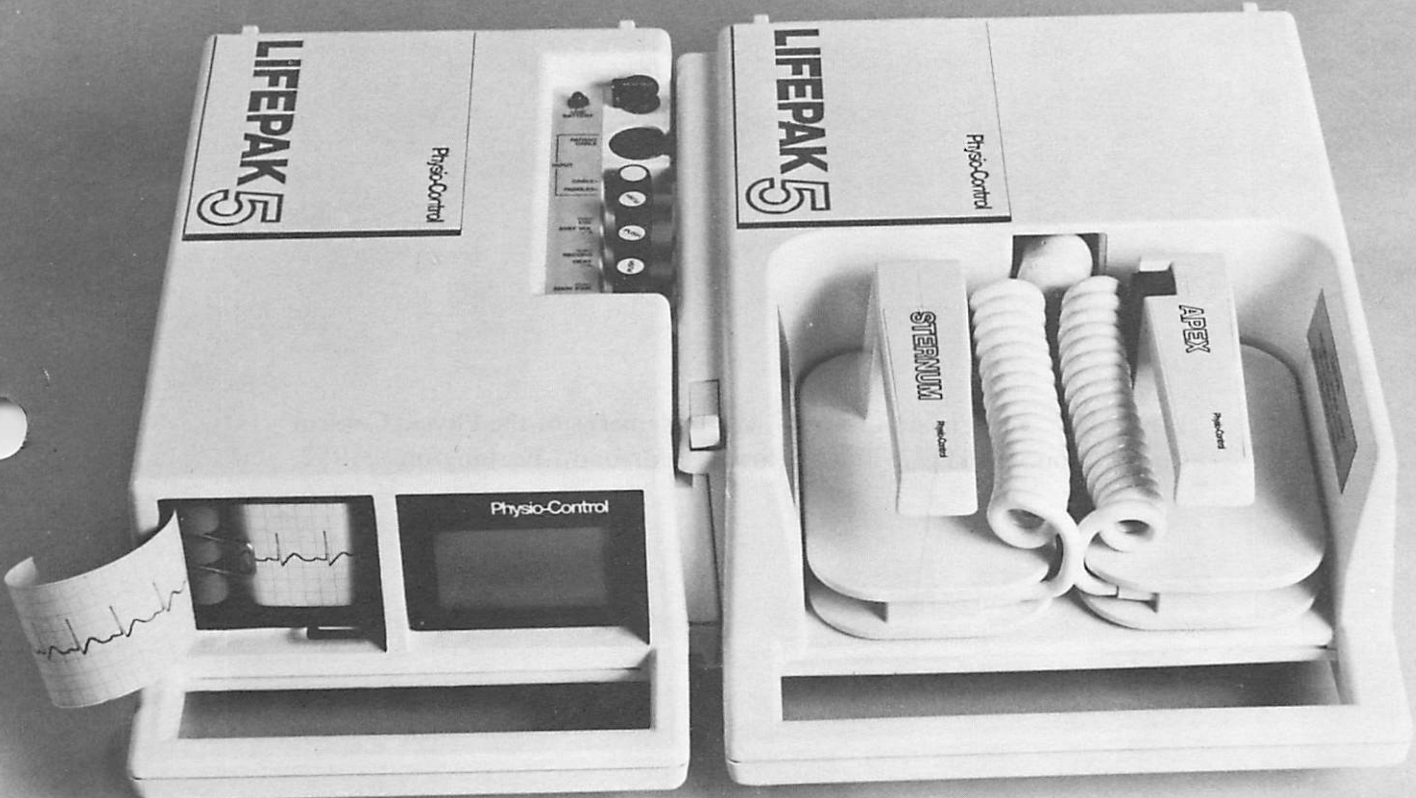
Operating and Service Manual

LIFEPAK® 5

Cardioscope/Recorder and DC Defibrillator



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Physio-Control®

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SERIAL NO. ____________

Litho in U.S.A.

CHANGE SUMMARY

Due to continuing design update and addition of options available, the configuration of this instrument may change. This form will accompany any change pages impacted by a particular design change or update. This is a continuing historical form that will log all changes, with the date of these changes and the pages effected. Each individual change page will be dated at the bottom of the page, a page with no date is an original page. Check the change information section at the rear of this manual for any interim changes. For more detailed information concerning changes, contact your Service Representative or Physio-Control, Redmond, Washington.

CHANGE DATE	PAGES EFFECTED	REASON FOR CHANGE	EFFECTIVITY
26 Jul 1976	All	Completely retyped and updated	
Jan 1977	i,ii,iii,1-1,1-3 thru 1-7,2-2 thru 2-6,2-10,2-10A, 2-11,2-14,2-16, 2-17,3-1,3-11, 3-12,3-14,3-20 thru 3-24,3-27, 3-28,3-31,3-31A, 3-31B,3-32,3-32A, 3-33,3-34,4-1,4-2, 4-4,4-5,4-8,4-9, 4-12,4-15,4-18 thru 4-27,4-31,4-32, 4-34,4-35,4-35A, 4-39 thru 4-48	Pages of Text (Sections 1 thru 4) updated to latest configuration and functional changes including options.	
	All of Section 5 5-1 thru 5-65	Section 5 updated with new drawings and parts lists.	
	Section 6 6-1 thru 6-17	Added new section providing engineering schematic drawings.	
May 1978	Front page, 1-2 thru 1-7, 2-3 thru 2-6, 2-9 thru 2-14, 2-16, 3-1, 3-15 thru 3-18, 3-21, 3-23, 3-24, 3-27, 3-28, 3-31 thru 3-34 (added pages 3-32B&C), 4-12, 4-23, 4-24, 4-31 thru 4-35A, 4-40, 4-42 thru 4-48, (added pages 4-45A&B)	Pages of text (Sections 1 thru 4) updated to latest configuration and functional changes including the high energy option.	
	5-2 thru 5-65	Section V; updated assembly drawings & parts lists.	

CHANGE SUMMARY
(continued)

CHANGE DATE	PAGES EFFECTED	REASON FOR CHANGE	EFFECTIVITY
May 1978	6-1 thru 6-16	Section VI; updated the engineering schematic drawings to the latest configuration.	

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SECTION 1

INTRODUCTION

1-1. SCOPE

This manual provides the operating and service procedures for the LIFEPAK 5 Cardioscope/Recorder and DC Defibrillator Modules manufactured by Physio-Control Corporation, Redmond, Washington.

The six sections of the manual provide introductory, physical and functional descriptions; operating procedures; circuit description; maintenance procedures; illustrated parts lists; and engineering drawings.

1-2. PHYSICAL DESCRIPTION

The following paragraphs provide a brief physical description of the cardioscope/recorder and DC defibrillator modules plus accessory equipment available.

Figure 1-1 shows the LIFEPAK® 5, Cardioscope/Recorder Module, DC Defibrillator Module, Battery/Pak, and optional Battery/Pak Charger. Table 1-1 lists the general specifications of LIFEPAK 5.

1-3. GENERAL

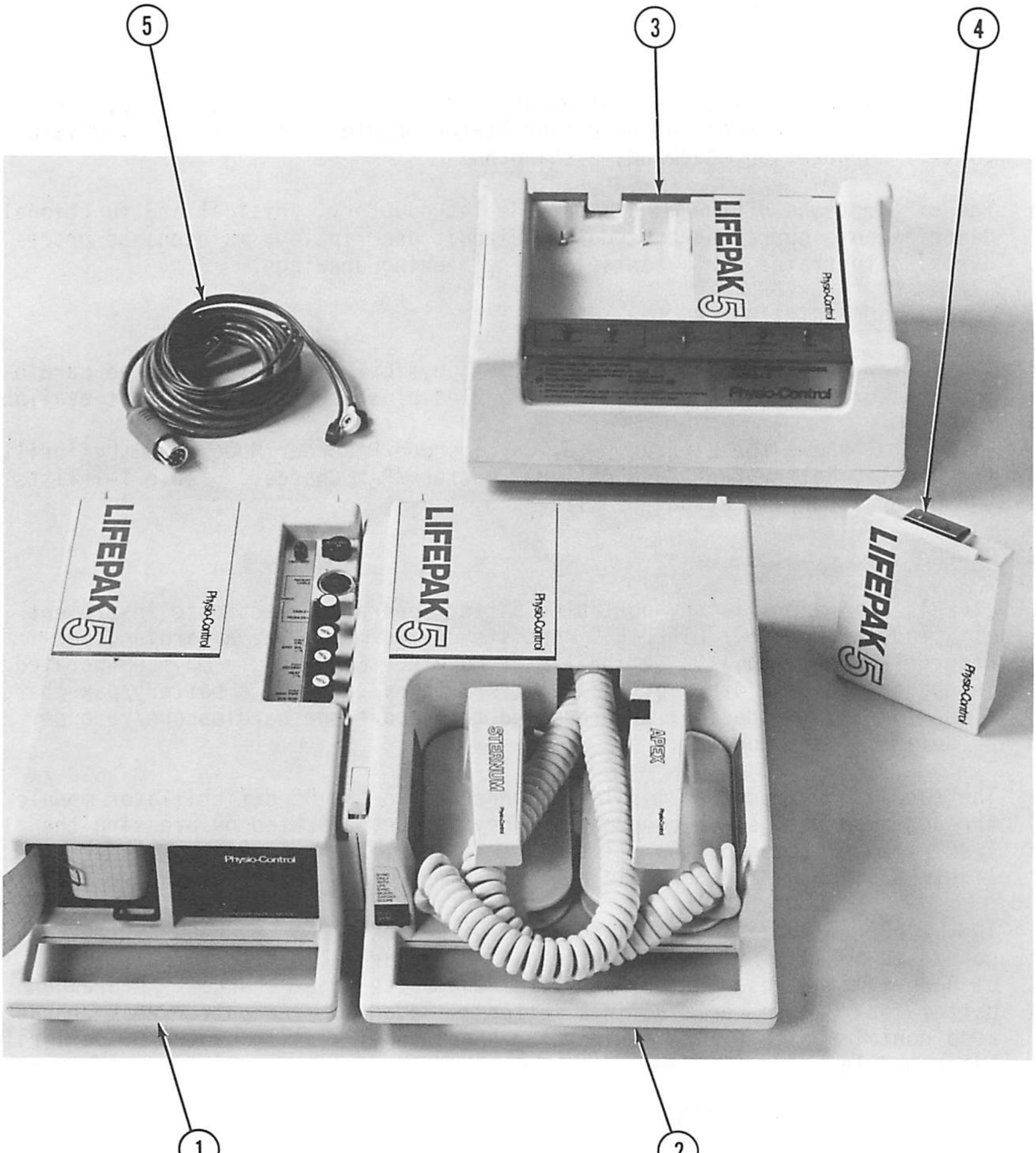
LIFEPAK 5 is a precision, portable, battery operated electronic instrument of a modular design. LIFEPAK 5 consists of two modules: a Cardioscope/Recorder Module and a DC Defibrillator Module. Each module may be operated independent of the other or as a unit. Battery/paks and a battery/pak charger, also of a modular design, are required to support the cardioscope/recorder and DC defibrillator modules.

The cardioscope/recorder module is connected to the DC defibrillator module through a special slide connector. They may be separated by pressing the lock release button on the slide. When joined, the two units provide a lightweight combination providing the ultimate in portability and versatility.

The LIFEPAK 5 Cardioscope/Recorder and DC Defibrillator modules are never connected to AC line power. Instead, the rechargeable battery/paks are exchanged with fresh battery/paks from the battery/pak charger. A drained battery/pak can be replaced in a matter of seconds. The battery/pak charger also contains a test load for regular operational testing of the DC defibrillator module.

1-4. CARDIOSCOPE/RECORDER MODULE

The cardioscope/recorder provides a means of rapidly assessing the patient's condition in a non-hospital environment such as paramedics may encounter. Because of the cardioscope/recorder's small size and weight, it may be easily placed on the patient's stretcher for continuous monitoring while transporting a patient. The cardioscope/recorder provides a continuous no-fade display through either a cardioscope for real time monitoring or through a delayed recorder display allowing the user to obtain a hard copy of the information displayed on the cardioscope.



1. CARDIOSCOPE/RECORDER
2. DC DEFIBRILLATOR
3. BATTERY/PAK CHARGER
4. BATTERY/PAK
5. PATIENT CABLE

Figure 1-1. LIFEPAK®5

TABLE 1-1.

LIFEPAK 5 GENERAL SPECIFICATIONS

CHARACTERISTIC	*QUANTITY OR SPECIFICATION
CARDIOSCOPE/RECORDER MODULE:	
● SIZE (Envelope)......................	3/8x7.5x13.3 inches (9.7x19.1x33.8cm)
● WEIGHT (including battery/pak........	8.25 pounds (3.7 kg)
● CARDIOSCOPE DISPLAY..................	60 x 36 mm
Sweep Speed........................	25 mm/sec ±1 mm
Bandwidth (3 dB)..................	0.5 to 40 Hz
● RECORDER DISPLAY.....................	40 mm
Sweep Speed........................	25 mm/sec ±0.75 mm
Bandwidth (3 dB)..................	0.5 to 40 Hz
● ECG OUTPUT...........................	1 volt/millivolt (optional 1 mv/mv)
Bandwidth..........................	0.1 to 40 Hz
● POWER SOURCE (Battery/Pak)........... (see below also)	Nickel Cadmium Battery, 12 VDC, 1 AH
Cardioscope monitoring.............	1.7 hour minimum at -10°C
Cardioscope monitoring in conjunction with 10 minutes of recorder monitoring......................	1 hour minimum at -10°C
● INPUT: Obtained through 3-lead (six lead connector) patient cable or paddles...................	Patient Cable 10 feet (3 m) plus 3 feet (0.9 m) with leads
Common Mode Rejection (to chassis ground with 5 Kohm misbalance)....	80 dB minimum
● LOW BATTERY INDICATOR (flashes when battery is low)....................	Terminal voltage of 10.2 nominally at 25°C
● ENVIRONMENTAL CONDITIONS (see below)	
DC DEFIBRILLATOR MODULE:	
● SIZE (envelope)......................	3.8x9.2x13.3 inches (9.7x23.4x33.8 cm)
● WEIGHT (including battery/pak).......	10.5 pounds (4.7 kg)
● WAVEFORM.............................	Monophasic Pulse, 5 milliseconds (Edmark)
● OUTPUT ENERGIES (delivered)..........	40,80,120,180,240,320 joules ± 10% (Optional 20,50,100,200,300,400 joules ± 10%)
● CHARGE TIME TO 300 JOULES............	10 seconds
(CHARGE TIME TO 400 JOULES)..........	12.5 seconds
● ENERGY BLEED DOWN AFTER 30 SECONDS...	15% maximum
● BATTERY TEST INDICATOR (flashes when down to)...............	Terminal voltage of 10.2 nominally @ 25°C

(continued on next page)

TABLE 1-1.

LIFEPAK 5 GENERAL SPECIFICATIONS (continued)

CHARACTERISTIC	* QUANTITY OR SPECIFICATION
DC DEFIBRILLATOR MODULE (continued)	
● OUTPUT PADDLES:	
Size..............................	82 cm^2
Coil cord length..................	7.5 feet (2.3 m)
● POWER SOURCE (Battery/Pak)..........	Nickel Cadmium Battery, 12 VDC, 1 AH
Capability (see below also).......	12 300 joule discharges minimum at -10°C. 32 400 joule discharges minimum at +25°C.
● DEFIBRILLATOR SYNCHRONIZER (option) Synchronized defibrillating pulse for elective cardioversion timed to occur on the down slope of the first patient-generated R-wave which follows defibrillate command.	
Sync Indicator..................	Intensification marker on CRT trace identifies sync trigger point.
Sensitivity Control.............	ECG size control acts as threshold control.
Sync-Defib Mode Control.........	Pushbutton switch can be depressed to change mode instantly from Sync to Defib or Defib to Sync.
● ENVIRONMENTAL CONDITIONS (see below)	
ACCESSORIES:	
● BATTERY/PAK.........................	Nickel Cadmium
Size (envelope)..................	1.1x3.7x5.4 inches (2.8x9.4x13.7cm)
Weight...........................	1.3 pounds (0.6 kg)
Output...........................	12 VDC, 1 AH
● BATTERY/PAK CHARGER:	
Size (envelope)..................	4.3x11.3x8.3 inches (10.9x28.7x21.1cm)
Weight...........................	5.25 pounds (2.4 kg)
Power Source=....................	115V, 50-60 Hz; 230V, 50-60 Hz; or 11-15 VDC. (max. input power 30W)
Recharge Time (two battery/paks charged simultaneously) at 25°C	4-5 hours
Test Load........................	50 ohms ±5 ohms
ENVIRONMENTAL CONDITIONS (excluding battery/pak charger): Unless otherwise stated the performance requirements of LIFEPAK 5 shall be met under the following storage and operating conditions.	
● TEMPERATURE RANGE..................	-10°C to +55°C (operating) -35°C to +65°C (storage)

(continued on next page)

TABLE 1-1.

LIFEPAK 5 GENERAL SPECIFICATIONS (continued)

CHARACTERISTIC	*QUANTITY OR SPECIFICATION
ENVIRONMENTAL CONDITIONS (continued)	
● ATMOSPHERIC PRESSURE	525 mm Hg to 800 mm Hg
● RELATIVE HUMIDITY	0 to 95%
● VIBRATION (capable of meeting after vibration)	MIL-STD-810C Method 514.2 curve V
● SHOCK (capable of meeting after shock).............................	MIL-STD-810C Method 516.2 Procedure 1, figure 516.2-2
● SPLASH TEST (capable of meeting after splash, excluding paper recorder) ..	MIL-STD-108E, paragraph 4.9
● DROP (without resulting in operator or patient hazard during drop)......	1.5 foot (45.7 cm) drop on a concrete floor on each axis (6 drops)
● TELEMETRY (operate with)	ECG telemetry equipment (operating at 450 M Hz up to 15 watts) shall not be located closer than 6 inches (15.3 cm)

*Specifications subject to change without notice.

1-5. DC DEFIBRILLATOR MODULE

The DC defibrillator provides the means to deliver a controlled monophasic defibrillating pulse to the patient's heart. The paddles provided with the unit may be used either to monitor the patient's ECG signal, when used in conjunction with the cardioscope/recorder, or to deliver the defibrillating pulse. Operation of the DC defibrillator module is accomplished entirely through controls mounted on the paddles. This provides the user with a greater flexibility, helping to eliminate the dependency on other personnel.

1-6. ACCESSORY EQUIPMENT

The following accessory equipment is available with the LIFEPAK 5.

1-7. BATTERY/PAK CHARGER

The battery/pak charger is capable of delivering 300 MA to each of two battery/packs. Full charge in 4-5 hours for depleted cells. The charger contains a test load for testing the DC defibrillator. The battery charger will operate on 115V, 50-60 Hz; 230V, 50-60 Hz; or 11-15 VDC.

1-8. BATTERY/PAK

The battery/paks are made of high quality rechargeable nickel-cadium cells with the following capabilities:

1. Cardioscope/Recorder Module. Capable of delivering 1.7 hours of cardioscope monitoring or one hour of cardioscope monitoring and 10 minutes of monitoring and recording at - $10^{o}C$.

2. DC Defibrillator Module. Capable of delivering twelve 400 joule discharges at $-10^{o}C$ and at least 32 discharges at $25^{o}C$.

1-9. PATIENT CABLE

Ten-foot shielded three lead cable with six pin connector (W, R, G).

1-10. FEATURES AND FUNCTIONAL DESCRIPTION

The following paragraphs provide a functional description of the cardioscope/recorder and DC defibrillator modules.

