Battery Support System

Operating Instructions Summary

These operating instructions are for quick reference only. See the Battery Support System Operating Instructions for detailed information.

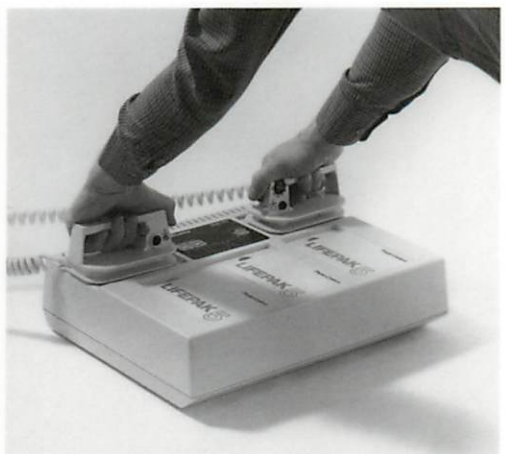
BATTERY CARE AND MAINTENANCE

- Always use the Battery Support System to charge LIFEPAK® 5 batteries.
- Do not put fully charged batteries in the Battery Support System for charging.
- Charge batteries in the ambient (room) temperature ranges of 20°C to 30°C.
- Do not deplete batteries below their cutoff voltage (as indicated by low battery warning on LIFEPAK 5 equipment).
- Rotate batteries through all LIFEPAK 5 equipment.
- Perform at least 3 reconditioning cycles with all batteries once every 90 days.
- Use batteries regularly. If batteries are stored, perform a reconditioning cycle before using.

DEFIBRILLATOR TESTING

1. Select the desired delivered energy test level by pressing either TEST LOAD SELECT control.
2. Position the defibrillator paddles so that the APEX paddle is centered on the right TEST LOAD PLATE and STERNUM paddle is centered on the left TEST LOAD PLATE. PADDLE SURFACES SHOULD NOT COME IN CONTACT WITH ANY OTHER SURFACE OF THE BATTERY SUPPORT SYSTEM.
3. Charge the defibrillator to the delivered energy test level displayed on the control panel.
4. APPLY FIRM PRESSURE with both paddles on the TEST LOAD PLATES and discharge the defibrillator.
5. If the energy delivered is within ± 10% of the selected level, the selected level will be displayed. Delivered energy levels outside these limits will be displayed as an actual value.

CAUTION: For multiple delivered energy tests, deliver only 15 defibrillation pulses at maximum energy in a 10 minute period. Afterward, allow a 15 minute resting period. Do not deliver more than 20 defibrillation pulses in one hour. This will avoid heat build-up and subsequent damage to the unit.



BATTERY CHARGING

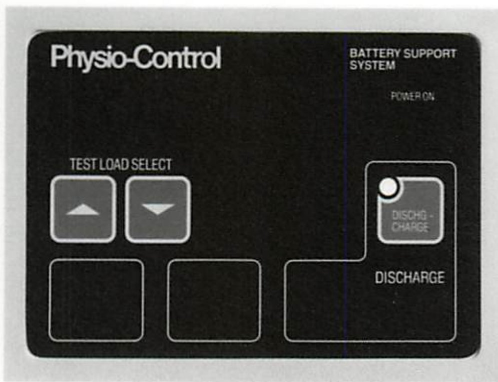
1. Insert the battery into any well. "CHARGE" indicator will light indicating normal operation. ("CHARGE" indicator will flash or "FAULTY" indicator will light when a defective battery is detected.)
2. The "READY" indicator will light when battery is charged to a useable level.

- The Battery Pak will take four and one-half hours maximum to reach full charge and the FASTPAK™ battery will take 70 minutes maximum.

BATTERY RECONDITIONING

1. Place battery in far right battery well.
2. Wait for "READY" indicator to light.
3. Press the "DISCHG-CHARGE" control.
4. When battery is ready for use, the "READY" indicator will light and "% BATT CAP" will be displayed.

- All LIFEPAK 5 batteries should undergo at least three reconditioning cycles once every 90 days.
- If "% BATT CAP" is less than 70% after three discharge/charge cycles or if battery seems to be performing poorly, please see BATTERY EVALUATION section in Battery Support System Operating Instructions Manual.



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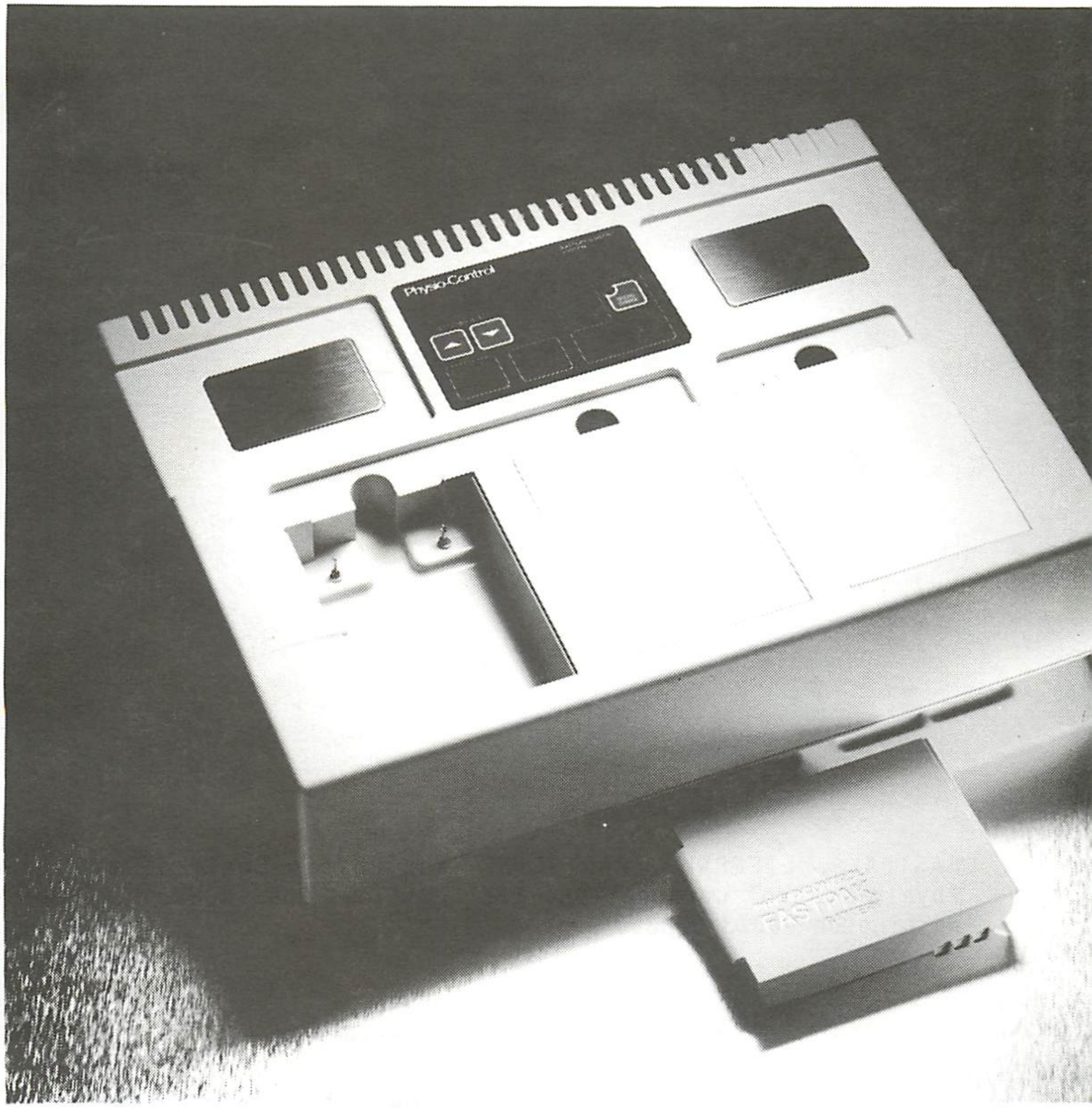

Battery Support System

for use with PHYSIO-CONTROL® defibrillator/monitors

Operating and Service Manual

Manual No. 802065-04
June 1990

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PART NO. ______________

SERIAL NO. ____________

WARRANTY

Refer to the product warranty statement included in the accessory kit shipped with the product. Duplicate copies may be obtained from the local Physio-Control Sales and Service office.

LIST OF EFFECTIVE PAGES

CONFIGURATION INFORMATION

This manual is current to the listed revision level of the following part numbers. The part numbers appear in the same order as in Table 5-1.

DESCRIPTION	PART NUMBER	REV
BATTERY SUPPORT SYSTEM FINAL ASSEMBLY	801807-10 THRU -18	E3
COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY	802166-04	B9
DEFIB PULSE ATTENUATOR PCB ASSEMBLY	802174-01	C1
SWITCH INTERFACE/DISPLAY PCB ASSEMBLY	801894-01	D2
WIRE HARNESS ASSEMBLY	802519	ORIG2
REED SWITCH HARNESS ASSEMBLY	803061	ORIG4
MEMBRANE SWITCH ASSEMBLY	801878	ORIG5

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LIST OF TABLES

HOW TO USE THIS MANUAL

This manual is divided into six major sections in addition to the front matter. The front matter contains information about the current revision configurations, a Safety Summary and general operating cautions, as well as the Table of Contents, List of Illustrations, and List of Tables.

Section 1 of the Battery Support System manual provides introductory information including General Specifications, PHYSICAL and FUNCTIONAL DESCRIPTIONs. This section also includes the THEORY OF OPERATION with detailed circuit descriptions.

Section 2 familiarizes the user with the operation of the equipment. It lists ACCESSORIES AND REPLACEMENT ITEMS, identifies CONTROLS AND INDICATORS, provides PERIODIC SERVICE PROCEDURES, and gives OPERATOR MAINTENANCE instructions. This section is not intended to instruct the operator in the clinical use of the instrument; however, a separate OPERATING INSTRUCTIONS booklet is available for that purpose.

Section 3 contains a list of recommended TEST EQUIPMENT, explains the TEST SETUP, and provides procedures to perform FUNCTIONAL TEST AND CALIBRATION. Troubleshooting information is also included.

Section 4 provides general maintenance for the Battery Support System. Included are a list of TOOLS AND MATERIALS, procedures for cleaning and repair, and DISASSEMBLY PROCEDURES.

Section 5 contains ILLUSTRATED PARTS LISTS for mechanical assemblies. PARTS LISTS, COMPONENT LAYOUTS, and SCHEMATIC DIAGRAMS are provided for Printed Circuit assemblies.

Section 6 consists of COMPONENT REFERENCE DIAGRAMS which provide data for selected electronic components used in this instrument.

SAFETY INFORMATION

OVERVIEW

This safety information is provided for both operating and servicing personnel and is divided into three sections: Terms Used in this Manual, Symbols Used in this Manual or on the Equipment, and Warnings. Additional Warnings and Cautions not appearing in this section are found throughout the manual where they specifically apply.

TERMS USED IN THIS MANUAL OR ON THE EQUIPMENT

DANGER: Immediate hazards which WILL result in severe personal injury or death.

WARNING: Hazards or unsafe practices which COULD result in severe personal injury.

CAUTION: Hazards or unsafe practices which COULD result in minor personal injury or product damage.

NOTE: Points of particular interest for more efficient or convenient instrument operation. Additional information or explanation concerning the subject under discussion.

SYMBOLS USED IN THIS MANUAL OR ON THE EQUIPMENT

Any or all of the following symbols may be used in this manual or on the equipment.

Static Sensitive Device (SSD).

* Additional information in Section 6, Component Reference Diagrams.


DANGER--High voltage present.


ATTENTION--Refer to manual for more information.


Defibrillation protected, type CF patient connection.


Defibrillation protected, type BF patient connection.


Off (Power disconnected from ac mains)

On (Power connected to ac mains)


Protective ground (earth) terminal


Fusible link

(Symbols cont.)

- Equipotentiality connector
- Output
- Input
- ECG data
- 1010 Serial data

WARNINGS

Following are descriptions of general hazards and unsafe practices that could result in death, severe injury, or product damage.

Refer to NFPA 99-1984, Health Care Facilities and NFPA 70-1987, National Electrical Code for specific guidelines on the standards and practices for health-care instruments and environments.

DO NOT USE IN THE PRESENCE OF FLAMMABLE GASES

Do not operate this product in the presence of flammable gases or anesthetics. Explosion or fire can result. Refer to safety documents NFPA 99-1984, *Use of Inhalation Anesthetics (Flammable and Nonflammable)*, and NFPA 70-1987, *National Electrical Code* (Health Care Facilities section), before operating this product in the proximity of flammable gases or anesthetics.

DO NOT MOUNT PRODUCT DIRECTLY ABOVE PATIENT

Place the product in a location where it cannot harm the patient should it fall from its shelf or other mount.

MAKE PERIODIC SAFETY INSPECTIONS

Perform frequent electrical and visual inspections on cables and wires. Broken or frayed wires, or loose snap fittings may cause interference or loss of signal. Pay particular attention to the point at which the wires enter the terminals, since repeated flexing at these points eventually causes the wire strands to break.

POWER SOURCE

The Battery Support System operates from an ac power source that does not apply more than 250V RMS (132V RMS in USA and Canada) between the supply conductors or between either supply conductor and ground.

The ac power source is supplied to the instrument through a grounded (three-pronged plug) power cord. The power cord must be inserted into a mating (Hospital Grade) power outlet with a protected earth ground contact. If the integrity of the earth ground contact is questionable, operate the instrument on its internal battery power source.

This product is compatible with isolated power systems used in operating rooms.

PROPER POWER CORD USAGE

Use only the power cord and connector specified for this product. Use only a power cord that is in good condition.

The three-wire (18 gauge, SJT-grade) power cord is wired (in USA and Canada) to a three-terminal polarized plug (Hospital Grade) that connects the instrument to the power source and to protective ground. The ground (earth) terminal of the plug is connected directly to the frame of the instrument. To reduce the risk of electric shock, insert this plug only into a mating (Hospital Grade) power outlet with a protective ground contact. Never bypass the ground connection, severe shock could result.

Inspect the power cord periodically for fraying or other damage, and replace as needed. Never operate the instrument from ac mains power with a damaged power cord or plug.

USE THE PROPER FUSE

To reduce fire hazard use only the fuse specified for your instrument. Replace damaged fuses with one identical in type, voltage rating, and current rating as the original. Fuse replacement instructions can be found in Section 2, Operation.

DO NOT STERILIZE

Do not sterilize this product. Sterilization environments can cause severe damage. Do not autoclave or gas sterilize accessories unless manufacturer instructions clearly approve it.

USE ONLY RECOMMENDED ACCESSORIES

For proper instrument operation, use only accessories recommended by Physio-Control. Paragraph 2-2, ACCESSORIES AND REPLACEMENT ITEMS lists accessories recommended for use with this product.

USE SAFE METHODS OF INTERCONNECTION

Properly ground the instrument to protect against electrical shock from the product cabinet whenever other equipment is electrically connected to this product.

It is extremely important that equipment interconnections be made in accordance with NFPA No. 70-1987 National Electrical Code, Article 517, Health Care Facilities. Compliance with articles 517-80 and 517-120 is especially important.

NOTE: Within certain governmental jurisdictions, all interconnected accessory equipment must by labeled by an approved testing laboratory. Verify leakage current and grounding requirements after interconnecting this instrument with accessory equipment.

SERVICE

Component replacement and internal adjustments must be made by service personnel qualified by appropriate training and experience.

A qualified technician should check a product that has been dropped, damaged, severely abused, or to verify the instrument is operating within performance standards as listed in Section 2, Performance Verification Procedure (PVP), and that the leakage current values are acceptable.

Before attempting to clean or repair any assembly in this instrument, the technician should be familiar with the information provided in Section 4, Maintenance.

If assistance in servicing the instrument is needed, contact Physio-Control at 1-800-426-8047.

SECTION 1
DESCRIPTION

1-1. OVERVIEW

This section describes the general features, specifications, and circuits of the Battery Support System. The section is divided into three parts: Physical Description provides a general description of the specifications; Functional Description briefly outlines the circuitry at a functional block level; Theory of Operation provides detailed circuit descriptions at the component level.

1-2. PHYSICAL DESCRIPTION

The Battery Support System (see Figure 1-1) is a companion instrument to the LIFEPAK 5 defibrillator/monitor, The LIFEPAK 10 defibrillator/monitor, and the LIFEPAK 250 automatic advisory defibrillator. The system can charge, exercise (or recondition), and evaluate the standard Battery Pak and the FASTPAK Battery (nickel-cadmium, +12 Vdc, 1Ah).

Individual sets of indicators for each of the three compartments show the charge, ready, or faulty state of the batteries. The far-right charge compartment contains discharge circuitry for exercising batteries and an additional indicator shows this state.

The digital display on the Battery Support System indicates defibrillator energy selected, defibrillator energy delivered, or (for the right-most compartment) the percentage of available battery capacity in the Battery Pak. The amount of discharged energy from the defibrillator is determined by a test load circuit.

The system is available in 100Vac, 117Vac, or 235Vac versions. The Battery Support System charges from 1 to 3 standard Battery Pak or FASTPAK Batteries. The system can detect the battery type and adjust the charge rate accordingly. General specifications appear in Table 1-1.

1-3. FUNCTIONAL DESCRIPTION

The Battery Support System initiates a charge cycle when a battery is installed in a battery compartment. Each compartment displays whether the battery is CHARGING, READY, or FAULTY (at a critically-low voltage).

The DISCHARGE function is available in battery compartment 3 on the right side of the instrument. Pressing DISCHG-CHARGE begins a battery discharge cycle. The Battery Support System automatically initiates a charge cycle after the discharge cycle. When the charge cycle is complete, % BATT CAP lights along with a number value that indicates the battery capacity before the reconditioning cycle.

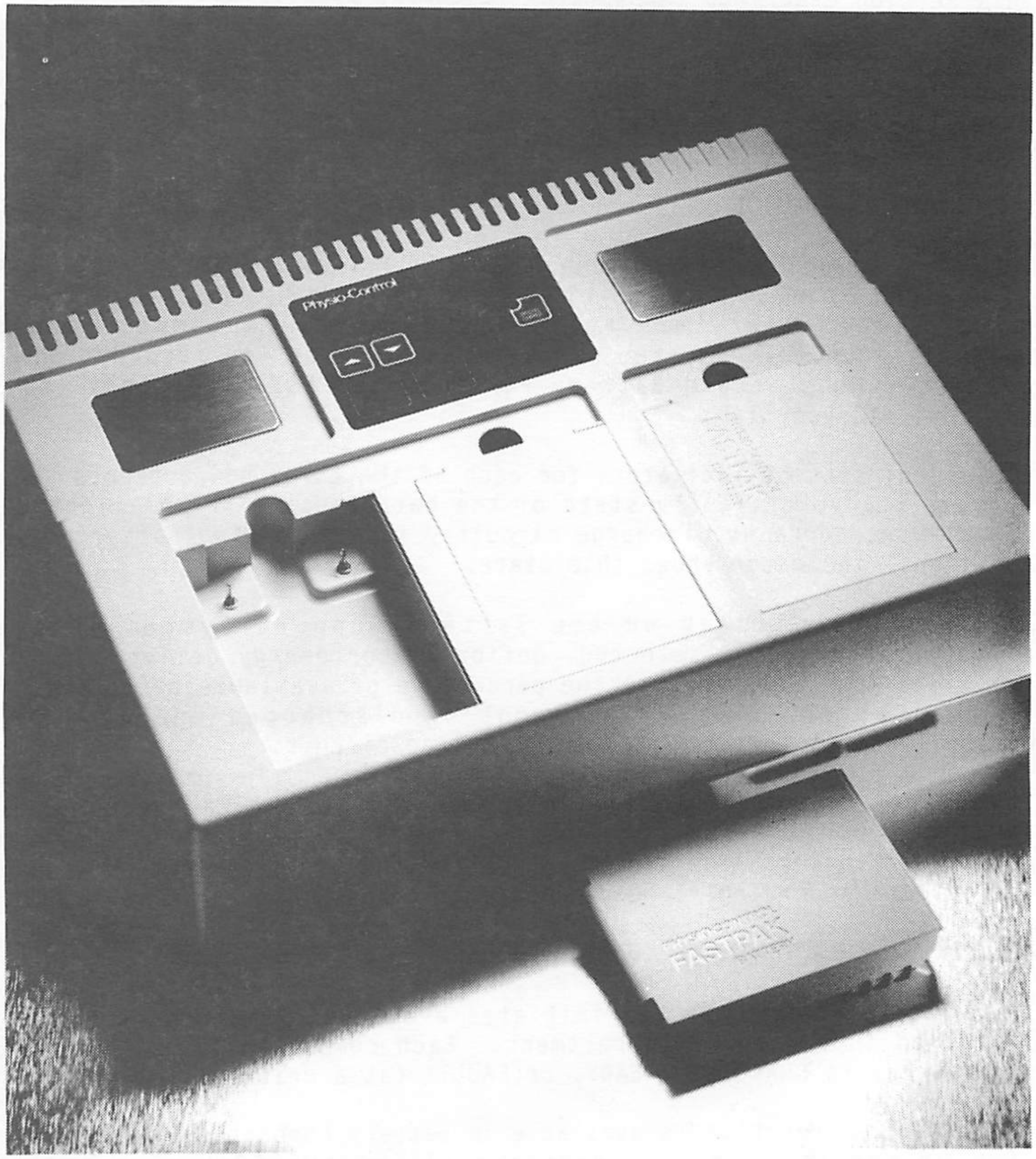


FIGURE 1-1. BATTERY SUPPORT SYSTEM

TABLE 1-1

GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATIONS
GENERAL	
• SIZE	10.5cm H x 42cm W x 32.5cm D (4.1in x 16.5in x 12.8in)
• WEIGHT	20.1lb (9.14kg) with three batteries installed
• AC INDICATOR	Indicator illuminates when connected to ac line
POWER SOURCE	100Vac ± 10%, 50/60Hz 117Vac ± 10%, 50/60Hz 235Vac ± 10%, 50/60Hz
CHARGE SYSTEM	
• CHARGE TIME	Recharges 3 Battery Paks to 90% capacity in 4.5hrs or 3 FASTPAKS to 90% capacity in 70min
• DISCHARGE TIME	Discharges a fully charged Battery Pak or FASTPAK Battery in 60min
• INITIATION	Begins charge cycle when a battery is inserted in any battery compartment
• ISOLATION	Isolates batteries thermally from the heat-generating portion of the system
• BATTERY TYPE	+12Vdc, 1Ah, nickel-cadmium
TEST LOAD	50 Ω, 50W test load
DISPLAY	
• TEST LOAD SELECT RANGE	0-500J for displayed energy selected
• RESOLUTION	10J for displayed energy selected 1J for displayed energy delivered
ENVIRONMENT	
• TEMPERATURE RANGE (without Battery Paks)	Operating: 10°C to 40°C Storage: -30°C to 65°C
• RELATIVE HUMIDITY	10% to 90%, noncondensing

*All specifications at 25°C unless otherwise stated. Specifications subject to change without notice.

Each of the three battery positions are thermally isolated from the heat-generating portion of the instrument, by a system of vents and air pockets. These features prevent heat produced by operation of the Battery Support System from adversely affecting the battery-charge-level detection circuitry.

The Battery Support System also features an ac POWER ON indicator, an LED DISCHARGE indicator, selectable defibrillator test load values through the TEST LOAD SELECT membrane switches, and test load pads for checking the defibrillator output energy.

Control and indicator functions are detailed in Section 2.

1-4. THEORY OF OPERATION

The Battery Support System consists of three printed circuit board (PCB) assemblies, the Computational Power Supply PCB Assembly, Defib Pulse Attenuator PCB Assembly, and the Switch Interface/Display PCB Assembly. This section contains a detailed description of the circuits found on these PCB assemblies. Schematic diagrams of the PCBs appear in Section 5. Refer to the schematics while reading the circuit descriptions. Section 6 contains additional information about selected ICs (indicated by a * on the schematic) to aid in circuit analysis and troubleshooting. Figure 1-2 provides a functional block diagram.

1-5. COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (802166).

The Computational Power Supply PCB Assembly consists of the system power supply, microcomputer, real-time clock, analog-to-digital (A/D) converter and charge select circuitry. Figure 5-4 provides a complete schematic diagram of all the circuitry on this assembly.

1-6. System Power Supply. (Refer to Figure 1-3, System Power Supply Block Diagram.) The input transformer has dual-tapped primaries. Each of the primary windings is rated at 117.5V with a tap at 100V. In parallel, the primary supports the system from a 50Hz or 60Hz line with nominal voltages of 117.5V or 100V. Series connections of the primary windings provide 235V and a 50Hz or 60Hz capability. A terminal block mounted on the heat sink provides convenient connection and jumper capability.

1-7. Rectified and Regulated Supplies. Transformer secondary windings pins 3 through 5 provide power to the full-wave rectifier (CR3 and CR4) for the +24Vdc supply and power to the full-wave bridge rectifier (CR1) for the +12Vdc and -12Vdc supplies. VR1 regulates the +12Vdc supply and VR2 regulates the -12Vdc supply. Pins 1 and 2 of the secondary windings supply power to diode bridge CR2 for the +5Vdc line.

This +5V supply is regulated by VR3 and Q1. With a load at the +5V supply, current draws through VR3 and R2, in series with the input of VR3. As the load increases and exceeds about 65mA, the voltage drop across R1 activates Q1 and provides a portion of the required current through the transistor. The resistor, in series with Q1, ensures circuit stability at elevated temperatures and light loads. Under typical light loads and normal transistor current gain, one-tenth of the current flows through VR3 and the remainder through Q1.

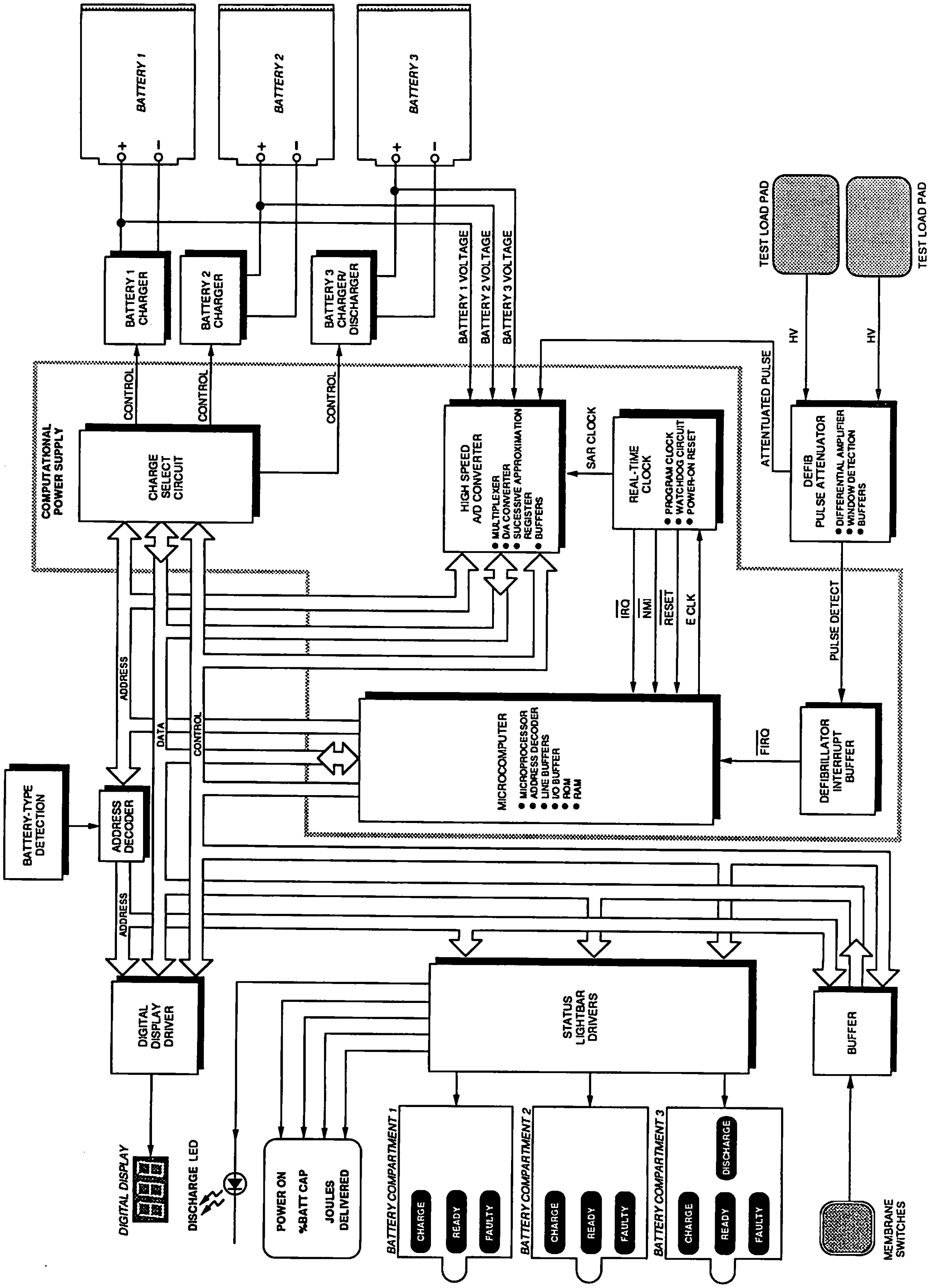


FIGURE 1-2. FUNCTIONAL BLOCK DIAGRAM

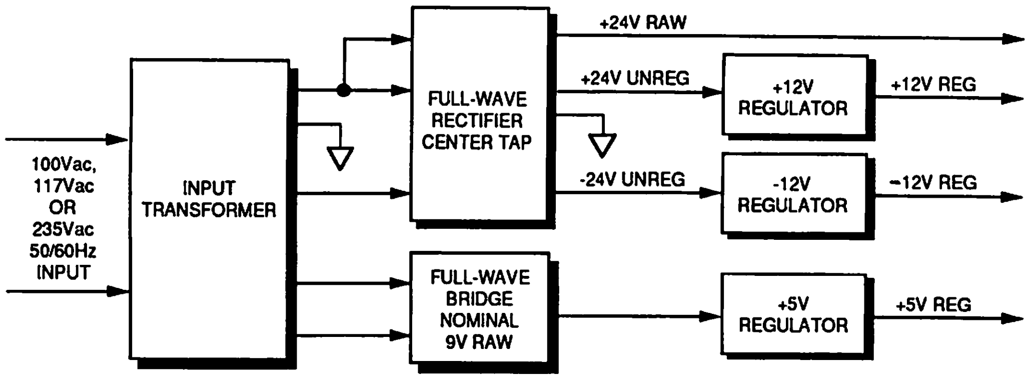


FIGURE 1-3. SYSTEM POWER SUPPLY BLOCK DIAGRAM

1-8. Microcomputer. (See Figures 1-2 and 5-4.) The microcomputer consists of microprocessor U4, RAM U12, ROM U11, and supporting circuitry. The functions and lines described are microprocessor timing, power-on reset, interrupt request, system bus control lines, address lines, and data bus.

