HEWLETT PACKARD

43130A DEFIBRILLATOR

PART NUMBER 43130-91909

MICROFICHE NUMBER 43130-90999

This manual applies to instruments beginning with serial number prefix 2812A.

Fifth Edition

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2-1. INTRODUCTION

This section describes the theory of operation of the 43130A defibrillator. It is primarily board oriented; i.e., discussion of various system components is contained in the section relating to the printed circuit board which connects to them, e.g. the battery is discussed under Battery Charger board.

2-2. SYSTEM OVERVIEW

The unit is comprised of five major circuitry assemblies, four of which are contained on printed circuit boards. These five assemblies are the Control board, Display board, High Voltage Charger board, High Voltage Circuit, and Battery Charger board.

A. CONTROL BOARD

- Reads front panel operator inputs
- Controls the defibrillator charge and discharge sequences
- Controls front panel display
- Performs ECG processing for the synchronizer.

B. DISPLAY BOARD

- Provides the drive signals for Energy display and discrete LED indicators on the front panel display

C. HIGH VOLTAGE CHARGER BOARD

- Generates voltage to charge the HV Capacitor
- Provides an indication of the HV Capacitor voltage to the Control board
- Provides safety discharge of the HV Capacitor.

D. HIGH VOLTAGE CIRCUITRY

- Delivers current with a specified waveform to a load between the defibrillator paddles
- Provides an indication of the discharge current to the Control board
- Provides a test load for discharge of the HV Capacitor.

E. BATTERY CHARGER BOARD

- Isolates and conditions line voltage to charge the battery
- Provides several low voltages to power other circuitry.

2-3. CONTROL BOARD

The control board circuitry is comprised of a control processor, gate array, analog-to-digital conversion circuitry, speaker circuit, front panel switch logic, processor reset circuit, marker pulse circuit, and front panel display voltage supply.

2-4. MAIN CONTROL PROCESSOR

U61, the control processor, is an 8051 single-chip microcontroller. It is the heart of the Control board circuitry. System control is accomplished either directly, from the processor's own I/O ports; or indirectly, through the control gate array's I/O lines.

The processor's software is executed once every 4.167 ms on a cyclic basis. The 4.167 ms software cycle is generated by a timer internal to the processor. Software functions include servicing the A/D converter; updating the display; reading the front panel switches, energy select switch, and paddle switches; digital filtering of the patient ECG for the synchronizer; HV capacitor charge and discharge control; and system diagnostics.

2-5. CONTROL GATE ARRAY

The control gate array, U62, is a collection of several smaller digital circuits. It generates many of the system timing signals, and provides I/O expansion for the control processor. The major functional areas of the gate array are the clock oscillator, system timing chain, memory map control logic, control registers, switch control logic, tickle/reset circuit, speaker tones, and charge rate control.

2-6. CLOCK OSCILLATOR

The processor and the gate array are driven by a 12Mhz crystal controlled oscillator. This oscillator is part of the gate array. See Figure 2-1. The external circuitry for the oscillator consists of R48, R49, C34, C35, and Y1. The oscillator input is XTALIN pin 6, and the output XTALOUT is pin 7 of U62. The signal OSCOUT is a buffered output of the oscillator. This signal is used internal to the gate array for driving the system timing chain, and external for driving the clock input of the processor (U61-18).

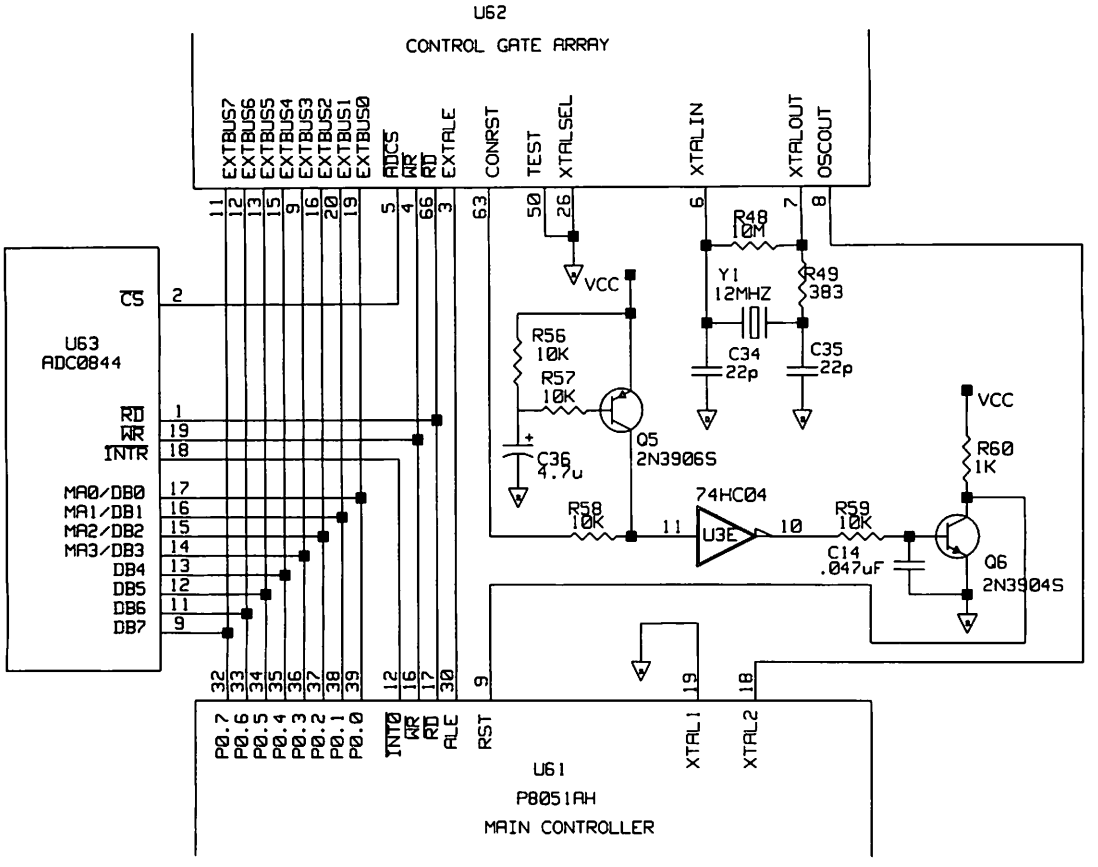


Figure 2-1. Memory Mapped I/O.

2-7. MEMORY MAPPED I/O

The gate array control registers, the switch control logic; as well as, the A/D converter (U63) are configured as memory mapped I/O to the processor. Port P0 (pins 32 to 39) of the processor is used as the external address/data bus. The control gate array and A/D converter are connected to this bus as shown in Figure 2-1. The memory map control logic is located internal to the gate array. It consists of an address latch and combinational logic to decode the address. The memory mapped devices are accessed by data memory read/write instructions from the processor.

2-8. GATE ARRAY CONTROL REGISTERS

There are three registers internal to the control gate array, that are configured as external memory locations to the processor. They are used for internal control of the gate array, and also as direct outputs to other parts of the system. Each register is updated once every 4.167 ms software cycle.

2-9. ANALOG/DIGITAL CONVERSION

U63 is an 8-bit successive approximation A/D converter. The converter has an internal 4 channel analog multiplexer, and generates its own timing with an internal clock. Typical conversion times are 40 microseconds. A +5 volt 1% voltage reference, U67, is used as the reference input to pin U63-8.

An A/D conversion is initiated when the processor executes an external data memory write instruction to the address the A/D converter occupies in the memory map. See Figure 2-2. When this occurs, pin U62-5 from the gate array goes low and selects the A/D converter, U63. The data written to the A/D converter is the multiplexer channel address of the signal intended for conversion. The actual conversion begins when the write signal, pin U63-19, returns high at the end of the external data memory write instruction from U61. After the conversion is completed, the A/D interrupt signal, pin U63-18, goes low and generates an interrupt at pin 12 of U61. The processor, U61, reads the conversion result with an external data memory read instruction, and then starts another conversion.

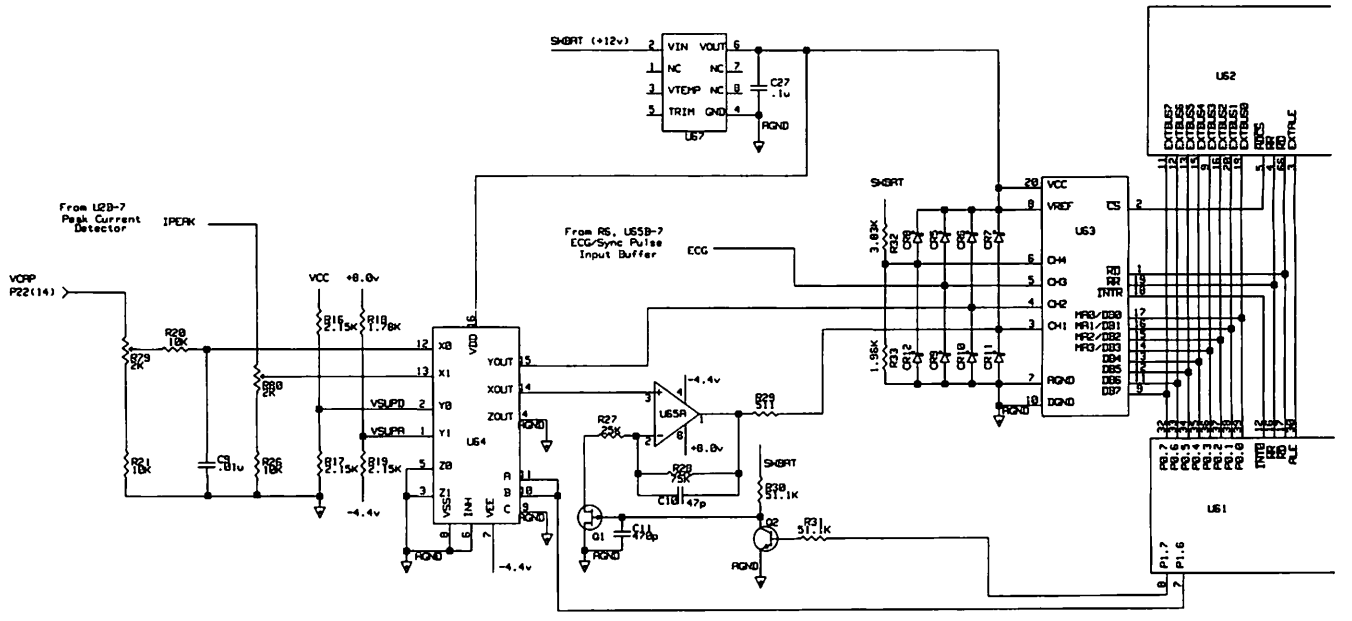


Figure 2-2. A/D Convert.

Five to six A/D conversions are performed each 4.167 ms software cycle. Conversions are done on the patient ECG signal (ECG), HV capacitor voltage signal (VCAP), battery voltage (SWBAT), and supply voltages (VSUPD and VSUPA). The order of conversions is ECG, VCAP (at unity gain), SWBAT, VCAP (at 4x gain), VSUPD, and VSUPA. The second conversion of VCAP (at 4x gain) is done only if the first conversion (at unity gain) is less than 1.2 volts. The second conversion of VCAP is done after the SWBAT conversion, to give the gain of U65A time to settle after being changed. An A/D conversion of the peak discharge current signal IPEAK is performed during the discharge sequence.

The output signal of the ECG/Sync pulse buffer stage, U65B, is input to Channel 3 of the A/D converter (pin 5 of U63). Diodes CR5 and CR9 serve as input protection for U63.

The battery voltage SWBAT is divided down by resistors R32 and R33. The divided signal is input to Channel 4 of the A/D converter (pin 6 of U63). Diodes CR16 and CR17 are used as input protection for U63.

The HV capacitor voltage signal (from the Defibrillator Charger board) is divided down through potentiometer R79 and resistor R21. This divider is used to adjust out the component tolerance of the HV capacitor, and calibrate the delivered energy. The divided VCAP signal is input to X0 (pin 12) of U64. Similarly, the peak discharge current signal IPEAK is divided down through R80 and R26. The IPEAK divider is used to calibrate the test energy accuracy. The divided IPEAK signal is input to X1 (pin 13) of U64.

The digital +5 volt supply is divided down through resistors R16 and R17 to obtain the signal VSUPD. This signal is input to Y0 (pin 2) of U64. The analog +8 volt and −4.4 volt supplies are summed together through resistors R18 and R19 to obtain the signal VSUPA. This signal is then input to Y1 (pin 1) of U64.

U64 is a triple 2 to 1 analog multiplexer. The control inputs A (pin 11) and B (pin 10) for outputs XOUT (pin 14) and YOUT (pin 15) are both connected to P1.6 (pin U61-7) of the main control processor. When P1.6 is low, the signals VCAP and VSUPD are output at XOUT and YOUT respectively. When P1.6 is high, the signals IPEAK and VSUPA are output at XOUT and YOUT of U64. The signal XOUT is input to the gain stage U65A. The signal YOUT is input to Channel 2 (pin 4) of the A/D converter. Diodes CR6 and CR10 act as input protection for Channel 2.

U65A is configured as a programmable non-inverting gain stage, and the gain is determined by the state of transistor Q1. When Q1 is pinched-off, the gain is unity; and when Q63 is on, the gain is 4. The state of Q1 is controlled by the main control processor, through transistor Q2. When Q2 is on, the gate of Q2 is at ground, and Q1 is on; and when Q2 is off, the gate of Q1 is pulled to +12 volts and Q1 is pinched-off. Resistors R27 and R28 set the gain when Q1 is on. Capacitors C10 and C11 are for noise suppression, when Q1 and Q2 are switching.

2-10. ECG/SYNC PULSE INPUT BUFFER, (Figure 2-3)

A high level ECG or Sync pulse from an external monitor is input to connector J26. This signal is then input to filter stage U65B. This filter stage is an inverting buffer amplifier with passband from approximately 0.5 to 55 Hz. The input signal's characterisitics can be either a pre-amplified analog ECG, from .5 to 5 volts in amplitude; or a positive going sync pulse, up to 180 ms wide and from 3 to 12 volts in amplitude. If the input is a sync pulse, R6, R7, CR3, and C5 will remove the "sharpness" of the falling edge, thus preventing synchronization with the trailing edge of the marker. The output of this buffer is input to Channel 3 of the A/D converter.

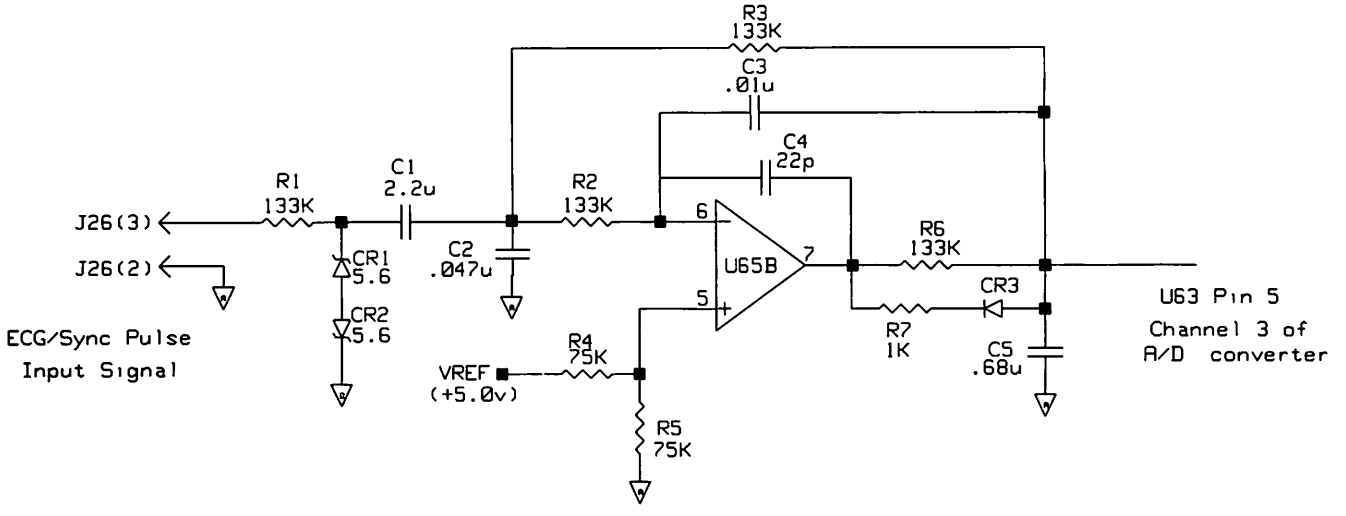


Figure 2-3. ECG/SYNC Pulse Input Buffer.

2-11. PEAK CURRENT DETECTOR

During a test discharge, the peak discharge current through the test load is measured, and used to calculate the energy delivered. The discharge current flows through a 1:2500 current stepdown transformer, T1, mounted in the lower case. The proportional secondary current is converted to a voltage by R23. This voltage is then integrated and held by the peak hold circuit; which consists of open collector comparator U1B, op-amp U2B, resistor R24 and capacitor C8. The output of the peak hold circuit is IPEAK, which is then divided down through R80 and R26 (for calibration purposes), and input to X1 of U64. The peak hold circuit is reset by the processor, via a gate array control register, through R25 and U62 pin 54. R22 and C7 perform a low pass filtering function to prevent noise from disturbing the peak current reading. (See Figure 2-4.)

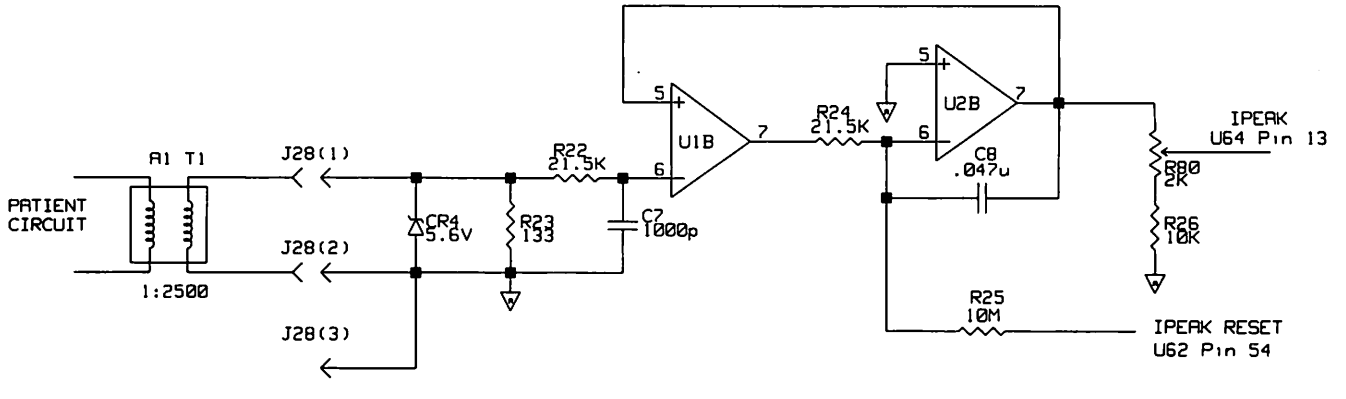


Figure 2-4. Peak Current Detector.

2-12. SWITCH CONTROL LOGIC, (Figure 2-5)

The front panel switches, paddles in pockets switch, and the option switches on the Control board are input to processor thru the gate array. The processor reads these switches by executing a data memory read to a specific address. The switches are read each software cycle and debounced in software.

Pin 2 of U62 serves a special function in the switch logic. It is read into the control processor to check if the instrument's power has just been turned on. Capacitor C6 is connected to pin 2 and charged through a pull-up transistor internal to U62. The main control processor checks the logic level of pin 2 (which effectively is the charge on C6) to determine if the unit has recently been turned on.

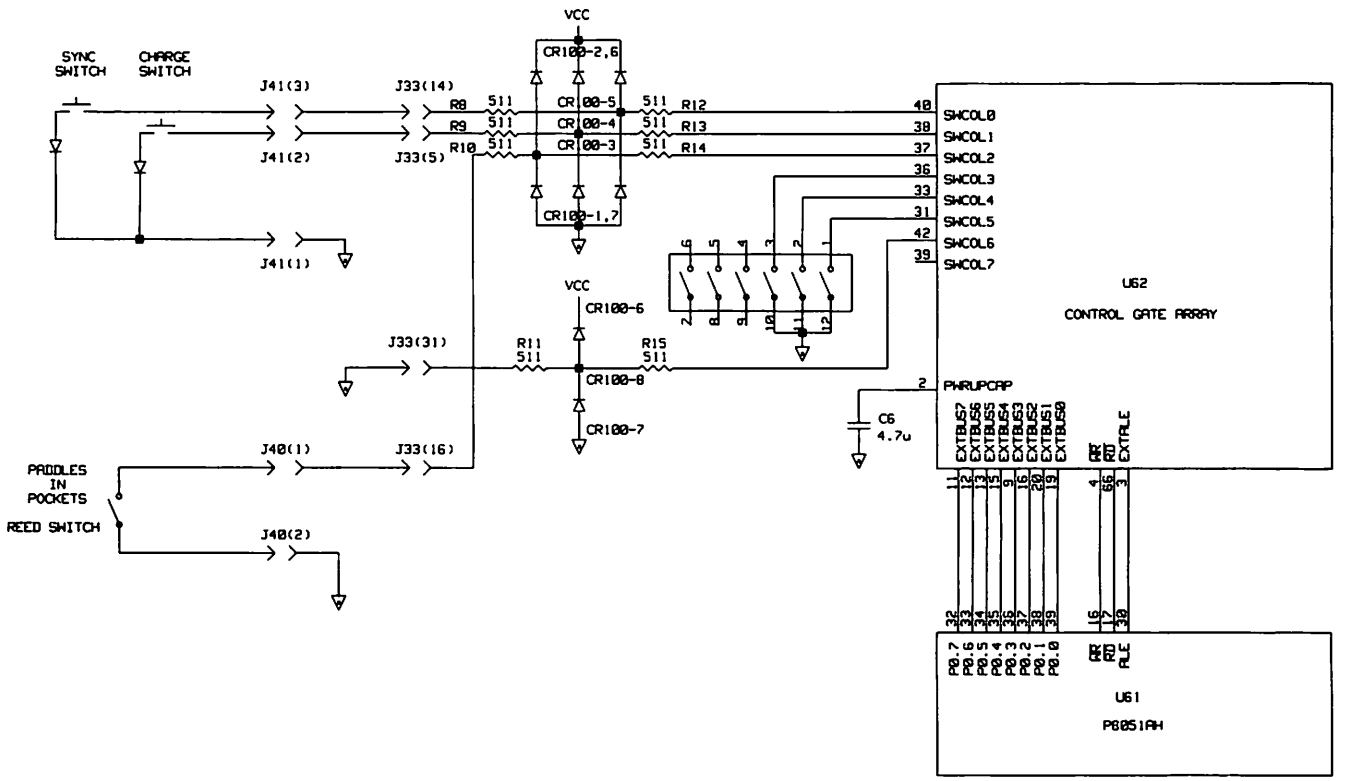


Figure 2-5. Switch Control Logic.

2-13. SPEAKER CIRCUITRY, (Figure 2-6)

The speaker circuit generates the power-up tone, charge done tone, and the QRS beeper tone. The tones are derived from the control gate array signals CHGTONE (pin U62- 23), and RWTONE (pin U62-10). The signal CHGTONE is a 1953 Hz square wave, and RWTONE is a 1736 Hz square wave. The processor controls which signal is enabled, through the gate array control registers.

The signals CHGTONE and RWTONE are "diode OR'ed" together to drive the base of transistor Q7, which drives the speaker DS61. DS61 is connected from the +5v supply to ground, through the collector-emitter junction of Q7. Capacitor C19 provides energy storage for the speakers current surges.

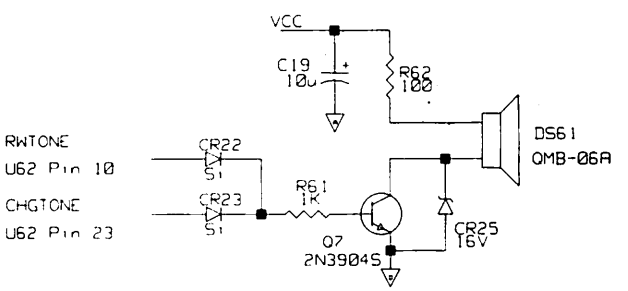


Figure 2-6. Speaker Circuitry.

2-14. TICKLE/RESET CIRCUIT

The tickle/reset circuit, inside the control gate array, provides a means of software recovery for the processor. This is a useful circuit when operating in an electrically noisy environment. The circuit is basically a ripple counter that is driven by the system timing chain internal to the gate array. If allowed to run freely, the counter output CONRST (pin U62-63) will generate a signal that is 6.4 ms high and 6.4 ms low. An additional circuit makes it possible to change this signal to 44.8 ms high and 6.4 ms low. The pulse duration is programmed through one of the gate array control registers. During normal operation the 6.4 ms pulse duration is selected. The 44.8 ms pulse duration is used during the discharge sequence.

The signal CONRST is connected into the power-up reset circuit consisting of Q5, Q6, U3E, R56, R57, R58, R59, R60, C36, and C14. The output of this circuit is input to the RST pin of the processor (U61-9). Thus the processor can be reset by either the gate array or the power-up circuit. See Figure 2-1.

Under normal operation, the main control processor "tickles" or resets the tickle/reset ripple counter once each 4.167 ms software cycle. This prevents CONRST from ever going high and resetting the main control processor. However, if the processor operation is upset by electrical noise and fails to "tickle", then CONRST will reset the processor within 6.4 ms. When reset, the software will start over from program address location 0; and "tickle" rapidly for 25 ms before resuming normal operation. "Tickling" is accomplished by writing to one of the gate array control registers. The tickle signal from U61 is output as a test signal on pin 1 of U62.

During a discharge sequence, the main control processor turns on the patient control signal PATRLY (pin U62-61) to close the patient relay, then programs the tickle/reset circuit for a long (44.8 ms) reset pulse, and stops tickling. Because of the relay's mechanical delay, the processor goes into reset before the relay closes. The processor is held in reset, while the relay closes and the HV capacitor energy is discharged through the patient. This protects the processor's internal registers during the relay closure, which is a time of high electrical interference. Also, the processor is brought up in a known state after the discharge.

When the processor comes out of reset after the discharge, it tickles rapidly for 25 ms, and then performs an A/D conversion of the peak discharge current signal IPEAK. A second conversion of IPEAK is done (at 4x gain) if the signal at unity gain was less than 1.2 volts. These peak current samples are used for calculating the delivered energy for self-test discharges. Afterwards, the patient relay control signal PATRLY (pin U62-61), and the safety relay control signal SFTYRLY (pin U62-59) are turned off to open the patient relay and close the safety relay. The processor then waits for CONRST to go high again, and hold it in reset while the safety relay closes. This second long reset protects the processor from any electrical interference that might occur on the closing of the safety relay. This electrical interference can be significant if an open paddles discharge occurs.

After coming out of the second long reset, the processor tickles rapidly for 25 ms, and then resumes normal operation. See Figure 2-7.

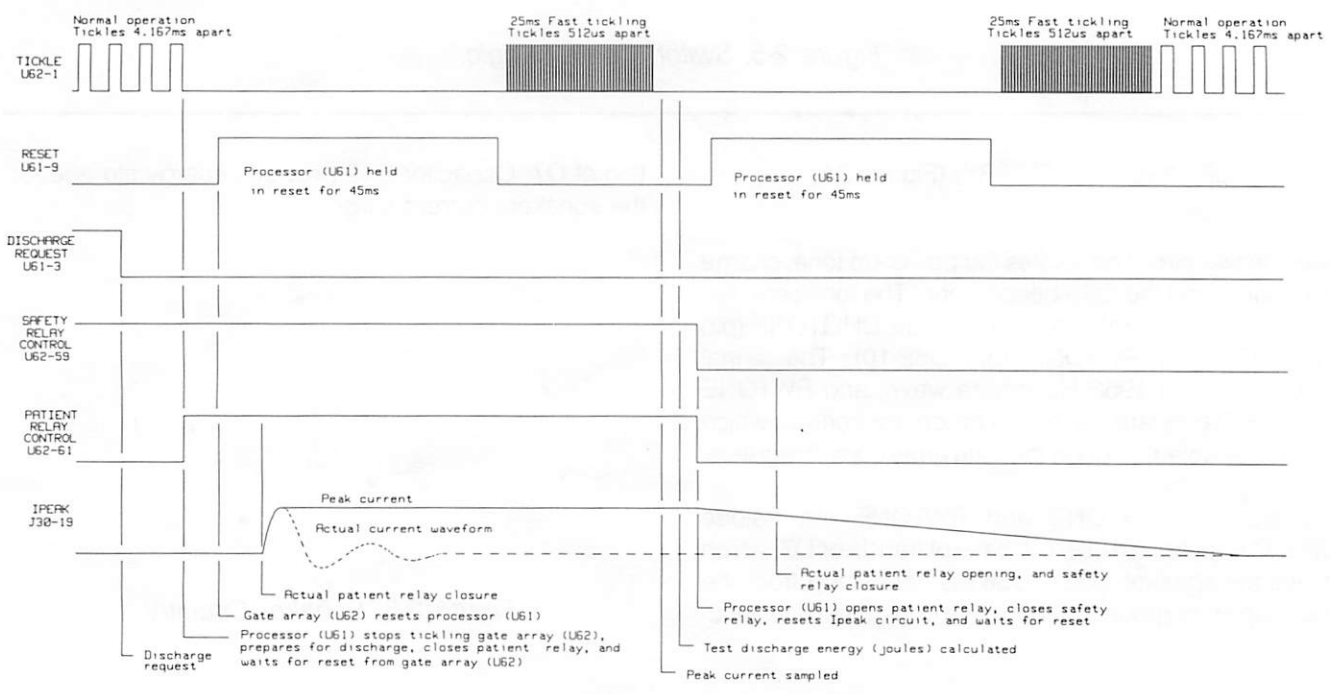


Figure 2-7. Tickle/Reset Timing Diagram.

2-15. HV CAPACITOR CHARGE AND DISCHARGE

The processor reads the energy select switch in through P2.0-P2.3 (pins 21-24 of U61) every 4.167 ms software cycle. The energy select switch must remain at the same setting for 500 ms, before it is used as the selected energy for charging the HV capacitor. Charging is initiated by pressing the front panel charge switch, or the paddles charge switch. At the beginning of a charge, U61 begins displaying the HV capacitor energy on the display in real time.

The processor turns on the safety relay control signal (pin 59 of U62) by writing to one of the gate array control registers, and then waits 50 ms for the safety relay to open. The processor then selects a pulse width (or charge rate) and turns on the charge rate control signal CHGFREQ (pin U62-60) via the control registers. At the same time, the charge enable signal CHGENBL (pin U61-6) goes low to enable the High Voltage Charger circuitry.

NOTE

UNDER LOW BATTERY CONDITIONS, CHGFREQ MAY TURN OFF, AND CHGENBL MAY GO HIGH PERIODICALLY TO ALLOW THE BATTERY VOLTAGE TO RECOVER BEFORE CONTINUING THE CHARGE. THIS MAY INCREASE DEFIBRILLATOR CHARGING TIME.