1-11. CARDIOSCOPE/RECORDER MODULE

All controls are clearly labeled and accessible at the top of the unit. The location and function of all controls are described and illustrated in Section 2.

The patient-generated ECG waveform is displayed on either the no-fade cardioscope or recorder which are driven by electrical networks designed for fast recovery from external overloading signals. The cardioscope trace sweeps at 25 mm/sec. The recorder provides documentation at 25 mm/sec. that is delayed by 2.4 seconds. In effect, this provides the user with a 2.4 second memory. The circuitry is shielded to reject radio frequency interference.

When monitoring a patient's ECG waveform through the patient cable, lead II is usually viewed. This input is completely protected from high voltage levels as may be obtained from the DC defribillator. A systole beeper with adjustable volume level is provided for audible monitoring when the cardioscope or recorder cannot be watched.

All information displayed on the cardioscope or recorder has been stored first in a digital memory. The patient ECG signal is sampled continuously and each time a sample has been taken, the signal at that instant is converted into a binary word and stored in the memory.

The following additional features are included in the cardioscope/recorder unit: a one volt/millivolt ECG signal in real time is available at the ECG OUT jack for radio or telephone telemetry; a one millivolt calibration switch (CAL) is provided to calibrate the instrument; a low battery indicating light that flashes when battery terminal voltage is nominally 11.5V at 25°C.

1-12. DC DEFIBRILLATOR MODULE

All controls are mounted on the paddles. The location of all controls are described and illustrated in Section 2.

Features on the DC defibrillator module include: a ready flasher indicating the state of charge of the charge storage capacitor; and a battery test function which flashes the on indicator when battery terminal voltage is nominally 11.5V at 25°C.

A charge storage capacitor is the source of the high voltage defibrillating pulse. On command, relays disconnect the capacitor from the charging circuitry and a resultant pulse is discharged through the chest of a patient, through the external paddles. The energy available from the DC defibrillator can be adjusted in six discrete positions ranging from 40 to 320 joules (or optional 400 joule unit) delivered. Occasionally a defibrillating pulse must be repeated. The DC defibrillator generally is capable of being recharged to meet this need in 10 seconds. (12.5 seconds for 400 j unit)

1-13. SYNCHRONIZED CARDIOVERSION (option)

The synchronizer option is available for the LIFEPAK 5 at the time the instrument is manufactured with circuitry for this option, installed in both the Cardioscope/Recorder and Defibrillator modules. The LIFEPAK 5 Cardioscope/Recorder and Defibrillator modules will operate identically to the standard models when operated separately.

NOTE: Synchronized cardioversion is not possible unless both the Cardioscope/Recorder and Defibrillator modules have the optional synchronizer circuitry installed.

The function of this circuit is to provide a synchronized trigger pulse to LIFEPAK 5. This trigger pulse causes delivery of the defibrillating pulse at a point nominally 30 milliseconds after the peak of the R-wave in the ECG cycle for converting atrial fibrillation, atrial flutter or other arrhythmias. By using the R-wave as the initiating signal, the defibrillating pulse is delivered at a time which avoids the vulnerable T-wave portion of the ECG cycle where electrical shock may cause ventricular fibrillation.

SECTION 2

OPERATION

2-1. GENERAL

This section provides information and procedures to properly operate and provide operator service for the LIFEPAK 5 Cardioscope/Recorder, DC Defibrillator and Battery/Pak Modules.

2-2. CONTROLS AND INDICATORS

The following paragraphs provide a brief description of the controls and indicators on LIFEPAK 5 Cardioscope/Recorder, DC Defibrillator and Battery/Pak Modules.

2-3. CARDIOSCOPE/RECORDER MODULE

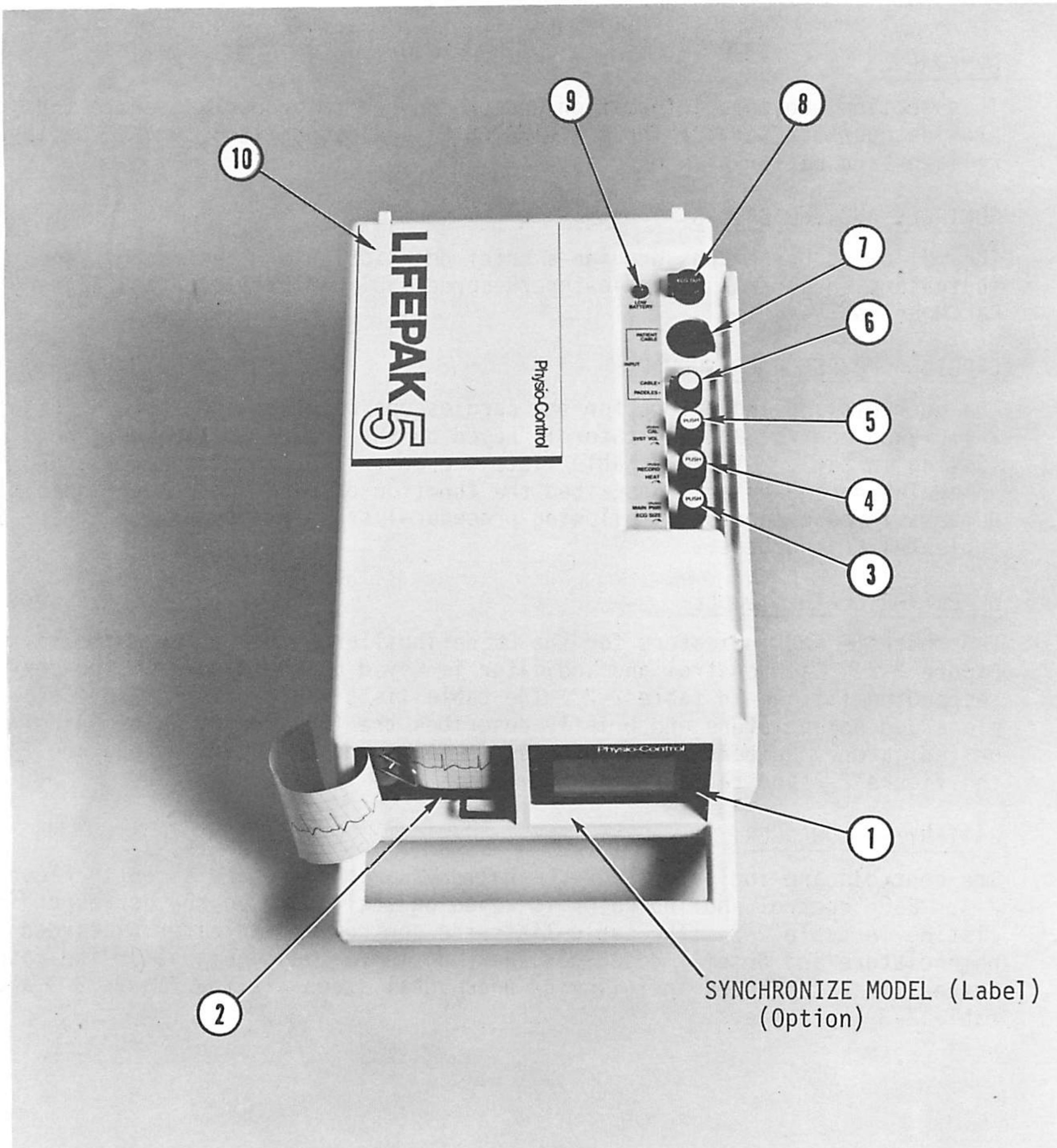
The controls and indicators for the cardioscope/recorder are shown in Figure 2-1. Each control and indicator is keyed on the figure to the corresponding listing in table 2-1. The table lists the control or indicator placarded nomenclature and briefly describes the function of each control or indicator. Numbers in parentheses in following procedural steps are the figure 2-1 and table 2-1 key numbers.

2-4. DC DEFIBRILLATOR MODULE

The controls and indicators for the DC defibrillator module are shown in Figure 2-2. Each control and indicator is keyed on the figure to the corresponding listing in table 2-2. The table lists the control or indicator placarded nomenclature and briefly describes the function of each control or indicator. Numbers in parentheses in following procedural steps are the figure 2-2 and table 2-2 key numbers.

2-5. BATTERY/PAK CHARGER

The controls and indicators for the battery/pak charger are shown in Figure 2-3. Each control and indicator is keyed on the figure to the corresponding listing in table 2-3. The table lists the control or indicator placarded nomenclature and briefly describes the function of each control or indicator. Numbers in parentheses in following procedural steps are the figure 2-3 and table 2-3 key numbers.



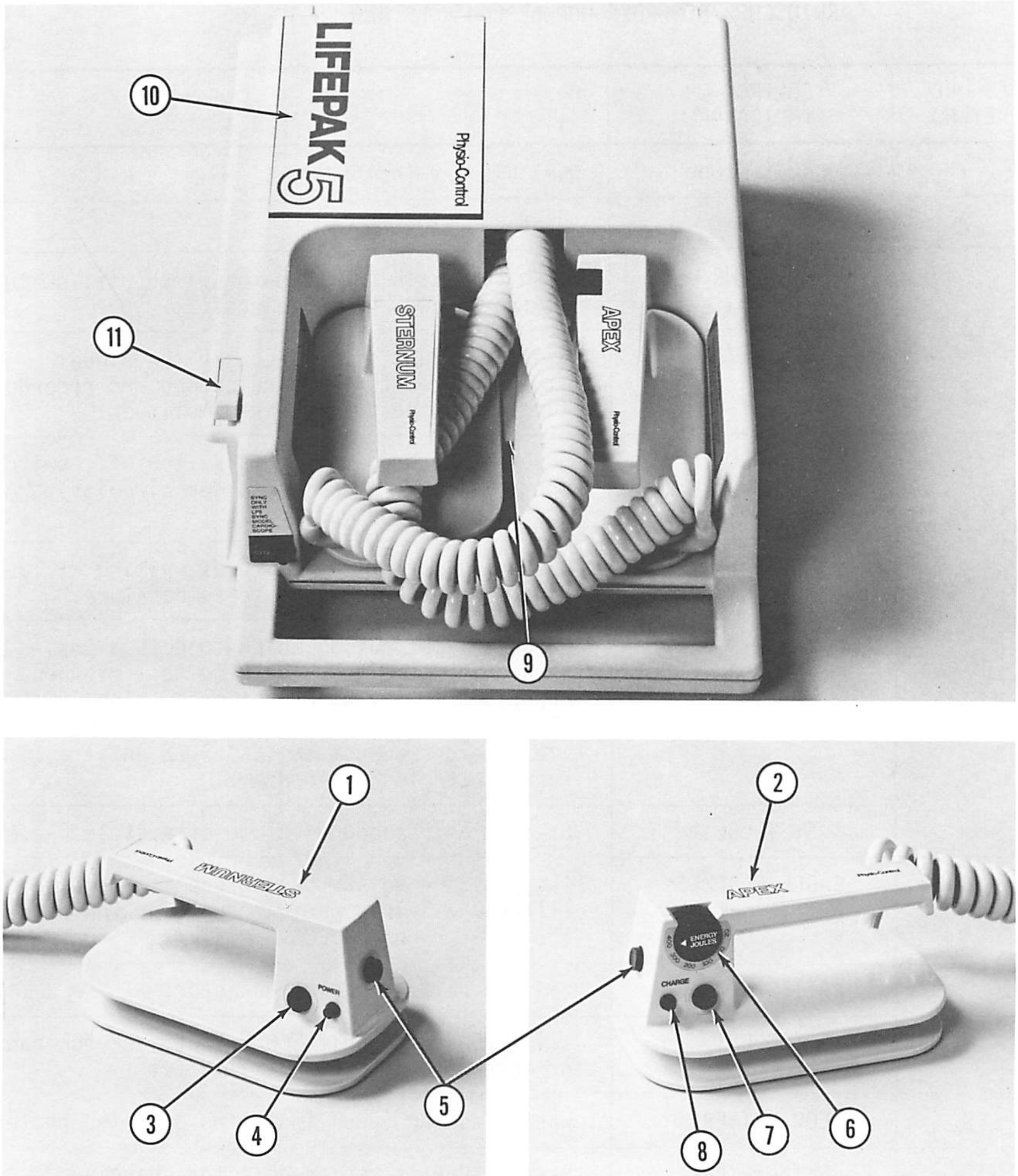
1. CARDIOSCOPE
2. RECORDER
3. MAIN PWR PUSHBUTTON AND ECG SIZE
4. RECORDER POWER AND STYLUS HEAT
5. CAL AND SYST VOL
6. CABLE/PADDLES
7. PATIENT CABLE
8. ECG OUT
9. LOW BATTERY
10. BATTERY/PAK

Figure 2-1. Cardioscope/Recorder Module Controls and Indicators

TABLE 2-1.

CARDIOSCOPE/RECORDER MODULE CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	Cardioscope	CRT display (no-fade).
2	Recorder	Heated stylus type.
3	MAIN PWR. (PUSH)	Push to switch on, push to switch off; switch controls power to all circuits.
	ECG SIZE	Used to adjust simultaneously the signal amplitude fed to the cardioscope and recorder. Turn clockwise to increase amplitude.
4	RECORD (PUSH)	Push to switch on, push to switch off; switch controls power to all recorder circuits. MAIN PWR also must be on.
	HEAT	Used to adjust temperature of writing stylus. Turn clockwise to increase temperature.
5	CAL (PUSH)	Momentary pushbutton which injects a positive going step corresponding to 1 mv when depressed. Convenient for presetting ECG SIZE in absence of input ECG. To standardize recorder adjust the ECG SIZE until a 10 mm square wave is obtained.
	SYST VOL	Used to adjust sound volume of systole beeper.
6	CABLE/PADDLES	Two position rotary switch used to select either the 3-lead patient cable or the paddles for monitoring the ECG signal.
7	PATIENT CABLE	Six pin patient cable connector.
8	ECG OUT	1 volt per millivolt ECG output jack for radio or telephone. (optional 1mv/mv)
9	LOW BATTERY	When flashing (red) indicates depleted battery.
10	Battery/Pak	Battery/Pak is replaceable for charging.



1. STERNUM PADDLE
2. APEX PADDLE
3. POWER PUSHBUTTON
4. POWER INDICATOR
5. DISCHARGE PUSHBUTTON
6. ENERGY JOULES
7. CHARGE PUSHBUTTON
8. CHARGE INDICATOR
9. INTERLOCK SWITCH
10. BATTERY/PAK
11. SYNCHRONIZER PUSHBUTTON (OPTION)

Figure 2-2. DC Defibrillator Module Controls and Indicators

TABLE 2-2.

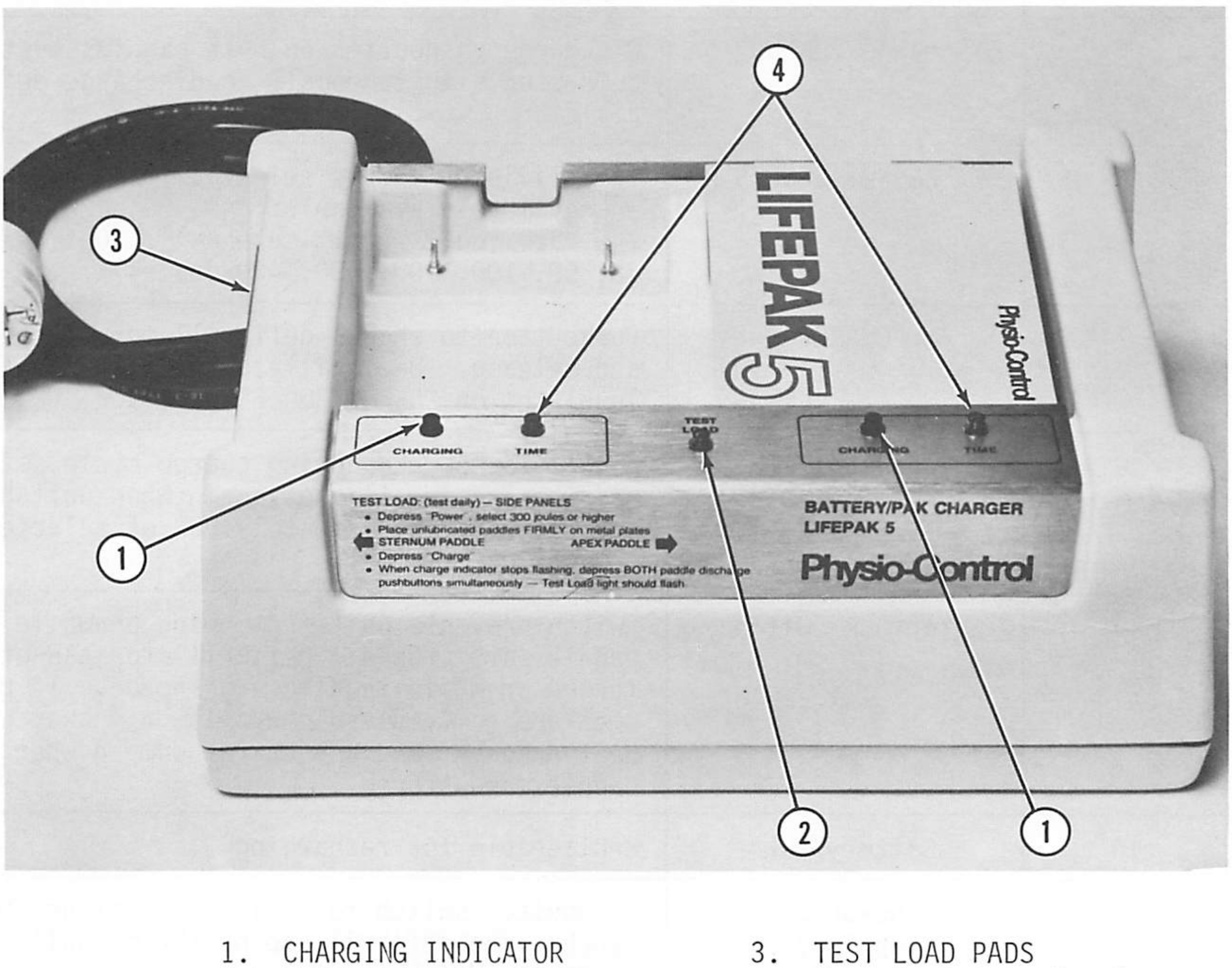
DC DEFIBRILLATOR MODULE CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	STERNUM Paddle	Contains a POWER pushbutton, a POWER indicator and a Discharge pushbutton.
2	APEX Paddle	Contains a Discharge pushbutton, ENERGY JOULES selector, CHARGE pushbutton and Charge Indicator.
3	POWER Pushbutton	Press to switch on, press to switch off; switch controls power to all circuits.
4	POWER Indicator (Low Battery Level)	Green light indicates power on to defibrillabor. Green flashing light indicates depleted battery. Battery/Pak should be replaced with charged Battery/Pak.
5	Discharge Pushbutton	Discharge pushbutton on both paddles must be depressed simultaneously to discharge defibrillator.
6	ENERGY JOULES	Defibrillator energy selector. Six discrete energy levels available: 40, 80, 120, 180, 240, 320 joules (watt-seconds). (Optional 20, 50, 100, 200, 300, 400 joules)
7	CHARGE	Pushbutton to charge defibrillator. Depress and release. Defibrillator will charge to level set on ENERGY JOULES selector.
8.	Charge Indicator	Light flashes red during charge cycle, steady red when ready, flashes again when unit has bled down to approximately 90% of selected energy level.
9	Interlock Switch	Switch prevents unit from being on while paddles are stored. Defibrillator cannot be turned on while paddles are stored. If paddles are removed and power is on, power will be turned off and any charge dumped when paddles are stored.
10	Battery/Pak	Replaceable for recharging.
11	SYNC/DEFIB (option)	Pushbutton switch for selecting either the synchronize defibrillate or the manually triggered defibrillate mode.

