PS-416

Patient Simulator

Operating and Service Manual

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ATTENTION: MANUFACTURERS/IMPORTERS OF PATIENT MONITORING OR ECG DIAGNOSTIC EQUIPMENT.

The model PS-416 patient simulator is intended to be used as a simulation device only. Recommended applications include routine preventive maintenance inspections and as a sales demonstration or training tool. The model PS-416 patient simulator is not to be used as the primary calibration standard or the certification test instrument for medical devices.

February 1991.

SPECIFICATIONS

SECTION 1

INTRODUCTION

The Model PS-416 is a high performance patient simulator which includes simulation of ECG, respiration, dynamic blood pressure and static temperature. All functions are set from a 2 digit display operated by a 5 switch keyboard and 5 slide switches. The unit has 3 electrically isolated sections. The main section contains ECG and respiration. Blood pressure is in another isolated section. Temperature is in the third isolated section.

ECG

ECG configuration is 12 lead with independent outputs for each signal lead referenced to RL. A HIGH LEVEL ECG output is also included. Waveforms include NSR from 30 to 240 BPM, performance waveforms, paced and a selection of arrhythmias. Amplitude is ad~ustable on all waveforms.

NORMAL ECG

RATES: 30, 60, 80, 120, 160, 200, 240 BPM. Accuracy is 1%. Auto steps through the rates at 30 second intervals.

AMPLITUDES: 0.5mV, 1.OmV, 1.5mV and 2.OmV on lead II. Accuracy is 5%. The high level output is approximately 0.5V per mV of the low level output

IMPEDANCE: Limb leads are selectable at 500ohm and lOOOohm. V leads are lOOOohm. Accuracy is 5%.

ECG PERFORMANCE

Amplitudes set by ECG AMPLITUDE.

SQUARE: Rate is 2 Hz

PULSE: 4 Seconds

TRIANGLE: 2 Hz

SINE: 0.5, 10, 40, 50, 60 and 100 Hz

AUTO: Starts at a 2 Hz square wave. Depress the execute key to advance the waveform to pulse. After one pulse it automatically steps through the sine waves at 2 second intervals. The sequence holds at the triangle wave until the execute key is pressed again. The square wave will then resume.

OTHER WAVEFORMS

AFIB, 2~BLK II, RBBB, PAC, PVC EARLY, PVC STD, PVC R ON T, MF PVC, BIGEMINY, RUN OF 5 PVC, VTACH, VFIB, PACED, and FETAL/MAT.

BLOOD PRESSURE

INPUT/OUTPUT IMPEDANCE: 300 ohms

EXCITER INPUT VOLTAGE RANGE: 2 to 16 V

EXCITER INPUT FREQUENCY RANGE: DC to 4000 Hz

OUTPUT SENSITIVITY: 5 or 40 uV/V/mmHg

OUTPUT RANGE: O to +300 mmHg

ACCURACY: 1% of range + 1 mmHg at 80 BPM, normal sinus ECG only.

RATES: All dynamic pressures track all normal sinus rates and physiologically track all arrhythmias.

ISOLATION: BP is electrically isolated from the rest of the unit.

WAVEFORMS:

ATM (O mmHg)
ARTERIAL (120/80 mmHg)
LEFT VENTRICLE (120/0 mmHg)
RIGHT VENTRICLE (25/0 mmHg)
PULMONARY ARTERY (2 5/10 mmHg
PAW (10/2 mmHg)
STATIC: 0, 20, 40, 80, 100, 200, 250, 300 mmHg

RESPIRATION

OUTPUT CONFIGURATION: Lead I, II or RL-LL

BASELINE IMPEDANCE: 500 or 1000 ohms . Accuracy is 5% .

DELTA IMPEDANCE: O, O . 1, O . 2, O . 5, 1 . O and 3.O ohms. Accuracy is 10%.

RATES: APNEA, 15, 20, 30, 40, 60, and 120 BrPM Accuracy is 5%

TEMPERATURE

SELECTIONS: 30°, 37° 40°. Accuracy is .4°C.

PROBE COMPATIBILITY: 400 and 700 series YSI types

ISOLATION: Electrically isolated from the rest of the instrument.

POWER REQUIREMENTS
9V battery. 50 hour life. Battery eliminator optional.

STANDARD ACCESSORIES

Soft Vinyl Carrying Case

Instruction Manual

OPTIONAL ACCESSORIES

Battery Eliminator (UL approved)

BP Cable, unterminated. part no. 3010-0048

BP Cable, prewired for selected patient monitors
Consult current price list.

Temperature Cable for 400 YSI.
part no. 3010-0192.
Temperature Cable for 700 YSI.
part no. 3010-0193.

Calibration Cables

Blood Pressure, part no. 3010-0205

Temperature, part no. 3010-0288.

PHYSICAL CHARACTERISTICS

HEIGHT: 1.8 inches
WIDTH: 4.0 inches
LENGTH: 7.4 inches
WEIGHT: 2.0 pounds

TEMPERATURE REQUIREMENTS

OPERATING: 59°F to 95°F (15°C to 35°C)
STORAGE: 32°F to 131°F (0°C to 55°C)

STORAGE

Store in the supplied carrying case with the battery removed. Store in dry area within storage temperature limits. There are no other storage requirements.

