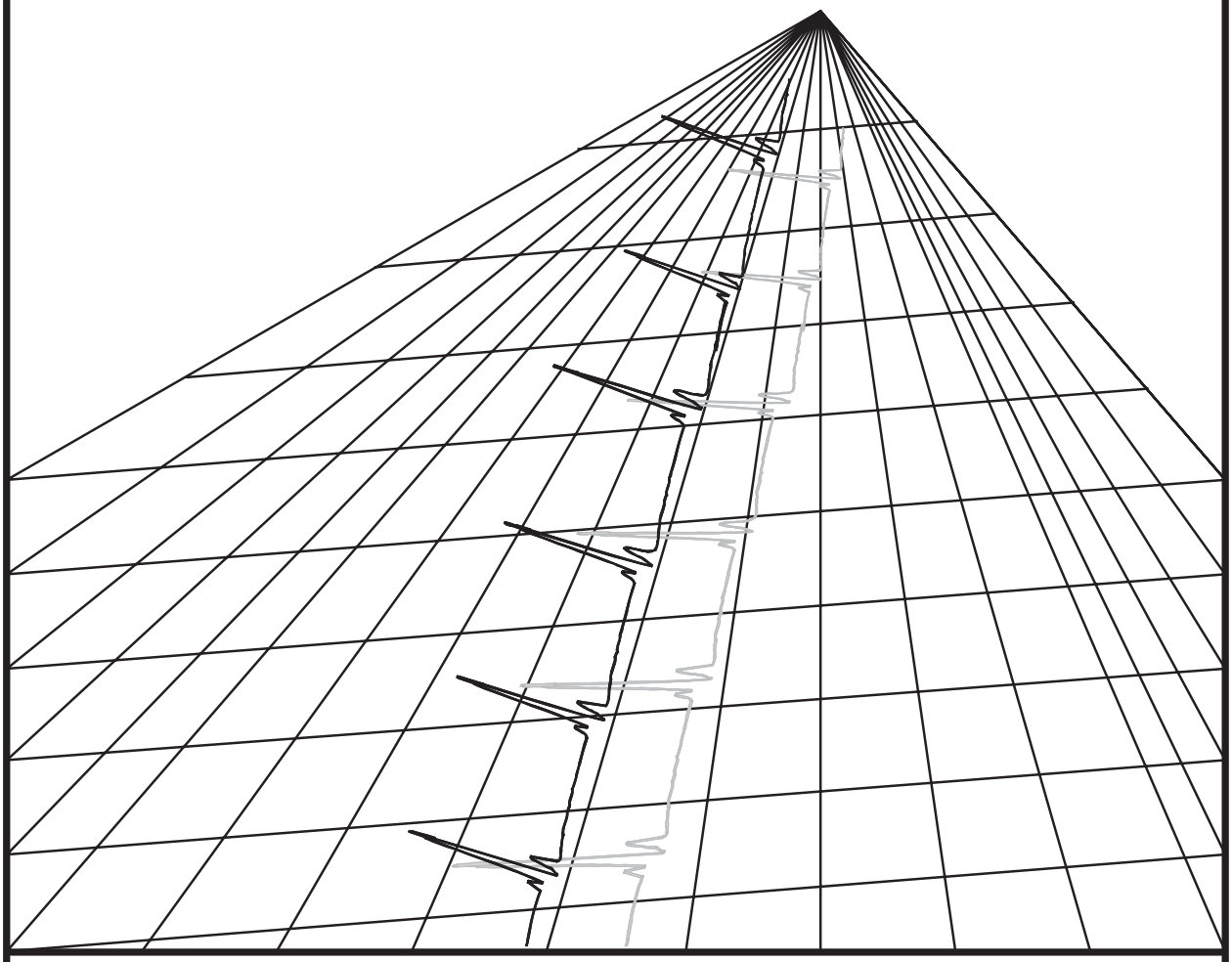
IVY BIOMEDICAL SYSTEMS, INC.

Model 101R/NR
Patient Monitor
R-wave Trigger



2409-00-20

Service Manual

101R/NR0999
2409-00-20 REV 00

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WARRANTY

All products warranted to be free from defects in material and workmanship and to operate within published specifications, under normal use, for a period of two years from date of original shipment.

If an examination discloses such products or component parts to have been defective, then our obligation is limited to repair or replacement (at our option). Fuses and batteries are not covered under this warranty.

During the first year of service, there is no charge for parts or labor. In the second year of service, the customer is charged for labor only.

INTRODUCTION

This manual is to provide information on the correct use of the Model 101R/NR monitor. It is up to the user to ensure that any applicable regulations respecting the installation and operation of the monitor are observed.

Manufacturer's Responsibility

The manufacturer of this equipment is responsible for the effects on safety, reliability, and performance of the equipment only if:

- assembly operations, extensions, re-adjustments, or repairs are carried out by persons authorized by the manufacturer
- the electrical installation complies with all applicable regulations
- the equipment is used in accordance with the instructions in this manual.

Incorrect operation or failure of the user to maintain the monitor in accordance with proper maintenance procedures relieves the manufacturer or his agent from all responsibility for consequent non-compliance, damage, or injury.

For technical and service information, please refer to the Model 101R/NR Service Manual.

READ THE ENTIRE SAFETY INFORMATION SECTION BEFORE YOU OPERATE THE MONITOR.

SAFETY

Electrical

This product is intended to be operated from a mains power source of nominally 100, 120, 220 and 230 V ~. The correct mains operating voltage is specified on the monitor's rear panel.

To prevent electrical hazards to all personnel, this monitor must be properly grounded. The power cable supplied with this equipment provides for this protection. Do not attempt to defeat this protection by modifying the cable or by using ungrounded adapters.

WARNING: Electric shock hazard! Do not remove covers or panels. Refer service to qualified service personnel.

WARNING: To avoid electrical shock, disconnect the monitor from its power source before changing fuses. *Replace only with same type and rating of fuse.*

WARNING: Do not clean monitor while it is on and/or plugged in.

WARNING: This unit uses a common isolation path for ECG leads. Do not connect any non-isolated accessories to the ECG input connected to a patient, as this may compromise the safety of the unit. When attached to other devices, insure that the total chassis leakage currents of all units do not exceed 300μA.

Explosion

DANGER: Explosion hazard! Do not use this equipment in the presence of flammable anesthetics.

Patient Connections

Patient connections are electrically isolated **Type CF** —| ♥ |—. For all connections use insulated probes. Don't let patient connections contact other conductive parts, including earth. See instructions for patient connections in this manual.

Carefully route patient cables to reduce the possibility of patient entanglement or strangulation.

Leakage current is limited internally by this monitor to less than 10 μA. However, always consider additional leakage current that can be caused by other equipment used on the patient at the same time as this monitor.

To ensure that the leakage current protection remains within the specifications, use only the patient cables specified in the patient connections instructions in this manual.

Pacemakers: Rate meters might continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely on rate meter alarms. Keep pacemaker patients under close surveillance.

Electrosurgery

Avoid electrosurgery burns at monitoring sites by ensuring proper connection of the electrosurgery return circuit. If improperly connected, some electrosurgery units might allow energy to return through the electrodes.

Defibrillation Protection

This equipment is protected against 360 J discharge and electrosurgery potentials. The monitor is internally protected to limit current through the electrodes to prevent injury to the patient and damage to the equipment as long as the defibrillator is used in conformance with the manufacturer's instructions.

EMC

This equipment has been certified to be protected to emissions and immunity according to IEC-601-1-2.

Description of Warning Labels

Attention, consult ACCOMPANYING DOCUMENTS before attempting to change power supply selection or carry out interconnections. Equipment connected should comply with IEC-601-1 or IEC-950 with configuration to IEC-601-1-1.

Protective earth (ground) adjacent to this symbol. Internal connection on mains connector/filter.

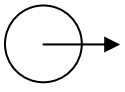
Equipotential earth connector adjacent to this symbol.

Type CF equipment, Defibrillator proof.

Fuse type/rating.

○ = OFF, | = ON.

Alternate Current (AC)



Output signal.

MONITOR DESCRIPTION

The Model 101R/NR Portable Patient Monitor is a dual trace monitor for ECG and heart rate, which produces an output pulse corresponding in time to the R-wave. The monitor is intended primarily for use in timed imaging studies, TMR/PMR and any application requiring precision R-wave synchronization.

Specifications

ECG

Lead Selection:	LI, LII, LIII menu selectable.	
Patient Cable:	6-Pin AAMI Standard connector	
Isolation:	Isolated from ground related circuits by >4 kV rms, 5.5 kV peak	
CMRR:	≥90 dB with patient cable and 51 kΩ/47 nF imbalance	
Input Impedance:	≥20 MΩ at 10 Hz with patient cable	
Frequency Response CRT:	Filtered:	0.5 to 25 Hz
	Unfiltered:	0.5 to 45 Hz
Frequency Response X1000 output:	Filtered:	0.5 to 25 Hz
	Unfiltered:	0.2 to 100 Hz
Input Bias Current:	Any lead configuration <200 nA dc maximum	
Electrode Offset Potential:	±0.5 V DC	
Noise:	<20 μV peak-to-peak, referred to the input with all leads connected through 51 kΩ/47 nF to ground	
Defibrillator Protection:	Protected against 360 J discharge and electrosurgery potentials	
Leakage Current:	<10 μA at normal condition	
Electrosurgical Interference Protection:	Standard	
Notch Filter:	50/60 Hz (automatic).	

Cardiotach

Range:	15 to 255 bpm
Accuracy:	±1%
Resolution:	1 bpm
Sensitivity:	300 μV peak
Pace Pulse Rejection Width:	0.1 to 2 ms at 2 to 700 mV
Tall T Wave Rejection:	Rejects T waves ≤R wave

Alarms

High Rate:	100 to 250 bpm in 5 bpm increments
Low Rate:	30 to 100 bpm in 5 bpm increments
Asystole:	R to R interval >6 seconds
Lead Off:	Detached lead or offset potential >0.5 V

Test Mode

ECG:	1 mV/100 ms @ 70 bpm

Display

Type:	CRT, P31 phosphor, non-fade
Trace:	Dual, Fixed (moving bar), single trace normal operation. Dual trace in "freeze" mode.
Screen Size:	14.25 cm by 10.2 cm, 17.5 cm diagonal
Sweep Speed:	25, 50 mm/s

Mechanical

Size:	Height: 6.25 in. (16 cm) Width: 12.5 in. (31 cm) Depth: 16.0 in. (40 cm)
Weight:	< 20 lbs (9 kg)

Trigger Output

Phase Delay fromElectrode Leads to Trigger Output:	< 3 ms
R to R Trigger Accuracy:	±200 μs typical @ 1 mV input
Sensitivity and Threshold Adjustment:	Fully Automatic
Optional Trigger Delay:	User adjustable from 0 to 700 ms in 5 ms increments.

Environmental

Operating Temperature Range:	5°C to 45°C
Storage Temperature Range:	-25°C to 60°C
Relative Humidity:	0-90% non-condensing

Power Requirements

Voltage Input:	100, 120, 220, 230, V ~, 50/60 Hz; +10% - 15% (to change mains operating voltage see text on Monitor Setup).
Maximum ac Power Consumption:	85 VA

Safety

Unit meets or exceeds the specifications for the AAMI Cardiac Monitor Standard. Units meet UL544, CSA, and CE-MDD 93/42/ECC requirements. ISO-9001 Approval # 98-1044.

Controls and Indicators

Basic Keys

MAINS POWER SWITCH: A switch to control ac power input to the monitor. The **|** position is on, **O** is off.

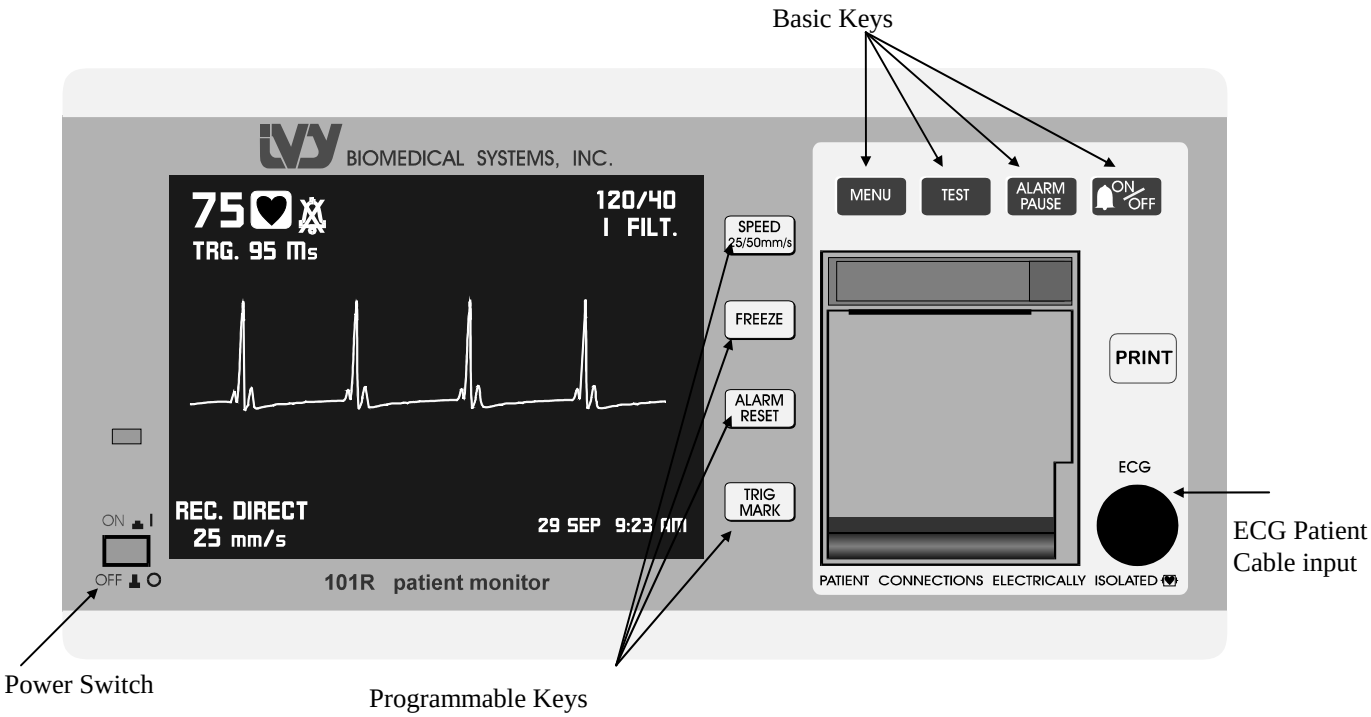
Puts monitor into setup mode and causes setup menu to be displayed on the right portion of the screen. The monitor returns to normal mode after pressing MENU again or if no keys are pressed for 20 seconds.