TABLE 2-3.

BATTERY/PAK CHARGER CONTROLS AND INDICATORS

FIGURE KEY NO.	CONTROL OR INDICATOR	FUNCTION
1	CHARGING Indicator	Red indicator is full on when charging is in progress.
2	TEST LOAD Indicator	Amber indicator lights when discharging is over 160 joules, will not light when discharge is 80 joules or below.
3	Test Load Pads	Provides access for paddles to internal 50 ohm load.
4	TIME Indicator	Green indicator illuminates after battery/pak has been charged for 4½ hours.



1. CHARGING INDICATOR
2. TEST LOAD INDICATOR
3. TEST LOAD PADS
4. TIME INDICATOR (LED)

Figure 2-3. Battery/Pak Charger Controls and Indicators

2-6. OPERATING INSTRUCTIONS

Operating instructions are presented for the LIFEPAK 5 Cardioscope/Recorder, DC Defibrillator and Battery/Pak Charger Modules. Observe the following cautions while operating the LIFEPAK 5.

> **CAUTION**
>
> This instrument is to be used by authorized personnel only.
>
> Operator should be thoroughly familiar with information covered in sections 1 and 2 before using.
>
> The LIFEPAK 5 should not be used in the presence of flammable agents or anesthetics.
>
> Do not discharge defibrillator with paddles shorted together.
>
> Stay clear of patient when defibrillating.
>
> For patient and operator safety, do not connect accessory equipment to the ECG OUT jack unless accessory equipment in combination with LIFEPAK 5 has been evaluated for fire and shock hazard.

2-7. ELECTRODE APPLICATION

The LIFEPAK 5 uses a special six pin patient cable connector (7) and three lead cable. The use of this cable has resulted in a tremendous reduction in cable related artifact. Part of the improvement from the past comes from running the cable shielding all the way down to the cable snaps. This cable, therefore, has heavier leads which do not easily tangle and are not replaceable. A similar cable with 5 leads may be used; however, the "right leg" and "V lead" are not used.

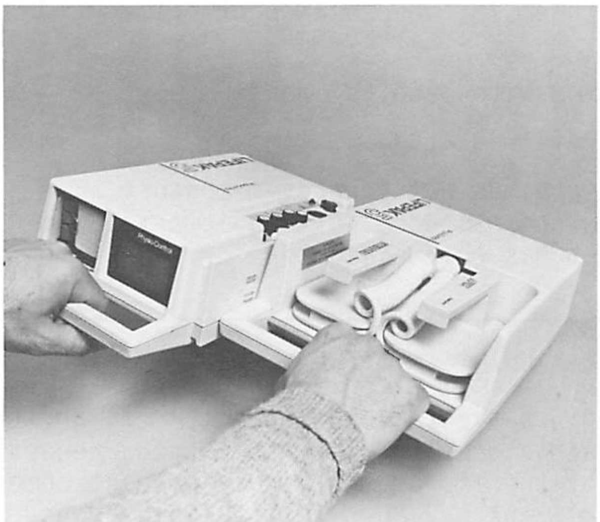
Proper electrode application is the key to eliminating electrode artifact. Electrode artifact comes from poor contact between the electrode and the patient's skin. Supporting the patient cable to prevent tugging on the electrodes will eliminate one source of this artifact. However, preparation of the skin at the electrode site is by far the most important consideration. The skin should be roughed, cleaned with alcohol, then fanned dry. Non-prejelled electrodes should be connected to the cable snaps, have 1/4 in. to 1/2 in. (6.4 mm to 12.7 mm) of jel applied in a mound over the screen, then be attached to the patient. Prejelled electrodes should be attached to the cable snaps, inspected to insure that the jel has not dried out, then attached to the patient.

Muscle artifact often presents itself when the patient moves. Much of this artifact can be eliminated by locating the electrodes away from muscle masses.

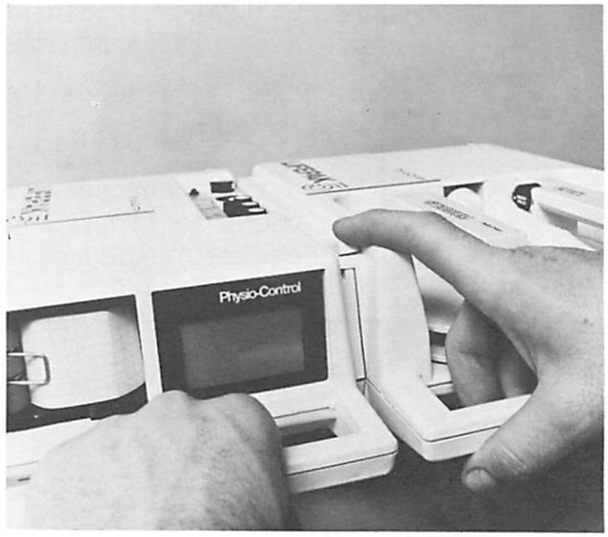
2-8. MODULE CONNECTION

The cardioscope/recorder module is connected to the DC defibrillator module through a special slide connector. They may be separated again by pressing the lock release button on the slide. The slide connector makes both the mechanical and the electrical connections between the two units. Refer to figure 2-4.

When the modules are separated, the electrical slide contacts are exposed. These exposed contacts do not represent a safety hazard and are used only to transfer the paddle pickup of the ECG signal from the DC defibrillator to the cardioscope/recorder. No dangerous voltages are ever present at these contacts.



SLIDE CONNECTION



LOCK RELEASE

Figure 2-4. Module Connection

2-9. CARDIOSCOPE/RECORDER MODULE

The following paragraphs provide brief operating instructions for LIFEPAK 5 Cardioscope/Recorder Module. Refer to paragraph 2-12 for operator service which includes an operational checkout. Numbers in parentheses refer to figure 2-1 and table 2-1.

1. Plug patient cable into PATIENT CABLE (7) connector. If paddles are to be used, the cardioscope/recorder and DC defibrillator modules must be joined together.
2. Attach either patient cable or paddles to patient.
3. Set CABLE/PADDLES (6) selector switch to position desired.

> CAUTION
>
> Do not drain the battery completely; turn the instrument MAIN PWR (3) off when not in use.

4. Depress MAIN PWR (3) pushbutton.
5. If recorder monitoring is desired, depress RECORD (4) pushbutton. Adjust stylus HEAT (4) control as required.

   NOTE: If paper replacement is required refer to paragraph 2-15.

6. Depress CAL (5) momentary pushbutton, adjust ECG SIZE (3) control for a 10 mm squarewave display on recorder (2) or a convenient display on cardioscope (1).
7. Adjust ECG SIZE (3) control to obtain desired patient generated ECG display on cardioscope (1) and/or recorder (2).
8. Adjust SYST VOL (5) to desired volume.
9. If desired, connect external monitoring device (radio) to ECG OUT (8) jack.

> CAUTION
>
> For patient safety do not connect accessory equipment to the ECG OUT (8) unless the accessory equipment in combination with the LIFEPAK 5 has been evaluated for fire and shock hazard.

2-10. DC DEFIBRILLATOR MODULE

The following paragraphs provide brief operating instructions for LIFEPAK 5 DC Defibrillator Module. Monitoring using the paddles is discussed in paragraph 2-9. Refer to paragraph 2-12 for operator service including an operational checkout. Numbers in parentheses refer to figure 2-2 and table 2-2.

1. Depress and release POWER (3) pushbutton on STERNUM (1) paddle. Green POWER indicator (4) will light.
2. Set ENERGY JOULES (6) to desired level.
3. Depress CHARGE (7) pushbutton and release.
4. Place paddles firmly on patient's chest.
5. DC defibrillator is ready to fire when red Charge Indicator (8) light stops flashing and glows steady red. DC Defibrillator will not fire unless fully charged to preset level.

NOTE: Once the DC defibrillator has charged to the desired level and the Charge Indicator (8) stops flashing, the unit is ready to fire. If not fired, the charge will slowly bleed down. Once the charge has bled to 90% of the desired level, the charge indicator (8) will flash two or three times and the DC defibrillator will automatically recharge to the desired level.

If the ENERGY JOULES (6) selector position is inadvertently or intentionally changed while the DC defibrillator is charged, the charge is automatically dumped. It is necessary to recharge the unit to defibrillate at a different setting.

CAUTION

Stay clear of patient when defibrillating.

6. Depress both paddle Discharge pushbuttons (5) simultaneously for counter shock.

7. If repeat counter shock is indicated, depress CHARGE (7) and repeat as above.

8. To dump charge and turn off DC defibrillator, depress POWER (3) pushbutton on STERNUM (1) paddle. POWER light (4) will go out.

2-11. SYNCHRONIZED CARDIOVERSION (option)

The following paragraphs provide brief operating instructions for the optional LIFEPAK 5 synchronized cardioversion.

NOTE: Synchronized cardioversion is not possible unless both Cardioscope/Recorder and Defibrillator modules have the optional synchronizer circuitry installed.

1. Connect the Cardioscope/Recorder and Defibrillator modules together.

2. Turn ON main power switch on both Cardioscope/Recorder and Defibrillator. Defibrillator will come on in manually triggered defibrillate mode.

3. Connect patient to patient cable and set INPUT SELECTOR switch to CABLE.

> **CAUTION**
>
> DO NOT use defibrillator paddes as ECG pickup for elective cardioversions. Artifact from poor contact or movement of paddles could cause synchronizer to fire defibrillator prematurely.

4. Push SYNC pushbutton switch (11) ON. Red switch button will illuminate.

5. Adjust ECG SIZE (3) control until marker blip occurs on ECG complex on cardioscope (CRT). SYNC pushbutton switch will flash and SYSTOLE SOUND will beep with marker. (It may be necessary to more the electrodes to get a signal with sufficient amplitude).

6. Set ENERGY JOULES (6) to desired level.

7. Depress CHARGE pushbutton and release.

8. To discharge, depress BOTH discharge buttons and hold until defibrillator fires on the next R-wave. Defibrillator will fire within 20 milliseconds of marker.

   After discharge, the defibrillator automatically returns to the emergency defibrillate mode. If repeat synchronized cardioversion is required, place the defibrillator in the SYNC mode again by depressing the SYNC pushbutton switch (11) on. When button is illuminated, synchronizer is on.

2-12. BATTERY/PAK CHARGER

The following procedures provide brief operating instructions for LIFEPAK 5 Battery/Pak Charger. A discharged battery/pak requires 4-5 hours in the charger to insure a complete recharge. Each battery/pak recharges independently in the charger so either one or two battery/paks may be inserted. Proceed as follows:

1. Connect the battery/pak charger to a source of power (115 VAC, 230 VAC or 12 VDC). A power cord is provided for AC input, a jack for DC input.

   NOTE: The 12 VDC source must be fused externally (2 Amps).

2. Align the battery/pak with the recessed mounting area so that the battery/pak clip is towards the rear.

3. Lower the front end of the battery/pak into the recessed mounting area.

4. Lower the rear end of the battery/pak into the recessed mounting area.

5. Verify that the CHARGING indicator (1, figure 2-3) illuminates. (A 3 second delay in illumination of the CHARGING indicator is normal).

6. After 4-5 hours of charging, the TIME indicator should illuminate which indicates that the battery/pak has been charged to its maximum capacity. (Maximum battery/pak capacity will vary depending upon the ambient temperature at which it is charged. See step 7).

7. A battery/pak may be left in the charger indefinitely without damaging it; however, longest life will be obtained when it is exercised regularly per paragraph 2-15.

NOTE: To maximize battery life and capacity, the battery/pak should be charged at a room ambient (approximately 22°C, 70°F) temperature.

2-13. OPERATOR SERVICE

The following paragraphs provide operator service procedures including daily operational checkout, battery/pak replacement, recorder paper replacement and recorder stylus adjustment and replacement.

2-14 OPERATIONAL CHECKOUT

Table 2-4 provides an operational checkout procedure for the cardioscope/recorder and Table 2-5 an operational checkout procedure for the DC defibrillator module. These procedures may be performed simultaneously if both modules are joined together.

These procedures will determine whether or not the LIFEPAK 5 Cardioscope/Recorder and DC Defibrillator Modules function normally. The tests should be performed as routine maintenance on a daily basis. The operational checkout procedures are presented in tabular form to allow the using activity to copy them and use them as an ongoing preventive maintenance aid.

TABLE 2-4.

CARDIOSCOPE/RECORDER MODULE OPERATIONAL CHECKOUT

PROCEDURE	RESULT
NOTE: This procedure may be performed in conjunction with the DC defibrillator module checkout presented Table 2-5. All numbers in parentheses are those in figure 2-1.	
1. Install battery/pak (refer to paragraph 2-15), if necessary.	
2. Attach patient cable to PATIENT CABLE (7) connector.	
3. Set CABLE/PADDLES (6) selector switch to CABLE.	
4. Depress MAIN PWR (3) pushbutton.	Verify that a luminous trace appears on cardioscope.

(continued on next page)

TABLE 2-4.

CARDIOSCOPE/RECORDER MODULE OPERATIONAL CHECKOUT (continued)

PROCEDURE	RESULT
5. Observe the LOW BATTERY (9) indicator.	Verify that the LOW BATTERY (9) indicator does not flash on and off. If it does, refer to paragraph 2-14.
6. Depress RECORD (4) pushbutton.	Verify that recorder starts. If paper replacement is required, refer to paragraph 2-16.
7. Adjust stylus HEAT (4) control for a satisfactory trace on recorder.	Verify that satisfactory line width and darkness is obtained on recorder. If not, refer to paragraph 2-17.
8. Depress CAL (5) momentary pushbutton and adjust ECG SIZE (3) control to obtain 10mm display on recorder.	Verify that a satisfactory display (pulse) is obtained on recorder. If not, refer to maintenance procedures.
9. Observe display on cardioscope.	Verify that a satisfactory display pulse is obtained on cardioscope. If not, refer to maintenance procedures.
10. Touch patient cable leads while increasing the setting of the STYL VOL (5) control.	Systole beeper should sound.
11. Observe cardioscope display while touching patient cable probes.	Verify that the cardioscope exhibits erratic vertical deflections.

TABLE 2-5.

DC DEFIBRILLATOR MODULE OPERATIONAL CHECKOUT

PROCEDURE	RESULT
NOTE: This procedure may be performed in conjunction with the cardioscope/recorder checkout presented in table 2-4. The battery/pak charger will be required to complete this test.	
1. Install battery/pak (refer to paragraph 2-15), if necessary.	
2. If cardioscope/recorder is connected to the DC defibrillator module, test cardioscope/recorder according to table 2-4, proceed with the following steps after completing steps in table 2-4. If the cardioscope/recorder is not connected, proceed to step 10.	

(continued on next page)

TABLE 2-5.

DC DEFIBRILLATOR MODULE OPERATIONAL CHECKOUT (continued)

PROCEDURE	RESULT
3. Verify DC defibrillator POWER (4, figure 2-2) indicator is off. 4. Set CABLE/PADDLES (6, figure 2-1) selector switch on cardioscope/recorder to PADDLES position. 5. Depress cardioscope/recorder MAIN PWR (3, figure 2-1) pushbutton.	Verify that a luminous trace appears on cardioscope.
6. Touch one paddle face. ECG SIZE (3, figure 2-1) may require adjustment.	Interference should appear on cardioscope.
7. Increase setting of cardioscope/recorder STYL VOL (5, figure 2-1) while touching paddle.	Systole beeper should sound.
8. Repeat steps 6 and 7 for other paddle.	See steps 6 and 7.
9. Depress RECORD (4, figure 2-1) pushbutton on cardioscope/recorder module. Repeat interference test by touching paddles. Recorder stylus HEAT (4, figure 2-1) may require adjustment. After test, depress RECORD (4) pushbutton to turn recorder off.	Interference should appear on recorder.
10. Depress DC defibrillator POWER (3, figure 2-2) pushbutton.	Verify green POWER (4, figure 2-2) indicator lights.
11. Set ENERGY JOULES (6, figure 2-2)selector to 240 joules (200 on 400 joule unit). NOTE: Do not discharge paddles in open air. 12. Place paddles firmly on battery/pak charger test load pads (4, figure 2-3).	

(continued on next page)

TABLE 2-5

DC DEFIBRILLATOR MODULE OPERATIONAL CHECKOUT (continued)

PROCEDURE	RESULT
NOTE: Do not lubricate paddles. Use firm contact at time of discharge on test load plates to prevent arcing, pitting of paddles, and to insure delivery of energy. Because of heat created at time of discharge into test load, do not repeat testing of DC defibrillator more often than 10/hour.	
13. Depress CHARGE (7, figure 2-2) pushbutton.	Charge indicator (8, figure 2-2) should flash until selected energy level is reached, then glow steady red.
14. Depress both paddle (1 and 2, figure 2-2) Discharge buttons (5, figure 2-2).	Battery/Pak charger TEST LOAD indicator (3, figure 2-3) should flash.
15. Set ENERGY JOULES (6,figure 2-2) to 80 joules (50 joules on optional 400 joule unit) 16. Place paddles firmly on battery/pak charger test load pads (4, figure 2-3). 17. Depress CHARGE (7, figure 2-3) pushbutton. 18. Depress both paddle (1 and 2, figure 2-2) Discharge buttons (5, figure 2-2).	Verify that battery/pak charger TEST LOAD indicator (3, figure 2-3) does not flash.
19. Depress cardioscope/recorder MAIN PWR (3, figure 2-1) and DC defibrillator POWER (3, figure 2-2) pushbuttons.	Verify all power is removed from cardioscope/recorder and DC defibrillator modules.
20. Insert paddles fully in their compartments. Depress the POWER (3, figure 2-2) pushbutton.	POWER indicator (4, figure 2-2) will not light.
21. Remove left paddle from compartment. Depress POWER (3, figure 2-2) pushbutton.	POWER indicator (4, figure 2-2) will light.
22. Insert paddle back in compartment.	POWER indicator (4, figure 2-2) will extinguish.

Figure 2-5. Battery/Pak Replacement

2-15. BATTERY/PAK REPLACEMENT

NOTE: Longest life will be obtained from the battery/paks when they are exercised every 3 or 4 months as follows:

a. Install battery/pak in defibrillator (see item 2 below).

b. Set ENERGY JOULES selector to maximum energy level.

c. Turn defibrillator on.

d. With the paddles firmly placed on battery/pak charger test load pads, charge and discharge defibrillator paddles until charge up time exceeds 30 seconds (see Table 2-5, item 13).

Refer to figure 2-5 and proceed as follows:

1. To remove the battery/pak press button at rear of battery/pak and lift.

2. To install the battery/pak proceed as follows:

   a. Align the battery/pak with the recessed area so that the battery/pak clip is towards the rear.

   b. Lower the front end of the battery/pak into the recessed area.

   c. Lower the rear end of the battery/pak into the recessed area and press until a click is heard.

2-16. RECORDER PAPER REPLACEMENT

Refer to figure 2-6 and proceed as follows:

1. Pull out paper carrier.

2. Remove old paper roll.

3. Replace with new paper roll.

4. Pull out short length of paper and close paper carrier.

5. Depress MAIN PWR (3, figure 2-1) pushbutton.

6. Depress RECORD (4) power pushbutton. While recorder is running, guide paper over all metal rollers and under rubber roller. Paper will be pulled through by rubber roller.

7. Verify that the stylus HEAT (4) control provides adjustment for a satisfactory line width and darkness. If not, refer to paragraph 2-17.