The charge is completed when the energy on the HV capacitor reaches the selected energy setting. CHGFREQ is disabled and CHGENBL returns high to stop the HV Charger circuitry. The charge done tone CHGTONE (pin U62-23) is enabled. Transistors Q3 and Q4 are turned on by P1.1 going high, to light the charge done LED in the apex paddle; and P2.6 goes high to turn on the front panel charge done LED. Periodically CHGFREQ and CHGENBL may be activated to refresh the energy on the HV capacitor; and keep it charged to near as possible the selected energy setting. The HV capacitor will remain charged for 60 seconds after the charge is completed. At the end of 60 seconds, the processor will close the safety relay and dump the charge internally through the safety resistor. During the last 10 seconds, the charge done tone is intermittent to warn of this impending internal dump.

After the charge done tone comes on, the processor waits 125 ms before it begins checking for the discharge request signal (pin U61-3) to go low. The low indicates that both paddles discharge switches were pressed at the same time. When this signal is detected, the processor turns on the patient relay control signal to close the patient relay, and waits for a reset from the tickle/reset circuit. The tickle/reset circuit holds the processor in reset for 45 ms, while the energy is being discharged through the patient. After coming out of reset, the processor samples the peak discharge current signal (IPEAK) and calculates the delivered energy if it was a test discharge. The processor then turns off the patient relay control signal and the safety relay control signal; to open the patient relay, and close the safety relay. The processor then waits for another reset, and is held in reset for 45 ms again, while the safety relay closes. After this second reset, the processor resumes normal operation. After a discharge or internal dump, the processor will continue to display the HV Capacitor energy in real time for 10 seconds or until the energy decreases to less than one Joule, which ever occurs first. After a self-test discharge, the energy delivered to the 50 ohm test load is flashed 3 times on the display.

2-16. SYNCHRONIZED CARDIOVERSION

For synchronized cardioversion, the charge and discharge sequence is the same except that the patient relay drive is not actviated until an R-wave is detected by the synchronizer. The synchronizer is software implemented in the control processor, U61. In SYNC mode operation, the processor filters the digitized ECG/Sync input signal and looks for the R-wave, or leading edge of a Sync pulse, to synchronize the discharge. When in SYNC mode, the sync LED on the front panel is turned on and with each R-wave or Sync pulse detected the LED flashes off for about 180 ms. This flash is also accompanied by a beep from the speaker circuit.

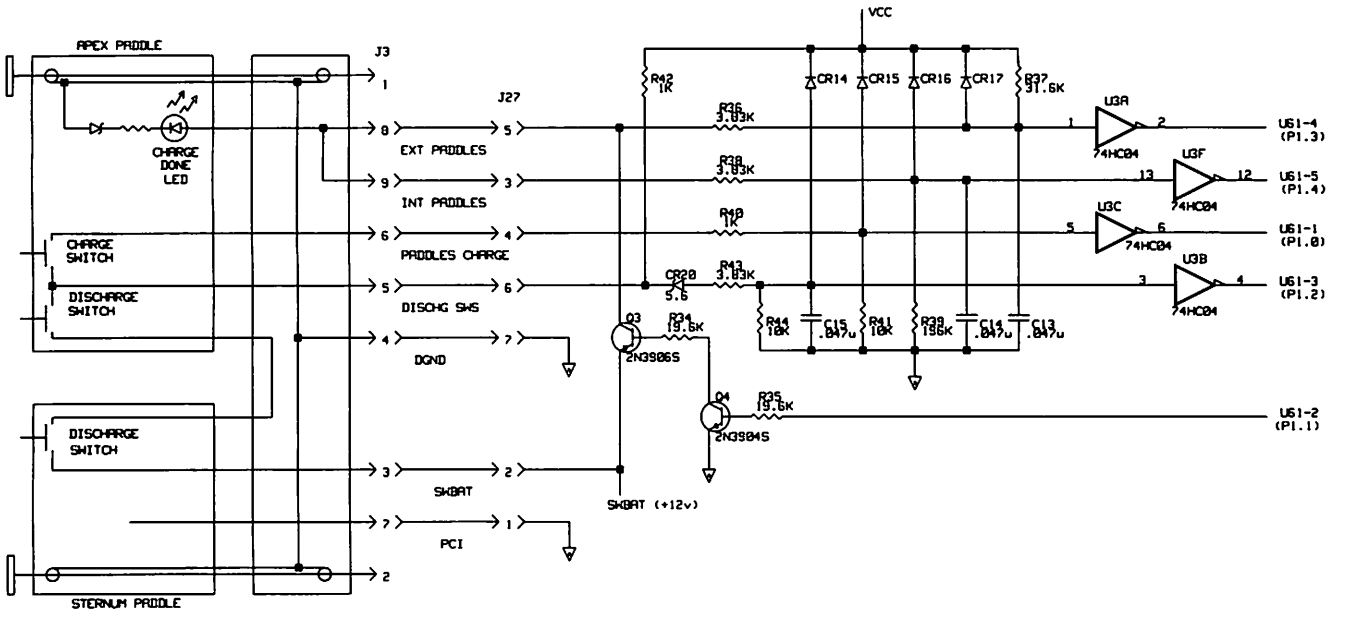


Figure 2-8. Paddles Status.

2-17. PADDLES STATUS

Several signals from the paddles are input to the Control board, and used by the control processor. See Figure 2-8.

The signal DISCHG SWS (J27-6) indicates when the discharge switches are both pushed. When the switches are open, the signal is pulled to +5 volts through R42; and when closed, the signal is pulled to +12 volts (SWBAT). CR20, CR14, R44, and R43 provide logic level translation, before the signal is input to inverter U3B. The output of this inverter is input to P1.2 of U61. A low level at P1.2 indicates the discharge switches are closed.

When the charge switch is closed, the signal PADDLES CHARGE (J27-4) is connected to DISCHG SWS, and is pulled to +5 volts through R108. When the switch is open, PADDLES CHARGE is at ground. The signal is input to U3C, and the output of U3C is input to P1.0 of U61. A low level at P1.0 indicates the charge switch is pressed. R41, R40, and CR15 provide overvoltage protection for U3C in case the charge and discharge switches are both closed.

Signals INT PADDLES (J27-3) and EXT PADDLES (J27-5) are used to determine whether a paddles set is plugged into the instrument; and also, whether the paddles are internal or external paddles. INT PADDLES is pulled to ground through R39 and EXT PADDLES is pulled to +5 volts through R37. These signals are input to P1.3 and P1.4 of U61, through inverters U3A and U3F.

Under normal conditions an external paddles set is connected to the instrument, and the signals are connected together. In this case, both signals are a logic high; and P1.3 and P1.4 are low.

If U61 detects that a paddles set is not connected, the defibrillator charge and discharge funtions will be inhibited. A charge in progress will be aborted, and the energy dumped internally. If U61 detects an internal paddles set is connected, the energy selection is software limited to 50 joules. Energy switch settings greater than 50 joules are interpreted as 50 joules.The signal EXT PADDLES is also used to light the charge done LED in the apex paddle. When the HV charge is done, P1.1 of the main control processor goes high and turns on Q4, which turns on Q3. With Q3 turned on, EXT PADDLES is pulled to +12 volts (SWBAT) and the charge done LED is turned on.

2-18. SYSTEM DIAGNOSTICS

The control processor performs diagnostic checks of the instrument each 4.167 ms software cycle. These checks are to verify that the unit is operational and can be safely charged and discharged. If an unsafe condition is detected, the processor will disable the charge and discharge sequences, and display error messages on the energy display. Error conditions that are checked include the A/D converter malfunctioning; the supply voltages out of specification; the safety relay circuitry stuck open or closed; and the HV capacitor overcharged, leaking, or arcing.

2-19. DISPLAY CONTROL AND POWER SUPPLY

The front panel energy display, and low battery, charge done, and sync LEDs are controlled by the processor. The three digit 7-segment energy display uses a multiplexed drive scheme as shown in Figure 2-10 of Section 2-21. Like segments of each digit are connected together to form an 8 (segment) by 3 (digit) array. Segment information is presented to each digit sequentially, and the digit is enabled. Each digit is turned on for one 4.167 ms software cycle, then the next digit is enabled. Thus, the refresh rate is 12.5 ms or 80 Hz. Segment control is accomplished through one of the gate array control registers, which acts as a latch. This latch is designated by P5.0-7, and is output on pins 43-46, 49, 52, 53, and 58 of the gate array (U62). The digits are enabled by P3.3, P3.4, P3.5 of the processor (U61). The energy display is used to display the deliverable energy, test energy, battery voltage (in service mode), and error codes. The low battery, charge done, and sync LEDs are enabled by P2.4, P2.5, and P2.6 of the processor.

A +8.4V power supply used by several of the LEDs is made up of U4, a three terminal adjustable regulator, on a heatsink. The voltage is set by R46 and R47; the output is bypassed and clamped by C26 and CR32, respectively.

2-20. MARKER PULSE CIRCUIT

Generation of a negative-going pulse on J26 pin 1 is initiated by a high logic pulse from U61. At that time C38, C39, and C40 have already been charged by SWBAT through CR26 and CR27. When Q8 turns on, the capacitor's positive terminals are pulled near ground; and the negative terminals turn on the common base Q4 stage, which sinks current from the output, see Figure 2-9. The marker pulse output is -10V, 12mS and less than 1.5mA.

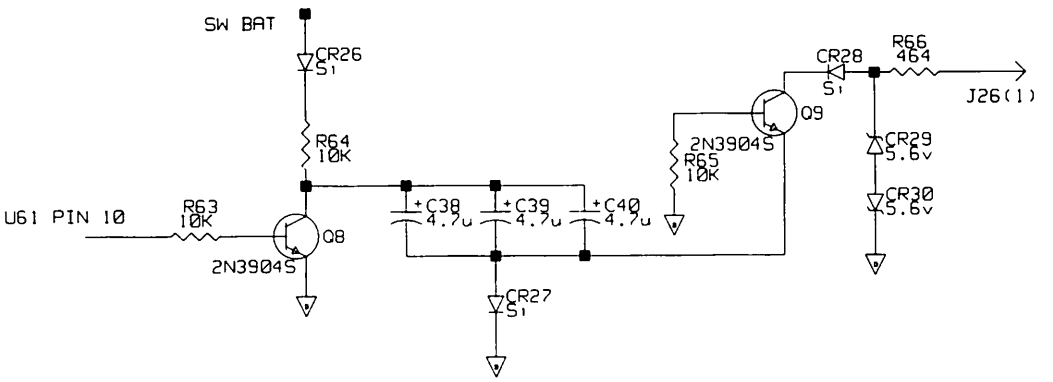


Figure 2-9. Marker Pulse Circuit.

2-21. DISPLAY BOARD

The three digit 7-segment energy display uses a multiplexed drive scheme as described in section 2-19 and depicted in Figure 2-10. U1 contains eight channels of transistors, configured in such a way that a logic one on an input will enable an output Darlington pair to source current from the 8.4V supply on pin 9 (see Figure 2-11.). U2 contains seven (one unused) channels of transistors configured so that that a logic one on an input will enable an output Darlington pair to sink current to ground (see Figure 2-12.).

The SYNC, CHARGE DONE, and LOW BATTERY LEDs are driven steady state. The BATTERY CHARGING and POWER ON LEDs are illuminated by current originating on the Battery Charger Board A4. The Display Board also serves to pass Front Panel Switches and Paddles In Place Switch information to the Control Board A7.

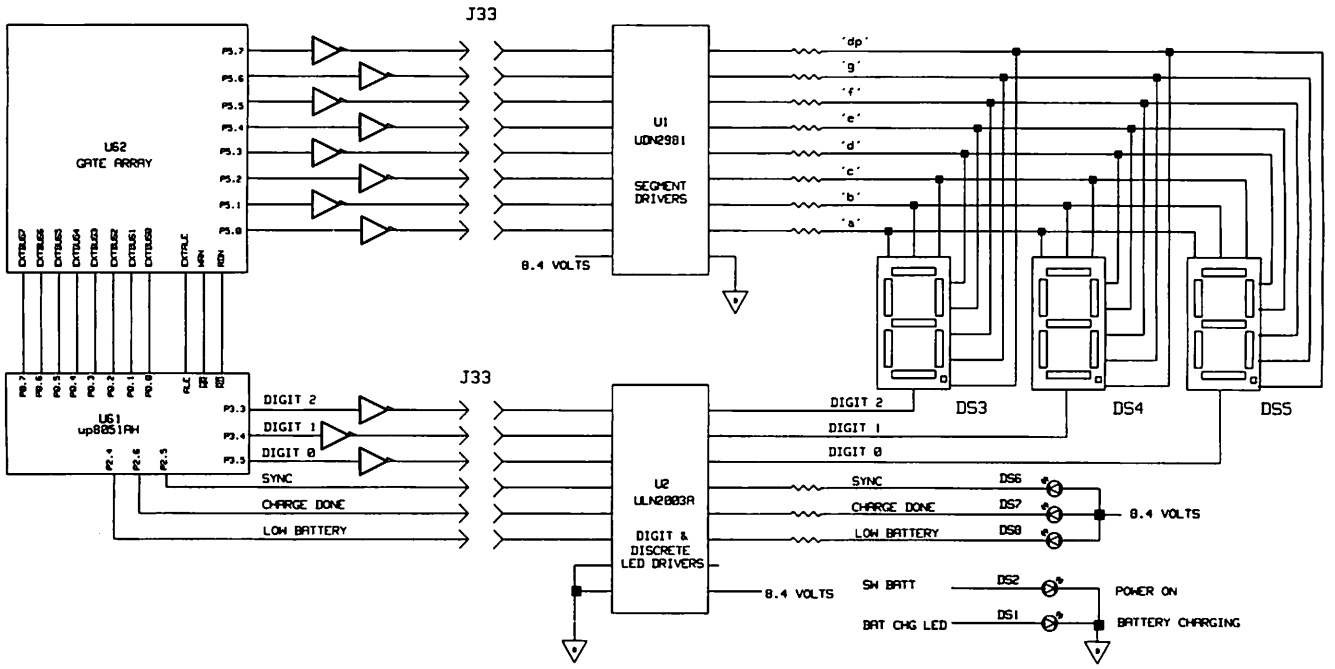


Figure 2-10. Display Control Circuit.

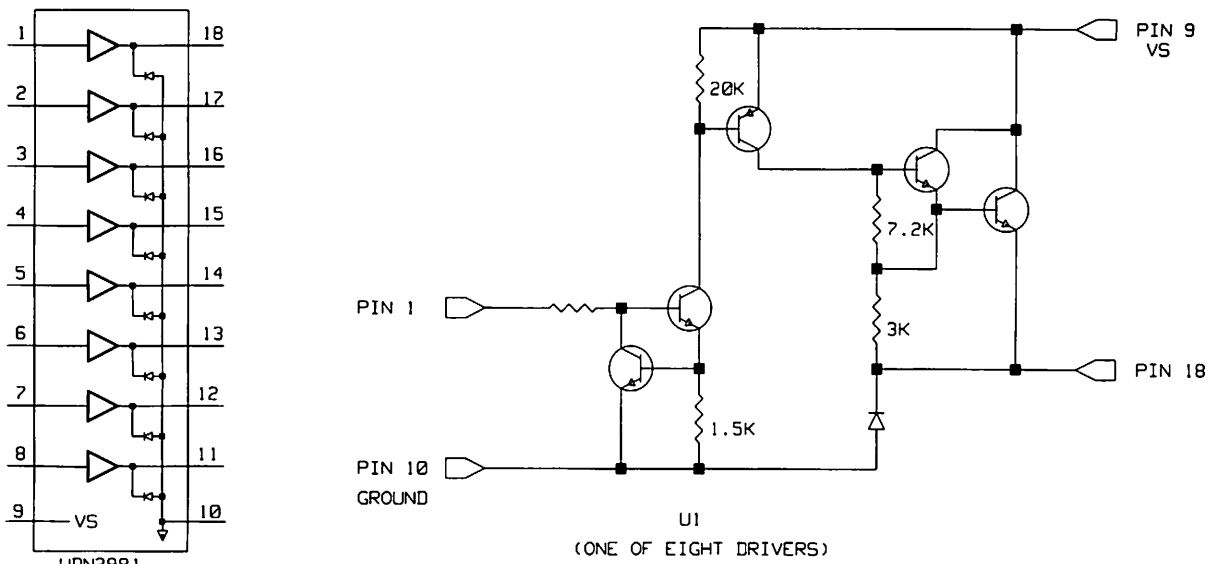


Figure 2-11. Display Segment (Source) Drivers.

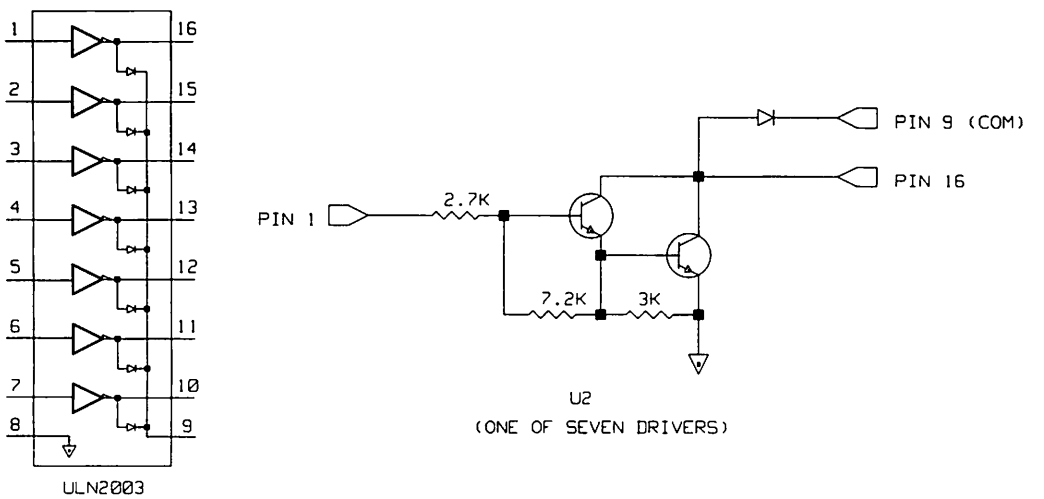


Figure 2-12. Display Digit and Discrete LED (Sink) Drivers.

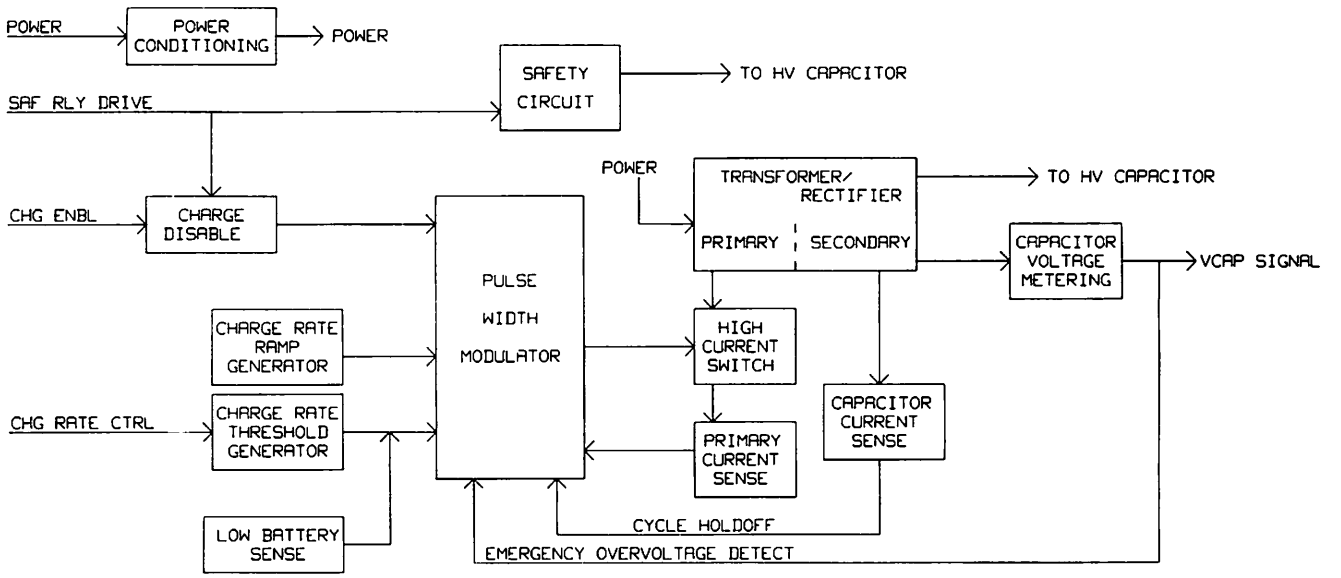


Figure 2-13. Power Supply Module.

2-22. HIGH VOLTAGE CHARGER BOARD

The interaction of the different blocks in Figure 2-13. will be described in this section. Then in following sections the circuitry in each block will be described in detail.

The High Voltage Charger Board operates as a variable frequency flyback DC- DC high voltage switching power supply for purposes of charging the HV Capacitor. Charging begins with reception of the proper SAF RLY DRIVE (safety relay drive, CHG ENBL (charge enable), and CHG RATE CNTL (charge rate control) signals from off-board. The Pulse Width Modulator, as the central controlling block, outputs a pulse the duration of which is dependent upon the time required for the Charge Rate Ramp to reach the Charge Rate Threshold. During this time the High Current Switch, a power MOSFET, is turned on; the result is a current ramp in the transformer primary. At the end of the Pulse Width Modulator output pulse duration the power MOSFET stops conducting, and the Transformer/Rectifier secondary conducts current onto the off-board Main Storage Capacitor. The Capacitor Current Sense circuit then detects current, which causes it to inhibit the restart of another Pulse Width Modulator output. When the capacitor current reaches zero, however, the Cycle Holdoff is released, and the entire cycle is repeated. Meanwhile the capacitor voltage is being scaled and buffered by the Capacitor Voltage Meter circuit for output to the Control Board. During all this time the Power Conditioning circuit provides bypassing for the Switched Battery input, and provides fusing and bypassing for the Raw Battery input; and the Safety Relay Drive input to the Safety Circuit operates to disconnect a shunt resistor from the HV Capacitor.

A number of signals and blocks serve as inputs to the Pulse Width Modulator block, to influence its output. The Charge Disable circuit uses the Safety Relay Drive input as well as the Charge Enable input to enable charging as appropriate. The Charge Rate Ramp Generator generates a voltage ramp which is slower when the battery voltage is lower, to partially compensate for otherwise slowed charging under low battery conditions. The charge rate is varied remotely by duty cycle modulation into the Charge Rate Control input which is received by the Charge Rate Threshold Generator circuit. This circuit also AC-couples the Charge Rate Control input to protect against an erroneous stuck-high condition. The Low Battery Sense circuit disables defibrillator charging if the battery voltage drops below 10 volts. The Primary Current Sense circuit monitors the Transformer/Rectifier primary current for a possible overcurrent condition, in which case the pulse width modulator would terminate its output pulse. Finally, the Pulse Width Modulator block receives the output from the Capacitor Voltage Metering circuit, to disable charging in the event of a runaway charge condition where the HV Capacitor reaches an unacceptably high voltage level.

2.23. POWER CONDITIONING CIRCUIT, (Figure 2-14)

High- and low-current battery and ground lines enter the HV Charger Board on separate lines. The ground lines are connected on the Battery Charger Board. The high-current battery line enters the HV Charger Board unfused and unswitched, and is fused by F1, which is mounted in FH1. It is then filtered by C8, a low ESR capacitor needed to supply the high current surges required in the primary circuit. The low-current battery line enters the HV Charger Board having been through a circuit breaker and through a relay controlled by the front panel switch. It is bypassed by C2 and C9 to low-current ground. The low-current ground is also used as an analog ground for the capacitor voltage indication which is returned to the Control Board.

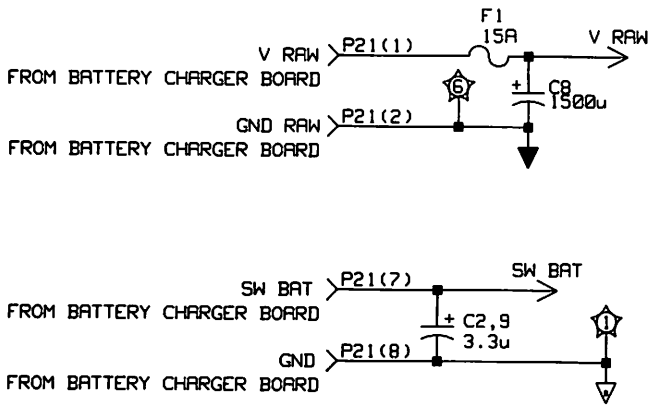


Figure 2-14. Power Conditioning Circuit.

2-24. SAFETY CIRCUIT, (Figure 2-15)

The defibrillator safety circuit is composed of K1, R1, CR1, C11, and R19. The Safety Relay Drive line is brought low by a relay driver on the Battery Charger Board, in response to a command from the Control Board. The high voltage relay K1 will then open, which disconnects R1 from the negative HV capacitor terminal. Upon command from the Control Board the line will be released and the relay will again close, allowing R1 to discharge the capacitor to zero or to some other value selected by the Control Board. Disconnecting power will also release the relay contacts into their normally closed position, safely shunting the HV capacitor terminals. Upon release of the Safety Relay Drive line, CR1 serves to augment the Battery Charger Board's diode clamping as protection from the K1 coil inductive spike. In addition, CR1 helps protect the driver circuitry from spikes that may be capacitively coupled through the relay when the opening or closing relay contacts undergo rapid voltage swings. C11 and R19 are relay contact snubber components that help to reduce the rate of voltage change across the contacts during contact opening or bounce, thereby reducing radiated and conducted noise.

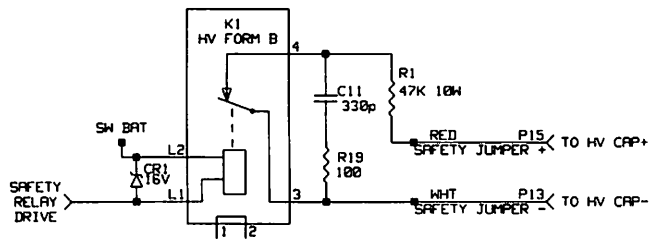


Figure 2-15. Safety Circuit.

2-25. PULSE WIDTH MODULATOR, (Figures 2-16A and 2-16B)

For this circuit implementation, the pulse width modulator can be seen in Figure 2-16B; a voltage source the output of which can be disabled by any one of five conditions; and a 5 volt reference. Figure 2-16A shows a more complete but less intuitive representation of the device; schematics of several of the internal functional blocks are available from manufacturer's catalogs.

The output stage is an emitter follower; so the output voltage will be slightly less than switched battery when the output is turned on, and will be floating when the output is off or disabled. Resistors R11 and R12 provide the only current sinking on the output. The 5 volt reference output is bypassed with C1.

There are five conditions which can cause the output to turn off:

1. If current is sourced into pin 10,
2. If the voltage at pin 7 is greater than that at pin 9,
3. If the voltage at pin 1 is greater than that at pin 2,
4. If a voltage greater than 3 volts is placed on pin 3,
5. If the voltage at pin 4 exceeds the voltage at pin 5 by 200 millivolts or more.

Any one of conditions 3 through 5 will also cause a Darlington transistor (internal to the Pulse Width Modulator) to pull the voltage at pin 7 down to about 0.8 volts above ground. It should also be mentioned that pin 9 is the output of a transconductance opamp in the Pulse Width Modulator, the inputs of which are pins 1 and 2. Pin 9 is a current source of about 100 microamps at essentially any time that the voltage at pin 2 is higher than that at pin 1 unless condition 5 is met as described above.

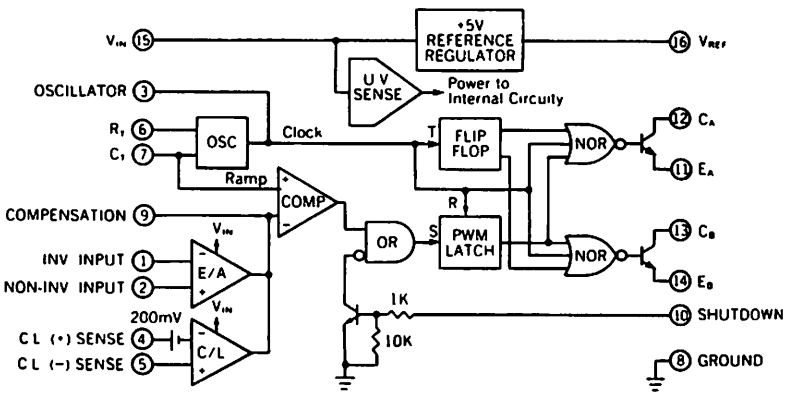


Figure 2-16A. Pulse Width Modulator.

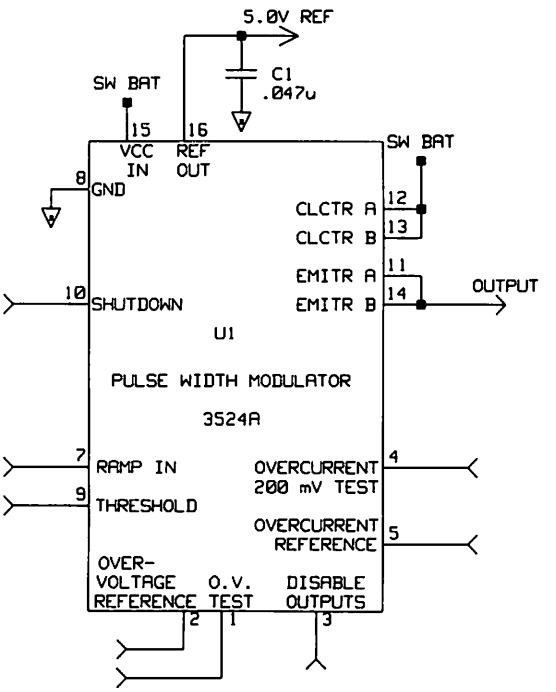


Figure 2-16B. Pulse Width Modulator.

2-26. CHARGE DISABLE CIRCUIT, (Figure 2-17)

R2, CR2, and CR3 form the charge disable circuit. In order for the charger to operate, the Charge Enable input must be brought low, and the safety relay must be driven. The diodes provide the OR function for disabling charge, as well as improving the logic zero voltage margin from the off-board signals.

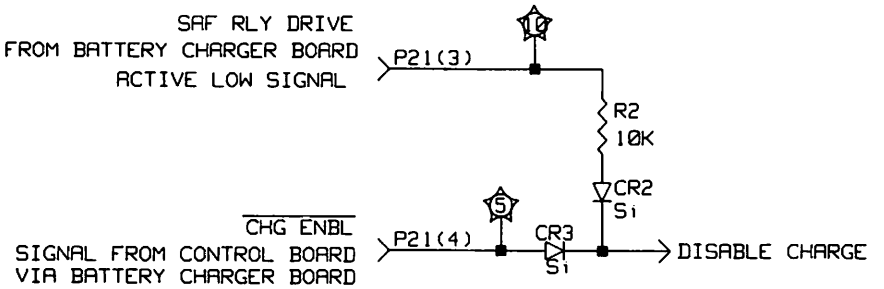


Figure 2-17. Charge Disable Circuit.

2-27. RAMP GENERATOR CIRCUIT, (Figure 2-18)

R3 and C3 form the Ramp Generator circuit. The exponential voltage rise is terminated after only a few volts excursion, when it reaches the voltage at pin 9 or when any of the other conditions described in the Pulse Width Modulator section are met; so the ramp is approximately linear. When the battery voltage is lowest, the ramp is the slowest, increasing the T1 primary on-time in partial compensation for decreased primary voltage.