Disables the audible and visual alarms for a two-minute period to allow the operator perform procedures that would otherwise set off the alarms. This avoids the problem of turning off the alarms and forgetting to turn them back on. Press this key again to return the alarms to normal before the two minutes have expired.

Generates a 1 mV pulse at 70 bpm that is displayed on the ECG trace and sent to the X1000 output on the rear panel while the switch is depressed. This is used to ensure that the monitor is functioning correctly.

Turns the alarm audio on and off. When off, the ALARMS OFF message is displayed on the left side of the screen.

Activates recorder. Push to start, push again to stop. (101R)



Programmable Keys

Each of the following keys, to the right of the CRT display, has a normal function, printed on the key, and two menu functions, displayed on the screen in the setup modes. The additional functions are accessed by pressing the MENU key once. Return to normal function by pressing MENU key again.

SPEED 25/50mm/s

Selects the speed at which the ECG trace moves across the screen.

FREEZE

Stops the movement of the ECG waveform on the display for closer evaluation and displays the waveform as a second trace below the actual trace. Press FREEZE again to resume movement.

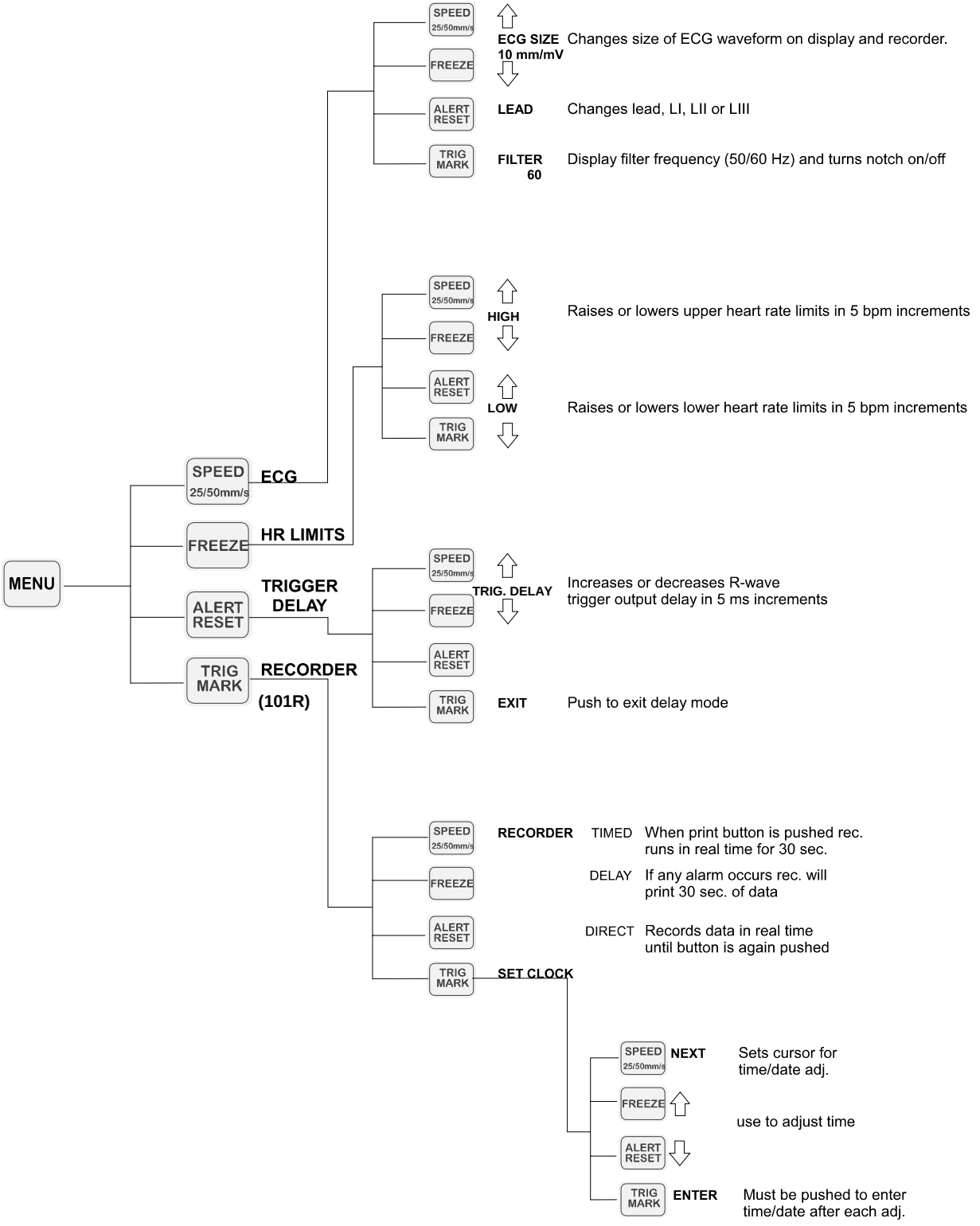
ALERT RESET

Resets the audible and visual indicators for an alarm that has been activated.

TRIG MARK

Enables the Trigger-Spot feature, which highlights the point in the ECG waveform when the trigger output pulse occurs.

MENU STRUCTURE



Display

HEART RATE: Displayed in beats per minute (bpm) on the upper left part of the screen.

SETUP: Selections made in the menu setup modes (alarm limits, lead selection, and filter on/off) are displayed in small characters at the upper right corner.

ECG: Trace is displayed across the screen moving from right to left.

ALARMS: The following alarm indications are displayed in reverse video. Alarm indications appear on the upper right portion of the screen and flash once per second except ALARMS OFF, which is displayed on the upper left portion of the screen and is displayed as  .

 *:*	The audible alarms have been turned off.
LEAD OFF:	A lead has become disconnected. This alarm cannot be reset with the ALERT RESET key.
HR HIGH:	The high heart rate limit has been exceeded for four seconds.
HR LOW:	The low heart rate limit has been exceeded for four seconds.
ASYSTOLE:	The interval between heartbeats has exceeded six seconds.

Rear Panel

The following are located on the rear panel.

POWER INPUT: A receptacle for a standard ac power cord.

When the monitor is connected to another piece of equipment through this rear panel connector, always make sure that each piece of connected equipment has its own separate ground connection.

Do not attempt to connect cables to these connectors without contacting your Biomedical Engineering Department. This is to ensure the connection complies with leakage current requirements of one of the following applicable standards: UL 544, CSA 22.2 No. 125 or IEC 601-1. The maximum non-destructive voltage that may be applied to these connectors is 5V.

TRIGGER OUTPUT: A BNC type connector for the output of the trigger pulse indicating the timing of the peak of the R-wave. The output can be delayed from the peak of the R-wave through user controls.

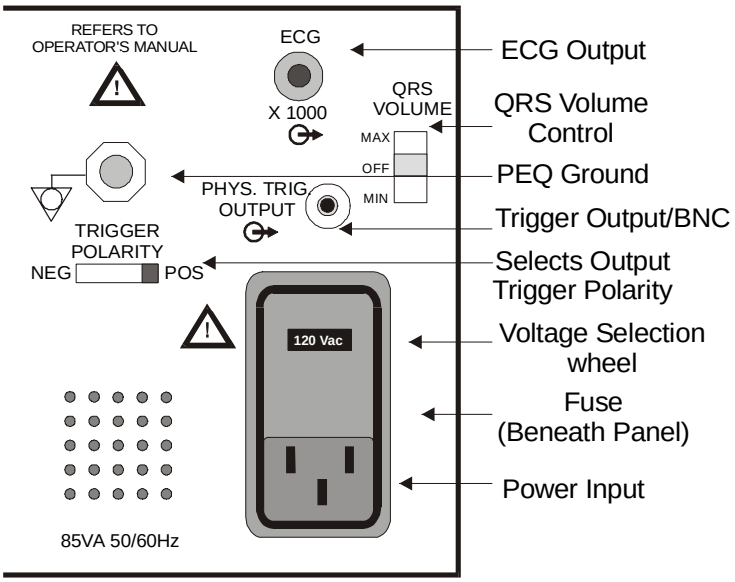
QRS VOLUME CONTROL: A switch to control the QRS beep audio volume. Alarm audio is not affected.

PEQ GROUND: Potential Equalization - A ground connection that can be used to ensure that no potential differences can develop between this equipment and other electrical equipment.

FUSE: Replace only with the same type and rating of fuse as indicated on the fuse rating label.

ECG X1000: This is an ECG analog wave output.

TRIGGER POLARITY SWITCH: Selects output trigger polarity.



Fuse rating

100V | 120V	220V | 230V
T 1.6 Amp	T 1.0 Amp
250V	250V
5mm x 20mm	5 mm x 20 mm

MONITOR SETUP

To setup the instrument for operation:

1. Plug the ac line cord into a power source providing the proper voltage.

Check the monitor's rear panel to verify the voltage range required by the monitor.

2. Press the **POWER** switch at the left side of the front panel to turn power on.
3. Connect the patient cable to the ECG connector on the front panel.
4. Connect the Trigger Output from the monitor rear panel to the device being triggered.

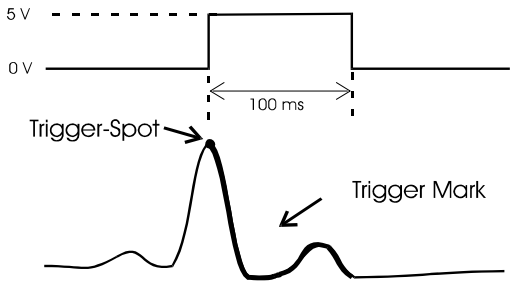
To change Mains Voltage:

1. Locate power entry module in Rear Panel.
2. Remove line cord.
3. Pry down entry cover.
4. Locate and remove voltage wheel and set for appropriate voltage.
5. Replace fuse with proper size (see fuse rating).
6. Replace cover.

TRIGGER OUTPUT

The Trigger Pulse

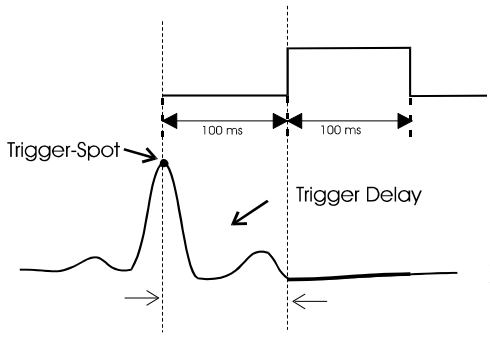
The ECG Trigger Output produces a 100 ms, 0 - 5 V trigger pulse starting at the peak of each R-wave, which is available on the **TRIGGER OUTPUT** BNC connector on the rear panel of the monitor. The following shows the timing of the trigger pulse compared to the ECG waveform.



Trigger-Spot Display

Press the **TRIG MARK** key on the front panel to highlight the portion of the ECG waveform corresponding to the timing of the trigger pulse. Press **TRIG MARK** again to disable Trigger-Spot.

Optional Trigger Delay



Trigger delay is user adjustable by using the Trigger Delay menu. Range is from 0 to 700 ms in 5 ms increments.

Intensity modulation highlights position of ECG where delay occurs.

ECG MONITORING

When ECG monitoring, the display shows the ECG waveform across the center; the heart rate, heart rate limits, and lead selection in the upper left corner; and alarm indications. Also, a heart symbol flashes each time a heartbeat is detected.

Safety Considerations

Disposable products are intended for single-use only. Do not attempt to re-use these products.

Patient connections are electrically isolated **Type CF** —|♥|—. For all connections use insulated probes. Don't let patient connections contact other conductive parts, including earth. See instructions for patient connections in this manual.

Leakage current is limited internally by this monitor to less than 10 μA. However, always consider additional leakage current that can be caused by other equipment used on the patient at the same time as this monitor.

Avoid electrosurgery burns at monitoring sites by ensuring proper connection of the electrosurgery return circuit. If improperly connected, some electrosurgery units might allow energy to return through the electrodes.

Rate meters might continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely on rate meter alarms. Keep pacemaker patients under close surveillance.

Patient Connections

To ensure compliance with both safety and performance specifications, use the patient cables supplied by Ivy Biomedical Systems (see Accessories).

Use only high quality silver/silver-chloride electrodes or equivalent.