PERIODIC MAINTENANCE

It is recommended that the unit be calibrated at 6 month intervals.

INTENDED USE

The model PS-416 is intended for use in hospitals to check the operation of patient monitors. It is not intended for calibration purposes.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

INSTALLATION

SECTION 2

INTRODUCTION

This section contains information for making a visual and electrical inspection of the instrument, processing a claim, repackaging for shipment, and installation procedures.

UNPACKING AND INCOMING INSPECTION

Standard receiving practices should have been followed upon delivery of the instrument; i.e., the shipping carton should have been checked for damage and if damage was found, the carrier's agent should have been asked to be present while the instrument was unpacked. There are no special unpacking instructions but care should be taken to not damage the unit. Inspect the unit for physical damage, such as bent or broken parts, dents or scratches.

CLAIMS

If physical damage is found or operation is not within specifications when the instrument is received, notify the carrier immediately. Please read the sheet on damage and shortage in the back of the manual. If Metron A/S or the factory representative is notified, arrangements will be made for repair or replacement of the instrument without waiting for settlement of carrier's claim, however, a new purchase order must be issued to cover this work.

WARRANTY REPAIR

The warranty statement for all Metron A/S products is printed on the back side of the title page of this manual.

The warranty does not cover the cost of transportation. No C.O.D. shipment will be accepted without prior authorization. All transportation and phone charges will be billed to the customer.

REPACKAGING FOR SHIPMENT

When shipping an instrument to Metron A/S, attach a tag describing the required services and include Model number, Serial number, and return address.

Use the original carton and packaging material for shipment. If they are not available, use the following guide for repackaging:

a) Use a double walled carton of sufficient strength for the weight to be shipped.

b) Use heavy paper or cardboard to protect all instrument surfaces. Use a non-abrasive material around all projecting parts.

c) Use at least four inches of tightly packed industrial approved shock-absorbent material around the instrument.

PREPARATION FOR USE

The Model PS-416 is a portable instrument designed for battery operation.

Contact Metron A/S for special cables.