Microprocessor Timing - Timing for the microprocessor U4 is from a 4MHz parallel resonant crystal, Y1. The microprocessor internally divides this frequency by four and sends two 1MHz signals to the E CLK and Q CLK outputs (the Q CLK leads the E CLK by 90°). These two buffered clocks provide all the on-board timing signals for the system.

Power-on Reset - The RESET line to the microprocessor activates only at power-on or in response to the power-on watchdog timer (see paragraph 1-9). R18 in the +5Vdc line and C27 to ground form a reset circuit that maintains the RESET in the low state (less than 800mV) until the clock oscillator is fully operational. CR17, normally reverse-biased and in parallel with timing resistor R17, rapidly discharges the reset capacitor during short-duration power drop-out conditions.

Interrupt Request - The three interrupt request lines used by microprocessor U4 are:

- IRQ - The standard Interrupt Request responds to each low signal by stacking the entire machine cycle. This interrupt may be inhibited under software control or by the occurrence of any hardware interrupt.
- FIRQ - The Fast Interrupt Request responds to each low level input by stacking only the condition code register and the program counter. FIRQ may be inhibited by software or an NMI.

- $\overline{NMI}$ - The Nonmaskable Interrupt stacks the entire machine cycle. Nothing may inhibit this interrupt except an $\overline{NMI}$ in progress.

System Bus Control Lines - The four control lines buffered from the microprocessor and distributed on the system bus are the Read/Write (R/$\overline{W}$), Enable Clock (E CLK), *Quadrature Clock (Q CLK), and Bus Available (BA). From the first three of these, two more signals are generated and added to the bus. These low-level signals are Write ($\overline{W}$) and Output Enable ($\overline{OE}$).

The following is a description of system bus control lines.

- R/$\overline{W}$ - The R/$\overline{W}$ line from the microprocessor indicates the directional status of the microprocessor data bus. When high, the data bus acts as an input and is ready to read data from an external source. A low indicates that the microprocessor is writing onto the bus and all other sources are ignored.

- E CLK - The E CLK is one-fourth of the microprocessor crystal frequency. The falling edge of this signal corresponds to the time that data presented to the microprocessor is latched by internal registers.

- Q CLK - The Q CLK leads E CLK by 90°. The falling edge corresponds to a point in microprocessor output data that is a minimum of one-quarter clock cycle after it is enabled and one-half clock cycle before data terminates.

- BA - The BA signal indicates the state of the address and data bus from the microprocessor. A high on this line indicates that these are in the high impedance state at the microprocessor and may be used by some other device.

- $\overline{W}$ - The $\overline{W}$ signal is set low when the R/$\overline{W}$ line is low and the Q CLK is high. Because of the relationship of the trailing edge of Q CLK to valid microprocessor output data, the trailing edge of $\overline{W}$ is used to latch data to memory or a peripheral to allow at least 250ns of setup and hold time.

- $\overline{OE}$ - The $\overline{OE}$ signal is set low when both R/$\overline{W}$ and E CLK are high. This provides a 500ns window in which memory or a peripheral may respond to a microprocessor request for data. The hold time required by the microprocessor is supplied by circuit propagation delay times.

Address Lines (12-15) - The four high-order address lines A(12-15) divide the upper half of the U4 addressable space into 16 blocks of 2048 addresses each. (The lower half is not used, so enable signals are not developed for it.) The inverted high-order bit (A15) goes to the chip enable of a 4-to-16-line demultiplexer U5. U5 then decodes the binary number on the next three address lines A(12-14) to a unique line driven to the low state. The output of U5 is an open collector with pull-up resistors providing a disable mode for external access of the microcomputer bus.

*Quadrature: The relation between two periodic functions when the phase difference between them is one-fourth of a period.

Address Lines (0-11) - The 12 low-order address lines A(0-11) are buffered by line drivers with three-state outputs.

Address Blocks - The four high-order blocks of U4 address access memory. The two upper address blocks enable memory located in EPROM U11 (capable of storing 4096 bytes of information). The remaining memory is in RAM U12 with a storage capacity of 2048 bytes.

Data Bus - The I/O buffer U18 provides a controlled bidirectional data bus between the microcomputer and system peripherals. A pair of exclusive OR gates U17B and U17C are programmable inverters to interface the two control lines: the chip select (CS) line and the direction control (DIR) line.

When chip select (CS) is high, data flow through the buffer in either direction is inhibited. The NAND gate U16C plus the inversion from the exclusive OR U17B applies this level when address lines A13 and A14 are high. For addresses within the four upper blocks of memory, only the microcomputer memory applies to the microprocessor data bus. Outside this address range, the buffer enables and peripheral devices are accessed.

The direction control (DIR) line connects through U17C and U7 to the R/$\overline{W}$ line. When buffer U18 enables, the gate direction defined by the microprocessor requirements and R (read) presents a high to the buffer.

1-9. Real-Time Clock. The real-time clock is from the microprocessor E CLK. The count-down string is from a pair of flip-flops U8A and U8B and a 14-bit binary counter U10. Bit 13 of the binary counter generates a real-time interrupt on each positive edge. The real-time clock period is 32.786ms.

The first latch U3B clocked on the leading edge of bit 13 generates an interrupt on $\overline{IRQ}$. Since this latch associates only with the leading edge of the clock signal, it resets at the completion of interrupt routines of varying duration without affecting the clock rate.

The second latch U3A sets low only if a low still exists on $\overline{IRQ}$. This low indicates that a second real-time clock interval has passed without the successful completion of an interrupt service routine. The output goes to the Nonmaskable Interrupt ($\overline{NMI}$) to direct operation to an error-recovery routine (watchdog timer).

An active low output at $\overline{W}$ and E7 causes an interrupt reset for both time-related interrupt latches. The negative output NAND gate U9D routes through NOR gate U9A to the reset input of the $\overline{IRQ}$ latch, U3B at pin 13, and to the set input of the $\overline{NMI}$ latch, U3A at pin 4. The J9 jumper at the input pins of U9A connects either to the output of U9D or to the 5V pull-up resistor, R90. When the inputs (pins 2 and 3) are tied together, U9A functions as an inverter. If J9 shorts pins 1 and 2, the output of U9D maintains both the interrupt latches U3A and U3B in the inactive state to allow circuit test without interrupts.

The outputs from U3A and U3B with the real-time clock output go to AND gate U34C. The presence of the error-recovery interrupt ($\overline{NMI}$) when one-half of the next real-time clock period ends, passes the signal at pin 8 through NOR gate U34B with the power-on signal at pins 3 and 4. The output applies to the microprocessor $\overline{RESET}$ to restore system operation after any program disruption.

1-10. <u>High Speed A/D Converter</u>. (Refer to Figure 1-4, A/D Converter Timing Diagram.) An 8-channel analog multiplexer provides data for analog-to-digital (A/D) conversion by successive approximation. A 12-bit digital-to-analog (D/A) converter is the heart of the High Speed A/D Converter circuitry.

The conditioned input signal goes to the R FDBK input U30 pin 18, so that the D/A converter outputs a current proportional to the difference between the input signal and the value applied at the digital inputs. This error signal is amplified by a current-to-voltage translator U24B (impedance amplifier) which has high-gain near zero. A pair of Schottky diodes CR18 and CR19 paralleled in the feedback path limit output excursion.

The following paragraphs describe the functions of the successive approximation register, A/D interface circuitry, and A/D converter output.

<u>Successive Approximation Register</u> - The successive approximation register (SAR) U29 is a clock-driven sequencer that tests each bit location in a 12-bit binary word and sets the bit according to the condition presented at the D input pin 11. At the outset of a start command, the SAR sets all output bits high except for the most significant bit (MSB) which is set low. On the rising edge of the next clock, the D input is evaluated. If D input is low, the bit is left low. If D is high, the bit turns high. In either case, the next MSB is set low and the test repeated. This sequence repeats until all 12 bits are tested. The resulting digital output holds until the next start pulse. (The start pulse is created when $\overline{W}$ and E4 pulse simultaneously. The duration of the pulse varies incrementally according to the $\overline{W}$ and E4 relationship with the A/D clock.)

The SAR uses the clock from the second stage of the real-time clock which dictates the conversion rate of 4µs per bit. With the maximum one-clock cycle to synchronize the start command, conversion completes within 52µs after the start command.

The positioning of the microprocessor $\overline{Write}$ command relative to E CLK allows a minimum of 250ns prior to a clock edge. The total access time of 500ns does not include the required positive clock edge. A pair of bistable multivibrators U26A and U26B, function as a pulse stretcher to allow time for the clock edge. E4 goes to the D input of U26B, and outputs at Q as a low on the leading edge of the $\overline{Write}$ command. Q goes to the $\overline{S}$ pin of the SAR (U29 pin 14) and the D input of U26A, driven by the SAR clock. On the next positive SAR clock edge of U26A Q output is low setting U26B to initial conditions and removing the start command. U26A is restored on the next SAR clock cycle.

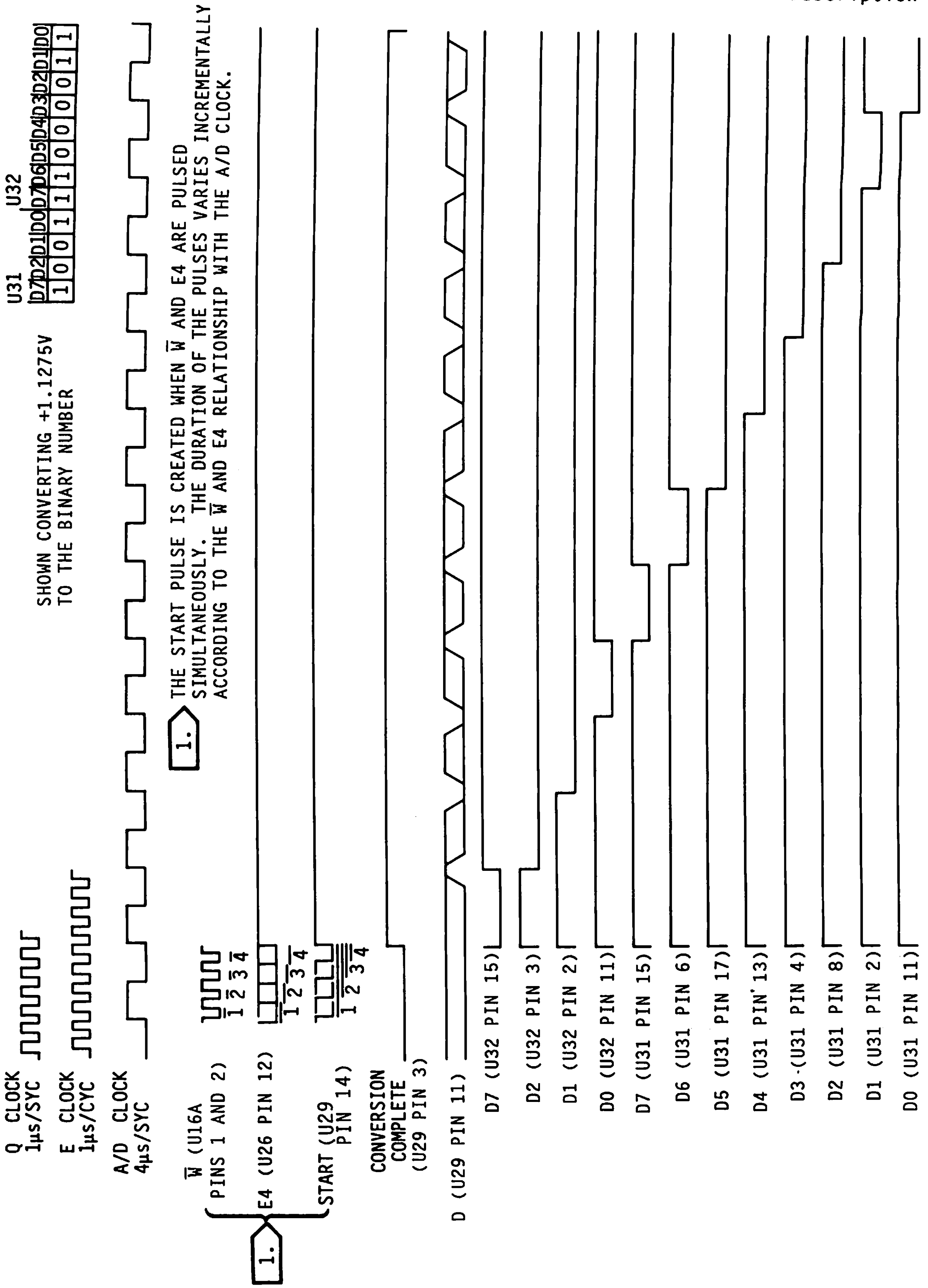


FIGURE 1-4. A/D CONVERTER TIMING DIAGRAM

Comparator U27 compares the output of the current-to-voltage translator U24B with OV. The output swings high if the error voltage is positive and low if the error voltage is negative. The output of U27 connects to the D input of U29.

A/D Interface Circuitry - An 8-channel multiplexer U19 and a sample-and-hold circuit consisting primarily of op amps U23 and U24A provides input to the analog-to-digital (A/D) converter.

A 3-bit binary code transmitted by the microprocessor U4 controls U19, an 8:1 channel multiplexer. A 4-bit latch U20 stores this code for continuous application. The 3-bits of latch U20 are low order bits of the associated microprocessor byte which controls multiplexer U19 gating. The information latches into U20 pin 9 through AND gate U25B. (The output of U29B is the AND function result of the E3 with $\overline{W}$ inputs.) This latch has a second set of outputs which, when buffered, parallel with the inputs on the bidirectional data bus. Normally, these outputs are in the high impedance state but the negative AND function of E3 with $\overline{OE}$ allows a reading of the multiplexer routing status.

U23, the sample-and-hold circuit, receives the output from the multiplexer on pin 3. The low conversion complete (CC) signal from U29 pin 3 goes to U23 pin 8 (the hold line) and the analog voltage maintains on pin 5 of U23. The sample-and-hold voltage adjusts to the current input value at the completion of each A/D conversion.

U24A interfaces between U23 and the input to the D/A (digital-to-analog) converter (U30 pin 18). This circuit provides gain compensation with calibration by potentiometers R21 and R23 at the inverting input.

A/D Converter Output - The A/D converter output data is available at the output of buffers U31 and U32. U32 pins 1 and 19 are enabled by the negative NAND output of E5 and $\overline{OE}$ at U9B to define an address block. The output of U9B is the input to NAND gate U15B with the inverted A0 at U14B. The buffer U31 holding the low 8-bits is enabled by the same address block selection logic. The U9B output is applied to NAND gate U15A with A0 at U14B pin 3. In this case A0 is not inverted.

1-11. Charge Select Circuitry. Each battery charger circuit replicates each of the three batteries. Additional circuitry includes a discharge circuit for battery position 3 and a battery voltage sense network.

The charge select circuit consists of a pair of 4-bit latches, U21 and U22. These latches switch control outputs S(0-6) which correspond to data at D0 through D6. Charger functions are controlled as follows:

- S0 - Battery position 1 charge inhibit.
- S1 - Battery position 1 high charge enable.
- S2 - Battery position 2 charge inhibit.
- S3 - Battery position 2 high charge enable.
- S4 - Battery position 3 charge inhibit.
- S5 - Battery position 3 high charge enable.
- S6 - Battery position 3 discharge enable.

The NAND gate U34A prevents discharger operation if the microprocessor malfunctions while the battery in position 3 charges. To enable this gate, it must have two low inputs plus the negative-going line created when S6 (discharger enable) inverts through U14A. Both low inputs are derived from S4 and S5 (S4 inverts first through U14F).

NOTE: In the following description, only component reference designators from battery position 1 charger are used. The other two charger circuits are identical.

1-12. Battery Charge Circuitry. The battery charge circuit consists of an op amp U33A with an NPN-PNP transistor pair Q5 and Q6 on the output providing the necessary power capability. The battery charges in the current mode so a current-sense resistor R35 is in the negative lead of the circuit. The voltage across this resistor is monitored by U33A for potential voltage differences between the power circuit conducting the pulsed charging current and the reference circuit.

Without charge inhibit or high charge signals, the charger maintains a pulsed charge current at about 300mA for a Battery Pak. The charge current is controlled by U33A having the noninverting input fixed at 1V while 701mV is applied to the inverting input through summing control resistor R42.

NOTE: Over a 2min period, the 300mA pulsed charge current averages to 98mA.

When a high-charge-enable switch signal is applied (FASTPAK batteries only), S1 grounds R42 and provides a 1V differential between the U33A input pins. To stabilize the circuit, 0.5V must be dropped across the current-sense resistor, R35. This results in 1A of charge current.

C35 directly connects the output of U33A to the inverting input, forming an inner feedback loop. This causes the current-feedback signal to be integrated about the noninverting-input reference voltage. This averages the pulsed charge current to satisfy the input-command requirements. At typical line voltage the charge current is about 2A pulses at a 50% duty cycle.

The drive signal from U33A pin 1 to the first transistor stage is modified by grounding through VFET Q7. This occurs when a charge inhibit signal appears on S0. A high on this switch control line sinks drive current from the transistor base, inhibiting all charge modes. The integrater circuit is not affected, so short-duration charge inhibits during a battery-voltage read are compensated for during subsequent current pulses.

When the battery is being read by the A/D converter, Q5 turns off and a voltage that corresponds to the battery status is measured by the A/D converter at the junction of R30 and R31. With the battery removed, R30 and CR31 provide an alternate current path around Q5 and cause the terminal voltage to increase near the +24V supply. This appears to the A/D converter as a substantial voltage increase which the microprocessor recognizes as a missing battery.

1-13. <u>Battery Discharger Circuit</u>. The discharger circuit connected to the charger circuit of battery position 3 operates in the constant current mode independently from the charge circuit except at the interface circuit as described in paragraph 1-11.

A separate current-sense resistor R80 is used at the emitter of power transistor Q17, controlling current flow. By definition, a discharged battery must exceed +9V so a higher sense-resistor value at R80 has been used. The high forward drop of Q17 is adjusted to take advantage of the high power gain.

The control bias to U33C pin 10 requires a 2V level from the stable reference-voltage divider. This, in conjunction with the 2-to-1 control to feed back the resistor ratio allows a current of 1A to flow when U33C pin 9 is grounded by the FET switch, Q18. When Q18 is off, R85 pulls to the reference voltage 10.24Vdc (VR), and drives the output of U33C negative to cut Q17 off.

R93 and C69 connected across the input terminals of op amp U33C stabilize the circuit by reducing loop gain and frequency response.

1-14. <u>Battery-Terminal Voltage</u>. Each positive battery-terminal voltage is monitored by the High Speed A/D Converter through a 4-to-1 voltage divider. Since the current-sense resistor is included in this voltage measurement, accurate voltages can be read only with the current source disabled or a known current flowing such that the sense-resistor voltage drop may be taken into account. Sequential readings are obtained only in the discharge operating mode where instantaneous current is constant enough.

1-15. <u>DEFIB PULSE ATTENUATOR PCB ASSEMBLY (802174)</u>. (See Figure 5-5.)

The Defib Pulse Attenuator PCB Assembly provides the detection of a defibrillator pulse, the conditioning of the analog pulse shape output, and the application to the High Speed A/D Converter on the Computational Power Supply PCB Assembly. A 50Ω, 50W load resistor (R1) is attached directly across the test load pads. Differential input op amp U1A with a gain less than unity attenuates the defibrillator pulse to a level acceptable for the conversion circuitry.

The window detector gets its input from the differential amplifier, U1A pin 1. A gain amplifier U1B increases detection sensitivity while a pair of level detectors (U3A and U3B) form the window detector. The wired OR output of the window detector is filtered to provide noise suppression. A final level detector with hysteresis U3C provides the open-collector drive necessary to prevent the Fast Interrupt Request ($\overline{\text{FIRQ}}$) circuit on the Computational Power Supply PCB a $\overline{\text{FIRQ}}$ from being interrupted.

The conditioning of the analog input consists of the R91 and C26 filter on the Computational Power Supply PCB with a -3dB pole at 2kHz and a buffer amplifier to provide minimum source impedance.

1-16. SWITCH INTERFACE/DISPLAY PCB ASSEMBLY (801894). (See Figure 5-6.)

The Switch Interface/Display PCB Assembly contains the LED lightbar readouts to provide the necessary interface logic connecting the Membrane Switch Assembly to the microprocessor bus. This PCB provides storage, decoding, and display elements for viewing. Circuitry used to detect whether a Battery Pak or a FASTPAK battery has been installed is also located on the Switch Interface/Display PCB.

1-17. Address Decoder and Buffer. Address decoding for the storage, decoding, and display functions is accomplished with a dual 2-to-4-line decoder (U6). The first decoder section is enabled by address-block enable E8 with $\overline{W}$ and $\overline{OE}$ as data inputs. When E8 is low and $\overline{W}$ and $\overline{OE}$ high, the 1Y1 and 1Y2 lines of U6 are set low (0V). This enables the inverting buffer, U7, and allows the membrane switches to be read by the microprocessor.

Decoding of the second stage occurs when $\overline{W}$ and E8 are low and $\overline{OE}$ is high. The enable of the second decoder stage, U7 pin 19, is set high (+5V), allowing further decoding for a microprocessor Write command.

1-18. Status Lightbar Drivers and Digital Display Drivers. Each of the display elements (DS6 through DS8) are driven by binary-coded decimal-to-7 segment decoder (U1-U3 respectively) containing latches to retain the display information. The decoder blanks the display for all values outside the valid binary-coded decimal range. The decoder sources the required drive current for the display elements when using a series current-limiting resistor. The display current is about 15mA nonmultiplexed.

The data inputs to the second decoder stage use address lines A0 and A1 to actuate the lightbar drivers and digital display. Each lightbar contains four LEDs connected in series. Each lightbar backlights a legend on the front panel. Power for the lightbars is derived from the unfiltered +24V supply. All lightbars in a group are mutually exclusive so that only one current-limiting resistor per group is needed. Display-control data is loaded into two latches, U4 and U5, which control lightbar-driver transistors, Q1 through Q14.

1-19. Battery-Type Detection. The Battery Support System charges two types of batteries, the standard Battery Pak and the FASTPAK Battery. The Battery Pak charges at 300mA, and the FASTPAK Battery charges at 1000mA.

A reed switch mounted inside the top cover adjacent to each battery compartment detects the battery type. An installed FASTPAK Battery in the battery compartment closes the reed switch. An installed Battery Pak does not.

Active lows from the microprocessor on the E9 and $\overline{OE}$ lines read the status of the reed switch and enable the tristate buffer U8. The reed-switch inputs provided to buffer U8 are now read by the microprocessor on data lines D0-D2. When the reed switch is closed, providing a low on the respective data line, the microprocessor selects the high charge rate of 1000mA (C/1). When the reed switch is open, providing a high on the respective data line, the microprocessor selects the low charge rate of 300mA (C/3).

SECTION 2
OPERATION

2-1. OVERVIEW

This section provides the following information and procedures:

- Accessories and Replacement Items
- Controls and Indicators
- Periodic Service Procedures
- Performance Verification Procedure
- Operator Maintenance

2-2. ACCESSORIES AND REPLACEMENT ITEMS

The following list is provided for reference only. Contact Physio-Control PARTSLINE at 1-800-331-1086 or your local district service office when placing orders.

Battery Support System Operating Instructions	802371-01
Battery Pak, Standard	09-10424-03
FASTPAK Battery	09-10424-04
FASTPAK Battery (with modified cover)	09-10424-09
Power Cord Assembly	803619*
Power Cord Assembly	803650*

2-3. CONTROLS AND INDICATORS

A. The controls and indicators on the Battery Support System are shown in Figure 2-1. Each item on the figure is keyed to a corresponding number in Table 2-1. The table lists the nomenclature and briefly describes the function of each item.

B. Figure 2-2 provides the rear panel view of the Battery Support System. Each item on this figure is keyed to a corresponding number in Table 2-2. The table lists the nomenclature of each item and briefly describes its function.

C. Figure 2-3 shows the types of Battery Paks currently in use.

* Contact Physio-Control for the correct part number and dash number required for your specific Battery Support System.

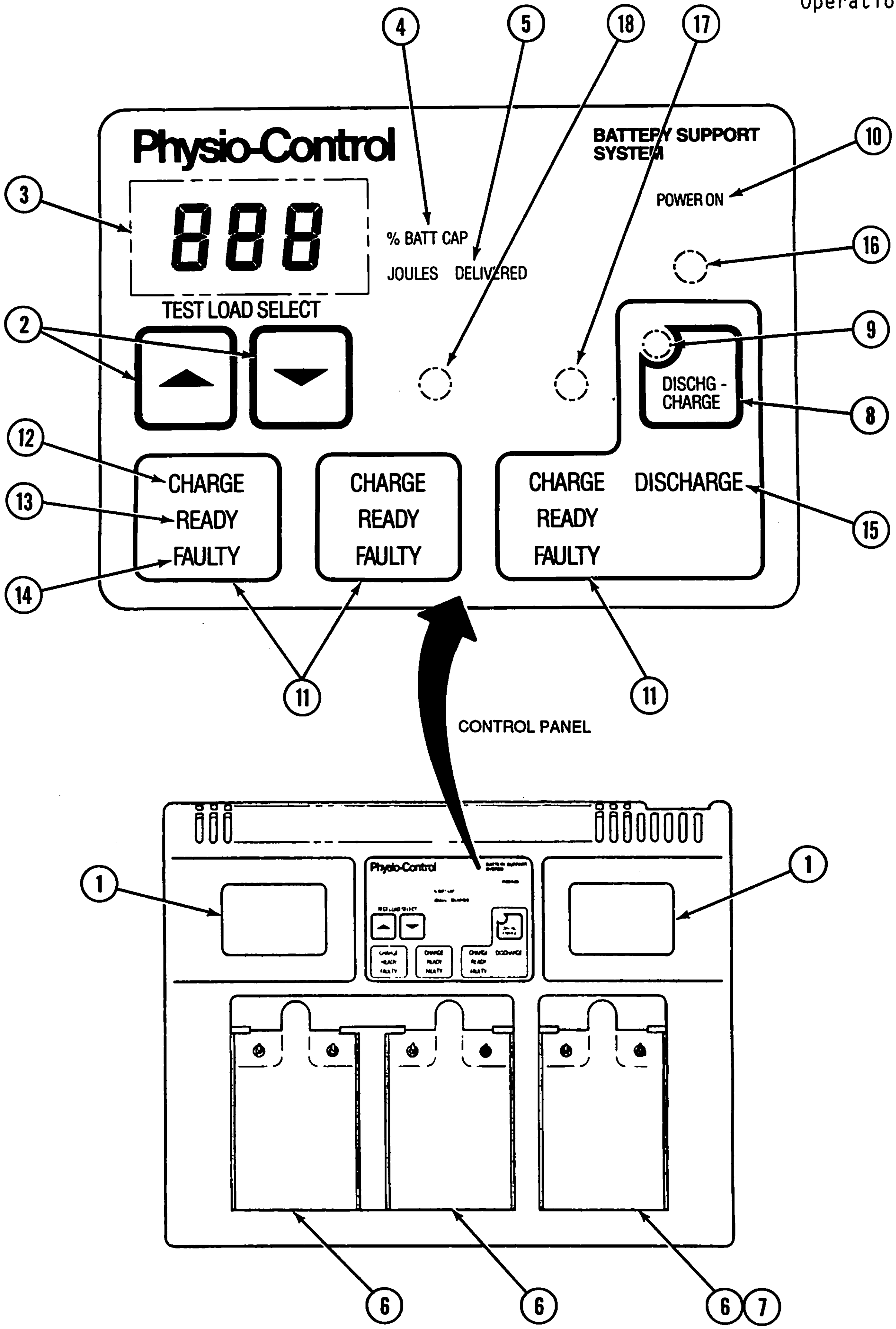


FIGURE 2-1. BATTERY SUPPORT SYSTEM CONTROLS AND INDICATORS

TABLE 2-1

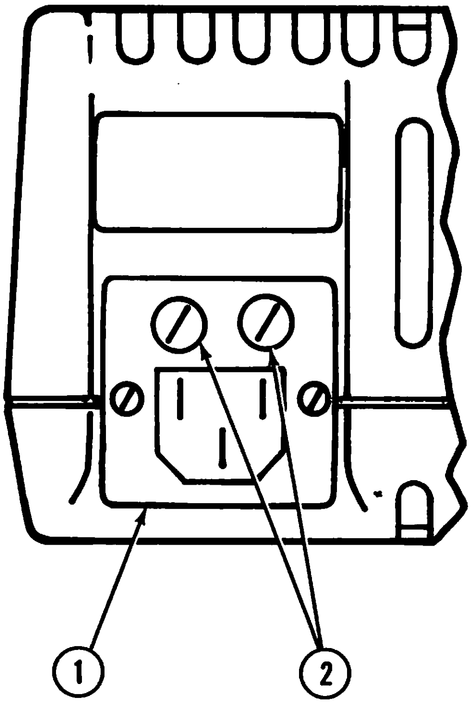
BATTERY SUPPORT SYSTEM CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	Test Load Pads	Surfaces receive test defibrillation current from paddles.
2	TEST LOAD SELECT	Arrows increase or decrease setting for defibrillator test output energy. When used in conjunction with Test and Calibration Mode controls, the instrument can be stepped through six test modes.
3	Digital Display	3-digit display shows percentage of battery capacity, defibrillator energy selected, or defibrillator energy delivered. Display range is 0-500J for energy selected. Resolution is 10J for displayed energy selected and 1J for displayed energy delivered.
4	% BATT CAP	Lights upon completion of reconditioning cycle. Lights during recharge if DISCHG-CHARGE pushbutton is pressed.
5	JOULES DELIVERED	Lights for 5sec ± 1sec after defibrillator is discharged into Test Load Pads.
6	Charge Positions	Compartments for charging one, two, or three batteries simultaneously.
7	Discharge Position	Right-side charging compartment also has discharge and reconditioning cycle circuits.
8	DISCHG - CHARGE	Initiates battery discharge for the battery in the right-side charge position. Press to display percentage of battery capacity during recharge.
9	DISCHG - CHARGE LED	LED remains on during discharge and flashes during recharge.
10	POWER ON	Lights when instrument is connected to appropriate power source.
11	Battery Charge Indicators	Show the state of the battery in each compartment.

