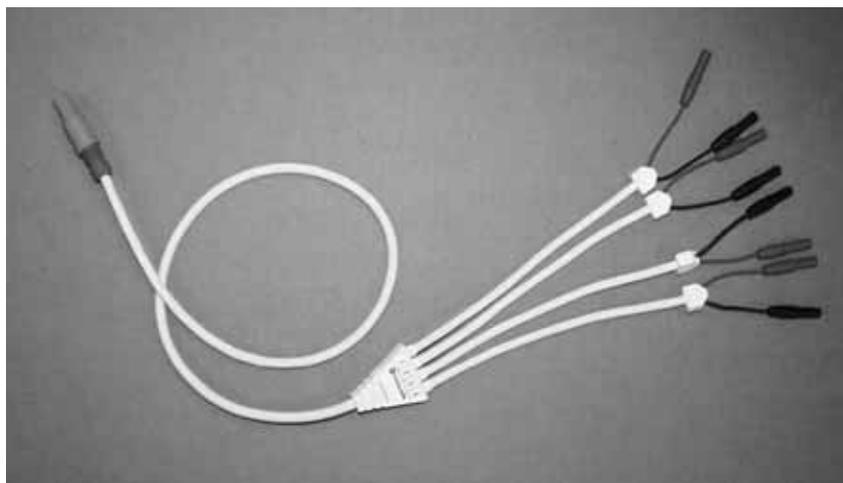
The four stimulus inputs on the Stimulator Input Cable (see photo below) connect to the stimulator.

Each Catheter Input Module is broken down into two groups of 16 poles each. For example, Block A is broken into A (1-16) and A (17-32).

Each pacing channel, requires one positive and one negative pole. In order to maximize the number of pacing channels, only one positive and one negative designation should be made for each group.

For detailed instructions on how to designate pacing channels and enable pacing for particular sites, refer to the on-line help in the software application.

Stimulator Input Cable



ECG 10 Lead Set



10 Lead ECG Cable



Power Cord



3 Operation

Getting Started

WARNING

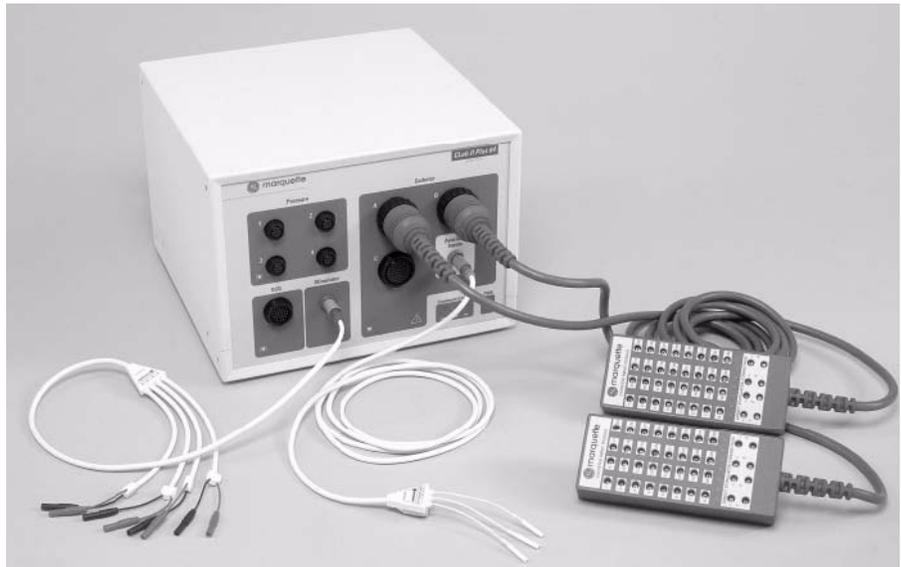
ELECTRIC SHOCK HAZARD — Do not allow any foreign materials such as fluids to come in contact with the CardioLab II Plus Amplifier.

If fluid of any kind should leak into the CardioLab II Plus Amplifier, discontinue using the amplifier and contact GE Medical Systems - Information Technologies.