OPERATION

SECTION 3

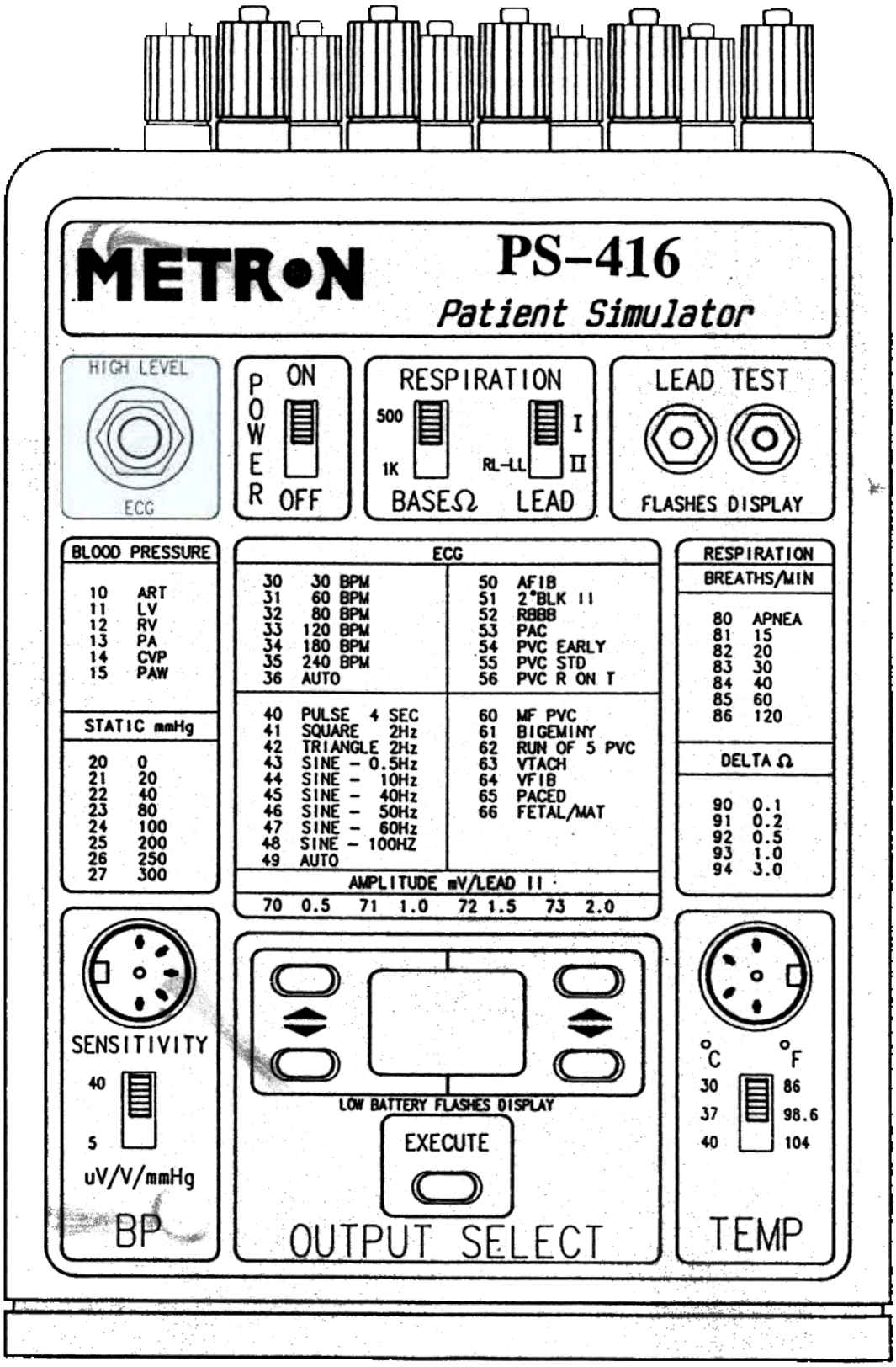


FIGURE 3-1
CONTROLS and FUNCTIONS

INTRODUCTION

This section contains operating instructions and explanations of the controls and indicators (figure 3-1) for the Model PS-416 Patient Simulator.

POWER

The power switch is a slide switch located on th top panel. To increase battery life, turn the instrument off when not in use. The display will indicate a low battery condition by flashing.

BATTERY REPLACEMENT

The battery compartment is accessible from the bottom of the unit. Replace with one 9 Volt alkaline battery (Duracell MN1604 or equivalent).

NOTE: Do not use mercury, air, or carbon-zinc batteries.

TOP PANEL CONTROLS AND CONNECTORS

DISPLAY AND KEYBOARD

The PS-416 has a two digit display. Above the display on the top panel is a list of the available waveforms and an associated 2 digit number. To execute a waveform, set its number in the display using the 4 increment/decrement keys directly to the left and right of the display. Then execute the waveform with the execute key.

HIGH LEVEL ECG OUTPUT

A lead II waveform at .SV per mV of the low level lead II signal is output at the High Level ECG jack (a 1/4 inch standard phone jack), located on the top panel of the PS-416. For use with high level input monitors.

RESPIRATION

The respiration signal is contained within the ECG leads. The LEAD SELECT switch determines which lead it is on. This must be set to correspond to the type of patient monitor used. The BASELINE IMPEDANCE switch sets the impedance between any two limb leads. Respiration parameters (breaths/min) are set and executed from the keyboard of the PS-416.

BLOOD PRESSURE

Cables to connect to the blood pressure connector are available from Metron A/S (figure 3-2). For many monitors, the cables are available pre-wired. Unterminated cables are available for other monitors. The SENSITIVITY switch must be set to match the patient monitor's input sensitivity (either 5 or 40 uV/V/mmHg). Waveform is determined by the PS-416 keyboard.

TEMPERATURE

Cables to connect to the temperature connector are available from Metron A/S. The type of cable used determines the type of probe simulated, either 400 or 700 series YSI probes. Temperature is selectable by a slide switch.

LEAD TEST

Tests continuity of ECG leads. Connect each end of the lead to be tested to the two lead test terminals. Display flashes if the lead is good.