TABLE 2-1 (Continued)

BATTERY SUPPORT SYSTEM CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
12	CHARGE	Lights during charge (and recharge for the right-side position). Flashes if the battery is defective.
13	READY	Lights when battery is ready for use (about 70min for a completely discharged FASTPAK, 4.5hr for a Battery Pak).
14	FAULTY	Lights when the battery terminal voltage is less than +5V or less than +12.5V after completion of the charge cycle.
15	DISCHARGE	Lights when the battery is discharging.
Test and Calibration Mode Controls:		
16	Test Enable	Enables the test and calibration mode control.
17	Test and Calibration	Pressed simultaneously with Test Enable initiates the test and calibration mode.
18	Power Age Cycler	For factory use only.



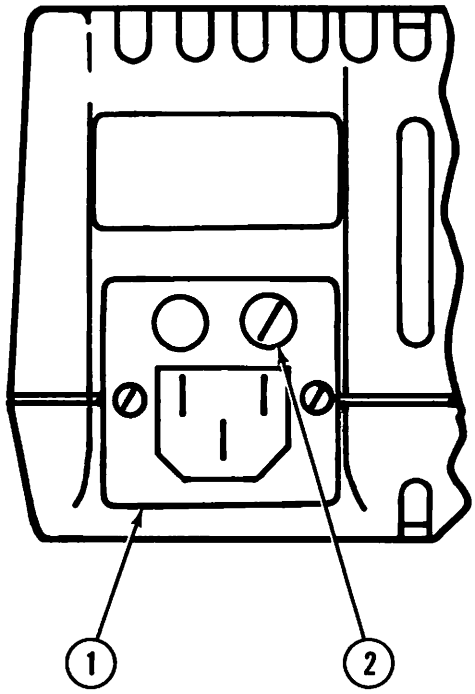


FIGURE 2-2. REAR PANEL CONTROLS

TABLE 2-2

REAR PANEL CONTROLS

FIGURE KEY NO.	ITEM	FUNCTION
1	Fuseholder Receptacle Connector	Connection for ac power cord.
2	Main Power Fuse (Slow-blow)	Voltage/current surge protection.

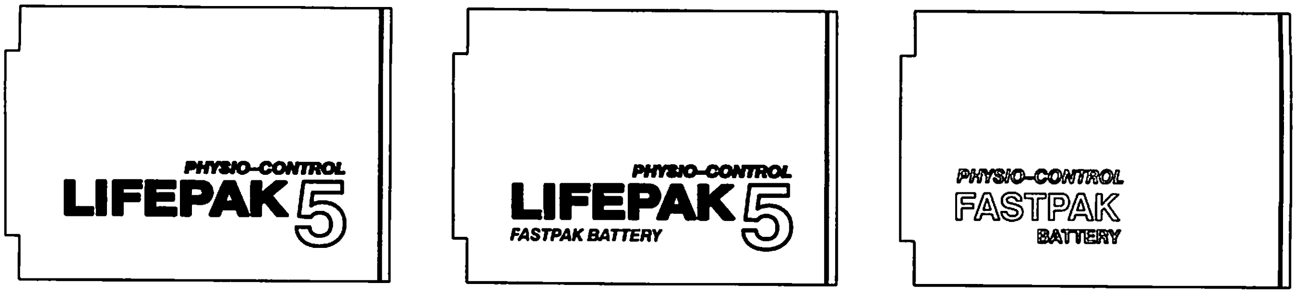


FIGURE 2-3. BATTERY PAKS

2-4. PERIODIC SERVICE PROCEDURES

Complete the following Performance Verification Procedure (PVP) at least quarterly to maintain Battery Support System operation, and after any service or repair of the instrument. If a component is replaced, the affected circuits may need adjustment. If so, see Section 3 for test and calibration procedures.

2-5. PERFORMANCE VERIFICATION PROCEDURE (PVP)

This section provides a suggested Performance Verification Procedure (PVP) and Checklist (Figure 2-4) for the Battery Support System. The Checklist is provided for convenience and may be copied when needed.

The following items are needed to complete the PVP:

Equipment Required	Part Number or Specification
3 FASTPAK Batteries	Fully charged
Physio-Control Defibrillator	LIFEPAK 5 defibrillator LIFEPAK 10 defibrillator/monitor LIFEPAK 250 automatic advisory defibrillator with test paddles
2 Battery Adapter Cables	Mini-alligator clip to mini-banana plug
Digital Multimeter	Fluke 8050A or equivalent
Permanent Magnet	Small sized
Leakage Analyzer	Dempsey 431 or equivalent

1. PHYSICAL INSPECTION

   Inspect the instrument for cracks, dents, lifted labels, etc. Inspect the ac power cord for cracked or broken insulation or other physical damage. Check for pitted test load pads and broken battery pins.

2. AC OPERATION

Connect the instrument to the appropriate ac power for its option (110/220V, 50/60Hz). Verify that the POWER ON legend is illuminated and that the rest of the display is blank.

3. BATTERY CHARGE

Install a fully charged FASTPAK Battery into each of the battery compartments.

A. Verify that the CHARGE legends light and that all others remain off.

B. After about 8min to 10min, verify that the READY legend lights and that all others remain off.

NOTE: Fully charged batteries refer to batteries that have been removed from the Battery Support System within 20min. Batteries stored at room temperature will self-discharge and affect the 8-10min time frame.

4. BATTERY DISCHARGE

Place a battery in battery compartment 3. Press DISCHG/CHARGE and verify that the discharge LED and DISCHARGE legend light. Remove the battery.

WARNING

SHOCK HAZARD. THE DEFIBRILLATORS USED FOR TESTING STORE AND DELIVER POTENTIALLY HAZARDOUS VOLTAGES. TEST AND SERVICE PERSONNEL MUST BE FAMILIAR WITH THESE INSTRUMENTS BEFORE PERFORMING THE PROCEDURES.

5. DISPLAYED ENERGY TEST

Use a calibrated LIFEPAK 5 defibrillator, a LIFEPAK 10 defibrillator/monitor, or a LIFEPAK 250 automatic advisory defibrillator, and select a discharge level of 200J.

Press TEST LOAD SELECT ▲ on the Battery Support System until the display reads 200J.

A. Discharge the defibrillator into the test load pads on the Battery Support System and verify that the display reads 200J.

B. Set the defibrillator and the Battery Support System to 360J and repeat the displayed energy test. Verify that the display reads 360J.

6. A/D CALIBRATION

Use the TEST LOAD SELECT ▲ controls to select 500J on the Battery Support System.

Place the defibrillator paddles on the test load pads.

Set the defibrillator to 360J and discharge immediately into the test load pads.

A. Record the digital display reading.

B. Reverse the paddles and repeat the A/D calibration test.

C. Verify the difference between the two readings is less than 5%.

7. BATTERY CHARGE CURRENT

Use the battery adapter cables to connect a FASTPAK Battery to the terminals of battery compartment 1. Observe proper polarity.

Insert the digital multimeter in series with the positive lead of the battery. Set the multimeter to Adc.

A. Verify that the CHARGE legend lights and that the multimeter indicates a charge current of 300mA ± 35mA.

Repeat the procedure for the other two battery compartments.

Connect the FASTPAK Battery and multimeter to battery compartment 1 as specified above.

Immediately place a small permanent magnet in the upper right corner of battery compartment 1.

B. Verify that the multimeter reads a charge current (C/3) of 1000mA ± 50mA after about 5sec.

8. BATTERY DISCHARGE CURRENT

Use the battery adapter cables to connect a FASTPAK Battery to the battery compartment 3 terminals. Observe proper polarity.

Insert the digital multimeter in series with the positive lead of the battery. Set the multimeter to Adc.

Press DISCHG-CHARGE.

Verify that the DISCHARGE legend lights and that the multimeter indicates a discharge current of 1000mA ± 35mA.

9. CASE LEAKAGE

Plug the Battery Support System into the test receptacle of the leakage analyzer and verify that the chassis leakage is less than 500μA with the ground lifted and polarity reversed.

10. GROUND RESISTANCE

Verify that the ground resistance measures less than 0.15 Ω (ground pin of ac receptacle to negative battery terminal).

DATE ____________

FIGURE 2-4. BATTERY SUPPORT SYSTEM PERFORMANCE VERIFICATION PROCEDURE CHECKLIST

1. PHYSICAL INSPECTION.. __________

2. AC OPERATION.. __________

3. BATTERY CHARGE.. __________
   A. CHARGE legends light.. __________
   B. READY legends on after 8-10min.............................. __________

4. BATTERY DISCHARGE.. __________

5. DISPLAYED ENERGY TEST
   A. 200J displayed.. __________
   B. 360J displayed.. __________

6. A/D CALIBRATION
   A. Reading with paddles in original position................... ________J
   B. Reading with paddles reversed............................... ________J
   C. Difference between readings................................. ________%

7. BATTERY CHARGE CURRENT
   A. CHARGE legend lights, 300mA charge current
      Battery Compartment 1....................................... __________
      Battery Compartment 2....................................... __________
      Battery Compartment 3....................................... __________
   B. 1000mA charge current....................................... __________

8. BATTERY DISCHARGE CURRENT...................................... __________

9. CASE LEAKAGE... ________µA

10. GROUND RESISTANCE... ________Ω

2-6. OPERATOR MAINTENANCE

The following routine maintenance recommendations should be observed by both the operator and technician for proper operation of the Battery Support System. Refer to the Operating Instructions (802371-01) for detailed battery information.

2-7. Battery Maintenance.

Proper maintenance is required for maximum efficiency of the nickel-cadmium batteries used in the Battery Support System. The following paragraphs provide brief operating instructions for the care and maintenance of these batteries.

Batteries should be charged at an ambient temperature of 20-30°C. The Battery Support System should not be placed in direct sunlight, over a radiator, or in cold storage since batteries will not reach full capacity if charged in extreme temperatures. These results cannot be overcome by extending the charge period.

When 90% of the available battery capacity has been used, the battery has reached its "cutoff voltage" and terminal voltage drops rapidly. Using a battery past this cutoff voltage may cause permanent battery damage. Physio-Control instruments using these batteries have low battery warning indicators and upon seeing this signal batteries should be removed for recharging.

Nickel-cadmium batteries typically self-discharge at a rate of 1% per day. This discharge rate increases with battery age and high storage temperature. Use batteries regularly and exercise (recondition) those that have been stored before reusing.

2-8. Battery Exercising.

For optimum performance a nickel-cadmium battery should be regularly exercised or reconditioned at least once every 90 days. This process fully charges the battery, discharges it to a preset level, then fully recharges it again. The right-side charge compartment in the Battery Support System contains the discharge circuitry necessary to perform a battery exercise cycle.

To exercise a battery, place it in the right-side charge compartment and press DISCHG-CHARGE at any point in the CHARGE or READY sequence. The READY legend lights and % BATT CAP displays when the battery is ready for use. Maximum battery capacity may increase with repeated reconditioning cycles. Initiate a second discharge cycle by removing the battery and reinserting it.

For additional information on battery characteristics or maintenance, contact a Physio-Control service representative.

2-9. Fuse Replacement.

Access the fuses from the rear of the instrument in the Fuseholder Receptacle Connector (refer to Figure 2-2, Rear Panel Controls).

2-10. External Cleaning.

Clean the Battery Support System case with mild soap and water and use a damp sponge or towel. Do not immerse in water. Do not use alcohol or ketones (MEK, acetone, etc.) on the plastic case or keypad area. Refer to Section 4 for more extensive cleaning procedures.

2-11. Preparation for Storage or Shipment.

Save the original shipping box and packing for the Battery Support System for later use in storage or shipment (see Figure 2-5).

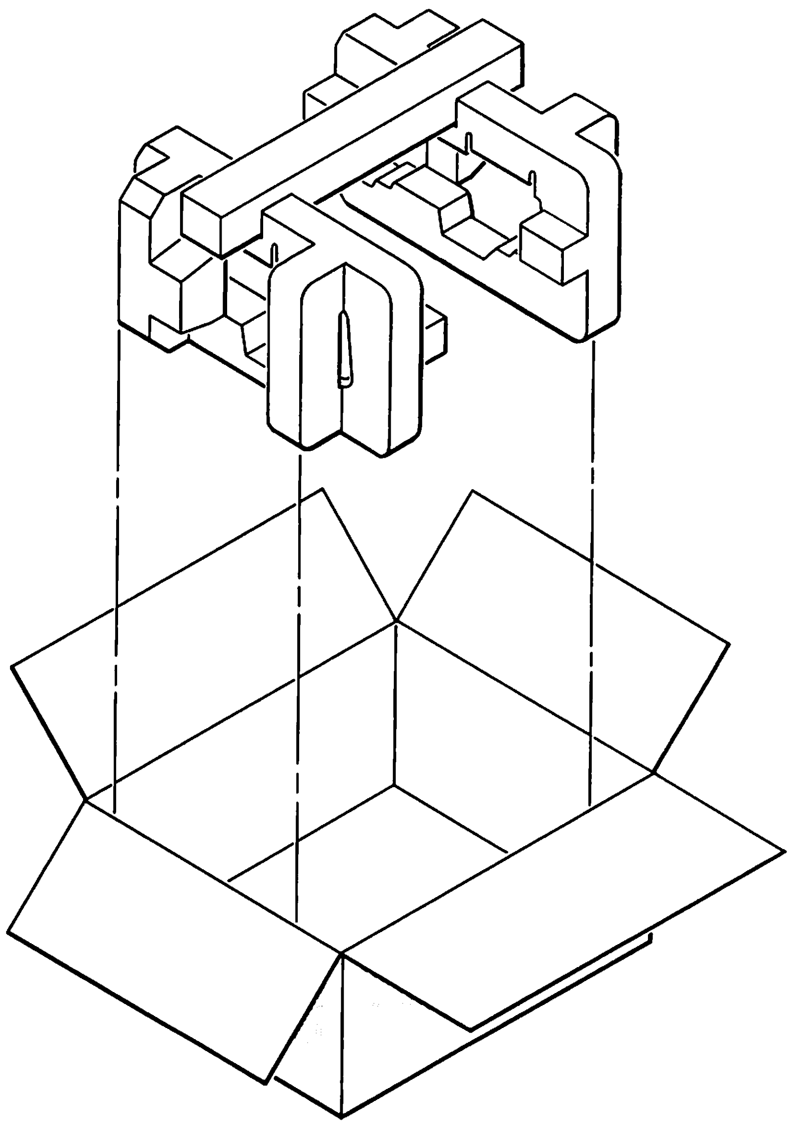


FIGURE 2-5. PREPARATION FOR STORAGE OR SHIPMENT

SECTION 3
TESTING AND TROUBLESHOOTING

3-1. OVERVIEW

The Testing and Troubleshooting Section provides the following information:

- Servicing Guidelines
- Test Equipment
- Test Setup
- Functional Test and Calibration Procedures
- Troubleshooting

CAUTION

AVOID PRINTED CIRCUIT BOARD (PCB) DAMAGE. SOME PCB ASSEMBLIES IN THE BATTERY SUPPORT SYSTEM CONTAIN STATIC SENSITIVE DEVICES ATTENTION (SSDs) AND REQUIRE SPECIAL HANDLING PROCEDURES.

WARNING

SHOCK HAZARD. THE DEFIBRILLATORS USED FOR TESTING STORE AND DELIVER POTENTIALLY HAZARDOUS VOLTAGES. TEST AND SERVICE PERSONNEL MUST BE FAMILIAR WITH THESE INSTRUMENTS BEFORE PERFORMING THE PROCEDURES. READ THE WARNING IN PARAGRAPH 3-4, TEST SETUP, BEFORE CONNECTING ANY TEST EQUIPMENT TO THE BATTERY SUPPORT SYSTEM.

3-2. SERVICING GUIDELINES

Observe these servicing guidelines before and during service, repair, or troubleshooting. Detailed service and repair information at component level is provided in Section 4.

Perform a close visual inspection before disassembly.

Before removing a PCB or mechanical assembly for repair or replacement, label each lead or draw a sketch showing the location of cables, wires, and hardware.

3-3. TEST EQUIPMENT

Test instruments necessary for maintenance and calibration of the Battery Support System are listed in Table 3-1. Although specific, commercially available test instruments are recommended, OTHER TEST EQUIPMENT WITH SPECIFICATIONS EQUIVALENT TO THOSE LISTED MAY BE USED.

TABLE 3-1

TEST EQUIPMENT

NOMENCLATURE	CHARACTERISTICS	MANUFACTURER
Oscilloscope	100MHz, dual trace	Tektronics 464 or equivalent
Frequency Counter	10MHz	Fluke model 1911A or equivalent
Digital Multimeter	3-1/2 digit, 2A	Fluke model 8050A or equivalent
Energy Test Meter		Dempsey 429B Mod #1 or equivalent
Physio-Control defibrillator	LIFEPAK 5 defibrillator OR LIFEPAK 10 defibrillator/monitor OR LIFEPAK 250 automatic advisory defibrillator	Physio-Control Corp. (PCC) No. 9-00285 or PCC No. 801528 PCC No. 804200 PCC No.805163
Test Paddles (2 required)*		PCC No.803602
Battery Pak (required)**		PCC No. 9-10424-03
FASTPAK Battery (required)**		PCC No. 9-10424-04 PCC No. 9-10424-09
Stopwatch	Accuracy: 0.1sec	
Test Header	With 10 kΩ resistors	Refer to Figure 3-6
Signature Analyzer		Hewlett-Packard 5004A or equivalent

* For use with the LIFEPAK 250 automatic advisory defibrillator.

** To perform the tests on the Battery Support System, 3 batteries are required. One standard Battery Pak and one FASTPAK Battery must be used. The third battery type may be either.

3- 4. TEST SETUP

A. To access test points separate the upper and lower case of the Battery Support System according to Section 4, Case Separation.

B. Connect the test equipment as shown in Figure 3-1.

NOTE: Extender cables may be used as an option to easily access the test points.

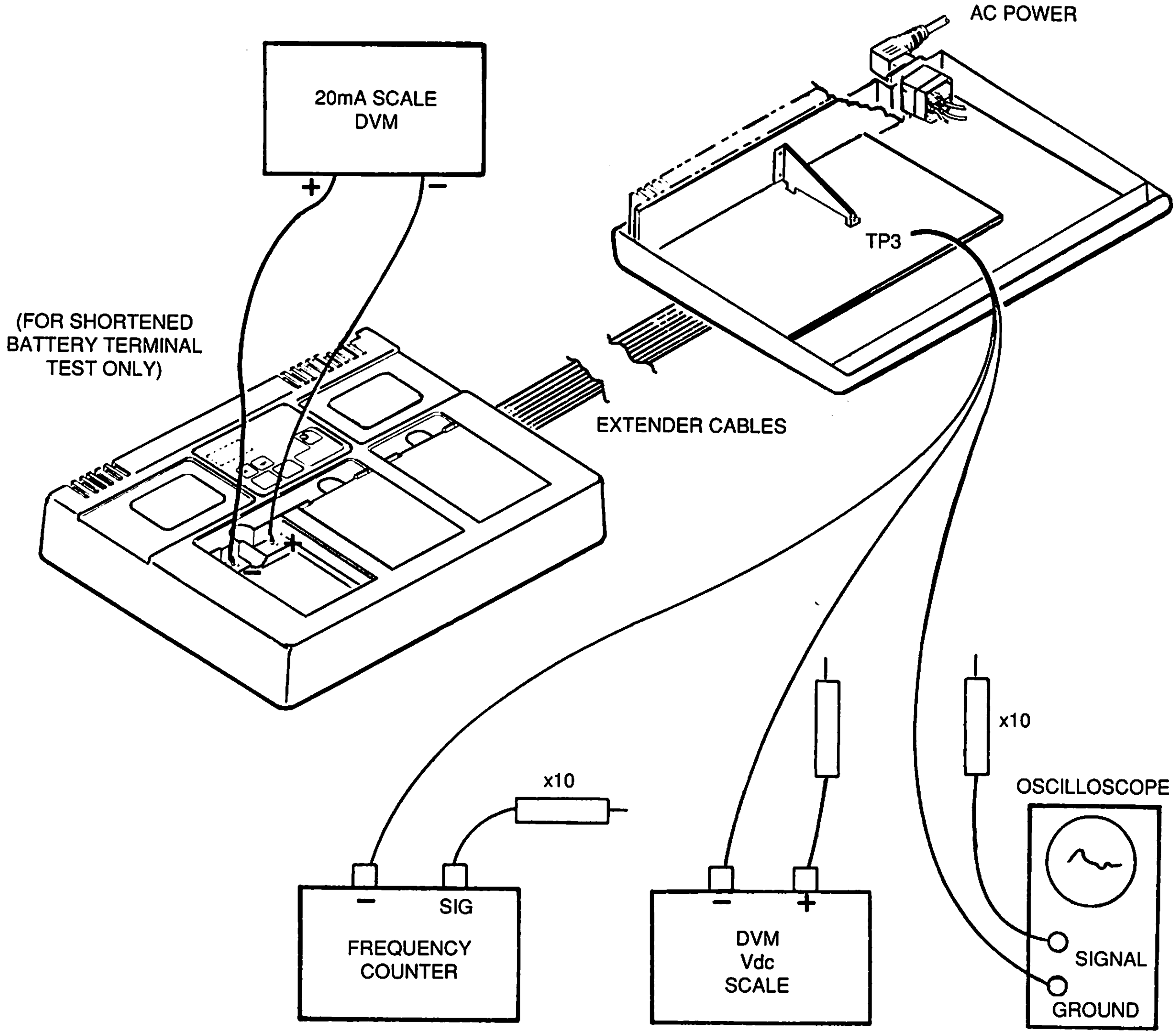


FIGURE 3-1. TEST SETUP

C. Confirm the jumper installation on the Computational Power Supply PCB Assembly as follows: J9 shorts pin 2 to pin 3 (on -01 configuration, J10 shorts pin 1 to pin 2 and J11 shorts pin 1 to pin 2. J10 and J11 are only on -01 configuration). Refer to Figure 3-2 for the location of the jumper(s).

WARNING

SHOCK HAZARD. THE FUNCTIONAL TEST AND CALIBRATION PROCEDURES REQUIRE PERIODIC USE OF A DEFIBRILLATOR WHICH STORES AND DELIVERS POTENTIALLY HAZARDOUS VOLTAGES. TO PREVENT INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT CAREFULLY FOLLOW THE INSTRUCTIONS GIVEN IN THE PROCEDURE.

CAUTION

AVOID TEST INSTRUMENT DAMAGE. DO NOT CONNECT LOADS OF ANY KIND TO THE BATTERY CHARGE TERMINALS UNLESS SPECIFICALLY DIRECTED TO DO SO IN THE TEST PROCEDURES. DO NOT LEAVE THE INSTRUMENT UNATTENDED WHEN OPERATING IN THE SELF-TEST MODE SINCE THE BATTERY CHARGE CONTROL IS INHIBITED. THE INSTRUMENT CYCLES THROUGH THE VARIOUS CHARGE RATES WITH NO CURRENT LIMITING.

3-5. FUNCTIONAL TEST AND CALIBRATION PROCEDURES

These procedures verify that the Battery Support System operates within factory specifications. If the instrument malfunctions, locate and repair the problem using Table 3-8, Troubleshooting Guide, before attempting circuit calibration or adjustment.

3-6. Assembly Check.

Before applying power, use an ohmmeter to confirm that the tabs of all power transistors and voltage regulators (except VR1 and VR3) mounted on the heat sink are electrically isolated from the heat sink. Verify that the dc resistance between the ac power ground pin and the heat sink ground lug is 0.1 Ω or less.

3-7. Power Supply Check.

A. Connect the instrument under test to ac power.

B. Verify the dc voltages specified in Table 3-2, at test points 1 through 7. Figure 3-2 shows the board locations for these test points. Use TP3 as the ground reference for all dc voltage measurements unless otherwise specified.

NOTE: The instrument under test is connected to ac power for the remainder of the Functional Test and Calibration Procedures.

C. Verify that the POWER ON indicator is on and that the 3-digit display is off. Immediately after power is applied, one or more LEDs may briefly flash. This is normal.

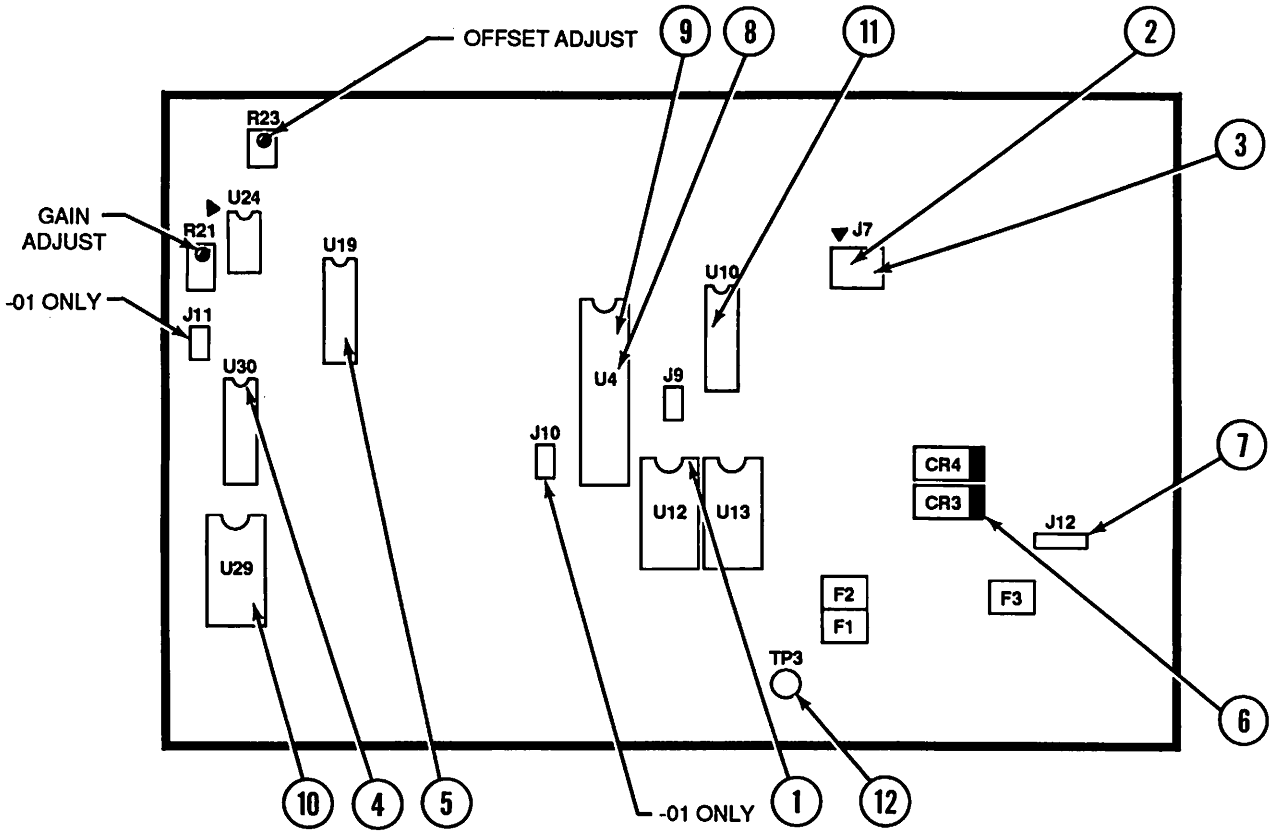


FIGURE 3-2. COMPUTATIONAL POWER SUPPLY PCB TEST POINT LOCATIONS

TABLE 3-2

COMPUTATIONAL POWER SUPPLY PCB TEST POINTS

TEST POINT	LOCATION	DESCRIPTION	SIGNAL AND TOLERANCE
1	U12 pin 24	+5V supply	+5V ± 0.25Vdc
2	J7 pin 1	+12V supply	+12V ± 0.6Vdc
3	J7 pin 2	-12V supply	-12V ± 0.6Vdc
4	U30 pin 17	A/D Reference (VR)	+10.24V ± 0.03Vdc
5	U19 pin 11	Cal Reference	+2.37V ± 0.05Vdc
6	CR3 cathode	+24V unregulated	+24.5V ± 2.5Vdc
7	J12	Unregulated V	+11.0V ± 1Vdc*
8	U4 pin 34	E CLK	1MHz ± 500Hz
9	U4 pin 35	Q CLK	1MHz ± 500Hz
10	U29 pin 13	A/D Clock	250kHz ± 125Hz
11	U10 pin 2	IRQ Clock	33ms ± 1ms
12	TP3	GND	GND

* Some instruments have SAR6936 transformers with an unregulated output of 13.5Vdc ± 1.0Vdc.

3-8. Microprocessor and Interrupt Clocks Verification.

Use the frequency counter to measure the E CLK, Q CLK, and A/D Clock at test points 8 through 10. Use an oscilloscope to measure the IRQ clock at test point 11. Refer to Table 3-2 for frequency specifications at each test point location.

3-9. Logic Check with Signature Analysis.

A. Disconnect ac power.

B. Disable the interrupts by moving J9 to short pins 1 and 2.

C. Connect the signature analyzer to the Computational Power Supply PCB as follows:

Start at P1 pin 35.............Rising Edge
Stop at P1 pin 35..............Falling Edge
Clock at U7 pin 13.............Falling Edge
Ground at TP3

D. Reconnect ac power to the Battery Support System.

E. Simultaneously press hidden keypad switches S4 and S6 to enter the self-test software (see Figure 3-3).

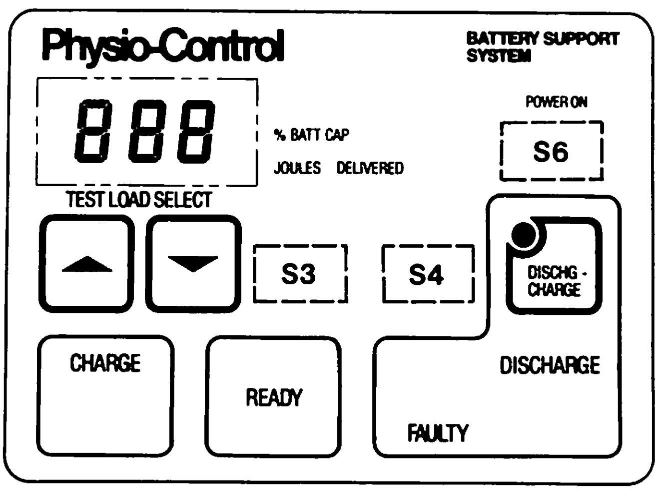


FIGURE 3-3. TEST CONTROL LOCATIONS

NOTE: If the instrument fails to respond to the TEST LOAD SELECT commands, it may indicate that microprocessor U4 or address buffers and decoders U5 through U7 on the Computational Power Supply PCB Assembly (Figure 5-4) have failed. In this event, perform the Free-Run Troubleshooting Test of paragraph 3-16.