DO NOT allow hydraulic fluid from any device to contact any conductive surface. Hydraulic fluid is electrically conductive.

NOTE

Connect the CardioLab II Plus Amplifier and all accompanying components in a clean and dry environment with a temperature between 0°C and +35°C and a humidity less than 95% relative at 35°C non-condensing.



Connecting Cables to the Amplifier

When making connections to the CardioLab II Plus Amplifier, make sure that the cables are connected securely in the appropriate locations. Refer to Chapter 2 Equipment Overview for a description of all equipment and components.

To connect the pressure, ECG, and catheter cables to the amplifier, line the pins with the appropriate connection and firmly push the head of the cable into place. Turn the connector ring to the right (clockwise) to secure the cable into the connection.

To connect the stimulator and auxiliary inputs cables to the amplifier, line the pins with the appropriate connection, hold the head of the cable by the shell and firmly push the cable into place.

To connect the power cord to the back of the amplifier, line the pins with the connection and firmly push the head of the cord into place.

To connect the fiber optic cable to the back of the amplifier, remove the protective cap, hold the cable by the head and firmly push it into place. The cable will only connect in one orientation. DO NOT force the fiber optic cable into the connection. If the cable does not connect with ease, flip the cable and try to connect it again.

Disconnecting Cables From the Amplifier

To disconnect the pressure, ECG, and catheter cables from the amplifier, turn the connector ring to the left (counter-clockwise) and firmly pull the cable straight back.

To disconnect the stimulator and auxiliary inputs cables from the amplifier, hold the head of the cable by the shell and firmly pull the cable straight back. The stimulator and auxiliary input cables will not disconnect from the amplifier when pulled by the cord.

To disconnect the power cord from the back of the amplifier, hold the cord by the head and firmly pull the cord straight back.

To disconnect the fiber optic cable from the back of the amplifier, hold the head of the cable while pinching the sides. Firmly pull the cable straight back and attach the protective cap.

Installation Checkout

Once the appropriate cable connections have been made to the CardioLab II Plus Amplifier, the communication indicators on the front of the amplifier should turn on. If the indicators do not turn on, check the fiber optic cable for cracks and wear.

If the XMT indicator is on, the CardioLab II Plus Amplifier is transmitting data to the acquisition computer. The XMT indicator will turn on regardless if the transmission of data is successful or not. The RCV ERR indicator will turn on if the amplifier is having difficulty transmitting data to the computer.

The RCV CMD indicator will turn on when the acquisition computer is sending data to the CardioLab II Plus Amplifier. If the RCV ERR indicator is on, the acquisition computer may be having difficulty transmitting data to the computer.

The RCV ERR indicator may also turn on if the fiber optic cable has been connected to the amplifier incorrectly.

Refer to the manuals listed in the table in the Related Manuals section in Chapter 1 for information on configuring and diagnosing the CardioLab II Plus Amplifier using the acquisition computer.

A Appendix A – Maintenance and Troubleshooting

Overview

Maintenance/Repair Log

A “Maintenance/RepairLog” is included in this appendix to aid in keeping a record of the work done on the amplifier.

NOTE

Unless you have an Equipment Maintenance Contract, GE Medical Systems - Information Technologies does not in any manner assume the responsibility for performing the recommended maintenance procedures. The sole responsibility rests with the individual or institution using the equipment. GE Medical Systems - Information Technologies, Inc. service personnel may, at their discretion, follow the procedures provided in this manual as a guide during visits to the equipment site.

Environmental Protection

Even though the amplifier will be operated in many different environments, some precautions must be observed.

- Take care to avoid extremes of temperature, moisture, and humidity. The amplifier is not waterproof.
- Protect the amplifier from spills or other debris. Eating, drinking, and smoking should not be permitted near the amplifier during patient hookup or amplifier maintenance.