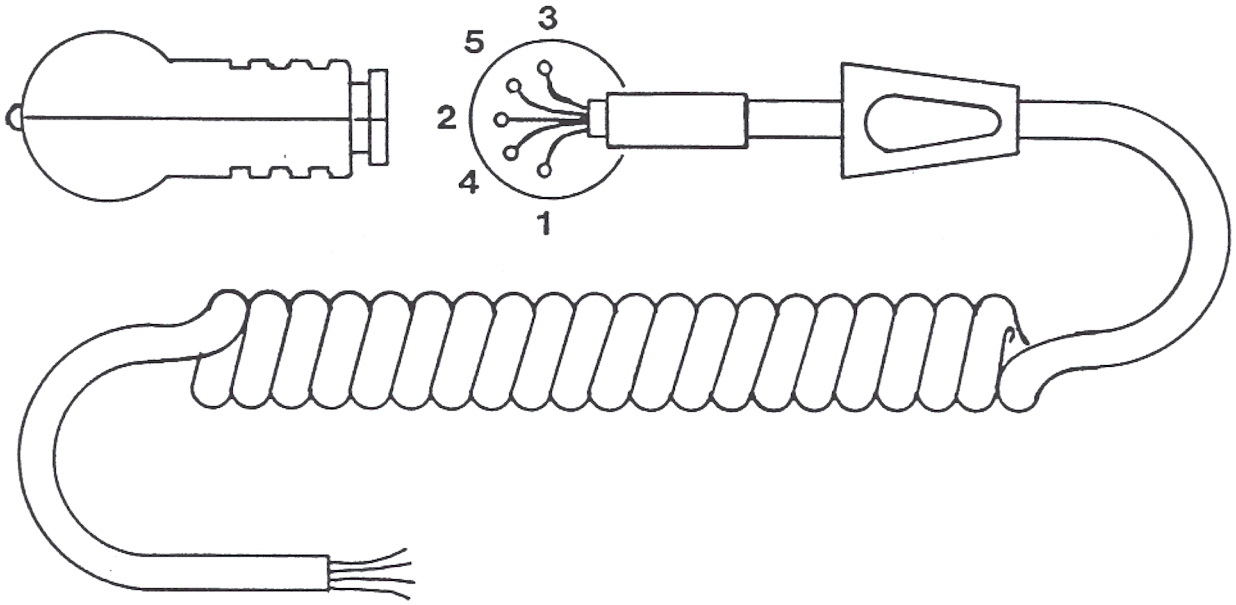
REAR PANEL CONNECTORS

ECG LEADS

Ten special binding posts are compatible with disposable snaps and 3.2mm or 4mm electrodes and banana plugs. Waveform parameters are selectable from the keyboard.

BATT ELIM

The unit has a micro jack for the battery eliminator option. Use only eliminators supplied by Metron A/S.



WIRING TABLE

FUNCTION	COLOR	PIN NO
OUTPUT(+)	BLACK	4
OUTPUT(-)	RED	1
EXCITER(+)	WHITE	3
EXCITER(-)	GREEN	5
ECG REF	BLUE	2

Patient Simulator
B.P. OUTPUT CABLE ASSEMBLY

FIGURE 3-2

Section 4

Preformance Check and Calibration

PERFORMANCE CHECK

The following procedure completely checks out the operation of the Model PS-416.

EQUIPMENT REQUIRED

PATIENT MONITOR with ECG, respiration, blood pressure, temperature and cardiac output.

INTERCONNECT CABLES for the above functions. These are available from Metron A/S for most monitors.

DIGITAL MULTIMETER.

The PS-416 operating modes are selected from the keyboard
on the PS-416. See the operating procedure for details.
See specifications for tolerances.

1. Install a battery and turn the PS-416 on. The display will read the software revision, then after a few seconds it reads 32.

2. Short the LEAD TEST terminals together and the display should flash.

3. Check the resistance between RL and each of the other limb leads (RA, LA, LL) in both BASELINE IMPEDANCE switch positions. When measuring LL, set the sead switch to I, and when measuring LA, set the sead switch to II. Resistance tolerances: 475-525 and 950-1050. Return the BASELINE IMPEDANCE switch to 500n.

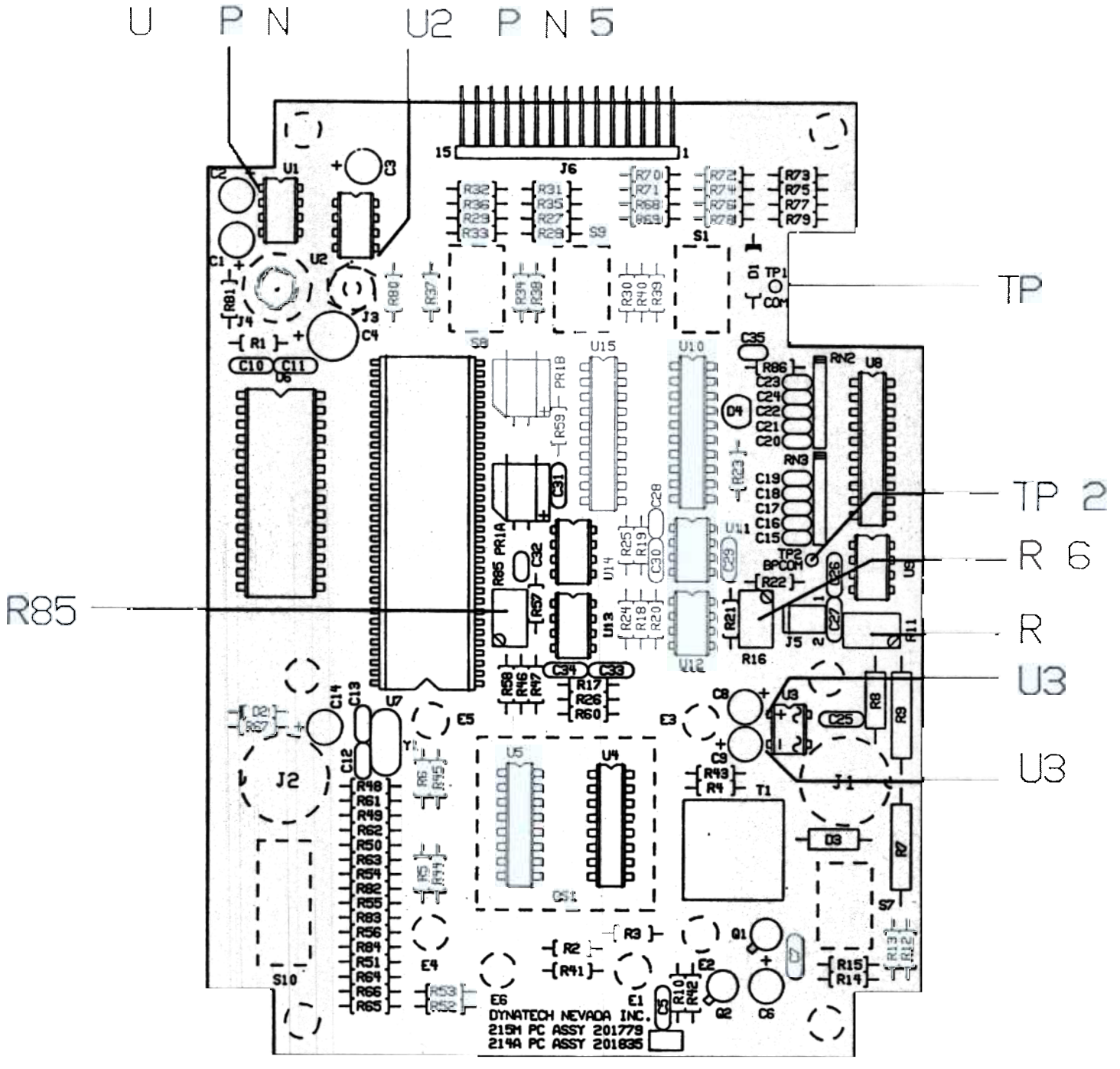
4. Check that the resistance between Vl and each of the other V leads is 95o-lo5o ohm.