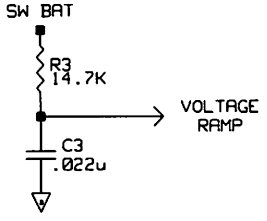


Figure 2-18. Ramp Generator Circuit.

2-28. CHARGE RATE THRESHOLD GENERATOR CIRCUIT, (Figure 2-19)

The components that form the Charge Rate Threshold Generator are C4, CR4, R4, R5, C5, U2C, R6, and CR5. The Charge Rate Control signal from the Control Board is a 15.6 kHZ, variable duty cycle, logic level square wave. A higher duty cycle yields a higher charge rate threshold, which will cause a faster charge. C4 and CR4 AC-couple and rectify the Charge Rate Control signal so that if the incoming signal is erroneously stuck high, the charge rate threshold will go low. R4, R5, and C5 filter the AC component from the resulting signal. U2C buffers that averaged value, and R6 overcomes the high output impedance that may result from the op amp's operation near ground. CR5 assures that the output of U2C will only sink current from U1 pin 9, allowing either U1 or U2B to pull pin 9 low.

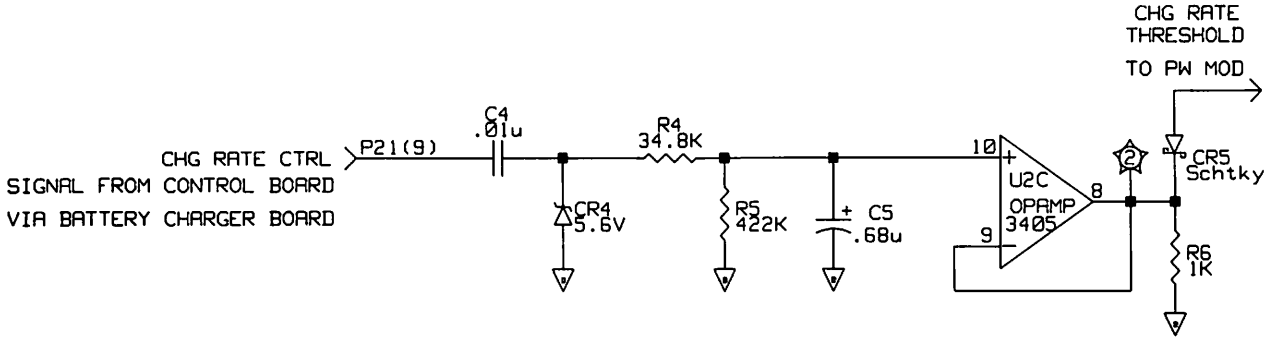


Figure 2-19. Charge Rate Threshold Generator Circuit.

2-29. LOW BATTERY SENSE CIRCUIT, (Figure 2-20)

R7 and R8 divide the battery voltage in half; C6 filters the divided voltage. If the resulting voltage drops below 5 volts, i.e., if the battery voltage drops below 10 volts long enough, then the output of U2B will sink current and thus disable the output of U1 as described in the Pulse Width Modulator section above.

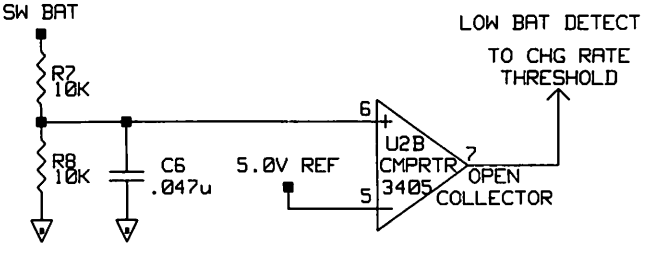


Figure 2-20. Low Battery Sense Circuit.

2-30. HIGH CURRENT SWITCH CIRCUIT, (Figure 2-21)

A high output from the pulse width modulator turns on the high current switch, Q1, which is a power MOSFET. Upon removal of the high output from the pulse width modulator, R11 and R12 will bleed off the gate charge, turning off the power MOSFET. If the drain voltage approaches an unsafe value for the device, CR6 will pull up on the gate voltage, so that the MOSFET will turn on and keep the drain voltage to a safe value. CR7 inhibits conduction of CR6 when the MOSFET switch is turned on. CR8 protects the device from spurious transients which could damage the gatesource junction. The MOSFET is mounted on a heatsink to keep it cool. The heatsink is electrically at the drain potential.

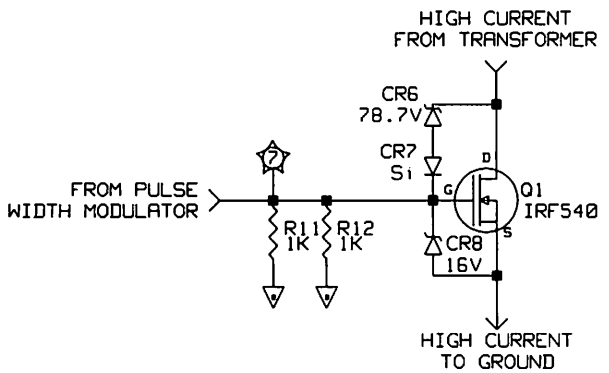


Figure 2-21. High Current Switch Circuit.

2-31. PRIMARY CURRENT SENSE CIRCUIT, (Figure 2-22)

R10, R9, and C7 form the Primary Current Sense circuit. The voltage across the current measuring resistor R10, a low inductance resistor, is directly related to the primary current. R9 and C7 filter from the signal high frequency components which are due to various primary and secondary circuit parasitic capacitances and stray inductances, including the secondary capacitance ringing reflected as mentioned in the Transformer/Rectifier description below. In addition, R9 and C7 attenuate the signal slightly in order to allow the primary current to ramp higher than would otherwise be possible with worst case component tolerances.

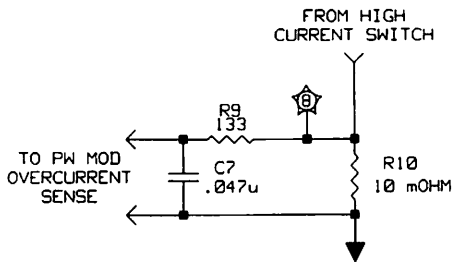


Figure 2-22. Primary Current Sense Circuit.

2-32. TRANSFORMER/RECTIFIER CIRCUIT, (Figure 2-23)

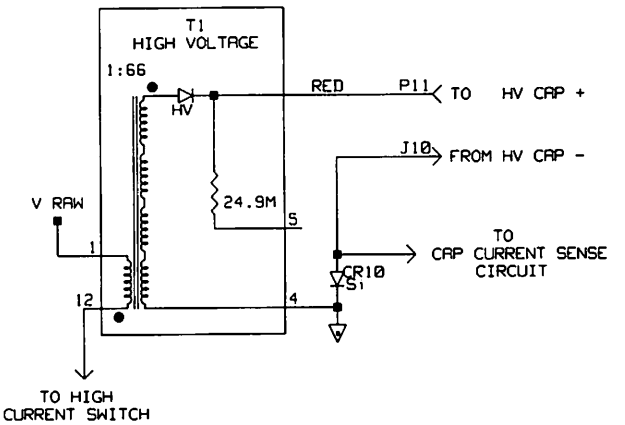


Figure 2-23. Transformer/Rectifier Circuit.

The Transformer/Rectifier circuit involves four of the five parts in T1: the primary winding, the secondary winding, the core, and the high voltage rectifier. The metering resistor, also part of T1, is discussed as part of the Capacitor Voltage Metering circuit.

When the high current switch Q1 turns on, approximately full battery voltage is applied across the primary winding. The high voltage rectifier is then reverse-biased; the rectifier anode is at a negative voltage approximately equal in magnitude to the battery voltage times the turns ratio (66). The constant voltage across the primary inductance, then, causes a constant slope current ramp in the primary circuit. When the high current switch Q1 turns off, the flux in the core of T1 causes current to flow in the secondary winding. The secondary voltage rises rapidly until the high voltage rectifier becomes forward-biased. At that time current is conducted into the HV capacitor positive terminal. The initial rectifier current is related to the ending primary current by the transformer turns ratio; and, because the secondary inductance is held at a near-constant voltage (approximately equal to the HV capacitor voltage), the current ramps down nearly linearly with time. Cessation of current is detected by the Capacitor Current Sense circuit, and the primary-secondary cycle is repeated. Note that when the HV Capacitor is at a high voltage, the secondary conduction time is less than when it is at a low voltage; hence the variable frequency capacitor charging.

It should be noted that a number of parasitic capacitances and stray or leakage inductances have an effect on the voltage and current waveforms. For example, when the power MOSFET switch turns off, the flux that is not coupled to the secondary winding will cause the MOSFET drain voltage to go higher than would be calculated by reflecting the secondary voltage back to the primary. The actual voltage depends on the amount of parasitic capacitance available for energy storage, and

on the amount of energy that is dissipated by such resistive losses as the MOSFET during switching. Another parasitic capacitance that plays a significant role is the interwinding secondary capacitance. When the MOSFET stops conducting and the secondary starts conducting, the rise time of the secondary voltage is limited by the relatively constant secondary current that is charging secondary stray capacitances. Then at the end of the secondary conduction portion of the cycle, when the high voltage rectifier becomes reversebiased, the secondary capacitances will ring with secondary stray and leakage inductances, and with reflected impedances from the primary. This ringing can continue during the entire primary conduction time. It will couple magnetically into the primary circuit; and will couple capacitively, via the capacitances of the high voltage rectifier's reverse-biased junctions, into the Capacitor Current Sense circuit.

2-33. CAPACITOR CURRENT SENSE CIRCUIT, (Figure 2-24)

Current from the HV Capacitor negative terminal, which flows during the time the rectifier in transformer T1 is forward- biased, flows to the transformer secondary through diode CR10. At that time U1 pins 11 and 14 are low, so that R13 serves to reduce the voltage that would otherwise be produced by R14 and R15. The CR10 diode voltage is then greater than the resulting voltage on U2A pin 3, so the output of U2A is open. R16 and the emitter follower Q2 then drive U1 pin 3 high, inhibiting the pulse width modulator output from going high. When current in the capacitor ceases, the voltage across CR10 becomes less than that at U2A pin 3, and the cycle hold-off signal at U1 pin 3 goes low. At that time the pulse width modulator output, U3 pins 11 and 14, will go high, which raises the voltage on U2A pin 3 by way of R13. During this time, some current will flow alternately in CR9 and CR10 due to the high voltage rectifier's capacitive coupling of transformer secondary ringing as described in the transformer/rectifier section above. The output of U2A will not toggle, however, because of the increased threshold on pin 3 during primary conduction.

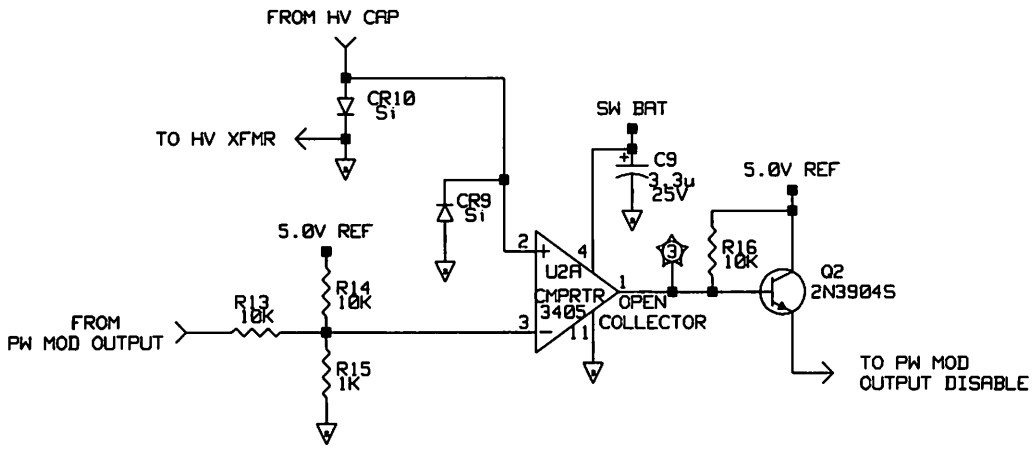


Figure 2-24. Capacitor Current Sense Circuit.

2-34. CAPACITOR VOLTAGE METERING CIRCUIT, (Figure 2-25)

Transformer T1 contains a resistor connected on one side to the high voltage rectifier cathode, which is at the HV capacitor voltage. The other side comes out of T1 on pin 5, and connects on the PC board to R17, which serves to divide the voltage down to a voltage under 5 volts. C10 filters any noise, and U2D buffers the voltage. CR11 protects U2D from any positive or negative spikes that may enter the board at that point, and R18 helps to maintain low impedance on the Vcap line. The capacitor voltage indication is sent to the Control Board for its use in determining the defibrillator's state of charge, and also to U1 pin 1, which will disable charging in the event that the capacitor voltage indication reaches an unacceptably high value of 5 volts.

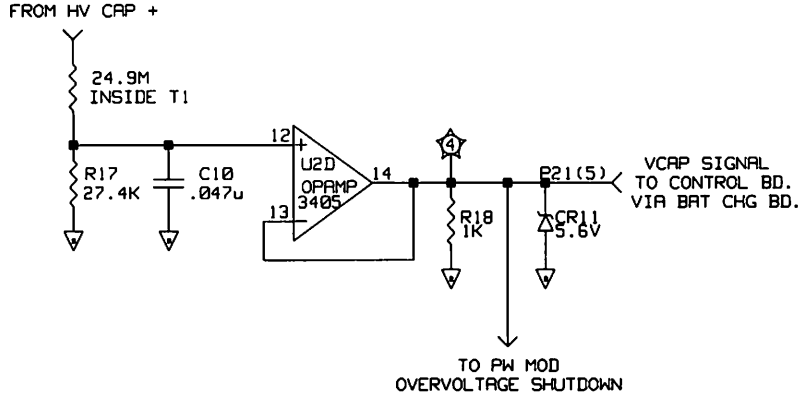


Figure 2-25. Capacitor Voltage Metering Circuit.

2-35. HIGH VOLTAGE CIRCUITRY

High Voltage Circuitry functions to store energy during defibrillator charging; and to switch, waveshape, and measure energy during defibrillator discharging. The patient is isolated from the High Voltage Charger Board and from the HV Capacitor at all times except during discharge; the charging circuit is isolated from the HV Capacitor and from the patient during discharge. A resistive load is provide for test discharges.

2-36. HV CAPACITOR CHARGE CIRCUIT, (Figure 2-26)

The HV Capacitor Charge Circuit is composed of the High Voltage Charger Board A5; the HV Capacitor A1C1; and the Patient Relay A1K1. The Defibrillator Charger Board supplies the energy needed to charge the HV Capacitor, and also supplies a shunt resistive load to dump charge when needed. The HV Capacitor includes a 24.9 megohm bleeder resistor as well, to preclude a buildup of charge when the High Voltage Charger Board is disconnected from the circuit. The Patient Relay is a double-pole, double-throw, high voltage, high surge current relay. The relaxed position of the relay is shown.

2-37. HV CAPACITOR DISCHARGE CIRCUIT (Figure 2-26)

The HV Capacitor discharge circuit is composed of the HV Capacitor A1C1; the Patient Relay A1K1; the HV Inductor A1L1; the Current Transformer A1T1; and the Test Load Resistor A1R1.

When the 12 ohm coil of the Patient Relay is supplied with current by the Battery Charger Board A4, the relay contacts A1K1a and A1K1b will switch from the normally closed position to the normally open position. The RF chokes included in the relay assembly help to suppress EMI from high-energy arcing of the contacts. The HV Inductor provides smoothing of the current waveform to meet specified parameters; in addition, its 11 ohms of winding resistance provides energy dissipation in the event that the defibrillator is discharged into a low external impedance. The Current Transformer divides the discharge current by a factor of 2500, for use by a peak detector on the Analog ECG Board A6. The Test Load Resistor is available between the paddles' pockets, for use in simulating a discharge into a 50 ohm patient.

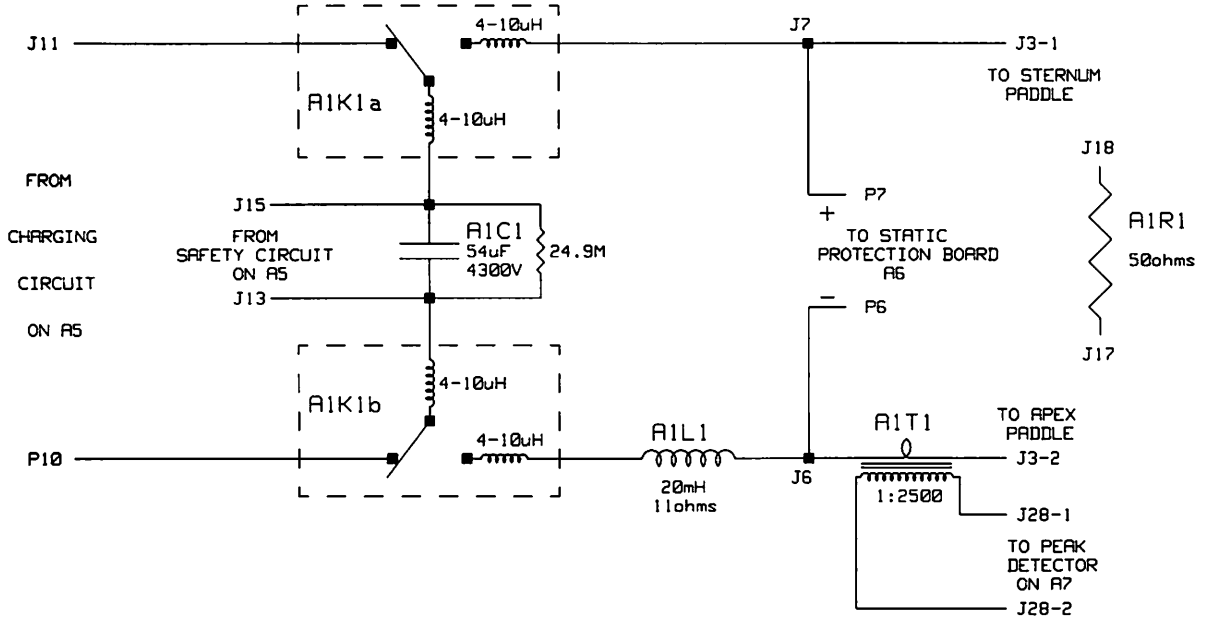


Figure 2-26. Capacitor Discharge Circuit.

2-38. STATIC PROTECTION BOARD

The static protection board provides a high resistance (low current) leakage path to ground. This path is necessary to bleed off any electric charge that builds up on the paddles due to the stray capacitance (approximately 600 pF) of the paddles cables. This charge could be due to electrostatic charge, and/or an open discharge of the instrument.

High voltage diodes CR1 and CR2 isolate this bleeder circuit from the paddle electrodes during the normal discharge sequence of the instrument. Refer to Figure 2-27.

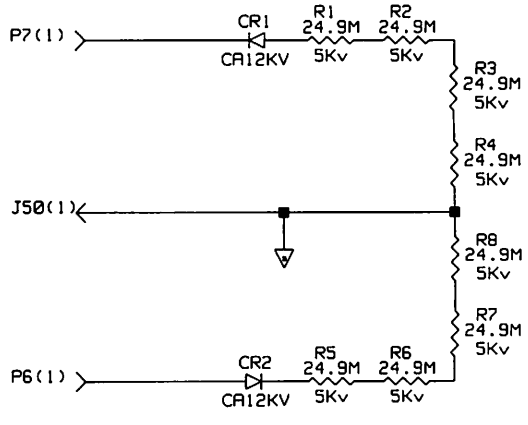


Figure 2-27. Static Protection Board.

2-39. BATTERY CHARGER BOARD AND LOW VOLTAGE POWER SUPPLIES

WARNING

HIGH CURRENT A.C. LINE VOLTAGE AND UP TO 300 V.D.C. ARE EXPOSED WHEN THE BATTERY CHARGER IS CONNECTED TO A.C. POWER, WITH POTENTIAL LETHAL SHOCK HAZARD! FOR EXAMPLE, THE PRIMARY (A.C.CIRCUITS) GROUND IS SUCH A SHOCK HAZARD WITH RESPECT TO SAFETY/SECONDARY CIRCUITS GROUND.

SEVERAL OF THE COMPONENTS, ESPECIALLY THE HEAT SINKS AND POWER RESISTORS, MAY BE HOT ENOUGH TO CAUSE BURNS IF TOUCHED, EVEN FOR A WHILE AFTER POWER IS OFF!

CAUTION

SINCE THE PRIMARY (A.C.CIRCUITS) GROUND IS AT HIGH VOLTAGE AND CURRENT WITH RESPECT TO GROUND, IT MUST NEVER BE CONNECTED TO ANY INSTRUMENT OR A.C. SAFETY GROUND WHEN CONNECTED TO A.C. POWER! IF GROUNDED, SUCH A CONNECTION WILL CAUSE SERIOUS DAMAGE TO THE BATTERY CHARGER CIRCUITS OR IF NOT, YOU MAY EXPOSE INSTRUMENT FRAMES TO LETHAL VOLTAGES. ANY CONTACT BETWEEN PRIMARY (A.C.CIRCUITS) AND SECONDARY (BATTERY/POWER SUPPLIES) GROUNDS WILL CAUSE SERIOUS DAMAGE TO COMPONENTS AND/OR CIRCUIT BOARD TRACES!

WHEN MAKING ACTIVATED PRIMARY CIRCUIT MEASUREMENTS OTHER THAN WITH RESPECT TO SAFETY GROUND EITHER USE A DIGITAL MULTIMETER WITH FULL FLOATING, 1000 VOLT RATED INPUT, OR A DUAL PROBE OSCILLOSCOPE OPERATED IN A DIFFERENTIAL INPUT MODE!

ANY CONNECTION WHICH CAUSES POWER FET Q1 TO CONDUCT WITHOUT OPERATION OF U1 DUTY CYCLE OR CURRENT LIMIT PROTECT CIRCUITRY WILL CAUSE Q1 TO SHORT, POSSIBLY DAMAGING R2, Q2, CR8, CR50 AND PERHAPS OTHER COMPONENTS.

Line voltage is converted to a constant voltage charging source for the unit's battery with a forward-converter switching power supply. An input line filter isolates switching noise from the power cord. This supply is factory strapped for either 110 or 220 VAC.

Battery power is connected directly to the High Voltage Charger board and clock and through a circuit breaker and low battery shutdown to other circuits.

A combination of linear and switching power supplies create the +5V, +8V, and −4.4V regulated outputs. Circuits on this board power the battery charge LED and drive the safety and patients relay coils.

2-40. BLOCK DIAGRAM

Figure 2-28. is provided as a schematic flowchart, showing the power flow and interconnects for the several schematic sections discussed separately below.

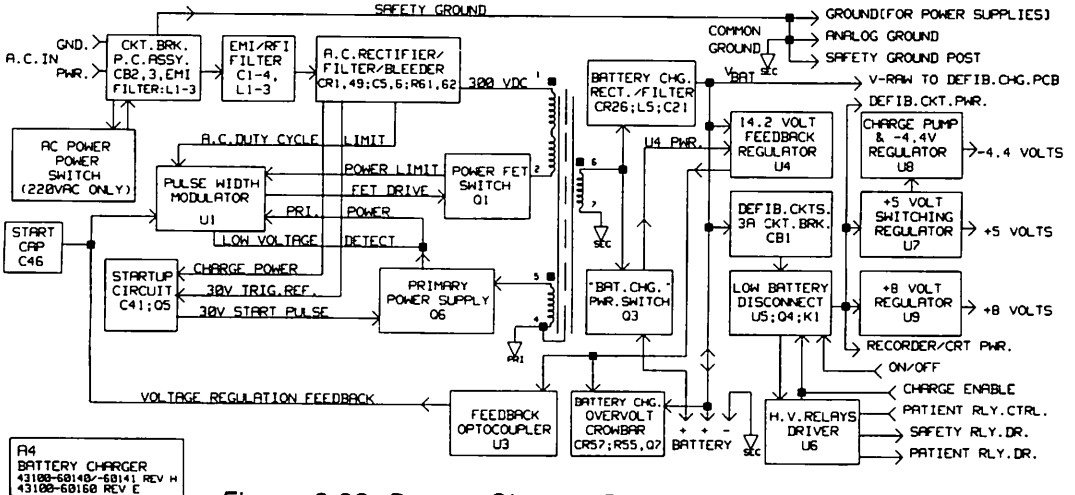


Figure 2-28. Battery Charger Block Diagram.

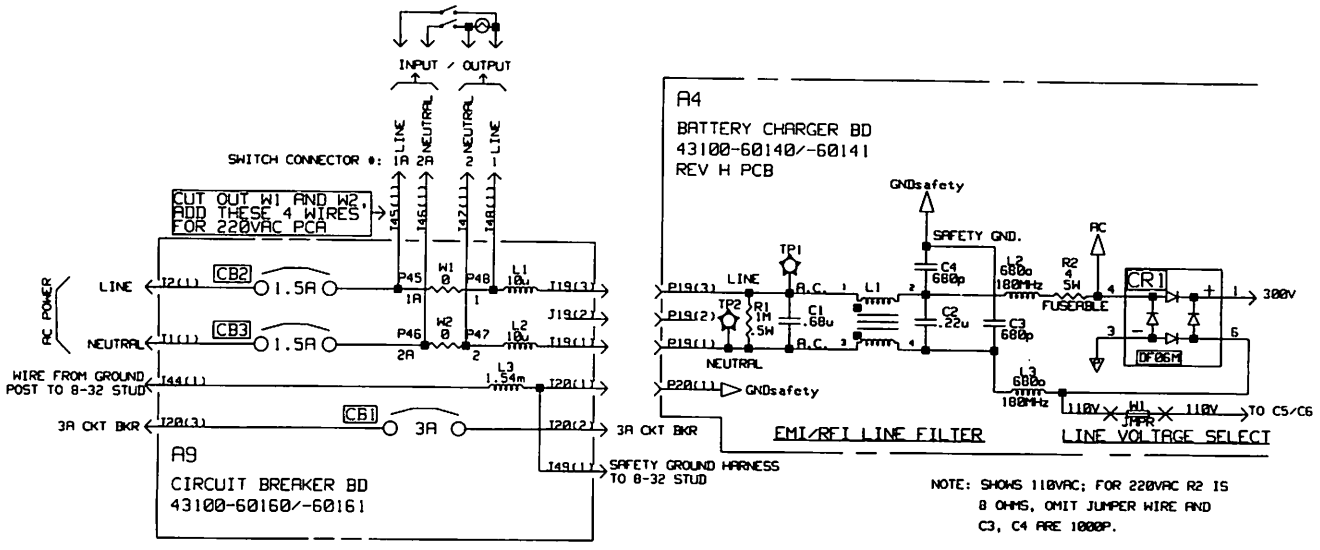


Figure 2-29. Power Input/Ground/Protect/Line Filter Circuit.

2-40. POWER INPUT/GROUND/PROTECT/ LINE FILTER CIRCUIT, (Figure 2-28)

The power cord line and neutral connect to the Circuit Breaker Board, sending AC power through the circuit breakers and EMI suppression inductors L1 and L2: (a) directly to the battery charger in the 110 VAC model, or (b) through the ON/OFF DPST power switch in the 220 VAC model. The power cord safety ground connects to the ground post, which then connects through EMI inductor L3 on the Circuit Breaker Board to the battery charger EMI filter ground and the DC power supply (secondary) ground, plus the green/yellow safety ground wire leading to the: (a)recorder frame, (b)ECG output jack and (c)volume adjust potentiometer frame.

A line filter attenuates conducted EMI/RFI from the switching power supplies and digital circuitry, to conform to FCC and VDE standards. L1, C1 and C2 form a common-mode filter, while C3 and C4 provide the differential-mode filtering. The capacity-to-ground of the power cord, C3 and C4 are limited to keep leakage current under the safety standard limit. R1 is a safety bleeder for C1 and C2. A metal enclosure surrounds the off-line switching power supply circuits and serves also in confining EMI/RFI.

2-41. AC RECTIFIER/FILTER CIRCUIT

This is a standard 110/220 VAC "off-line" circuit. For 110 VAC, jumper W1 utilizes rectifier CR1 and filter capacitors C5 and C6 as a voltage doubler. For 220 VAC with jumper W1 out, C5 and C6 are charged in series, for the same nominal 300 VDC. R2 (4 ohms/110VAC or 8 ohms/220VAC) limits inrush current through CR1, C5 and C6 and is fuseable at currents well above normal circuit breaker trip ratings, but such that a short in CR1 or Q1 will blow R2 in a time short enough to limit damage to other circuit components.

Bleeder resistors R61 and R61 plus Zener CR49 set the midpoint voltage of C5 and C6 and provide the 30 volt start capacitor reference voltage to PUT Q5.

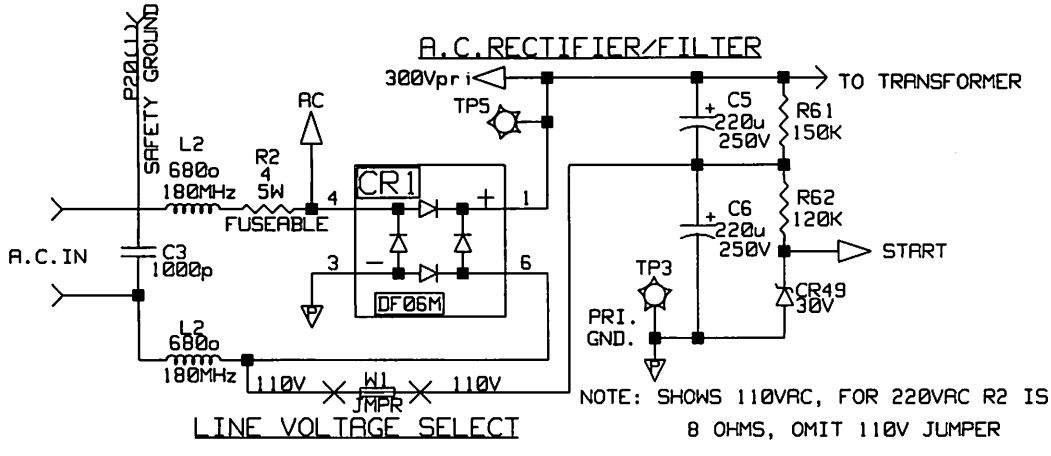


Figure 2-30. AC Rectifier/Filter Circuit.

2-43. PULSE-WIDTH MODULATOR CONTROL CIRCUIT, (Figures 2-31 and 2-32)

U1 is an off-line switcher Pulse-Width Modulator (PWM) I.C. The ERROR AMPLIFIERS give ON-OFF control: OFF if pin 2 is more positive than pin 1 or pin 14 more positive than pin 13. The duty cycle reduces from 100% to 0% when either pin 4 changes from nominal 0 to 2.8 VDC or pin 3 changes from nominal 0.7 to 3.5 VDC.
The LOW VOLTAGE DETECT (CR15, R22, and 5V ref) turns U1 OFF if FET Q1 gate drive drops below about 8.6 VDC, where unsaturated drive could cause Q1 overheating.

POWER LIMIT is used to limit Battery Charger current to the battery, etc. Current through Q1 is sensed by CVR R9. The peak voltage on R9 is reflected across CR69 and held by C9 (R8 is a bleeder). This peak voltage is compared with a threshold set by R19 and R20 to limit the maximum battery charger current to a nominal 3 amperes. C15 and R21 provide feedback stabilization in this mode.