F. Test 0, EPROM Code Check.

1. Press TEST LOAD SELECT ▲. Verify that a single-digit 0 appears in the far right location of the Switch Interface/Display PCB, indicating test 0 of the self-test mode.

2. Connect the signature analyzer probe to the +5V point at U13 pin 24. Verify a signature of CH8P which indicates correct EPROM function and code integrity.

G. Test 1, RAM Read/Write Test

1. Press TEST LOAD SELECT ▲. Verify that the digital display changes to 1.

2. Connect the signature analyzer probe to the +5V point at U13 pin 24. A signature of 473C indicates a functional RAM.

H. Test 2, I/O Port Test.

1. Press TEST LOAD SELECT ▲. Verify that the digital display changes to 2.

2. Use the signature analyzer and probe the test points identified below to verify the signatures in Table 3-3.

TABLE 3-3

I/O PORT TEST

SIGNAL	TEST POINT	SIGNATURE
+5V	U13 pin 24	FPFP
EØ	U5 pin 1	FPFU
E1	U5 pin 2	8ØAU
E2	U5 pin 3	3FCH
E3	U5 pin 4	415H
E4	U5 pin 5	52C2
E5	U5 pin 6	522H
E6	U5 pin 7	A229
E7	U5 pin 8	CHA9
E8	U5 pin 9	FPFP
E9	U5 pin 10	C555
E1Ø	U5 pin 11	7H12
E11	U5 pin 13	Ø35Ø
E12	U5 pin 14	3ØA2
E13	U5 pin 15	8A98
E14	U5 pin 16	937F
E15	U5 pin 17	937F
CS	U18 pin 19	P788
DIR	U18 pin 1	8357

TABLE 3-3 (Continued)

I/O PORT TEST

SIGNAL	TEST POINT	SIGNATURE
D3	U18 pin 11	7624
D2	U18 pin 12	U092
D4	U18 pin 13	P2PP
D1	U18 pin 14	837A
D5	U18 pin 15	8901
D0	U18 pin 16	173F
D6	U18 pin 17	0HFA
D7	U18 pin 18	394A
C2	U7 pin 5	0000
C0	U7 pin 7	FPFP
C1	U7 pin 9	4H99
C3	U7 pin 16	0000
BA	J10 pin 3	0000
$\overline{OE}$	U12 pin 20	8357
$\overline{WE}$	U12 pin 21	FPFP
S0	Q7 gate	798C
S1	Q8 gate	U510
S2	Q11 gate	1A3H
S3	Q12 gate	C635
S4	Q15 gate	99FA
S5	Q16 gate	A613
S6	U14A pin 1	U313
DISCHG	Q18 gate	4P04
U20 $\overline{OE}$	U25A pin 3	FPFP
U20 $\overline{W}$	U25B pin 6	FPFP
U21/U22 $\overline{OE}$	U25C pin 8	FPFP
U21/U22 $\overline{W}$	U25D pin 11	FPFP
U31 $\overline{OE}$	U15A pin 3	FPFP
U32 $\overline{OE}$	U15B pin 6	FPFP

I. Test 3 and Test 4, A/D Calibration.

1. Press TEST LOAD SELECT ▲ and hold until a 3 appears. Notice that the display alternates between the 3 for test 3 and a three-digit number. The three-digit number is the absolute value difference between the current A/D output and the correct A/D output. (Refer to Figure 3-2 for the location of R21 and R23.)

2. Adjust R23 on the Computational Power Supply PCB Assembly to obtain an output voltage of -5.12V ± 0.02V at U24 pin 1. This adjustment provides the correct offset for the A/D section.

3. Verify that the three-digit flashing display is stable within the 000 to 025 range.

4. Press TEST LOAD SELECT ▲ until a 4 appears. Notice that the display alternates between the 4 and a three-digit number. The three-digit number is the absolute value difference between the current A/D output and the correct A/D output with a calibration reference input of 2.37V ± 0.05V applied at U19 pin 11.

5. Adjust R21 to obtain an output voltage of -7.49V ± 0.01V at U24 pin 1. This adjustment provides the correct gain for the A/D section.

6. Verify that the three-digit flashing display is stable within the 000 to 025 range.

J. Test 5, Display PCB Test.

1. Press TEST LOAD SELECT ▲ and hold until Switch Interface/Display PCB lightbars begin to flash on and off.

2. Observe that the LEDs in the following test pattern are sequenced repeatedly.

   a. All LEDS are off except for the POWER ON legend and the display shows X 5 (middle digit off). The 5 denotes self-test 5 and the X is any digit from 0 to 7.

   b. All three CHARGE legends are on for about 1sec.

   c. All three READY legends are on for about 1sec.

   d. All three FAULTY legends are on for about 1sec.

   e. The DISCHARGE legend and circular amber LED are on for about 1sec.

   f. The % BATT CAPACITY and JOULES DELIVERED legends are on for about 1sec.

   g. The 7-segment displays count together from 000 to 999.

3. Verify that status legends (CHARGE, READY, FAULTY) are not readable when the associated lightbar is off.

4. Verify that each status legend is uniformly lit.

5. Verify that the 7-segment digit displays read "0 5" during the times that the status-bar LEDs are lit. The 5 is the test number and the 0 is the binary equivalent of the input pattern at J2 on the Switch Interface/Display PCB.

   a. With the battery charge compartments empty, the left digit should be 0.

b. With a Battery Pak installed in any of the charge compartments, the left digit should be 0.

c. Place a FASTPAK Battery in charge position 1 (left-most) only and verify that a 1 is displayed.

d. Place a FASTPAK Battery in charge position 2 (middle) only and verify that a 2 is displayed.

e. Place a FASTPAK Battery in charge position 3 (right-most) only and verify that a 4 is displayed.

NOTE: Any other number indicates a Battery-Type Selection circuit failure if only one FASTPAK Battery is installed.

K. <u>Test 6, Battery Charge/Discharge Circuit Test</u>.

1. Press TEST LOAD SELECT ▲ and hold until a 6 is displayed. For each charge position the test software will:

   a. Illuminate CHARGE and switch into the full charge mode for about 10sec.

   b. Illuminate READY and switch into the trickle charge mode for about 10sec.

   c. Illuminate FAULTY and switch off for about 10sec.

2. Successively place a FASTPAK Battery into each battery position.

   a. When the CHARGE LEDs light, verify that the current drawn by this load is 950mA to 1050mA.

   b. When the READY LEDs light, verify that the current drawn by the load is 265mA to 335mA.

   c. When the FAULTY LEDs light, verify that the current drops to less than 10mA.

   d. Repeat this test with a Battery Pak.

   e. When the CHARGE LEDs light, verify that the current drawn is 950mA to 1050mA.

   f. When the READY LEDs light, verify that the current drawn is 265mA to 335mA (pulsed).

L. <u>Test 7, Discharge Circuit Test</u>.

1. Press TEST LOAD SELECT ▲ until a 7 appears. Verify that the DISCHARGE legend for the third battery position lights for about 10sec. After 10sec, DISCHARGE shuts off for 10sec. (This sequence will repeat until the J9 jumper is moved back to the normal operation position.)

2. Place a Battery Pak into battery position 3 and verify a current draw of 1000mA ± 35mA. Remove the Battery Pak from the instrument.

3-10. Watchdog Timer Test.

A. Move the J9 jumper back to the normal operating position, shorting pins 2 to 3.

B. Simultaneously press and hold S4 and S6 and observe that the 3-digit display shows a blinking single-digit 0. (The display must be blanked before this step is done.)

C. While holding S4 and S6 down, verify that:

1. U4 pin 2 is pulsing as shown in Figure 3-4.

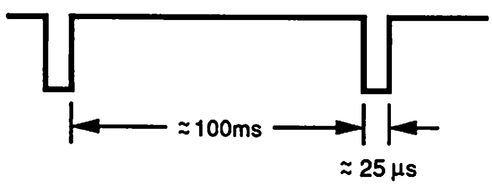


FIGURE 3-4. $\overline{\text{NMI}}$ WAVEFORM

2. U4 pin 3 is pulsing as shown in Figure 3-5.

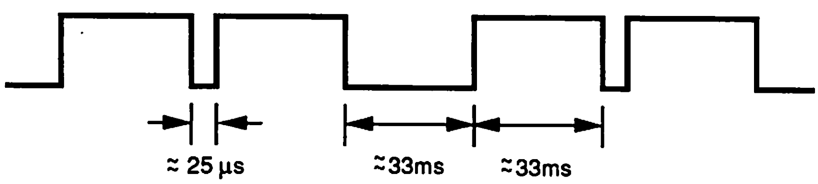


FIGURE 3-5. $\overline{\text{IRQ}}$ WAVEFORM

3. U4 pin 37 is held inactive high.

3-11. Shorted Battery Terminal Test.

A. Cycle ac power to the instrument.

B. Set the digital multimeter (DMM) for Adc and select the 20mA range.

C. Before proceeding with the test, check that the DMM is protected by a fast-blow fuse rated at a maximum of 2A.

D. Connect the DMM in series with the battery position 1 terminals (see Figure 3-1, Test Setup).

1. Verify that battery position 1 FAULTY legend is on.

2. Verify that the current is less than 2mA.

E. Connect the DMM in series with the battery position 2 terminals.

1. Verify that the battery position 2 FAULTY legend is on.

2. Verify that the current is less than 2mA.

F. Connect the DMM in series with the battery position 3 terminals.

1. Verify that the battery position 3 FAULTY legend is on.

2. Verify that the current is less than 2mA.

3-12. Keypad and Display Board Operation.

A. Repeatedly press TEST LOAD SELECT ▲ and ▼. Observe that the 7-segment display counts up and down in increments of 10.

B. Enter 00 in the digital display and allow the display to blank (within about 25sec). Press and hold ▲. Observe the display count up (by 100), from 00 to 500.

C. Release ▲ when 00 is displayed. Press and hold ▼. Observe the display count down (by 100), from 500 to 00.

D. Verify that the JOULES legend is on concurrently with the 3-digit display.

E. Confirm that both the 3-digit display and JOULES legend remain on for 25sec ± 5sec after the TEST LOAD SELECT controls are pressed for the last time.

F. With no battery installed in the battery position 3, press DISCHG-CHARGE. Verify that the display does not change.

G. Install a Battery Pak in battery position 3. Press DISCHG-CHARGE. Verify that the DISCHARGE legend lights and that the CHARGE or READY legend shuts off.

3-13. Displayed Energy Check with a LIFEPAK 5 or LIFEPAK 10 defibrillator/monitor.

WARNING

SHOCK HAZARD. POTENTIALLY HAZARDOUS VOLTAGES ARE PRESENT ON THE DEFIBRILLATOR PADDLES DURING THE FOLLOWING TESTS. TEST AND SERVICE PERSONNEL MUST BE FAMILIAR WITH THIS INSTRUMENT BEFORE PROCEEDING.

WARNING

SHOCK HAZARD. PLACE THE UPPER CASE OVER THE LOWER CASE IN THE ORIGINAL ASSEMBLED POSITION TO REDUCE SHOCK HAZARD WHEN APPLYING DEFIBRILLATOR CHARGE TO THE BATTERY SUPPORT SYSTEM.

A. Place the Battery Support System upper case over the lower case, so that all internal cables and upper case are correctly positioned.

B. These tests require the use of a properly calibrated LIFEPAK 5 defibrillator or a LIFEPAK 10 defibrillator/monitor and an energy test meter.

NOTE: The following charge/discharge procedures are MANDATORY for correct defibrillator use.

1. Select the desired energy level on the defibrillator using the ENERGY JOULES control.
2. Position the paddles on the test load pads.
3. Press CHARGE to initiate the charge cycle.
4. Press the paddle discharge pushbuttons simultaneously and hold.
5. Allow the defibrillator to automatically discharge upon reaching the selected energy level.

NOTE: Discharge the defibrillator immediately after it is fully charged. The stored charge decreases rapidly and results in an unknown delivered energy level.

C. Install 3 Battery Paks into the Battery Support System and place the defibrillator directly on top of them. This is the worst-case position for coupling radio frequency (RF) from the defibrillator into the Battery Support System.

1. Select 20J on the Battery Support System using TEST LOAD SELECT controls and set the defibrillator to 20J. Follow the charge/discharge procedures in paragraph 3-13B.
2. Verify that the display does not change and that the JOULES DELIVERED legend is on.
3. Verify that the display and JOULES DELIVERED blank within 5sec ± 1sec.
4. Place the defibrillator next to the Battery Support System for the remainder of the tests.

D. Select 40J on the Battery Support System and 20J on the defibrillator. Follow the charge/discharge procedures in paragraph 3-13B.

1. Verify that the display changes to about 20J and that the JOULES DELIVERED legend comes on.

2. Verify that the display and JOULES DELIVERED blank within 5sec ±1sec.

E. Select 20J on the Battery Support System and 100J on the defibrillator. Set the energy test meter to 100J if equipped with range select.

1. Place the paddles on the energy test meter contacts with the APEX paddle on the right contact. Follow the charge/discharge procedures in paragraph 3-13B. Note the energy test meter reading.

2. Repeat step 1 with the paddles placed on the Battery Support System test load pads, then again with the paddles on the energy test meter. Note both readings.

3. Average the two energy test meter readings noted in steps 1 and 2 and verify that the energy reading on the Battery Support System is within ±8% (0.92 to 1.08 times the energy test meter average).

4. Reverse the paddles (APEX paddle on the left contact) and discharge the defibrillator on the test load pads of the Battery Support System. Verify that the noted energy reading with the APEX paddle on the right is within ±3% of the reading with the APEX paddle on the left. Adjust R23 if necessary (Test 3 and 4, A/D Calibration).

F. Select 500J on the Battery Support System and 300J on the defibrillator. Set the energy test meter to 400J if equipped with range select.

1. Use the procedure in paragraph 3-13E, steps 1 and 2, and verify that the displayed Battery Support System energy is within ±8% of the average of the two energy meter readings (APEX on right).

2. Reverse the paddles (APEX on left) and discharge the defibrillator on the test load pads of the Battery Support System. Note the display reading. Verify that the energy reading with the APEX paddle on the right is within ±3% of the reading with the APEX paddle on the left. Adjust R21 if necessary (Test 3 and 4, A/D Calibration).

G. Use the noted display reading in paragraph 3-13F step 2 and select the appropriate value listed in Table 3-4. (For example, if in step 2 the delivered energy displayed was 282J, the appropriate selected value would be 300J.) Discharge the defibrillator into the test load pads. Verify that the displayed number does not change and that the JOULES DELIVERED legend is on.

H. Again use the noted display reading from paragraph 3-13F step 2 and select the appropriate value listed in Table 3-5. Discharge the defibrillator into the test load pads. Verify that the actual energy delivered is displayed and the JOULES DELIVERED legend is on.

TABLE 3-4

ENERGY CALCULATION

If the JOULES DELIVERED display reads...	Select a value of
280-284	300
285-293	310
294-302	320
303-311	330
312-320	340
321-329	350

TABLE 3-5

ACTUAL ENERGY CALCULATION

If the JOULES DELIVERED display reads...	Select a value of
280-286	320
287-295	330
296-304	340
305-313	350
314-322	360
323-331	370

3-14. Displayed Energy Check with the LIFEPAK 250 automatic advisory defibrillator.

WARNING

SHOCK HAZARD. POTENTIALLY HAZARDOUS VOLTAGES ARE PRESENT ON THE DEFIBRILLATOR PADDLES DURING THE FOLLOWING TESTS. TEST AND SERVICE PERSONNEL MUST BE FAMILIAR WITH THIS INSTRUMENT BEFORE PROCEEDING.

> **WARNING**
>
> SHOCK HAZARD. PLACE THE UPPER CASE OVER THE LOWER CASE IN THE ORIGINAL ASSEMBLED POSITION TO REDUCE SHOCK HAZARD WHEN APPLYING DEFIBRILLATOR CHARGE TO THE BATTERY SUPPORT SYSTEM.

A. Place the Battery Support System upper case over the lower case, so that all internal cables and upper case are correctly positioned.

B. These tests require the use of a properly calibrated LIFEPAK 250 automatic advisory defibrillator and an energy test meter.

NOTE: The following charge/discharge procedures are MANDATORY for correct defibrillator use.

1. Put the defibrillator in MANUAL mode.

2. After the full-screen message display clears, press ANALYZE.

3. The LIFEPAK 250 can deliver either 200J or 360J:

    a. For 200J, press and hold SHOCK until the defibrillator energy is discharged.

    b. For 360J, wait for the prompt "PUSH FOR 360J" then press 360J. When "SHOCK NOW!" appears on the display press SHOCK.

C. Install 3 Battery Paks into the Battery Support System and place the defibrillator directly on top of them. This is the worst-case position for coupling radio frequency (RF) from the defibrillator into the Battery Support System.

1. Connect the test paddles to the patient-cable terminals on the defibrillator and place the paddles on the Battery Support System test load pads.

2. Select 200J on the Battery Support System and follow the charge/discharge procedures in paragraph 3-14B for 200J.

3. Verify that the display does not change and that the JOULES DELIVERED legend is on.

4. Verify that the display and JOULES DELIVERED blank within 5sec ±1sec.

5. Place the defibrillator next to the Battery Support System for the remainder of the tests.

D. Select 100J on the Battery Support System and follow the charge/discharge procedures in paragraph 3-14B for 200J.

1. Verify that the display changes to about 200J and that the JOULES DELIVERED legend comes on.

2. Verify that the display and JOULES DELIVERED blank within 5sec ±1sec.

E. Select 100J on the Battery Support System and 400J on the energy test meter if equipped with range select.

1. Place the test paddles on the energy test meter contacts and follow the charge/discharge procedures in paragraph 3-14B for 200J. Note the reading.

2. Repeat the previous step with the test paddles placed on the Battery Support System test load pads, then again with the paddles on the energy test meter. Note the readings.

3. Average the two energy test meter readings noted in steps 1 and 2 and verify that the energy displayed on the Battery Support System is within ±8% (0.92 to 1.08 times the energy test meter average).

4. Reverse the test paddles and discharge the defibrillator on the test load pads of the Battery Support System. Verify that the noted energy reading with the paddles in the first position is within ±3% of the reading with the paddles in the second position. Adjust R23 if necessary (Test 3 and 4, A/D Calibration).

F. Select 500J on the Battery Support System and 400J on the energy test meter if equipped with range select.

1. Use the procedure in paragraph 3-14E, steps 1 and 2 but deliver 360J from the defibrillator. Verify that the displayed Battery Support System energy is within ±8% of the average of the two energy meter readings.

2. Reverse the test paddles and discharge the defibrillator on the test load pads of the Battery Support System. Verify that the energy reading with the paddles in the first position is within ±3% of the reading with the paddles in the second position. Adjust R21 if necessary (Test 3 and 4, A/D Calibration).

3-15. TROUBLESHOOTING

When a failure is located on a particular PCB assembly, the information in Table 3-8 may be used to locate the failed component. Find the symptom that most closely resembles the actual failure and follow the procedure in the right column.

3-16. Free-Run Troubleshooting Test.

If the instrument fails to respond to the TEST LOAD SELECT command during the Logic Check, the Free-Run Troubleshooting Test will allow the main components of the Battery Support System to operate without the RAM, ROM, or I/O buffer.

A. Disconnect ac power from the Battery Support System, and remove all the Battery Paks and FASTPAK Batteries.

B. Remove U11, U12, and U18 from the sockets in the Computational Power Supply PCB Assembly.

C. Move the J9 jumper so that it shorts pin 1 to pin 2.

D. Install the Test Header (see Figure 3-6) at U12.

E. Connect the signature analyzer as follows:

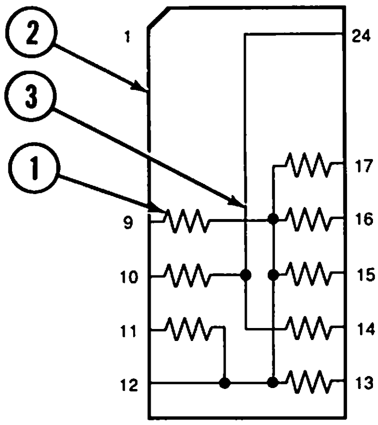
Start at U4 pin 23.............Rising Edge
Stop at U14D pin 9.............Rising Edge
Clock at U7 pin 13.............Rising Edge
Ground at TP3

F. Apply ac power to the Battery Support System and verify the signatures in Table 3-6.

TABLE 3-6

FREE-RUN TROUBLESHOOTING TEST

SIGNAL	TEST POINT	SIGNATURE	SIGNAL	TEST POINT	SIGNATURE
+5V	U13 pin 24	0003	E0	U5 pin 1	7074
A2	U6 pins 3,17	8484	E1	U5 pin 2	PF63
A4	U6 pins 5,15	1U5P	E2	U5 pin 3	2F1U
A6	U6 pins 7,13	U759	E3	U5 pin 4	09UA
A7	U6 pins 9,11	6F9A	E4	U5 pin 5	79CA
A5	U6 pins 8,12	0356	E5	U5 pin 6	AUCC
A3	U6 pins 6,14	P763	E6	U5 pin 7	2H91
A1	U6 pins 4,16	FFFF	E7	U5 pin 8	A8HP
A0	U6 pins 2,18	UUUU	E8	U5 pin 9	7423
A10	U7 pins 3,17	37C5	E9	U5 pin 10	APC2
A9	U7 pins 8,12	6321	E10	U5 pin 11	47UA
A8	U7 pins 6,14	7791	E11	U5 pin 13	54H4
A11	U4 pin 19	6U28	E12	U5 pin 14	4P23
A12	U4 pin 20	4FCA	E13	U5 pin 15	A98A
A13	U4 pin 21	4868	E14	U5 pin 16	F4AC
A14	U4 pin 22	9UP1	E15	U5 pin 17	F4AC
A15	U4 pin 23	0002	CS	U18 pin 19	3281
$\overline{\text{A15}}$	U5 pin 19	0001	IRQ CLK	U8B pin 9	UUUP
A11	U17A pin 3	6U28			



ITEM NO.	PART NO.	DESCRIPTION	QTY
1	200470-486	RESISTOR, 10 kΩ, 1/4W, 5%	8
2	200675-005	SOCKET, DIP, 24 contact	1
3	90-09138	WIRE, Solid Bus, 22 AWG	A/R

FIGURE 3-6. TEST HEADER

3-17. Fault Isolation. If the Battery Support System fails a functional test, the circuit failure may be isolated to a particular assembly by using Table 3-7. Find the test that failed in the TEST column of Table 3-7 and determine the assembly suspected of causing the failure. Proceed to the Troubleshooting Guide (paragraph 3-18) to find the failed component.

TABLE 3-7

FAILURE ISOLATION

STEP	TEST	SUSPECTED ASSEMBLY
3-7	Power Supply Check	Computational Power Supply PCB
3-8	Microprocessor and Interrupt Clocks Verification	Computational Power Supply PCB
3-9	Logic Check with Signature Analysis	Computational Power Supply PCB Assembly
3-10	Watchdog Timer Test	Computational Power Supply PCB
3-11	Shorted Battery Terminal Test	Switch Interface/Display PCB or Computational Power Supply PCB
3-12	Keypad and Display Board Operation	Switch Interface/Display PCB, Membrane Switch Assembly, or Interconnection Cable
3-13 3-14	Defibrillator Test Load/ Energy Calculations	Computational Power Supply PCB
3-16	Free-Run Troubleshooting Test	Computational Power Supply PCB

3-18. Troubleshooting Guide. When a failure is isolated to a particular PCB assembly, the information in Table 3-8 may be used to locate the failed component. Find the symptom that most closely resembles the actual failure and follow the procedure in the right column.

TABLE 3-8

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY

SYMPTOMS	PROCEDURE
MICROPROCESSOR SUPPORT CIRCUITRY	
No Q CLK or E CLK	• Check +5V at U4 pin 7. If +5V is out of tolerance, proceed to Power Supply Troubleshooting. If +5V is within tolerance, proceed to next step. • Check $\overline{HALT}$ input to U4 pin 40. If $\overline{HALT}$ is not at +5V, resistor R29 may have failed. Measure the resistance and replace if necessary. If $\overline{HALT}$ is at its correct voltage, proceed to next step. • Check MRDY, U4 pin 36, and BUSY, U4 pin 33, inputs. If MRDY or BUSY is not at +5V, R15 may have failed. Measure the resistance and replace if necessary. If MRDY and BUSY are at their correct voltages, proceed to next step. • Check crystal Y1 for an active input at U4 pins 38 or 39 with an oscilloscope equipped with a x10 probe. (Use only a x10 probe as the loading effect of the oscilloscope will cause the frequency to change and yield any frequency measurements invalid.) If pins 38 and 39 are not active, replace U4. If Q CLK and E CLK are still not active, replace Y1.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
MICROPROCESSOR SUPPORT CIRCUITRY (Continued)	
$\overline{\text{RESET}}$ line inactive (does not go low)	• Check +5V on U10 pins 11 and 16. If +5 is out of tolerance, proceed to Power Supply Troubleshooting. If +5 is within tolerance, proceed to next step. • Check U4 pin 37 for a low 0.1sec after power is applied. If a low does not appear at U4 pin 37, look for a high at U34 pins 3 and 4. If U34 pins 3 and 4 do not go high, replace U14. If U34 pins 3 and 4 go high, replace U34.
$\overline{\text{NMI}}$ line inactive	• Check +5V supply. If +5V is out of tolerance, proceed to Power Supply Troubleshooting. If +5V is within tolerance, proceed to next step. • Check for an active input at U8A pin 3. It is normally 1MHz. If not, refer to I/O Port Test, paragraph 3-9, step H, and perform signature analysis for CØ. If 1MHz is present, proceed to next step. • Check the divide-by-4 output at U8B pin 9. If the frequency is substantially lower or nonexistent, replace U8. If the frequency is 250kHz, proceed to next step. • Check the frequency at U10 pin 2. If pin 2 is not active, replace U10.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
MICROPROCESSOR SUPPORT CIRCUITRY (Continued)	
$\overline{\text{NMI}}$ line inactive (continued)	• If pin 2 has 30Hz square wave, proceed to next step. • Check for an active output at U17D pin 11. It is normally 30Hz. If pin 11 is not active, replace U17. If pin 11 has 30Hz square wave, replace U3.
$\overline{\text{IRQ}}$ line inactive	• Check +5V supply. If +5V is out of tolerance, proceed to Power Supply Troubleshooting. If +5V is within tolerance, proceed to next step. • Refer to the I/O Port Test, paragraph 3-9, step H, and perform signature analysis on E7 and $\overline{\text{W}}$. If the signature is incorrect, proceed to Microprocessor Troubleshooting. If the signature is correct, proceed to next step. • Check for an active output at U9D pin 13. If the output is inactive, replace U9. If the output is active, proceed to next step. • Check for an active output at U9A. If the output is a constant low, the jumper at J9 may be in the wrong position. It should be across pins 3 and 2. If the output is active, replace U3.
A/D Clock inactive	• Refer to the I/O Port Test, paragraph 3-9, step H, and perform signature analysis for C0. If the signature is incorrect, proceed to Microprocessor Troubleshooting. If the signature is correct, replace U8.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
	A/D CONVERTER
Incorrect data	• Check 10.24V reference and +5V, +12V, and -12V supplies. If supplies are out of tolerance, proceed to Power Supply Troubleshooting. If supplies are within tolerance, proceed to next step. • Check A/D Clock input (250kHz square wave). If clock is not functional, go back to Microprocessor Support Circuitry Troubleshooting in this table. If clock is functional, proceed to I/O Port Test, paragraph 3-9, step H, and perform signature analysis of DØ-D7, AØ, E3-E5, $\overline{OE}$, and $\overline{W}$. If the signatures are not correct, proceed to Microprocessor Troubleshooting. If the signatures are correct, perform signature analysis of U20, $\overline{OE}$, and U20, $\overline{W}$. If they are not correct, replace U25. If they are correct, replace U20. • Check A/D Calibration (refer to paragraph 3-9 step I). If out of calibration, adjust as necessary.
	CHARGER SELECT CIRCUIT
Select lines inactive	• Check +5V supply. If supply is not in tolerance, proceed to Power Supply Troubleshooting. If the supply is within tolerance, proceed to next step.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
CHARGER SELECT CIRCUIT (Continued)	
Select lines inactive (continued)	• Check for active lines at the output of U25C pin 8 and U25D pin 11. If these lines are not active, replace U25. If these lines are active, proceed to next step. • Refer to I/O Port Test, paragraph 3-9, step H, and perform signature analysis on DØ-D7, $\overline{OE}$, $\overline{W}$, and SØ-S6. If the signature on DØ-D7, $\overline{OE}$, or $\overline{W}$ is incorrect, proceed to Microprocessor Troubleshooting. If the signatures on DØ-17, $\overline{OE}$, or $\overline{W}$ are correct and SØ-S3 are not correct, replace U21. If the signatures on DØ-D7, $\overline{OE}$, or $\overline{W}$ are correct and S4-S6 are incorrect, replace U22.
BATTERY CHARGER	
Incorrect charge current	• Check +5V, ±12V, +24V, and +10.25V reference supplies. If the voltages are out of tolerance, proceed to Power Supply Troubleshooting. If the currents are out of tolerance, check the Reed Switch Wire Harness.
MICROPROCESSOR	
E CLK and Q CLK inactive	See Microprocessor Support Circuitry. • Refer to the I/O Port Test, paragraph 3-9, step H, and check the signature on C1 and C2 (U7 pins 5 and 9). If C1 and C2 signatures are correct, replace U15. If C1 and C2 signatures at U7 are incorrect, check C1 and C2 signatures at U4 pins 32 and 35. If C1 and C2 are correct, replace U7; if not, replace U4.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
	MICROPROCESSOR (Continued)
$\overline{OE}$ incorrect signature	• Refer to I/O Port Test, paragraph 3-9, step H, and check the signature of C0 and C1 at U7 pins 7 and 9. If the signatures are correct, check the signatures of C0 and C1 at U4 pins 34 and 35. If the signatures are correct, replace U7. If the signatures are not correct, replace U4.
E0-E15 incorrect signature	• Refer to the I/O Port Test, paragraph 3-9, step H, and perform signature analysis on A12-A14. If they are incorrect, replace U4. If they are correct, replace U5. • Referring again to the I/O Port Test, paragraph 3-9, step H, perform signature analysis on A15. If the signature is correct, replace U5. If the signature is incorrect, analyze the signature for A15 on U4 pin 23. If the signature is correct, replace U14.
E0-E15 incorrect signature	If the signature is incorrect, replace U4.
A0-A11 incorrect signatures	• Check signatures of A0-A7 on U6 pins 2, 4, 17, 6, 15, 8, 13 and 11, and A8-A11 on U7 pins 6, 8, 17 and 2. If the signatures are correct, replace U6 or U7. If the signatures are incorrect, replace U4.
D0-D7 incorrect signatures	• Replace U4.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
MICROPROCESSOR (continued)	
Fails Test 0 EPROM Code Check	• Replace U11.
Fails Test 1 RAM Read/Write Test	• Replace U12.
POWER SUPPLY	
+5V out of tolerance	• Lift jumper from WP7 and connect a 10 Ω, 20W resistor from WP7 to ground. Measure the voltage at VR3 pin 1. If the voltage is not +5.00V ± 0.25V, replace CR3. If the voltage is +5.00V ± 0.25V, proceed to next step. • Connect a 100 Ω, 1W resistor from WP7 to ground. If the output voltage is +5.00V ± 0.25V, replace Q1. If the output voltage is out of tolerance, proceed to next step. • Examine the ripple voltage that appears on the unregulated voltage at P12. If the ripple is 60Hz, replace CR2.
+12V out of tolerance	• Examine the ripple voltage that appears on the unregulated voltage at VR1 pin 1. If the ripple is 120Hz, replace VR1. If the ripple is 60Hz, replace CR1.
-12V out of tolerance	• Examine the ripple voltage that appears on the unregulated voltage at VR2 pin 1. If the ripple is 120Hz, replace VR2. If the ripple is 60Hz, replace CR1.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
POWER SUPPLY (continued)	
A/D Converter reference out of tolerance	• Measure the voltage at VR4 pin 1. If the voltage is +12.0V ± 0.6V, replace VR4. If the voltage is not +12.0V ± 0.6V, proceed to +12V out of tolerance above.
Output inactive	• Check ±12V supplies. If the voltages are not +12.0V ± 0.6V and -12.0V ± 0.6V, proceed to Power Supply Troubleshooting. If the voltages are in tolerance, proceed to the next step. • Check for an open wire on the Test Load Pads. • Measure the resistance of R2 and R3; replace if they are open. If R2 and R3 are correct, replace U1.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