5. Connect the ECG posts on the PS-416 to the monitor. Set the Model PS-416 to 80BPM and lmV. Check the rate and amplitude on the monitor.

6. Set the monitor to measure respiration. Set the LEAD SELECT SWITCH for the lead the monitor uses. Set the Model PS-416 for 20BrPM and 1 ohm. Check the rate on the monitor.

7. Connect the BLOOD PRESSURE to the monitor. Set the SENSITIVITY SWITCH as required for the monitor. Set the PS-416 to ATM and zero the monitor. Set the PS-416 to 300mm and the monitor should read 300mm.

8. Connect the monitor to the temperature channel. Check the monitor reading in all three temperature switch settings.



FIGUR 4 1

ADJU TM NT LOCATOR

CALIBRATION

This section includes the procedure for a complete calibration of the PS-416. Refer to figure 4-1 for the location of all adjustments.

EQUIPMENT REQUIRED

DIGITAL MULTIMETER: 5 1/2 digit

DC VOLTAGE SOURCE: 10V ± 10mV @ 30mA

CALIBRATION CABLES: available from Metron A/S
Blood Pressure part no. 3010-0205.

SETUP

Remove the four screws on the bottom cover. Pull the bottom cover off.

Set the top panel switches as follows.

BASELINE IMPEDANCE	500
LEAD SELECT	II
SENSITIVITY	40

CALIBRATION PROCEDURE

1. Turn the Model PS-416 on. Test the power supplies using the following chart. All readings in volts.

TEST POINTS	LOW LIMIT	HIGH LIMIT
U1 pin1 - TP1(low)	+4.75	+ 5.25
U2 pin5 - TP1(low)	-5.00	-10.00
U3 pin+ - TP2(low)	+4.70	+ 5.20
U3 pin- - TP2(low)	-4.70	- 5.20

2. Check for at least 1Mn between TP1 and TP2.

3. Turn the power off. While depressing the EXECUTE switch turn the power back on. This enters the calibration procedure. The display should read 00.

4. Connect a DMM to LL and RA (low). Execute a display setting of 00. Record the DMM voltage reading (typically < .1mV).

5. Set the display to 01 and execute it. Adjust R16 for the voltage to be 2mV plus the voltage measured in step 19. Be sure to include the voltage polarities when adding the readings. The adjustment tolerance is +/-.020mV.

6. Connect the DMM to LL and RA (low). Set the display to 02 execute it. Record the DMM resistance reading (typically 500 + 25ohm).

7. Set the display to 03 and execute it. Adjust R85 for the reading in step 6 plus 3ohm.

8. Repeat steps 6 and 7 until the difference between the reading is 3 +/- .o3ohm.

9. Move the DMM to LA and RA. Set the BASELINE IMPEDANCE SWITCH to lead I. Remeasure the resistance using the procedure in steps 6 and 7 but do not readjust R85. The result should be 3 +/- .3ohm.

10. Connect a blood pressure calibration cable (# 3010-0205) to the blood pressure connector. Connect the other end of the cable to a +10V power source and the DMM as shown in the following chart.

CABLE WIRE CONNECTION

GRY +10 V
GRN GND FOR 10V
BLK +DMM
RED -DMM

With the cable connected check that the +10V voltage source is 10 +- .01V.

11. Set the display to 04 and execute it. Record the DMM voltage reading (typically < 1mV).

12. Set the display to 05 and execute it. Adjust R11 for the reading in step 12 plus 120mV. The adjustment tolerance is .2mV.