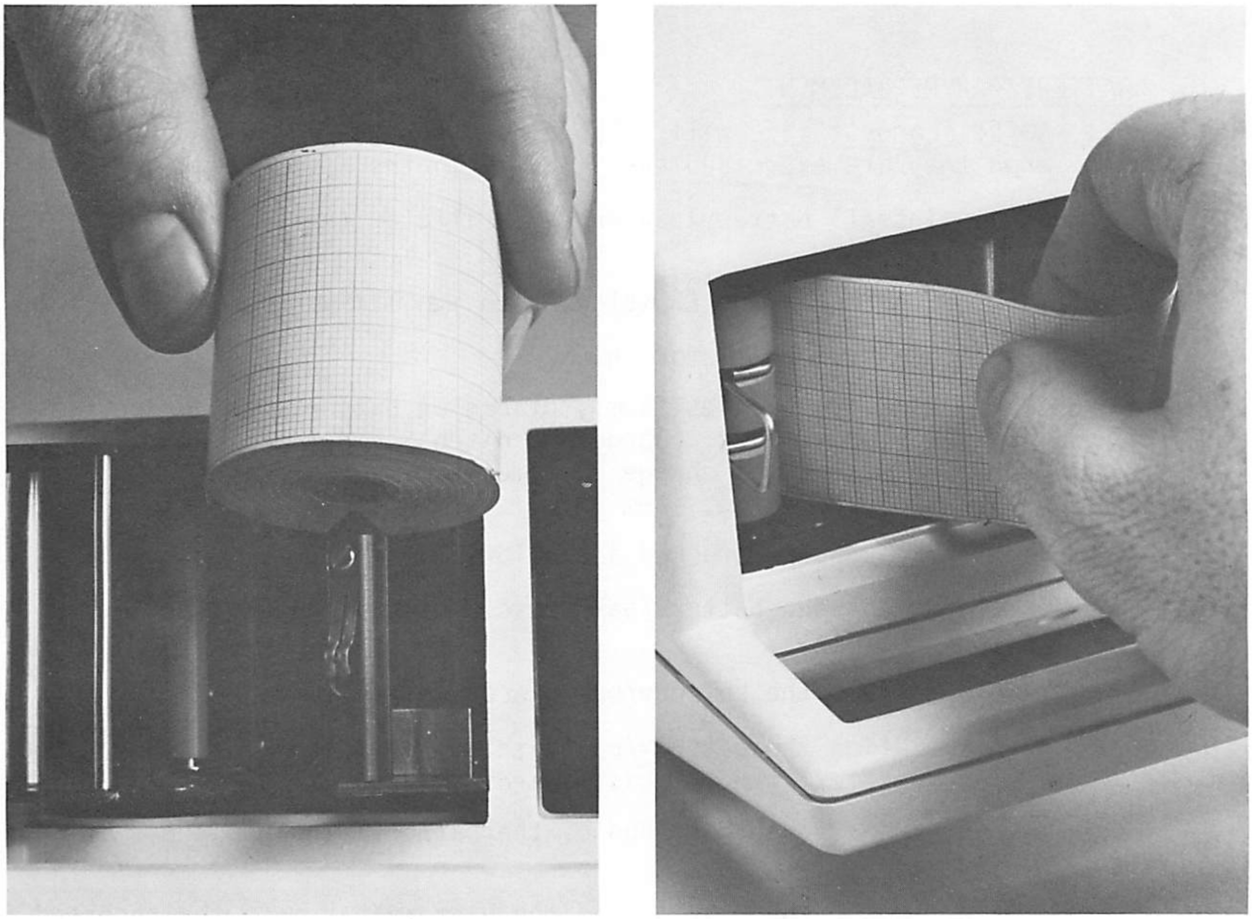


Figure 2-6. Recorder Paper Replacement

2-17. RECORDER STYLUS REPLACEMENT AND ADJUSTMENT

Refer to figure 2-7 and proceed as follows:

NOTE: The special stylus replacement tool (part of the replacement kit) will be required in the following procedure. For more detailed information refer to instruction sheet accompanying replacement stylus.

1. If replacement is required, pull out paper carrier.
2. Push stylus replacement tool onto the tip of the stylus until it is hooked as shown in figure 2-7(A).

   NOTE: A small flashlight will help in positioning tool onto stylus and in installing stylus.

3. Pull gently on tool until stylus loosens from its mounting and extract the stylus. Remove stylus from tool.
4. Install new stylus on tool per figure 2-7(B). Use tool to position stylus so that the dove tail on the stylus

lines up with the dove tail on stylus mounting block. Using stylus tool, push gently until stylus is snugly seated.

5. Refer to paragraph 2-9 and obtain a CAL display on the recorder. Adjust stylus HEAT (4, figure 2-1) for satisfactory darkness.

   NOTE: When stylus HEAT control is increased overshoot on the leading edge will increase.

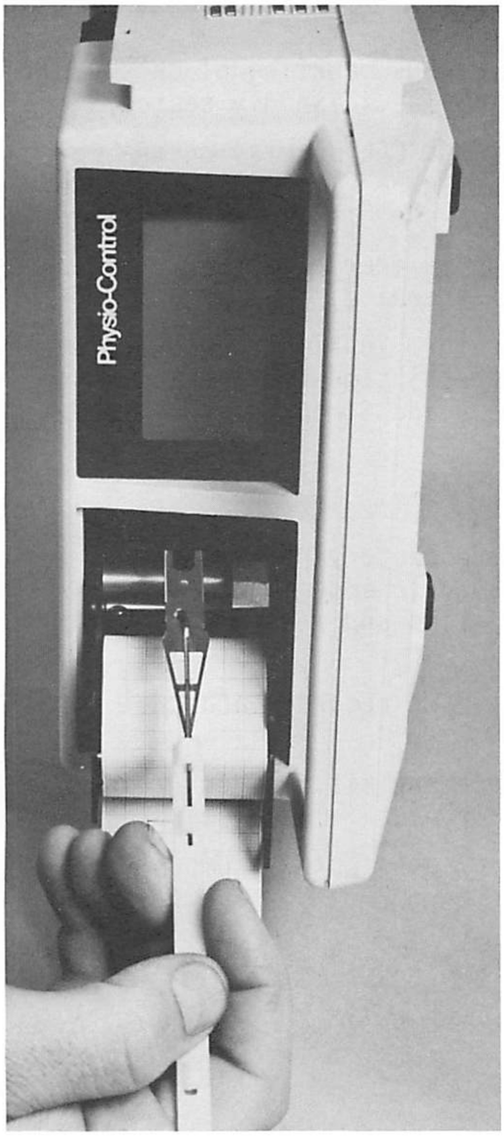
6. Compare recorder display to waveform in figure 2-8, and if required proceed as follows with adjustment. Waveform A is acceptable (nominal), waveforms B and C require recorder adjustment.

   NOTE: The stylus comes from the factory preadjusted, adjustment capability is provided to accommodate for variations in paper characteristics and recording conditions.

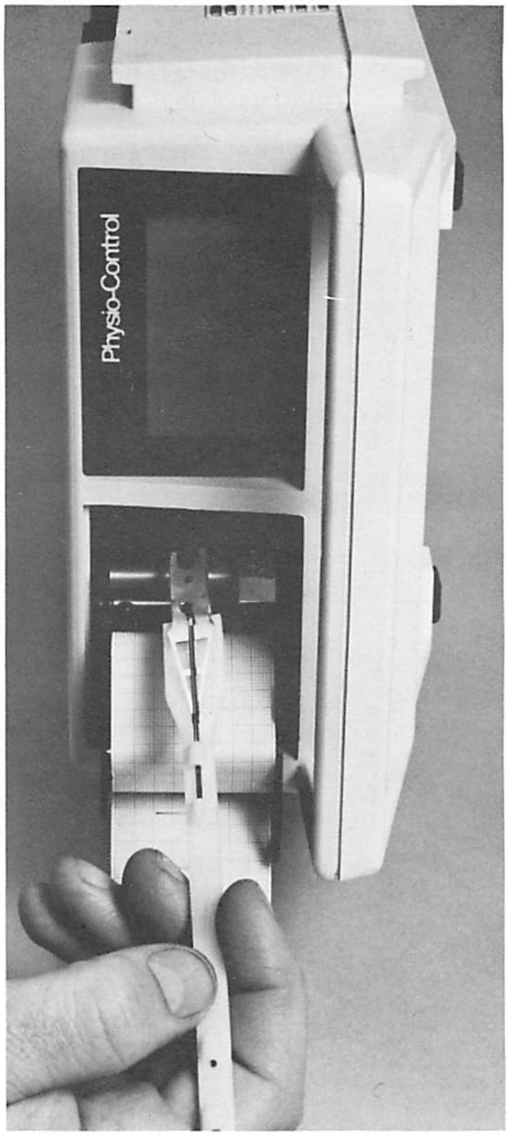
7. If adjustment is required, shut down recorder and pull out paper carrier to expose stylus.

8. Use wrench, provided with replacement kit, to add (counterclockwise) stylus pressure or decrease (clockwise) pressure.

9. Repeat steps 5 through 8 until a satisfactory compromise (A, figure 2-8) is obtained.



A
REMOVAL



B
INSTALLATION

Figure 2-7. Recorder Stylus Replacement

Figure 2-8. Recorder Waveforms

SECTION 3

CIRCUIT DESCRIPTION

3-1. INTRODUCTION

This section provides a detailed description of the circuits contained in LIFEPAK 5 Cardioscope/Recorder and DC Defibrillator modules. The section is organized into four major parts. A brief functional or block diagram description of the overall operation of the LIFEPAK 5 is presented first. The subsequent parts are presented by cardioscope/recorder module, DC defibrillator module and accessory equipment.

3-2 FUNCTIONAL DESCRIPTION

The LIFEPAK 5 block diagram presented in figure 3-1 provides an overall view with typical waveforms and direction of travel. Schematic diagrams of the major circuits are also provided, to allow for examination of the circuits from two levels while reading the circuit descriptions.

NOTE: In rare instances the in-text schematics provided in this section may differ slightly (e.g., component values) from the configuration that the user may have. This would occur only, if the PCB board in question was a different revision than the one presented in-text. In any case, the engineering PCB board schematic in section 6 would carry the applicable configuration and the interim change information noted in the Change Information section at the rear of the manual.

In the monitor mode of operation the patient ECG signal is routed through either the patient cable or paddles to the input and amplifier stage. In the input and amplifier stage the ECG signal is filtered, amplified, modulated, demodulated and further amplified before it is sent to the no-fade circuitry.

In the no-fade circuitry, the ECG signal is converted from analog to digital form. The digital information is stored in a memory and reconverted to analog form for display on the cardioscope and recorder.

In the defibrillator mode, the energy of the defibrillator pulse is stored as a charge on a capacitor located in the DC defibrillator module. On command, relays disconnect the capacitor from the charging circuitry and connect it to the paddles which deliver the resulting electrical pulse to the patient.

3-3 CARDIOSCOPE/RECORDER MODULE

The LIFEPAK 5 Cardioscope/Recorder Module circuit description is presented by individual circuit function starting with the input and amplifier circuitry and continuing through the no-fade, cardioscope and recorder display, systole sound, low battery level and power supply circuitry. The interconnecting wiring diagram in section 5 provides the complete interconnection data for the sub-assemblies comprising the LIFEPAK 5 Cardioscope/Recorder Module.

NOTE: For the circuit description of the Synchronized Defibrillation option refer to paragraph 3-42.

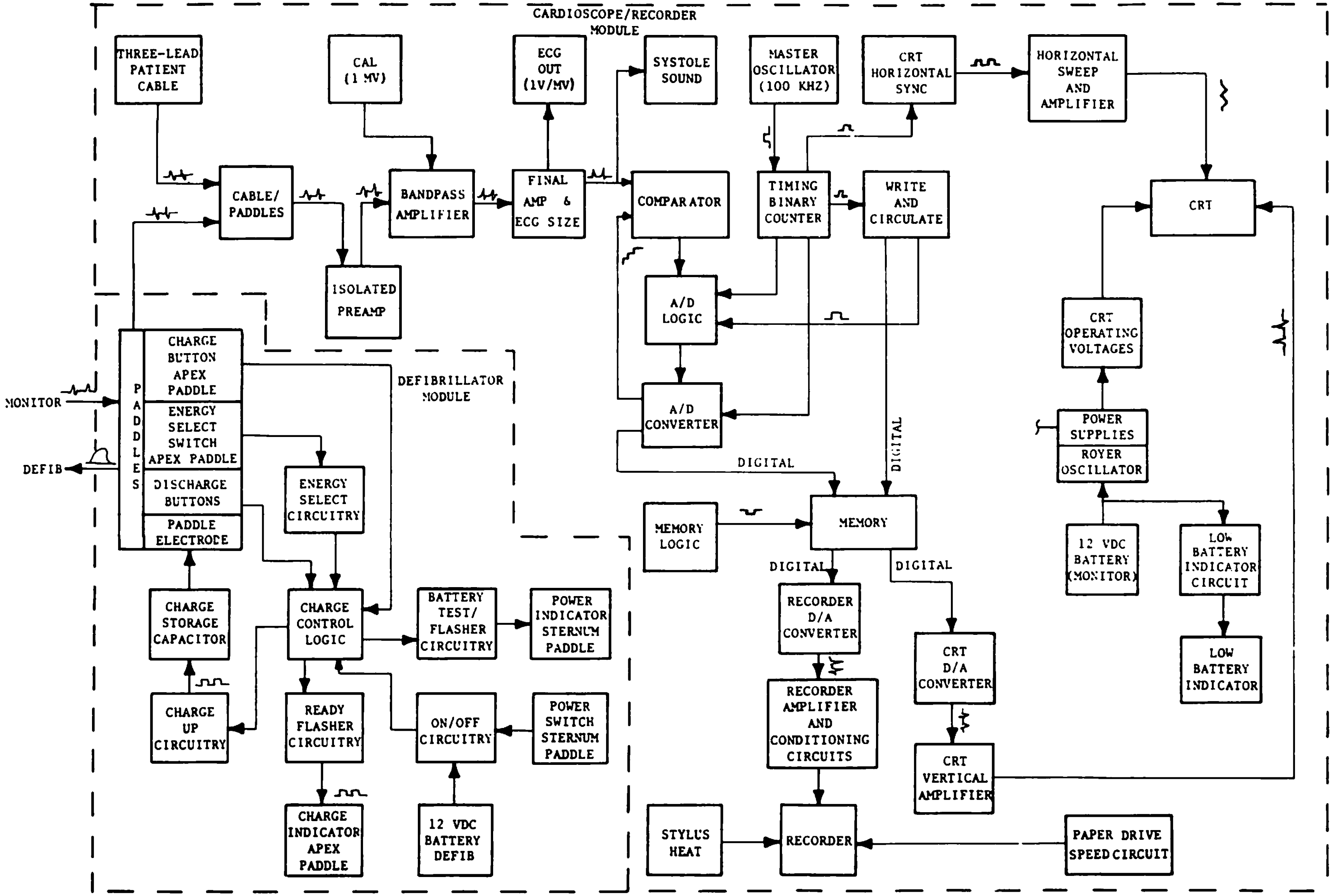


Figure 3-1. LIFEPAK®5 Block Diagram

3-4. INPUT AND AMPLIFIER STAGES

The following paragraphs describe the cardioscope/recorder module input and amplifier stages including patient cable or paddles, isolated preamp, chopper isolator, bandpass amplifier, notch filter and the ECG out. Figure 3-2 provides an expanded block diagram of the input and amplifier stages showing interface with other circuitry. The input and amplifier stages are physically located on the preamp board and outside controls located on the control board. The paddles are physically located with the DC defibrillator module. For a more detailed analysis, figure 3-3 provides a complete schematic for the input and amplifier circuitry.

3-5. Patient Cable and Paddles. The patient generated ECG signal is fed into the cardioscope/recorder through either the patient cable or paddles. The paddles, part of the DC defibrillator module, permit quick assessment of the patient's condition during an emergency. Refer to paragraph 3-34 for detailed information concerning the DC defibrillator module. The standard three-lead patient cable and electrodes are used for long term monitoring and during patient transportation.

Preamplifier protection against overvoltage, inadvertently introduced through the patient cable, is provided by surge protectors VSP1 thru VSP4. These surge protectors are mounted on the control board. VSP1, VSP2 and VSP4 shunt inadvertent voltages above 90 volts to the isolated preamp ground. Voltages above 470 volts on the isolated ground are shunted to the chassis ground by surge protector VSP3. Additional surge protection is provided in the DC defibrillator module when the paddles are used.

A two-position switch CABLE/PADDLES S1, mounted on the control board, selects either patient CABLE or PADDLES. The ECG signal from the paddles is fed through a transfer relay to the CABLE/PADDLES switch S1. The transfer relay disconnects the charge storage capacitor from the paddles. The patient cable is routed directly to the CABLE/PADDLES switch S1 through surge protectors VSP1 through VSP4. From S1 the ECG signal is routed to the preamplifier overvoltage protection circuitry. In either case the third lead is used as a reference.

3-6. Isolated Preamplifier. Input RFI filtering is provided at the input to U5 by C30 through C32. Input common mode or normal mode voltages greater than plus or minus 10 volts are clamped to the isolated power supply through diodes CR6 through CR9. These overrange voltages are dropped across resisters R36 and R37.

Isolated power is produced for the isolated preamplifier from a full wave bridge consisting of T2, CR13 thru CR16, C37 and C38. The primary of T2 receives 48 volts peak-to-peak, 12 KHz from the Royer oscillator through J3-1 and J3-2. Refer to the power supply section presented in paragraph 3-28 for additional details.