DEFIB PULSE ATTENUATOR PCB ASSEMBLY

SYMPTOMS	PROCEDURE
	DIFFERENTIAL AMPLIFIER
Output is offset	• Check for failed input diode, CR1-CR4.
Incorrect gain	• Check the values of gain resistors R2-R5. If R2-R5 are in tolerance, replace U1.
	DEFIBRILLATOR PULSE BUFFER
Output inactive	• Check ±12V supplies. If the supplies are not +12.0V ± 0.6V and -12.0V ± 0.6V, go back to Power Supply Troubleshooting in this table. If the power supply is within tolerance, proceed to next step. Measure the resistance from U1A pin 1 to U2 pin 3. It should be about 15 kΩ. If the meter overranges, R14 is open or a conductor is open. If the resistance is correct, replace U2.
Inaccurate output	• Check the values of R14-R16, R18, R20, and C4. Replace if out of tolerance. If the values are within tolerance, replace U2. If the values are not within tolerance, check the values of R8-R11. Replace if out of tolerance. If the values of R8-R11 are in tolerance, replace U3.
Defib Pulse Buffer (To FIRQ) output inactive	• Replace U3.
Defib Pulse Buffer (to Converter) A/D output	• Replace U2.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

DEFIB PULSE ATTENUATOR PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
WINDOW DETECTOR	
Output inactive	• Check ±12V supplies. If the supplies are not +12.0V ± 0.6V and -12.0V ± 0.6V, go back to Power Supply Troubleshooting. If the power supplies are within tolerance, replace U1 or U3.
Output offset	• Check ±12V supplies. If the supplies are out of tolerance, go back to Power Supply Troubleshooting in this table.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

SWITCH INTERFACE/DISPLAY PCB ASSEMBLY

SYMPTOMS	PROCEDURE
	DIGITAL DISPLAY CIRCUIT
Displays incorrect data	• Check +5V on U1-U3 and U6. Check +5V on U4, U5, and R4, and +24V on R1, R9, R13, and R17. If voltages are out of tolerance, go back to Power Supply Troubleshooting. If voltages are within tolerance, proceed to next step. • Refer to I/O Port Test, paragraph 3-9, step H, and perform signature analysis on DØ-D7, A1, AØ, $\overline{OE}$, $\overline{W}$, E8. If a signature is not correct, go back to Microprocessor Circuit Troubleshooting. If the signatures are correct, proceed to next step. • Check for an inactive clock line at U4 pin 11 and U5 pin 11. If a line is inactive, replace U6. If the lines are active, proceed to next step.
All segments off	• Check EL (enable line) on U1-U3 for an inactive line. If EL is inactive, replace U6. If all ELs are active, proceed to next step.
Segment missing	• Check for inactive segment drivers. If the line is active, replace display. If a line is inactive, replace the driver (U1, U2 or U3).

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

SWITCH INTERFACE/DISPLAY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
DIGITAL DISPLAY CIRCUIT (continued)	
A single lightbar is always on or always off	• Check for an inactive lightbar drive line. If the drive line is inactive, replace either U4 or U5. If the drive line is active, check for a failed transistor (Q1-Q14). If the transistor has not failed, check for a failed lightbar.
MEMBRANE SWITCH	
Incorrect response to entry	• Check +5V on U7. If not +5.00V ± 0.25V, go back to Power Supply Troubleshooting. If voltage is within tolerance, proceed to next step. • Verify that +5V is present at each input (S1-S8). If not, check for an open pull-up resistor (R21-R28). If all inputs are at +5V, proceed to next symptom and related procedures.
A switch does not work	• Verify that +5V on the corresponding input line is pulled to less than 0.4V when the switch is pressed. If not, disconnect the membrane switches by removing J2 and measure the resistance of the closed membrane switch.

TABLE 3-8 (Continued)

TROUBLESHOOTING GUIDE

SWITCH INTERFACE/DISPLAY PCB ASSEMBLY (Continued)

SYMPTOMS	PROCEDURE
MEMBRANE SWITCH (Continued)	
A switch does not work (continued)	If the resistance of any closed switch contact exceeds 20 Ω, replace the membrane switch. If the switch inputs are being pulled lower than 0.4V, proceed to next step. • Refer to I/O Port Test, paragraph 3-9, step H, and perform signature analysis on DØ-D7. If a signature is incorrect, go back to Microprocessor Troubleshooting.

SECTION 4
SERVICE AND MAINTENANCE

4-1. OVERVIEW

The Service and Maintenance section of this manual provides the following information:

- Cleaning and Repair Tools and Materials
- Disassembly Procedures
- Inspection Techniques
- Cleaning Procedures
- Printed Circuit Repair Techniques
- Cover and Case Replacement

4-2. GENERAL RECOMMENDATIONS

Before servicing or repairing the instrument:

- Become familiar with the information in this section
- Perform a close visual examination first (see paragraph 4-5)
- Use the information in Section 5 to aid in identifying components, assemblies, and wire and cable harnesses
- Refer to the Maintenance Flow Diagram, Figure 4-1.

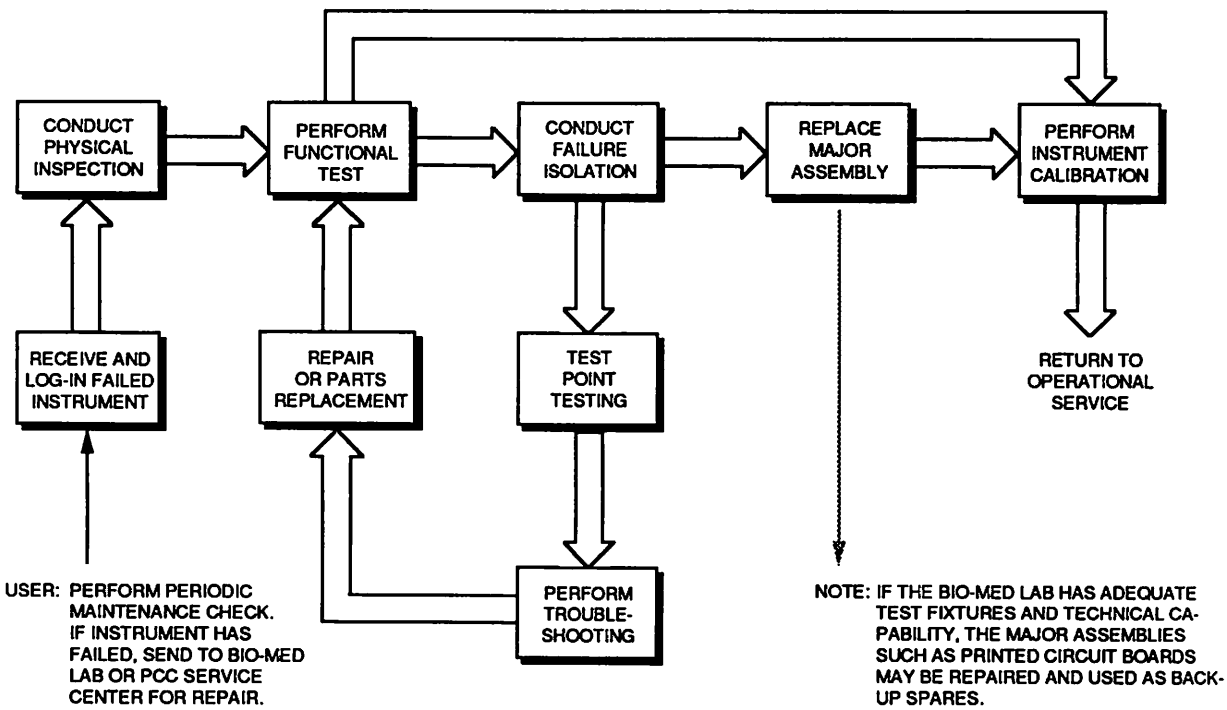


FIGURE 4-1. MAINTENANCE FLOW DIAGRAM

4-3. CLEANING AND REPAIR TOOLS AND MATERIALS

Table 4-1, Cleaning and Repair Tools and Materials, lists recommended tools, materials, and chemicals required for cleaning and repair activities. Although specific items are recommended in Table 4-1, other tools and materials with specifications equivalent to those listed may be used.

TABLE 4-1

CLEANING AND REPAIR TOOLS AND MATERIALS

NOMENCLATURE	CHARACTERISTICS	MANUFACTURER
Static-protected work area	Grounded conductive surface and wrist strap	Electronic supply dealers
X-32B and Xersin®* solder	Low flux, no cleaning necessary	Multicore Westbury, NY 11590
Wire	Refer to Table 4-4	
Sleeving	Teflon, refer to Table 4-3	
5-Minute® Epoxy	Adhesive	Devcon Danvers, MA 01923
Tak Pak®	Adhesive and 710 accelerator	Loctite Newington, CT 06111
Silverstat Soldapullt®	Low-static desoldering tool Model AS196	Edsyn Van Nuys, CA 91406
Crocus cloth		
Isopropyl alcohol		
Acid brush		
Cotton swabs		
Vacuum cleaner		
Soft-bristle brush	Nonmetallic	
Cloth	Clean and lint-free	
Compressed air	Clean and dry (60 psi, max.)	

*The symbol ® indicates a registered trademark.

4-4. DISASSEMBLY PROCEDURES

The following procedures provide a logical sequence for disassembling the major components of the Battery Support System. Reassembly procedures are the reverse unless otherwise noted. Separate or disassemble only to the extent required. Parenthetical numbers refer to item numbers in the Final Assembly, Figure 5-1.

WARNING

SHOCK HAZARD. DISCONNECT AC POWER BEFORE PERFORMING THE DISASSEMBLY PROCEDURE.

CAUTION

SOME PCB ASSEMBLIES IN THE INSTRUMENT CONTAIN STATIC SENSITIVE DEVICES (SSDs). USE SPECIAL HANDLING PROCEDURES FOR STATIC SENSITIVE DEVICES.

4-5. Case Separation.

1. Disconnect the Power Cord from the rear of the instrument.
2. Remove the Battery Paks from the battery compartments.
3. Place the instrument upside down and remove the 8 screws (45).
4. Hold the Upper (8) and Lower (7) Case halves together and turn the instrument over to its normal operating position.
5. Lift the Upper Case straight up until it clears the top of the heat sink, then set it on its side behind the lower case.

4-6. Defib Pulse Attenuator PCB Assembly (A2) Removal. Complete the procedures for Case Separation and proceed as follows:

1. Disconnect P1 from J1.
2. Disconnect P2 from J2.
3. Remove 2 screws (43) and 2 standoffs (51).

CAUTION

AVOID PCB DAMAGE. REMOVE RTV SEALANT CAREFULLY.

4. Remove RTV sealant and hardware on R1 to disconnect the high-voltage wires.

NOTE: Apply 0.1in of RTV sealant to the leads and hardware of R1 at installation.

4-7. Switch Interface/Display PCB Assembly (A3) Removal. Complete the procedures for Case Separation and proceed as follows:

1. Disconnect P2.

2. Remove 5 screws and washers (43, 65) on the Switch Interface/Display PCB Assembly (A3). Pull the PCB back slightly and disconnect the 3 remaining cables.

4-8. Computational Power Supply PCB Assembly (A1) Removal. Complete the procedures for Case Separation and proceed as follows:

1. Disconnect J2, J5, P2-P8, P12, and P13 from the Computational Power Supply PCB Assembly (A1).

2. Remove 3 screws (44) and one washer (66) from the PCB. Lift the PCB up and slightly to the left to expose the terminal strip (55).

3. Remove 2 screws (45) on the terminal strip and the kep nut (31) from the heat sink ground stud.

4. Remove the ground wire from the heat sink ground stud.

5. Lift the Computational Power Supply PCB Assembly from the Lower Case (7).

4-9. Transformer Assembly Removal. Complete the procedures for Case Separation and proceed as follows:

1. Disconnect P3 from the Computational Power Supply PCB Assembly (A1).

2. Remove the cable retainer (35).

3. Remove 2 screws and washers (44, 65) that hold the Transformer Assembly (62) in place.

4. Move the Transformer Assembly to the right to access the terminal strip (55).

CAUTION

AVOID EQUIPMENT DAMAGE. BEFORE DISCONNECTING WIRES FROM THE TERMINAL STRIP, NOTE THE LOCATION AND COLOR OF EACH WIRE FOR REASSEMBLY. REFER TO FIGURE 5-2, INTERCONNECT DIAGRAM.

5. Loosen the screws on the left column of the terminal strip and remove the wires.

6. Lift out the Transformer Assembly.

4-10. Membrane Switch Assembly Removal. Complete the procedures for Case Separation and Switch Interface/Display PCB Assembly Removal then proceed as follows:

CAUTION

AVOID EQUIPMENT DAMAGE. THE MEMBRANE SWITCH ASSEMBLY WILL BE DAMAGED BY REMOVAL. VERIFY THAT IT HAS FAILED BEFORE REMOVING.

Carefully lift a right-side corner of the Membrane Switch Assembly (52) and peel it toward the left so the interconnect cable is also removed. The Membrane Switch Assembly is damaged by removal and must be replaced with a new one.

4-11. Paddle Test Plate Replacement. If a paddle test plate is pitted as a result of arcing, it must be replaced. Complete the procedures for Case Separation and proceed as follows:

1. Carefully remove the terminal guard (16). RTV sealant (48) is used to secure the terminal guard and it may be difficult to remove.

2. Remove the kep nut (31).

3. Replace the paddle test plate (32).

4. Place the high voltage lead over the threaded shaft and install the kep nut.

5. Apply a liberal amount of RTV sealant to the paddle test plate threads and kep nut, and push the terminal guard over the threads.

NOTE: Replace the terminal guard if it was damaged during removal. Do not attempt to reuse it.

4-12. INSPECTION TECHNIQUES

When servicing or repairing the instrument, routinely begin with a visual inspection of the hardware and components for signs of damage to locate the source of failure. When the failure source is found, inspect the surrounding area for peripheral damage which may also have been caused by the failure.

4-13. Exterior Inspection.

Visually inspect the entire instrument for wear, damage, corrosion, deterioration, and damage resulting from extreme temperatures or dropping. Lift and hold the instrument upside down while listening for loose hardware.

4-14. Interior Inspection.

Table 4-2, Inspection Techniques, lists the major hardware components of the instrument, possible problems associated with each item, and recommended corrective actions.

4-15. CLEANING PROCEDURES

Use the following cleaning procedures when performing routine preventive maintenance or as needed after disassembly and repair. These cleaning procedures augment each institution's specific cleaning practices.

TABLE 4-2

INSPECTION TECHNIQUES

INSPECT	POSSIBLE PROBLEMS	CORRECTIVE ACTION
<u>Hardware Inspection</u>: 1. Connector pins	 a. Bent b. Loose or corroded	 a. Straighten (if slight) b. Replace
2. Wire insulation and tubing	a. Deterioration, wear, pinching, or damage	a. Replace
3. Components (Mechanical and Electrical)	a. Loose mountings b. Leads broken, or damaged c. Deterioration or leakage	a. Repair b. Replace c. Replace
4. Terminals and connections	a. Improper installation b. Loss or wear c. Failed solder connections	a. Install correctly b. Replace c. Resolder (if not damaged) or replace
5. Nameplate, labels, and decals	a. Not legible	a. Replace if damaged
6. Chassis, covers, and brackets	a. Warped, bent, surface damage, or missing hardware	a. Replace
7. Screws and nuts	a. Loose or cross-threaded	a. Tighten or replace
<u>PCB Inspection:</u> 8. PCB surfaces	 a. Charred, cracked, or brittle	 a. Replace PCB
NOTE: Due to the high operating temperatures of some components, some degree of discoloration of the PCB surface can be expected.		
9. Conductors	a. Lifted b. Broken or scratched	a. Repair as appropriate (see Repairing a Lifted Conductor) b. Repair as appropriate (see Repairing a Broken/Scratched Conductor)
10. Flex circuits	a. Torn or damaged	a. Replace

4-16. Exterior Cleaning.

> **WARNING**
>
> SHOCK OR FIRE HAZARD. DO NOT IMMERSE ANY PORTION OF THE INSTRUMENT IN WATER. FLUID SPILLS AND SPLASHES WILL DAMAGE THE INSTRUMENT'S ELECTRICAL COMPONENTS.

Clean the instrument case and test load contacts with mild soap and water. Do not use alcohol or solvents. These agents may damage the materials of the instrument. Do not autoclave the instrument.

4-17. Interior Cleaning.

> **WARNING**
>
> PERSONAL SAFETY HAZARD. VENTILATE WORK AREA WHEN USING SOLVENTS. OBSERVE MANUFACTURER WARNINGS REGARDING PERSONNEL SAFETY AND EMERGENCY FIRST AID. KEEP FIRST-AID EQUIPMENT AVAILABLE WHEN USING CHEMICALS.

> **WARNING**
>
> CHEMICAL FIRE HAZARD. OBSERVE SHOP SAFETY AND FIRE PRECAUTIONS. STORE SOLVENTS AND SOLVENT-SOAKED RAGS IN APPROVED CONTAINERS. REFER TO MANUFACTURERS INSTRUCTIONS ON CONTAINERS FOR RECOMMENDED FIRE-FIGHTING PROCEDURES. KEEP FIRE-FIGHTING EQUIPMENT AVAILABLE.

Clean the interior of the instrument as needed or whenever regular maintenance or repair is performed. The following paragraphs recommend cleaning procedures.

A. Magnetics.

> **CAUTION**
>
> AVOID DAMAGING COMPONENTS. DO NOT USE SOLVENTS TO CLEAN TRANSFORMERS OR INDUCTORS.

Never use chemicals or solvents to clean transformers or inductors. The chemical action of solvents may remove the varnish from the wire coils, rendering the component useless. Solvents also neutralize adhesives on the cover tape. Tape separation from the windings may result.

Use a dry, nonmetallic, soft-bristle brush to clean transformers and inductors.

B. Metallic Parts.

1. Loosen dust and dirt by brushing all surfaces and parts with a nonmetallic, soft-bristle brush. Remove loosened dirt using dry compressed air.

2. Wipe metal surfaces with a soft, nonabrasive cloth dampened with isopropyl alcohol.

> **CAUTION**
>
> PREVENT NAMEPLATE DAMAGE. DO NOT USE ABRASIVE CLEANERS OR SOLVENTS TO WIPE NAMEPLATES AND LABELS--THE NAMEPLATE INFORMATION MAY DISAPPEAR.

3. Wipe surfaces of nameplates and labels with a clean, dry cloth.

C. Plastic Parts.

> **CAUTION**
>
> AVOID EQUIPMENT DAMAGE. DO NOT USE SOLVENTS TO CLEAN PLASTIC PARTS.

1. Clean surfaces of plastic parts with a mild soap and water solution.

2. Dry the cleaned surfaces with a clean cloth.

D. Printed Circuit Boards.

> **CAUTION**
>
> AVOID COMPONENT DAMAGE. USE SPECIAL HANDLING PROCEDURES WHEN WORKING ON STATIC SENSITIVE DEVICES ATTENTION (SSDs).

1. Clean assemblies with a vacuum cleaner or dry, low pressure compressed air (60 psi).

2. Clean soldering surfaces with a nonmetallic, soft-bristle brush dipped in alcohol. Air dry 10 minutes or use low pressure compressed air before soldering.

4-18. PRINTED CIRCUIT REPAIR TECHNIQUES

This section provides information to assist in returning the instrument to proper operating condition. Inspect and disassemble only to the extent required to identify all areas requiring repair.

Before removing an assembly for repair or replacement, it is recommended that the technician label each lead or draw a sketch showing the location of cables and wires. Refer to Figure 5-1, Final Assembly, the Interconnect and Wire Harness diagrams. These drawings provide details on wire and cable routing and assembly interconnection.

> **CAUTION**
>
> AVOID PCB DAMAGE. UNSKILLED OR UNTRAINED PERSONNEL SHOULD NOT ATTEMPT TO SOLDER OR REPAIR ANY PRINTED CIRCUITS.

The following repair procedures are included to provide an alternative to replacing the failed assembly, although it is recommended that the damaged assembly be returned to Physio-Control for repair or replacement.

> **CAUTION**
>
> AVOID COMPONENT DAMAGE. REPEATEDLY BENDING WIRES OR COMPONENT LEADS MAY WEAKEN OR BREAK THEM.

A. Only slightly bent or warped connector pins or chassis frame members may be straightened. More severely damaged parts should be replaced.

B. Components installed on the PCBs must be replaced; they are not repairable.

C. Some broken, scratched, or lifted PCB conductors may be repairable. Refer to paragraphs 4-21 thru 4-23 for detailed instructions to assess the extent of damage to conductors and perform appropriate repairs.

D. Replacement electrical wire must match original characteristics as specified in the parts list.

E. Refer to each assembly parts list for information regarding correct replacement part numbers for wire and cable terminations.

4-19. PCB Component Replacement.

Two types of solder are recommended for use on Physio-Control products: X-32B and Xersin. Use X-32B when soldering on PCBs, and Xersin when soldering large surfaces to relatively small surfaces (e.g., connecting a wire to a transformer tab). These solders are preferred because the flux residue is nonconductive and does not require cleaning.

> **CAUTION**
>
> AVOID COMPONENT DAMAGE. USE A HEAT SINK WHEN SOLDERING SEMICONDUCTOR COMPONENTS. PLATED-THRU HOLES ARE EASILY DAMAGED. APPLY THE MINIMUM HEAT NECESSARY TO PROPERLY SOLDER COMPONENTS TO PCBs.

The following guidelines will help the qualified technician return a PCB to correct operating condition.

A. Replace electronic components that do not meet electrical test specifications in Section 3, Testing and Troubleshooting.

B. The soldering iron tip must not be rated at more than 371°C (700°F). Use a solder vacuum to remove solder from the component lead and pad. When replacing PCB components, always use the minimum amount of heat necessary to melt the solder and form a reliable solder joint.

CAUTION

AVOID COMPONENT DAMAGE. INSTALL POLARIZED COMPONENTS CORRECTLY.

C. Installing polarized components improperly may damage the component or circuitry. Observe proper polarity before soldering polarized components in place. Refer to transistor indexing, tab positions, diode markings, and capacitor polarities illustrated in the Section 5 component layout when installing components on any PCB.

D. When replacing a heat sink mounted component, always determine whether the tab should be electrically isolated. If so, verify isolation between the component tab and the heat sink with an ohmmeter before soldering the leads.

E. Always test the repaired PCB before instrument assembly.

4-20. PCB Repair.

CAUTION

AVOID PCB DAMAGE. IMPROPER HANDLING CAN EASILY DAMAGE PCBs BEYOND REPAIR. PLATED-THRU HOLES CONNECTING THE CIRCUITRY ON TWO SIDES OF THE PCB CAN BE DAMAGED BY TOO MUCH HEAT.

The Battery Support System uses double-sided PCBs. Double-sided PCBs are repaired following standard practices. Conductive patterns are printed on both sides and interconnections are usually made with plated-thru holes.

4-21. Repairing a Conductor.

Conductor damage may be termed "broken/scratched" or "lifted." Both conditions are defined separately and each condition has different repair instructions. As a quick-reference guide, Table 4-3 summarizes these definitions and cross-references where to find complete conductor repair instructions. Table 4-4 recommends appropriate wire gauges to repair broken/scratched or lifted conductors.

TABLE 4-3

CONDUCTOR REPAIR INSTRUCTIONS

BROKEN/SCRATCHED		LIFTED	
<7mm (0.25in)	>7mm (0.25in)	<13mm (0.5in)	>13mm (0.5in)
Para. 4-22A	Para. 4-22B	Para. 4-23	Para. 4-22B
Figure 4-4	Figure 4-5	Figure 4-6	Figure 4-5

TABLE 4-4

WIRE GAUGE SELECTION

WIRE GAUGE	CONDUCTOR WIDTH
30	0.51mm (0.020in) or narrower
24	1.27mm (0.050in) or narrower
22	2.03mm (0.080in) or narrower
21	2.54mm (0.100in) or narrower
20	3.81mm (0.150in) or narrower
18	5.08mm (0.200in) or narrower

A broken or scratched surface reduces the cross-sectional area of the conductor to less than the original design specifications (refer to Figure 4-2, Typical Broken/Scratched Conductor). Damage exceeding 20% of the conductor width requires repair. Conductor width is defined as the narrowest section of the conductor.

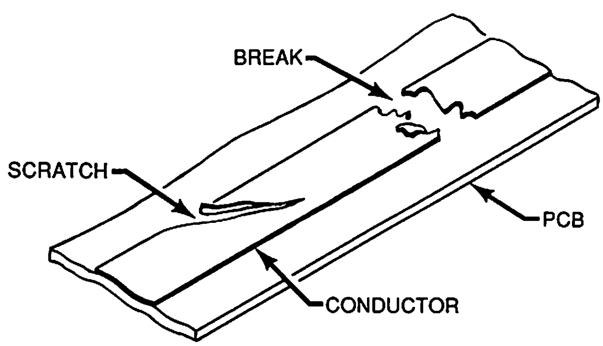


FIGURE 4-2. TYPICAL BROKEN/SCRATCHED CONDUCTOR

A lifted conductor is one in which a portion of the conductor is separated from the PCB surface, but is not broken (see Figure 4-3, Typical Lifted Conductors). Repair is needed when more than 50% of the conductor width is lifted.

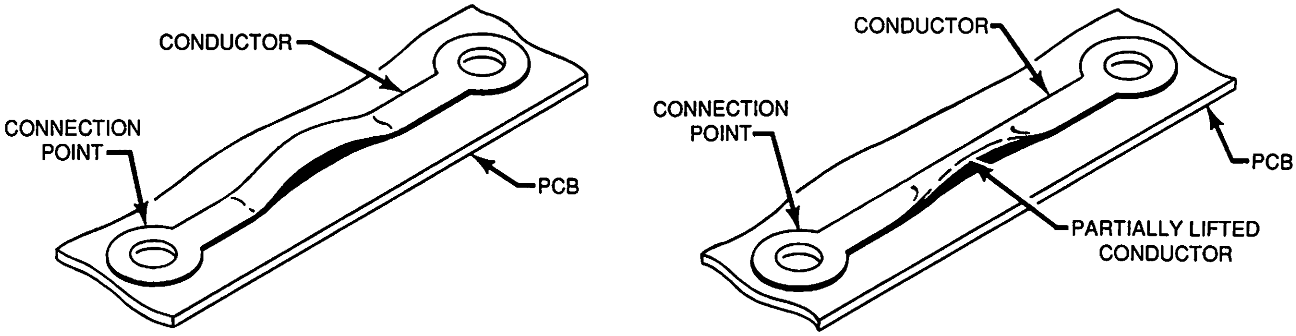


FIGURE 4-3. TYPICAL LIFTED CONDUCTORS

4-22. <u>Repairing a Broken/Scratched Conductor</u>.

The following paragraphs provide instructions on repairing a broken/scratched PCB conductor.

A. Perform the following steps to repair a break of <u>less than</u> 7mm (0.25in).

1. Use a flexible eraser to clean both sides of the break in the conductor, at least 7mm (0.25in) on each side. Next, clean the area with an acid brush and isopropyl alcohol.

2. Cut a piece of 22-gauge solid, tinned, copper wire which extends 7mm (0.25in) longer than the break on both sides.

3. Place the wire on the centerline of the conductor, across the break, and solder in place (see Figure 4-4, Repairing a Conductor Break Less Than 7mm).

4. Spread 5-Minute Epoxy adhesive over the entire repair and allow to dry at room temperature for 1hr.

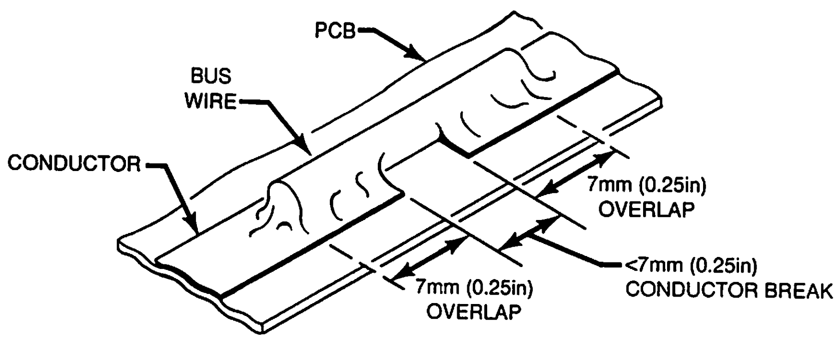


FIGURE 4-4. REPAIRING A CONDUCTOR BREAK LESS THAN 7mm

B. Perform the following steps to repair a break greater than 7mm (0.25in). Do not attempt to repair breaks longer than 12 inches. Refer to Figure 4-5, Repairing A Conductor Break Greater Than 7mm.