FEEDBACK pin 3 is used for: (a)Startup, as C46 charges up, (b)safety turn-off (if Optocoupler U3 output transistor open circuits, V-REF pulls up pin 3 to 4.4 VDC) and (c)output voltage regulation, via U3 (unless Power Limit takes over).

The DUTY CYCLE LIMIT, pin 4, normally operates below a controlling level, with with FEEDBACK, pin 3, limiting the duty cycle. At pin 4 the DC set point combines a sample of the 5V reference, C5 plus C6 voltage and ground currents (through R14, R13 and R15). This permits higher duty cycles at low A.C. line voltage, since longer Q1 ON times are required to provide the same energy transfer. R12 and C13 provide soft start by momentarily raising the voltage at pin 4. The Nominal U1 oscillator frequency is 42 kHz. This is set by C14, R16, R17 and R18. R17 and R18 sample the A.C. line voltage to modulate the 42 kHz at the line frequency rate.

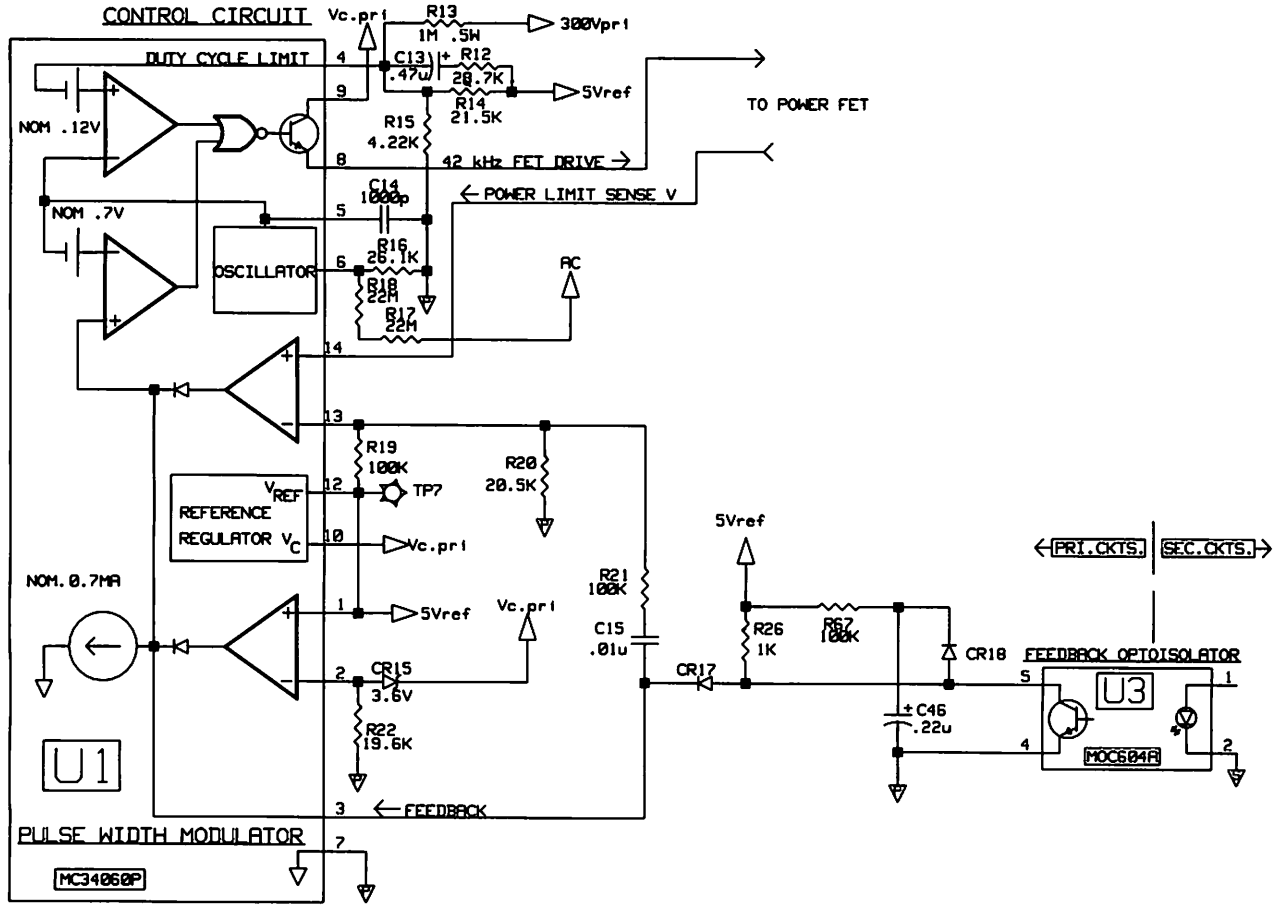


Figure 2-31. Pulse-Width Modulator Control Circuit.

2-44. POWER FET/TRANSFORMER SWITCHING CIRCUIT, (Figure 2-32)

PWM U1 output drive, pin 8, is adequate to directly drive power FET Q1 ON, but needs a pull-down circuit (Q2, CR8 and R7) for rapid turn OFF. CR8 provides gate and CR4-6 drain-source protection for Q1. R9 is a current-viewing resistor and C10 a high frequency clamp.

Q1 is the power switch in this forward-converter power supply, with T1 having one winding (pins 3-4) for added primary circuit power plus an isolated winding (pins 6-7) to provide power for charging the battery.

CR1, R1 and C7 form the primary snubber, reducing component stress and EMI generation when Q1 turns OFF.

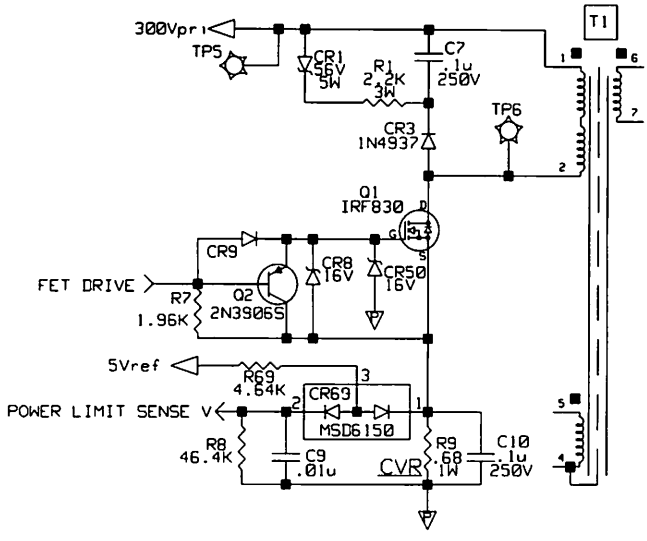


Figure 2-32. Power FET/Transformer Switching Circuit.

2-45. STARTUP AND PRIMARY CIRCUIT POWER SUPPLY, (Figure 2-33)

It is necessary to provide power to U1 circuits at above 8.6 VDC to start up the battery charger switching operation. C41 is charged through R72 and R71. Once C41 reaches 30 VDC, PUT Q5 discharges C41 through Q6, charging C44 and C43 high enough to initiate the U1 startup. Within milliseconds, PUT Q5 will reset and C41 will begin to recharge. The junction of R72 and R71 is clamped to 100V by CR68 to guarantee that Q5 will reset.

With the gate of Q6 clamped to 18V by CR55, the primary voltage is limited nominally to 12 to 15 volts.

Switching power flow through transformer T1 then provides a steady flow of AC to CR54, with CR55 activating the Q6 gate for a nominal 15VDC Vc-pri. voltage.

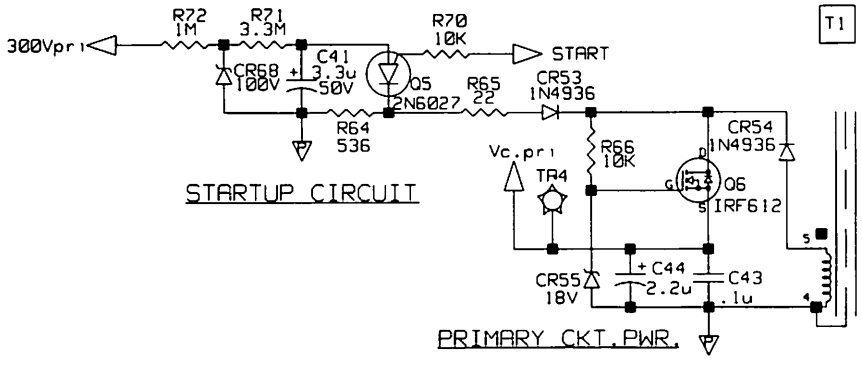


Figure 2-33. Startup Circuit and Primary Circuit Power Supply.

2-46. SECONDARY RECTIFIER/FILTER CIRCUITS, (Figure 2-34).

This is a switching, forward converter battery charger. L5 is the swinging inductor; CR26, the forward and catch diodes; and C21, the filter capacitor. The battery is directly connected in parallel with C21.

U10A and associated components regulate voltage. If not current limited, the battery charging voltage is set by this stage. U10 is a CMOS op amp and is powered through CR72 and R87. R80 is an additional pull-up for U10A. The op amp controls the LED current in U3 through the MOSFET source follower (Q9). U3, then returns an analog signal to the PWM for feedback. Micropower zener U11 and voltage divider R77 and R78 set the regulation at 14.60V. R79 and C48 turn U10A into an integrator/low pass filter, which is necessary for compensating the entire voltage regulation loop. C52, C53, and C55 are bypass caps.

Whenever there's swicthing action on T1, Q3 is turned on via the charge pump (C22, 23; CR28, 29; R33, 34, 88, 89). When Q3 is on, it does three things. It provides LED current for U3 opto-LED. It turns on the front panel BAT CHG LED. It disengages a normally closed relay in the CRT filament circuit (on the CRT deflection board) to prevent overheating. When T1 is absent of switching action, Q3 turns off to conserve power.

If the output (Vbat) is excessively loaded down or shorted, the feedback which requests power from the primary is cutoff because the power pin of U10 is 5.6V (CR72) below Vbat. Conversely, if the regulation stage fails to regulate and Vbat goes above the intended set-point, the CROWBAR circuit comprised of CR57, R55, C49, and Q7 will 'steal' the opto-LED current and shut down the primary circuit. This is momentary because Q5 fires periodically. (See Section 2-46 for operation of Q5.) CR77 insures that when Q7 is conducting, there will be minimal current for the LED.

2-47. LOW BATTERY SHUTDOWN CIRCUIT, (Figure 2-35).

The battery, Vbat, is connected (a) directly to the Defibrillator Charger Board (j21, pin 1) and the float charge regulator circuit (fig 2-34), (b) to this LOW BATTERY SHUTDOWN circuit through 3A circuit breaker CB1 on the Circuit Breaker Board (fig 2- 35), and (c) after CB1 to the other parts of the instrument via relay K1. To activate K1, the front panel ON/OFF switch must pull J22 pin 11 LOW to ground and U 10B output must be HIGH.

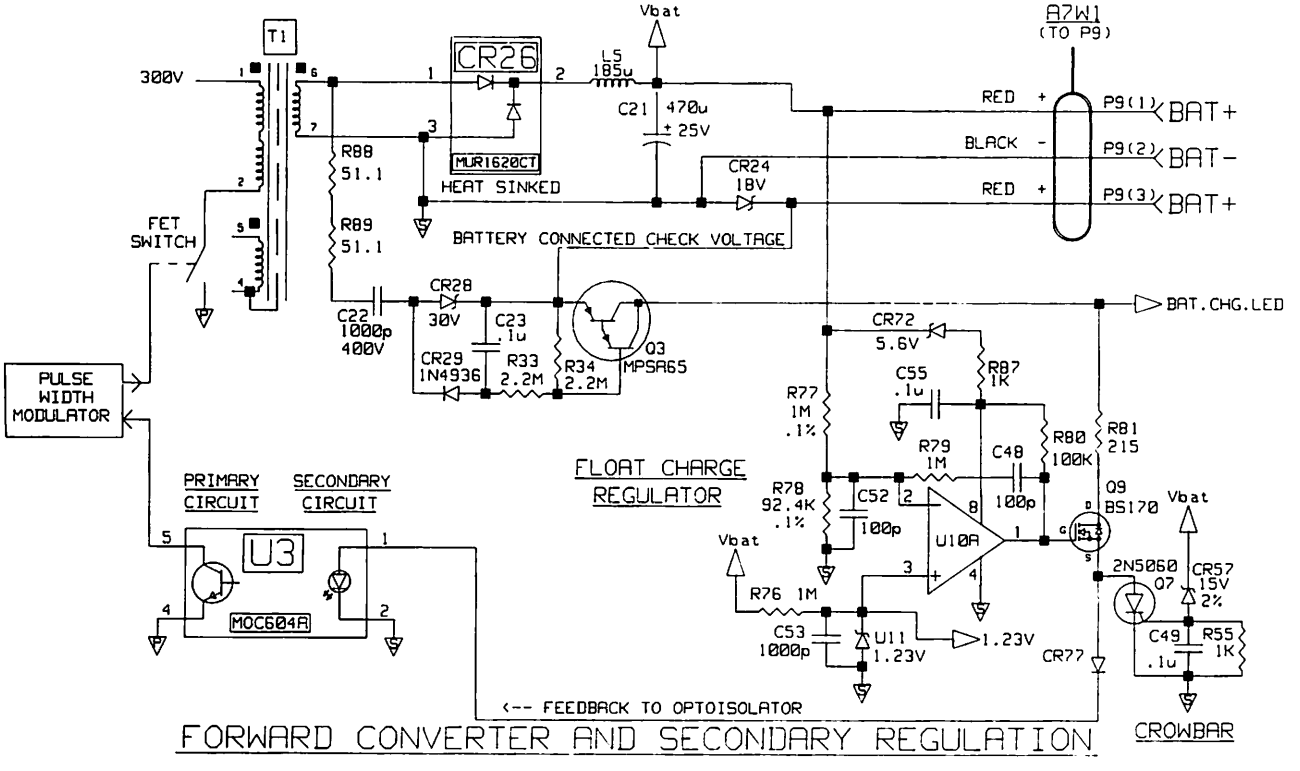
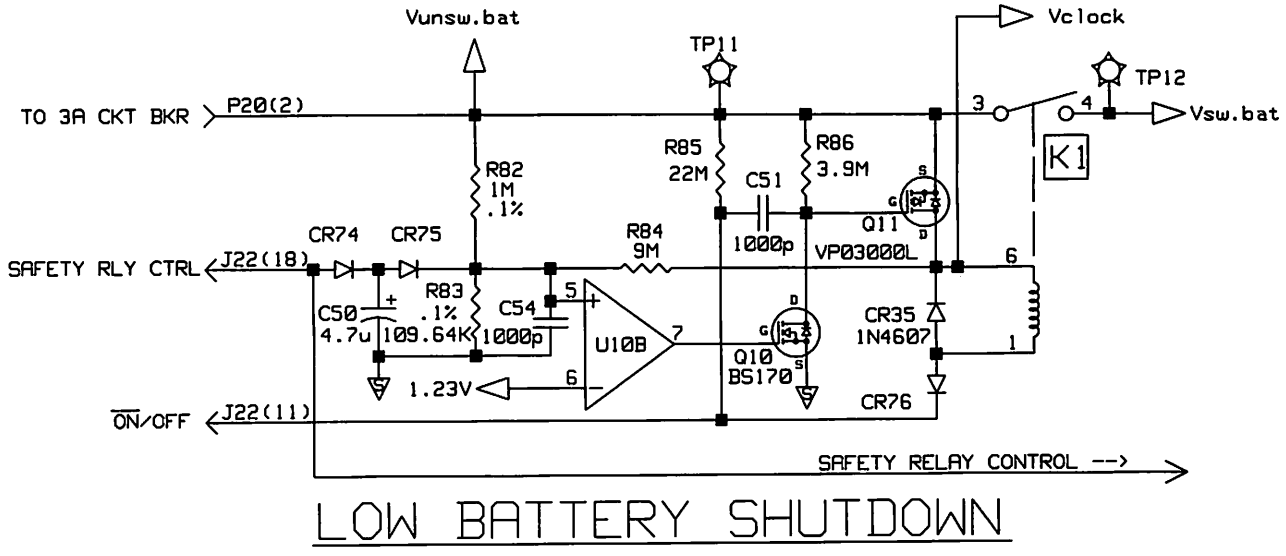


Figure 2-34. Forward Converter and Secondary Regulator.

U10B is configured as a comparator with hysteresis. R82-84 set the ON/OFF voltages (Vunsw.bat) at 11.37V/12.64V. The output of U10B controls the relay K1 through two inverting stages Q10 and Q11. After a SHUTDOWN incident, the instrument may be turned ON again briefly by turning the front panel switch OFF and then back ON. When the front paneel switch is OFF, J22, pin 11 is disconnected from ground and C51 will discharge through R85 and R86. When turned ON again, the ensuing transient will pull the GATE of Q11 low through C51 and U10B is latched high, even if the 12.64V hysteresis requirement is not met.

When Q11 is ON, power is supplied to the instrument's REAL TIME CLOCK (Vclock). If Q11 is OFF for more than a few minutes, the clock loses its power and content and must be re-set. (There's a backup cap that sustains the clock for temporary battery disconnections, for example, for battery replacement.) While Q11 is OFF, R84 is not pulled HIGH through R85 due to the blocking action of CR76. Q11 comes back ON when the battery charger is connected to AC line and Vunsw.bat comes up again.

Whenever SAFETY RLY CTRL is HIGH (SAFETY RELAY opens), there can be an extra load on the battery due to the defibrillator HV charger, and the battery voltage may be depressed. At these times, through CR74 and CR75, the noninverting input of U10B is held HIGH, preventing SHUTDOWN. After SAFETY RLY CTRL returns LOW again, C50 continues to hold off the SHUTDOWN function briefly, allowing time for battery chemistry (and voltage) to recover.



LOW BATTERY SHUTDOWN

Figure 2-35. Low Battery Shutdown Circuit.

2-48. REGULATED POWER SUPPLIES, (Figure 2-36)

The +8 volts is regulated by U9, a 5% linear regulator connected to the switched battery line. A switching regulator provides the higher current needed for the +5 volt supply. U7 is a 1.5 amp peak output switching I.C., with L6 and C31 the step-down components. U7 reference spec and precision divider resistors R47 and R48 maintain the 6% reference accuracy. R46 limits the output current to about one ampere maximum. The +5 volt surges are limited by CR43.

C33, CR38, CR39 and C34 form a charge pump, giving a negative voltage. CR40, R50, R51 and U8 form a −4.4 volt linear regulator circuit with about 6% accuracy. Current limiting is inherent in both U8 and U9. The Nominal U7 oscillator frequency is 45 kHz. This is set by C30 and R53.

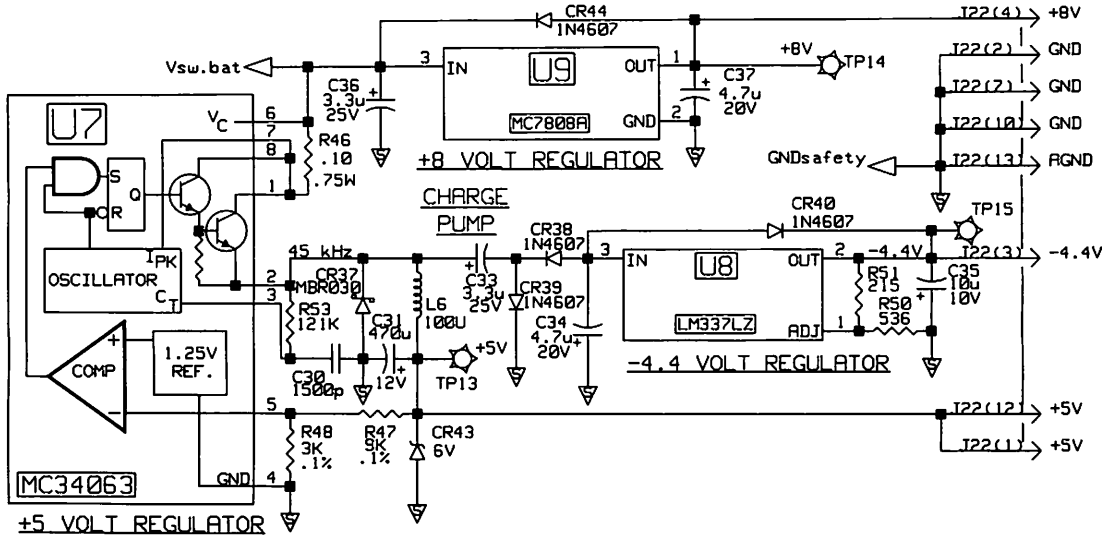


Figure 2-36. Regulated Power Supplies.

2-49. PATIENT/SAFETY RELAY DRIVE CIRCUITS, (Figure 2-37)

U6 is a 1.5 amp., dual-Darlington driver with integral snubber diodes. Transistor pins 2, 3 and 4 drive the patient relay coil, while pins 5, 6 and 7 drive the safety relay coil.

The High Voltage Charger Board receives command signals from the Control Board, and charges the HV Capacitor. The High Voltage Charger Board returns to the Control Board a scaled-down representation of the HV Capacitor voltage; the Control Board uses the information to alter charge commands as necessary. The High Voltage Charger Board also responds to safety relay control, originating on the Control Board and arriving via a relay driver which is on the Battery Charger Board. Closure of the normally closed relay will discharge the HV Capacitor with a 2.5 second time constant.

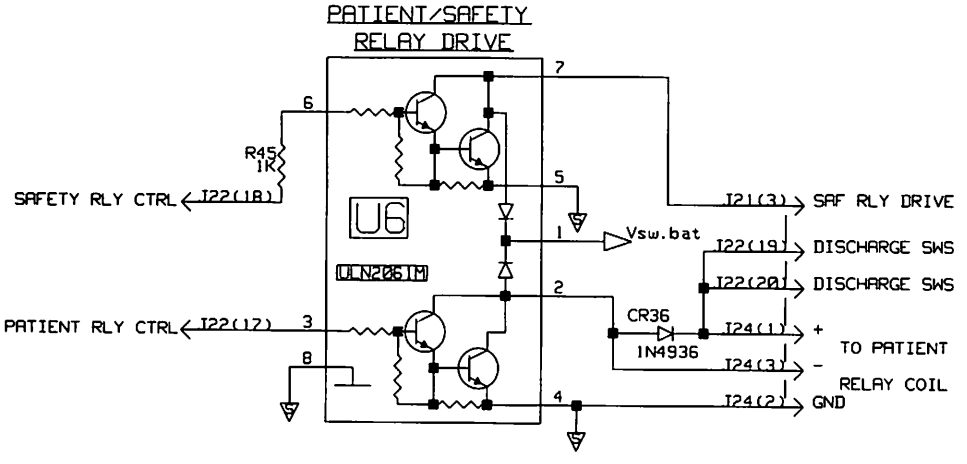


Figure 2-37. Patient/Safety Relay Drive Circuits.

NOTES

A. INSTRUMENT MODES

3-1. SERVICE MODE:

1. Turn unit off for 5 seconds.
2. Press and hold the SYNC button.
3. Turn the ENERGY SELECT knob on to the MONITOR position.
4. Release the SYNC button after about one second. (The alternately flashing HP/888 will end prematurely.)
5. Battery voltage should be flashing with 3 decimal points.
6. To exit service mode turn unit off, or discharge with the paddles out of the pockets.

3-2. READ BATTERY VOLTAGE:

1. Place the unit into Service Mode.
2. Battery voltage should be flashing on the energy display with 3 decimal points (i.e. 14.2 volts would be indicated by 1.4.2. flashing on the display).

NOTE

Unit plugged in and battery charger working normally ~14.2v
Unit not plugged in and battery fully charged ~13v
Low battery warning message comes on ~11.8v
Low battery shutdown ~11.2v

B. LEVEL II PERFORMANCE CHECKS

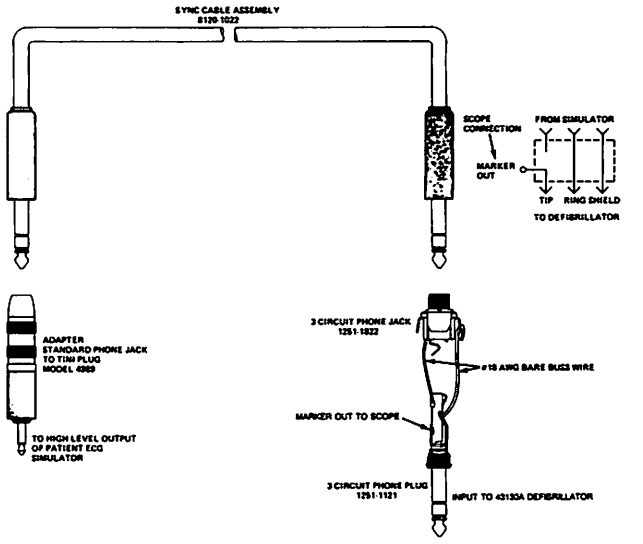
Perform these checks every six months. For best results, use the equipment recommended. Record the defibrillator serial number and the date the checks were performed.

3-3. TEST EQUIPMENT

Test equipment required for performing the level II performance, safety and maintenance checks is listed in Table 3-1. Table 3-2. lists the equipment necessary if the Dempsey model 431F safety analyzer is not used. Test equipment characteristics and a recommended commercial model are included. If the recommended model is not available, select another with similar characteristics and capabilities.

WARNING

LETHAL VOLTAGES ARE PRESENT INSIDE THE DEFIBRILLATOR AND ARE EXPOSED WHEN THE DEFIBRILLATOR COVERS ARE REMOVED. DO NOT WORK INSIDE THE INSTRUMENT WHEN POWER IS APPLIED OR IF DEFIBRILLATOR IS CHARGED.



ITEM	MFG. or SUPPLIER	MODEL or PART NO.
Adapter, Std. Phone jack to TINI Plug	Pomona Electronics, Div. I.T.T.	Model 4989
3 circuit Phone Jack	Hewlett-Packard	HP P/N 1251-1822
3 Circuit Phone Plug PJ-05/(W/E 310)	Hewlett-Packard	HP P/N 1251-1121
Sync. Cable Assembly	Hewlett-Packard	P/N 8120-1022

Figure 3-1. Sync Cable Assembly.

Table 3-1. Required Test Equipment for Performance, Safety and Maintenance Tests.

REQUIRED TEST EQUIPMENT FOR LEVEL II PERFORMANCE, SAFETY, and MAINTENANCE TESTS	
DIGITAL VOLTMETER Recommend: HP 3466A	Capable of 5 to 15 V DC +/– 1% measurements
OHMMETER HP 3466A	Capable of 0.1 to 10 ohm +/– 2% measurements
ENERGY METER Recommend: Dempsey Model 429	Capable of 5 to 400 Joule, critically damped sinusoidal waveform measurements with +/– 2% of full scale accuracy. Load resistance 50 ohm +/– 0.5%.
STOPWATCH OR TIMER	Capable of measuring 2 to 12 second events with hand start/ stop actuation to 1/4 sec. accuracy
PATIENT ECG SIMULATOR Recommend: Parke-Davis 3175 Dynatech Nevada 212B	Output Level: High level CAL or ECG .5 to 5 volts outputs.
TEST CABLES AND COMPONENTS (1) Marker to discharge delay test setup	See Figure 3-1.
SAFETY ANALYZER Recommend: Dempsey Model 431F	See Table 3-2. or substitute equipment

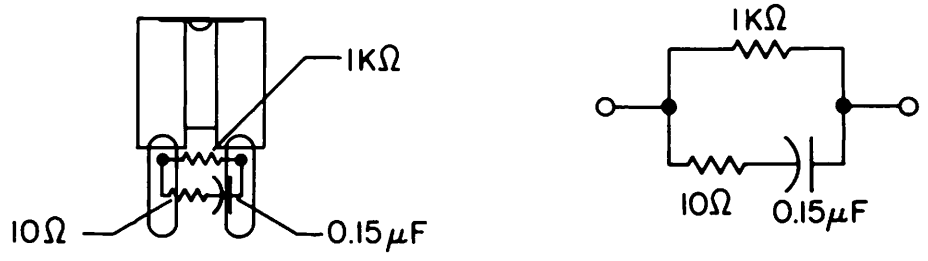
Table 3-2. Equipment Necessary if the Dempsey Model 431F Safety Analyzer is not used.

EQUIPMENT NECESSARY IF THE DEMPSEY MODEL 431F SAFETY ANALYZER IS NOT USED

REQUIREMENT	NECESSARY QUALIFICATIONS
DIGITAL VOLTMETER Recommend: HP 3466A	Capable of 10 μV DC +/– 0.5% measurements
2 to 3 WIRE AC PLUG ADAPTOR HP 1251-1852	Must have ground wire pig-tail
TEST PLUG FOR 120 VAC SOURCE HP 04655-60100	1 MΩ resistor in hot lead

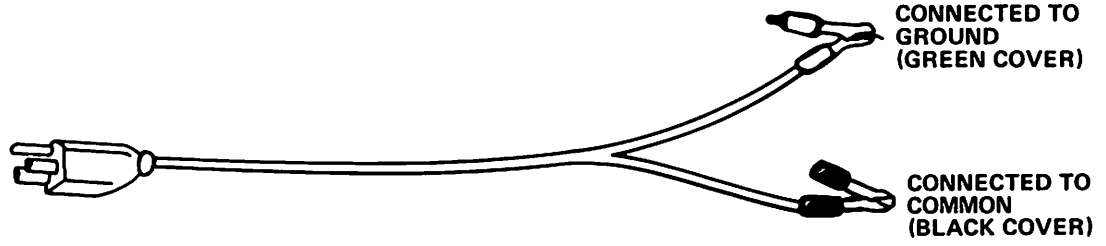
CURRENT METERING NETWORK	HP 1251-1284 HP 0757-0159 HP 0757-0984 HP 0160-3238	Dual Banna Plug 1 KΩ 1% Reisitor 10KΩ 1 % Resistor 0.15 μF Capacitor

CONNECTED AS FOLLOWS:



Ground Test Cable	HP 1251-3133 HP 8120-0022 (2) H. H. Smith, 331	NEMA Male Plug Cable, 6 feet required Alligator Clip, 1 green, 1 black

CONNECTED AS FOLLOWS:



3-4. ENERGY ACCURACY

Connect the Equipment as shown in Figure 3-2.

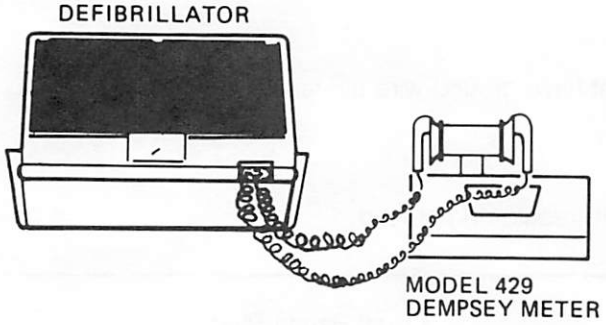


Figure 3-2. Energy Accuracy Test Setup.

With the instrument in service mode (See Section 3-1.), set the ENERGY SELECT knob to each of the positions indicated in the table below; press the CHARGE button and allow the unit to charge. The CHARGE DONE tone will sound and the CHARGE DONE indicator on the Apex paddle and on the display panel will light when the unit is ready to discharge. Firmly press the paddles to the energy meter and press both DISCHARGE buttons simultaneously. Record the energy levels measured.

Compare the delivered energy levels indicated on the Dempsey with the information below.