CIRCUIT DESCRIPTION

SECTION 5

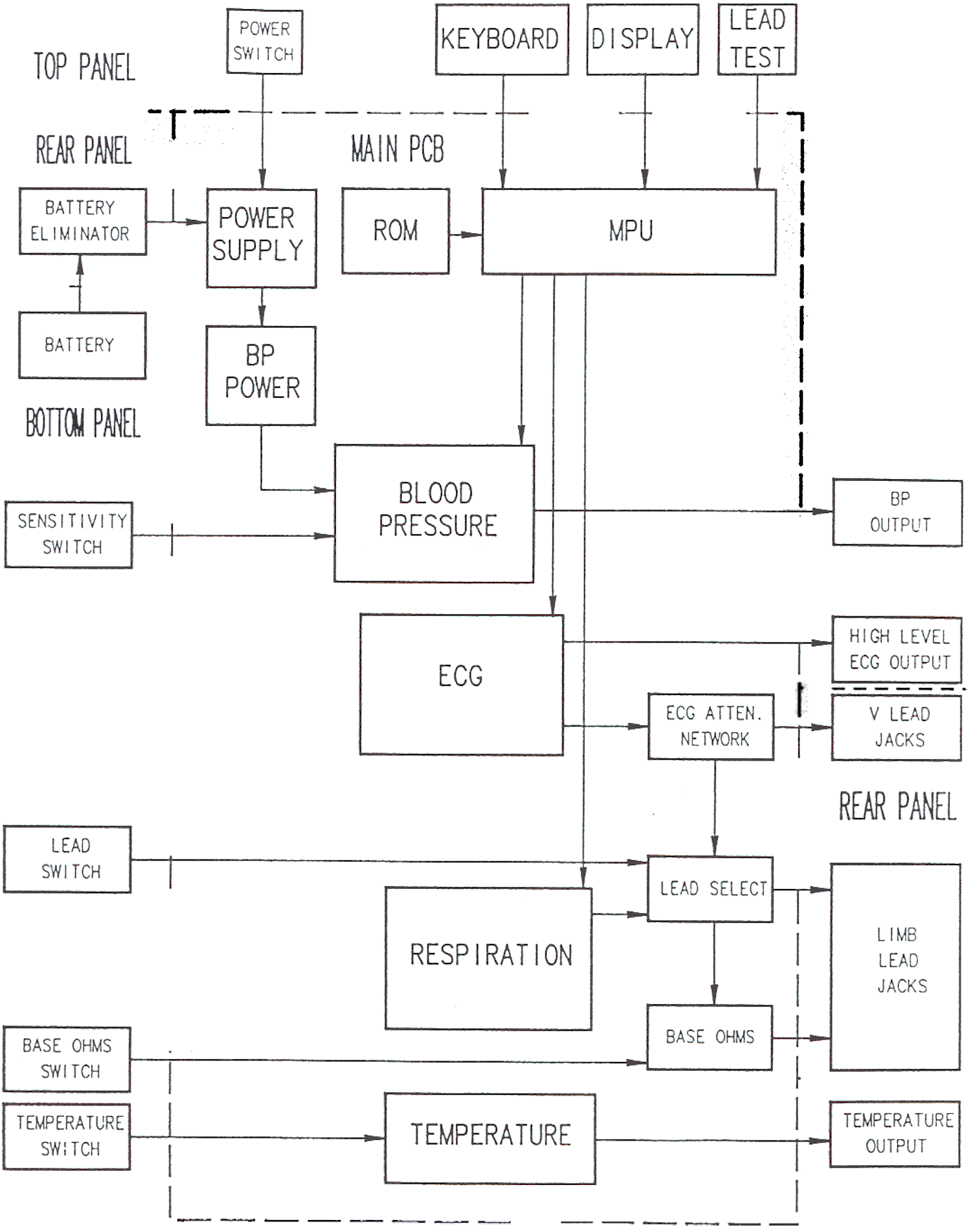


FIGURE 5-1
MODEL PS-416 BLOCK DIAGRAM

INTRODUCTION

The Model PS-416 Patient Simulator is a battery powered microprocessor controlled device with a two digit liquid crystal display.

Schematic 1 shows the microprocessor, power supplies, switch PCB, display, and temperature simulation circuit.

Schematic 2 contains the blood pressure and circuitry, and rear panel jacks.

BLOCK DIAGRAM DESCRIPTION

Refer to figure 5-1 for the block diagram. Words in CAPITAL LETTERS in the following text refer to blocks in the block diagram.

The POWER SWITCH connects the BATTERY (or battery eliminator) to the POWER SUPPLIES. Information from the KEYBOARD instructs the MPU which function to execute. The number of the selected function is shown on the DISPLAY. The MPU uses the programmed information from ROM to control the Model PS-416. The MPU controls operation of the BLOOD PRESSURE, ECG, and RESPIRATION circuitry.

The BLOOD PRESSURE circuit processes data from the MPU and sends it to the BP OUTPUT. The BP SENSITIVITY switch determines the uV/V/mmHg output sensitivity of the BLOOD PRESSURE circuit.

The ECG circuit processes data from the MPU which is output at the HIGH LEVEL ECG OUTPUT jack. Another signal from the ECG circuit is routed to the ECG ATTENUATION NETWORK before being output at the V LEAD and LIMB LEAD JACKS.

The LEAD SWITCH determines which ECG LIMB LEADS the RESPIRATION signal will be output to. The BASE OHMS SWITCH sets the output resistance of the LIMB LEADS to be either 500n or 1Kn.