1. Use a flexible eraser to clean both sides of the break in the conductor, at least 7mm (0.25in) on each side. Next, clean the area with an acid brush and isopropyl alcohol.

2. Cut a piece of 22-gauge solid, tinned, copper wire which extends 7mm (0.25in) longer than the break on both sides.

3. Slide a piece of teflon sleeving over the prepared wire. The sleeving must be long enough to cover all of the wire that might come in contact with other conductors or non-insulated leads. Hold the wire on the centerline of the conductor, across the break, and solder each end in place.

4. Follow the original conductor pattern as closely as possible.

5. Jumpers longer than 60mm (2.5in) require an additional adhesive such as Tak Pak, applied at least every 50mm (2in) along the sleeved jumper. Refer to Figure 4-5, Repairing A Conductor Break Greater Than 7mm.

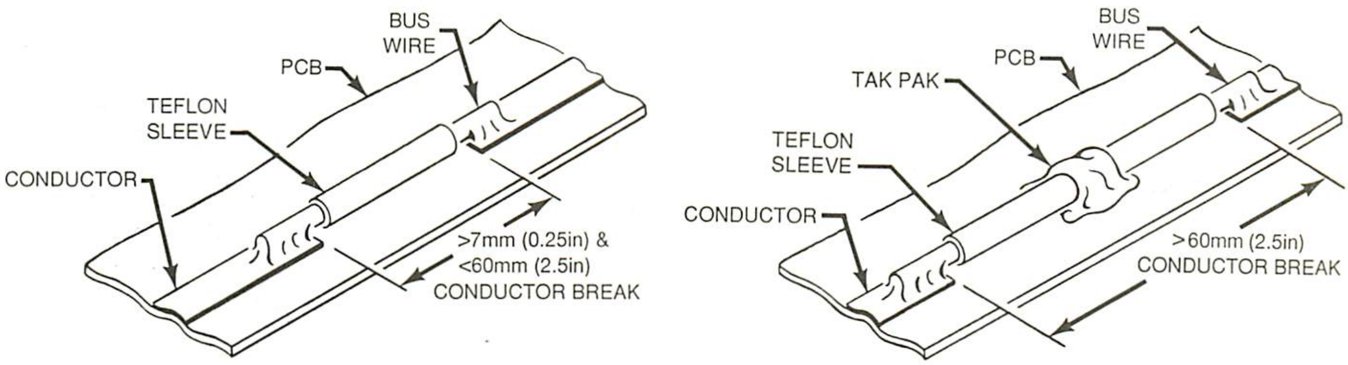


FIGURE 4-5. REPAIRING A CONDUCTOR BREAK GREATER THAN 7mm

4-23. Repairing a Lifted Conductor.

If a lifted area exceeds 13mm, it is repaired as a damaged conductor greater than 7mm (0.25in). Refer to paragraph 4-22, Repairing a Broken/Scratched Conductor, for detailed repair instructions.

A lifted conductor is repairable if the lifted area is less than 13mm (0.5in), or if the lifted area is less than half the distance between the two connection points, whichever is smaller. Repair any lifted conductor when more than 50% of the conductor width is lifted.

The following paragraphs describe how to repair a lifted conductor properly. Refer to Figure 4-6, Repairing A Lifted Conductor.

A. Rinse the area to be repaired with isopropyl alcohol and dry with compressed air. Be sure that the underside of the lifted conductor is clean. Remove any obstacles which prevent the lifted conductor from making complete contact with the substrate surface below.

B. Flow a small amount of the 5-Minute Epoxy onto the substrate and to the underside of the lifted conductor. Press the lifted conductor to make good contact with the substrate.

C. Cut a piece of bus wire which extends 7mm (0.25in) longer than the lifted area on both sides and place it onto the center of the lifted conductor. Before soldering to the lifted conductor, pre-tin the ends of the bus wire.

D. Solder the bus wire to the conductor making good connection between the conductor and wire.

E. Flow 5-Minute Epoxy onto the conductor to cover a distance of at least 3mm (0.125in) in all directions from the damaged area.

F. Dry at room temperature for 1hr.

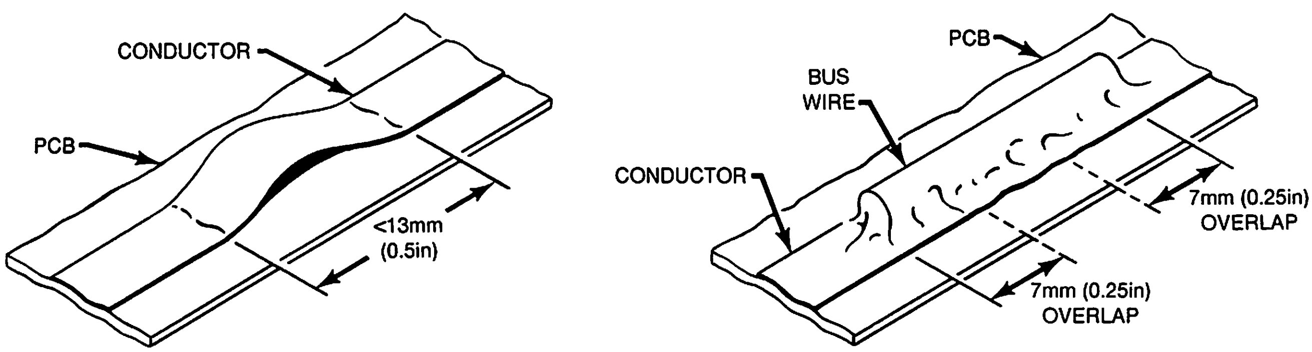


FIGURE 4-6. REPAIRING A LIFTED CONDUCTOR

4-24. COVER AND CASE REPLACEMENT

Damaged covers and cases should be replaced.

SECTION 5
ASSEMBLIES, PARTS LISTS, SCHEMATICS

5-1. OVERVIEW

This section provides exploded view drawings of mechanical assemblies, component layouts and schematics for electronic PCB assemblies. Table 5-1 lists the assemblies and their corresponding figure numbers. For those ICs marked with a star (*) on the following schematics, additional reference information can be found in Section 6.

5-2. PARTS LISTS

A. **FIG-ITEM** This column contains the figure number of the illustrated assembly followed by the reference designators or the assigned item numbers of parts used in that assembly. Reference designators are listed alphanumerically; item numbers are listed numerically.

B. **PART NUMBER** Physio-Control Corporation part number is listed in this column. Part ordering information is provided in paragraph 5-3.

C. **DESCRIPTION** This column contains descriptive information. For a part that is used more than once, subsequent listings refer to the initial listing with a "Same as ___" citation. This citation may also list a component value when necessary. Static Sensitive Devices (SSDs) are identified in this column by this symbol ATTENTION.

D. **USE CODE** This column contains letter codes that indicate configuration differences. Configurations and their corresponding letter codes are listed at the beginning of each parts list. Subsequent use of the letter codes indicates which parts are used in each configuration. A blank in this column indicates that the part is used in all configurations.

E. **QTY** The final column specifies the total quantity used for each part number listed. The abbreviation REF indicates a major assembly or subassembly.

5-3. PART ORDERING

When ordering from Physio-Control Corporation, give the instrument part number and serial number (refer to the serial number label on the instrument). Include the part number, reference designation, and description. Different parts may be substituted by Physio-Control to reflect modifications and improvements of the instrument circuitry.

TABLE 5-1

BATTERY SUPPORT SYSTEM ASSEMBLIES, PARTS LISTS, SCHEMATICS

DRAWING NO.	NOMENCLATURE	FIGURE NO.
801807	BATTERY SUPPORT SYSTEM FINAL ASSEMBLY	5-1
801807	INTERCONNECT DIAGRAM	5-2
SK50444	SYSTEM FUNCTIONAL SCHEMATIC	5-3
802166	COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY ATTENTION	5-4
802174	DEFIB PULSE ATTENUATOR PCB ASSEMBLY	5-5
801894	SWITCH INTERFACE/DISPLAY PCB ASSEMBLY ATTENTION	5-6
802519	WIRE HARNESS ASSEMBLY	5-7
803061	REED SWITCH HARNESS ASSEMBLY	5-8
801878	MEMBRANE SWITCH ASSEMBLY	5-9

TABLE 5-2

ASSEMBLY LOCATION CODES

DRAWING NO.	NOMENCLATURE	FIGURE NO.
802166	COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY	A1
802174	DEFIB PULSE ATTENUATOR PCB ASSEMBLY	A2
801894	SWITCH INTERFACE/DISPLAY PCB ASSEMBLY	A3
---	CHASSIS/HARNESS	A4

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-1				
	801807-10	BATTERY SUPPORT SYSTEM, 120V, English	A	REF
	801807-11	BATTERY SUPPORT SYSTEM, 120V, French, CSA	B	REF
	801807-12	BATTERY SUPPORT SYSTEM, 120V, English, CSA	C	REF
	801807-13	BATTERY SUPPORT SYSTEM, 120V, Spanish	D	REF
	801807-14	BATTERY SUPPORT SYSTEM, 100V, English	E	REF
	801807-15	BATTERY SUPPORT SYSTEM, 240V, English	F	REF
	801807-16	BATTERY SUPPORT SYSTEM, 240V, French	G	REF
	801807-17	BATTERY SUPPORT SYSTEM, 240V, German	H	REF
	801807-18	BATTERY SUPPORT SYSTEM, 240V, Spanish	I	REF
A1	802166-01	• COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (See Figure 5-4) ATTENTION		1
	802166-03	• COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Replaces 802166-01) *		1
	802166-04	• COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY (Replaces 802166-03) *		1
A2	802174-00	• DEFIB PULSE ATTENUATOR PCB ASSEMBLY (See Figure 5-5)		1
	802174-01	• DEFIB PULSE ATTENUATOR PCB ASSEMBLY (Replaces 802174-00)		1
A3	801894-01	• SWITCH INTERFACE/DISPLAY PCB ASSEMBLY (See Figure 5-6) ATTENTION		1
2	201754-000	• ADHESIVE, Bonding Agent, Cyanoacrylate, #8300		A/R
3	9-10424-03	• BATTERY PAK, LIFEPAK 5		2
	9-10424-04	• BATTERY PAK, LIFEPAK 5, FASTPAK		2
	9-10424-09	• BATTERY PAK, FASTPAK		1
4	804491-00	• BRACKET, Capacitor		1
5	200100-134	• CAPACITOR, Electrolytic, 12,000µF/40V, +75%		1
6	200100-023	• CAPACITOR, Electrolytic, 15,000µF/15V, +75%		1
7	801933-07	• CASE, Lower, Painted		1
8	801948-05	• CASE, Upper, Painted		1
9	200602-000	• CONNECTOR, Fuseholder, Receptacle, 2 Fuse, 5 x 20mm	G-I	1
10	200602-002	• CONNECTOR, Fuseholder, Receptacle, 1 Fuse, 5 x 20mm	A-F	1
11	802278-00	• CONNECTOR, Banana Plug, Miniature, 4-40 x 0.480 L		6
12	202236-000	• FOOT, Mounting, Black rubber, Self-adhesive		4
13	200619-018	• FUSE, Slow Blow, 2A/250V, 5 x 20mm	F-I	2
14	200619-021	• FUSE, Slow Blow, 4A/250V, 5 x 20mm	A-E	1
15	201605-011	• GROMMET, Continuous, Nylon, 0.052 T		A/R
16	800256-04	• GUARD, Terminal, Electrode Plate		2
17	803061-00	• HARNESS ASSEMBLY, Reed Switch (See Figure 5-8)		1
18	801791-00	• HEAT SINK, Aluminum		1
19	201797-003	• INSULATOR, Silipad, Transistor, TO-220, 0.855 L x 0.312 W		2
20	800814-05	• INSULATOR, Thermal Conductive, 0.940 L x 0.800 W		5
21	1-50318-05	• LABEL, Caution, French	B	1
	1-50318-12	• LABEL, Caution, English/French	C	1
	1-50318-14	• LABEL, Caution, English	A	1
	1-50318-15	• LABEL, Caution, English, UL	E,F	1
22	801879-04	• LABEL, Overlay, Switch/Display, English	A,C,E,F	1
	801879-05	• LABEL, Overlay, Switch/Display, French	B,G	1
	801879-07	• LABEL, Overlay, Switch/Display, Spanish	D,I	1
	801879-08	• LABEL, Overlay, Switch/Display, German	H	1
23	802117-00	• LABEL, Serial Number	A,E,F	1
	802117-01	• LABEL, Serial Number	G	1
	802117-02	• LABEL, Serial Number, CSA, French	B	1
	802117-03	• LABEL, Serial Number	H	1
	802117-04	• LABEL, Serial Number	D,I	1
	802117-05	• LABEL, Serial Number, CSA, English	C	1
24	801517-04	• LABEL, UL	C	1
25	802195-00	• LABEL, Warning, Battery, English	A,C,E,F	3
	802195-01	• LABEL, Warning, Battery, French	B,G	3
	802195-02	• LABEL, Warning, Battery, German	H	3
	802195-03	• LABEL, Warning, Battery, Spanish	D,I	3

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-1				
26	801362-03	• LABEL, Warning, Fuse	A,C,E,F	1
27	802153-20	• LABEL, Warning, Fuse, English, 4A	A,C,E	1
	802153-21	• LABEL, Warning, Fuse, French, 2A	G	1
	802153-22	• LABEL, Warning, Fuse, German, 2A	H	1
	802153-23	• LABEL, Warning, Fuse, Spanish, 2A	I	1
	802153-24	• LABEL, Warning, Fuse, French, 4A	B	1
	802153-25	• LABEL, Warning, Fuse, Spanish, 4A	D	1
	802153-26	• LABEL, Warning, Fuse, English, 2A	F	1
28	201199-003	• NUT, Hex, 4-40 x 0.250 W		12
29	90-03019	• NUT, Hex, Kep, 4-40 x 0.250 W/0.125 T		2
30	201199-100	• NUT, Hex, 4-40 x 0.188 W		2
31	90-03021	• NUT, Kep, 6-32 x 0.250 W x 0.095 T		5
32	801790-00	• PLATE, Paddle Test		2
33	201472-003	• RETAINER, Cable Tie, Nylon, White		4
34	90-10055	• RETAINER, Cable Tie, Nylon, 3.50 L x 0.080 W		8
35	200530-005	• RETAINER, Cable Clamp		1
36	201358-011	• RETAINER, Clip		2
37	802024-00	• RIBBON CABLE, 26 Conductor, 16.00 L		1
38	201105-541	• SCREW, Flat Head, 4-40 x 0.562 L		2
39	200531-013	• SCREW, Pan Head, Dual, 6-19 x 0.312 L		2
40	200531-012	• SCREW, Pan Head, Dual, 6-19 x 0.250 L		3
41	200476-759	• SCREW, Pan Head, 4-40 x 0.187 L		2
42	200476-760	• SCREW, Pan Head, 4-40 x 0.250 L		7
43	200476-793	• SCREW, Pan Head, 6-32 x 0.312 L		7
44	200476-794	• SCREW, Pan Head, 6-32 x 0.375 L		5
45	200476-796	• SCREW, Pan Head, 6-32 x 0.500 L		10
46	200476-792	• SCREW, Pan Head, 6-32 x 0.250 L		2
47	201173-029	• SCREW, Set, Hex, 6-32 x 0.750 L		1
48	202257-001	• SEALANT, RTV 102, Silicon, White		A/R
49	802247-00	• SHIELD, Nomex		1
50	803106-00	• SHIELD, Transformer		1
51	200302-026	• STANDOFF, Hex, M/F, 6-32 x 1.00 L/0.250 W		7
52	801878-00	• SWITCH ASSEMBLY, Membrane (See Figure 5-9)		1
53	90-08010	• TAPE, Adhesive, Foam, 1.000 W x 0.125 T		A/R
54	201765-007	• TAPE, Foam, Single Stick, 0.750 W x 0.250 T		A/R
55	200970-004	• TERMINAL, Barrier Strip, 6 Contact		1
56	200267-026	• TERMINAL, Lug, Quick Disconnect, 22-18 AWG		1
57	200276-209	• TERMINAL, Lug, Ring Tongue, #10, 22-16 AWG		5
58	200276-211	• TERMINAL, Lug, Ring Tongue, #6, 22-16 AWG		6
59	200671-007	• TERMINAL, Lug, Spade, #5, 22-16 AWG, Red	A-E	6
	200671-007	• TERMINAL, Lug, Spade, #5, 22-16 AWG, Red	F-I	4
60	200916-000	• TERMINAL, Receptacle, Quick Disconnect, 0.23 W, 22-18 AWG		3
61	200514-000	• TERMINAL, Receptacle, Quick Disconnect, 90°, 0.25 W/0.03 T, 22-18 AWG		3
62	802007-01	• TRANSFORMER ASSEMBLY, 100/117/235V, 50/60 Hz, 24/11Vdc		1
63	201756-014	• TUBING, PVC, Clear, #8		A/R
64	90-04060	• WASHER, Flat, #4 x 0.250 OD/0.015 T		6
65	90-04064	• WASHER, Flat, #6 x 0.312 OD/0.032 T		6
66	90-04013	• WASHER, Flat, #6, 0.080 T		1
67	90-04005	• WASHER, Lock, Internal Tooth, #4 x 0.265 ID/0.015 T		12
68	90-04014	• WASHER, Lock, Internal Tooth, #6 x 0.285 OD/0.025 T		1
69	200431-849	• WASHER, Shoulder, Nylon, #4 x 0.200 OD/0.060 T		7
70	802519-00	• WIRE HARNESS ASSEMBLY		1
71	200357-055	• WIRE, Stranded, PVC, 300V, 18 AWG, CSA, Black		A/R
72	201535-090	• WIRE, Semi, PVC, 300V, 18 AWG, 16-30 Green/Yellow		A/R
73	800357-056	• WIRE, Stranded, PVC, 300V, 18 AWG, CSA, Red		A/R
74	200357-054	• WIRE, Stranded, PVC, 300V, 18 AWG, CSA, White		A/R
75	200357-109	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Black		A/R
76	200357-110	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Red		A/R

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-4				
J2	201785-000	• TERMINAL, Crimp, Quick Disconnect, Male, 16-14 AWG		3
J3	200663-026	• CONNECTOR, Plug, 90°, 5 Contact		1
J4-6	200096-000	• CONNECTOR, Plug, Locking, 2 Contact		3
J7	200096-001	• CONNECTOR, Plug, Locking, 3 Contact		1
J8	200534-003	• CONNECTOR, Plug, Locking, 5 Contact		1
J9	200396-036	• CONNECTOR, Plug, 3 Contact	A	2
	200396-036	• CONNECTOR, Plug, 3 Contact	B,C	1
J10		• (Same as J9)	A	
J11	200396-035	• CONNECTOR, Plug, 2 Contact	A	1
J12,13		• (Same as J2)		
P1	200397-024	• CONNECTOR, Plug, 50 Contact		1
P2	200397-012	• CONNECTOR, Plug, 26 Contact		1
P5	200534-002	• CONNECTOR, Plug, Locking, 4 Contact		1
Q1,5	201355-000	• TRANSISTOR, PNP, TIP36, TO-218		4
Q6	200942-001	• TRANSISTOR, NPN, PN2222A, TO-92		4
Q7,8	200585-001	• TRANSISTOR, VFET, VN0106N3, TO-92		7
Q9		• (Same as Q1)		
Q10		• (Same as Q6)		
Q11,12		• (Same as Q7)		
Q13		• (Same as Q1)		
Q14		• (Same as Q6)		
Q15,16		• (Same as Q7)		
Q17	201354-000	• TRANSISTOR, NPN, TIP140, TO-218		1
Q18		• (Same as Q7)		
Q19		• (Same as Q6)		
R1	200121-003	• RESISTOR, 0.499 Ω, 3W, 1%		4
R2	200120-014	• RESISTOR, 10 Ω, 1W, 5%		1
R15	200054-193	• RESISTOR, 1 kΩ, 1/8W, 1%, RN55C		1
R16	200054-201	• RESISTOR, 1.21 kΩ, 1/8W, 1%, RN55C		2
R17	200054-288	• RESISTOR, 10 kΩ, 1/8W, 1%, RN55C		1
R18	200054-317	• RESISTOR, 20 kΩ, 1/8W, 1%, RN55C		17
R20	200054-352	• RESISTOR, 46.4 kΩ, 1/8W, 1%, RN55C		1
R21	200527-028	• POTENTIOMETER, 10 kΩ, 1/2W, 10%, Multiturn		2
R22	200054-321	• RESISTOR, 22.1 kΩ, 1/8W, 1%, RN55C		1
R23		• (Same as R21)		
R24	200054-383	• RESISTOR, 97.6 kΩ, 1/8W, 1%, RN55C		1
R25	200054-356	• RESISTOR, 51.1 kΩ, 1/8W, 1%, RN55C		1
R26	200054-388	• RESISTOR, 33.2 kΩ, 1/8W, 1%, RN55C	A	1
	200054-388	• RESISTOR, 33.2 kΩ, 1/8W, 1%, RN55C	B,C	4
R27,29	200054-257	• RESISTOR, 4.75 kΩ, 1/8W, 1%		7
R30	200054-097	• RESISTOR, 100 Ω, 1/8W, 1%, RN55C	A	3
		• (Same as R26)	B	
R31	200054-385	• RESISTOR, 102 kΩ, 1/8W, 1%, RN55C	A	3
	200054-481	• RESISTOR, 1.02 MΩ, 1/8W, 1%, RN55C	B,C	3
R32	200676-039	• RESISTOR, 390 Ω, 3W, 5%		3
R33	200054-339	• RESISTOR, 34 kΩ, 1/8W, 1%, RN55C	A	3
	200054-435	• RESISTOR, 340 kΩ, 1/8W, 1%, RN55C	B,C	3
R34		• (Same as R27)		
R35		• (Same as R1)		
R36,37	200054-480	• RESISTOR, 1 MΩ, 1/8W, 1%, RN55C		8
R38	200054-226	• RESISTOR, 2.21 kΩ, 1/8W, 1%, RN55C		3
R39		• (Same as R18)		
R40	200054-508	• RESISTOR, 2 MΩ, 1/8W, 1%, RN55C		8
R41		• (Same as R18)		
R42		• (Same as R40)		
R43	200054-210	• RESISTOR, 1.50 kΩ, 1/8W, 1%, RN55C		3
R44,45		• (Same as R18)		
R46		• (Same as R30, 100 Ω)	A	
		• (Same as R26)	B	

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-4				
R47		• (Same as R31, 102 kΩ)	A	
		• (Same as R31, 1.02 MΩ)	B,C	
R48		• (Same as R32)		
R49		• (Same as R33, 34 kΩ)	A	
		• (Same as R33, 340 kΩ)	B,C	
R50		• (Same as R27)		
R51		• (Same as R1)		
R52,53		• (Same as R36)		
R54		• (Same as R38)		
R55		• (Same as R18)		
R56		• (Same as R40)		
R57		• (Same as R18)		
R58		• (Same as R40)		
R59		• (Same as R43)		
R60,61		• (Same as R18)		
R62		• (Same as R30, 100 Ω)	A	
		• (Same as R26)	B	
R63		• (Same as R31, 102 kΩ)	A	
		• (Same as R31, 1.02 kΩ)	B,C	
R64		• (Same as R32)		
R65		• (Same as R33, 34 kΩ)	A	
		• (Same as R33, 340 kΩ)	B,C	
R66		• (Same as R27)		
R67		• (Same as R1)		
R68,69		• (Same as R36)		
R70		• (Same as R38)		
R71		• (Same as R18)		
R72		• (Same as R40)		
R73		• (Same as R18)		
R74		• (Same as R40)		
R75		• (Same as R43)		
R76,77		• (Same as R18)		
R78,79		• (Same as R36)		
R80	200121-005	• RESISTOR, 1 Ω, 3W, 1%		1
R81	200054-259	• RESISTOR, 4.99 kΩ, 1/8W, 1%, RN55C		1
R82		• (Same as R18)		
R83		• (Same as R40)		
R84		• (Same as R18)		
R85		• (Same as R40)		
R86	200054-162	• RESISTOR, 475 Ω, 1/8W, 1%, RN55C		1
R87		• (Same as R18)		
R88	200054-367	• RESISTOR, 66.5 kΩ, 1/8W, 1%, RN55C		1
R89		• (Same as R18)		
R90		• (Same as R27)		
R91		• (Same as R16)		
R92		• (Same as R27)		
R93	200054-350	• RESISTOR, 44.2 kΩ, 1/8W, 1%, RN55C		1
R95-97	200054-097	• RESISTOR, 100 Ω, 1/8W, 1%, RN55C	C	3
RN1	200424-033	• RESISTOR NETWORK, 15 x 4.7 kΩ, 0.10W, 2%		1
TP3	801959-00	• TERMINAL, Test Point		1
U3	200335-000	• IC, Digital, 74LS74, D-Type Flip-Flop		3
U4	201318-000	• IC, Digital, 6809P, Microprocessor		1
U5	201357-000	• IC, Digital, 74159, Decoder		1
U6,7	201305-000	• IC, Digital, 74LS244, Buffer		4
U8		• (Same as U3)		
U9	200587-000	• IC, Digital, 74LS02N, NOR Gate		1
U10	201313-000	• IC, Digital, 4020, Binary Counter		1
U11	802244-04	• IC, Digital, 2732A, EPROM		1
U12	202252-000	• IC, Digital, 2016, RAM		1
U14	201378-000	• IC, Digital, 74LS14, Buffer/Inverter		1

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-4				
U15,16	200342-000	• IC, Digital, 74LS00, NAND Gate		2
U17	201312-000	• IC, Digital, 74LS86, Exclusive OR Gate		1
U18	201309-000	• IC, Digital, 74LS245, Buffer		1
U19	201327-000	• IC, Linear, LF13508, Analog Multiplexer		1
U20-22	201356-000	• IC, Digital, 25LS2518, D Register		3
U23	200855-000	• IC, Linear, LF398N, Sample and Hold, TO-5		1
U24	201370-000	• IC, Linear, LF412CN, Op Amp		1
U25	201310-000	• IC, Digital, 74LS32, OR Gate		1
U26		• (Same as U3)		
U27	200806-000	• IC, Linear, LM311, Voltage Comparator		1
U29	201308-000	• IC, Digital, 2504, Successive Approximation Register		1
U30	801194-00	• IC, Interface, 7541, D/A Converter ATTENTION		1
U31,32		• (Same as U6)		
U33	200199-000	• IC, Linear, TL084, Op Amp		1
U34	200446-000	• IC, Digital, 74LS27, NOR Gate		1
U35-37	200854-006	• IC, Linear, LM334, Adjustable Current Source		3
VR1	200227-003	• IC, Linear, LM340T-12, Voltage Regulator, +12V, TO-220		1
VR2	200209-004	• IC, Linear, LM320T, Voltage Regulator, -12V, TO-220		1
VR3	200227-000	• IC, Linear, LM340T-5, Voltage Regulator, +5V, TO-220		1
VR4	201369-003	• IC, Linear, LH0071, Voltage Reference, +10.24V, TO-5		1
XU4	200675-029	• SOCKET, DIP, 40 Contact		1
XU11,12	200675-025	• SOCKET, DIP, 24 Contact		2
XU18	200907-004	• SOCKET, DIP, 20 Contact		1
XU30	200907-003	• SOCKET, DIP, 18 Contact		1
Y1	200417-004	• CRYSTAL, Microprocessor, 4MHz		1
2	802039-00	• BRACKET, Mounting		1
3	200049-020	• CAPACITOR, 2700pF/100V, 20% (Installed on circuit-side from pin 1 to pin 37 of U4)		1
4	201176-000	• CONNECTOR, Receptacle, Jumper, 2 Contact	A	3
	201176-000	• CONNECTOR, Receptacle, Jumper, 2 Contact	B	1
5	200917-001	• FUSEHOLDER		1
6	201199-100	• NUT, Hex, 4-40 x 0.188 W x 0.063 T (Not shown)		1
7	90-03021	• NUT, Kep, 6-32 x 0.250 W x 0.095 T		4
8	201533-000	• RETAINER, Cable		1
9	200476-792	• SCREW, Pan Head, 6-32 x 0.250 L		2
10	200476-760	• SCREW, Pan Head, 4-40 x 0.250 L (Not shown)		1
11	200476-794	• SCREW, Pan Head, 6-32 x 0.375 L		2
12	201785-010	• TERMINAL, Crimp, Quick Disconnect, Male, 22-18 AWG	C	1
13	200283-004	• TUBING, Heatshrink, Polyolefin (Used on item 17)	C	A/R
14	200624-040	• TUBING, Teflon, Clear (Not shown, used on R95-97)	C	A/R
15	90-04004	• WASHER, Flat, Fiber, #4 x 0.250 OD/0.062 T (Not shown, used on CR2)	A,B	2
16	201301-605	• WIRE, Jumper, Teflon Insulation, 0.300 L, 22 AWG		4
17	201535-064	• WIRE, Semirigid, PVC, 20 AWG, Red	C	A/R