Table 3-3. Delivered Energy Accuracy.

Energy Selected	Delivered Energy (Joules)
2	1 - 3
3	2 - 4
5	4 - 6
7	5 - 9
10	8 - 12
20	16 - 24
30	26 - 34
20	43 - 57
70	60 - 80
100	85 - 115
150	127 - 172
200	170 - 230
300	255 - 345
360	306 - 414

3-5. SELF-TESTING ACCURACY

1. Make sure the paddles and the paddle contacts in the storage pockets are clean and free of contaminants. This is to assure good electrical contact and prevent paddle surface damage during discharge.

2. Place the paddles firmly in their storage positions. Apex on the right side and Sternum on the left.

3. Turn the unit on in service mode (See section 3-1.)

4. Select 100J with the ENERGY SELECT knob. Charge and discharge the unit.

5. The test energy should flash on the display 3 times (90-110 Joules).

6. Repeat at 360J for results of 324-396 Joules.

3-6. DEFIBRILLATOR CAPACITOR CHARGE TIME

Place the instrument in the service mode (See Section 3-1.) and unplug the unit from AC power. Read the battery voltage (See Section 3-2.). If the battery is above 12.3 volts proceed, otherwise allow it to charge fully by plugging into an AC outlet for 8 hours or more.
Set the energy to 360 Joules and press the CHARGE button. The CHARGE DONE tone should indicate charge completion in less than ten seconds.

3-7. SYNCHRONIZER

1. Set the ENERGY SELECT switch to 20 Joules, and press the SYNC/DEFIB button to enter the Sync mode. The SYNC LED should light on the display panel, and blink off each time a high-level ECG is detected or sync pulse received.

2. Place the paddles in their storage pockets.

3. Press CHARGE on the Apex paddle to charge the unit. The charge is done when the CHARGE DONE tone turns on and the CHARGE DONE LEDs on the Apex paddle and the display panel light.

4. Press both DISCHARGE buttons simultaneously. The unit should not discharge.

5. Connect a signal source (for example, the CAL or HIGH-LEVEL output of a Patient ECG Simulator) to the SYNC/ECG input of the 43130A. The signal source should have a .5 to 5 volt amplitude; the wave shape is not critical.

6. Charge the unit to 20 Joules again.

7. Press and hold both DISCHARGE buttons. The unit should discharge in synchronization with the input signal from the Patient ECG simulator.

C. SAFETY AND MAINTENANCE CHECKS

These checks should normally be performed every six months or after a major repair.

NOTE

Make these initial checks before performing the safety tests

1. Check that paddle electrodes are in good condition, clean and not pitted. Remember to check pediatric electrodes as well as the adult adapters. Check for obvious cracks (small chips, gouges and scratches are acceptable and will not affect instrument performance). Check cable strain reliefs for cracks or other signs of deterioration at the paddles.

2. Check that the CHARGE button will initiate charge and DISCHARGE buttons function when the cables are stretched to their full length. Check that discharge only occurs when both buttons are simultaneously pressed.

3-8. POWER CORD TO CHASSIS GROUND RESISTANCE CHECK

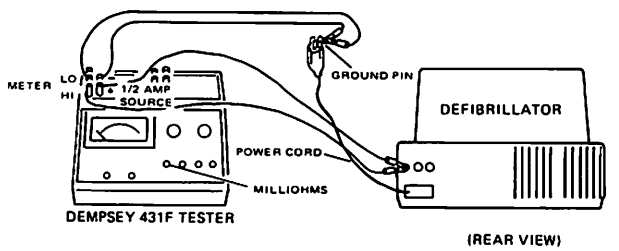


Figure 3-3. Power Cord to Chassis Ground Resistance Check

1. Set the test equipment up for the test as shown in Figure 3-3. If the Dempsey 431F is not available, use a conventional ohmmeter.

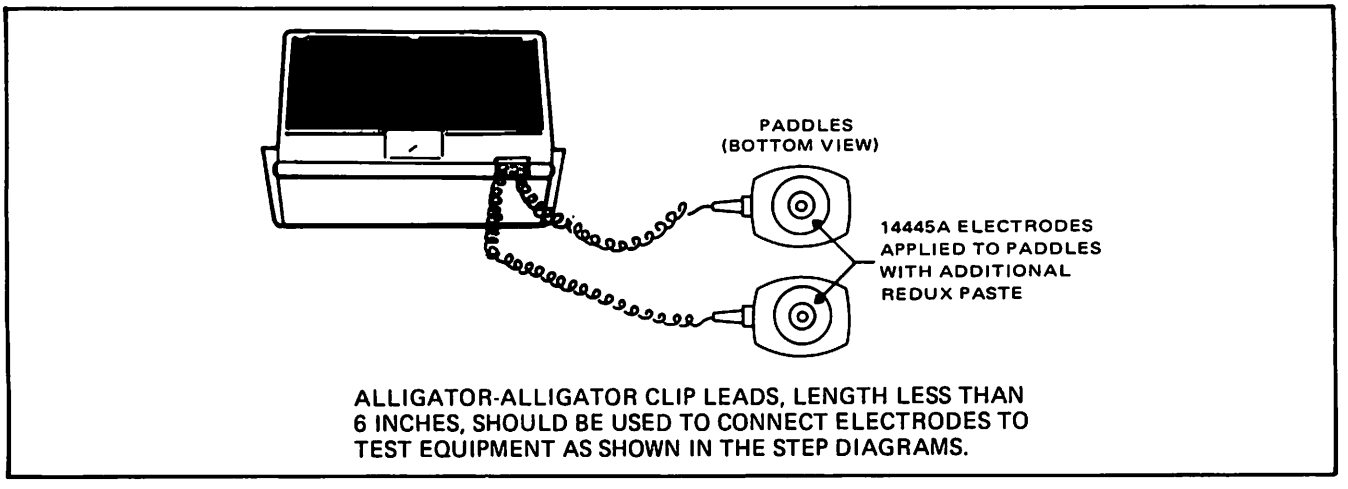
2. Connect the dual banana plug of a Kelvin Kable between the LO meter terminal of the Dempsey and the – (negative) terminal of the½ amp source on the Dempsey.

3. Connect the clip on the other end of the Kable to the ground pin of the male power connector.

4. Connect the dual banana plug of the second Kelvin Kable between HI terminal of the meter section and the + (positive) terminal of the ½ amp source.

5. Connect the clip on the other end to a banana/banana cable inserted in the external ground jack on the rear of the defibrillator.

6. Press MILLIOHMS and read the resistance on the current ranges. The test limit is less than or equal to 0.20 ohms.



Test Connections to Paddles.

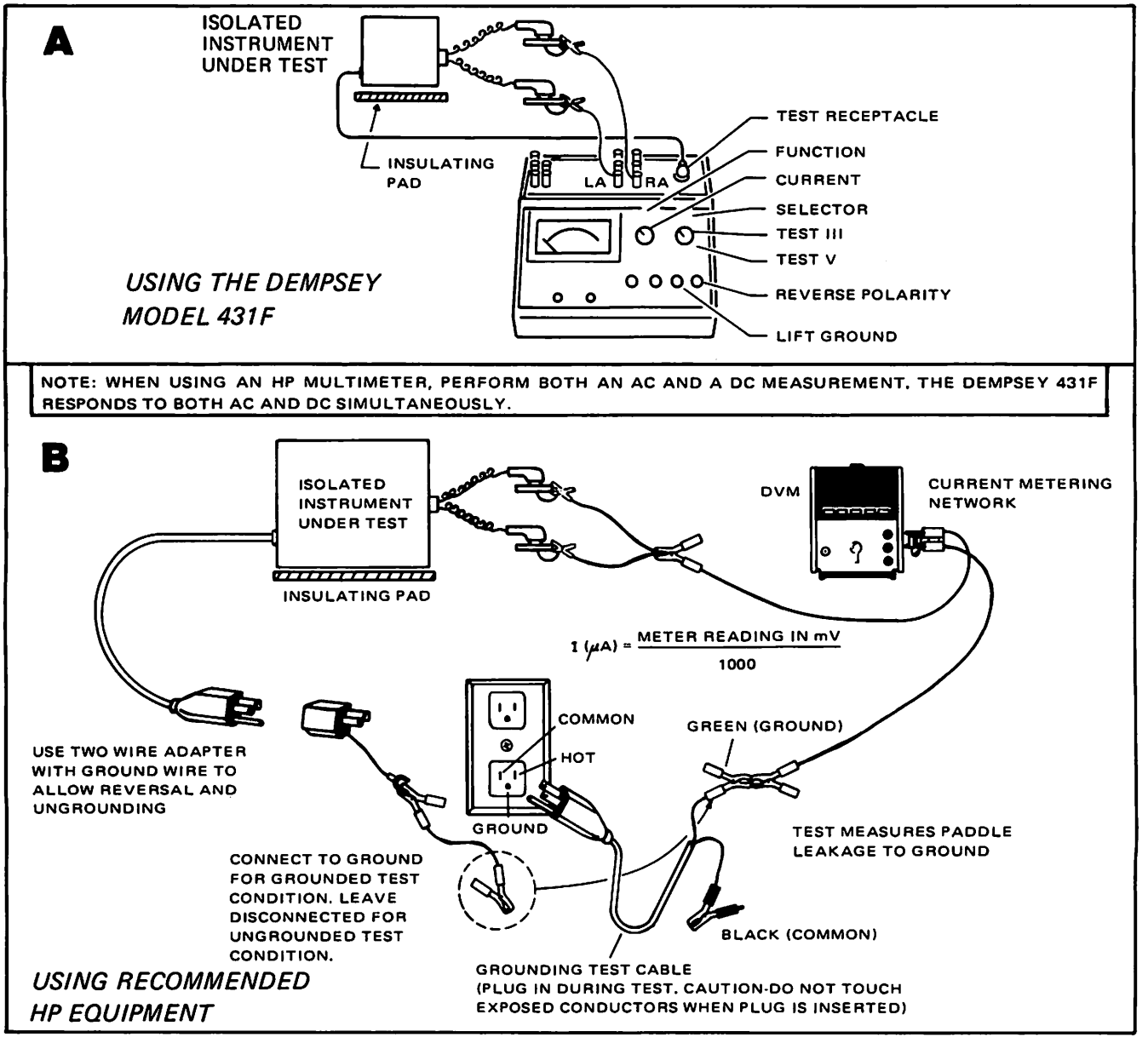


Figure 3-4. Paddle Leakage Current to Ground.

3-9. PADDLE LEAKAGE CURRENT (SOURCE LEAKAGE) TO GROUND

Perform the check as follows:

1. Connect the test equipment as shown in Figure 3-4.

2. Set the Dempsey FUNCTION switch to CURRENT. (Set the SELECTOR switch to either RA or LA to test either paddle. For paddle-to-paddle checks, ground either paddle and test the other.)

3. Measure paddle source leakage to ground for each paddle individually. Current should be no more than 100 μA for external paddles and 50 μA for internal paddles from paddle to ground.

4. Perform the same test under each of the following conditions with the power ON and OFF.

WARNING
MAKE ALL PADDLE TEST CONNECTIONS BEFORE PERFORMING FIFTH CHECK (live paddles). KEEP PADDLES SEPARATED AND ON INSULATED PAD DURING TEST.

a. Chassis grounded, standard power polarity.
b. Chassis grounded, reverse power polarity.
c. Chassis ungrounded, standard power polarity.
d. Chassis ungrounded, reverse power polarity.
e. Defibrillator charged to 360J. (see warning above)
f. Defibrillator discharged by turning power switch off with energy control.
DO NOT PRESS DISCHARGE BUTTONS

3-10. PADDLE LEAKAGE CURRENT (SINK CURRENT) WITH 115 VOLTS APPLIED

Perform the check as follows:

1. Connect the test equipment as shown in Figure 3-5A or B. If the Dempsey 431F is used, also follow the instructions included in that portion of the figure. Use clip leads to connect the right paddle to the RA output of the Dempsey and the left paddle to the LA output.

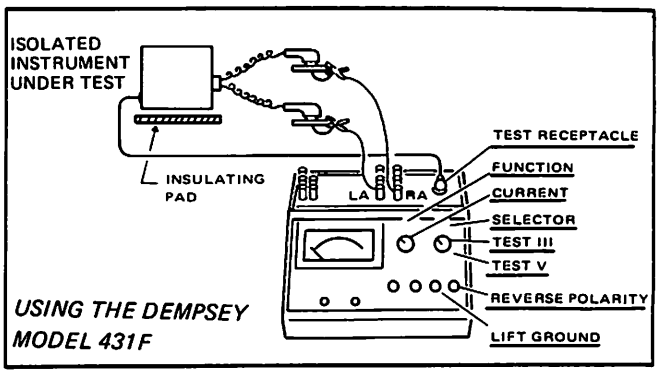


Figure 3-5A. Paddle Leakage Current (Sink Current) with 115 Volts Applied.

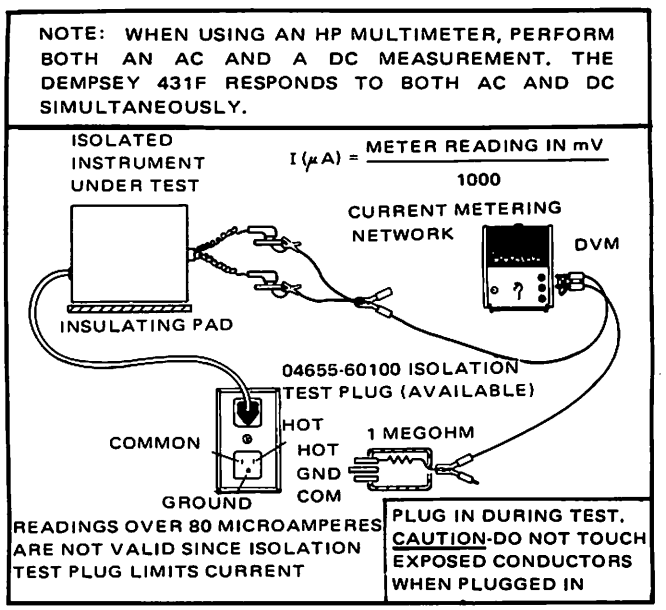


Figure 3-5B. Paddle Leakage Current (Sink Current) with 115 Volts Applied.

2. Set Dempsey FUNCTION switch to CURRENT.

3. Press the red 115 V test button under each of the following conditions with the power ON and OFF. Current should be no more than 100 μA for external paddles and 50 μA for internal paddles.

CONDITIONS:

a. Chassis grounded, standard power polarity.
b. Chassis grounded, reverse power supply.

D. ADJUSTMENTS

Internal adjustments are made at the factory and normally do not require attention. If assemblies are repaired or replaced, however, check and adjust as necessary.

All test equipment necessary to make the adjustments is listed in each Adjustment Procedure.

The instrument case must be opened to gain access to the adjustment controls. Refer to Section IV.

3-11. DEFIBRILLATOR OUTPUT ENERGY CALIBRATION

This is for adjustment of the output energy on discharge. Adjustment location is on the Control Board 43130-60200 (A7).

Equipment Required:

Energy Meter Recommend Dempsey 429/428A,B	Capable of 2 to 400 Joule measurement with critically damped sinusoidal waveform. Accuracy +/−2% of full scale Load resistance 50 ohms +0.5%

Procedure:

1. Set the Energy switch to 100 Joules.
2. Place the paddles in contact with the energy meter contacts, press the CHARGE button, and after the CHARGE DONE LED on the Apex paddle lights, press both DISCHARGE buttons.
3. Adjust the HV capacitor voltage signal by adjusting R79 if necessary, to obtain proper delivered energy.
4. Set the Energy switch to 360 Joules.
5. Charge and discharge the defibrillator into the energy meter and again make adjustments of R79 until the energy delivered is equal to or slightly greater than the energy switch setting.
6. Check settings to confirm they are meeting specifications below:

Table 3-4. Delivered Energy Specifications

2J +1 J	30J +15%	300J +15%
3J +1 J	50J +15%	360J +15%
5J +1 J	70J +15%	
7J +2 J	100J +15%	
10J +2 J	150J +15%	
20J +4 J	200J +15%	

7. *If an adjustment has been required, the self-test accuracy should also be tested and adjusted (refer to 3-12).*

3-12. SELF TEST ENERGY ACCURACY ADJUSTMENT (A7 R80)

This is for adjustment of the peak current circuit output to calibrate the self test mode accuracy. Adjustment location is on the Control Board 43100-60200, (A7).

NOTE

The Defibrillator Output Energy Calibration must be performed before this adjustment (refer to 3-11).

NOTE

To avoid overheating of the internal 50 ohm test load (with consequent inaccuracies of the derived information) do not exceed the equivalent of three 360J discharges per minute.

Procedure:

1. Put the instrument in Service mode (See Section 3-1.). Place paddles in storage pockets.
2. Set the Energy switch to 360 Joules. Charge and discharge the defibrillator.
3. Adjust the I-peak potentiometer R80 to obtain a self test reading on the display of 360 Joules.
4. Set the Energy switch to 100 Joules. Charge and discharge the defibrillator. Check that the Selftest reading, is between 90 and 110 Joules.

3-13. SWITCH SETTINGS

Six switches in a DIP package are located on the control board A7. One of these switches is used to customize the unit's operation. Under normal operation they should never need changing. Their function is listed here against the case of inadvertant changes or if the control board is changed and needs to be set. When viewed from the front of the instrument the switches are numbered from 6 to 1.

Switch 1 — This switch is not used and its position is not critical.

Switch 2 - Revert to Defib

Switch 2 changes SYNC operation so that the unit will revert to Defib mode after a synchronized discharge. Left position unit will remain in SYNC after discharge, and right position unit reverts to Defib mode.

Switches 3 thru 6

These switches are not used and their positions are not critical. However, they should be kept in the left position.

3-14 CHARGE DONE TONE OPTION

The CHARGE DONE tone function can be permanently eliminated by removing CR22 on the control board. Refer to Section VI for location of CR22.

WARNING

DISCONNECT THE DEFIBRILLATOR FROM THE A.C. POWER SOURCE BEFORE PROCEEDING.

4-1. BATTERY REMOVAL

1. Refer to Figure 4-1.
2. Rotate the battery cover latches 90 degrees.
3. Open the battery compartment.
4. Unplug the battery connector and remove the battery.

4-2. DISASSEMBLE

1. Remove the Paddles.
2. Place the unit on its top on the workbench.
3. Remove the battery (see Section 4-1.).
4. Loosen screws indicated by the arrows in Figure 4-1.

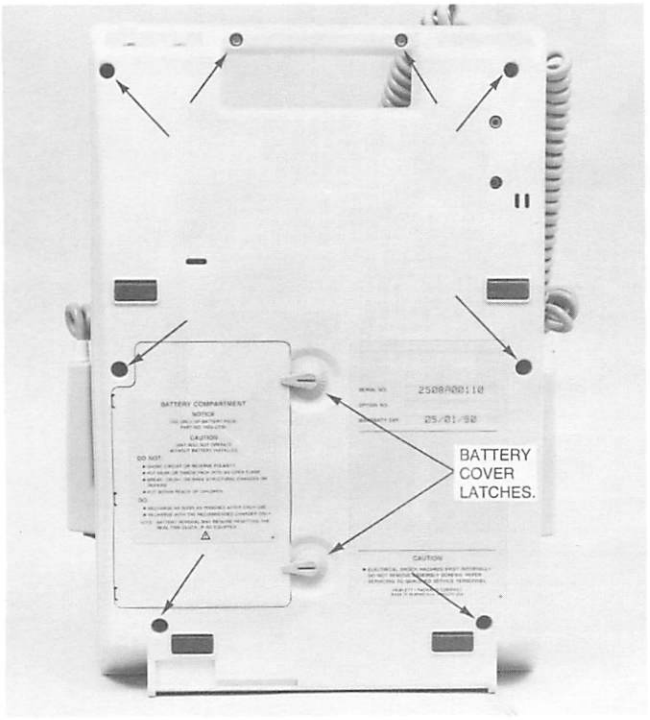


Figure 4-1. Screw Locations for Disassembly.

5. Hold the top and bottom case halves together and turn the unit over. (The screws will fall out.)
6. Lift the top half of the case from the bottom half. Place the top section on its side to the left of the bottom section. See Figure 4-2.
7. For many procedures, the top and bottom sections must be disconnected from each other. If this is necessary, disconnect J22. Refer to Figure 4-3. The green/yellow ground wire must be disconnected from the grounding screw near the energy switch in the top section.

CAUTION

If the battery has been re-installed to operate the defibrillator, remove it before re-assembly. Re-assembly should present no problems. However, some positioning of the ribbon cables will be necessary.

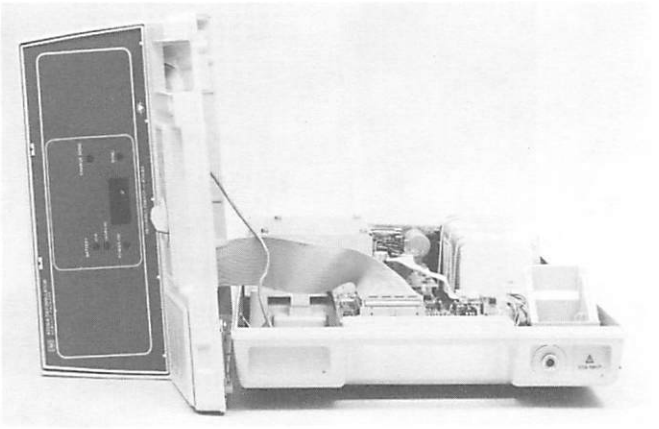


Figure 4-2. Inside View.

4-3. LOW VOLTAGE POWER SUPPLY/BATTERY CHARGER BOARD (A4)

1. Open the instrument as outlined in Section 4-2, Paragraphs 1-5.
2. Remove the battery charger circuit board shield by removing the four screws indicated by the arrows in Figure 4-3.
3. Lift off the cover.
4. Disconnect J9, J21, J22, and J24 (see Figure 4-3.).

5. Unscrew the four aluminum spacers indicated by the arrows in Figure 4-3.

6. Compress the latch on the plastic spacer (Figure 4-4.) and lift the board until it clears the latch. Place a finger under the board at that point and near the circuit breaker connections and lift the board out.

7. When installing this board, be certain the circuit breaker connectors and the plastic spacer engage before pressing the board in place.

8. Reconnect the cables, install the four aluminum spacers and install the shield.

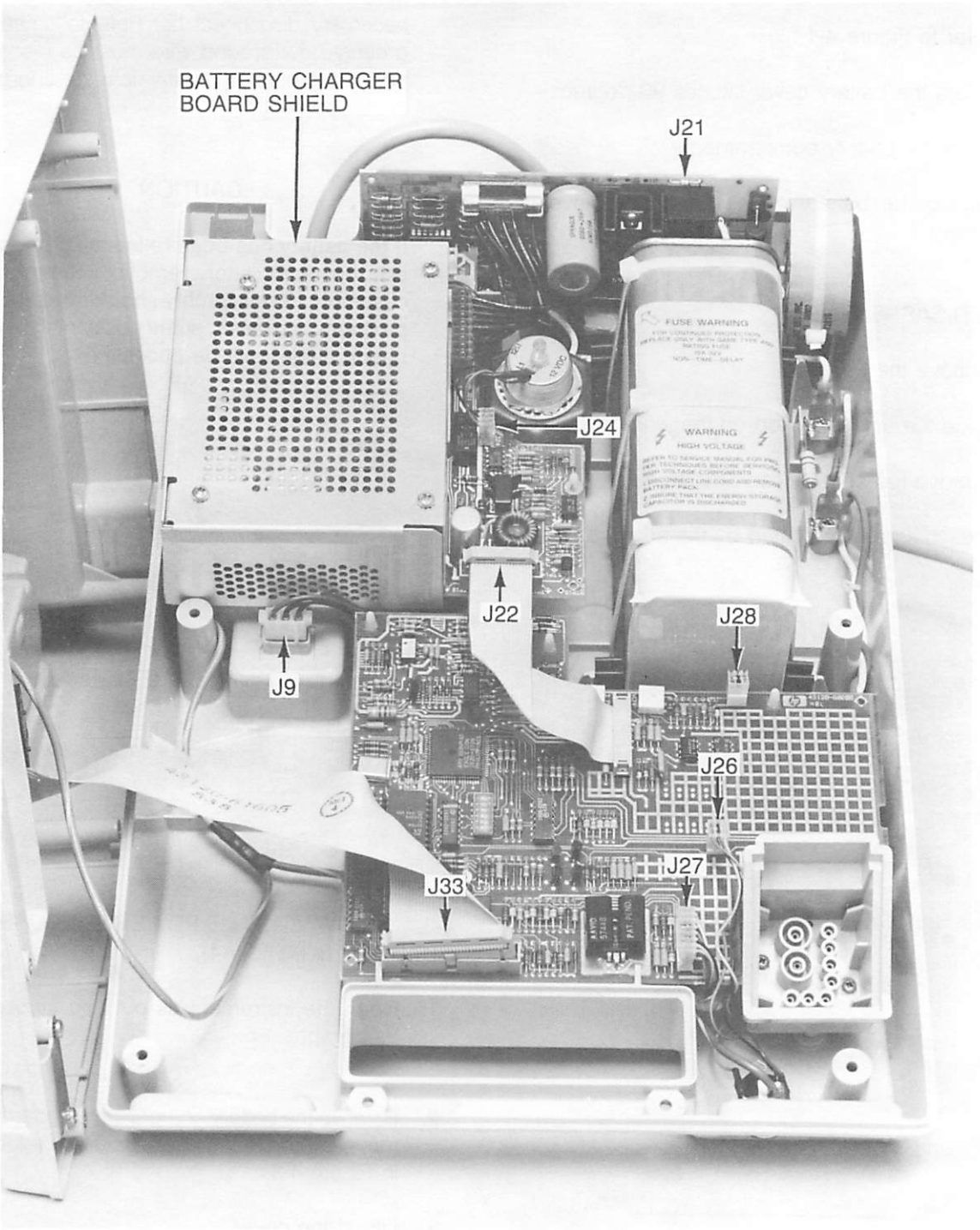


Figure 4-3. Circuit Board Shield Removal.

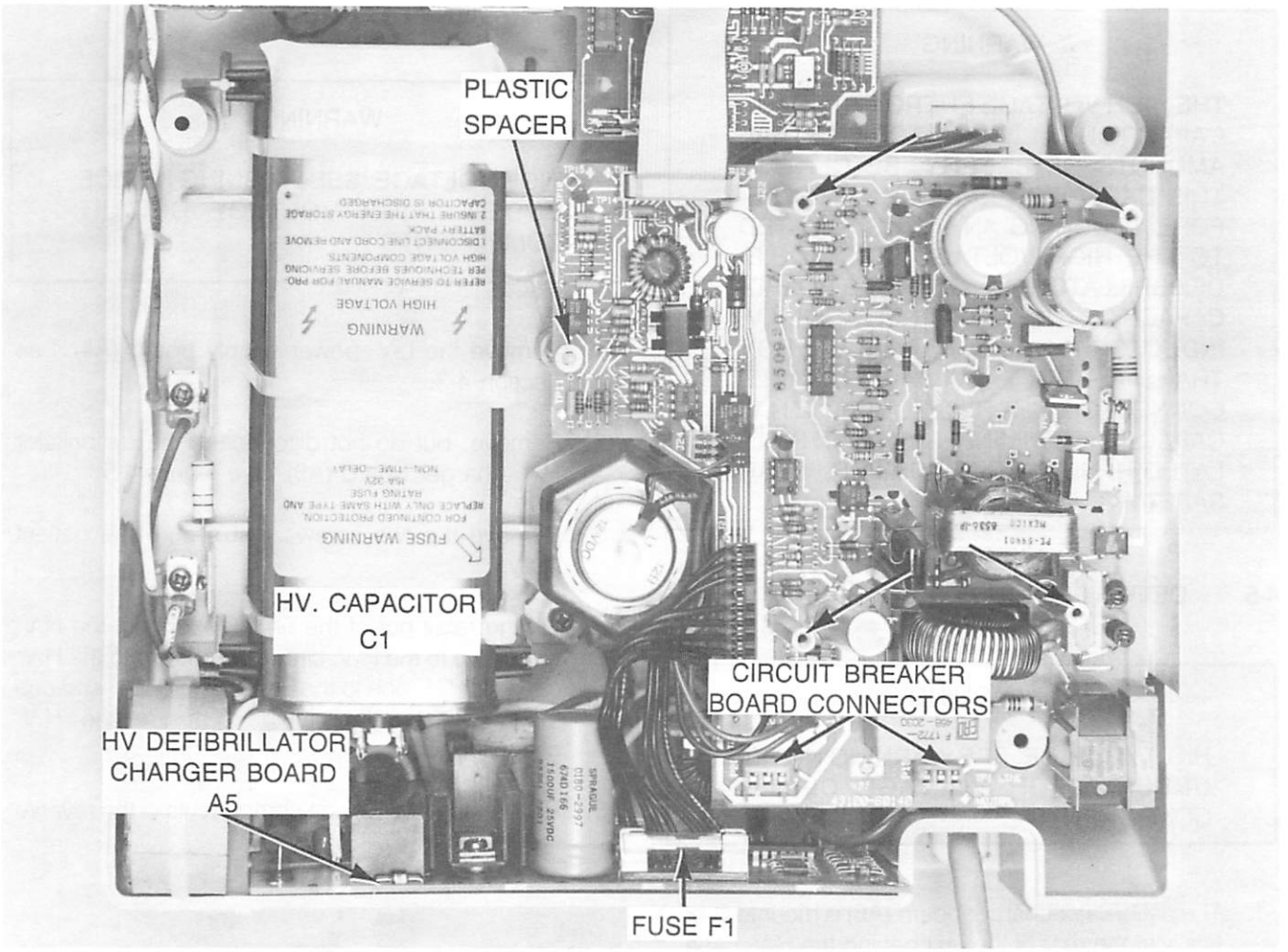


Figure 4-4. Low Voltage Power Supply Board Removal.

4-4. CIRCUIT BREAKER BOARD (A3)

NOTE

A special knurled nut wrench, Part Number 8710-0983, is required to remove the nuts from the circuit breakers. These nuts are made of aluminum and the use of pliers will deface the nuts.

1. The circuit breaker board is located under the L.V. power supply board (A4). This board must be removed to allow access to the circuit breaker board. See Section 4-3. for instructions.

2. The circuit breakers are soldered to the circuit breaker board so the entire assembly must be removed.

3. After the low voltage power supply board is removed, disconnect the A.C. power line quick connect lugs from the circuit breaker board.

4. Remove the knurled circuit breaker nuts.

5. Lift the circuit breaker board assembly out of the case.

6. Refer to Section 4-3 Paragraphs 7 and 8 when reinstalling the L.V. power supply board.

WARNING

THE HIGH VOLTAGE ENERGY STORAGE CAPACITOR C1 CAN STORE LETHAL AMOUNTS OF ENERGY. BE CERTAIN THIS CAPACITOR IS DISCHARGED BEFORE TOUCHING ANYTHING RELATED TO THE HIGH VOLTAGE CIRCUIT, I.E. DEFIBRILLATOR H.V. CHARGER BOARD, CAPACITOR C1, PATIENT RELAY K1, H.V. INDUCTOR L1, DISCHARGE ENERGY TRANSFORMER T1 OR PADDLE CABLE CONNECTOR. SHORT CIRCUIT THE H.V. CAPACITOR TERMINALS WITH AN INSULATED HANDLE SCREWDRIVER. WEAR SAFETY GLASSES.