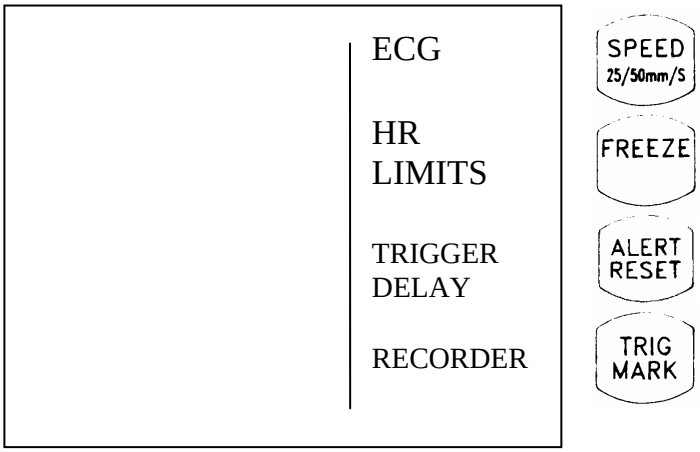
Use the following procedure for ECG monitoring:

1. Prepare each electrode site and apply the electrodes.
2. Connect the patient cable to the monitor's front panel **ECG** input.
3. Attach the leads to the electrodes.
4. Use the procedures described in the following sections for alarm limit settings, lead selection, amplitude adjustment, and enabling or disabling the filter.

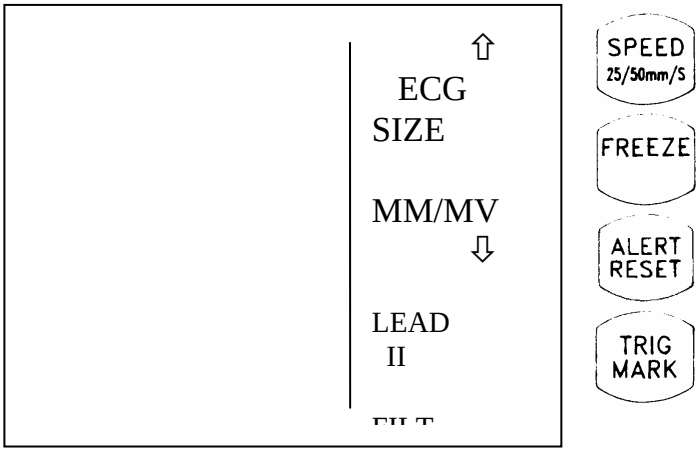
ECG Waveform Amplitude (Size)

Use the following procedure to adjust the amplitude (size) of the displayed ECG waveform.

1. Press the **MENU** key once. The first menu appears.



2. Press the first programmable key (SPEED 25/50 mm/s) once to select ECG.



3. Use the top two programmable keys to the right of the display to adjust the ECG waveform amplitude.

   ⇧ Increases ECG size

   ⇩ Decreases ECG size

Lead Selection

Select [**LEAD**] to change the lead selection. The current lead selection is shown below the alarm limits in the upper right portion of the display.

Available lead selections are Lead I, Lead II, or Lead III.

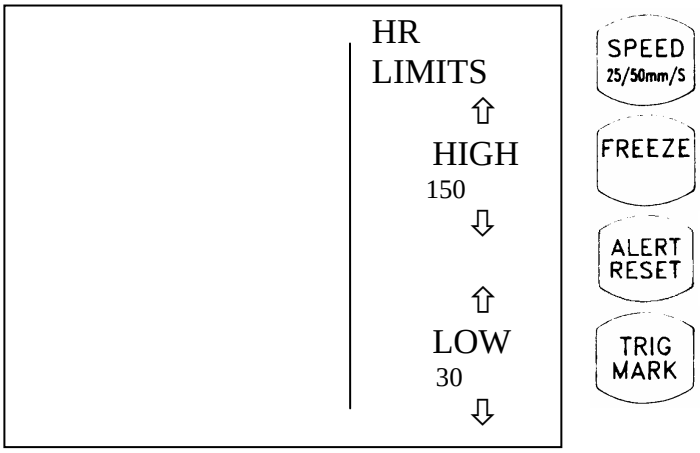
ECG Filter

Select [**FILTER**] to turn the filter on or off. The filter on/off indication is shown in the upper right portion of the display. The filter sets the frequency response of the displayed waveform as follows:

Filtered:	0.5 to 25 Hz
Unfiltered:	0.5 to 45 Hz

Alarm Limits

1. With the first menu (heart rate alarm limits) displayed, select **[HR LIMITS**] to change the Heart Rate Alarm Limits.



2. Use the four programmable keys to the right of the display to set the high and low heart rate limits.

⇧	Increases high HR limit
⇩	Decreases high HR limit
⇧	Increases low HR limit
⇩	Decreases low HR limit

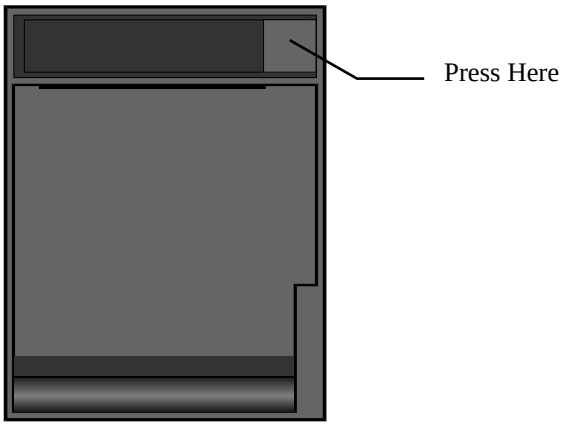
Each time you press a key, the corresponding limit changes by 5 bpm. The current limits are always shown in the upper left portion of the display.

RECORDER OPERATION
101R only

Changing Paper

Replace the roll of thermal paper as follows. (Recorder paper is Ivy P/N: 590035)

1. Press the paper eject button to open the door at the front of the recorder.



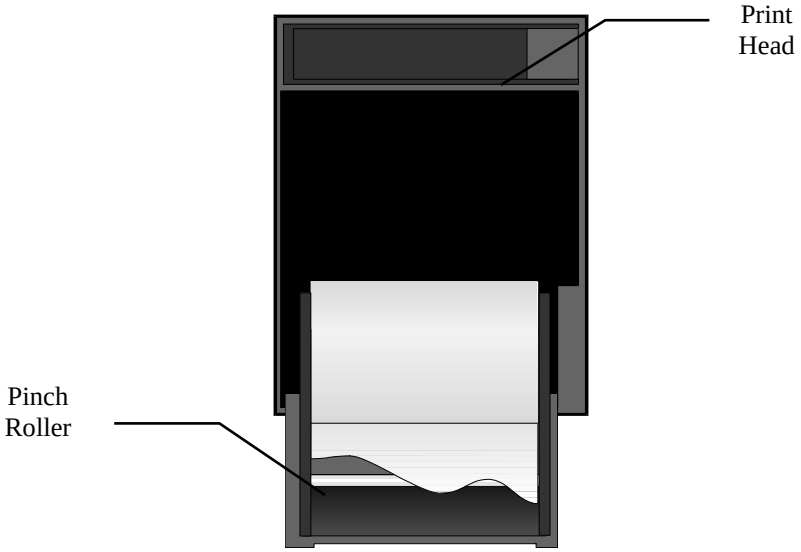
   If the door does not open completely, pull it toward you until it is completely open.

2. Reach in and remove the spent paper core by pulling it gently toward you.

3. Place a new paper roll between the two round tabs of the paper holder.

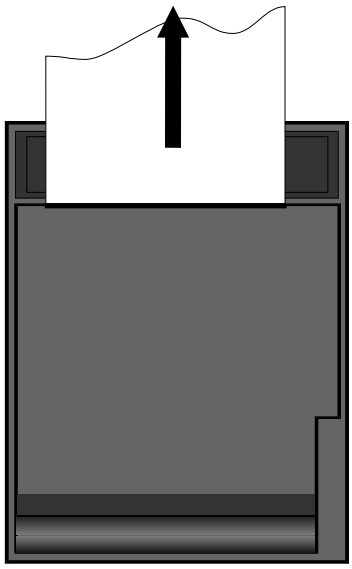
4. Pull some paper from the roll. Make sure the sensitive (shiny) side of the paper faces the print head. The shiny side of the paper normally faces inside the roll.

5. Align the paper with the pinch roller on the door.



6. Hold the paper against the pinch roller and close the door.

7. The paper should advance one inch. If the paper doesn't move, open the door and repeat starting at step 5.



Recorder Menus

The recorder user interface is through the menu structure of the 101R/NR.

1. Press the **MENU** key to display the main menu..

2. Select [RECORDER] to display the recorder menu.

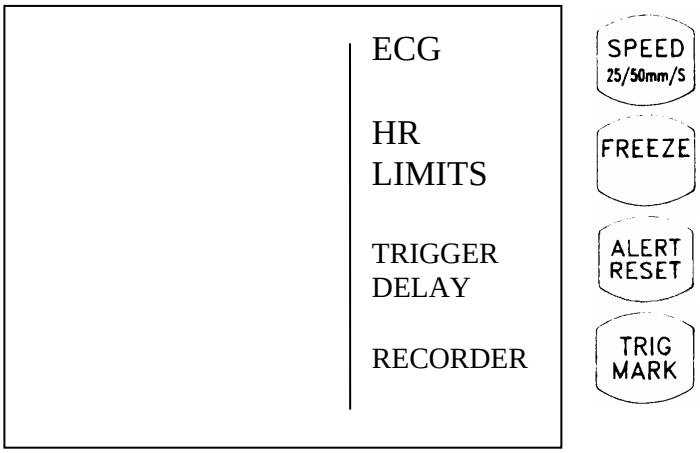
NOTE: At the start of each printout, the printer produces a header consisting of the current readings for all parameters in use at the time of the printout, whether the parameter is displayed or not.

Recorder Modes

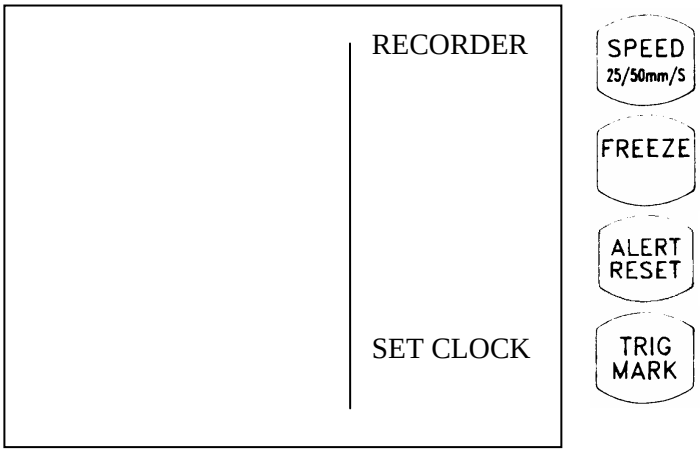
Use the following procedure to select the printing mode to be used. Selections are DIRECT, TIMED and DELAY.

The print mode is indicated in the lower left corner of the display.

1. Press the **MENU** key once.



2. Press the programmable key (TRIG. MARK) once to select RECORDER.



3. Press the programmable key (SPEED 25/50) to select printing mode.

Direct To print in direct, press the **PRINT** key. Press **PRINT** again to stop printing.

The plot is preceded by a header which contains all parameter readings and the time/date.

The speed of the plot and vertical resolution are the same as the display. The plot is labeled with the speed of the plot in mm/s, the recorder mode, and the parameters.

Timed TIMED mode starts by pressing **PRINT** and prints for 30 seconds.

Delay Delay mode plots the 19 seconds before and 12 seconds after the occurrence of an alarm condition or if print button is pushed.

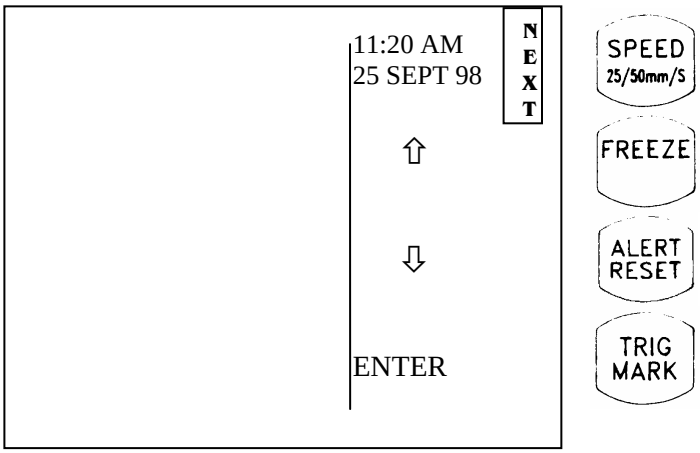
To set the Time and Date

Use the following procedure to set the date and time. The date and time are indicated in the lower right corner of the display.

1. Press the MENU key once. The main menu appears.

2. Press the programmable key (TRIG. MARK) once to select RECORDER.

3. Press the programmable key (TRIG. MARK) once to select SET CLOCK.



4. Press the programmable key (SPEED 25/50mm/s) to place the flashing cursor under the hour, minutes, date, month or year.

5. Press the programmable key (FREEZE) to increase ⇧ what the cursor is under or press the programmable key (ALARM RESET) to lower ⇩ what the cursor is under.

6. After changing the settings press the programmable key (TRIG MARK) to ENTER the settings.

ALARM MESSAGES

Alarm messages are displayed in reverse video.

Press **ALERT RESET** to reset all alarms except LEAD OFF.

The following describes each of the alarm indications.

	All audible alarms have been turned off.
LEAD OFF	A lead has been disconnected or the electrode offset potential has exceeded ±0.5 V. This alarm *cannot* be reset with the ALERT RESET key.
HR HIGH	The high heart rate alarm limit has been exceeded for four seconds.
HR LOW	The low heart rate alarm limit has been exceeded for four seconds.
ASYSTOLE	The interval between heartbeats has exceeded six seconds.

MONITOR TESTING

Press the **TEST** key to test the internal functions of the monitor. You should do this each time you begin monitoring a patient.

The **TEST** function generates a 1 mV pulse at 70 bpm, causing a waveform and a 70 bpm indication on the display and a signal at the rear panel connector. If these indications are not present, contact qualified service personnel.