The setting of the TEMPERATURE SWITCH determines which temperature the TEMPERATURE circuit will simulate.

Shorting the LEAD TEST terminals together with a good ecg lead will cause the MPU to flash the DISPLAY.

SCHEMATIC 1 OF 2

POWER SUPPLIES

The power supply consists of U1, U2, D1, C1, C2, C3, and C4. The Model PS-416 patient simulator is a battery operated unit that uses either a 9.0 volt battery or battery eliminator (connections for battery and eliminator shown on schematic 2).

U1 is a low power voltage regulator. D1 protects U1 and U2 in the event the battery is connected to the unit backwards. C1 helps reduce noise to the voltage input at U1-8. The input voltage is then regulated to +5.0V at U1-1. If the battery voltage goes too low (approximately 6 volts), the voltage level at pin 5 will go low. This signal will instruct the CPU to flash the display. At all other times, the signal at U1-5 is pulled to +5V by R80.

U2 is a voltage inverter that switches a positive voltage to a corresponding negative voltage. C3 charges to the input voltage (at pin 8) which is internally transferred from a positive voltage to a negative voltage. This voltage is then output to pin 5 of U2. C4 reduces the output ripple. The negative voltage is then used by the ECG and respiration op amps.

ISOLATED BLOOD PRESSURE POWER SUPPLY

The blood pressure power supply consists of components T1, U3, Q1, Q2, C5-C9, and R10. This supply generates +5V and -5V for use in the blood pressure circuitry only.

The components Q1, Q2, C6, and C7 create an oscillator circuit at the primary winding of transformer T1 (pins 4, 6, 9, and feedback winding, pins 1, 2, and 3) C5 and R10 set the operating current. T1 then steps the primary voltage up at the secondary winding. U3 rectifies the square wave output at T1 to +5Vdc and -5Vdc. C8 and C9 act as filter caps to eliminate any voltage spikes.

CONTROLLING CIRCUITRY

This circuit is composed of U7, U6, Y1, J3, SWITCH PCB, and related components.

MICROPROCESSOR (U7)

The Model PS-416 is controlled by an HD63A03XP CMOS 8-bit Micro Processing Unit (MPU). This IC features 192 bytes of RAM and 24 parallel I/O pins: 16 I/O pins at Ports 2 and 6; 8 input pins at Port 5.

The MPU is powered by VCC and VSS (pins 33, 1, and 42). VCC requires +5V (+4.50V - +5.50V) and VSS is tied to ground. The system clock is derived from the crystal Y1 and the MPU. Y1 oscillates at a frequency of 4MHz which is then divided down to 1MHz internally by the MPU.

D2, R67, and C14 comprise the MPU reset circuit. When the Model PS-416 is powered up, current through R67 will begin to charge C14. The active low RST (U7-6) line remains low until C14 charges and causes it to go high, thereby initiating MPU operation. A delayed reset after powerup insures that all the circuitry has stabilized before the MPU starts.

Three I/O ports are configured as follows:

PORT 6 8 bit I/O	P60 to P67	To systemdata bus.
PORT 2 8 bit I/O	P20 to P27	Control lines forECG, BP, resp, and display flash
PORT 5 8 bit Input only	P5 to P57	Switch PCB input and low battery input signal.

MEMORY (U6)

Software containing information to run the Model PS-416 resides at U6, a 32Kx8 ultraviolet erasable, electrically programmable read only memory (ROM). A decoupling capacitor, C10, is connected from VCC to GND to suppress voltage peaks, and prevent possible damage to the memory. U6 is the only ROM sending data to the MPU. There is no need, therefore, to ever strobe the chip select line (CS, U6-20), so this line is tied to ground. A low signal to the memory request line (MR, U6-22) will initiate data read by the MPU.

KEYBOARD

Port 5 of the MPU (P51 - P57) is the input port for the keyboard. These lines will be pulled high by RN1 (resistor network 1) until one of the keys (function, select, or execute) on the front panel of the Model PS-416 is pressed, connecting that line to ground. The MPU continually strobes the Port 5 inputs, looking for a low signal from the keyboard.

DISPLAY

The display circuit contains U4, U5, and DS1

U4 and U5 are two BCD-to-seven segment latch/decoder/ drivers required to operate the two digit liquid crystal display (LCD). The MPU will send an active high signal to the latch enable (LE) input of each driver. This will allow the BCD (binary coded decimal) data from Port 6 of the MPU to be latched in at pins 5, 3, 2, and 4 of each decoder. U4 drives the MSD (most significant digit) and U5 the LSD (least significant digit).

A OV to +5V, 60 Hz square wave generated by the MPU is sent to pins 1, 2, 6, and 18 of the display (DS1) to drive the background of the LCD. The same 60 Hz square wave is also sent to the phase input (PH) at pin 6 of each of the decoders (U4 and U5). The phase input will reverse the phase of the A-G outputs of the decoders in relation to the phase of the LCD background. Example: when the phase of the "A" output of a decoder is opposite that of the LCD background, the "A" segment of the digit will be turned on, or be darker than the background.

TEMPERATURE SIMULATION

A parallel resistor network comprises the temperature circuit which simulates temperature thermistors used in the patient.