4-5. DEFIBRILLATOR H.V. BOARD (A5)

WARNING

HIGH VOLTAGE. SEE WARNING NOTICE UNDER "HIGH VOLTAGE CIRCUIT COMPONENTS"

1. The defibrillator charger board (A5) is mounted vertically at the rear of the unit behind the H.V. capacitor. See Figure 4-5.

2. Refer to Figure 4-3. Disconnect J21. To remove the board, grasp the upper corners and lift. The board is a rather tight fit and it may be difficult to get it loose.

3. When the board is loose, disconnect two wires from the patient relay and two wires from the H.V. capacitor.

4. When installing the H.V. board, connect the patient relay and H.V. capacitor before pressing board in place.

4-6. PATIENT RELAY (K1)

WARNING

HIGH VOLTAGE. SEE WARNING NOTICE UNDER "HIGH VOLTAGE CIRCUIT COMPONENTS"

1. Remove the L.V. power supply board (A4). See Section 4-3.

2. Remove, but do not disconnect, the defibrillator H.V. charger board (A5). See Figure 4-5.

3. Remove the two screws that secure the patient relay.

4. Lift the relay out of the unit. Disconnect the H.V. wires (two to the H.V. circuit board, two to the H.V. capacitor C1, one to the H.V. inductor L1, and one to a H.V. terminal junction beside the H.V. capacitor.)

5. Reconnect and replace components in the reverse order.

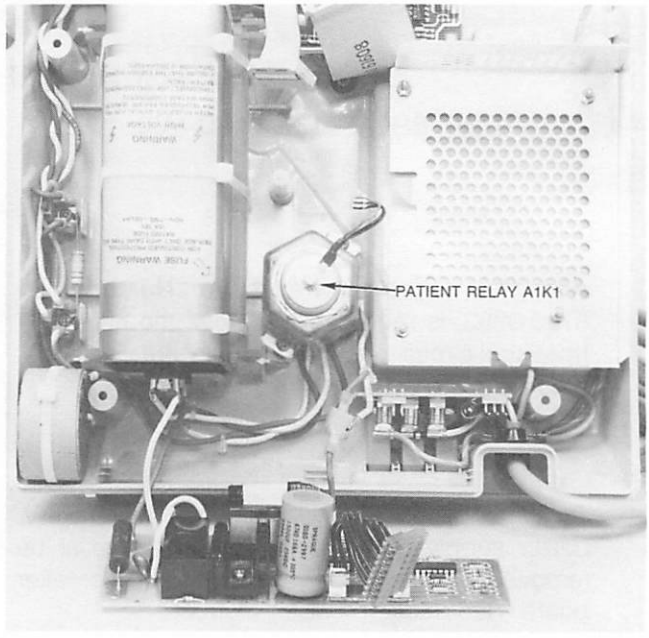


Figure 4-5. Defibrillator Charger Board Removal.

4-7. H.V. CAPACITOR (C1)

> WARNING
>
> HIGH VOLTAGE. SEE WARNING NOTICE UNDER "HIGH VOLTAGE CIRCUIT COMPONENTS." BE CERTAIN THE CAPACITOR IS DISCHARGED.

1. Disconnect the four push-on lugs from the capacitor terminals.
2. Clip the three tie-wraps and remove the capacitor.
3. Install the new capacitor and secure with three tie wraps (P/N 1400-1318).

> WARNING
>
> DO NOT REMOVE THE RESISTOR FROM THE CAPACITOR TERMINALS.

4-8. SAFETY RELAY

The safety relay is part of the H.V. defibrillator charger board assembly (A5). In case of safety relay failure, the entire assembly should be replaced. See Section 4-5.

4-9. CONTROL BOARD (A7)

1. Refer to Figure 4-3. Disconnect J22, J26, J27, and J28.
2. The control board is located in front of the H.V. capacitor C1. It is mounted in notches in the case behind the handle and on three plastic spacers at the rear of the board.
3. Compress the latches on the plastic spacers, one at a time and lift the board enough to keep the latch compressed. When the last latch is compressed place your fingers under the board near the spacers and lift the board out of the defibrillator.
4. When replacing the board, place the front board edge in the notches in the case. Line up the holes over the plastic spacers and press down evenly so the back of the board remains level as the spacer latches engage.

4-10. DISPLAY OVERLAY PANEL

1. Lift one of the clips at the top of the panel and slip a small flat-blade screwdriver between the clip and the panel. See Figure 4-6.
2. Pry the panel out far enough to allow the clip to drop behind the panel. Now repeat the procedure on the other clip.
3. Lift the panel out. See Figure 4-7.
4. Replacement is a reversal of the procedures outlined above.

> NOTE
>
> When re-installing the panel, lift the clips at the top when you press the panel in place.

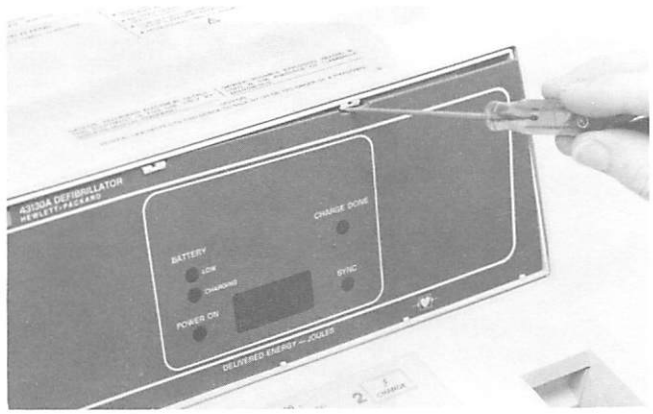


Figure 4-6. Front Panel Removal.

Figure 4-7. Front Panel Removal.

4-11. DISPLAY DIGIT REPLACEMENT

It is not necessary to remove the display board to replace the display digits.

1. Remove the display overlay panel as described in Section 4-11.

2. The digits are socket mounted and can be lifted from the socket. When replacing the display digits, begin on the left end of the socket to be certain of the displays are in the proper socket contacts. See Figure 4-8.

NOTE

Due to variation in display intensity, H-P supplies replacement display digits as a matched set. Order P/N. 43130-69500.

4-12 DISPLAY BOARD REPLACEMENT

1. Open the instrument case as outlined in Section 4-2.

2. Remove the display overlay panel as described in Section 4-11.

3. Remove the 4 nuts indicated by the arrows if Figure 4-9.

4. Lift the display board off the screws and disconnect J40 and J41 on the component side of the board.

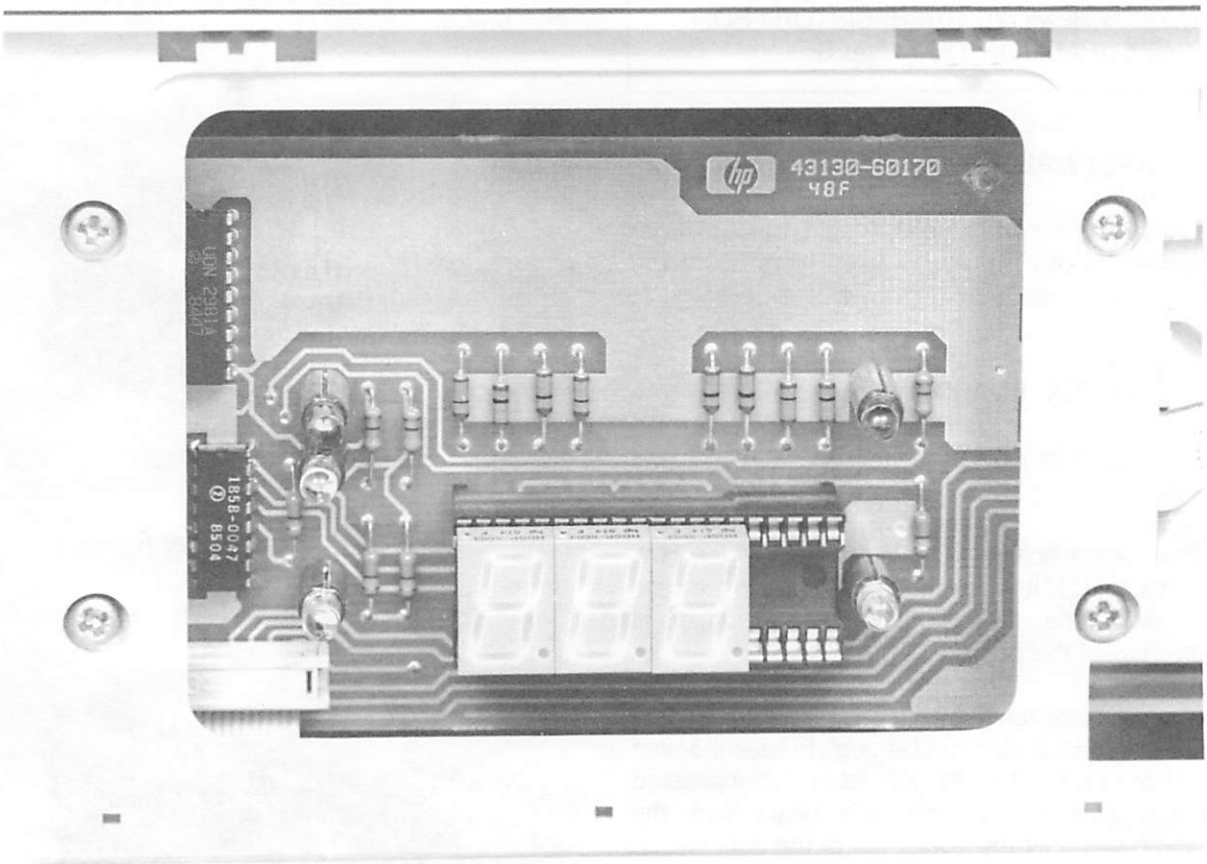


Figure 4-8. Display Digit Replacement.

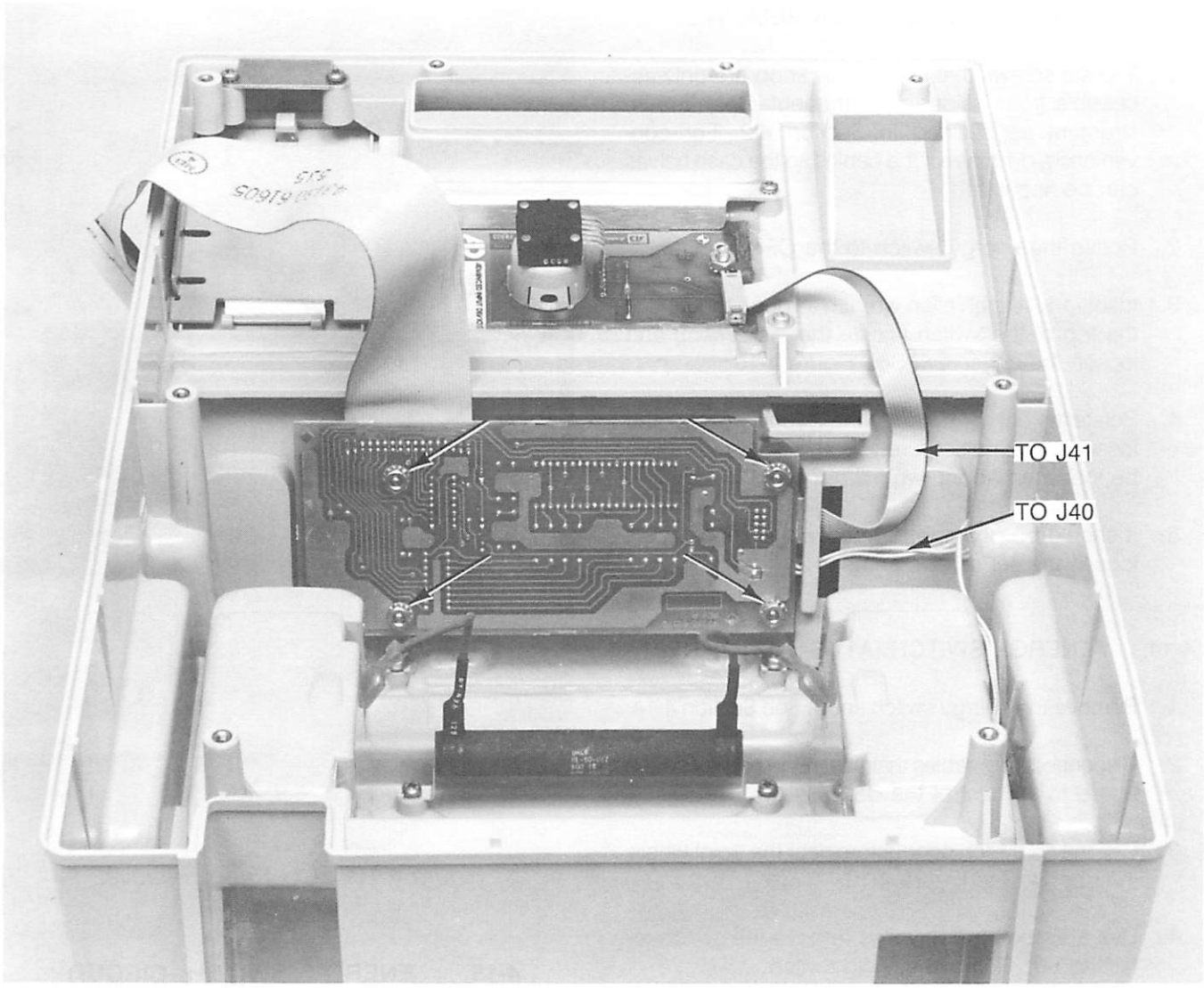


Figure 4-9. Display Board Replacement.

4-13. ENERGY SWITCH KNOB REMOVAL

1. The set screws that secure this knob are only accessible from inside the instrument. Open the instrument as outlined in Section 4-2. For convenience, disconnect the cables so the case halves can be separated.

2. Rotate the energy switch to the OFF position.

3. Insert a 1/16 inch allen wrench through the hole at the top of the switch (inside the instrument) and loosen the set screw. See Figure 4-10.

4. Rotate the energy switch to the 7 Joule position and loosen a second set screw. Both set screws should be loosened about two full turns.

5. It should be possible to remove the knob. If not, loosen the set screws another full turn.

4-14. ENERGY SWITCH (A11-S1) 43100-61901

1. Remove the energy switch knob. See Section 4-14.

2. Disconnect any cables that attach the energy switch board to the rest of the defibrillator.

3. Clip the six switch conductors near the point where they bend. See Figure 4-10.

4. Use a ½ inch nut driver to remove the switch retaining nut. Remove the old switch.

5. Unsolder the switch conductors from the circuit board lugs. Use a solder sucker or solder wick to remove the solder from the circuit board terminals.

6. Install the new switch. Tighten the retaining nut and solder the switch conductors to the circuit board terminals.

7. Be certain the knob is correctly aligned before tightening the set screws. Tighten the screw at the 7 Joule position first.

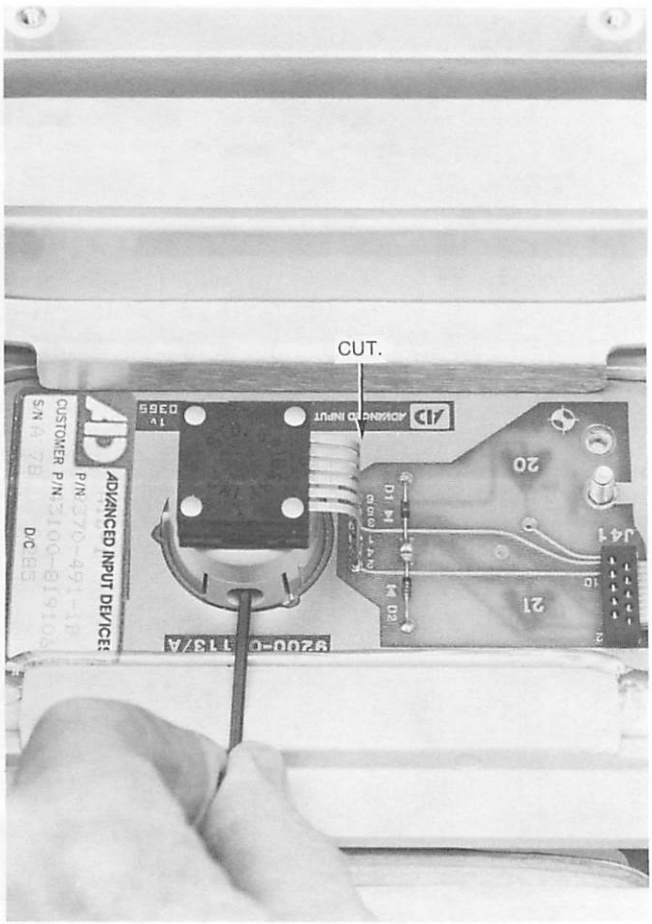


Figure 4-10. ECG Knob Removal.

4-15. ENERGY SWITCH CIRCUIT BOARD ASSEMBLY (A11)

NOTE

The energy switch board is sealed to the upper case half with silicone rubber. This must be removed before the circuit board can be replaced. A model-maker's knife with a small sharp blade may be helpful. There is no known solvent that will dissolve the silicone rubber after it has cured that would not damage the case.

1. Remove the knob. See Section 4-14.

2. Remove the energy switch retaining nut. Remove the two screws that secure the metal bracket at the bottom of the switch board.

3. Disconnect any cables from the energy switch board to other parts of the defibrillator.

4. Use the model-makers knife to cut through the silicone rubber. Remove as much of the silicone rubber from the instrument case as possible.

5. When installing the circuit board use a non-corrosive type silicone rubber. It should not have the acrid smell of acetic acid.

4-16. BATTERY COMPARTMENT LATCHES

1. Remove the battery and battery comparment cover.

2. Open the case as described in Section 4-2.

3. Remove the low voltage power supply board. See Section 4-3.

4. Depending on which latch requires replacement, it may be necessary to remove the patient relay (K1). See Section 4-6.

5. The latch retainer ring may be pried off with a flat blade screwdriver or the ring may be cut with diagonal pliers.

6. Insert the new latch and install new mounting hardware on the shaft. Use long-nose pliers to press the retainer ring into place. Apply pressure on opposite sides of the ring at the same time. Do this at several points around the ring.

4-17. PADDLE SWITCH REPLACEMENT

Paddle switch replacement, anterior-anterior paddles.

Switch replacement consists of replacing a small circuit board assembly. No soldering is necessary.

Paddle	Circuit Board	Label
Apex	43100-60125	43100-84513
Sternum	43100-60135	43100-84514

Tools required: Small posidrive screwdriver, long-nose or flat-nose pliers with very thin jaws.

1. Unplug the paddle set from the defibrillator. If the paddles are not removable, disconnect the defibrillator from AC power line. Make certain the energy switch is in the off position.

2. Remove the label from the top of the paddle handle.

3. Remove the two screws that secure the cover.

4. Slide a knife blade or other very thin object between the rear edge of the cover and cable strain relief. Pry the cover loose.

5. Lift the cover then slide it forward to clear discharge switch button. Set the cover aside.

6. Lift the circuit board out of the paddle. Unplug the connector at the rear of the board.

NOTE

If there is a CHARGE DONE LED mounted on the paddle, unplug the two-pin LED connector on the side of the board opposite the CHARGE switch. See Figure 4-21.

7. Remove the red DISCHARGE switch button and the small spring from the switch actuator. Note that one end of the spring is smaller in diameter.

8. When installing the DISCHARGE switch button, place a finger behind the bend in the actuator so it cannot slide back. The short side of the button goes up.

9. Force the small end of the spring over the rear of the actuator bar. It will be a snug fit. If the paddle has a CHARGE switch, be sure the button is in place before installing the circuit board.

10. Reconnect the wires to the circuit board.

11. Place the board in the grooves in the paddles and press it down. Use long-nose pliers to position the end of the spring over the small projection on the plastic piece behind the spring.

NOTE

If paddle has CHARGE DONE LED route the LED wires away from H.V. lead to paddle.

12. Place the lower front edge of the cover in position at the front of the paddle handle. Rock the cover back so that the discharge button projects through the opening.

13. When everything is in place, install the screws and the label.

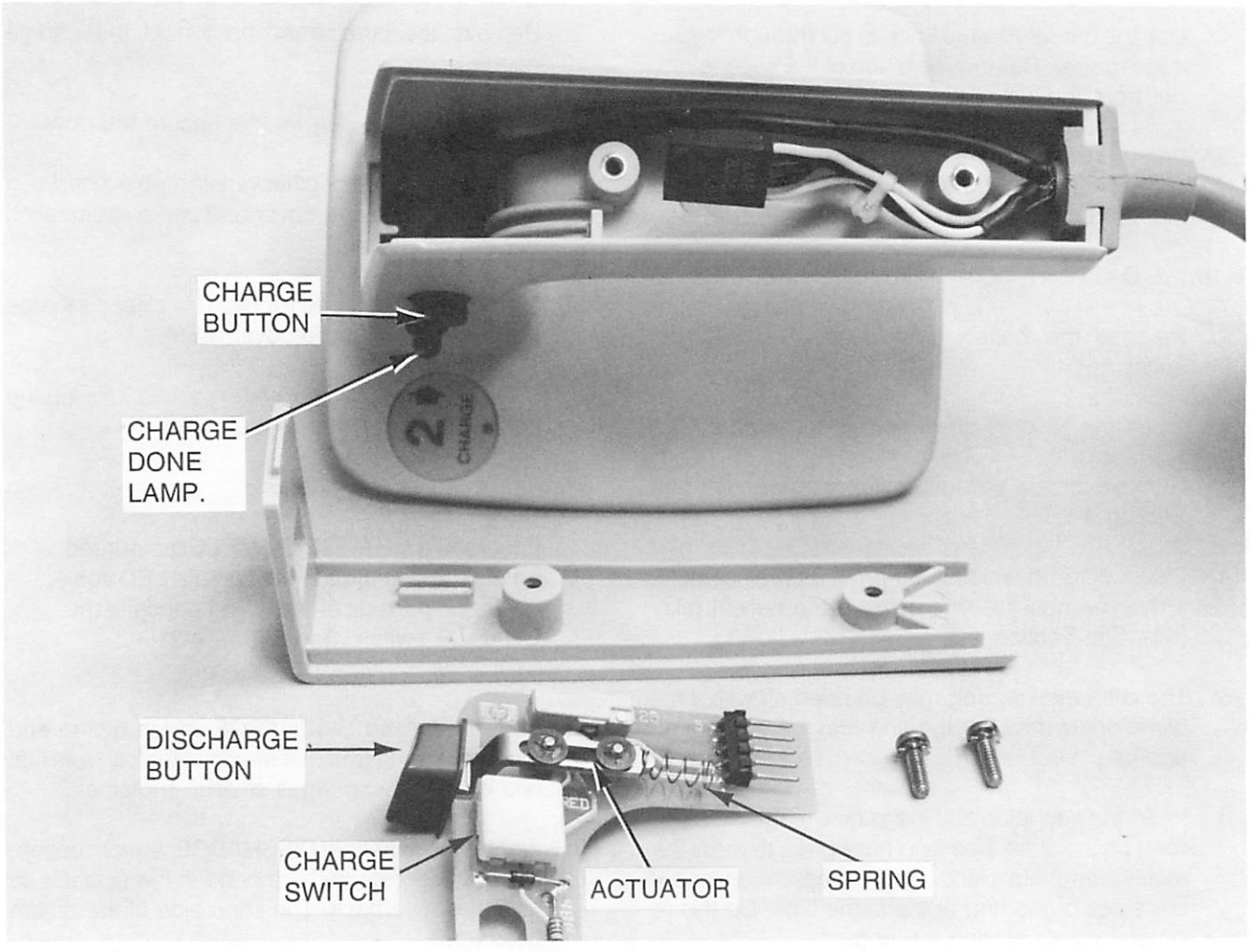


Figure 4-11. Paddle Switch Replacement.

Hint to locating trouble areas:

1. Most problems in troubleshooting this instrument will be logical, i.e., if the display doesn't work the problem is likely on the display board, or the control board.

2. However, in many cases signal lines pass through several boards. For example, the discharge switches pass through the lower case, the control board, and finally the battery charger board to the patient relay.

3. Therefore, although the failure rate is low on the control board, it does have a high opportunity for failure because of its complexity.

4. Remember all functions rely on proper power. Check voltages.

SYMPTOM **PAGE**

ERROR MESSAGES

SYMPTOM	SUSPECT AREA	CHECKS
Display flashes "E2"	Defib charging too slowly	See Defibrillator secton
Display flashes "E3"	Defib cap arcing	See Defibrillator section
Display flashes "E4"	Defib charged but shouldn't be	See Defibrillator section
Display flashes "E5"	Defib overcharged	See Defibrillator section
Display flashes "E6"	LV supply out of spec	See Battery Charger section
Display flashes "E7"	A/D won't respond	See System Dead section

SYSTEM DEAD

SYMPTOM	SUSPECT AREA	CHECKS
System dead	Power	Check circuit breakers Check battery voltage at the terminals
No low voltage supplies, or switched battery voltage on printed circuit assemblies.	Energy switch panel, A11	Check for continuity between J41 pin 10 and J41 pin 6, when energy switch in 'Monitor On' position.
	Front panel switches, A10	Check for continuity between J33 pin 16 and J33 pin 19 when energy switch in 'Monitor On' position.
	Control board, A7	Check for continuity between J33 pin 16 and J22 pin 11.
	Battery Charger board, A4	See Battery Charger section
Unit does not come on when energy switch is turned on. Audible relay click. Supply voltages okay. No power up tone.	Clock oscillator on Control board, A7	Check U62 pins 6 and 7 for 12 Mhz sine wave, with amplitude of 5 volts. Check U62 pin 8, and U61 pin 18 for 12 Mhz square wave with 5 volt amplitude

SYSTEM DEAD

SYMPTOM	SUSPECT AREA	CHECKS
Same symptoms as above, with or without a continuous power up tone and display	Control processor, U61 or gate array, U62 on Control board, A7	Check Vcc on U62 pins 34 and 68 for voltage > 4.5 volts. Check U61 pin 40 for Vcc of 4.7 to 5.3v. Check U63 pin 20 for Vcc of 4.9 to 5.1 volts. Check pin 1 of U62. This is the decoded "tickle" signal from U61. Signal should be a CMOS logic level signal with a period of 4.167ms (240Hz) and approximate 40% duty cycle. Check U61 pin 9 for a positive going reset signal. Check external address/data bus U61 pins 32 thru 39; U62 pins 9, 11, 12, 13, 15, 16, 19, and 20; and U63 pins 9, 11 thru 17 for activity. Check for pins being stuck high, low, or disconnected. Check WR signal between U61 (pin 16) and U62 (pin 4). Normally should be high with narrow low going strobes. Check ALE signal between U61 (pin 30) and U62 (pin 3). Should be 2 mHz square wave with 300 ns high pulse. Check signal on C6 and U62 pin 2 during turn on. Should take several hundred milliseconds to charge to Vcc.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Unit will not respond to either charge button or aborts a charge in progress with no error indication.	Paddles have become disconnected from unit	Verify paddles are connected to the unit.
	Cable connections J27 pins 3 and 5	Check for continuity of cable. Also, these two pins should be shorted if external paddles plugged into unit.
	Paddles connector J3 pins 8 and 9	Verify these two pins are shorted together on the external paddles set.
	U61 or U3 on Control board, A7	U61 pins 4 and 5 should be at ground. U3 pins 2 and 12 at ground. U3 pins 1 and 13 at approximately 4 volts.
Unit does not respond to Apex paddle charge switch.	U61 or U3 on Control board, A7	Check signal at J27 pin 4, U61 pin 1, and U3 pins 5 and 6 while pressing and releasing the paddles charge switch.
	R42 on the Control board, A7	Check for connections between Vcc and J27 pin 6.
	External paddles	Check continuity between P3 pins 5 and 6 when paddles charge switch pressed.
Unit does not respond to discharge switches.	U61 or U3 on Control board, A7	Check signals at J27 pin 6, P22 pins 19 and 20, U61 pin 3, and U3 pins 3 and 4; while pressing and releasing discharge switches.
	Paddles	Check continuity between P3 pins 3 and 5 with discharge switches pressed.
50J interlock does not work with internal paddle set.	U61 or U3 on Control board, A7	Check signals J27 pins 3 and 5, U3 pins 1 and 13; all should be at ground. Signals U3 pins 2 and 12, U61 pins 4 and 5 should be high
	Internal paddles	Check for continuity between P3 pins 7 and 8. Check for high impedance between P3 pin 9 and all other pins.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
The defibrillator does not seem to charge. The CRT displays 0 joules, then in a few seconds displays "E2" and aborts the charge.	A. The defibrillator is charging, but the capacitor voltage is not being recognized.	A. Listen for the high-pitched charging sound when charging is initiated. If it is heard, check TP4 and suspect U2D or a problem on the Vcap line to the A/D on the Control Board. Use caution in the high voltage area!
	B. Cables P21, P11, J10; power supplies; Fuse F1.	B. 1. Check cables for proper connection 2. Check the voltage at P21 pin 7 (SW BAT) with respect to TP1 (GND). It should be greater than 10 volts. 3. Check the voltage at P21 pin 1 (V RAW) with respect to TP6 (GND RAW). It should be greater than 10 volts. 4. Check for fused V RAW voltage (on the right side of the fuse, looking at the component side of the board) with respect to TP6 (GND RAW). If it is less than V RAW, suspect Fuse F1. Remove the fuse and continue troubleshooting to find the cause of the failure.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
	C. U1 is not receiving the correct input or delivering the correct output.	C. With fuse F1 removed, and during a charging attempt, ensure that: 1. U1 pin 10 is less than 700 millivolts. 2. U1 pin 7 has a sawtooth wave on it. 3. U1 pin 9 is above 1.5 volts. If not, and if CHG RATE CTRL is present, check TP2 and suspect U2C or U2B circuit. 4. U1 pin 1 voltage is less than U1 pin 2 voltage. 5. U1 pin 4 is less than 200 millivolts. 6. U1 pin 3 is not stuck high. If it is, check TP3 and suspect U2A or Q2. 7. TP7 is toggling from about zero to >10 volts.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
	D. Power MOSFET Q1 Transformer T1.	D. or With Fuse F1 removed, ensure that: 1. The resistance from TP9 to TP7 is >1megohm with TP9 the positive ohmmeter lead. 2. The resistance from TP7 to TP8 is >400ohms with TP7 the positive ohmmeter lead. 3. The resistance from TP9 to TP8 is >1megohm with TP9 the positive ohmmeter lead. 4. The resistance from TP8 to TP9 is like a diode with TP8 the positive ohmmeter lead. Then with Fuse F1 in place, but when not attempting to charge, 1. Accurately measure the voltage from TP8 to TP6. If greater than 1 mV, suspect Q1. 2. Measure the voltage at TP9. If less than V RAW, suspect T1 (primary). Then with Fuse F1 in place, and during a charging attempt, verify that TP7 is toggling from about zero to greater than 10 volts. 1. If TP9 is not toggling, suspect Q1. 2. If TP9 is toggling, suspect T1 (secondary).