Voltage gain in the symmetrical differential first stage of amplification (U5) is nominally 50. Its output is proportional to the differential voltage at the input. This stage also acts as a low pass filter for RF frequencies which is determined by C30, C31 and C32. Rapid recovery from

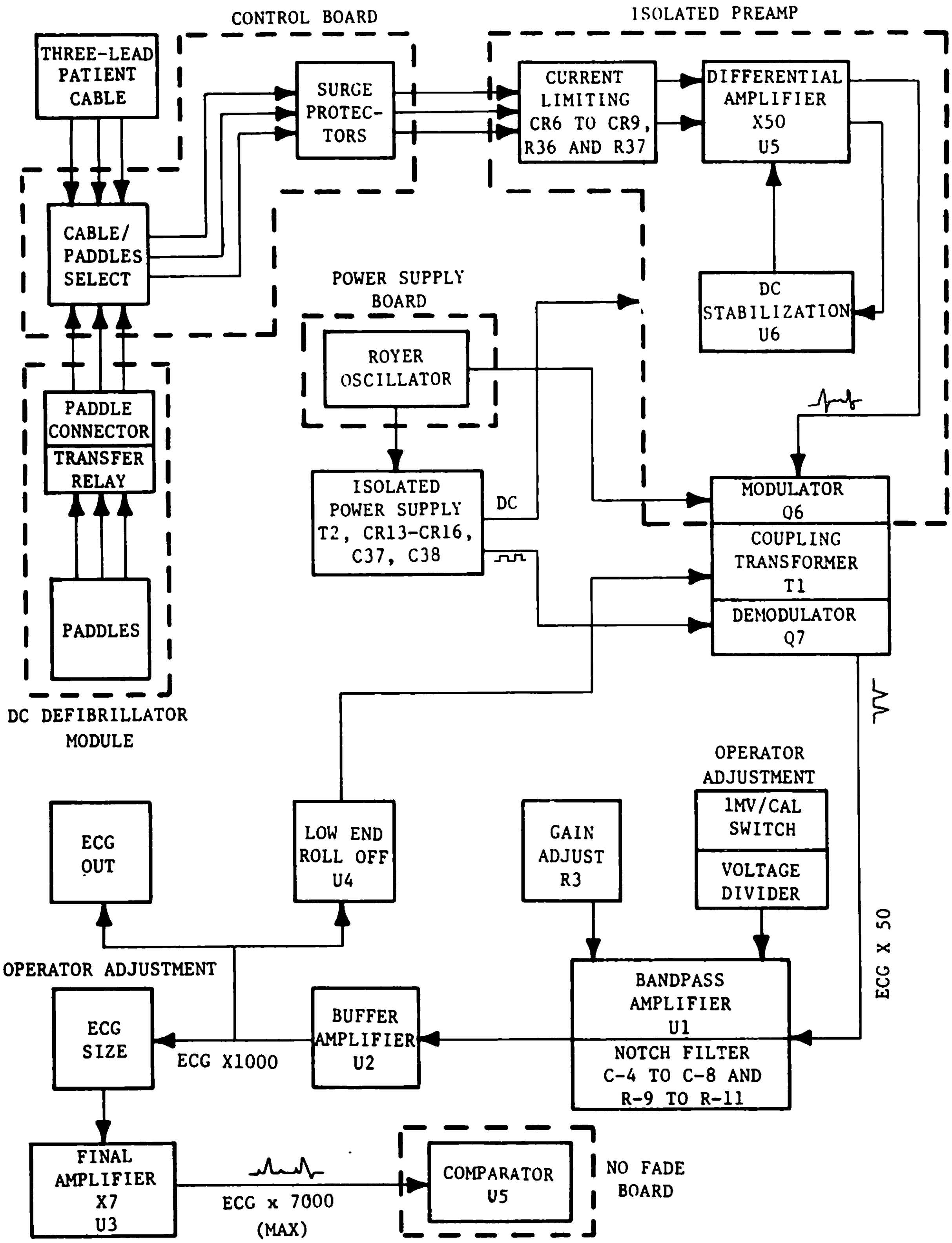
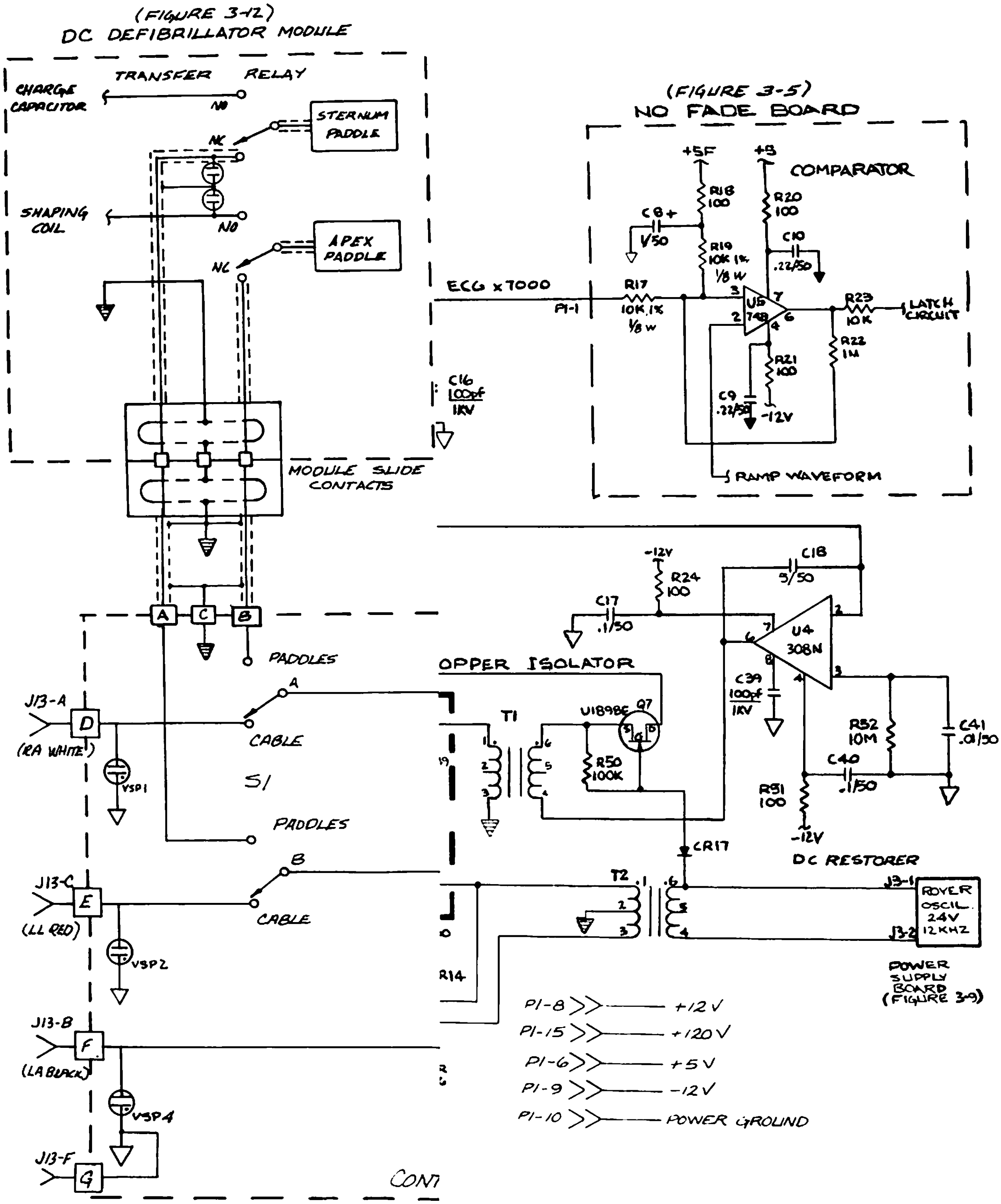


Figure 3-2. Input and Amplifier – Expanded Block Diagram



Amplifier Circuitry - Schematic Diagram

large DC offsets at the output of U5 is accomplished by the DC stabilization circuit consisting of U6, R47, CR10 and CR11. Large DC offsets occur when power is first applied at instrument turn-on, or when the paddles or patient cable electrodes are moved on the patient and drive the instrument cardioscope trace off the display screen. Fast circuit recovery is necessary to minimize the trace off-screen time. Under normal conditions, the input of U6 is connected to the U5 output by R46. R46 and C33 provide a low frequency roll-off at approximately 0.04Hz. Any DC signal from U5 at R46 generates a compensating signal which is fed back to U5 through R44. C36 slows down the fast recovery response to allow the display of pacemaker signals.

3-7. Chopper Isolator. To preserve isolation of the circuitry, the amplified ECG signal is transformer coupled to the other cardioscope/recorder circuitry. To preserve the very low frequency components of the ECG wave, which would be lost in conventional inductive coupling of a transformer, the signal is chopped at a rapid rate, passed through a transformer, then sampled at the same rate and filtered to remove the chopper frequency component.

FET chopper Q6 is driven by the 12KHz square wave from the non-inverting secondary of T2, which is also the source for the isolated power supply. The chopping action of Q6 effectively amplitude modulates the 12KHz signal with the ECG signal. The ground return of the primary of T1 and the center tap of T2 is isolated ground.

FET chopper Q7 is driven by the 12KHz square wave from the primary of T2. Thus, the frequency and phase of the voltages driving Q6 and Q7 are the same. This action essentially demodulates the 12KHz modulated signal and restores the ECG signal. U4 determines the low end roll-off of the restored ECG signal. U4 is instrumental in eliminating unwanted low frequency signals such as drift within the circuitry or electrode-offset potential produced between the input electrodes.

3-8. CAL (1mv). The CAL circuitry injects a step voltage corresponding to one millivolt referenced to patient input when the CAL switch S4 is depressed. The switch is physically located on the control board.

The overall gain of the isolated preamp and chopper isolator stages is approximately 50. Therefore, the calibration signal injected at the input to U1 must be 50 times the one millivolt calibration signal at the preamplifier input that it simulates.

When the CAL switch is depressed, the output of a five volt divider is applied to the input of U1. The divider is made up of R1, R2 and R3. Pot R2 is adjusted to produce a voltage step of one volt at the ECG OUT jack (radio jack).

3-9. Bandpass Amplifier and Notch Filter. The restored ECG signal at the input of operational amplifier U1 is a normal positive going R-wave. U1 and its associated circuitry establishes a 43 Hz roll-off frequency. Voltage gain through U1 is nominally 20. The twin T, active 60 Hz notch is determined by the network consisting of R9 thru R11, C4, C6, C7 and C8. The filter has approximately 45dB rejection at 60 Hz. The notch is made narrow through the use of feedback through divider R13 and R14, and operational amplifier U2 to the common side of the filter. This scheme also minimizes attenuation through the filter in the flat portions of its response curve. The bandpass filter has no adjustment. Gain pot R4 is used to set the gain of the amplified ECG signal to 1000 and must be done before the one millivolt CAL is adjusted. Operational amplifier U2 also provides a buffered output to the ECG OUT jack. A nominal one millivolt peak-to-peak patient generated signal is amplified to a peak-to-peak value of one volt at this point.

3-10. ECG SIZE and Final Output Amplifier. The ECG SIZE potentiometer, located on the control board, is used by the operator to set the ECG signal amplitude simultaneously to the vertical amplifier of the cardioscope and the recorder pen motor via the no-fade circuit. Operational amplifier U3 provides the final stage of amplification before the ECG signal is sent to the no-fade circuit (refer to paragraph 3-11). Voltage gain through U3 is nominally seven.

3-11. NO-FADE CIRCUIT

The following paragraphs describe the cardioscope/recorder no-fade circuit including a general overall description followed by detailed circuit analysis. Figure 3-4 provides an overall block diagram of the no-fade stage showing interface with all other stages. For a more detailed analysis, figure 3-5 provides a complete schematic of the no-fade circuitry.

3-12. General. The no-fade circuit is divided into two main functional parts: the timing and control pulse generator, and the converter and memory circuits. When power is applied to the instrument, a master oscillator continuously generates a 100 KHz signal. This signal is used to drive the timing binary counter of the pulse generator circuit and the A/D binary counter in the analog-to-digital converter circuit. The ECG signal from the input and amplifier circuitry is fed into the comparator where it is compared to a reference voltage formed across the resistance ladder of the analog-to-digital converter. This reference voltage is generated by the A/D binary counter and takes the form of a positive-going staircase ramp. When the reference signal matches the incoming ECG signal, the binary gate blocks further pulses to the A/D binary counter and the reference voltage is held. This voltage, in the form of an eight bit digital word, is then transferred to the memory; the A/D binary counter is reset and again the reference signal ramp is formed to match the incoming ECG signal. This process continues at a sample rate of 200 Hz per second. Conversion from the digital word in the last stage of the memory to an analogous voltage occurs in the resistance network of the digital-to-analog converter. The words in the buffer memory are entirely circulated and synchronized with the cardioscope sweep so the contents of the memory are entirely displayed during each sweep. The contents are again run through during the retrace sweep, but not displayed. Thus, the instrument display of the ECG signal is updated at the rate of two words per sweep, one during the display and one during retrace.

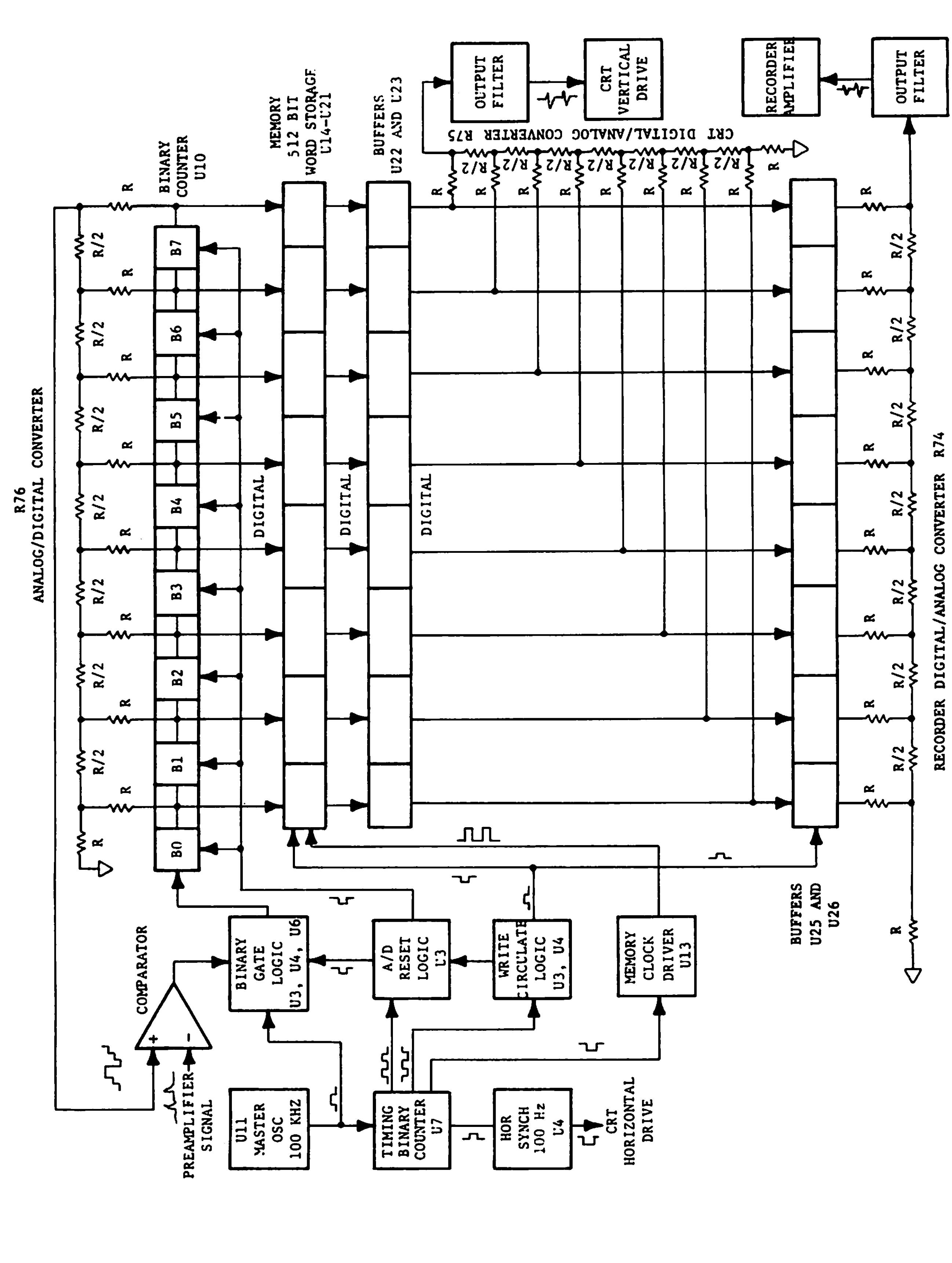


Figure 3-4. No-Fade Circuitry – Block Diagram

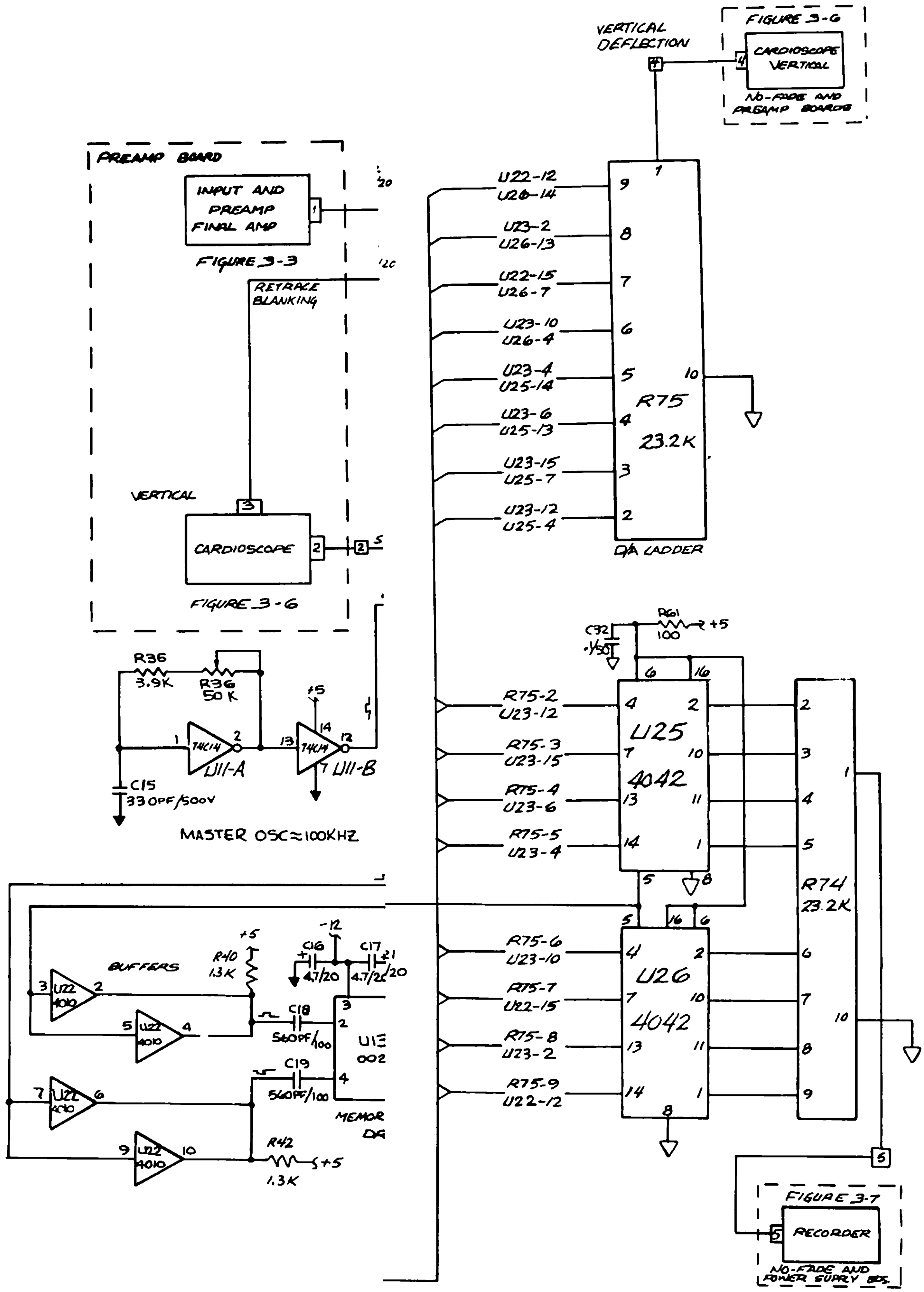
3-13. Timing Counter Circuitry. A frequency of approximately 100 KHz generated by the master oscillator U11-A and B is used to produce timing and control signals for the no-fade circuit. This signal will be referred to as the clock pulse. The clock pulse is used to drive the timing counter U7. The clock pulse has two stable voltage levels which will be termed 0 for zero voltage level and 1 for the positive level.

The clock pulse enters the timing counter U7-10 at the CLK input. The timing counter U7, in this configuration, uses ten ripple-carry binary counter stages. The state of the counter is advanced one step in binary order on the negative-going (i.e., 1 to 0) transition of the clock pulse. Resetting the timing counter to the all-0's state is accomplished using the positive-going pulse obtained from one-shot multivibrator U3-A. U3-A is triggered from a normally negative-going pulse at the output of NAND gate U6-A pin 3. A second condition, called the freeze mode, is obtained by shorting internal contacts TP1 and TP2. This applies a positive five volts to U6-A-1 resulting in the write and recirculate signal being formed by U3-A every 512 clock pulses rather than every 513 as in the run mode. This prevents substitution of memory words and continues to circulate the memory contents without any updated changes.