Inspection and Cleaning

Since the CardioLab II Plus Amplifier has no moving parts except for the fan, it requires little maintenance. However, to prolong the use of the amplifier, GE Medical Systems - Information Technologies recommends the following maintenance schedule be performed on the amplifier to maintain safe and efficient operation of the unit:

Table 1. Preventative Maintenance Schedule - CardioLab II Plus Amplifier	
Maintenance Time	Maintenance Actions
Daily	<ul style="list-style-type: none"> ■ Check the case for cracks or other damage ■ Inspect all cords and cables for fraying or other damage. ■ Inspect all plugs, cables, and connectors for bent prongs or pins. ■ Verify that all cords and connectors are securely seated. ■ Inspect controls for proper operation.
Weekly	<ul style="list-style-type: none"> ■ Clean the external cables (such as ECG, blood pressure and catheter inputs) and the Catheter Input Module with isopropyl alcohol by wiping the surface with a soft, clean cloth. DO NOT immerse and external cables or the Catheter Input Module in isopropyl alcohol or in fluids of any kind.
Monthly	<ul style="list-style-type: none"> ■ Inspect all tips of the fiber optic cables and, if necessary, clean them with alcohol and a cotton swab ■ Clean all dust and debris from the fiber optic cable connectors.
Yearly	<ul style="list-style-type: none"> ■ Check the summation of the leakage current. The total system earth leakage current must not exceed 50 microamperes ■ With the power supply disconnected from the line voltage, check the earth ground connection by verifying that the resistance between the earth terminal of the AC inlet on the amplifier and any exposed metal surface of the enclosure is less than 0.1 ohms. ■ Check the electrical integrity of the signal connections in the catheter input modules. <p>NOTE Yearly maintenance activities on the CardioLab II Plus Amplifier should only be done by qualified technical personnel.</p>

Precautions

Do not open the CardioLab II Plus Amplifier unless instructed to do so by a qualified technical personnel.

Do not immerse any part of the amplifier in water.

Do not use organic solvents, ammonia based solutions, or abrasive cleaning agents which may damage equipment surfaces.

Cleaning

Clean the exterior surfaces with a clean, soft cloth and a mild dishwashing detergent diluted in water.

- Wring the excess water from the cloth. Avoid contact with open vents, plugs, or connectors.
- Do not spray or spill fluid directly on the amplifier.
- Dry the surfaces with a clean cloth or paper towel.

Amplifier Troubleshooting

See the How to Reach Us section in the front of this manual for information on contacting GE Medical Systems - Information Technologies for customer service, product support, supplies, and service parts.

If the amplifier does not send signals to the CardioLab system or you receive an unable to communicate with amplifier message:

- Ensure that the amplifier is plugged in and turned on.
- Verify that the external cables are connected properly and are securely attached.
- Replace the fiber optic cable (FOC).
- Clean the FOC with isopropyl (rubbing) alcohol and blow out the connectors with compressed air.
- Disconnect the FOC from back of the computer and make sure that there is a light coming from the end of the cable that was plugged into CPU IN.
- With the amplifier and computer turned on, the green LED next to the CPU IN port on the computer will turn green when connected properly.
- If the problem is intermittent, this problem may indicate a dirty or broken FOC or connector.
- If the problem persists, ensure that all connections inside the amplifier are secure and the boards are seated securely in their slots.

Random spikes or square waveforms appear in signals when not stimulating the patient:

- Clean the FOC contacts with a non-abrasive, lint-free cloth and isopropyl alcohol.
- Replace the fiber optic cable.
- If the waveforms only exist on one channel, try replacing either the catheter, catheter extender, or catheter junction box. You may also try another Catheter Input Module.

Noise on Intracardiac Signals

The noise should resemble 60 Hz or some other relatively consistent interference which are not associated with stim artifact.

- Go to the amplifier test selection under Administration and perform a hardware reset on the amplifier (this is equivalent to turning the amplifier off and on, which would be the second option).
- Verify that the catheter is correctly plugged into the Catheter Input Module (CIM) and that these poles have been correctly entered into the study configuration.
- Remove/replace the catheter extender cables, especially if they have been re-sterilized.