Under normal operation, no internal adjustment or recalibration is required. Safety tests and internal adjustments should be done by qualified personnel only. Safety checks should be performed at regular intervals or in accordance with local or governmental regulations. In the event that internal adjustment or recalibration is necessary, refer to the Service Manual for this equipment.

CLEANING

Monitor

WARNING: To avoid possible shock hazard, disconnect the monitor from the power source and detach the ECG cable before cleaning.

Clean the exterior surfaces of the monitor with a cloth or swab dampened with a warm water and mild detergent solution. Do not allow liquids to enter the interior of the instrument.

Patient Cables

Do not autoclave the patient cables.

Wipe the cables using soap and water or alcohol. Never submerge the cables in any liquid or allow liquids to enter the electrical connections.

ACCESSORIES

Accessories

3 Lead Patient Cable	590170
Patient Leads	590162
BNC Interconnect Cable Assembly 8 ft long	1564-01-10
Box of 10 rolls of recorder paper	590035 (101R)

Disposal

Disposal of devices or consumables must be done in accordance to natural environmental laws.

THEORY OF OPERATION

General

This section provides general descriptions of the circuitry in the R Wave Trigger patient monitor. Refer to the schematic diagrams at the end of this manual to find the circuits described in this section. Also see the block diagram in the Troubleshooting section for an overview of the signal flow in the monitor.

High Voltage Power Supply and Video Amplifier

Purpose of the High Voltage Power Supply

The High Voltage Power Supply generates every signal that goes to the crt except the yoke signals, which are created by the Mother Board.

CRT Theory

Free electrons are created in the base of the crt by applying a voltage to the filament. A large voltage (6.5 kV in this case) between the anode and cathode accelerate the free electrons from the filament to form a beam. This beam strikes the phosphor at the face of the crt and forms a dot on the screen. The yokes, one horizontal (X yoke) and one vertical (Y yoke), aim the beam by deflecting it with a magnetic field. This moves the dot across the screen, and since phosphor takes some time to cool down, this forms a line across the screen when done quickly. The grids (three in this case) can be biased to block the beam or to focus it. They are also used as intensity control.

Another way of changing the apparent intensity of the beam is to change the voltage at the cathode, or to quickly switch the cathode on and off. Turning the crt beam on and off is often referred to as z axis control. This causes the beam to appear and disappear. The phosphor holds some of the light from the beam while it is off, making it appear that the beam is on but dim.

Raster and Stroke Written Displays

Two different strategies are used to display data on the crt: *stroke writing* for the waveform traces and *vertical raster writing* for everything else. To simplify this explanation, we will break the screen down into three parts: a vertical raster section on the left to show numbers and icons; as stroke written section in the center for writing waveform data; and a vertical raster section on the right for writing scales, alarm messages, and menus.

The vertical raster written portion of the screen is divided into a grid of pixels, each pixel appearing at a fixed point. The space between pixels, although small, is always off. As the beam is traveling vertically down one row of pixels, the beam is turned rapidly on and off. It is on where a pixel is to be brightened and off where the pixel is darkened. When the crt beam reaches the bottom of one row of pixels (one raster) a retrace occurs, sending the beam to the top of the next raster to be drawn.

The vertical raster portion of the display is accomplished by turning the crt beam rapidly on and off as the beam travels vertically from top to bottom of the display at a frequency of about 16 kHz. At the same time that the beam is rapidly traveling vertically, it is also traveling in the horizontal direction with a trace time of about 4 ms for the left side of the crt. The size of the raster display on the right side of the crt differs and, depending on what is displayed, can take from 1.2 ms to approximately 3 ms. Waveform traces are displayed using stroke writing. Stroke writing is used because it offers a smooth, continuous, high resolution display. Stroke writing entails turning on the crt beam and varying the y-axis (vertical) deflection of the beam while the beam travels horizontally across the x axis. It takes about 2.8 ms to draw one complete waveform trace.

Timer Circuit

The Timer Circuit creates a waveform to be used by the high voltage module in the creation of the high voltages needed by the crt. It starts with the VERT SYNC input.

The VERT SYNC input is a 16 kHz square wave with a duty cycle of 56% that is created on the Mother Board. The main purpose of this signal is to synchronize the video circuits on the Mother Board while the crt displays rasters. It is a steady square wave that can be used as a clock.

The Timer Circuit inverts the VERT SYNC signal with a transistor and runs it to a monostable multivibrator (one-shot timer). The one-shot changes the duty cycle of the inverted waveform from 44% to between 12% and 60% (varied by adjusting the EFF potentiometer). The ability to change the duration of this signal allows the operation of the high voltage module to be fine tuned. A small duty cycle means less current to the high voltage module (longer battery life), but it also means lower display intensity during battery operation.

From the output of the one-shot, the signal is buffered by a power MOSFET and sent to the high voltage module.

High Voltage Module

The High Voltage Module contains a circuit board that produces several relatively high voltages to be used in the control of the crt. That circuit board is the Power Module assembly, Part Number 5001-00-XX. More information about the Power Module is included in a section about that board. For now, be aware that when the High Voltage Module is supplied with a 16 kHz square wave and the feedback amplifier is working, it produces three voltages: -100 V, +275 V, and 6,500 V.

Feedback Amplifier

The Feedback Amplifier takes a feedback signal from the High Voltage Module, inverts it, compares it to a voltage reference (the HV potentiometer), and sends it back to the High Voltage Module. It is used to keep the 6500 volt output of the High Voltage Module within tolerances. When the 6500 volt output is within tolerance, the -100 and +275 volt outputs should also be within tolerance.

Adjustment Circuit

The Adjustment Circuit takes the -100 V and +275 V outputs from the High Voltage Module, adjusts them with potentiometers, and applies them to the grids of the crt.

The first grid, G1, adjusts the intensity of the crt. It is adjusted with the INT potentiometer and should be between -100 V and -14 V.

The second grid, G2, also adjusts the intensity of the crt. It is adjusted with the CUTOFF potentiometer and should be between -14 V and +275 V.

The third grid, G3, adjusts the focus of the crt. It is adjusted with the FOCUS potentiometer and should be between -100 V and +275 V.

Cathode Generation Circuit

The main function of the cathode generation circuit is to produce the CATHODE signal for the crt. CATHODE is a mixture of the TREND INT and COAX Z signals. It turns the beam of the crt on and off.

The COAX Z IN is a digital signal that originates on the Mother Board, where it is called Z. It tells the crt when the beam should be off (between waveform strokes or during a retrace). The beam of the crt should be off when this signal is high.

TREND INT is an analog signal used to make the waveform traces brighter or darker in relation to the raster-written data on the crt.

The CATHODE Z IN signal enters the cathode generation circuit at the input of the Z buffer. The Z buffer contains an inverting buffer and transistor. The inverting buffer allows the signal to drive the following transistor without being severely loaded. That transistor also inverts the signal again and changes the level of the output. The signal produced by the transistor is similar to the CATHODE signal but not identical.

TREND INT enters the circuit at the trend intensity buffer, which contains a transistor, a diode, and the TREND INT potentiometer. The transistor buffers and inverts the signal. Next, the TREND INT potentiometer changes how much TREND INT signal is allowed to enter the CATHODE signal. Finally, the diode prohibits current from flowing the wrong way through the circuit. As a whole, the trend intensity buffer sinks current from the CATHODE signal for the desired effects.

Low Voltage Power Supplies

DC Voltages

The Low Voltage Power Supply is on the Mother Board. Its inputs are 13.4 V~ and 6.9 V~ from the power transformer.

Regulators U3, U4, and U5 generate +12 V and -12 V from the 13.4 V~. D23 uses the -12 V as an input to produce -7 V. Regulator U10 and pass transistors Q13 and Q18 generate ±8 V.

From the 6.9 V~, +8 V unregulated is taken from rectifier diodes D5 and D6. Regulator U2 generates +5 V.

Isolated DC Voltages

Isolation transformer T1 passes power from the non-isolated portion of the Mother Board to the isolated portion. The 16 MICROSECOND SYNC signal triggers U31 which turns Q36 on and off. This creates a varying current through the windings of T1 to allow power to be passed to transformer's secondary winding on the isolated portion of the circuit. The rectifiers D50 through D51 generate an unregulated ±6.5 V. Regulator U39 produces ±5 V through pass transistors Q38 and Q39.

ECG Input

Isolated Amplifiers

The ECG input signals (LL, LA, RA) are applied to overvoltage protection devices and to input amplifiers U54 A, B & C. The signals are then routed to lead selector switch U45. The selected signal is amplified by U46 and driven by optical couplers U42 and U43, which pass the signal to the non-isolated portion of the circuit.

Lead Off Sensor

If any of the leads are disconnected, a large offset on the input signal is detected by U47, which generates the LEAD OFF signal. This signal is passed to the non-isolated circuits through coupler U38 and sent to the digital circuits to generate the LEAD OFF alarm. This signal, through Q46, disables the ECG amplifiers.

Shield Drive

The common-mode error signal that serves as input to the shield drive circuit is derived from the signals summed through R242 and R243. This signal drives the shield drive amplifier U47. The output of the shield drive amplifier returns to the patient cable serving to prevent 50/60 Hz power interference.

Lead Selection

Lead select switch U45 selects proper signals according to the levels of the L0 and L1 signals from the digital circuitry. These signals are set according to the lead selection made by the user.

Test Signal Generation

One of the combinations of the L0 and L1 signals indicates TEST mode. In this mode, the lead select switch is off, and a 70 bpm signal generated by U44 is sent to ECG amplifier U55D.

ECG Waveform

ECG Filter

The signal from the output of coupler U40 and then through a low-pass filter to amplifier U26B. The signal at U26A Pin 1 is the filtered output. This signal is switched in or out by FET Q30 which is controlled by the $\overline{\text{NOTCH}}$ signal from the digital circuitry. Potentiometer RV13 (60 Hz) and RV14 (50 Hz) is used to adjust the notch filter. The processor senses the line freq from U18B and automatically switches in the correct notch filter.

X1000 Output

The output at U26 Pin 1 is the X1000 signal that is sent to the rear panel for use with a recorder or other equipment.

ECG Gain

The signal from U24 Pin 1 goes to ECG gain amplifier U24 Pin 7. The gain of this circuit is determined by resistors switched into the circuit by U25. This switch is controlled by signals G1, G2, and G3 from the digital circuitry. The gain depends on the settings made by the user. The output signal from U24 Pin 7 goes to the A/D converter in the digital circuitry.

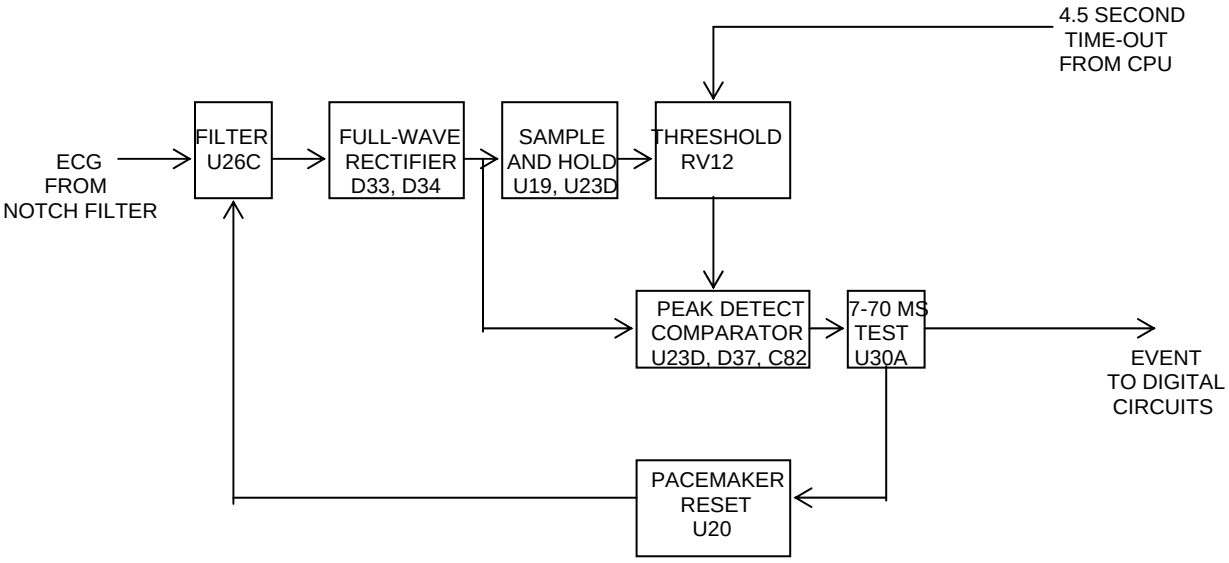
A/D Converter

The A/D converter is U21 along with amplifier U22A. The converter samples the analog ECG signal and generates a series of 1,024 eight-bit numbers which can be stored in memory and then sent through the D/A converter for ECG waveform display.

Cardiotach

Peak Detector

The peak detector generates a pulse at the peak of each R wave. The time between these pulses is used to compute the heart rate. See the Peak Detector block diagram below.



The ECG signal is picked off by amplifier U26C through a filter made up of R126 and C66 and the components in the feeback of U24D. This removes the baseline and T waves from the ECG signal. The signal is rectified by diodes D33, D34 to make sure that the R waves are always positive. The output of the filter and rectifier at U23 Pin 8 is a group of positive pulses for each QRS complex. The first large pulse is the R wave.

For a pulse to be detected, it must exceed a threshold, which is based on the amplitude of the last accepted pulse and is fine adjusted by potentiometer RV12. Sample and hold circuit U19 with U23D holds the peak level of each accepted pulse to form the threshold for the next pulse.