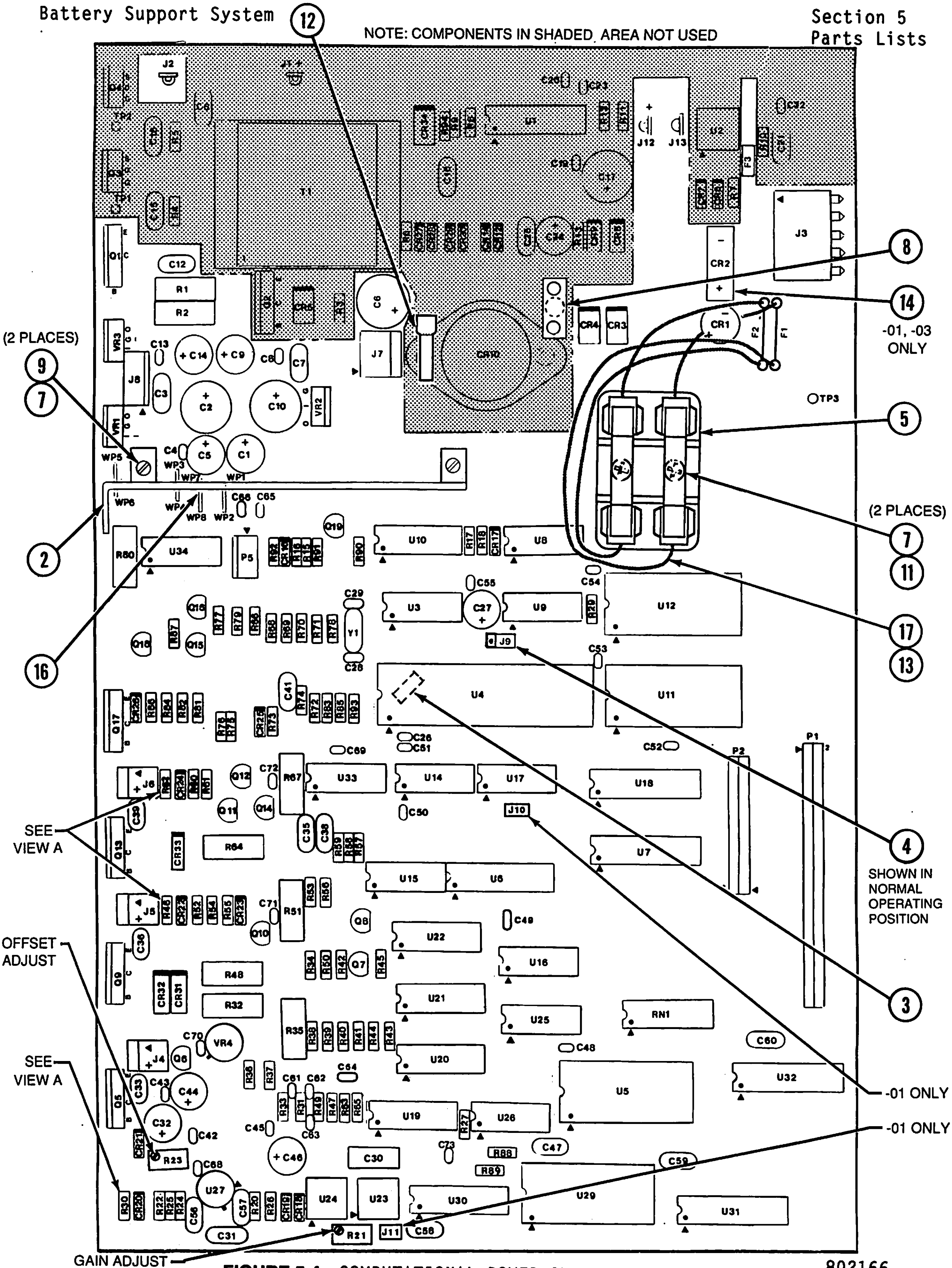
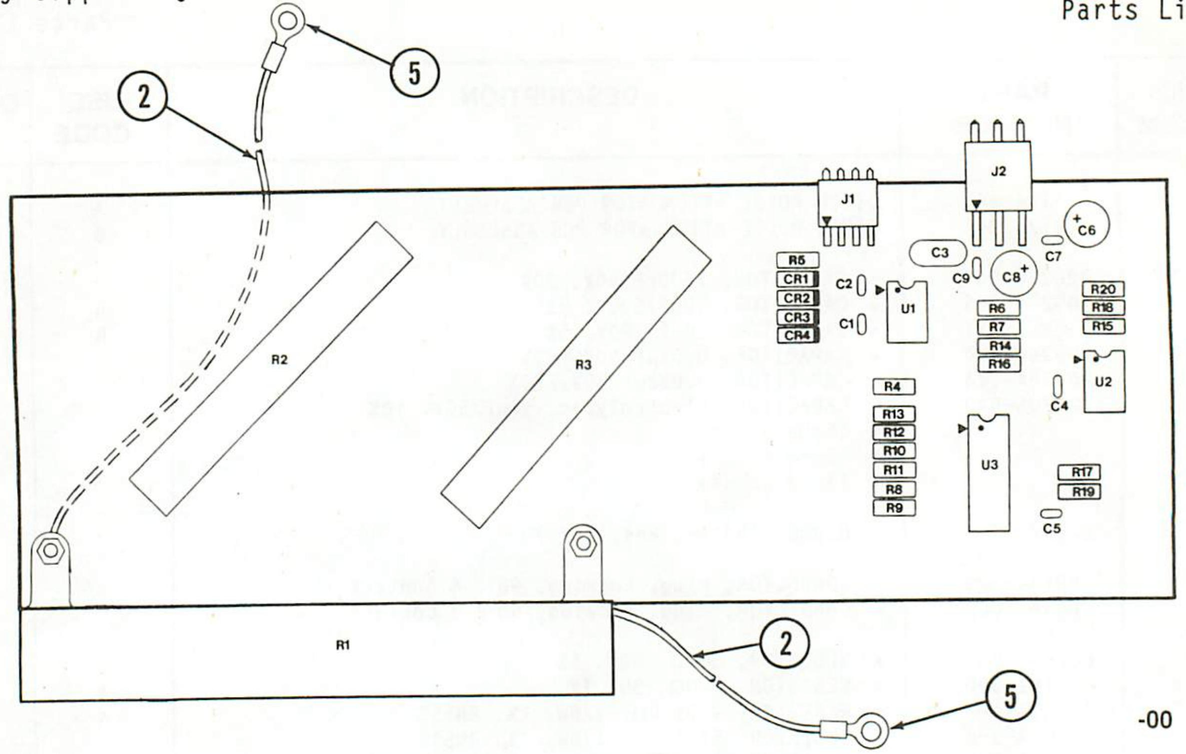


FIGURE 5-4. COMPUTATIONAL POWER SUPPLY PCB ASSEMBLY
(SHEET 1 OF 2)

802166

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-5				
A2	802174-00	DEFIB PULSE ATTENUATOR PCB ASSEMBLY	A	REF
	802174-01	DEFIB PULSE ATTENUATOR PCB ASSEMBLY	B	REF
C1,2	200264-004	• CAPACITOR, 1800pF/50V, 20%		2
C3	200274-005	• CAPACITOR, 10pF/500V, 5%	A	1
	200901-071	• CAPACITOR, 10pF/100V, 5%	B	1
C4	200264-010	• CAPACITOR, 0.01µF/50V, 20%		3
C5	200264-014	• CAPACITOR, 0.033µF/50V, 20%		1
C6	200205-049	• CAPACITOR, Electrolytic, 10µF/50V, 10%		2
C7		• (Same as C4)		
C8		• (Same as C6)		
C9		• (Same as C4)		
CR1-4	200971-000	• DIODE, 1N914B, 8ns, PIV 75		4
J1	200534-029	• CONNECTOR, Plug, Locking, 90°, 4 Contact		1
J2	200663-001	• CONNECTOR, Plug, Locking, 90°, 3 Contact		1
R1	802608-00	• RESISTOR, 50 Ω, 50W, 5%		1
R2,3	201141-000	• RESISTOR, 8 MΩ, 3W, 1%	A	2
R4,5	200054-285	• RESISTOR, 9.31 kΩ, 1/8W, 1%, RN55C	A	2
R6	200054-356	• RESISTOR, 51.1 kΩ, 1/8W, 1%, RN55C		1
R7	200054-222	• RESISTOR, 2 kΩ, 1/8W, 1%, RN55C		3
R8	200054-288	• RESISTOR, 10 kΩ, 1/8W, 1%, RN55C		3
R9		• (Same as R7)		
R10		• (Same as R8)		
R11		• (Same as R7)		
R12	200054-193	• RESISTOR, 1 kΩ, 1/8W, 1%, RN55C		1
R13	200054-317	• RESISTOR, 20 kΩ, 1/8W, 1%, RN55C		1
R14	200054-305	• RESISTOR, 15 kΩ, 1/8W, 1%, RN55C	A	2
	200054-305	• RESISTOR, 15 kΩ, 1/8W, 1%, RN55C	B	3
R15	200054-193	• RESISTOR, 1 kΩ, 1/8W, 1%, RN55C	A	1
		• (Same as R14)	B	
R16		• (Same as R14)		
R17		• (Same as R8)		
R18	200054-190	• RESISTOR, 931 Ω, 1/8W, 1%, RN55C	A	1
	200054-306	• RESISTOR, 15.4 kΩ, 1/8W, 1%, RN55C	B	1
R19	200054-384	• RESISTOR, 100 kΩ, 1/8W, 1%, RN55C		1
R20	200054-069	• RESISTOR, 51.1 Ω, 1/8W, 1%, RN55C		1
RN1	803370-00	• RESISTOR NETWORK, Multivalue, 15 kV, 0.25%	B	1
U1	200487-000	• IC, Linear, LF353N, Op Amp		1
U2	200254-000	• IC, Linear, LF355N, Op Amp		1
U3	200669-002	• IC, Linear, LM339N, Comparator		1
2	200405-020	• CABLE, Stranded, Unshielded, 22 AWG, 20 kV		A/R
3	90-03021	• NUT, Kep, 6-32 x 0.250 W		4
4	200476-794	• SCREW, Pan Head, 6-32 x 0.375 L		2
5	200276-211	• TERMINAL, Lug, Ring Tongue, 22-16 AWG, #6		4



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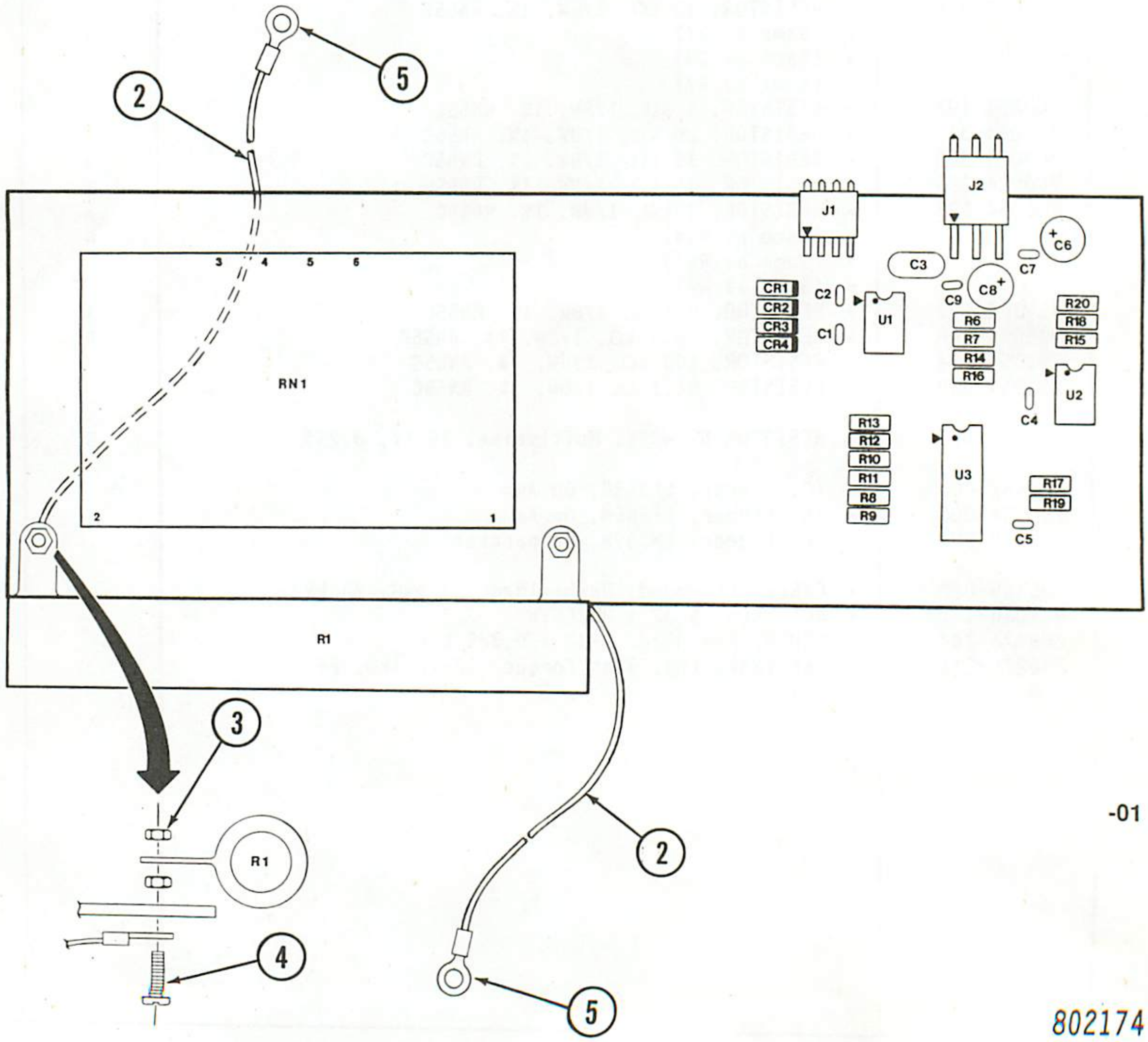

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802174

FIGURE 5-5. DEFIB PULSE ATTENUATOR PCB ASSEMBLY
(SHEET 1 OF 2)

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-6				
A3	801894-01	SWITCH INTERFACE/DISPLAY PCB ASSEMBLY		REF
CR1	200491-051	• LED, Yellow, Panel Mount, 2.5V		1
DS1	802349-13	• LED, Display, Lightbar, 4 LED, Green		1
DS2	802349-19	• LED, Display, Lightbar, 2 LED, Red		2
DS3	802349-03	• LED, Display, Lightbar, 4 LED, Red		12
DS4		• (Same as DS2)		
DS5		• (Same as DS3)		
DS6-8	801957-03	• LED, Display, Numeric, 7 Segment, Red		3
DS9-18		• (Same as DS3)		
J1	200534-030	• CONNECTOR, Plug, Locking, 5 Contact		1
J2	200534-029	• CONNECTOR, Plug, Locking, 4 Contact		1
P1	201338-005	• CONNECTOR, Header, 90°, 26 Contact		1
P2	200534-033	• CONNECTOR, Plug, Locking, 8 Contact		1
Q1-14	200942-001	• TRANSISTOR, NPN, PN2222A, TO-92		14
R1	200120-059	• RESISTOR, 750 Ω, 1W, 5%		4
R2	200120-057	• RESISTOR, 620 Ω, 1W, 5%		1
R3	200124-063	• RESISTOR, 430 Ω, 1/2W, 5%		1
R4	200054-114	• RESISTOR, 150 Ω, 1/8W, 1%, RN55C		1
R5-8	200054-257	• RESISTOR, 4.75 kΩ, 1/8W, 1%, RN55C		25
R9		• (Same as R1)		
R10-12		• (Same as R5)		
R13		• (Same as R1)		
R14-16		• (Same as R5)		
R17		• (Same as R1)		
R18-28		• (Same as R5)		
R29-49	200054-126	• RESISTOR, 200 Ω, 1/8W, 1%, RN55C		21
R50	200054-193	• RESISTOR, 1 kΩ, 1/8W, 1%, RN55C		1
R51-54		• (Same as R5)		
U1-3	201304-000	• IC, Digital, CD4511, Decoder/Driver ATTENTION		3
U4,5	201300-000	• IC, Digital, 74LS374, D-Type Flip-Flop		2
U6	201299-000	• IC, Digital, 74LS139, Decoder/Demultiplexer		1
U7	201298-000	• IC, Digital, 74LS240, Buffer		1
U8	201686-000	• IC, Digital, 74LS365A, Buffer		1
XDS1	201362-006	• SOCKET, Elevator, 8 Contact		11
XDS2-5	201362-010	• SOCKET, Elevator, 12 Contact		2
XDS6-8	202175-101	• SOCKET, Elevator, Bifurcated, 14 Contact		3
XDS9-18		• (Same as XDS1)		
2	802541-00	• DIVIDER, Lightbar		2
3	201124-541	• SPACER, Round, Fibre		1

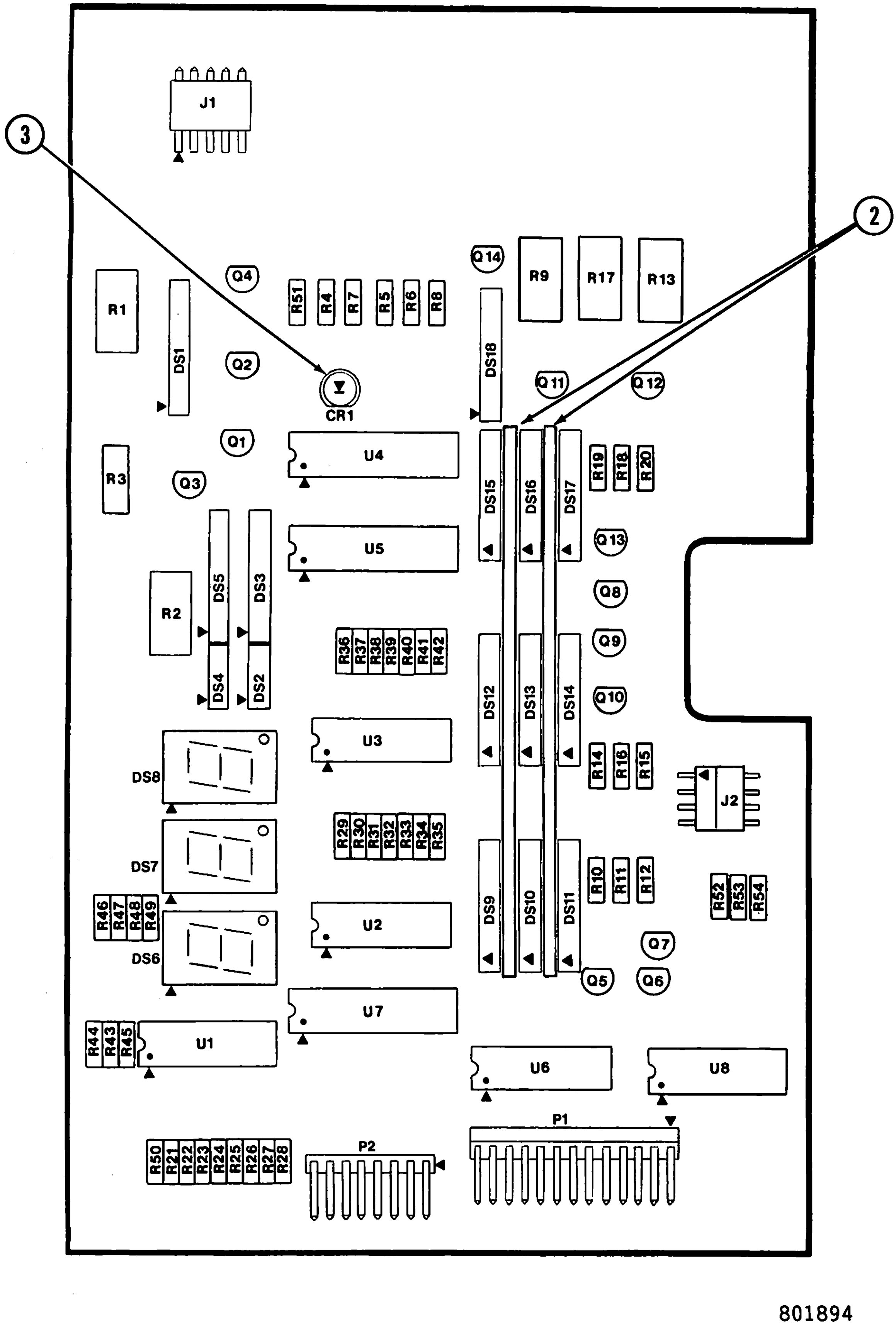


FIGURE 5-6. SWITCH INTERFACE/DISPLAY PCB ASSEMBLY
(SHEET 1 OF 2)

LEFT BLANK INTENTIONALLY

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-7				
	802519-00	WIRE HARNESS ASSEMBLY		REF
J5	200419-021	• CONNECTOR, Housing, Receptacle, Locking, 4 Contact		2
P1		• (Same as J5)		
P2	200277-001	• CONNECTOR, Housing, Receptacle, 3 Contact		2
P4-6	200277-000	• CONNECTOR, Housing, Receptacle, 2 Contact		3
P7		• (Same as P2)		
P8,9	200419-022	• CONNECTOR, Housing, Receptacle, Locking, 5 Contact		2
2	201223-014	• CABLE, Shielded, 1 Pair, 24 AWG		A/R
3	200536-009	• RETAINER, Cable Tie, Nylon, 0.10 W x 4.06 L		A/R
4	200276-210	• TERMINAL, Lug, Ring Tongue, 22-26 AWG		6
5	200276-211	• TERMINAL, Lug, Ring Tongue, 22-16 AWG, #6		1
6	200390-006	• TERMINAL, Socket, Crimp, 22-26 AWG		11
7	200390-000	• TERMINAL, Socket, Crimp, 22-30 AWG		16
8	200283-018	• TUBING, Heat Shrink, Black, 0.187 ID		A/R
9	200624-007	• TUBING, Teflon, Natural, Thin Wall, 0.042 ID		A/R
10	201535-018	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Black		A/R
11	201535-023	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Green		A/R
12	201535-026	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Gray		A/R
13	201535-021	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Orange		A/R
14	201535-019	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Red		A/R
15	201535-025	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, Violet		A/R
16	201535-028	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, White/Black		A/R
17	201535-032	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, White/Green		A/R
18	201535-112	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, White/Orange		A/R
19	201535-029	• WIRE, Stranded, PVC, 300V, 22 AWG, CSA, White/Red		A/R

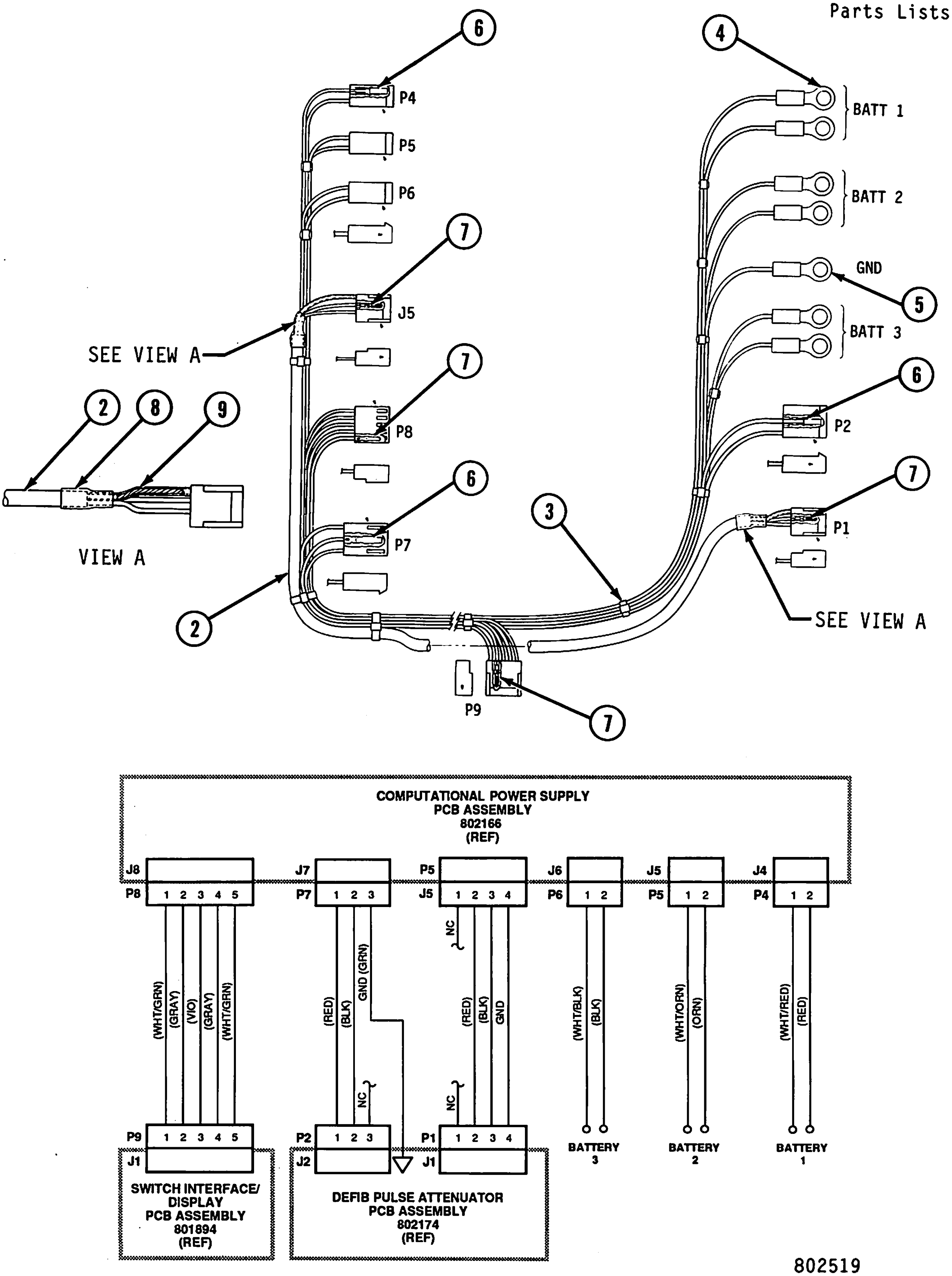
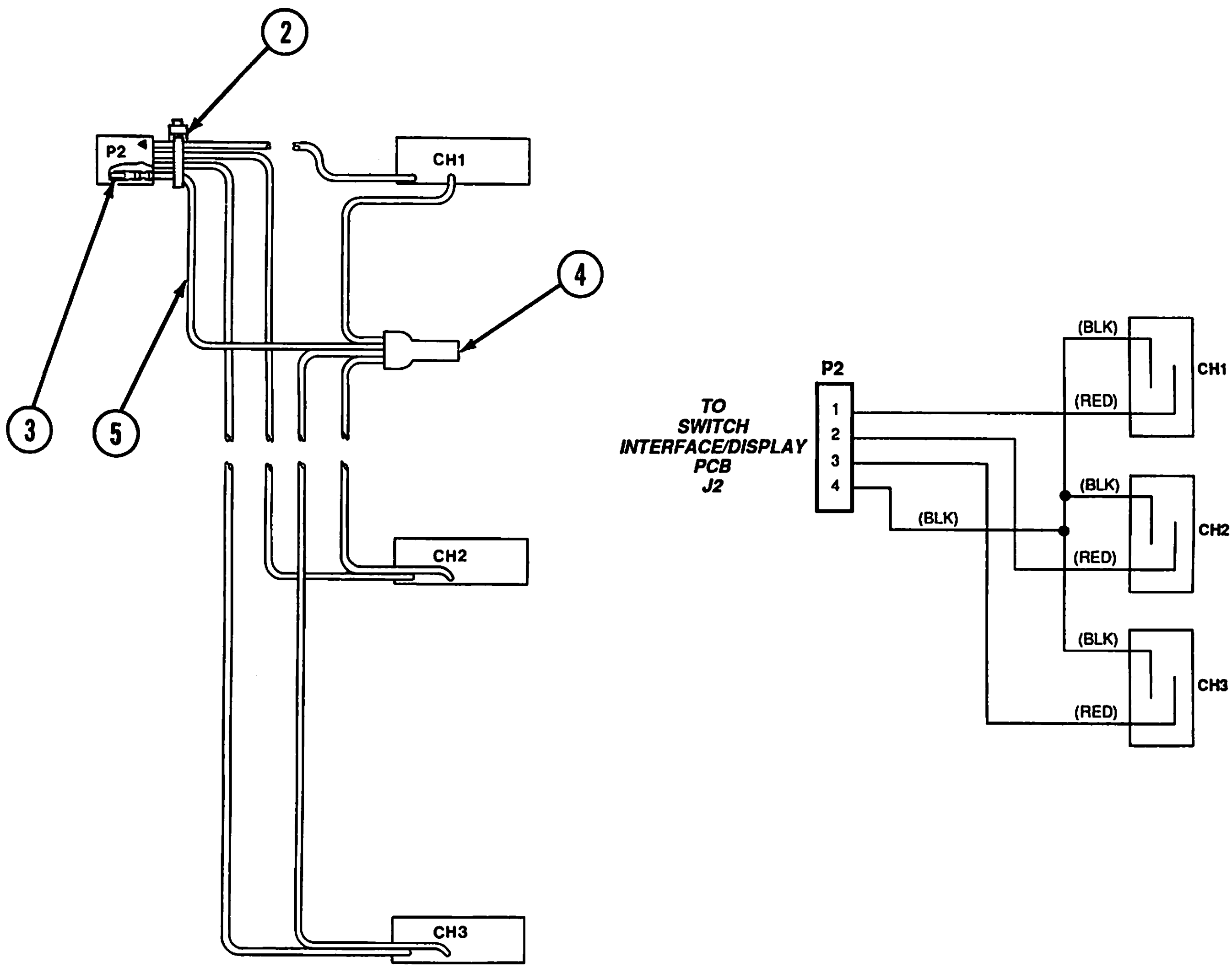


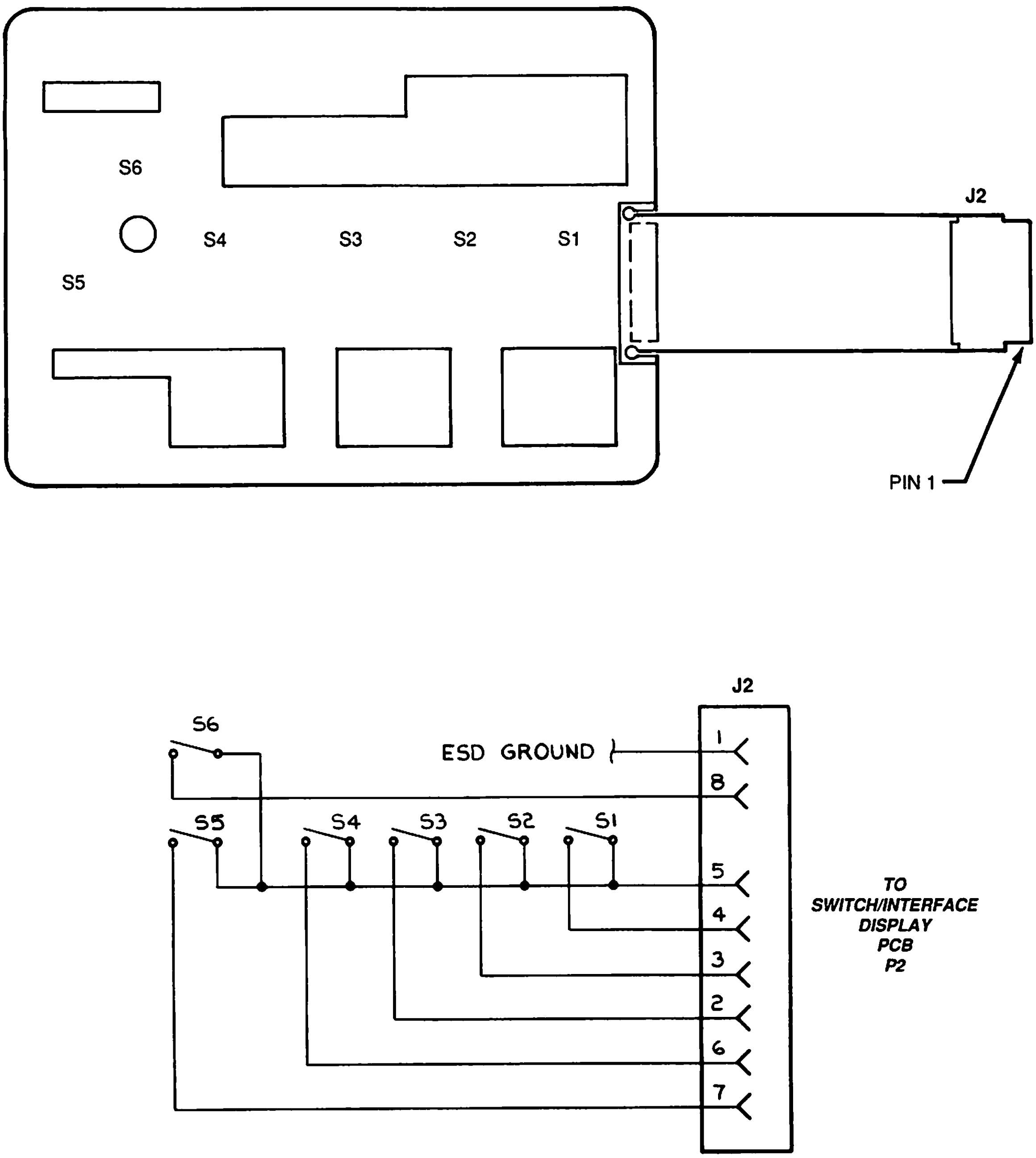
FIGURE 5-7. WIRE HARNESS ASSEMBLY

FIG-ITEM	PART NUMBER	DESCRIPTION	USE CODE	QTY
5-8	803061-00	REED SWITCH HARNESS ASSEMBLY		REF
CH1-3	803060-00	• SWITCH, Magnetic Reed		3
P2	200419-021	• CONNECTOR, Housing, 4 Contact		1
2	200536-009	• RETAINER, Cable Tie, Nylon, 0.10 W x 4.06 L		5
3	200390-000	• TERMINAL, Socket, Crimp, 22-30 AWG		4
4	200992-003	• TERMINAL, Splice, Closed End, 22-14 AWG		1
5	201535-033	• WIRE, Stranded, PVC, 300V, 26 AWG, CSA, Black		A/R



803061

FIGURE 5-8. REED SWITCH HARNESS ASSEMBLY



801878

FIGURE 5-9. MEMBRANE SWITCH ASSEMBLY

SECTION 6
COMPONENT REFERENCE DIAGRAMS

6-1. OVERVIEW

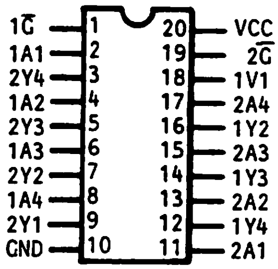
This section provides information about selected components in the Battery Support System. The pin configurations, function tables, and block diagrams are provided for analyzing and troubleshooting circuits. Figures 6-1 to 6-17 are arranged alphabetically by IC type.