For real-time testing during a case:

Make duplicate channels

- If the noisy signal is set to poles x and y, set up another channel (one with a high quality intracardiac signal, (for example, HRA or RVA) with the same poles and see if the noise is present there as well. This tests the channel.
- While keeping the channels consistent, try inputting the catheters to different poles on the CIM and see if the noise follows the signal. This tests the CIM poles.

NOTE

If the last two tests make no difference, the problem may exist with the catheter itself. Try replacing the catheter.

Detailed Testing: Amplifier Channel Test

- Input a simulated signal into poles 1 and 2 of the CIM block A and connect the ground of the simulator to the RL limb lead
- In the study configuration set all intracardiac channels to:
 - ◆ Poles 1 and 2

- ◆ Bicath type setting
- ◆ No notch filter and identical high and low pass settings.
- ◆ Make sure each signals is displayed on an active page.
- All of the signals should be identical. If one channel does not produce an identical signal, the channel may be bad.

Catheter Input Module Test

In the study configuration:

- All channels should be set to Bicath type with equal filter settings.
- Give each channel 2 poles in ascending order: Ch.1 (poles 1 and 2), Ch. 2 (poles 3 and 4), Ch. 3 (poles 5 and 6), etc. Continue to do this through all poles for all blocks.
- Plug a simulated signal from channel to channel, from one pair of poles to the next pair of poles. Connect the simulator ground to the RL limb lead.
- All of the signals should look the same, if one does not produce an identical signal, the pole in the catheter input module may be bad.
- Ensure that you are not placing the CIM in sterile bags and then pushing the catheter pins through the plastic and into the CIM. This plastic can become lodged in the CIM and create problems.
- Catheters with long pins (1/2 inch) normally produce less noise than catheters with short pins. This is due to the long pins' deep penetration into the CIM.
- Send a fax of any noise issues to customer support. Use calipers to demonstrate the cycle length of the noise. 60 Hz noise has a cycle length of 16.7 ms.

Noise on ECG Signals

- When inspecting a full 12 lead, is there one signal which is particularly clean?
 - ◆ If Lead I is clean and all other signals are noisy, apply an new left leg patch.
 - ◆ If Lead II is clean and all other signals are noisy, apply a new left arm patch.
 - ◆ If Lean III is clean and all other signals are noisy, apply a new right arm patch.
 - ◆ If all signals are noisy, apply a new right leg patch.
- Buff and clean the patient's skin before applying the new patch.

- If changing the patch does not help, swap the suspected limb lead with any of the other lead wires. For example, if Lead I is clean, and all other signals are noisy, swap the LL with a V wire.
- Ensure that all patches on the patient are of the same type. Do not use different types of patches because this will cause the Common Mode Rejection Ratio (CMRR) to decrease, producing more noise.
- In some cases, an abnormally high soft scale value in the study configuration can lead to noise. You can reduce this setting by one level and adjust your signal gains accordingly. For example, if you move from 1/4 to 1/8, you will have to increase the gain of your signals by 2 (for example, from 500 to 1000). Values of 1/8 or less are recommended.
- Select hardware reset from the amplifier test window.
- Ensure that neither the amplifier nor the computer/IEB is plugged into an emergency AC power outlet. While these may have good power, they may introduce noise into CardioLab due to the many extraneous circuits tied to them. Also, make sure the amplifier is not plugged into a power strip. The amplifier should always be plugged into its own dedicated outlet.
- Install a harmonic filter isolation transformer between the power source and the amplifier to further reduce noise.
- It may be necessary to replace the ECG cable (the cable from the front of the amplifier to the limb leads).
- Ensure that all AC outlets which CardioLab interfaces with are properly grounded. To ensure this, a receptacle tester should be used to look for these wiring faults.
- When testing for these problems, remember that auxiliary equipment such as RF pads and pulse oximeters may be adding noise to the patient. Therefore, remove all auxiliary equipment and add each piece individually while looking for signs of noise. Also, make certain that any auxiliary piece of equipment connected to the patient is not plugged into a power strip.
- When using a simulator to test ECG channels, ensure that the Right Leg lead is always attached to the simulator. This is used as a reference channel by the amplifier.