When a pulse exceeds the threshold, U23B Pin 7 goes low. When the peak occurs, U23B Pin 7 goes high. The time between when the signal exceeds the threshold and when the peak occurs must be between 7 and 70 ms for the pulse to be accepted. The 7 and 70 ms timing pulses are generated by one-shots U30. If the signal is accepted, the CPU generates a 10 ms EVENT pulse. The leading edge of the EVENT pulse occurs at the peak of the R wave. This signal goes to the digital circuitry for heart rate computation. Each filtered and rectified QRS complex usually generates more than one acceptable pulse. Therefore, the EVENT signal usually has two 10 ms pulses for each heartbeat. A 200 ms blanking in the digital circuitry eliminates all but the first pulse.

A 4.5 second time-out is produced by the CPU. If no acceptable pulses occur for 4.5 seconds, this one-shot times out and generates a signal that turns on U19. This causes the threshold circuit to acquire a new level.

Whenever a pulse is detected that is less than 7 ms wide, it is assumed to be a pacemaker spike. In this case, U20 is triggered, generating a 30 ms pulse, which turns on Q22 and Q23 to discharge the filter capacitors and turns on Q31 to inject the last threshold level into the peak detector comparator input.

The Trigger Output at the rear panel connector is derived from the EVENT signal. This output is one 1 ms pulse for each QRS complex, with the leading edge corresponding to the peak of the R wave. The signal level is -12 V to

+12 V. Other output pulses (+5 TTL) may be generated by removing U12 and changing C56 and R111. See component matrix on schematic.

Rate Computation

The EVENT signal goes to PLD U36 in the digital section where the 200 ms blanking removes all but one pulse for each heartbeat. The ouptut of the flip-flop goes to the interrupt input of the microprocessor U48. The microprocessor measures the time between interrupt pulses and computes the heart rate.

Alarm Generation

The microprocessor compares the current heart rate to the limits set by the user. If the limits are exceeded, the appropriate alarm signal is generated.

CRT Signals

Refer to the Key Signals portion of the Testing and Troubleshooting section of this manual for diagrams of each of the crt signals.

Vertical Deflection

The display generation is broken up into two timing periods, one for the raster display (digital information and alarms) and the other for the stroke display of the ECG waveform. Each time period is 9.2 ms.

The raster display also contains two time periods. The first is for the left display and the second for the right display. The left display contains the heart rate display, the setup information, and the ALARMS OFF indicator. The right display contains the alarm indicators.

During the stroke display period, the vertical deflection is the ECG waveform signal. This signal is selected through FET Q15 to the vertical deflection amplifiers U6 and U9 and transistors Q1, Q2, Q5 & Q6. During the raster display period, the vertical deflection is the vertical ramp generated by U8B, with its timing set by the $\overline{\text{V SYNC}}$ signal. The vertical ramp is passed through Q15 to the vertical deflection amplifiers.

Horizontal Deflection

The horizontal ramps are generated by U16 and U17 with timing controlled by the $\overline{\text{H SYNC}}$ signal. Four ramps are generated in each timing cycle. The two small ramps are for raster display, and the large ramps are for stroke display. An offset for the right side raster display is added to the circuit through U11D.

Horizontal Correction

Because the face of the crt is flat and the beam originates at a single point, the speed of the beam as it strikes the face is greater near the edges than at the center. Therefore, correction circuitry is required to produce a waveform that is linear over the entire screen. The linearity correction is provided by U17 and associated components.

The correction circuitry produces two signals that are added to the horizontal ramp to correct the linearity. First, U16A integrates the horizontal ramp to produce a parabolic waveform. This waveform is the mathematical equivalent of the speed of the beam across the crt face. This signal is inverted by U16B. The original signal and its inverse are fed into the SYM potentiometer RV6, which selects the portion of the positive or negative waveform required to produce a symmetrical trace between the left and right sides of the crt.

The second signal is an S-shaped waveform generated by U17A, which integrates the parabolic signal from U17B. This S-shaped signal, when added to the horizontal ramp has the effect of slowing the beam near the edges of the

screen. The amount of this signal added to the ramp is adjusted by the S potentiometer RV4. This allows adjustment of linearity between the edges and the center of the screen.

Using the adjustments described above, it is possible to achieve a linear signal across the entire crt screen for any crt. These adjustments should be done whenever a crt or Mother Board is replaced. The complete horizontal deflection signal including correction is summed at U7 Pin 2 and goes through amplifier U7 and transistors Q3, Q4, Q7 & Q8.

Unblanking

The unblanking (Z) signal indicates when to brighten the crt. This signal is created in the digital section. For the raster display, short pulses cause the brightening of each dot needed to generate the characters to be displayed. For the stroke portion, the signal is high during the entire horizontal sweep displaying the ECG waveform.

Audio Circuits

Two types of audio is produced by the monitor: a QRS beep and an alarm tone. The QRS beep is a short tone that is generated each time a QRS complex is detected by the monitor. The alarm tone is produced when any of the alarms are triggered. The alarm tone can be disabled by pressing the front panel

ON/OFF button.

ECG Audio

The audio signal originates in the digital circuitry. The ECG AUD signal is enabled at U51 by an output from the processor's I/O port U51 Pin 11. This signal allows the audio frequency from U51 to be passed to the audio amplifier. Two levels of ECG AUD, through resistor R90, go to the rear panel QRS VOLUME switch as AUDIO HI and AUDIO LO, where the user can select a high, low, or off setting. The selected signal then goes to the audio amplifier U13 and transistors Q19 and Q20, which drive the speaker.

Alert Audio

The ALRT AUDIO is enabled by the output from U36 Pin 18 in the digital circuit The ALERT AUD signal passes through volume adjust potentiometer RV11 to the audio amplifier U13.

Digital Circuitry

The digital circuitry consists of the microprocessor and its associated components. The 8 MHz clock is generated by the F1100.. The microprocessor is U48. U49 is the read only memory (ROM), which contains the program to operate the system. U32 is an input/output (I/O) port for passing information to and from the microprocessor circuits. U52 is random access memory (RAM). This memory is for temporary storage of data that the microprocessor must store. U36 generate timing signals for the system.

For the stroke display, the microprocessor sends the digital ECG waveform through FIFOs U27 and U28 to D/A converter U29 to generate the D/A signal that gets switched into the vertical deflection signal during ECG waveform display.

For raster display, the microprocessor sends the data through U36 and U15 to generate the Z signal. This signal brightens the crt at the proper times to generate the characters.

TESTING AND TROUBLESHOOTING

ECG Test

Equipment Required:

ECG Simulator (Fogg Model M310 or equivalent)

Initial Settings for the Test

HR high alarm limit	120
HR low alarm limit	40
Lead select	I
Filter	ON
Alarms	ON (ALARMS OFF message not displayed)

ECG Test Procedure

1. Connect the patient cable and simulator to the monitor and set the simulator as follows:

- Heart rate of 70 bpm
- Amplitude of 1.0 mV

2. Observe the following on the monitor display:

- ECG Lead I is displayed and is noise free
- Heart rate of 70 ±1 bpm
- The heart next to the heart rate indicator flashes with every QRS complex displayed.

3. Verify that ECG Leads I, II, and III display properly.

4. Change the heart rate on the simulator to 40 bpm. Notice the following:

- The HR LOW message appears over the ECG trace.
- Heart rate value of 40 ±1 bpm is displayed.

5. Press **ON/OFF**. Notice the following:

- Audible alarm stops
- ALARMS OFF message is displayed.

6. Press **FREEZE**. The waveform stops.

7. Press **FREEZE** to make the trace move again.

8. Press **SPEED**. The trace speeds up to twice its previous speed.

9. Press **SPEED** to slow the trace down again.

10. Press **ON/OFF**. The ALARMS OFF message goes off.

11. Adjust the high heart rate limit to 100 bpm.

12. Set the simulator heart rate to 120 bpm. The HR HIGH message is displayed, and an audible alarm sounds.

Troubleshooting

The monitor is made up of the following parts:

Front Touch Panel
Power Input
Rear Panel Heat Sink
Mother Board
High Voltage Power Supply Board
Trigger Board
CRT Display

This manual provides information to help determine which of these parts might be the cause of a problem. A simple block diagram of the monitor is included in this section to help. See the Disassembly procedure in this manual for removing the top cover.

General Checks

The first step is to determine what doesn't work. If nothing works, check those things that you would check on any instrument.

1. Make sure of the power source

2. Check the monitor's main fuse

3. Check the fuses on the low voltage side inside the monitor.

CRT Display

The display is generated from signals developed on the Mother Board. The crt gets its high voltage and cathode signal from the High Voltage Power Supply board.

If there is no picture at all, the problem is most likely the crt itself or the HVPS board. See the Key Signals section to check these components.

If there is a display but either the horizontal or vertical deflections are wrong, the problem is most likely the Mother Board.

Mother Board

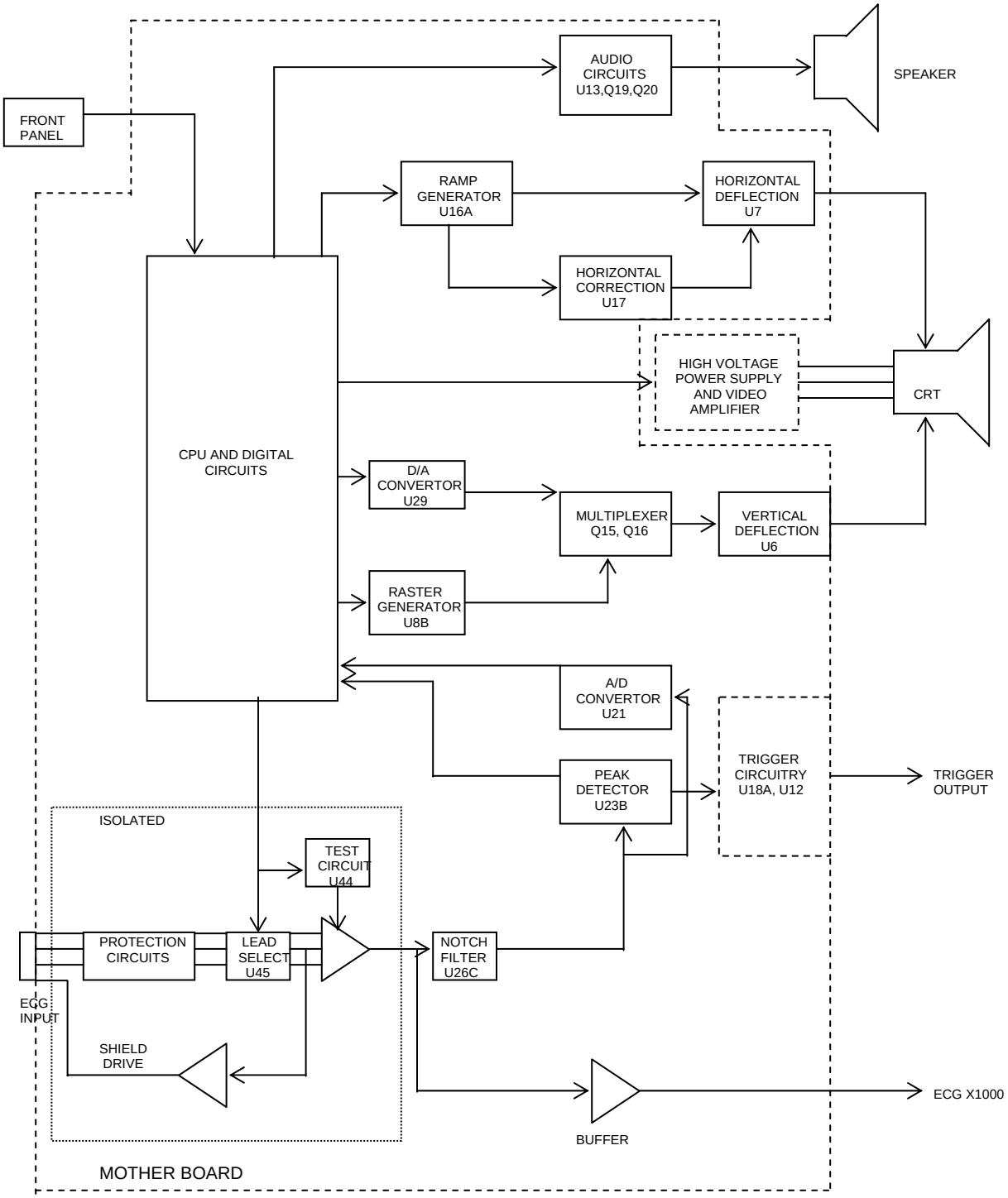
The Mother Board has all circuitry for processing the ECG, computing heart rate, and generating the alarms and the audio. Therefore, any problems with these functions are caused by problems on the Mother board.

Once you have determined the major component causing the problem, refer to the Disassembly section for instructions on replacement.

Troubleshooting Table

General	No Apparent Power	1. Power source 2. Main fuse 3. Internal fuses
CRT	No Display (Check Key Signals)	1. CRT 2. HVPS board 3. Mother Board
	Bad Horizontal or Vertical	1. Mother Board
ECG	Test OK	1. Patient Cable 2. Connector-Front Panel to Mother Board 3. Input Amplifiers on Mother Board
	Test Not OK	1. Mother Board
Audio	No Audio At All	1. Mother Board 2. Connection to Speaker 3. Speaker
	No Alarm Audio	1. Alarm On/Off Setting 2. Mother Board
	No ECG Audio	1. Rear Panel switch setting 2. Mother Board

Block Diagram



Voltage Measurements

The following procedures include voltage checks, key waveforms, and some adjustments. These procedures are only for qualified technicians with appropriate equipment, such as an oscilloscope and digital voltmeter. In most cases, the procedures in the Troubleshooting section of this manual are adequate for determining which major component of the monitor is the cause of a problem.