The clock pulses are fed to the memory clock driver U13 via two Schmitt triggers U11-C-10 and U11-D-6. R37 and C12 provide a delay between the memory clock pulses and the write/circulate pulses. The combination of the U3-A, U4-A, U6-A and U7 also provides the sweep generator with horizontal sweep input pulses of 100 Hz and retrace blanking. R36 is used to set the period of the horizontal sweep to 10 milliseconds (100 Hz).

3-14. A/D Circuitry. Clock pulses from the master oscillator are fed to the flip-flop U4-B-3 CLK input. These clock pulses are routed through U4-B to the A/D compare latch circuit where they are applied to the A/D binary counter U10. As utilized the A/D binary counter U10 consists of eight input pulse shaping and ripple-carry counter stages. A master-slave flip-flop configuration is utilized for each counter stage. The state of the counter is advanced one step in binary order on the negative-going transition of the input pulse. All inputs and outputs are fully buffered. The outputs of the eight stages are routed to a resistance ladder network R76 where they are weighted according to their bit significance and summed. This sum, applied to the comparator U5-2, is a staircase voltage starting at 0 volts and rising to 255 steps of 19.6 mv each.

As the staircase voltage ramp is rising, it is continuously compared with the ECG signal from the input stage applied to the comparator U5-3. At the point when the reference ramp matches the input signal, the output signal at U5-6 rises, U6-A-10 drops, U6-B-11 rises and U6-C-4 drops. This action latches the U6 network and blocks pulses from the clock to the A/D binary counter. Thus, the A/D counter is stopped at the point where the resistive ladder R76 output voltage is the same as the input signal voltage from the input stage. The one-shot multivibrator U3-B is triggered from the trailing edge of the write recirculate pulse and an A/D reset signal from U3-B-6 is applied to the A/D binary counter U10-11 and to the flip-flop U4-B-4. Prior to this point, the original circuit conditions are restored and the circuit is ready for another A/D conversion.



3-5 No-Fade Circuitry - Schematic Diagram

3-15. Memory Circuitry. All information displayed on the cardioscope or recorder has been stored first in digital form within the memory. The ECG signal is sampled continuously and each time a sample has been taken, the signal at that instant is converted into a binary word and stored in the memory. The memory consists of eight 512 bit shift registers U14 thru U21. The last stage in the memory is connected to the first stage to form a continuous word train. Each output section of the shift registers is connected to a pull down resistor network R47. One end of R47 is connected to ground. The outputs of the shift registers are routed to eight buffer stages contained in stages U22 and U23.

The control for the memory is provided by the memory clock driver U13 acting in conjunction with the write recirculate signal. The opposite phase clock pulses developed from the Schmitt triggers U11-C-10 and U11-D-6 are fed to four buffer amplifier stages contained in U22. Two stages each of paralleled buffers U22 are used for each input of the clock pulse driver U13 to establish high current handling capability. Each word in the memory is circulated continuously from one stage to the next succeeding stage at the rate of approximately 10^5 words per second on command of the clock signals Q1 and Q2. The two signals are sequential and both are required to shift a stage.

3-16. D/A Circuitry. The output of shift registers U14 through U21 are fed through eight buffer stages contained in U22 and U23 to the cardioscope vertical D/A resistive ladder R75 and to eight stages of recorder buffers contained in U25 and U26. These buffers (U25 and U26) contain four latch circuits each and are strobed by a common clock. The clock pulses at U25-5 and U26-5 are obtained from the write recirculate signal. The outputs of these buffers are then routed to D/A resistive ladder R74.

The D/A resistive ladders R74 and R75 convert the digital data into an analogous voltage without affecting the digital integrity of the word. The analog signal is then applied to the cardioscope vertical amplifier and recorder amplifier circuits (refer to paragraphs 3-17 through 3-23).

3-17. CARDIOSCOPE DISPLAY

The following paragraphs describe the cardioscope display circuits, including vertical, horizontal and timing circuits. Figure 3-6 provides a complete schematic of the cardioscope display circuits to assist in the following detailed circuit analysis. Operating voltages are derived from the system power supply presented in paragraph 3-25.

3-18. Vertical. An analog output from the A/D resistance ladder R75 in the no-fade circuit is fed to one stage of operational amplifier U24-A-2 (no-fade board) where it is referenced to the voltage from the CRT centering network of R53. This voltage is applied to U24-A-3. Adjustment of R53 changes the reference voltage and determines the vertical position of the cardioscope trace. The second stage of U24B (no-fade board) provides low pass filtering.

The ECG size potentiometer located on the control board controls the amplitude of the ECG signal to both the cardioscope and recorder via the no-fade circuitry (refer to paragraph 3-10).

Two stages of operational amplifier U9-A and B (preamp board) in conjunction with the differential amplifier Q15 and Q16 (preamp board) provide vertical deflection for the cardioscope. Retrace blanking is provided by driving the display vertically off the CRT through Q17. The signal at U9-B-1 is equal in amplitude and 180 degrees out of phase with that of U9-A-7. The differential amplifier has a gain of approximately 14. The retrace blanking timing signal is derived from the timing counter stage on the no-fade board.

3-19. Horizontal. A horizontal sweep timing pulse of 100 Hz, derived from the timing circuitry on the no-fade board, is applied to operational amplifier U7-2 (preamp board) which is connected as an integrating amplifier. The horizontal sweep timing pulse is adjusted with R36 (horizontal timing) on the no-fade board. The timing pulse is referenced to the voltage from the horizontal positioning network of R68. Adjustment of R68 changes the reference voltage and determines the horizontal positioning of the cardioscope trace. A triangle waveform is developed by U7 and R63 (horizontal sweep gain) is adjusted to provide a 25mm/second sweep. This waveform is applied to the horizontal deflection plates of the cardioscope CRT through the differential amplifier composed of the two sections of operational amplifier U8-A and U8-B driving Q13 and Q14.

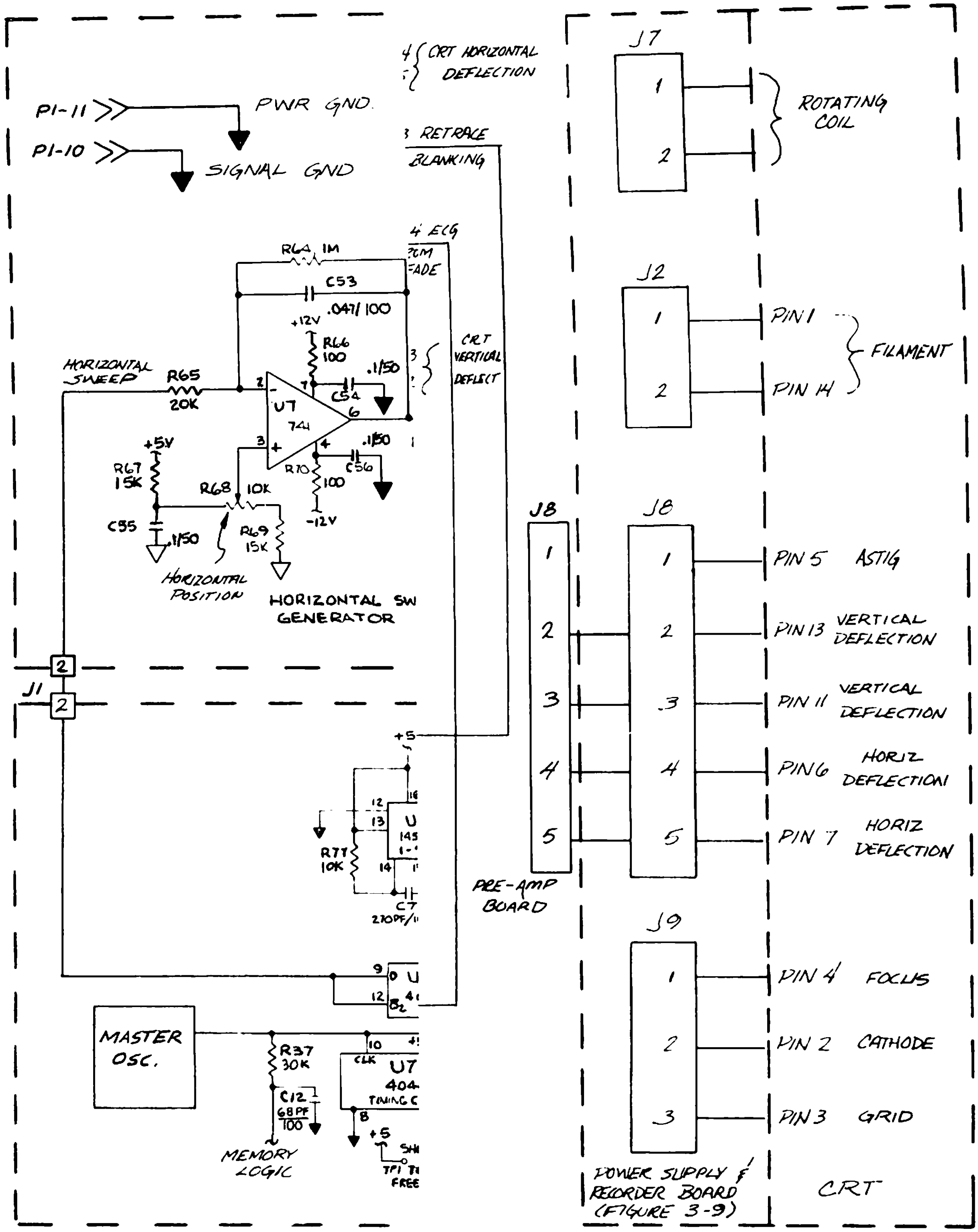
3-20. RECORDER DISPLAY

The recorder circuitry receives its ECG input from the D/A resistive voltage divider R74 (no-fade board). Its amplitude, like that of the cardioscope vertical, is adjusted by the ECG SIZE pot. When the recorder is not in use it is turned off to conserve energy. Figure 3-7 provides a detailed schematic to assist in the following circuit analysis.

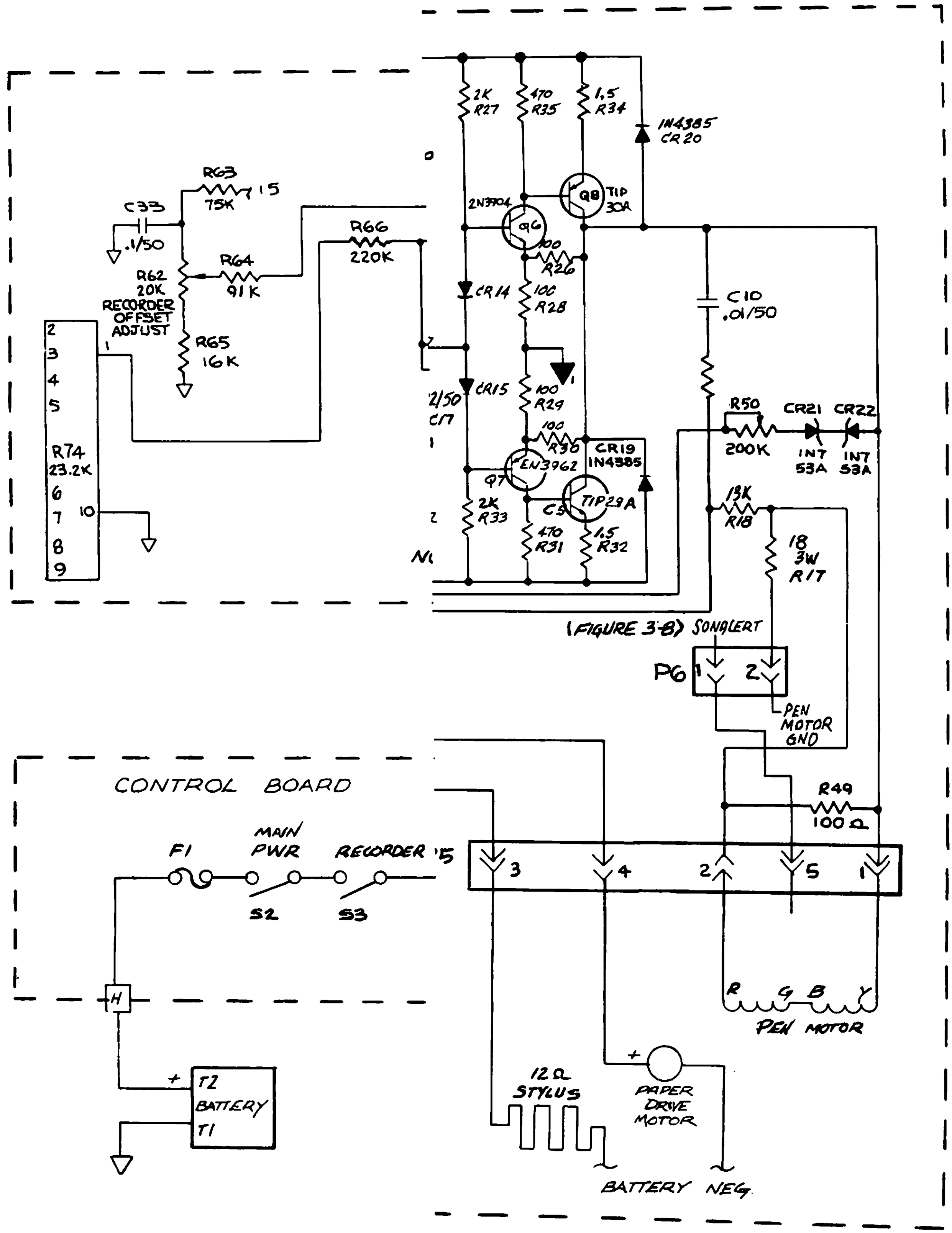
3-21. Offset and Signal Conditioning. The output signal at resistive ladder R74 is fed to the operational amplifier U8-A-2 (no-fade board) inverting input where it is referenced against a voltage formed by the network R63, R62, and R65. R62 (recorder offset adjust) is adjusted to null any offset at U8-A-1. Operational amplifier U8-B forms a low pass filter and its output is routed to amplifier U2 on the power supply and recorder board.

3-22. Pen Motor Amplifier. The incoming signal from the low pass amplifier U8-B on the no-fade board is amplified in operational amplifier U2 which drives the complementary-symmetry push-pull output stages Q6-Q7 and Q5-Q8. The combination of voltage and current feedback is designed to optimize the frequency response of the recorder. Recorder gain potentiometer R11 adjusts the magnitude of the feedback signal to U1-2.

3-23. Recorder Inverter, Stylus Heat and Paper Drive Motor. The squarewave from the Royer oscillator (T2, Q9 and Q10) is rectified and filtered to supply negative 12 volts for the recorder pen motor circuit (refer to paragraph 3-29). The stylus heat voltage is developed from the 12 VDC battery, timer U1 and Q2 varies the duty cycle from 16 to 25%. The stylus HEAT potentiometer provides duty cycle adjustment capability. Operational amplifier



…e Circuitry — Schematic Diagram



Circuitry – Schematic Diagram

provides a DC voltage to the paper drive motor. The paper drive motor's speed is adjusted for 25 mm/sec by R15 (timing adjust). The paper drive circuits are designed to maintain a constant motor speed regardless of normal loading effects on the motor.

3-24. SYSTOLE SOUND

The systole sound circuit consists of a R-wave detector, where the patient's R-wave is detected and a square pulse timed on the down slope of the R-wave is generated. The output pulses the systole sound transducer. Figure 3-8 provides a detailed schematic to assist in the following detailed circuit analysis.

The systole sound circuitry receives its input from the final amplifier on the preamp board. The input R-wave can be either positive or negative going, therefore a bipolar detection is used. It passes through narrow-band filter C6, R14, C3 and U2-7 (no-fade Board). The signal is centered on about 11 Hz, to emphasize the R-wave and de-emphasize the T-wave which might otherwise falsely trigger the detector.

The reference voltage at U2-3 or U2-2 determined by R9 through R11 or R6 through R8, is set so the trailing edges of the negative-going square pulses at U2-1 or R6-R8 occur high upon the down slope of the R-wave.

The train of square pulses, applied across CR3, loses practically all of the negative-going swing while retaining a sharp positive spike. The spikes are used to trigger the one-shot multivibrator Q2 and Q3. The positive-going pulse train at the collector of Q2 is buffered by Q1. Each time Q2 turns off it turns on Q1, applying a pulse across the SYST VOL pot R3. The SYST VOL pot R3, located on the control board is used to adjust the systole level to the sonalert. The sonalert is physically located in the recorder module.

3-25. POWER SUPPLY

The following paragraphs describe the cardioscope/recorder power supply stages including the Royer oscillator, plus or minus 5 volt, plus or minus 12 volt, 120 volt and CRT operating voltages. Figure 3-9 provides a detailed schematic to assist in the following detailed circuit analysis.

3-26. General. The cardioscope/recorder is powered by a 12-volt, rechargeable, nickel-cadmium battery. The 12 VDC from the battery is applied through the MAIN PWR pushbutton switch S2, located on the control board, to P10-2 and P10-1. The cardioscope/recorder power supply circuit is protected by a one amp fuse F2. This voltage is sensed by the low battery indicating circuit. This circuit is discussed in paragraph 3-33.

The 12 VDC, for all circuits except the recorder, is then applied to a three terminal eight volt regulator U3. The regulator employs internal current limiting, thermal shutdown, and safe area compensation, making it essentially blowout proof. The regulator is mounted on a heat sink, which is connected to pin 3 ground. Pin 1 provides the input and pin 2 the output to the Royer oscillator.

For the recorder, the 12 VDC from the battery is applied through the MAIN PWR pushbutton switch S2 and RECORD power pushbutton S3. The recorder circuitry is protected by a two amp fuse F1. The 12 VDC enters the power supply and recorder board through P4-5 (+) and P4-6 (pwr gnd) to the recorder Royer oscillator.