Signals Offset from the Channel Labels

- Go into the amplifier test option under the Administration menu and select Reset Hardware.
- If this does not fix the problem, click on the Zero tab in the amplifier test window and zero the signals with the offset.

- Ensure that the soft scale is no greater than 1/4. Also, abnormally high gain settings for ECGs may contribute to an offset problem.
- Check the filter settings for the signal.
- Continued problems with signal offset may mean that the amplifier needs calibration. Calibration must be performed by a trained GE Service personnel.

ECGs are Flat

- When inspecting a full 12 lead, is there any one signal which is flatline?
 - ◆ If Lead I is flat and all other signals are good, apply a new left leg patch.
 - ◆ If Lead II is flat and all other signals are good, apply a new left arm patch.
 - ◆ If Lead III is flat and all other signals are good, apply a new right arm patch.
- If changing the patch doesn't help, swap the suspected limb lead wire with any of the other lead wired.
- In many cases, an abnormally low soft scale value can lead to flatlines. Values of 1/8 and 1/4 are recommended.
- Select Reset Hardware from the amplifier test window under the Administration menu.
- It may be necessary to replace the ECG cable (the cable between the amplifier and the limb leads).
- If using a simulator to test the ECG signals, always make sure the right leg lead is attached to the ground of the simulator.

Stimulus Artifact on Intracardiac Channels

NOTE

If this is the first case in which you have seen this problem, the problem is most likely with a "case variable". A case variable is something which has changed since the last case was performed. Catheters and catheter extenders are good examples of case variables. If the amplifier has worked properly in the past, it is doubtful that it has suddenly developed a stim artifact problem. New or re-sterilized catheters may have a short or bad connection.

- Does the artifact occur when pacing from one catheter but not from others?
 - ◆ If yes, connect a catheter that is not producing stim artifact to the same inputs on the catheter input module (CIM) where the

catheter with the stim artifact is connected. Pace through the new catheter.

- ◆ If no artifact is present, the problem is with the original catheter.
- If artifact is still present, move the catheter to poles on the CIM which are seldom used. If there is no stim artifact here, the problem may be with the original poles on the CIM. They may have loosened over time. The pacing poles at the bottom of the CIM may also be used for this purpose.
- Replace the stim cable from the stimulator to the amp. If artifact is no longer present, the cable was bad.
- Move the stim cable input for the stim channel with the artifact problem to another channel on the stimulator. If the artifact is no longer present, the stimulator channel may be bad.
- Try using another stimulator. A hand held temporary pacemaker or another battery operated stimulator will work.
- Connect the catheter directly to the stimulator. If the artifact is no longer present, the problem may be with the amplifier or one of the cables connected to the amplifier.
- For continued problems with stim artifact, please fax a snapshot of the signals to customer support for evaluation.

Stimulus Artifact on ECG Signals

- Does the artifact appear on all of the surface leads?
 - ◆ If Lead I is clean and all other ECGs have artifact, replace the left leg patch.
 - ◆ If Lead II is clean and all other ECGs have artifact, replace the left arm patch.
 - ◆ If Lead III is clean and all other ECGs have artifact, replace the right arm patch.
 - ◆ If all ECGs have artifact, replace the right leg patch.
- Buff and clean the patient's skin before applying new patches.
- If the artifact occurs at random times on random signals, this is further evidence that a faulty patch or lead may be causing the artifact. If changing the patch above does not help, try swapping the associated lead wire with one that is known to be producing a good signal.
- Reduce the gain on the affected signals.
- Select the Reset Hardware button in the amplifier test window under the Administration menu.

- Ensure that you are not placing the CIM in sterile bags and pushing the catheters through the bag into the poles. This plastic can become lodged in the junction box and create problems.
- Catheters with long pins (1/2 inch) normally produce less artifact than catheters with short pins. This is due to the long pins' deep penetration into the CIM.
- Replace the stim cable.