Schematic diagrams of the monitor are included at the end of this manual. See the Disassembly procedure in this manual for removing the top cover.

Measure the following voltages with a DVM using the ground connection lug on the rear panel as the reference. See Mother Board layout for test point (TP) locations.

Unregulated Voltages

+20 V	Measure at fuse F3	Normal: 14.5 to 20 V
-20 V	Measure at fuse F2	Normal: -14.5 to -20 V
+8 V	Measure at fuse F1	Normal: 6.5 to 8.5 V

Regulated Voltages

+12 V	Measure at +12 TP	Normal: 11.6 ±0.7 V
-12 V	Measure at -12 TP	Normal: -11.6 ±0.7 V
+12 X	Measure at +12X TP	Normal: 12 ± 0.5 V
+5 V	Measure at +5 TP	Normal: 5 V ±100 mV
+8 V	Measure at +8 TP	Normal: 8 V ±10 mV
-8 V	Measure at -8 TP	Normal: -8 V ±100 mV
-7 V	Measure at -7 TP	Normal:-7 V ±200 mV
VREF	Measure at V REF TP	Normal: 2.41 V ±5 mV

Isolated Voltages

Measure the following in the isolated section of the Mother Board using ISOL GND TP as the reference. See Mother Board layout for test point (TP) locations.

+6.5 V	Measure at +6.5 TP	Normal: +6.5 to 7.0 V
-6.5 V	Measure at -6.5 TP	Normal: -6.5 to 7.0 V

Smaller of above must be 6.5 V; neither more than 7.0 V.

+5 V	Measure at +5 TP	Normal: 5.0 V ±200 mV
5 V	Measure at -5 TP	Normal: +5 reading ±100 mV

Both 5 V must be within 100 mV of each other.

High Voltage Power Supply

+275 V	Measure at +275 TP	Normal: +100 to +400 V
-100 V	Measure at -100 TP	Normal: -50 to -125 V

Key Signals

The following are a few signals to help verify the proper operation of the monitor. Use an oscilloscope and refer to Mother Board layout for test point locations.

ECG Waveform

1. Press and hold the TEST button on the monitor's front panel.

2. Put the scope probe at the rear panel X1000 output. The signal should appear as 1 V peak pulses. The same waveform should appear on the monitor's display. The rate indication on the display should be 70 bpm.

   This verifies the operation of the ECG circuitry from very near the front of the monitor's ECG section. To verify the remaining circuit, use a simulator at the ECG input to generate a 1 mV ECG signal.

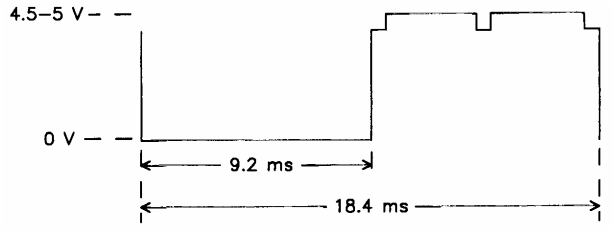
CRT Display

The following are signals generated by the Mother Board for creating the display. If these signals are correct but the display isn't, the problem is not on the Mother Board. See Mother Board layout for test point locations.

For each of the following the signals, trigger the oscilloscope (negative) on Raster Enable (RE test point).

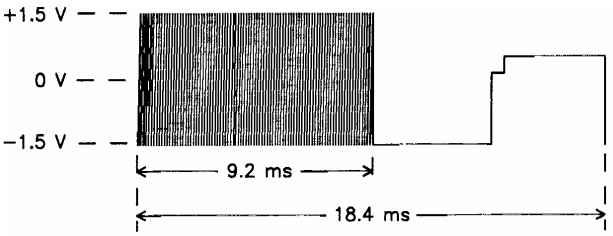
Raster Enable

RE Test Point



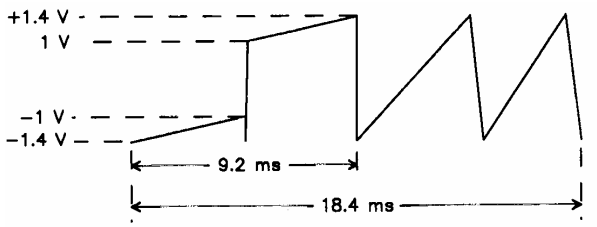
Vertical Deflection Signal

Vi Test Point



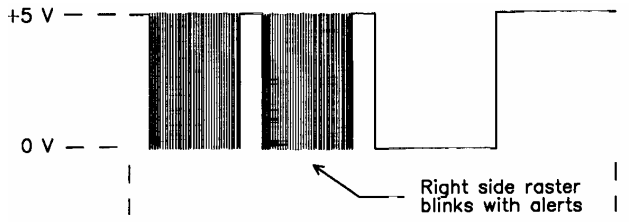
Horizontal Deflection Signal

Hi Test Point



CRT Unblanking Signal ($\overline{Z}$)

Z Test Point - Part of signal blinks with alarm indication.



To verify operation of the High Voltage Power Supply board, check the dc voltages as indicated in the Voltage Measurements section (High Voltage Power Supply).

Also check the following dc filament voltages at the crt socket harness.

5 V	brown	Normal: 4.9 to 5.1 V
-7 V	black	Normal: -6.8 to -7.1 V

Adjustment Procedure

The following adjustments are *not* meant as field procedures. However, if these procedures are attempted, they must be done correctly and according to the procedures listed here. See the Disassembly procedure in this manual for removing the top cover.

Equipment Required

Digital Voltmeter Sine Wave Generator
Oscilloscope
ECG Simulator

ECG Signal

1. Press and hold the TEST button on the monitor's front panel.

2. With an oscilloscope, look at the signal at the X1000 output on the rear panel.

3. Adjust RV17 (ECG BAL) until the signal's baseline is at 0 V.

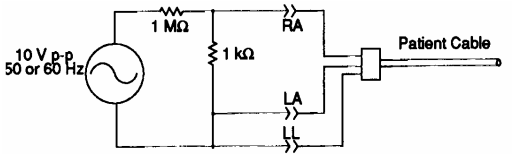
4. Adjust RV18 (ECG GAIN) until the peak signal is 1 V.

5. Repeat adjustments as necessary.

50/60 Hz Notch Filter

1. With the monitor's front panel controls, set the filter to ON and the lead selection to Lead I.

2. Insert a 10 mV p-p 50 or 60 Hz sinusoidal signal into the monitor's front panel ECG input. See the diagram below for a suggested input circuit.



3. With an oscilloscope, look at the signal at the NOTCH test point on the Mother Board.

4. Adjust RV13 for 60 Hz and RV14 for 50 Hz for minimum amplitude signal at the NOTCH test point. This signal should be ≤600 mV p-p. To turn on the correct filter set TP21 high (+5) for 60 Hz and ground for 50 Hz. A clip lead tied to +5 or ground will accomplish this.

5. From the front panel, set the filter to OFF. The signal at the NOTCH test point should be approximately 10 V p-p.

6. To test the auto notch function, plug unit into a variable freq. power generator and slowly change the line freq. from 50 to 60 Hz.

Peak Detector

1. With the oscilloscope, look at the signal at U23 Pin 7.

2. Connect the ECG simulator and adjust the ECG level so that only one pulse is present at U23 Pin 7.

3. Put the oscilloscope on the T1 test point.

4. Put the oscilloscope on the T2 test point.

5. Set the simulator for an ECG input signal of 300 μV. Put the oscilloscope probe at U23 Pin 7.

6. Adj RV12 (T'HLD) until the signal at U23 Pin 7 changes to two pulses.

CRT Display

- **Beam Centering**

1. Reduce the intensity using the intensity pot at the top of the High Voltage Power Supply board.

2. Remove connector J202 from the Mother Board.

3. Adjust the rings at the rear of the crt to place the beam in the center of the screen.

4. Replace J202 and readjust the intensity.

- **Yoke Straightening**

1. With no ECG input signal, loosen the screw holding the yoke clamp at the rear of the crt.

2. Rotate the yoke so that the trend line on the display is horizontal.

3. Tighten the yoke clamp screw.

- **Horizontal Adjustments**

1. Put the oscilloscope on U16 Pin 1. There should be two large ramps and two small ramps.

2. Adjust RV15 so that the peak of the large ramp is 3.4 V.

3. Adjust RV5 so that the trend line (ECG waveform line) is 132 mm long.

4. Adjust RV16 (SS ADJ) so that the ALARMS OFF display area is 33 mm across.

5. Press the TEST button on the monitor's front panel. When pulses appear across the entire screen, press FREEZE to stop the motion.

6. Adjust RV4 (S) and RV6 (SYM) to make the pulses evenly spread across the screen. The S adjustment controls the linearity between the middle and ends, and the SYM adjustment controls the linearity from end to end.

7. Press FREEZE and release TEST so that there are no pulses. Press the MENU button.

8. Adjust RV9 (RSTP) so that the right end of the trend line just touches the left of side the menu box.

9. Repeat the above steps as necessary.

- **Vertical Adjustments**

1. Put the oscilloscope on U8 Pin 7.

2. Adjust RV1 (RASTER) so that the negative peak of the signal at U8 Pin 7 is at -2.5 V.

3. Press the MENU button on the monitor's front panel.

4. Adjust RV2 (V GAIN) so that the menu box is 86 mm high.

5. Adjust RV3 (V BAL) to center the menu box between the top and bottom of the screen.

6. Press the MENU key again to display the second menu.

7. Adjust RV8 (DA0) so that the trend line is at the same level as the center horizontal line in the second menu.

8. Repeat the above adjustments as necessary.

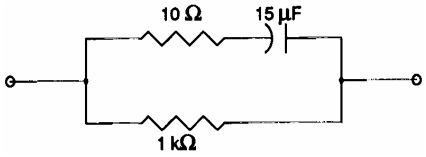
- **High Voltage Power Supply Board**

1. Adjust the Focus and Intensity adjustments near the top of the High Voltage Power Supply board for the desired display.

2. Adjust the Trend Intensity adjustment on the HVPS board to set the trend line intensity separately.

- **Isolation and Leakage Tests**

Use a leakage tester or use the ac voltage range on a digital voltmeter to measure across a 1 kΩ resistor in parallel with a 0.15 μF capacitor and 10 Ω resistor.



1. Measure between a known ground and the monitor's ground post on the rear panel. Wth the line cord properly grounded, with the ground removed, and with the line cord reversed, the readings should be less than 20 μA.

2. With the line cord grounded, measure between shorted patient leads and the hot side of the ac line. The reading should be less than 10 μA.

ASSEMBLY AND DISASSEMBLY

This section describes procedures for disassembly of the monitor for replacement of major components. For reassembly, use the same procedures but work in reverse. Always remember to save all hardware and to re-install any connectors removed during disassembly.

Removing the Cover

WARNING: Potentially dangerous voltages are present inside the monitor. Always disconnect the power cord from the ac outlet before removing the cover. Failure to comply could result in personal injury.

1. Disconnect the power cord from the ac outlet.
2. Remove the two screws in the rear that attach the top cover to the rear panel.
3. Slide the cover back and lift it off.
4. To remove the bottom cover, turn the monitor upside-down and use the same procedure.

Removing the High Voltage Power Supply

1. Remove the top cover as described above.

   The High Voltage Power Supply board is mounted vertically near the front of the monitor near the crt.
2. Remove J301 from the High Voltage Power Supply board.
3. Remove the connector from the back of the crt.
4. Remove the crt anode cap from the front of the crt by pulling up on the rubber from the edges.
5. Pull the High Voltage Power Supply board up and out of the card guides.

Removing the Yoke

The yoke is the electronic assembly located at the rear of the crt.

1. Remove the top cover as described above.
2. Remove the High Voltage Power Supply board as described above.
3. Remove J202 from the Mother Board.
4. Loosen the screw holding the yoke clamp on the crt and slide the yoke assembly off.

Removing the CRT

1. Remove the High Voltage Power Supply board as described above.
2. Remove the spring across the front of the crt.
3. Remove the two screws holding the crt bracket on the center side of the crt.
4. Tilt the crt toward the side of the monitor and guide it out of the unit.
5. After replacing the crt, do the CRT Display adjustments described in the Testing and Troubleshooting section of this manual.

Replacing the Main Power LED

1. Remove the top cover, the High Voltage Power Supply board, and the crt as described above.
2. Remove the LED retainer and pull out the LED.
3. Push in a new LED and replace the retainer.

Removing the Recorder Assembly

1. Open the recorder door and remove the paper from the recorder.
2. Loosen the two captive Philips-head screws inside the recorder housing.
3. Pull the Recorder Assembly straight out from the monitor.

Removing the Mother Board

The Mother Board is the main board in the monitor and is located across the bottom of the monitor.

1. Remove top and bottom covers as described above.

2. Remove the following connectors:

J201	Main Harness
J202	Yoke
J203	Front Panel
J204	ECG Input
J205	LED

3. Turn the monitor over and remove the screw at the front of the Mother Board that attaches the board to the front panel.

4. Remove the four screws across the bottom of the rear panel.

5. Squeeze the tabs on each of the plastic standoffs and gently pull on the board to remove it.

Removing the Touch Panel

The Touch Panel is glued to the front bezel.

1. Remove the top cover as described above.

2. Disconnect J203 (ribbon cable) from the Mother Board.

3. Use a knife to work a corner of the Touch Panel loose and pull the panel away from the front bezel.

4. Feed the ribbon cable through the slot in the front plate.

5. Make sure the clear plexiglas window is in place in the bezel. Then feed the ribbon cable on the new Touch Panel through the slot in the bezel.

6. Peel the protective backing from the Touch Panel and carefully press the panel onto the front bezel.

7. Connect J203 (ribbon cable) to the Mother Board.

PURCHASING INFORMATION

Parts List

The following are the part numbers for the major components in the monitor.