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Slow charging (greater than 10 seconds to 360 joules with fully charged battery) or charge aborted with "E2" flashing on the display.	A. J10 is disconnected.	A. Check J10 connection.
	B. Safety relay not opening.	B. With the instrument turned on and all cables connected, verify that neither "E4", "E5" or "E7"are not displayed on the front panel. Measure the voltage at TP4 and verify that it is less than 50 mV. Turn the instrument off and short the 2 terminals of the Main Storage Capacitor with an insulated-handle screwdriver; then connect an ohmmeter from C11 to R19 (neither connection at the junction of C11 and R19). Also connect a jumper from TP10 (CR1 anode) to TP1 (CR4 anode). Turn the instrument on. If the resistance indicates a short, suspect K1.
	C. CR9 or CR10 bad.	C. Disconnect P21, and measure the resistance across CR9. If a short is indicated, replace both CR9 and CR10.
	D. Charge rate control circuit problem.	D. During an attempt to charge, measure the voltage at TP2. If it is less than 1.5V, suspect U2C.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Charging begins, but then is aborted with "E3" flashing on the display.	A. Main Storage Capacitor arc	A. With the instrument turned on and all cables connected, verify that neither "E 4", "E6,", or "E7" are not displayed on the CRT. Measure the voltage at TP4 with respect to TP1 and verify that it is less than 50 mV. Turn the instrument off and short the 2 terminals of the Main Storage Capacitor with an insulated-handle screwdriver; then connect an ohmmeter across the 2 terminals. If the resistance settles to less than 30K ohms, suspect the capacitor. Remove the ohmmeter.
	B. Capacitor voltage measurement problem.	B. If it is verified that the capacitor is not shorted (see section A directly above), turn the instrument on and observe the voltage at U2 pin 12 during charge. After 800 mV is reached, if there is >10% change in voltage within 10 ms, suspect transformer T1. Otherwise measure the voltage at TP4. After 800 mV is reached, if there is >10% change in voltage within 10 ms, suspect U2D.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
"E4" flashing on the display.	A. Capacitor voltage measurement problem.	A. Measure the voltage at U2 pin 12. If it is greater than 50 mV, go to section B directly below. Otherwise measure the voltage at TP4. If it is <50 mV, suspect U2.
	B. Safety circuit problem.	B. After performing step A directly above, turn the instrument off to ensure that there is no safety relay drive. Wait at least 20 seconds. Then turn the instrument on. If the "E4" indication does not reappear on the CRT within 10 seconds, perform the following steps: 1. Check the voltage at TP4 to verify that it is less than 50 mV; 2. Short the Main Storage Capacitor with an insulated-handle screwdriver; 3. Remove Fuse F1 for further troubleshooting; 4. Suspect the safety relay drive signal at TP10 and on the Battery Charger Board.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
I peak error	A7 U2, U1, and associated components	U2B, U1B, and other components form a peak hold circuit. Current that flows through the paddles during discharge is monitored by this circuit. U1B is an open collector output comparator and hence is only capable of ramping the output of U2B in a positive direction. R25 discharges the peak hold circuit whenever IPKRST U62-54 is held high IPKRST is held high except for an 80 msec period during discharge. U2-7 should normally be at zero volts. R23 performs the current to voltage conversion. Suspect U2 if pin 7 has a triangular ripple component during reset.

DISPLAY PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Bat Chg LED not working	Bat chgr off	Verify instrument plugged in, AC power switch on (if applicable).
	Signal path	Follow Bat Chg signal from Bat Chg board to Control board to Display board.
Power On LED not	A8 DS2	Check for voltage across A8 R9 & 10
Displays bright; frequent burnout	8.4V too high	Check for 8.0V-8.8V from A7.
A8 DS, 4, 5, 6, 7, and 8 not lighting or dim	8.4V too low	Check for 8.0V-8.8V from A7.
	A8 U2	Check for voltages across R13 while in SYNC.
A8 DS6, 7, or 8 not lighting correctly	A8 DS6, 7, 8 or A8 U2	Check for drive signals to U2, and voltage across R13, 14, or 15.
	A8 U2	Check for voltages acress R13 while in SYNC.
A8 DS6, 7, or 8 not lighting correctly	A8 DS6, 7, 8 or A8 U2	Check for drive signals to U2, and voltage across R13, 14, or 15.
One digit not lighting correctly	A8 DS3, 4, 5 or A8 U2	Check for drive signals to U2. Interchange DS3, 4, 5 to determine if U2 or digit is bad.
One segment on one LED not lighting correctly	A8 DS3, 4, or 5	Interchange DS3, 4, 5 to verify bad digit
Same segment on all LED's not lighting correctly	A8 U1	Check for drive signals to U1. check for voltage across R1 thru R8.

ECG SYNC OR MARKER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Synchronizer not detecting QRS complex, i.e., no marker pulse, Sync LED does not flash, and no beep.	ECG output jack of monitor in use.	Check ECG output jack of monitor for high level ECG $\geqslant$ +.7v or sync pulse > +2v
	Sync Cable.	Check that proper Sync cable is being used to interface the 43130 and the monitor. Check that cable is not shorted or open.
	ECG/Sync input buffer, U65B on Control board (A7)	Check J26 pin 3 for ECG/Sync pulse from monitor. Check U65B pin 7 and U63 pin 5 for inverted signal from monitor. (See section containing waveforms)
Synchronizer detecting QRS complex. Sync LED flashes, beeper sounds on each complex, but no marker pulse.	Marker pulse circuit on control board (A7)	Check J26 pin 1 for marker pulse (approximately -12v and 12 ms). Check U61 pin 10, and base of Q8 for drive signal (+5v and 12 ms). Check collector of Q8 being pulled to ground, from +12v, with each drive signal. Check Q9 collector and emitter being pulled to −12v with each drive signal.
Synchronizer detecting QRS complex. Sync LED flashes, marker pulse working, but no beeper.	Speaker circuit on Control board (A7)	Check U62 pin 10 for 1736 Hz square wave with each QRS complex. Check CR22, R61, Q7, DS1 and R62
Synchronizer detecting QRS complex. Marker pulse working, beeper sounds on each complex. Sync LED not working.	LED circuitry on Display board (A8).	Check U2 pins 6 and 11, R14 and DS6.
	Drive circuitry on Control board (A7).	Check U61 pin 26, R100C, and J33 pin 26.

SERVICE MODE PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Will not enter Service mode.	Control board (A7)	
	SYNC switch (Matrix Column O and Row Z)	Check for switch continuity on Front Panel (A10) and Energy Switch Panel (A11)
Battery voltage is not flashing on display, but display appears to function properly	Main processor U61 on Control board (A7)	
No display	Display board (a)	See Display Problems

SERVICE MODE PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS

WARNING: HIGH CURRENT A.C. LINE VOLTAGE AND UP TO 300 V.D.C. ARE EXPOSED WHEN THE BATTERY CHARGER IS CONNECTED TO A.C. POWER, WITH POTENTIAL LETHAL SHOCK HAZARD! FOR EXAMPLE, THE PRIMARY (A.C.CIRCUITS) GROUND IS SUCH A SHOCK HAZARD WITH RESPECT TO SAFETY/SECONDARY CIRCUITS GROUND.

SEVERAL OF THE COMPONENTS, ESPECIALLY THE HEAT SINKS AND POWER RESISTORS, MAY BE HOT ENOUGH TO CAUSE BURNS IF TOUCHED, EVEN FOR A WHILE AFTER POWER IS OFF!

CAUTION: SINCE THE PRIMARY (A.C.CIRCUITS) GROUND IS AT HIGH VOLTAGE AND CURRENT WITH RESPECT TO GROUND, IT MUST NEVER BE CONNECTED TO ANY INSTRUMENT OR A.C. SAFETY GROUND WHEN CONNECTED TO A.C. POWER! IF GROUNDED, SUCH A CONNECTION WILL CAUSE SERIOUS DAMAGE TO THE BATTERY CHARGER CIRCUITS OR IF NOT, YOU MAY EXPOSE INSTRUMENT FRAMES TO LETHAL VOLTAGES. ANY CONTACT BETWEEN PRIMARY (A.C.CIRCUITS) AND SECONDARY (BATTERY/ POWER SUPPLIES) GROUNDS WILL CAUSE SERIOUS DAMAGE TO COMPONENTS AND/OR CIRCUIT BOARD TRACES!

WHEN MAKING ACTIVATED PRIMARY CIRCUIT MEASUREMENTS OTHER THAN WITH RESPECT TO SAFETY GROUND EITHER USE A DIGITAL MULTIMETER WITH FULL FLOATING, 1000 VOLT RATED INPUT, OR A DUAL PROBE OSCILLOSCOPE OPERATED IN A DIFFERENTIAL INPUT MODE!

ANY CONNECTION WHICH CAUSES POWER FET Q1 TO CONDUCT WITHOUT OPERATION OF U1 DUTY CYCLE OR CURRENT LIMIT PROTECT CIRCUITRY WILL CAUSE Q1 TO SHORT, POSSIBLY DAMAGING R2, Q2, CR8, CR50 AND PERHAPS OTHER COMPONENTS.

CAUTION: DISCONNECT THE BATTERY CONNECTOR BEFORE INSTALLING OR REMOVING THE BATTERY CHARGER BOARD (43100-6014X) TO AVOID TRACE OR COMPONENT DAMAGE.

SERVICE TIPS: MANY COMPONENT CHECKS CAN BE PERFORMED WITH A DIGITAL MULTIMETER WITH A.C. POWER AND BATTERY UNPLUGGED. OBSERVING THESE PRECAUTIONS ARE NECESSARY TO OBTAIN VALID READINGS AND THEY WILL MINIMIZE THE POSSIBILITY OF ELECTRIC SHOCK OR DAMAGE TO BOARD CIRCUITRY.

MOST DIODES WILL TEST A NOMINAL 0.6 V ON A DMM 2K OHMS SCALE, WHICH INJECTS 1 mA. SCHOTTKY DIODES WILL BE NOTICEABLY LOWER. PN JUNCTIONS IN BIPOLAR TRANSISTORS SUCH AS Q2 CAN BE TESTED IN THE SAME WAY. CHECK HIGH CAPACITY ELECTROLYTICS FOR CHARGE ACCEPT ON HIGH OHMS SCALE, OBSERVING CHARGE TIME SIMILARITY.

BATTERY/BATTERY CHARGER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Battery charging LED is off, battery runs down, unit operating.	A.C. power source	Check A.C. outlet voltage; is plug fully inserted?
	A.C. power switch (220V option only)	Check switch on back of the defibrillator: "0" not shown, green light illuminated?
	Circuit breakers CB2, CB3	Reset breaker(s) & check (some shorts may blow the breaker heater open circuit, see A.C. ON check below)
Battery charging LED is off, unit will not operate.	Battery	Remove battery cover, check for tight connector fit. If problem persists, take out battery, use DMM to check both red wire volts to black wire; if either reads zero or intermittant, replace battery & recheck.
AT THIS POINT, FURTHER CHECKS REQUIRE DISCONNECTING A.C. POWER, OPENING DEFIBRILLATOR CASE, UNPLUGGING BATTERY CONNECTOR AND REMOVING TOP EMI SHIELD FROM BATTERY CHARGER PCB.		
Battery charging LED is off, system O.K., battery charges.	Charge LED circuit	Check continuity of circuit from Q3 collector through to LED on front panel.

BATTERY/BATTERY CHARGER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Battery charging LED is off, battery runs down.	Fuseable R2	If open circuit, also use DMM of 2K scale to check CR1, CR4, 5 & 6, Replace if short or open circuited. Check across CR8, replace CR8, CR50,Q1, and Q2 if shorted. also test R9, CR3, replace if short or open. Replace R2, connect battery & A.C. power, checking charge LED & battery voltage (14.2V if battery is charged, lower if battery charge state is lower, but higher than if AC power is disconnected). Is the battery charger LED on now?
	Secondary circuits	Check CR26, CR28, CR29, CR30, CR56, CR57, Q3, Q7, and U3. With DMM.
THE FOLLOWING TESTS REQUIRE CONNECTING THE BATTERY: THIS CAN DESTROY COMPONENTS AND BOARD TRACES IF SHORTED!		
Battery charging LED flashes every 1-3 sec.	U4	If VBAT > 14.5 V during the flash with AC connected, replace U4.
Unit does not work when switched on with battery charged.	U5 circuit	Check for > 12VDC at TP 11 from the battery through breaker CB1. U5: Pin 6 goes from >10 to 0 VDC & pin 1 from >10 to 2.5 VDC; switch off to on, of defective U5 or related circuit component. Q4: Collector from 0 to >10 VDC or replace Q4 or CR35. K1: Replace if coil does not close contacts.

BATTERY/BATTERY CHARGER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Unit does not work or very abnormal, battery charged	Regulated voltage +5V low if < +4.7 VDC.	If requlated −4.4 VDC O.K., +5 VDC <4.7 VDC, unplug J22, jumper U5, pin 6, to SEC. GND & check +5V. If O.K., reconnect J22, unplug each printer circuit board to locate shorting load (gate array, capacitor, diode)
		If +5V low with unplugged J22 & jumper (Note: −4.4V will be very low without load on +5V) Check U7 circuit, including CR37-40, CR43, C31, C33, C34, or L6. Note the no load (J22 OFF) & monitor load waveforms in Figs. 3A & 3B. If signs of overheating in U7, etc., check voltages carefully with reconnected load after repair for possible cause on other printed circuit board!
	Regulated −4.4V abnormal	Check with monitor on or 10 ohm, 5 watt load on +5V. If U8, pin 3 is > −7 VDC check C33-35, CR38-40. If U8, pin 3 is −7 VDC and U8 output is abnormal, either U8 is bad or abnormal load conditions will be found on another board.
	Regulated +8V abnormal	Check U9, CR44, C37 or find problem on another board.
Unit does not turn off when battery is below 11 VDC.	U5/Q4/K1 circuit	Run above checks, replacing U5 if bad Q4 if shorted, or K1 if stuck. Also replace battery if it was discharged below 11 VDC: Low capacity!

BATTERY/BATTERY CHARGER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Patient or safety relay not operating.	U6 circuit	Check drives to pin 6 or pin 3: If absent, trace back to point of origin. Safety relay: If pin 7 does not go low, pin 6 high, replace U6. Otherwise, trace to relay. Patient relay: Check for >10 VDC at J24, pin 1, when both paddle discharge switches closed - possible paddle circuit problem Check U6, pin 2 low, pin 3 high momentarily, or replace U6. Otherwise check CR36 or trace to relay.
Shutdown occurs with discharge, but battery capacity appears good.	Circuit breakers 43100-6016X	Verify 3 amp breaker installed, not 1.5 amp. Check that resistance is approximately 0.5 OHM between pins 2 and 3 on 6014X P20. Reset breaker or replace 6016X assembly.

BATTERY/BATTERY CHARGER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
	THE FOLLOWING TESTS REQUIRE PRIMARY CIRCUIT TESTS WITH A.C. POWER ON AND BATTERY: OBSERVE CAUTIONS NOTED PREVIOUSLY!	
Still no charging LED and no increase in battery voltage	A.C. rectifier/filter	Use DMM, check for 300 VDC nom. at TP5 with respect to primary ground at TP3: If much less, trace A.C. volts through circuit breaker to P19 through L1, R2, CR1. If fault is located, unplug A.C. and recheck fault area with ohmmeter, and replace component or repair circuit board trace as required. Replace repaired board & test again with A.C. power.
300 VDC at TP5 O.K. but no charge.	Start circuit Q5, Q6	Is C41 charging up to 30V (it takes 5 seconds or so) and discharging through Q5, check CR8, CR54, CR55, and Q6.
	OBSERVE CAUTIONS NOTED ABOVE, USE TWO OSCILLOSCOPE PROBES IN DIFFERENTIAL MODE FOR THE START MODE TEST WHICH FOLLOW:	
	Q3 circuit	Normal charging, voltage on CR24 is >12 VDC.
	U4 circuit	Normal charging, U4, pin 8, is 2.5 VDC, pin 1 is between 3 and 4 VDC.
	U3 circuit	Normal charging, 1.0 VDC, pin 1 to pin 2; 3 to 4 VDC, pin 5 to pin 4.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

This section of the service manual includes schematic diagrams and identifies major assemblies, subassemblies, and components of both defibrillators to aid in ordering replacement parts. Each entry in these tables includes the reference designation, HP part number, check digit, quantity used within the referenced assembly, a brief description of the part, the NEC code of the manufacturer of the part and the part number assigned by the manufacturer. Wherever possible, parts lists for the assemblies are printed on the same page as the schematic diagram and component location drawing or on immediate adjacent pages.

6-2. REFERENCE DESIGNATIONS.

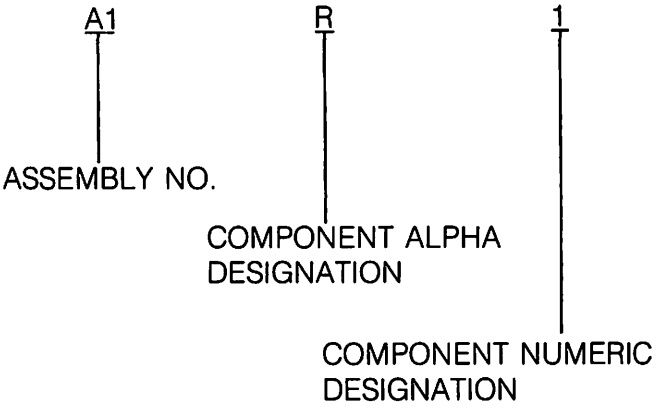
The parts listings use an alphabetical-numerical (alpha-numeric) method of listing the end item, assemblies, subassemblies and circuit components. These items are defined as follows:

1. An END ITEM is the instrument with all the supplied accessories. The END ITEM is made up of assemblies to aid in the location of parts.

2. Each assembly and subassembly is assigned an "A" number (A1, A2, A3, etc). Assemblies and subassemblies that can be purchased have part numbers in the part number column of the table; those that cannot be purchased do not have part numbers in the columns.

3. Components within the assembly and subassembly circuits are assignedf circuit reference designators (C1 capacitor, R1 resistor, etc). These parts are prefaced by the assembly number (A1C1, A2C2, A1R1, A2R2, etc), to indicate the assembly on which the part is located.

An example of the alpha-numeric numbering method used to identify assemblies, subassemblies and circuit components is shown below:



The complete reference designations is read as the first resistor (R1) of the first assembly (A1).

6-3. ORDERING INFORMATION.

NOTE: Occasionally, electronic items in the replacement parts list will be found to carry standard commercial identification numbers but which also are indicated as being manufactured by HP. These components have been selected to meet specific operational criteria. The use of these components purchased through normal commercial channels may result in degradation of the operation performance or reliability of the unit.

To order a replacement part, address order or inquiry to the local Hewlett-Packard Sales/Service Office (see list of addresses at the rear of this manual) and supply the HP part number of the item from the listing.

To order a part not listed in a table, provide the following information:

1. Model number of the instrument.

2. Complete serial number of the instrument.

3. Description of the part including function and location.

To order a part from a manufacturer other than Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from the listing. Manufacturer's codes are listed in Table 6-1.

Table 6-1. Manufacture's Code.

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
0003J	NIPPON ELECTRIC CO			
00853	SANGAMO ELEC CO S CAROLINA DIV	PICKENS	SC	29671
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE	CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
0192B	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA	91745
03508	GE CO SEMICONDUCTOR PROD DEPT	SYRACUSE	NY	13201
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04222	AVX CERAMICS CORP	MYRTLE BEACH	SC	29577
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
12617	HAMLIN INC	LAKE MILLS	WI	53551
13606	SPRAGUE ELECT CO SEMICONDUCTOR DIV	CONCORD	NH	03301
17856	SILICONIX INC	SANTA CLARA	CA	95054
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
20932	EMCON DIV ITW	SAN DIEGO	CA	92129
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25088	SIEMENS CORP	ISELIN	NJ	08830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
27777	VARO SEMICONDUCTOR INC	GARLAND	TX	75040
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
32293	INTERSIL INC	CUPERTINO	CA	95014
34649	INTEL CORP	MOUNTAIN VIEW	CA	95051
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
71590	CENTRALAB ELEK DIV GLOBE-UNION INC	MILWAUKEE	WI	50501
72136	ELECTRO MOTIVE CORP SUB IEC	WILLIMANTIC	CT	06226
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108
75915	LITTELFUSE INC	DES PLAINES	IL	60016
84411	TRW CAPACITOR DIV	OGALLALA	NE	69153

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	Q	= transistor	V	= vacuum tube photocell, etc.
B	= motor	FL	= filter	R	= resistor		
BT	= battery	HR	= heater	RT	= thermistor	W	= cable
C	= capacitor	J	= jack	S	= switch	X	= socket.
CP	= coupler	K	= relay	T	= transformer	XDS	= lampholder
CR	= diode	L	= inductor	TB	= terminal board	XF	= fuseholder
DL	= delay line	M	= meter	TC	= thermocouple	Y	= crystal
DS	= device signaling (lamp)	MP	= mechanical part	TP	= test point	Z	= network
E	= miscellaneous electronic part	P	= plug				

ABBREVIATIONS *

A	= amperes	fil hd	= fillister head	n	= nano (10^{-9})	rot	= rotary
ACC	= accessories	flm	= film	NC	= normally closed		
AFC	= automatic frequency control	FR	= front	Ne	= neon	s-b	= slow-blow
Al	= aluminum	fwd	= forward	NETWRK	= network	scon	= semiconductor
AMP	= amplifier	fxd	= fixed	Ni Pl	= nickel plate	Se	= selenium
as ord	= as ordered			NO	= normally open	sect	= section(s)
		G c/s	= gigacycles per second (see G Hz)	NPN	= negative positive negative	SEMS	= machine screw with washer
Be Cu	= beryllium copper			NPO	= negative positive zero (zero temperature coefficient)	SEQ	= sequential
BFO	= beat frequency oscillator	Ge	= germanium			Si	= silicon
bh	= binder head	GEN	= generator			sil	= silver
bp	= bandpass	G Hz	= gigacycles per second	nsr	= not separately replaceable	sl	= slide
brs	= brass	gl	= glass			SPDT	= single-pole double-throw
		grd	= ground(ed)	obd	= order by description		
c/s	= cycles/second (see Hz)			od	= outside diameter	spl	= special
CALIB	= calibration	h	= henry(ies)	ov hd	= oval head	SPST	= single-pole single-throw
ccw	= counterclockwise	hex	= hexagonal	ox	= oxide		
cd pl	= cadmium plate	Hg	= mercury			sst	= stainless steel
cer	= ceramic	Hz	= cycle per second	pc	= printed circuit board	SWTCH	= switch
ch	= channel			PEMS	= circular press fitted nut		
cmo	= cabinet mount only	impg	= impregnated	pF	= picofarad (10^{-12} farads)	Ta	= tantalum
coef	= coefficient	incd	= incandescent	PH	= phone	td	= time delay
com	= common	ins	= insulation(ed)	ph brz	= phosphor bronze	Ti	= titanium
comp	= composition	ips	= inches per second	Phl hd	= Phillips head	tog	= toggle
conn	= connector			piv	= peak inverse voltage	tol	= tolerance
CRT	= cathode-ray tube	k, K	= kilo (1000)	pk	= peak	trim.	= trimmer
cw	= clockwise	Kc, k c/s	= kilocycles (see k Hz)	PNL	= panel	twt	= traveling wave tube
		KEPS	= hex nut with lockwasher	PNP	= positive negative positive		
dB	= decibel	k Hz	= kilocycles/second	poly	= polystyrene	μor U	= micro (10^{-6})
dep C	= deposited carbon			por	= porcelain	μA	= microamperes
DISP	= display	lin	= linear taper	pos	= position(s)	μF	= microfarads
DPDT	= double-pole double-throw	lkwash	= lockwasher	pot	= potentiometer	μV	= microvolts
DPST	= double-pole single-throw	log	= logarithmic taper	pp	= peak-to-peak		
		lp flt	= low-pass filter	PREAMP	= preamplifier	V	= volt(s)
EIA	= tubes or transistors meeting Electronic Industries Association standards will normally result in instrument operating within specifications. tubes and transistors selected for best performance will be supplied if ordered by stock numbers			prec	= precision (temperature coefficient, long term stability, and/or tolerance)	vac	= vacuum
		m	= milli (10^{-3})			Vacw	= volt(s) alternating current working
		mA	= milliamperes				
		mam	= milliammeter			var	= variable
		M	= mega (10^{6})	pt	= point	Vdcw	= volt(s) direct current working
		M c/s	= megacycles (see M Hz)				
		met flm	= metal film	rec	= recorder		
		mfr	= manufacturer	rect	= rectifier	W	= watt(s)
		mH	= millihenry	rev	= reverse	w/	= with
elect	= electrolytic	M Hz	= megacycles/second	rf	= radio frequency	w/o	= without
encap	= encapsulated	minat	= miniature	rh	= round head	wiv	= reverse working voltage
		mom	= momentary	rmo	= rack mount only		
F	= farad(s)	mtg	= mounting	rms	= root-mean-square	ww	= wirewound
fet	= field effect transistor	mV	= millivolt			Ω	= ohm
fh	= flat head	mW	= milliwatt				
FIG	= figure	my	= mylar ~ (Dupont de Nemours)				

Electric Accounting Machines (EAM) capitalize all abbreviations

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
A/P PADDLES		43130A #C03		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		180	I		85-09-05	5364	

YIELD	USAGE	PCSS	KEY	RT.	FD. I	FD. P	FORM	LOCK	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIG)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	YRY			+0							ANT-POST ELECT	C03	14412D		4	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	ECE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
ADULT INTERNAL		43130A #C04		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		180	I			85-09-05	5364	

YIELD	SECT	PUBS	XPLD	RT.	FD. I P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	Y	R	Y	+0						HANDLE SET-INT		C0414990B		4	+1.0000			
		R	Y	+0						ELECT SET-ADULT		C0414993A		M	+1.0000	ST		

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
PED INTERNAL		43130A #C05		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		180	I		85-09-05	5364	

YIELD	SECT	VEND	EXCH	RT.	FD. I	FD. P	FORM	COMP	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	Y			FY+0							HANDLE SET-INT		C0514990B		4	+1.0000				
				FY+0							ELECT SET-PED		C0514992A		M	+1.0000	ST			

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	ECE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
INFANT INTERNAL		43130A #C06		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		180	I			85-09-05	5364	

YIELD	SECT	PUBS	XPLOD	RT.	FD. I P	FORM	CONV	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	Y	Y	Y	+0						HANDLE SET-INT		C0614990B		4	+1.0000			
		Y	Y	+0						ELCTD-INTL INFT		C0614994A		M	+1.0000	ST		

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SERVICE MANUAL		43130A #C07		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		180	I		85-09-05	5364	

YIELD	SECT	PCBS	KPCS	RT.	FD. I P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	MFGR	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
			BY	+0						SERVICE MANUAL	C07	43130-91909		M	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EOE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
DELETE A/A PDLS		43130A #C09		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		005	I		85-11-05	5452	

YIELD	SECT	TYPE	KEY	RT.	FD. I	FD. P	FORM	CONT	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	Y	P	B	+0			N				PDL SET W/O PCI	C09	43100-60406		4	-1.0000				
		P	Y	+0			N				LABEL-LATCH/UN	C09	43100-84502		4	-1.0000				
		P	Y	+0			N				LABEL-APEX	C09	43100-84513		4	-1.0000				
		P	Y	+0			N				LABEL-STERNUM	C09	43100-84514		4	-1.0000				
		P	Y	+0			N				LABEL-CHARGE 2	C09	43100-84517		4	-1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
ACC POUCH KIT		43130A #K01		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		180	I			85-09-05	5364	

YIELD	SELECT	PUBS	XPLD	RT.	FD. I	FD. P	FORM	CONV	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	YR	Y		+0							KIT-SOFT POUCH	K01	43100-69500		M	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
FRENCH LABELS		43130A #L01		1 of

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23	86-08-25	6351	304800 0

S E C T / P U B S / X P L D	RT.	FD.	FORM	ITEM NO.	PART DESCRIPTION	PARENT OPTION	PART NUMBER	LOC	QUANTITY PER	POLICY
FY	+0		N		REMARKS	L01	0000-0000	M	+0.0000	N
				01	43130A #L01 CAN ONLY					
				02	BE PROVIDED WITH					
				03	43130A #N02					
				04	IF ORDERED W/O OPTION					
				05	Z05, SUB 43100-84526					
				06	FOR 43100-84526					
FY	+0		N		LABEL-LATCH/UN	L01	43100-84502	4	-1.0000	
FY	+0		N		LABEL-CAUTION	L01	43100-84503	4	-1.0000	
FY	+0		N		LABEL-LINE V	L01	43100-84507	4	-1.0000	
FY	+0		N		LABEL-IDENT	L01	43100-84509	4	-1.0000	
FY	+0		N		LABEL-BATT COMP	L01	43100-84510	4	-1.0000	
FY	+0		N		LABEL-APEX	L01	43100-84513	4	-1.0000	
FY	+0		N		LABEL-STERNUM	L01	43100-84514	4	-1.0000	
FY	+0		N		LABEL-CHARGE 2	L01	43100-84517	4	-1.0000	
FY	+0		N		LABEL-WARNING HV	L01	43100-84518	4	-1.0000	
FY	+0		N		LABEL-LATCH	L01	43100-84522	4	+1.0000	
FY	+0		N		LABEL-LINE VOLT	L01	43100-84526	4	+1.0000	
FY	+0		N		LABEL-IDENT	L01	43100-84527	4	+1.0000	
FY	+0		N		LABEL-BATT COMP	L01	43100-84528	4	+1.0000	
FY	+0		N		LABEL-APEX	L01	43100-84531	4	+1.0000	
FY	+0		N		LABEL-CHARGE "2"	L01	43100-84533	4	+1.0000	
FY	+0		N		LABEL-WARNING HV	L01	43100-84534	4	+1.0000	
YFB	+0		N		PANEL-ENERGY	L01	43130-61900	4	-1.0000	

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
FRENCH LABELS		43130A #L01		2

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23	86-08-25	6351	304800 0

YIELD	SECT	SUBS	KITS	PT.	FD.	FORM	KONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST 560)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY	ALTERNATE DELIVER TO
	Y	R	B	+0		N				PANEL-ENERGY	L01	43130-61901		4	+1.0000			
		F	Y	+0		N				LABEL-EMER DEFIB	L01	43130-84500		4	-1.0000			
		F	Y	+0		N				LABEL-EMER DEFIB	L01	43130-84501		4	+1.0000			
		F	Y	+0		N				PNL-FRT LED ENGL	L01	43130-84510		4	-1.0000			
		F	Y	+0		N				PNL-FRT LED FREN	L01	43130-84511		4	+1.0000			
		F	Y	+0		N				LABEL-ECG INPUT	L01	43130-84520		4	-1.0000			
		F	Y	+0		N				LABEL-ECG INPUT	L01	43130-84521		4	+1.0000			
		F	Y	+0		N				LBL-PDL PLACEMNT	L01	43130-84526		4	-1.0000			
		F	Y	+0		N				LBL-PDL PLACEMNT	L01	43130-84527		4	+1.0000			
		F	Y	+0		N				LBL-STERNUM	L01	43130-84533		4	+1.0000			
		F	Y	+0		N				CAUTION-DANGER R	L01	43130-84541		4	+1.0000			
		F	Y	+0						OP GUIDE	L01	43130-91908		6	-1.0000			
		F	Y	+0						OP GUIDE-FRENCH	L01	43130-91918		6	+1.0000			

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EOE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
GERMAN LABELS		43130A #L02		1 of

DIV.	MFG. SPECS.	I.T.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23		86-07-28	6311	304800 0