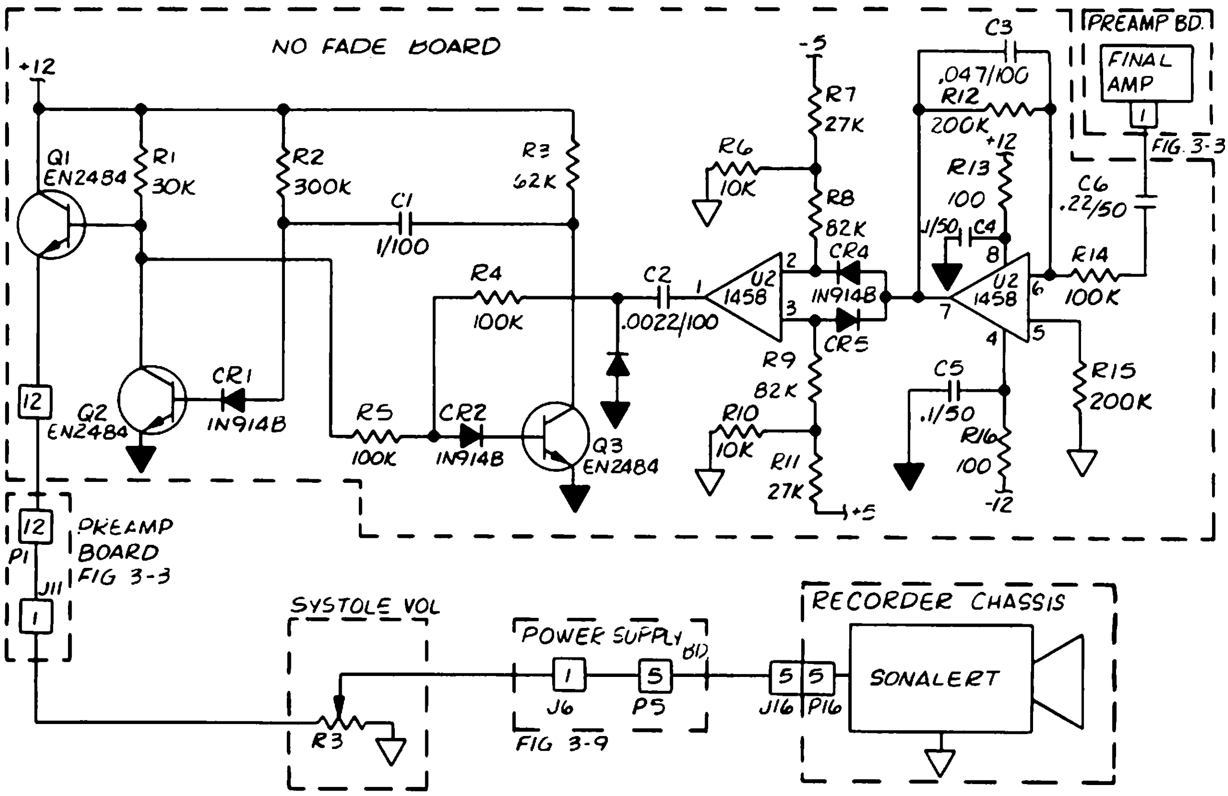


Figure 3-8. Systole Sound Circuitry - Schematic Diagram

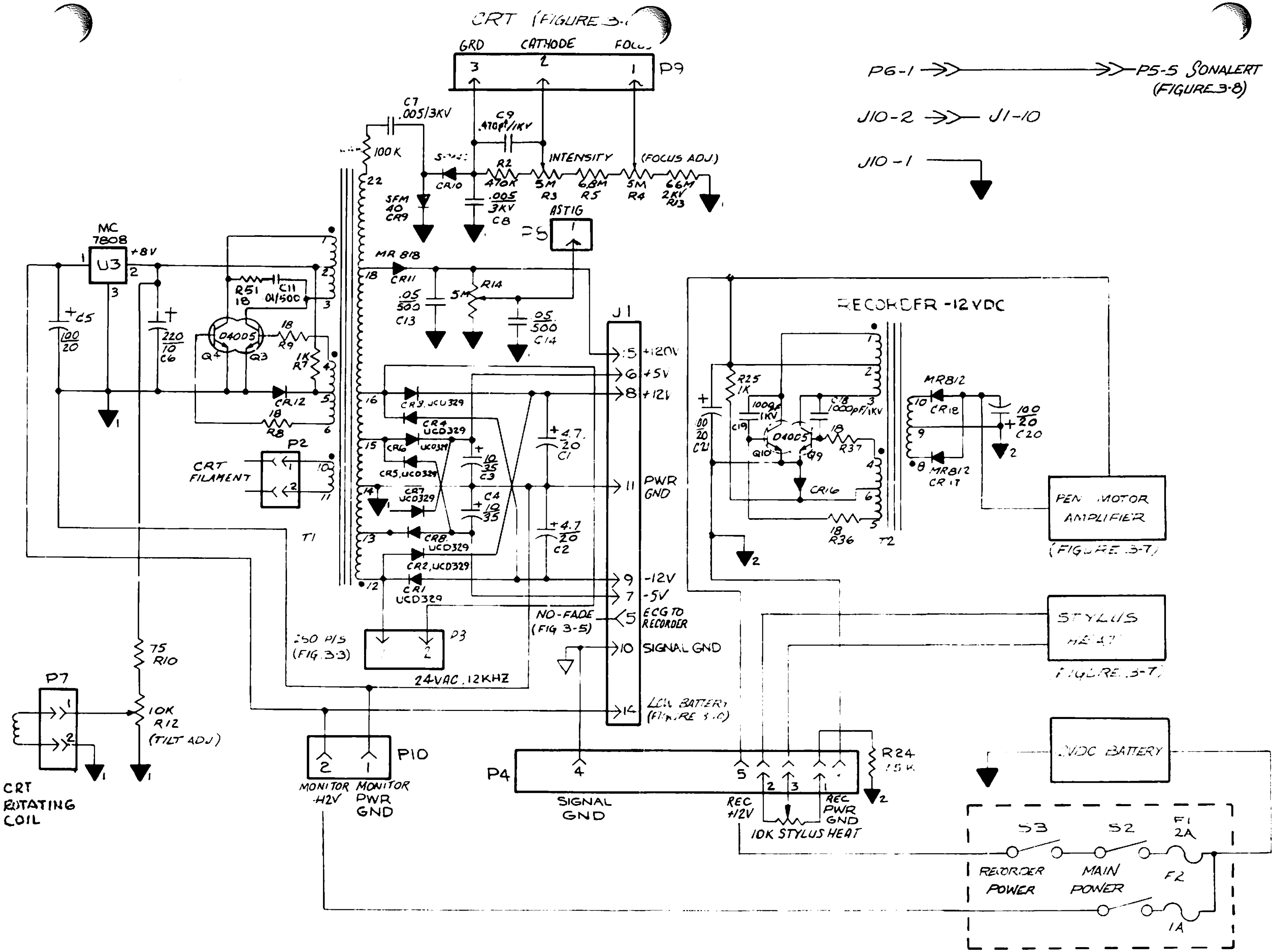


Figure 3-9. Power Supply Circuitry - Schematic Diagram

3-27. Royer Oscillator. Two Royer oscillators are provided, the following description is applicable for both. All circuitry except the recorder is supplied by the oscillator using T-1. The numbers in parentheses represent the recorder Royer oscillator. The Royer oscillator runs at about 12 KHz (16 KHz). The bases of switches Q3 and Q4 (Q9 and Q10) are driven in phase opposition by winding T1-4 and 6 (T2-4 and 6) on transformer T1 (T2). The center tap of T1 is held at 8VDC by regulator VR1 while the ends of the winding are alternately shorted by switches Q3 and Q4.

Switching from one pulse of the squarewave to the other occurs when the magnetic flux in the core of T1 (T2) reaches the saturation level, whereupon the drive o the base of the on switch Q3 or Q5 (Q9 or Q10) declines and begins to turn off that switch, causing the flux in the core to diminish and begin building up in the opposite direction. The process is continuous as long as power is applied to the circuit. The output signal across the collectors of Q3 and Q4 (Q9 and Q10) is a 12 KHz (16 KHz) squarewave of approximately 16 (24) volt amplitude.

3-28. Isolated Power Supply. To protect the patient against electric shock, the electrodes of LIFEPAK 5 which contact the patient are isolated from continuity with electrical power and earth ground. ECG signals are amplified in the isolated preamp, then transformer coupled to the other circuitry of LIFEPAK 5.

Plus and minus 12-volt power to operate the isolated preamp circuitry is produced by full-wave rectifier CR13 through CR16 and filters C37 and C38, which are mounted on the preamp board (see figure 3-3). The input power to this bridge is coupled through T1 on the power supply board to P3-1 and P3-2 and is 24 volts peak-to-peak.

3-29. Plus and Minus 12 Volt Supply. Plus and minus 12 volts is delivered to the cardioscope/recorder circuitry (except recorder) from a full-wave bridge consisting of CR1 through CR4 and filters C1 and C2. The 24 V peak-to-peak input to this bridge, from the Royer oscillator, is applied across the T1 secondary at pins 12 and 16. The plus or minus 12 volts is routed out of the bridge through J1-8(+), J1-7(-) and J1-6 (power ground).

The recorder minus 12 volts is derived from T2 primary pins 10 and 8. CR17 and CR18 and C20 full-wave rectify and filter the voltage at T2 secondary.

3-30. Plus and Minus 5 Volt Supply. Plus and minus 5 volts is delivered to the cardioscope/recorder circuitry from a full-wave bridge consisting of CR5 through CR8 and filters C3 and C4. The 10 volt peak-to-peak input to this bridge, from the Royer oscillator, is applied across the T1 secondary at pins 15 and 13. The plus or minus 5 volts is routed out of the bridge through J1-6(+), J1-7(-) and J1-11 (power ground).

3-31. Plus 120 Volt Supply. The CRT horizontal and vertical drive circuits require +120V. The +120 volts between T1-14 and T1-18 is rectified and filtered by CR11 and C13. This voltage is routed to the vertical and horizontal drive circuits through J1-15(+) and J1-11 (power ground).

3-32. CRT Operating Voltages. Refer to figure 3-6 for a cardioscope schematic diagram. CRT operating voltages are developed as follows:

1. CRT Filament. 6.3 VAC filament voltage is supplied to the CRT through P2-1 and P2-2.
2. ASTIG. Astigmatism voltage for the CRT is developed from the 120 volt supply. Potentiometer R14 is provided for adjustment. The voltage is routed out on P8-1(+) and J1-11 (power ground).
3. GRID. 1300 volts peak-to-peak is supplied across T1-22 and T1-14 from the Royer oscillator. This voltage is rectified, filtered and doubled by CR9, CR10 and C7. The output of this network is 1300 vdc and is routed to the grid through P9-3.
4. CATHODE AND FOCUS. Cathode and focus voltages are derived from the 1300 vdc voltage divider consisting of R2, R3, R4, R5 and R13. R3 provides adjustment for the cathode voltage (intensity adjustment) and R4 for the focus voltage. The cathode voltage is routed out through P9-2 and the focus voltage through P9-1.
5. CRT Rotating Coil. CRT rotating coil voltage is developed from the 8V voltage regulator U3 output. It is adjustable through R12. The voltage is routed out through P7-1(+) and P7-3 (power ground). The current through the rotating coil is used to align the CRT trace with its horizontal axis.

3-33. LOW BATTERY LEVEL CIRCUITRY

Refer to figure 3-10 while reading the following circuit analysis. One stage of operational amplifier U1 functions as a comparator amplifier. Reference voltage obtained from the +5 volt supply is fed through voltage divider network R25 and R27 to U1-A-6(-). This reference voltage is compared with that of the 12 VDC instrument battery supplied to U1-A-5 through voltage divider network R24, R26 and R28 and the reference voltage at U1-C-6. The output voltage at U1-A-7 will go low when the battery level drops below 10.0 VDC.

The second stage of U1-B functions as an oscillator and drives the LOW BATTERY indicator. This indicator will flash when the battery terminal voltage is nominally 10.0V at 25°C. When the voltage is low at U1-A-7 the oscillator stage is allowed to run and flashes the indicator.

3-34. DC DEFIBRILLATOR MODULE

The DC defibrillator module circuit description is presented by circuit function. A functional or block diagram description begins the first part of this section. The remaining part is a detailed description of the circuitry within the DC defibrillator module. The interconnecting wiring diagram presented in Section 5 provides the complete interconnection data for the subassemblies of the LIFEPAK 5 DC Defibrillator Module.

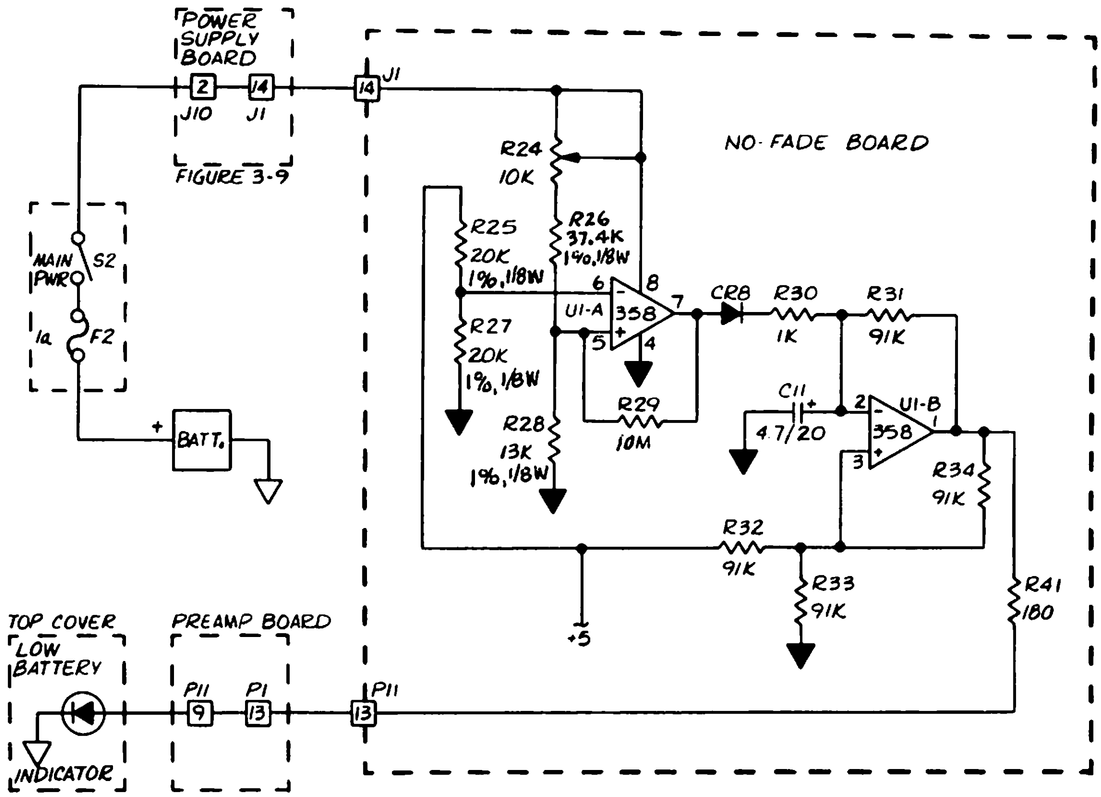


Figure 3-10. Low Battery Level Circuitry - Schematic Diagram

3-35. FUNCTIONAL DESCRIPTION

The DC defibrillator module block diagram presented by figure 3-11 provides an overall view with signal flow. For a more detailed analysis, figure 3-12 provides a complete schematic of the DC defibrillator.

When power is applied and the CHARGE button depressed, the charge control logic circuit initiates several commands. The main command is to enable the charge up circuitry to charge the charge storage capacitor. Simultaneously the charge control logic causes the Charge Indicator to flash, meaning the charge storage capacitor is being charged. The dump relay is energized by the dump control causing the bleeder resistor to be removed from the charge storage capacitor. The charge control logic also initiates the transfer disable signal so that the transfer control cannot be enabled, thus rendering the paddle buttons ineffective until the charge storage capacitor has reached full charge. Once the charge storage capacitor has reached the charge set by the ENERGY JOULES select switch S4, the ready comparator signals the charge control logic. The charge control logic disables the charge up circuitry and defeats the transfer lockout disable signal circuitry. At the same time the ready comparator changes the flashing indicator light to a steady light, signifying the instrument is ready. Depressing the paddle Discharge buttons S2 and S5 at this time causes the transfer control to energize the transfer relay. With the relay energized, the charge path is opened and the

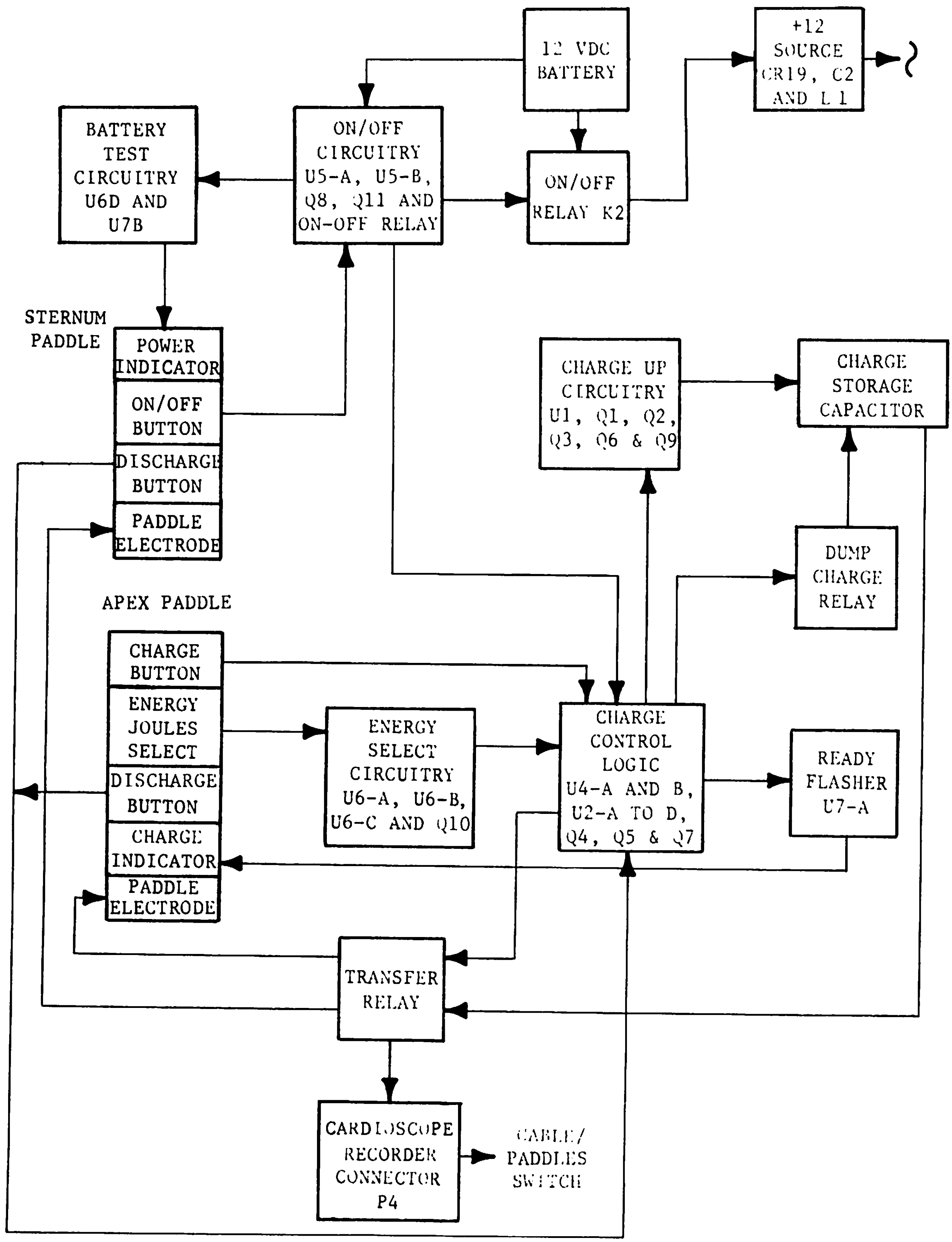


Figure 3-11. DC Defibrillator Module Block Diagram

discharge path completed for transfer of the stored energy to the paddles. At this time the dump relay is de-energized and places the bleeder resistor across the charge storage capacitor.

3-36. ON/OFF CIRCUITRY

The on/off circuitry toggles the input power off and on, and sets up initial conditions within the DC defibrillator module. The major components of this circuitry include U5-A and B, a data-type flip-flop, transistors Q8 and Q11, POWER switch S3, and the on/off relay K1.

The first stage of U5-A functions as a one-shot multivbrator whict turns transistor Q8 on long enough to precharge C1 before the on/off relay is energized. The quiescent state of U5-A's S(set) and R(reset) inputs are both high and the $\overline{Q}$ output (12) is high, therefore Q8 is off. When the POWER switch S3, located on the sternum paddle, is depressed, C33 charges up to the supply voltage and the R input (10) of U5-A is driven low. This action forces the $\overline{Q}$ output (12) of U5-A low, which turns on Q8. When the POWER switch S3 is released, U5-A's $\overline{Q}$ output (12) will stay low until C33 has discharged to approximately 65% of the supply voltage. At this time the reset gate threshold will be reached and the $\overline{Q}$ output (12) will be forced high again.