Cannot Stimulate the Patient

- Ensure that the stimulator input cable is connected to the front of the amplifier and the opposite end is connected to the appropriate poles on the stimulator.
- Ensure that the appropriate stim enable button at the top of the Real-Time window in the CardioLab application is turned on (red).
- Check the study configuration to ensure that the stimulus is set to go to the correct catheter.
- Check to make sure the stimulator is working properly. Bypass the amplifier by connecting the distal poles of the catheter to the stimulus poles at the bottom of the catheter input module. These poles are directly wired from the front of the amplifier.
- If you are still unable to pace, connect the distal poles of the catheter directly to the stimulator, bypassing the amp. If you still cannot pace, the problem is not with the CardioLab equipment and most likely lies with the stimulator or catheter. Check the output of the stimulator with a multi-meter or oscilloscope.

General Hints to Reduce Noise in a Typical EP Lab

- Good grounding is key. All equipment which is connected to the patient should be connected to the same electrical circuit (not the same outlet), if possible. By connecting all of the equipment to the same circuit, it is possible to prevent "grounding loops" from occurring which can cause noise.
- Any light fixtures or other antenna-like devices above or around the bed can be connected to the same circuit mentioned above.
- If possible, labs should not be positioned next to elevator generators, or any other power generators. Other major pieces of noise emitting equipment include MRI systems, etc.
- For ultimate noise protection, the lab can be enclosed in a "Faraday Cage". This involves enclosing the lab in a metal box which is then grounded. While this is expensive, it is quite effective.

CardioLab Amplifier Testing

NOTE

When testing the amplifier, always make sure the RL ECG lead wire is connected to the ground of the simulator or function generator. All signals in the amplifier use this lead as a reference.

- Make sure the patient catalog is set to System.
- Click on the CardioLab tab in the Navigator window and create a patient.
- Use the appropriate study types for the type of amplifier the lab will be using.
- Create a new patient using the Amp Test study type for the correct amplifier.
- With the Real-Time display on page 1, connect the ECG cable from the amp to your simulator. Verify signals.
- Switch to page 2 of the Real-Time display and connect the pressure output from your simulator to the pressure 1 input of the amp. Run zero pressure data and zero the signal on the window by highlighting it and pressing the zero key on the keyboard.
- Run pressure data on the channel and verify the pressure signal.
- Repeat the same procedure for all pressure waveforms.
- Change the Real-Time display to page 3 and connect your simulator to pins 1 and 2 of catheter block A.
- Run signal data into pins 1 and 2, verify that all of the signals on the page look identical.
- Run through this same procedure for each of the successive pages. Each page represents a different block.
- Go to the Study Configuration menu and select Switch.
- Choose the CIM/STIM study type for the appropriate amplifier.
- Set the display to page 1 and connect the simulator to pins 1 and 2 of catheter input module block A.
- Run simulated data using pins 1 and 2. Then move the simulator down the block. (i.e. pins 2 and 3, 4 and 5, etc.). Make sure the signals look the same as you run down the block.
- Repeat this procedure for each input module. Each page of signals is set up to test one whole block.
- To perform the stim test, go to the Real-Time channel configuration and under the amplifier select STIM.
- Go to the Display and Hardware Settings tab and turn auto-detect on for all four stim channels.

- Display the stim channels on one of the empty pages.
- Using the lab's stimulator, stimulate to each of the four inputs to ensure that the amplifier recognizes the stimulus. If no stimulator is available, connect the 2 mm pins from your stimulator to each of the stim inputs one at a time. Output a signal of at least .3 V and make sure the signal appears on each of the stim channels as you connect it.
- In the Real-Time window, select the Administration menu and select Amplifier Test.
- Choose Register readback and perform the readback function. The values sent should be the same ones as the ones received.
- Click on the walking ones tab and perform the walking ones test only once. Make sure there are no errors during the test. Errors imply communication problems with the channels.
- Select the Stim Walking Ones tab and perform the test once. Once again, there should be no errors.