Component	Part Number
High Voltage Power Supply & Video Assy	1117-00-01
Mother Board	5119-00-01
CRT	570000
LED	1062-00-01
Front Touch Panel (101R)	1010-03-10
Front Touch Panel (101NR)	1010-04-10

Terms and Conditions

- All prices are F.O.B. Branford, Connecticut. Payment: Net 30 days.
- Minimum order is $100 on all orders requiring an invoice prior to payment. When payment accompanies purchase order, no minimum applies.
- A 15% restocking charge will be made on an instrument returned for credit or exchange, unless a waiver is issued, in writing, by an employee of Ivy Biomedical Systems, Inc.
- One instruction manual and service instructions are supplied with each instrument. Additional copies may be ordered at $25 each.

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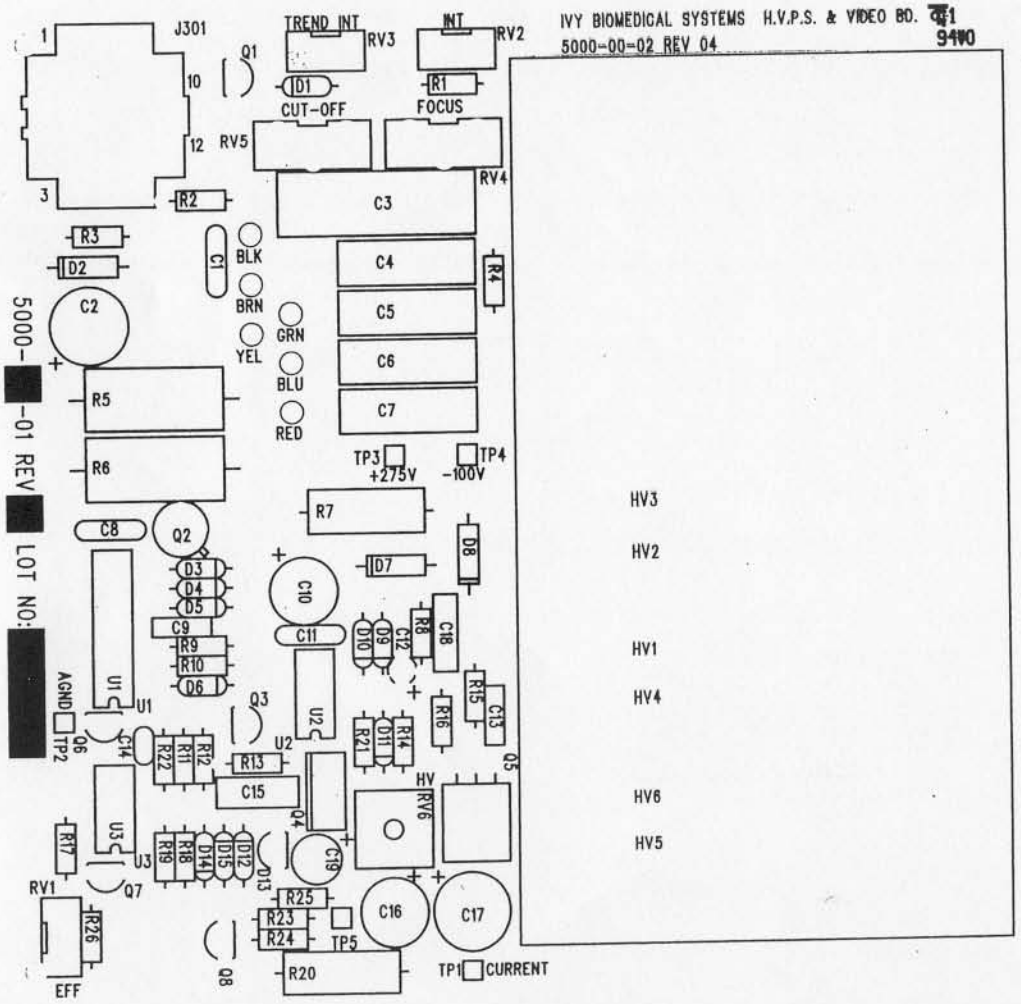
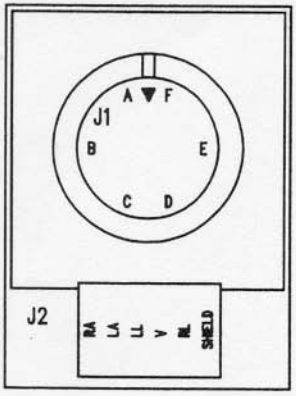
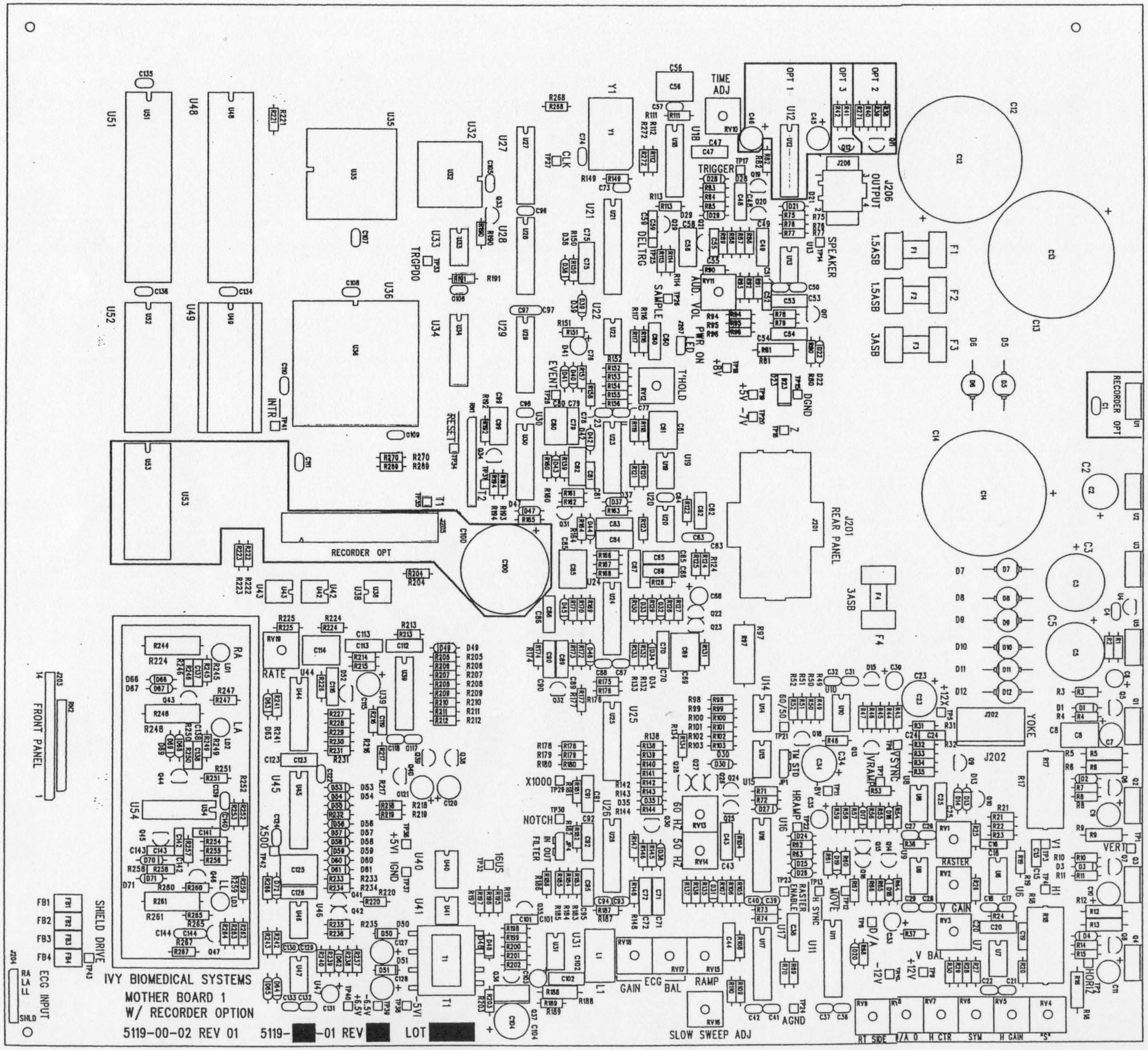
BOARD LAYOUT DIAGRAMS


IVY BIOMEDICAL SYSTEMS H.V.P.S. & VIDEO BD.
5000-00-02 REV 04
J301
TREND INT
RV3
INT
RV2
Q1
D1
R1
CUT-OFF
FOCUS
RV5
RV4
C3
R2
R3
D2
C1
BLK
BRN
GRN
YEL
BLU
RED
C4
C5
C6
C7
R4
C2
R5
R6
TP3
+275V
TP4
-100V
R7
C8
Q2
D3
D4
D5
C9
R9
R10
D6
C10
C11
D7
D8
D9
D10
C12
R8
C18
U1
Q3
U2
R15
C13
R16
R21
D11
R14
AGND
TP2
Q6
C14
R22
R11
R12
R13
C15
HV
RV6
Q5
Q4
C19
U3
R17
R18
R19
D14
D15
D12
D13
Q7
RV1
R25
R23
R24
TP5
C16
C17
R26
EFF
Q8
R20
TP1
CURRENT
HV3
HV2
HV1
HV4
HV6
HV5
5000-
-01 REV
LOT NO:

DRM NO: IVY187 IVY BIOMEDICAL SYSTEMS
ISOLATED INPUT BD. 5082-00-02 REV. 02
SILKSCREEN





DRW NO: IVY188 IVY BIOMEDICAL SYSTEMS MB 1 WITH RECORDER OPTION 5119-00-02 REV 01 SILKSCREEN

SCHEMATICS

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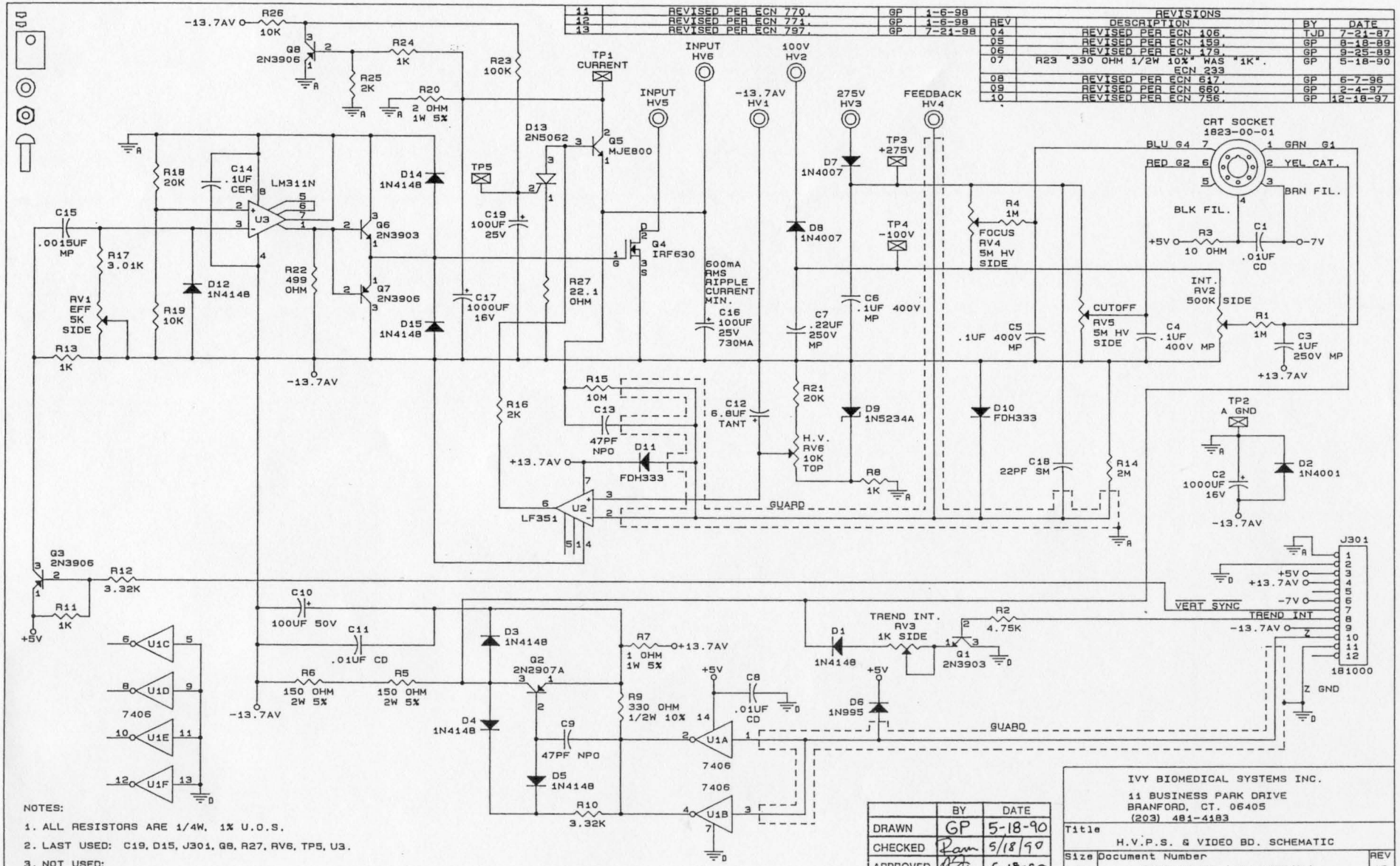

NOTES:

1. ALL RESISTORS ARE 1/4W, 1% U.O.S.
2. LAST USED: C19, D15, J301, Q8, R27, RV6, TP5, U3.
3. NOT USED:

	BY	DATE
DRAWN	GP	5-18-90
CHECKED	Ram	5/18/90
APPROVED		5-18-90

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Title: H.V.P.S. & VIDEO BD. SCHEMATIC

Size: B | Document Number: 5000-00-03 (-01 ASSY/PL) | REV: 13

Date: July 21, 1998 | Sheet 1 of 1

REVISIONS			
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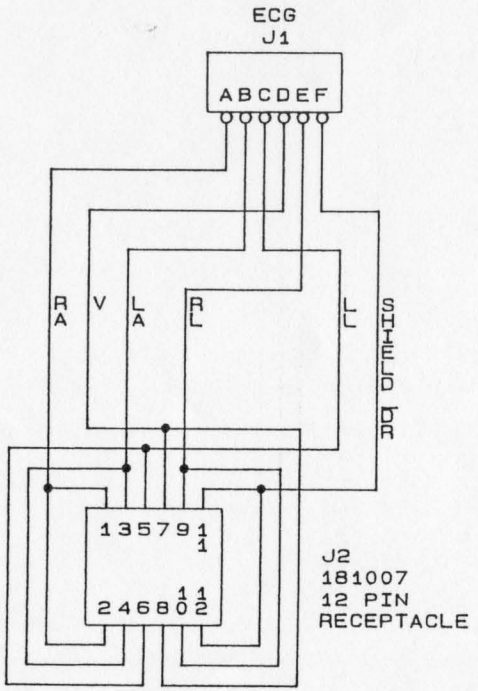
01	REVISED PER ECN 692.	GP	8-28-97
02	REVISED PER ECN 735.	GP	11-24-97



	BY	DATE
DRAWN	GP	7-10-97
CHECKED	Ram	7/10/97
APPROVED		7-10-97

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Title

ECG ISOLATED INPUT BOARD

Size	Document Number	REV
A	5082-00-01 (-03 SCHEMATIC)	02

Date: November 24, 1997 Sheet 1 of 1

REVISIONS			
REV	DESCRIPTION	BY	DATE
01	REVISED FOR REV-01 ARTWORK FAB PER ECN 741.	GP	11-26-97
02	REVISED PER ECN 804.	GP	7-27-98
03	REFERENCE REJECTED ECR 803.	GP	7-27-98
04	REVISED PER ECN 805.	GP	7-27-98
05	REVISED PER ECN 817.	GP	8-5-98
06	REVISED PER ECN 868.	GP	1-25-99
07	REVISED PER ECN 934.	GP	4-12-99
08	REVISED PER ECN 970.	GP	8-5-99
09	REVISED PER ECN 1052.	GP	11-20-00
10	REVISED PER ECN 1104.	GP	7-17-01
11	REVISED PER ECN 1105.	GP	7-17-01
12	REVISED PER ECN 1216.	GP	12-12-02
13	REVISED PER ECN 1217.	GP	12-12-02
14	REVISED PER ECN 1218.	GP	12-12-02
15	REVISED PER ECN 1251.	GP	2-4-03

INSTALL WITH RECORDER OPTION

U1 H.S. LT1085CT-12 — TO SHT. 4 +12VREC — C1 .1UF CER

+12V J201-16 — R97 100 OHM 2W 5% — +10/13.5VDC J201-32

13.4 VAC J201-25 — F3 3ASB 2AG — D8 1N5624

U4 LM78L12ACZ — C4 .1UF CER — +12X TP5

+12V TP9 — R81 470 OHM 1/2W 10% — POWER ON LED J207

+12X — R31 10 OHM — Q13 2N3906

R43 499 OHM — R47 1K — MC34002P U10B — R46 20K — D15 ICL8069CCZR — C30 6.8UF TANT

R45 49.9K — R44 9.09K — +8V TP18 — C23 1000UF 16V

D11 1N5624 — D9 1N5624 — C13 10000UF 35V

U3 LT1085CT-12 H.S. — C3 2200UF 35V — D7 1N5624

FILTER_GND J201-21 — FILTER_GND J201-22

A_GND J201-3 — A_GND J201-33 — A_GND J201-34 — A GND TP24

C12 10000UF 35V — R1 1K — C6 6.8UF TANT — R2 121 OHM — C5 2200UF 35V — D12 1N5624

REC_GND J201-4 — TO SHT. 4

13.4VAC J201-29 — F4 3ASB 2AG — D10 1N5624

U5 LT1033 H.S.

-12V J201-11 — TP10 -12V — -12V — D23 1N5338B — TP20 -7V

R52 10 OHM — Q18 2N3903 — C31 .1UF CER — C32 .1UF CER — MC34002P U10A — R51 499 OHM — R49 1K — R48 10K .1% 10PPM — R50 10K .1% 10PPM — C34 1000UF 16V — TP11 -8V — -8V — -7V

* TRIGGER PULSE OUTPUT

	1ms	100ms/150ms	200ms
C56	.01UF	1UF	.22UF
R111	60.4K	60.4K	806K
RV10	100K	100K	200K

REAR PANEL J201 194000

TO SHT. 4 A_GND Z_GND — TO SHT. 4 Z — AUDIO_HI — AUDIO_OFF — SPEAKER — SPEAKER_GND

V_SYNC- — -12V — -7V — +5V — +12V

6.9_VAC — AUDIO_LO — 6.9VAC

FILTER_GND — AUDIO_SHIELD — 13.4_VAC — ECG_VOLUME — 13.4VAC — ECG_AUDIO — A_GND — FIL_GND

TREND_INT — FILTER_GND — ECG_X1000 — ALERT_OUT — +10/13.5VDC — A_GND — FIL_GND

TO SHT. 4 TRGOUT — R272 1K

TO SHT. 4 DELTRG — C59 1000PF NPO — R113 10K — R112 10K — U14 ICM7556 U18A — TRIGGER TP17 — TIME ADJ. RV10 TOP ADJUST — R111 — C66

+5V J201-12 — C2 1000UF 16V — U2 LM2940T-5.0 H.S. — +5V TP19

6.9_VAC J201-13 — F1 1.5ASB 2AG — D5 1N5624

6.9VAC J201-17 — F2 1.5ASB 2AG — D6 1N5624 — C14 15000UF 16V SH

FIL_GND J201-35 — FIL_GND J201-36

D_GND J201-4 — D_GND J201-5 — D_GND J201-9 — D GND TP15

D28 1N4148 — U18B ICM7556 — TO SHT. 4 LNFREQ — D21 1N4148 — R83 100K — R84 10K — C47 .01UF MP

OPTION 1

C45 100UF 25V — C46 100UF 25V — U12 MC1488P

OPTION 2

R42 1K — 2N3903 Q12 — R41 10K — R271 402 OHM — R40 22.1 OHM — R39 10 OHM — Q11 2N3903 — R38 475 OHM — J206 174000 OUTPUT

OPTION 3

TO SHT. 4 ALERT_AUDIO — AUD. VOL. RV11 20K TOP — R90 2K — C55 10000PF NPO — R88 47.5 OHM — C50 .1UF CER — U13 LF351 — R76 499 OHM — Q20 2N3903 — Q19 2N3906 — R75 47.5 OHM — R82 47.5 OHM — SPEAKER TP14

TO SHT. 4 T500 — C58 .22UF MP — R114 4.75K — R85 1.47M — D29 1N4148 — Q21 2N5460 — R89 4.99K — R91 30.1K — C52 10000PF NPO — R92 49.9K — C51 .1UF CER

AUDIO_OFF J201-10 — C53 .1UF MP

SPEAKER_GND J201-18

SPEAKER J201-14 — C48 .022UF MP — R87 3.01K — R86 30.1K — R77 301K — C49 .0047UF MP

TO SHT. 4 T150- — R96 10K — +5V — C54 .033UF MP

AUDIO_HI J201-6

TO SHT. 4 ECG_AUDIO — R78 5.11K — Q17 2N5460 — D22 1N4148 — R80 1.47M

ECG_AUDIO J201-31 — R79 3.01K

ECG_VOLUME J201-27

AUDIO_LO J201-15 — R95 1K

AUDIO_SHIELD J201-23

NOTES:

1. ALL RESISTORS ARE 1/4W 1% U.O.S.
2. LAST USED: C144,D73,F4,FB4,J207,JP5, L1,LD3,Q48,R274,RN2,RV19, T1,TP43,U54,Y1.
3. NOT USED: JP2,JP3,U19,U37,U50.
4. ONLY 1 OF THE 3 OPTIONS ARE TO BE POPULATED WITH COMPONENTS AT A TIME.

LINK
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C:\ORCAD\SHEET\SH5119\5119-003.SCH
C:\ORCAD\SHEET\SH5119\5119-004.SCH
C:\ORCAD\SHEET\SH5119\5119-005.SCH

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(203) 481-4183

Title: MOTHER BOARD 1 ASSY, WITH RECORDER OPTION

Size: C — Document Number: 5119-00-01 (-03 SCHEMATIC) — Rev: 15

Date: Tuesday, March 08, 2005 — Sheet 1 of 4

REVISIONS			
REV	DESCRIPTION	BY	DATE
01	REVISED FOR REV-01 ARTWORK FAB PER ECN 741.	GP	11-26-97
02	REVISED PER ECN 804.	GP	7-27-98
03	REFERENCE REJECTED ECR 803.	GP	7-27-98
04	REVISED PER ECN 805.	GP	7-27-98
05	REVISED PER ECN 817.	GP	8-5-98
06	REVISED PER ECN 868.	GP	1-25-99
07	REVISED PER ECN 934.	GP	4-12-99
08	REVISED PER ECN 970.	GP	8-5-99
09	REVISED PER ECN 1052.	GP	11-20-00
10	REVISED PER ECN 1104.	GP	7-17-01
11	REVISED PER ECN 1105.	GP	7-17-01
12	REVISED PER ECN 1216.	GP	12-12-02
13	REVISED PER ECN 1217.	GP	12-12-02
14	REVISED PER ECN 1218.	GP	12-12-02
15	REVISED PER ECN 1251.	GP	2-4-03

NOTES:

1. ALL RESISTORS ARE 1/4W 1% U.O.S.
2. LAST USED: C144,D73,F4,FB4,J207,JP5, L1,LD3,Q48,R274,RN2,RV19, T1,TP43,U54,Y1.
3. NOT USED: JP2,JP3,U19,U37,U50.

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Title	MOTHER BOARD 1 ASSY, WITH RECORDER OPTION	
Size: C	Document Number: 5119-00-01 (-03 SCHEMATIC)	Rev: 15
Date: Tuesday, March 08, 2005	Sheet 2 of 4	

REVISIONS			
REV	DESCRIPTION	BY	DATE
01	REVISED FOR REV-D MOTHERBOARD PCB FAB PER ECN 741.	GP	11-29-87
02	REVISED PER ECN 804.	GP	7-27-88
03	REFERENCE REJECTED CCR 803.	GP	7-27-88
04	REVISED PER ECN 805.	GP	7-27-88
05	REVISED PER ECN 817.	GP	8-5-88
06	REVISED PER ECN 884.	GP	1-25-89
07	REVISED PER ECN 924.	GP	4-12-89
08	REVISED PER ECN 970.	GP	8-2-89
09	REVISED PER ECN 1065.	GP	11-20-00
10	REVISED PER ECN 1104.	GP	7-17-01
11	REVISED PER ECN 1105.	GP	7-17-01
12	REVISED PER ECN 1216.	GP	12-12-02
13	REVISED PER ECN 1217.	GP	12-12-02
14	REVISED PER ECN 1218.	GP	12-12-02
15	REVISED PER ECN 1251.	GP	2-4-03

SHIELD

ISOLATED

NON-ISOLATED

NOTES:

1. ALL RESISTORS ARE 1/4W 1% U.O.S.
2. LAST USED: C144,D73,F4,FB4,J207,JP5, L1,LD3,Q48,R274,RN2,RV19, T1,TP43,U54,Y1.
3. NOT USED: JP2,JP3,U19,U37,U50.

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Title: MOTHER BOARD 1 ASSY, WITH RECORDER OPTION

Size: D | Document Number: 5119-00-01 (-03 SCHEMATIC) | Rev: 15

Date: Tuesday, March 08, 2005 | Sheet 3 of 4

REVISIONS			
REV	DESCRIPTION	BY	DATE
01	REVISED FOR REV.D WORKSTAB PER ECN 741.	GP	11-28-97
02	REVISED PER ECN 804.	GP	1-27-98
03	REFERENCE REJECTED ECR 803.	GP	7-27-98
04	REVISED PER ECN 805.	GP	7-27-98
05	REVISED PER ECN 817.	GP	8-5-98
06	REVISED PER ECN 984.	GP	1-25-99
07	REVISED PER ECN 924.	GP	4-12-99
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10	REVISED PER ECN 1104.	GP	7-17-01
11	REVISED PER ECN 1105.	GP	7-17-01
12	REVISED PER ECN 1216.	GP	12-12-02
13	REVISED PER ECN 1217.	GP	12-12-02
14	REVISED PER ECN 1218.	GP	12-12-02
15	REVISED PER ECN 1251.	GP	2-4-03

INSTALL WITH RECORDER OPTION

INSTALL WITH RECORDER OPTION

NOTES:

1. ALL RESISTORS ARE 1/4W 1% U.O.S.
2. LAST USED: C144,D73,F4,FB4,J207,JP5, L1,LD3,Q48,R274,RN2,RV19, T1,TP43,U54,Y1.
3. NOT USED: JP2,JP3,U19,U37,U50.

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Title: MOTHER BOARD 1 ASSY, WITH RECORDER OPTION

Size: D | Document Number: 5119-00-01 (-03 SCHEMATIC) | Rev: 15

Date: Tuesday, March 08, 2005 | Sheet 4 of 4