YIELD	SECT / PUBS / XPLD / ST.	FD. I P	FORM	ITEM NO.	REFERENCE DESIGNATOR (FIRST 30)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	FY+0	N				REMARKS		0000-0000		M	+0.0000		N	
				01	43130A	#L02 CAN ONLY		0000-0000						
				02	BE PRO	VIDED WITH		0000-0000						
				03	43130A	#N02		0000-0000						
				04	IF ORD	ERED W/O OPT Z05		0000-0000						
				05	SUB 43	100-84507 FOR		0000-0000						
				06	43100-	84560		0000-0000						
	FY+0					LABEL-INFO		7121-4642		4	+1.0000			
	FY+0		N			LABEL-LATCH/UN		43100-84502		4	-1.0000			
	FY+0		N			LABEL-CAUTION		43100-84503		4	-1.0000			
	FY+0		N			LABEL-LINE V		43100-84507		4	-1.0000			
	FY+0		N			LABEL-IDENT		43100-84509		4	-1.0000			
	FY+0		N			LABEL-BATT COMP		43100-84510		4	-1.0000			
	FY+0		N			LABEL-APEX		43100-84513		4	-1.0000			
	FY+0		N			LABEL-STERNUM		43100-84514		4	-1.0000			
	FY+0		N			LABEL-CHARGE 2		43100-84517		4	-1.0000			
	FY+0		N			LABEL-WARNING HV		43100-84518		4	-1.0000			
	FY+0		N			LABEL-CHARGE "2"		43100-84552		4	+1.0000			
	FY+0		N			LABEL-LATCH/UNLA		43100-84556		4	+1.0000			
	FY+0		N			LABEL-CAUTION		43100-84557		4	+1.0000			
	FY+0		N			LABEL-LINE VOLT		43100-84560		4	+1.0000			
	FY+0		N			LABEL-IDENT		43100-84561		4	+1.0000			
	FY+0		N			LABEL-BATT COMP		43100-84562		4	+1.0000			
	FY+0					LABEL-APEX		43100-84565		4	+1.0000			

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
GERMAN LABELS		43130A #L02		2

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23	86-07-28	6311	304800 0

YIELD	SELECT	VALID	ET.	FD. I P	FOOT NOTE	ITEM NO.	REFERENCE DESIGNATOR (FIRST SET)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	YR	B	+0		N			PANEL-ENERGY		43130-61900		4	-1.0000				
	YR	B	+0		N			PANEL-ENERGY		43130-61903		4	+1.0000				
		FY	+0		N			LABEL-EMER DEFIB		43130-84500		4	-1.0000				
		FY	+0		N			LABEL-EMER DEFIB		43130-84503		4	+1.0000				
		FY	+0		N			PNL-FRT LED ENGL		43130-84510		4	-1.0000				
		FY	+0		N			PNL-FRT LED DUTC		43130-84513		4	+1.0000				
		FY	+0		N			LABEL-ECG INPUT		43130-84520		4	-1.0000				
		FY	+0		N			LABEL-ECG INPUT		43130-84522		4	+1.0000				
		FY	+0		N			LBL-PDL PLACEMNT		43130-84526		4	-1.0000				
		FY	+0		N			LBL-PDL PLACEMNT		43130-84528		4	+1.0000				
		FY	+0		N			LBL-STERNUM		43130-84534		4	+1.0000				
		FY	+0					LABEL-LINE VOLT		43130-84545		4	+1.0000				
		FY	+0					OP GUIDE		43130-91908		6	-1.0000				
		FY	+0					OP GUIDE-GERMAN		43130-91928		6	+1.0000				
		FY	+0					LICENSE-GERMAN		43130-91995		6	+1.0000				

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	SIZE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
DUTCH LABELS		43130A #L03		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23		86-07-28	6311	304800 0

YIELD	SECT/PUBS/XPLD/RT	FD. I/P	FORM	ITEM NO.	REFERENCE DESIGNATOR (FIRST 50)	PART DESCRIPTION	PARENT OPTION	PARTS NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	FY+0	N				REMARKS		0000-0000		M	+0.0000		N	
				01	43130A	#L03 CAN ONLY		0000-0000						
				02	BE PRO	VIDED WITH		0000-0000						
				03	43130A	#N02		0000-0000						
				04	IF ORD	ERED W/O OPT Z05		0000-0000						
				05	SUB 43	100-84507 FOR		0000-0000						
				06	43100-	84545		0000-0000						
	FY+0		N			LABEL-LATCH/UN		43100-84502		4	-1.0000			
	FY+0		N			LABEL-CAUTION		43100-84503		4	-1.0000			
	FY+0		N			LABEL-LINE V		43100-84507		4	-1.0000			
	FY+0		N			LABEL-IDENT		43100-84509		4	-1.0000			
	FY+0		N			LABEL-BATT COMP		43100-84510		4	-1.0000			
	FY+0		N			LABEL-APEX		43100-84513		4	-1.0000			
	FY+0		N			LABEL-STERNUM		43100-84514		4	-1.0000			
	FY+0		N			LABEL-CHARGE 2		43100-84517		4	-1.0000			
	FY+0		N			LABEL-WARNING HV		43100-84518		4	-1.0000			
	FY+0		N			LABEL-LATCH/UNLA		43100-84541		4	+1.0000			
	FY+0		N			LABEL-CAUTION		43100-84542		4	+1.0000			
	FY+0		N			LABEL-LINE VOLT		43100-84545		4	+1.0000			
	FY+0		N			LABEL-IDENT		43100-84546		4	+1.0000			
	FY+0		N			LABEL-BATT COMP		43100-84547		4	+1.0000			
	FY+0		N			LABEL-APEX		43100-84550		4	+1.0000			
	FY+0		N			LABEL-CHARGE "2"		43100-84552		4	+1.0000			
	FY+0		N			LABEL-WARNING HV		43100-84553		4	+1.0000			

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	ECE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
DUTCH LABELS		43130A #L03		2

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23		86-07-28	6311	304800 0

YIELD / SECT / FUSS / XPLD / RT	FD. I P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST 30)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
FY+C		N				LABEL-WARNING HV		43100-84568		4	+1.0000			
YFB+C		N				PANEL-ENERGY		43130-61900		4	-1.0000			
YFB+C		N				PANEL-ENERGY		43130-61902		4	+1.0000			
FY+C		N				LABEL-EMER DEFIB		43130-84500		4	-1.0000			
FY+C		N				LABEL-EMER DEFIB		43130-84502		4	+1.0000			
FY+C		N				PNL-FRT LED ENGL		43130-84510		4	-1.0000			
FY+C		N				PNL-FRT LED GERM		43130-84512		4	+1.0000			
FY+C		N				LABEL-ECG INPUT		43130-84523		4	+1.0000			
FY+C		N				LBL-PDL PLACEMNT		43130-84526		4	-1.0000			
FY+C		N				LBL-PDL PLACEMNT		43130-84529		4	+1.0000			
FY+C		N				LBL-STERNUM		43130-84535		4	+1.0000			
FY+C						OP GUIDE		43130-91908		6	-1.0000			
FY+C						OP GUIDE-DUTCH		43130-91938		6	+1.0000			

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SPANISH LABELS		43130A #L04		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23	86-07-28	6311	304800 0

YIELD	SPECIFIC	PLUS	INT.	FD. I	FD. P	EQUIP	ITEM NO.	REFERENCE DESIGNATOR (FIRST SOI)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY	+0	N					REMARKS		0000-0000		M	+0.0000		N		
							01		43130A #L04 CAN ONLY			0000-0000						
							02		BE PROVIDED WITH			0000-0000						
							03		43130A #N02			0000-0000						
							04		IF ORDERED W/O OPT Z05			0000-0000						
							05		SUB 43100-84507 FOR			0000-0000						
							06		43100-84605			0000-0000						
		FY	+0	N					LABEL-LATCH/UN		43100-84502		4	-1.0000				
		FY	+0	N					LABEL-CAUTION		43100-84503		4	-1.0000				
		FY	+0	N					LABEL-LINE V		43100-84507		4	-1.0000				
		FY	+0	N					LABEL-IDENT		43100-84509		4	-1.0000				
		FY	+0	N					LABEL-BATT COMP		43100-84510		4	-1.0000				
		FY	+0	N					LABEL-APEX		43100-84513		4	-1.0000				
		FY	+0	N					LABEL-STERNUM		43100-84514		4	-1.0000				
		FY	+0	N					LABEL-CHARGE 2		43100-84517		4	-1.0000				
		FY	+0	N					LABEL-WARNING HV		43100-84518		4	-1.0000				
		FY	+0	N					LBL-LATCH/UNLTCH		43100-84601		4	+1.0000				
		FY	+0	N					LBL-CAUTION		43100-84602		4	+1.0000				
		FY	+0	N					LBL-LINE VOLTAGE		43100-84605		4	+1.0000				
		FY	+0	N					LBL-IDENTIF		43100-84606		4	+1.0000				
		FY	+0	N					LBL-BATT COMPART		43100-84607		4	+1.0000				
		FY	+0	N					LBL-APEX		43100-84610		4	+1.0000				
		FY	+0	N					LBL-CHARGE "2"		43100-84612		4	+1.0000				
		FY	+0	N					LBL-WARNING HV		43100-84613		4	+1.0000				

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SPANISH LABELS		43130A #L04		2 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23	86-07-28	6311	304800 0

YIELD	SELECT	FIELD	XPLD	PT.	FD. I	FD. P	FORM	COM'T	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	Y	F	B	+0			N				PANEL-ENERGY		43130-61900		4	-1.0000				
	Y	F	B	+0			N				PANEL-ENERGY		43130-61904		4	+1.0000				
		F	Y	+0			N				LABEL-EMER DEFIB		43130-84500		4	-1.0000				
		F	Y	+0			N				LABEL-EMER DEFIB		43130-84504		4	+1.0000				
		F	Y	+0			N				PNL-FRT LED ENGL		43130-84510		4	-1.0000				
		F	Y	+0			N				PNL-FRT LED SPAN		43130-84514		4	+1.0000				
		F	Y	+0			N				LABEL-ECG INPUT		43130-84520		4	-1.0000				
		F	Y	+0			N				LABEL-ECG INPUT		43130-84524		4	+1.0000				
		F	Y	+0			N				LBL-PDL PLACEMNT		43130-84526		4	-1.0000				
		F	Y	+0			N				LBL-PDL PLACEMNT		43130-84530		4	+1.0000				
		F	Y	+0			N				LBL-STERNUM		43130-84536		4	+1.0000				
		F	Y	+0							OP GUIDE		43130-91908		6	-1.0000				
		F	Y	+0							OP GUIDE-SPANISH		43130-91948		6	+1.0000				

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
ITALIAN LABELS		43130A #L05		1 of

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23		86-07-28	6311	304800 0

YIELD	SECT / PURCH / XPLD	RT.	FORM	ITEM NO.	REFERENCE DESIGNATOR	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY	ALTERNATE DELIVER TO
	FY	+0	N			REMARKS		0000-0000		M	+0.0000		N	
				01		43130A #L05 CAN ONLY		0000-0000						
				02		BE PROVIDED WITH		0000-0000						
				03		43130A #N02		0000-0000						
				04		IF ORDERED W/O OPT Z05		0000-0000						
				05		SUB 43100-84507 FOR		0000-0000						
				06		43100-84626		0000-0000						
	FY	+0	N			LABEL-LATCH/UN		43100-84502		4	-1.0000			
	FY	+0	N			LABEL-CAUTION		43100-84503		4	-1.0000			
	FY	+0	N			LABEL-LINE V		43100-84507		4	-1.0000			
	FY	+0	N			LABEL-IDENT		43100-84509		4	-1.0000			
	FY	+0	N			LABEL-BATT COMP		43100-84510		4	-1.0000			
	FY	+0	N			LABEL-APEX		43100-84513		4	-1.0000			
	FY	+0	N			LABEL-STERNUM		43100-84514		4	-1.0000			
	FY	+0	N			LABEL-CHARGE 2		43100-84517		4	-1.0000			
	FY	+0	N			LABEL-WARNING HV		43100-84518		4	-1.0000			
	FY	+0	N			LABEL-LATCH/UNLA		43100-84622		4	+1.0000			
	FY	+0	N			LABEL-CAUTION		43100-84623		4	+1.0000			
	FY	+0	N			LABEL-LINE VOLT		43100-84626		4	+1.0000			
	FY	+0	N			LABEL-IDENT		43100-84627		4	+1.0000			
	FY	+0	N			LABEL-BATT COMP		43100-84628		4	+1.0000			
	FY	+0	N			LABEL-APEX		43100-84631		4	+1.0000			
	FY	+0	N			LABEL-CHARGE "2"		43100-84633		4	+1.0000			
	FY	+0	N			LABEL-WARNING HV		43100-84634		4	+1.0000			

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	ECE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
ITALIAN LABELS		43130A #L05		2

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-23		86-09-04	6364	304800 0

YIELD	SECT	SUBS	XPLD	RT.	FD.	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY	ALTERNATE DELIVER TO
	Y	R	B	+0						PANEL-ENERGY		43130-61900		4	-1.0000			
	Y	R	B	+0		N				PANEL-ENERGY		43130-61905		4	+1.0000			
		R	Y	+0		N				LABEL-EMER DEFIB		43130-84500		4	-1.0000			
		R	Y	+0		N				LABEL-EMER DEFIB		43130-84503		4	+1.0000			
		R	Y	+0		N				PNL-FRT LED ENGL		43130-84510		4	-1.0000			
		R	Y	+0		N				PNL-FRT LED ITAL		43130-84515		4	+1.0000			
		R	Y	+0		N				LABEL-ECG INPUT		43130-84520		4	-1.0000			
		R	Y	+0		N				LABEL-ECG INPUT	L05	43130-84525		4	+1.0000			
		R	Y	+0		N				LBL-PDL PLACEMNT	L05	43130-84526		4	-1.0000			
		R	Y	+0		N				LBL-PDL PLACEMNT	L05	43130-84531		4	+1.0000			
		R	Y	+0		N				LBL-STERNUM	L05	43130-84537		4	+1.0000			
		R	Y	+0						OP GUIDE	L05	43130-91908		6	-1.0000			
		R	Y	+0						OP GUIDE-ITALIAN	L05	43130-91958		6	+1.0000			

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	ECE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SWEDISH LABELS		43130A #L06		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-11-12		86-10-02	6404	304800 0

YIELD	SECT / PUBS / XPOLD / PT.	FD. I P	FORM / ECONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	PY+0	N				REMARKS	L06	0000-0000		M	+0.0000		N	
				01	CAN ONLY BE PROVIDED									
				02	WITH 43130A #N02.									
				03	IF ORDERED WITHOUT									
				04	43130A #Z05 SUBST.									
				05	43100-84507 FOR									
	PY+0					LABEL-LATCH/UN	L06	43100-84502		4	-1.0000			
	PY+0					LABEL-CAUTION	L06	43100-84503		4	-1.0000			
	PY+0					LABEL-LINE V	L06	43100-84507		4	-1.0000			
	PY+0					LABEL-IDENT	L06	43100-84509		4	-1.0000			
	PY+0					LABEL-BATT COMP	L06	43100-84510		4	-1.0000			
	PY+0					LABEL-APEX	L06	43100-84513		4	-1.0000			
	PY+0					LABEL-STERNUM	L06	43100-84514		4	-1.0000			
	PY+0					LABEL-CHARGE 2	L06	43100-84517		4	-1.0000			
	PY+0					LABEL-WARNING HV	L06	43100-84518		4	-1.0000			
	PY+0					LABEL-BATT COMP	L06	43100-84562		4	+1.0000			
	PY+0					LBL-LATCH/UNLTCH	L06	43100-84656		4	+1.0000			
	PY+0					LBL-CAUTION/DANG	L06	43100-84657		4	+1.0000			
	PY+0					LBL-LINE VOLTAGE	L06	43100-84660		4	+1.0000			
	PY+0					LBL-IDENT	L06	43100-84661		4	+1.0000			
	PY+0					LBL-CHARGE "2"	L06	43100-84663		4	+1.0000			
	PY+0					LBL-APEX	L06	43100-84665		4	+1.0000			
	PY+0					LBL-CHARGE "2"	L06	43100-84666		4	+1.0000			
	PY+0					LBL-WARNING, HV	L06	43100-84667		4	+1.0000			

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SWEDISH LABELS		43130A #L06		2 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-11-12	86-10-02	6404	304800 0

YIELD	SELECT	PUBS	XPLD	PT.	FD. I	FD. P	FORM	CONT	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		PB		+0							LABEL-ON/OFF SWD	L06	43120-84536		4	+1.0000				
	Y	PB		+0							PANEL-ENERGY	L06	43130-61900		4	-1.0000				
	Y	PB		+0							SWITCH AY	L06	43130-61906		4	+1.0000				
		PY		+0							LABEL-EMER DEFIB	L06	43130-84500		4	-1.0000				
		PY		+0							LBL-EMERG DEFIB	L06	43130-84506		4	+1.0000				
		PY		+0							PNL-FRT LED ENGL	L06	43130-84510		4	-1.0000				
		PY		+0							PNL-FRT LED SWED	L06	43130-84516		4	+1.0000				
		PY		+0							LABEL-ECG INPUT	L06	43130-84520		4	-1.0000				
		PY		+0							LBL-PDL PLACEMNT	L06	43130-84526		4	-1.0000				
		PY		+0							LBL-ECG INPUT	L06	43130-84538		4	+1.0000				
		PY		+0							LBL-PDL PLACMNT	L06	43130-84539		4	+1.0000				
		PY		+0							LBL-STERNUM	L06	43130-84540		4	+1.0000				
		PY		+0							OP GUIDE	L06	43130-91908		M	-1.0000				
		PY		+0							OP GUIDE-SWEDISH	L06	43130-91968		M	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
CSA APPROVAL		43130A #N01		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-08-29	86-09-30	6402	304800 0

YIELD	SECT	PCSS	XYZS	FT.	FD. I	FD. P	FORM	LOWER	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY		+0		N					REMARKS	N01	0000-0000		M	+0.0000		N		
									01		PARTS TO BE PACKAGED									
									02		AND SENT WITH UNIT									
		FY		+0		N					LABEL-CSA	N01	7120-6645		4	+1.0000				
		FY		+0	R	YN					LABEL-INFO	N01	7121-2526		4	+1.0000		YREQ		
		FY		+0	R	N					BAG-PLASTIC	N01	9222-0366		M	+1.0000		NREQ		
		FY		+0		N					LABEL-CAUTION	N01	43100-84503		4	-1.0000				
		FY		+0		N					LBL-CAUTION	N01	43100-84504		4	+1.0000				
		FY		+0		N					LABEL-IDENT	N01	43100-84509		4	-1.0000				
		FY		+0		N					LABEL-WARN,CSA	N01	43100-84520		4	+1.0000				
		FY		+0							LABEL-LATCH	N01	43100-84522		4	+1.0000				
		FY		+0							LABEL-BATT COMP	N01	43100-84528		4	+1.0000				
		FY		+0							LABEL-EMER DEFIB	N01	43130-84501		4	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EOE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
IEC/VDE APPROVAL		43130A #N02		1 OF

DIV.	MFG. SPECS.	I.T.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		007	I	85-11-05		89-02-13	9071	304800 0

YIELD	SECT	PUBS	XPLD	RT.	FD. I	FD. P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	ISSUE	ALTERNATE DELIVER TO
		F	Y	+0			N				CONN-SGL CONT	N02	1251-5964		4	+1.0000				
		F	Y	+0			N				BINDING POST-SGL	N02	1510-0038		4	-1.0000				
		F	Y	+0		N					DECAL,UL	N02	7120-7599		4	-1.0000		N		
		F	Y	+0							WARRANTY STMNT	N02	5953-6726		M	-1.0000				
		F	Y	+0							GUTS PROCEDURE	N02	5953-9964		M	-1.0000				
	Y	F	Y	+0			N				PCA BREAKERS	N02	43100-60160		4	-1.0000				
	Y	F	Y	+0			N				PCA BREAKERS	N02	43100-60161		4	+1.0000				
	Y	F	B	+0							CBL AY-LOW VOLT	N02	43100-61621		4	+1.0000				
		F	Y	+0							CASE AY-LWR	N02	43100-87106		4	-1.0000				
	Y	F	Y	+0			N				CASE AY-LWR MOD	N02	43120-87102		4	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDC NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
WALL MNT HRDWARE		43130A #R01		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304041FG

YIELD	SECT	PUBD	MPLD	MT.	FD. I P	FORM	LOAD	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PRESENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		PY		+0						HOLDER-WALL MTG		1400-1401		M	+1.0000				
		PY		+0						INST-WALL MT KIT		43100-91922		M	+1.0000				
															END OF OPTION LIST				

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
TAPE-UMATIC		43130A #Y01		1 OF

DIV.	MFG. SPECL	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304041FG

YIELD	SELECT	OPTION	QTY.	FD. I P	FORM	CONV	ITEM NO.	REFERENCE DESIGNATOR (FIRST SET)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
		FY	+0						TAPE-UMATIC		43100-89000		M	+1.0000			

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
TAPE-VHS		43130A #Y02		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I			86-07-28	6311	304041FG

YIELD	SECT	PURCH	XPLOD	FT.	FD. I:P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST 30)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	P	Y	+0							TAPE-VHS		43100-89001		M	+1.0000			

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDIT NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
TAPE-BETA		43130A #Y03		1 OF

DIV.	PEC. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304041FG

YIELD	STRUCT	ASSMB	XPLD	RT.	FD. I	FD. P	FGRP	LDWR	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEG)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY		+0							TAPE-BETA		43100-89002		M	+1.0000				

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	ESE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SVC TAPE-UMATIC		43130A #Y04		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304041FG

YIELD	SELECT	PCSS	XPLD	BT.	FD. I	FD. P	FORM	LOCK	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY	+0								SVC TAPE-UMATIC		43100-89003		M	+1.0000				

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SVC TAPE-VHS		43130A #Y05		1 OF

DIV.	MFG. SPEC.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304041FG

YIELD	SELECT	XPLD	XPLD	QTY.	PCL. I	PCL. P	FORM	LOAD	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY		+0							SVC TAPE-VHS		43100-89004		M	+1.0000				

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SVC TAPE-BETA		43130A #Y06		1 OF

DIV.	PPL SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304041FG

YIELD	SELECT	PUBD	XPLD	RT.	FD. I P	FORT	LOW T	ITEM NO.	REFERENCE DESIGNATOR (FIRST SET)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
			FY	+0						SVC TAPE-BETA		43100-89005		M	+1.0000				

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
50Hz OPERATION		43130A #Z01		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-10-31		86-07-28	6311	

YIELD	SECT	PUBSD	XPLD	RT.	FD. I P	FORM	CONV	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
	FY+0				N					REMARKS		0000-0000		M	+0.0000		N	
								01	OPTION	Z01 CAN ONLY BE		0000-0000						
								02	PROVIDED	WITH		0000-0000						
								03	43130A	#N02		0000-0000						

END OF OPTION LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
100V POWER		43130A #Z02		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I	85-09-11	86-07-28	6311	304800 0

YIELD	SELECT	SPLD	XPLD	RT.	FD. I P	FORM	ECNF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEV)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
	FY	+0	N							REMARKS		0000-0000		M	+0.0000		N		
								01		OPTION Z02 CAN ONLY BE			0000-0000						
								02		PROVIDED WITH			0000-0000						
								03	43130A	#N02			0000-0000						
															END OF OPTION LIST				

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
230V POWER		43130A #Z05		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		007	I	85-08-29	89-02-13	9071	304800 0

YIELD	SELECT	PUBS	XPLD	RT.	FD. I	FD. P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEG)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY		+0		N					REMARKS	Z05	0000-0000		M	+0.0000		N		
									01		OPTION Z05 CAN ONLY BE									
									02		PROVIDED WITH									
									03		43130A #N02									
		YF	Y	+0		N					PCA BATTERY CHGR	Z05	43100-60140		4	-1.0000				
		YF	Y	+0		N					PC AY-PWR SPLY	Z05	43100-60141		4	+1.0000				
		YF	B	+0							CBL AY-LOW VOLT	Z05	43100-61621		4	-1.0000				
		YF	B	+0							CBL AY-HIGH VOLT	Z05	43100-61641		M	+1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
UK PWR CORD		43130A #900		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-09-29	6401	304800 0

YIELD	SELECT	SPECIAL	EFF.	FD. I	FD. P	FORM	CONT	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEC)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY	+0			N				CBL-POWER CORD	900	8120-1703		4	+1.0000				
		FY	+0							CBL AY-PWR CORD	900	8120-4759		4	-1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
AUST PWR CORD		43130A #901		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304800 0

YIELD	SUBSTITUTE GROUP	MATERIAL TYPE	EFF.	FD. I P	FROM	LOCK	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEV)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	ISSUE	ALTERNATE DELIVER TO
		FY	+0						CBL-POWER CORD		8120-4464		4	+1.0000				
		FY	+0						CBL AY-PWR CORD		8120-4759		4	-1.0000				
														END OF OPTION LIST				

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
EUR PWR CORD		43130A #902		1 OF

DIV.	MFG. SPEC.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-08-25	6351	304800 0

YIELD	SECT	FLSD	KPLD	RT.	FD. I	FD. P	FORM	CONF	ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY		+0			N				CBL-POWER CORD	902	8120-1692		4	+1.0000				
		FY		+0							CBL AY-PWR CORD	902	8120-4759		4	-1.0000				

END OF MATERIAL LIST

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
SWISS PWR CORD		43130A #906		1 OF

DIV.	FPL SPECL	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304800 0

YIELD	SELECT	VALID	EXPLD	PT.	FD. I P	FORM	EXCH	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEG)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY	+0							CBL-POWER CORD		8120-2296		4	+1.0000				
		FY	+0							CBL AY-PWR CORD		8120-4759		4	-1.0000				
															END OF OPTION LIST				

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
DANISH PWR CORD		43130A #912		1 OF

DIV.	MFG. SPECS.	LT.	PRIMARY MODEL	RELEASE DATE	REVISION DATE	CYCLE	DELIVER TO
30		010	I		86-07-28	6311	304800 0

YIELD	SPECIAL	PHANTOM	EFF.	FTD. I	FTD. P	FORM	LOCK	ITEM NO.	REFERENCE DESIGNATOR (FIRST SEG)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P	POLICY ISSUE	ALTERNATE DELIVER TO
		FY	+0							CBL-POWER CORD		8120-2957		4	+1.0000				
		FY	+0							CBL AY-PWR CORD		8120-4759		4	-1.0000				
										END OF OPTION LIST									

MATERIAL LIST

HEWLETT PACKARD

DESCRIPTION	EDE NUMBER	MODEL OR ASSEMBLY NUMBER	OPTION	PAGE
S.AFRICA PWR CD		43130A #917		1 OF

DIV.	MFG. SPECS.	L.T.	PRIMARY MODEL	RELEASE DATE		REVISION DATE	CYCLE	DELIVER TO
30		010	I			86-07-28	6311	304800 0

YIELD	SECT	FLDS	XPLD	RT.	FC. I P	FORM	CODE	ITEM NO.	REFERENCE DESIGNATOR (FIRST 30)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM	POLICY P ISSUE	ALTERNATE DELIVER TO
		FY	+C							CBL-POWER CORD		8120-4600		4	+1.0000			
		FY	+C							CBL AY-PWR CORD		8120-4759		4	-1.0000			

END OF OPTION LIST

	FRONT PANEL	ENERGY PNL	PDL PLCMT	EMERG INST	LATCH/UN	CAUTION	BEEP VOL	ECG INPT
43130A	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84503	43130-84590	43130-84520
43130A #C09	43130-84510	43130-61900	43130-84526	43130-84500		43100-84503	43130-84590	43130-84520
43130A #L01	43130-84511	43130-61901	43130-84527	43130-84501	43100-84522	43100-84523	43130-84590	43130-84521
43130A #L02	43130-84512	43130-61902	43130-84528	43130-84502	43100-84556	43100-84557	43130-84590	43130-84522
43130A #L03	43130-84513	43130-61903	43130-84529	43130-84503	43100-84541	43100-84542	43130-84590	43130-84523
43130A #L04	43130-84514	43130-61904	43130-84530	43130-84504	43100-84601	43100-84602	43130-84590	43130-84524
43130A #L05	43130-84515	43130-61905	43130-84531	43130-84505	43100-84622	43100-84623	43130-84590	43130-84525
43130A #L06	43130-84516	43130-61906	43130-84539	43130-84506	43100-84656	43100-84657	43130-84590	43130-84538
43130A #N01	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84504	43130-84590	43130-84520
43130A #N02	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84503	43130-84590	43130-84520
43130A #N05	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84503	43130-84590	43130-84520
43130A #Z01	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84503	43130-84590	43130-84520
43130A #Z02	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84503	43130-84590	43130-84520
43130A #Z05	43130-84510	43130-61900	43130-84526	43130-84500	43100-84502	43100-84503	43130-84590	43130-84520

	LINE V	IDENT	BATTCOMP	STERN	APEX	GND	CHG 2	WARNING HV
43130A	43100-84507	43100-84509	43100-84510	43100-84514	43100-84513	43100-84515	43100-84517	43100-84518
43130A #C09	43100-84507	43100-84509	43100-84510			43100-84515		43100-84518
43130A #L01	43100-84526	43100-84527	43100-84528	43130-84533	43100-84531	43100-84516	43100-84533	43100-84534
43130A #L02	43100-84560	43100-84561	43100-84562	43130-84534	43100-84565	43100-84516	43100-84552	43100-84568
43130A #L03	43100-84545	43100-84546	43100-84547	43130-84535	43100-84550	43100-84516	43100-84552	43100-84553
43130A #L04	43100-84605	43100-84606	43100-84607	43130-84536	43100-84610	43100-84516	43100-84612	43100-84613
43130A #L05	43100-84626	43100-84627	43100-84628	43130-84537	43100-84631	43100-84516	43100-84633	43100-84634
43130A #L06	43100-84660	43100-84661	43100-84662	43130-84540	43100-84665	43100-84516	43100-84666	43100-84667
43130A #N01	43100-84507	43100-84520	43100-84510	43100-84514	43100-84513	43100-84515	43100-84517	43100-84518
43130A #N02	43100-84507	43100-84509	43100-84510	43100-84514	43100-84513	43100-84516	43100-84517	43100-84518
43130A #N05	43100-84508	43100-84509	43100-84510	43100-84514	43100-84513	43100-84516	43100-84517	43100-84518
43130A #Z01	43100-84508	43100-84509	43100-84510	43100-84514	43100-84513	43100-84516	43100-84517	43100-84518
43130A #Z02	43100-84617	43100-84509	43100-84510	43100-84514	43100-84513	43100-84516	43100-84517	43100-84518
43130A #Z05	43100-84508	43100-84509	43100-84510	43100-84514	43100-84513	43100-84516	43100-84517	43100-84518

	GND SYM, VDE	CSA	INFO					
43130A								
43130A #C09								
43130A #L01	43100-84569							
43130A #L02	43100-84569							
43130A #L03	43100-84569							
43130A #L04	43100-84569							
43130A #L05	43100-84569							
43130A #L06	43100-84569							
43130A #N01		7120-6645	7121-2526					
43130A #N02	43100-84569							
43130A #N05	43100-84569							
43130A #Z01	43100-84569							
43130A #Z02	43100-84569							
43130A #Z05	43100-84569							

HEWLETT-PACKARD DEFIBRILLATORS

CASE PART NUMBERS
For HP 43130 Defibrillator

Model	Features	Case Part Numbers
HP 43130A	Attached power cord Serial Prefix <2601	Upper 43100-87110 Lower 43100-87100
	Detachable power cord Protective feet Serial prefix ≥2601	Upper 43100-87116 Lower 43100-87106
	Option #N02 Rear Power Switch	Upper 43100-87116 Lower 43100-87102