Storing and Transporting the Amplifier

When the amplifier is transported or will not be in use for a long period of time:

- Disconnect and properly store any patient cables.
- Place the amplifier in an environment with a temperature between -15°C to + 50°C and a non-condensing humidity less than 95% relative at 35°C.

B Appendix B– Technical Information

Technical Specifications

Table 1. Technical Specifications - CardioLab II Plus Amplifier	
Item	Description
Physical Specifications	
Height	64/32 channel: 9.5 in 128/96 channel: 13.0 in
Width	64/32 channel: 13.0in 128/96 channel: 13.0 in
Depth	64/32 channel: 13.0in 128/96 channel: 13.0 in
Weight	64/32 channel: 25 lbs 128/96 channel: 31 lbs
Environmental Specifications	
Temperature	Operating: 0°C to +30°C non-condensing for Clab II Plus 128 and Clab II Plus 96 Operating: 0°C to +35°C non-condensing for Clab II Plus 64 and Clab II Plus 32
	Transport/Storage: -15°C to + 50°C non-condensing
Humidity	Operating: < 95% relative at 35°C non-condensing
	Transport/Storage: < 95% relative at 35°C non-condensing
Power Specifications:	
Power Requirements	100-240 V AC; 50-60 Hz
Power Input (64/32 channel)	0.0-0.5 Amps Class I, Type CF Continuous operation
Power Input (128/96 channel)	0.5-0.75 Amps Class I, Type CF Continuous operation
Design	
Sampling and Hold	Each channel sampled prior to acquisition.
Sampling Rate	1K, 2K and 4K
Gain Literacy	> 96%
CMMR	100 dB min
Input Impedance	> 1 Million Ohms
Leakage Current	Patient Source: < 10 uA
	Patient Sink: < 10 uA
	Patient Sink (mains voltage on applied part, single fault conditions): < 50 uA

Table 1. Technical Specifications - CardioLab II Plus Amplifier	
	Chassis Leakage: < 100 uA
ECG Input	
Outputs	12 lead ECG produced
High Pass Filter	0.05 Hz, 0.5 Hz, 5 Hz
Low Pass Filter	100 Hz
RF Filtering	All inputs
Gain	50-10,000 in 8 settings
Saturation Recovery	Less than 1 sec.
Notch Filter	Power line (50/60 Hz)
Catheter	
Inputs	32 channel: 32 intracardiac inputs, 4 pressure inputs, 10 ECG inputs 64 channel: 96 intracardiac inputs, 4 pressure inputs, 10 ECG inputs 96 channel: 160 intracardiac inputs, 4 pressure inputs 10 ECG inputs 128 channel: 224 intracardiac inputs, 4 pressure inputs, 10 ECG inputs
Outputs	16 channels/Block. Up to 112 channels. 32 channel: Block A 64 channel: Blocks A-C 96 channel: Blocks A-E 128 channel: Blocks A-G
Switching	Any input can be switched to any output within a Block.
High Pass Filter	DC, 0.05 Hz, 0.5 Hz, 5.0 Hz, 30 Hz, 100 Hz
Low Pass Filter	500 Hz, 2,000 Hz
RF Filtering	All inputs
Gain	50-10,000 in 8 settings
Saturation Recovery	Less than 1 sec.
Notch Filter	Power line (50/60 Hz)
Pressure (4 inputs)	
Inputs	Compatible with all standard external pressure transducers. 5uV/V/mmHg
Input Impedance	> 1 Million Ohms
Outputs	Up to 4 pressure channels
Low Pass Filter	6 Hz, 25 Hz, 100 Hz, 400 Hz
Excitation Voltage	5V DC
Output Impedance	< 0.050 Ohms
Range	-400mm Hg to +400 mmHg
Stimulator (1 input)	

Table 1. Technical Specifications - CardioLab II Plus Amplifier

Input	4 input channels
Outputs	Each group of 16 poles can only have one active positive (+) stim and one active negative (-) stim.



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