LEAD TEST

Connecting a good ECG cable or lead across the lead test terminals J3 and J4 will effectively short the two terminals together. This will cause the input to U7-9 to go low, instructing the MPU to flash the display. If the test lead is open, J3 and 4 will not be shorted together and the signal line at U7-9 will be pulled to +5V by R81.

SCHEMATIC 2 OF 2

POWER INPUT

BATTERY AND BATTERY ELIMINATOR

Connections for unit power input on the rear panel are at J6, pins 13 and 15. J17 is the connector for the battery eliminator, which is located on the rear panel. J18 is the connector for the battery, located in the battery compartment on the bottom of the unit.

BLOOD PRESSURE

The blood pressure circuit has been designed to be electrically isolated from the ECG circuitry in order to eliminate any ground return interference or offset problems caused by monitors. The major components comprising the blood pressure circuit are U8, U9, and S7.

DAC

U8 is a 12 bit multiplying digital to analog converter (DAC) that interfaces directly with the MPU.

Digital data is input to the DO - D7 pins of U8, with DO being the LSB and D7 the MSB. Connecting the chip select input (CS) to BP ground enables Write 1 (WR1). WR1 is an active low input that enables the loading of data at DO-D7 into the internal input latch of the chip.

U8 is capable of processing 12 bits of information. Since only 8 data lines are connected to the IC, the byte select control line (B1/B2) determines the order in which data is latched into the IC. When B1/B2 is high, the first 8 bits of data are latched. When B1/B2 is low, the remaining bits are latched.

Write 2 (WR2) enables data transfer from the input latch to the output latch of the IC once both input bytes have been latched. The data inputs are capacitively coupled to maintain BP circuit isolation. C25 provides a return current path for these capacitors.

A reference voltage (VREF) for DAC operation is supplied by the positive exciter voltage from the blood pressure monitor probe connected to the Model PS-416 top panel BP input. This reference voltage may be any where from 2 to 16Vac or dc. RFB input is an internal feedback resistor for the op amp U9.

OUT1 (U8-11) supplies current to op amp U9. The reference voltage is multiplied by the data from the data bus to produce the current output at OUT1.

SIGNAL AMPLIFICATION

An LF441A low power, low offset voltage, JFET-input operational amplifier (U9), takes the current output of the D to A converter and produces a voltage output proportional to the current input. The voltage is adjustable through R11, (BP AMPL) then attenuated according to the sensitivity switch setting. When switch S7 is set to 40uV/V/mmHg, output signal is attenuated by the voltage divider of R12 and R15. Setting S7 to 5uV/V/mmHg results in signal attenuation by R12, R13, and R14.

The 40uV/V/mmHg setting results in each exciter volt being equal to 40uV/mmHg. Example: if the exciter voltage input at J1-3 (+EXC) was 5V, the output at J1-1 (-OUT) will be 20uV/mmHg if the unit is set to output 100mmHg. If the switch is set to 5uV/V/mmHg, the output would be 2.5uV/mmHg.

The ECG circuit is formed by U10, U11, U12A and B, and the ECG posts on the rear panel.

DAC

U10 (this description will also apply to U15) is an 8 bit digital to analog converter which interfaces directly with the microprocessor. The MPU transmits data via the data bus to the U10 data input pins DO-D7. Data is loaded into the DAC's internal register whenever WR1 is low and LF is high concurrently.

OUT1 outputs current to op amp U11. The current output is determined by multiplying the reference voltage by the data input to U10.

SIGNAL AMPLIFICATION

The current signal from U10 (OUT1) is processed by U11 and U12A. The voltage output of these op amps is adjusted by R16 (ECG AMPL).

Resistors R68-R79 constitute the attenuation network for the ECG waveform at V1-V6, and R30, R34, and R38-R40 form an attenuation network for the limb leads.

HIGH LEVEL OUTPUT

U12B utilizes the ECG waveform signal at the output of U11 and data information from the MPU to develop the 1V high level ECG output at J17.

The PACE control line generated at the MPU introduces a voltage spike to the ECG circuit that simulates a pacemaker spike.

RESPIRATION

The respiration waveform is generated by U15, U14, U13, and PR1A and PR1B.

DAC

D to A conversion by U15 is the same as that of U10. Refer to description under ECG DAC.

SIGNAL AMPLIFICATION

Op amp U14 produces a voltage output at pin 6 proportional to the current input at pin 2. Signal amplitude is set by R85 (RESP AMPL) and R57. The signal is then sent to the inverting input of U13. U13 determines the amount of current through two photoisolators, PR1A and PR1B. The light emitted by the LED's is proportional to the amount of current flowing through them from the output of U13. The resistance of the photoresistors then varies in proportion to the light generated by the diodes. In this manner, the voltage output from U13 is converted to a resistance that varies to simulate respiration. The signal is then routed to the selected ECG lead.

S8, the lead selection switch, determines whether the respiration signal goes to LL or LA. Resistors R30, 34, 38, 40, and 39 form the network by which baseline ohms is determined. This can be either 1Kohm or 500ohms as selected by the BASE ohm switch S9.