TABLE 6-1

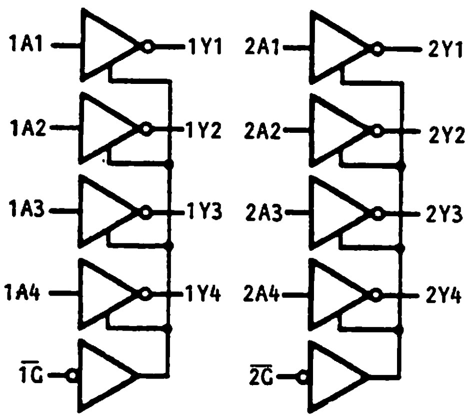
COMPONENT REFERENCE DIAGRAMS

LOCATION	REF. DES.	IC NUMBER	TYPE	FIG. NO.
Computational Power Supply (A1)	U3,U8,U26	74LS74	Flip-Flop, D-Type	6-10
	U4	6809P	Microprocessor	6-12
	U5	74159	Decoder/Demultiplexer	6-7
	U6,U7,U31, U32	74LS244	Buffer	6-2
	U10	4020	Counter, Binary	6-5
	U11	2732	EPROM, 4k x 8	6-9
	U12	2016/4016	RAM, Static, 2k x 8	6-14
	U18	74LS245	Transceiver, Buffer	6-17
	U19	LF13508	Multiplexer, Analog	6-13
	U20-U22	25LS2518	Register, D	6-15
	U29	2504	Successive Approximation Register	6-16
	U30	7541	Converter, D/A	6-4
Switch Interface/ Display (A3)	U1-U3	4511	Decoder/Driver, BCD-to-7-segment	6-8
	U4,U5	74LS374	Flip-Flop, D-Type	6-11
	U6	74LS139	Decoder/Demultiplexer	6-6
	U7	74LS240	Buffer, Tri-state, Inverting	6-1
	U8	74LS365A	Buffer, Tri-state, Non-inverting	6-3

TYPE	IC NUMBER	LOCATION	REF. DES.
BUFFER, TRI-STATE INVERTING	74LS240	SWITCH INTERFACE/ DISPLAY (A3)	U7



PIN CONFIGURATION



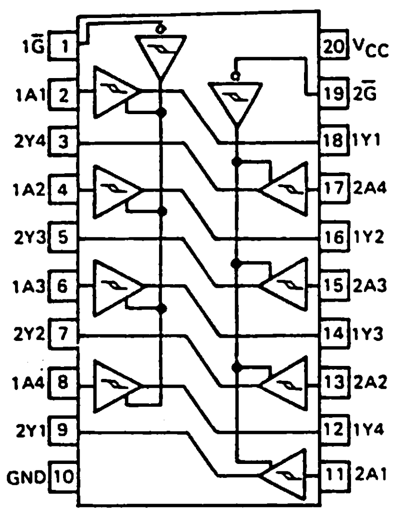
FUNCTIONAL DIAGRAM

INPUTS		OUTPUT
G̅	A	Y
H	X	Z
L	H	L
L	L	H

FUNCTION TABLE

FIGURE 6-1.

TYPE	IC NUMBER	LOCATION	REF. DES.
BUFFER	74LS244	COMPUTATIONAL POWER SUPPLY (A1)	U6,U7,U31,U32



CONNECTION DIAGRAM

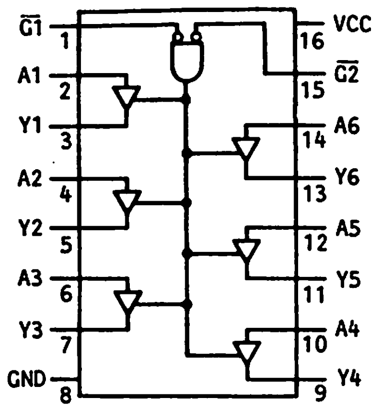
INPUTS		OUTPUT
1G̅, 2G̅	A	Y
L	L	L
L	H	H
H	X	(Z)

H= HIGH Voltage Level
L= LOW Voltage Level
X= Immaterial
Z= HIGH Impedance

FUNCTION TABLE

FIGURE 6-2.

TYPE	**IC NUMBER**	**LOCATION**	**REF. DES.**
BUFFER, TRI-STATE NON-INVERTING	74LS365A	SWITCH INTERFACE/ DISPLAY (A3)	U8



CONNECTION DIAGRAM

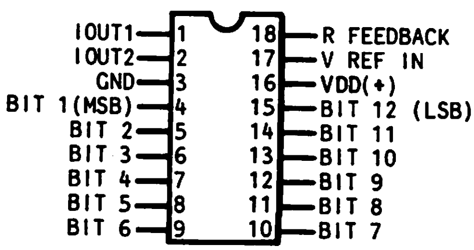
Inputs			Output
G1	G2	A	Y
H	X	X	Z
X	H	X	Z
L	L	H	H
L	L	L	L

FUNCTION TABLE

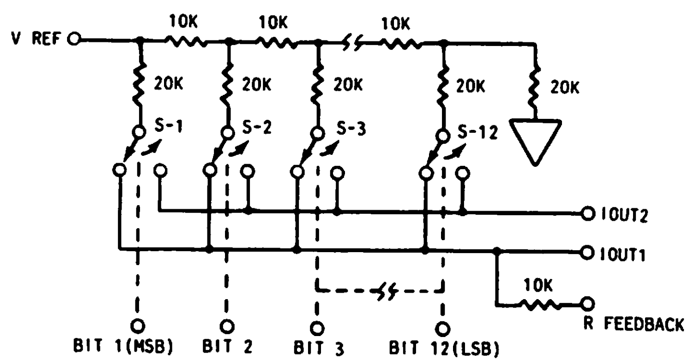
FIGURE 6-3.

TYPE	**IC NUMBER**	**LOCATION**	**REF. DES.**
CONVERTER, D/A	7541	COMPUTATIONAL POWER SUPPLY (A1)	U30

ATTENTION



PIN CONFIGURATION



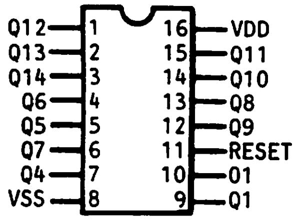
LOGIC: A SWITCH IS CLOSED TO IOUT1 FOR ITS DIGITAL INPUT IN A "HIGH" STATE.

FUNCTIONAL DIAGRAM

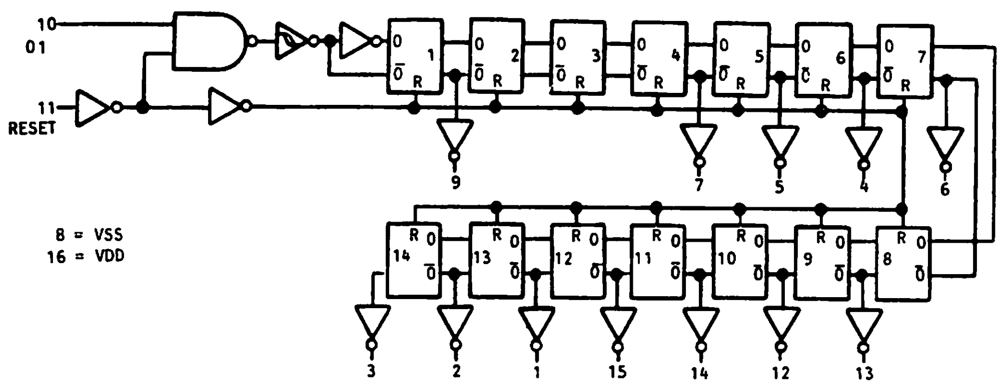
FIGURE 6-4.

TYPE	IC NUMBER	LOCATION	REF. DES.
COUNTER, BINARY	4020	COMPUTATIONAL POWER SUPPLY (A1)	U10

ATTENTION



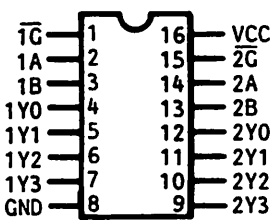
PIN CONFIGURATION



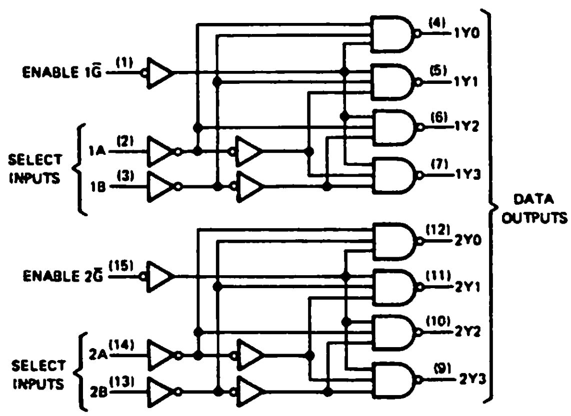
FUNCTIONAL DIAGRAM

FIGURE 6-5.

TYPE	IC NUMBER	LOCATION	REF. DES.
DECODER/ DEMULTIPLEXER	74LS139	SWITCH INTERFACE/ DISPLAY (A3)	U6



PIN CONFIGURATION



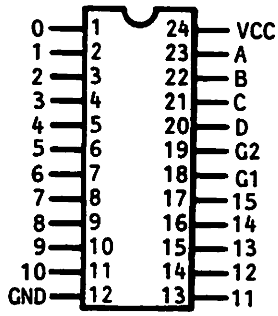
FUNCTIONAL DIAGRAM

INPUTS			OUTPUTS			
ENABLE	SELECT					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

FUNCTION TABLE

FIGURE 6-6.

TYPE	IC NUMBER	LOCATION	REF. DES.
DECODER/ DEMULTIPLEXER	74159	COMPUTATIONAL POWER SUPPLY (A1)	U5



PIN CONFIGURATION

INPUTS						OUTPUTS															
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

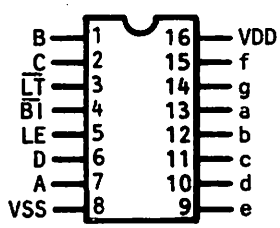
H = high level, L = low level, X = irrelevant

FUNCTION TABLE

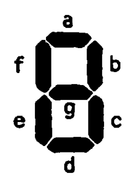
FIGURE 6-7.

TYPE	IC NUMBER	LOCATION	REF. DES.
DECODER/DRIVER, BCD-TO-7-SEGMENT	4511	SWITCH INTERFACE/ DISPLAY (A3)	U1-3

ATTENTION



PIN CONFIGURATION

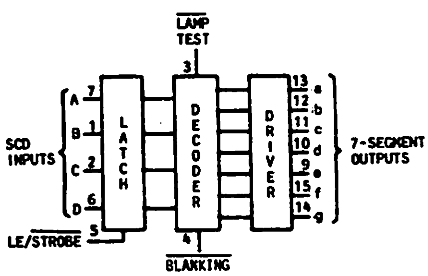


SEGMENT IDENTIFICATION

INPUTS							OUTPUTS							
LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	DISPLAY
X	X	0	X	X	X	X	1	1	1	1	1	1	1	8
X	0	1	X	X	X	X	0	0	0	0	0	0	0	BLANK
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	BLANK
0	1	1	1	0	1	1	0	0	0	0	0	0	0	BLANK
0	1	1	1	1	0	0	0	0	0	0	0	0	0	BLANK
0	1	1	1	1	0	1	0	0	0	0	0	0	0	BLANK
0	1	1	1	1	1	0	0	0	0	0	0	0	0	BLANK
0	1	1	1	1	1	1	0	0	0	0	0	0	0	BLANK
1	1	1	X	X	X	X				*				*

X = Don't care
*Depends upon the BCD code applied during the 0 to 1 transition of LE

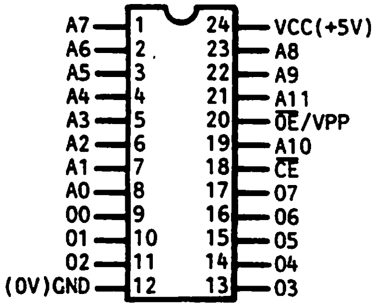
FUNCTION TABLE



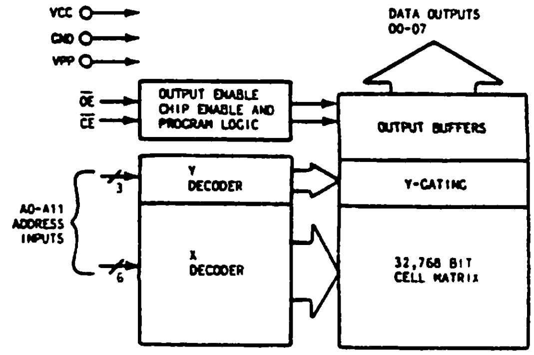
FUNCTIONAL DIAGRAM

FIGURE 6-8.

TYPE	IC NUMBER	LOCATION	REF. DES.
EPROM, 4K X 8	2732	COMPUTATIONAL POWER SUPPLY (A1)	U11



PIN CONFIGURATION



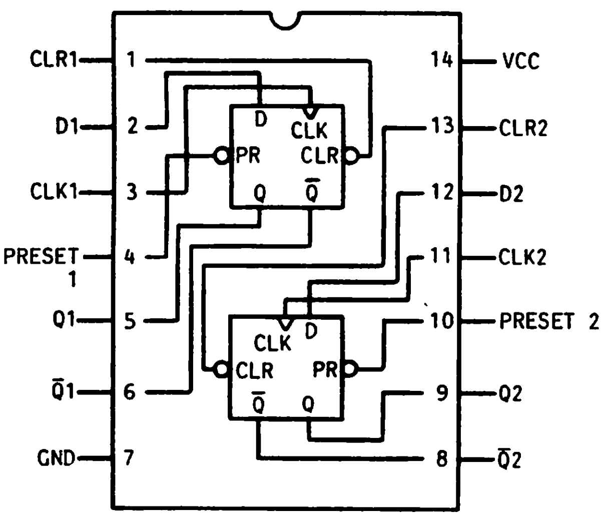
BLOCK DIAGRAM

PINS / MODE	$\overline{CE}$	$\overline{OE}/V_{PP}$	V_{CC}	OUTPUTS
Read	V_{IL}	V_{IL}	+5	D_{OUT}
Standby	V_{IH}	Don't Care	+5	High Z
Program	Pulsed V_{IL} to V_{IH}	V_{PP}	+5	D_{IN}
Program Verify	V_{IL}	V_{IL}	+5	D_{OUT}
Program Inhibit	V_{IH}	V_{PP}	+5	High Z

FUNCTION TABLE

FIGURE 6-9.

TYPE	IC NUMBER	LOCATION	REF. DES.
FLIP-FLOP, D-TYPE	74LS74	COMPUTATIONAL POWER SUPPLY (A1)	U3,U8,U26



CONNECTION DIAGRAM

INPUTS				OUTPUTS	
PR	CLR	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q0	$\overline{Q0}$

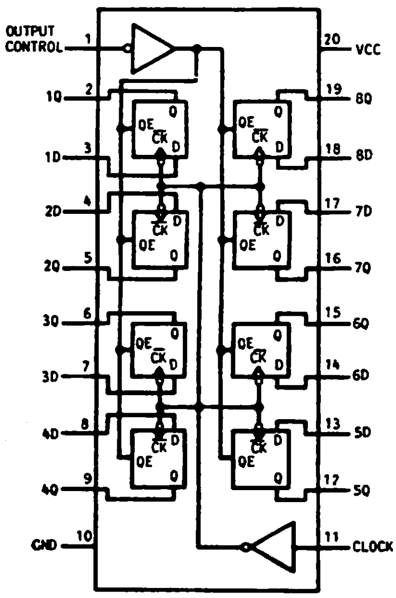
H = High level
L = Low level
X = Irrelevant
Q0 = The level of Q before the indicated steady-state input conditions were established.

*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

FUNCTION TABLE

FIGURE 6-10.

TYPE	IC NUMBER	LOCATION	REF. DES.
FLIP-FLOP, D-TYPE	74LS374	SWITCH INTERFACE/ DISPLAY (A3)	U4,U5



CONNECTION DIAGRAM

OUTPUT CONTROL	CLOCK	DATA	OUTPUT
L	↑	H	H
L	↑	L	L
L	L	X	QO
H	X	X	Z

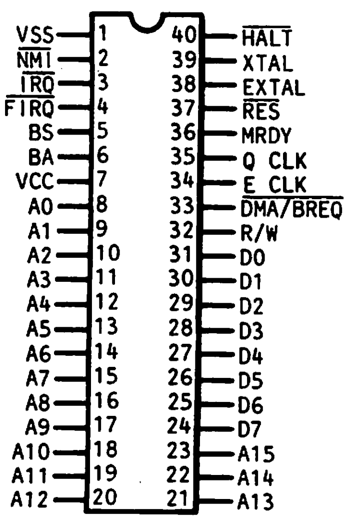
H = HIGH LEVEL
L = LOW LEVEL
↑ = TRANSITION FROM LOW TO HIGH
Z = HIGH IMPEDANCE STATE
QO = LEVEL OF OUTPUT BEFORE STEADY STATE INPUT CONDITIONS WERE ESTABLISHED

FUNCTION TABLE

FIGURE 6-11.

TYPE	IC NUMBER	LOCATION	REF. DES.
MICROPROCESSOR	6809P	COMPUTATIONAL POWER SUPPLY (A1)	U4

ATTENTION



PIN CONFIGURATION

BLOCK DIAGRAM

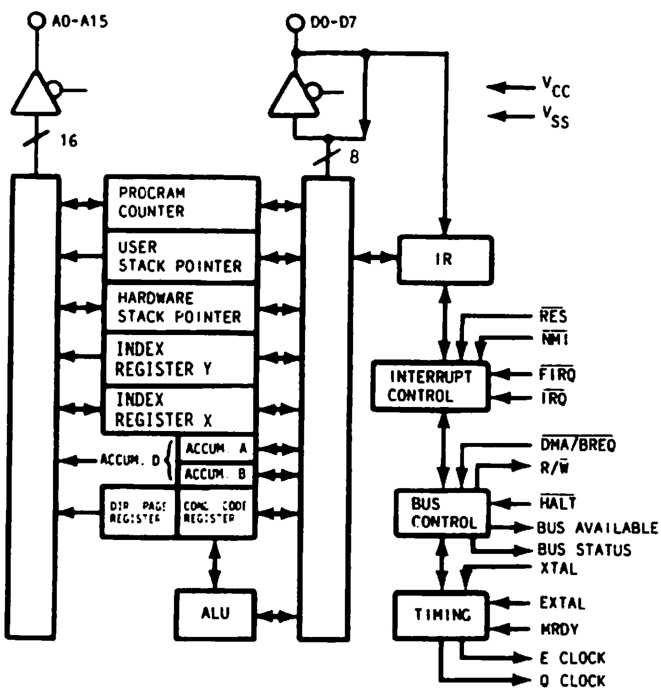
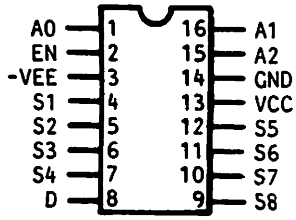
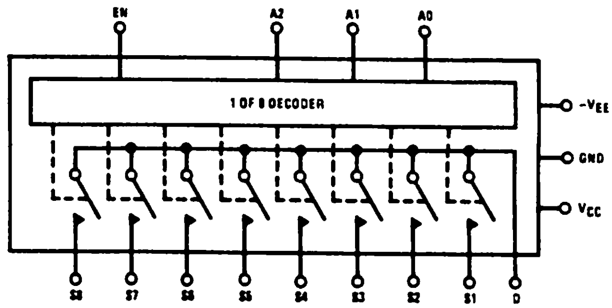


FIGURE 6-12.

TYPE	IC NUMBER	LOCATION	REF. DES.
MULTIPLEXER, ANALOG	LF13508	COMPUTATIONAL POWER SUPPLY (A1)	U19



PIN CONFIGURATION



CONNECTION DIAGRAM

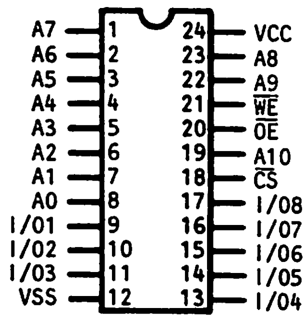
EN	A2	A1	A0	SWITCH ON
H	L	L	L	S1
H	L	L	H	S2
H	L	H	L	S3
H	L	H	H	S4
H	H	L	L	S5
H	H	L	H	S6
H	H	H	L	S7
H	H	H	H	S8
L	X	X	X	NONE

FUNCTION TABLE

FIGURE 6-13.

TYPE	IC NUMBER	LOCATION	REF. DES.
RAM, STATIC, 2K X 8	2016-4016	COMPUTATIONAL POWER SUPPLY (A1)	U12

ATTENTION



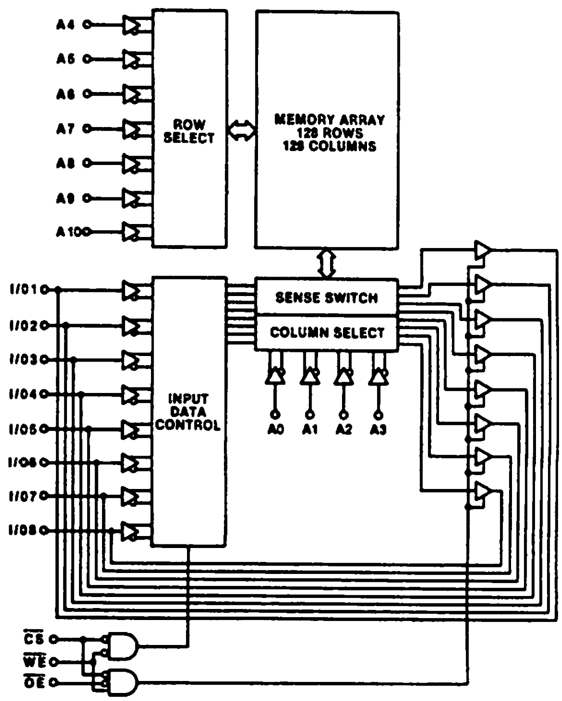
PIN CONFIGURATION

Pin Names	
A0 - A10	Address Inputs
$\overline{WE}$	Write Enable
$\overline{CS}$	Chip Select
$\overline{OE}$	Output Enable
I/01 - I/08	Data Input/Output
V_{CC}	Power (+5V)
V_{SS}	Ground

Truth Table

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	MODE	I/O	POWER
H	X	X	Not Selected	High-Z	Standby
L	L	H	Read	Dout	Active
L	H	L	Write	Din	Active
L	L	L	Write	Din	Active

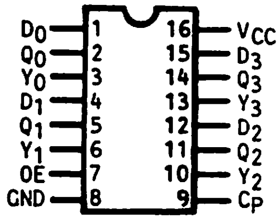
FUNCTION TABLE



BLOCK DIAGRAM

FIGURE 6-14.

TYPE	IC NUMBER	LOCATION	REF. DES.
REGISTER, D	25LS2518	COMPUTATIONAL POWER SUPPLY (A1)	U20-U22



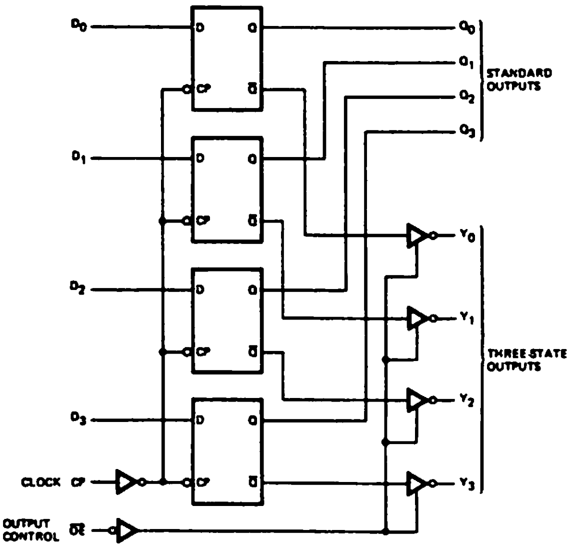
PIN CONFIGURATION

FUNCTION TABLE

INPUTS			OUTPUTS		NOTES
$\overline{OE}$	CLOCK CP	D	Q	Y	
H	L	X	NC	Z	–
H	H	X	NC	Z	–
H	↑	L	L	Z	–
H	↑	H	H	Z	–
L	↑	L	L	L	–
L	↑	H	H	H	–
L	–	–	L	L	1
L	–	–	H	H	1

L = LOW
H = HIGH
X = Don't care

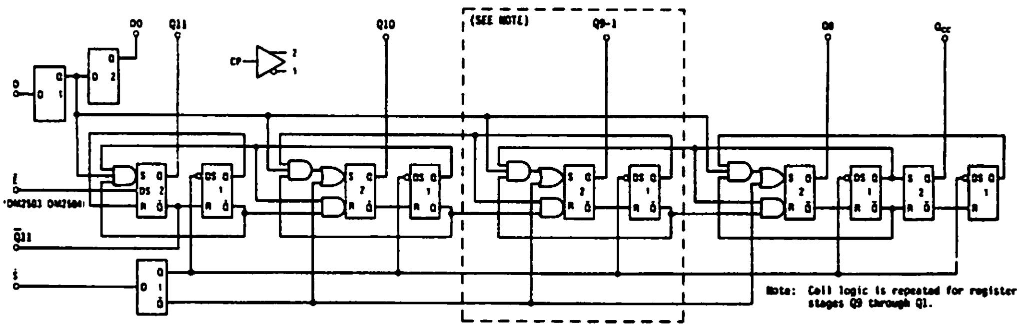
NC = No change
↑ = LOW to HIGH transition
Z = High Impedance



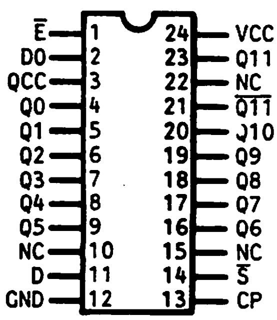
FUNCTIONAL DIAGRAM

FIGURE 6-15.

TYPE	IC NUMBER	LOCATION	REF. DES.
SUCCESSIVE APPROXIMATION REGISTER	2504	COMPUTATIONAL POWER SUPPLY (A1)	U29



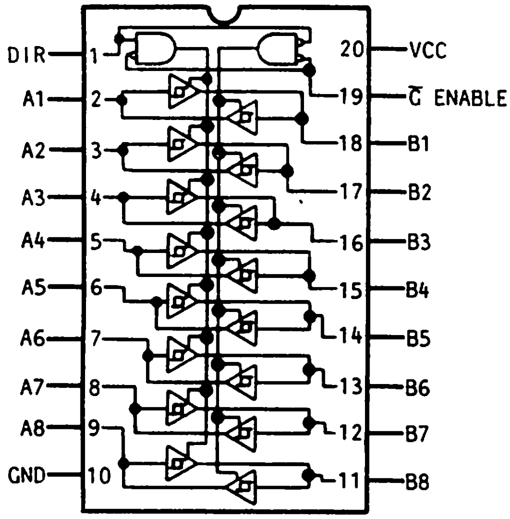
FUNCTIONAL DIAGRAM



PIN CONFIGURATION

FIGURE 6-16.

TYPE	IC NUMBER	LOCATION	REF. DES.
TRANSCEIVER, BUFFER	74LS245	COMPUTATIONAL POWER SUPPLY (A1)	U18



CONNECTION DIAGRAM

ENABLE C̄	DIRECTION CONTROL DIR	OPERATION
L	L	B data to A bus
L	H	A data to B bus
H	X	Isolation

H = High level
L = Low level
X = Irrelevant

FUNCTION TABLE

FIGURE 6-17.