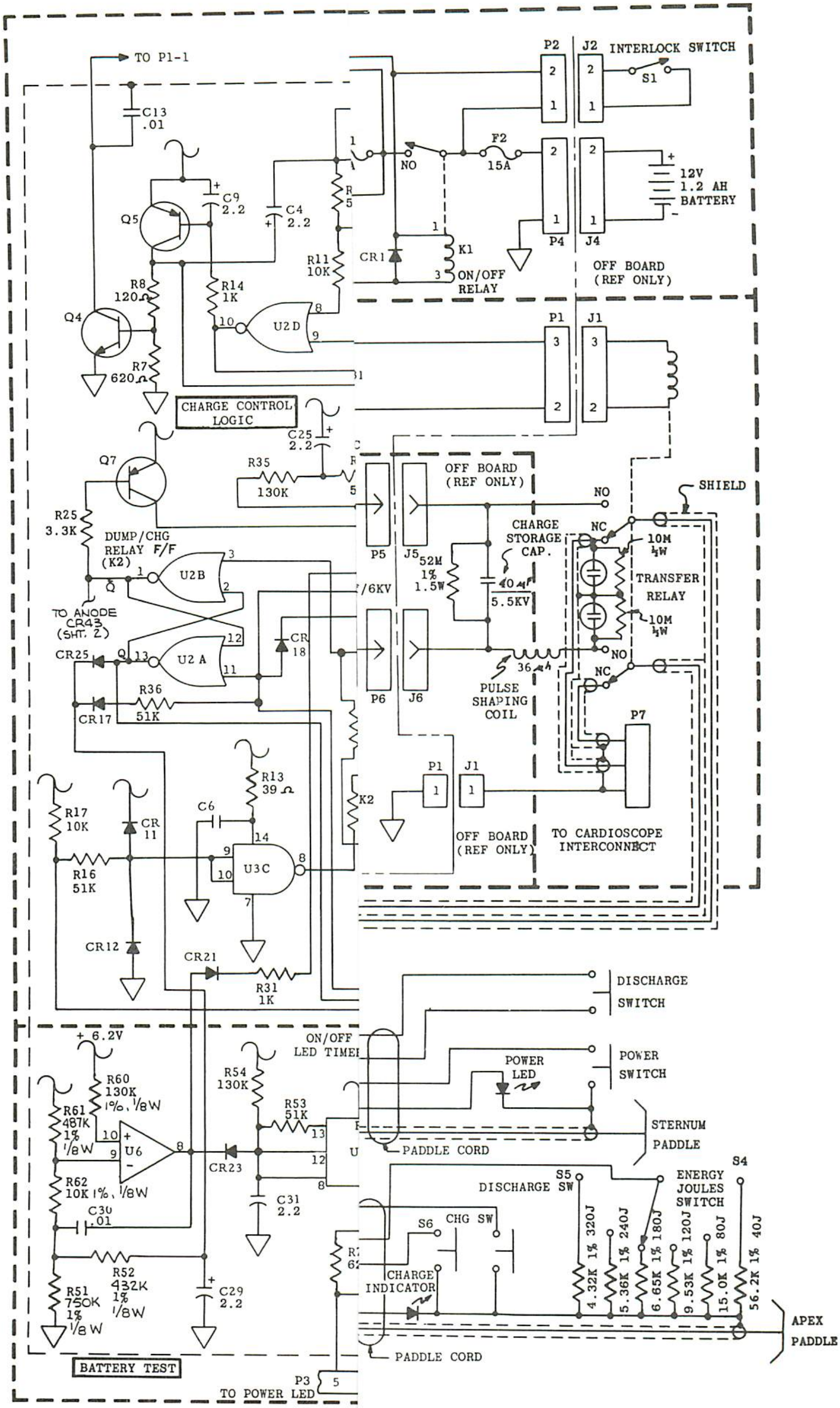
On the positive transition of U5-A's $\overline{Q}$ output (12), U5-B will be clocked to the opposite of its previous state. Therefore, if the Q output (1) of U5-B was previously low and transistor Q11 was off, it will be clocked high and transistor Q11 will turn on, energizing the on/off relay. The time constant of R46 and C33 is set so that the minimum time to reach the reset threshold of U5-A is adequate for Q8 to charge C1 and C2 to full supply voltage under minimum beta conditions. The purpose for this delay is to prevent the on/off relay from having to switch high capacitor charging currents, thereby degrading its contacts. The purpose of C32 and R63 is to put U5-B in its reset condition when the battery/pak is connected to the circuit.

L1 and C2 filter the 12 VDC battery voltage and supply a +12V source voltage to the circuitry. CR19 protects the 12V source from overvoltage transients.

3-37. ENERGY SELECT CIRCUITRY

The energy select circuitry senses the selected energy level and determines if the charge storage capacitor has the correct amount of voltage to deliver that energy. The major components of this circuitry include three stages of U6(A-C), transistor Q10 and the ENERGY JOULES select switch S4.

The function of the network consisting of R47, R48, R49, R50 and CR22 is to set up a stable reference voltage on the non-inverting input (12) of energy select amplifier U6-A. A 6.2V reference voltage is also applied to U6-D in the battery test circuitry. CR22 is a reference diode and R48 is a compensation trim pot for calibration of energy delivered.



lator Module Circuitry- Schematic Diagram

The output of U6-A is dependent on the resistors switched in by the ENERGY JOULES switch S4. Ready comparator U6-B will have a high output until the charge capacitor is charged up to a voltage which is proportionately higher than the output voltage of U6-A. At this point U6-B's output swings low, signifying to the charge control logic that the charge storage capacitor is charged to the correct energy level and to stop charging. At this point Q10 is turned on via U3-A-6 pulling the non-inverting input of U6-B-5 down by the divider network consisting of R57 and R58. This provides the hysteresis which allows the charge storage capacitor to bleed down approximately 10% in energy before the U6-B comparator signals the charge control to start charging again. This occurs several times after each charge initiation.

U6-C acts as an energy select disarm. Its function is to cause the charge control logic at U3-B-2 to direct the dump charge relay to dump. This would occur when changing the setting of the ENERGY JOULES switch S4 after the DC defibrillator has been charged.

3-38. CHARGE CONTROL LOGIC

The charge control logic circuitry controls the charge and the transfer of the energy stored on the charge capacitor. The major components of this circuitry include data flip-flops U4-A and U4-B, four stages of NOR gates U2-A through D, four stages of NAND gates U3-A through D, transistors Q4, Q5 and Q7 and the transfer and dump/charge relays.

When the circuitry is first turned on, the Q output (1) of U5-B in the on-off circuitry sets up the charge control logic in its initial conditions (refer to paragraph 3-36). This is done by causing a reset to the R input (4) of U4-A and to the flip-flop comprised of U2-A and B through NAND gates U3-A and B respectively.

After the on/off relay is energized, charge can be initiated by depressing the CHARGE button S6. Depressing the CHARGE button S6 causes U3-C's output (8) to swing high, clocking the CK input (3) of U4-A. With a high from the ready comparator U6-B on the D input (5) of U4-A the U4-A Q output (1) goes high. This causing U2-A and B flip-flops to be set, triggering Q7 to turn on and energize the dump charge relay K2. U4-A's $\overline{Q}$ output (2) will also swing low, which after a delay time determined by R35 and C25, causes U2-C's output to swing high. When U2-C's output (4) swings high it actuates the capacitor chargeup circuitry at (4) of U1. This delay is provided so that the dump/charge relay K2 will have time to activate, completing the charge path, before the capacitor charge up circuitry is actuated, thus preventing arcing at K2.

The charge circuit will be held on until the ready comparator U6-B's output (7) swings low, in turn causing a reset to U4-A through U3-A. Transfer is inhibited until ready by diode CR8 which holds the one input of U2-D low until the output of U3-A swings high. Once the output of U3-A swings high, transfer can be initiated by depressing the Discharge buttons S2 and S5, which causes U3-D's output to swing high. This causes U2-D's output to swing low, turning on Q4 and Q5. The capacitor feedback (C4) from the collector of Q5 to the input of U2-D pin 10 causes the transfer relay to stay activated until the capacitor C4 charges up to approximately one-half supply. The charge rate of this capacitor (C4) then determines the transfer relay minimum on time.

The function of U4-B is to cause an automatic recharge once after each charge initiation. Each time a charge is initiated by depressing the charge button, U4-B-8 is set via the positive swing of U3-C. Once the charge storage capacitor is completely charged and bleeds down to a not ready condition, the ready comparator's U6-B output swings high, causing a reset to U4-B, in turn causing the $\overline{Q}$ output (12) to swing high. This high is coupled via C7 to the CK input of U4-A-3. This clocks a high from the D input (5) of U4-A to the Q output (1), causing a recharge.

3-39. READY FLASHER CIRCUITRY

The ready flasher circuitry indicates the state of charge on the charge storage capacitor. The circuit essentially consists of oscillator U7-A and the Charge Indicator (ready) LED.

Once charge is initiated, U2-A's output swings high, enabling U4-A to oscillate whenever the ready comparator's U6-B output is high. The oscillator frequency is determined by R71, R72 and C38. Since the ready comparator U6-B is high whenever the charge storage capacitor is not completely charged, U7-A will oscillate. Its output will be a ready high whenever the ready comparator U6-B output is low. This yields a flashing Charge Indicator (ready) LED while the unit is charging or is not ready, and is on solid whenever the charge storage capacitor is fully charged and ready.

3-40. CAPACITOR CHARGE UP CIRCUITRY

The capacitor charge up circuitry charges the charge storage capacitor. The major components of this circuitry include high speed timer U1, transistors Q1, Q2, Q3, Q6 and Q9, and transformer T1.

The basic principle of the capacitor charge up circuitry consists of ramping up a current in the primary of transformer T1 to the point where the transformer is very nearly saturated while the transformer secondary essentially open circuited (CR6 reverse biased). The primary current is then terminated and the energy stored in the core is allowed to dump into the charge storage capacitor via the secondary winding, CR6 and the dump/charge relay K2.

High speed timer U1,R26 (pot), R5 and C8 are used to determine the on time of the primary current and therefore energy stored in the core during each cycle.

Q2 is the main output driver for the capacitor charge up circuitry. The voltage on capacitor C23, via emitter follower Q1 and R1, determines the base drive current for Q2. The charge rate of capacitor C23 is set to ramp up the base current for Q2 in conjunction with Q2's collector current ramp. The network of Q6, Q9, R28, R30, R32, R33, C23 and C24 provide a base turnoff current spike to Q2.

The primary current's off time is determined by the network consisting of Q3, R4, R21, CR13, R22 (pot) and R23. The timer output is held low until all the energy in the core of the transformer T1 is discharged into the secondary circuit. A delay time determined by C8, R23 and R22 (pot) is applied to the timer U1 to keep its output from going high again so that Q2 does not switch on into the high collector voltages seen during its off time. A 68 volt zener diode CR2 functions to protect Q2 from the high voltages of leakage inductance spikes and from inadvertent damage from operating the circuit with the secondary unloaded during test.

3-41 BATTERY TEST CIRCUITRY

The battery test circuitry monitors the battery charge state during quiescent conditions and during the charging of the charge storage capacitor. The circuitry protects the battery against cell reversal when the battery is depleted. The major components of this circuitry include comparator U6-D, timer U7-B and the POWER indicator (low battery indicator).

Comparator U6-D's output will be low if the battery voltage is above a predetermined level as defined by the difference between the reference voltage from CR22 (6.2V) and the ratio of R51 + R62/R61 voltage divider. When U6-D's output is low, C31 is held at 0.5V above ground, maintaining timer U7-B's output high.

When the battery voltage falls to approximately 10.0 volts with the DC defibrillator on as a load (Charge Indicator Off), comparator U6-D's output goes high allowing U7-B to oscillate. This drives the POWER LED causing it to flash, indicating low battery. This test only operates while the Charge Indicator is off.

To protect the battery from cell reversal during charging when the battery is depleted, a minimum voltage limit of approximately 8.5V during charging of the charge capacitor is placed on the battery. This is accomplished by reducing the current drawn by the capacitor charge up circuitry as the battery voltage approaches 8.5V. During charge U2-A's output is high, placing R52 in parallel with R61 and R62 causing U6-D to compare at 8.5V (versus 10.0V as mentioned before). When U6-D's output goes high a parallel charge path to R26 and R5 is created with CR21 and R31. This decreases the charge time of C8 and therefore decreases the on time of timer U1, causing the capacitor charge up current to decrease. This decrease also causes an increase in charge time.

3-42 SYNCHRONIZED CARDIOVERSION (OPTION)

The synchronizer cannot be operated unless the defibrillator module is connected to the cardioscope/recorder module with the synchronizer option. Figure 3-13 provides the schematic of the synchronizer circuitry.

When power is applied, a positive pulse is coupled to pin 12 of U8, through C42, causing pin 13 of U8 to go low. This low level pulse is inverted once at pin 10 of U8, and again at pin 1 of U8, causing a low level pulse at pin 13 of U9. This is the clear input which causes Q, pin 9 of U9, to go to a low level assuring that the defibrillator turns on in the non-synchronized mode.

When the sync pushbutton switch is pushed on, without a cardioscope/recorder module connected or connected to a cardioscope/recorder module without the synchronizer circuitry option installed, a positive pulse is applied to pin 11 of U9. Since pin 8 is connected to pin 12 of U9, the output of pin 8, of U9, toggles low momentarily. This causes Q13 to turn on, and since point P7-1 is not held low by the LED in U2, a positive level is applied to pin 3 of U8 causing pin 1 of U8 to go low and reset U9 to the non-synchronized mode.

Whenever U9 is in the non-synchronized mode, pin 9 of U9 is always low. This holds pin 4 of U9 low. Pin 8 of U9 holds pin 1 of U9 high through diode CR44. These are the preset and clear inputs of U9 and when addressed in the above manner, pin 5 of U9 is high allowing normal non-synchronized defibrillator operation.

When the sync pushbutton switch is pushed on, with the defibrillator connected to the cardioscope/recorder module with the synchronizer circuitry option, pin 8 of U9 again toggles low turning on Q13. However, the LED in U2 is now connected to P7-1 turning the LED on.

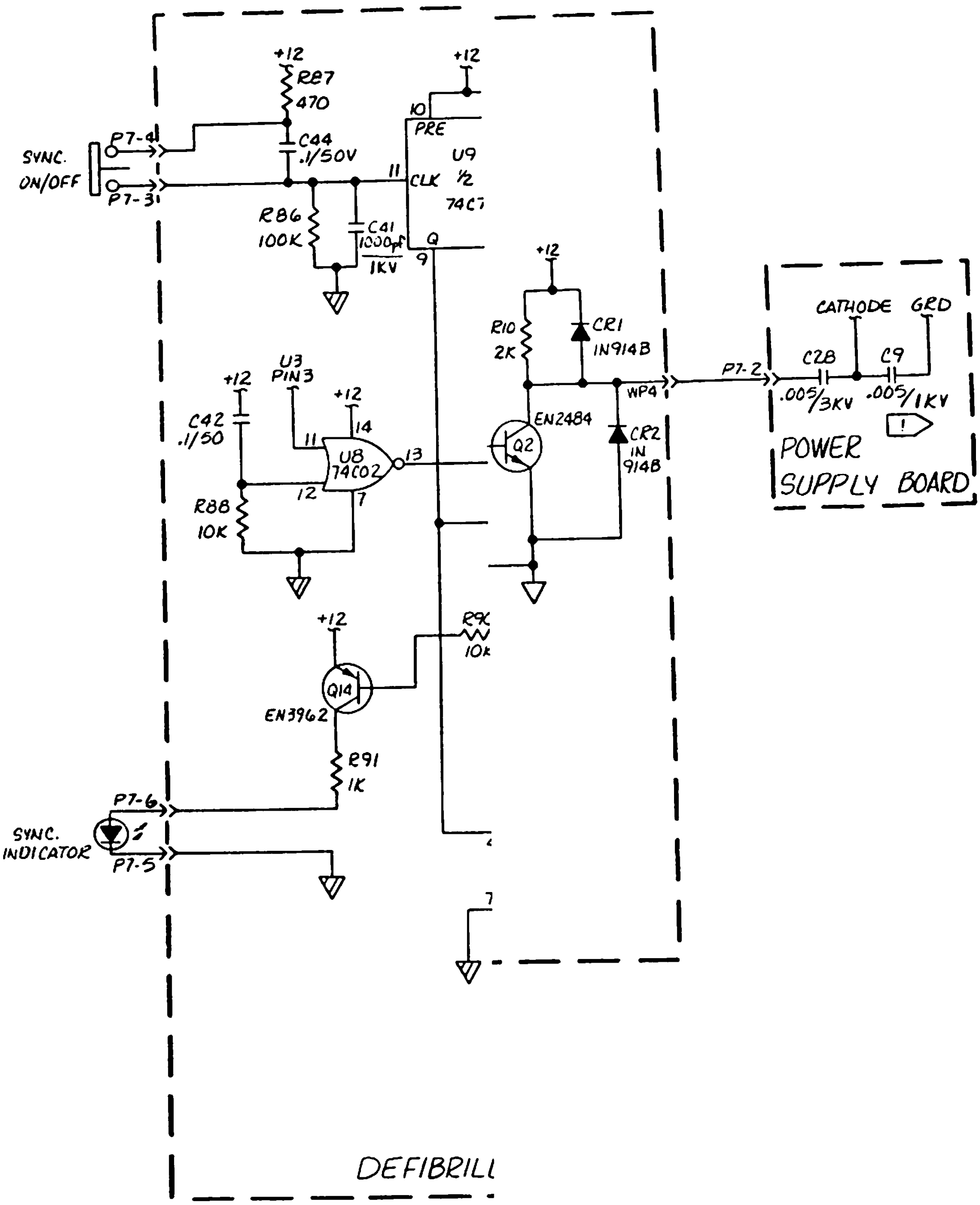
Since the voltage of the LED is less than the high level threshold vol age of U8, pin 3, pin 1 of U8 remains high. Pin 9 of U9 is now high and due to the interconnection of R92 and C43, pin 5 of U9 goes low inhibiting transfer. R89 also raises pins 5 and 6 of U8 to a high level which causes pin 4 of U8 to go low. This condition turns on Q14 and illuminates the synch indicator through current limiting resistor R91.

Turning the LED on in U2 causes the transistor in U2 to turn on and applies a high level to pin 2 and 5 of U3. A positive pulse of approximately 200 milliseconds duration is applied to J1-12 each time a patient generated R-wave is detected. The amplitude is divided down by R6 and R7, and then applied to pin 4 of U3. This causes pin 6 of U3 to go low for 200 milliseconds, whenever an R-wave is detected, and turns on Q1 through current limiting resistor R2, and in turn, turns on the LED in U1 through current limiting resistor R1. This causes the transistor in U1 to turn on and pull pins 5 and 6 of U8 low causing pin 4 of U8 and pin 3 of U9 to go high. Since D, pin 2, of U9 is at a high level, Q, pin 5 of U9 goes high momentarily allowing transfer when the discharge pushbuttons are pressed, then resets to a low level in approximately 1 m sec due to the RC network of R92 and C43. This prevents firing the defibrillator too far after the R-wave detection.

The high level pulse at pin 4 of U8 also turns off Q14 and the sync indicator LED for 200 milliseconds with each R-wave detected. When the defibrillator is fired, a high level pulse is applied to pin 11 of U8 causing the defibrillator to return to the non-synchronized mode.

If another synchronized discharge is desired, the sync pushbutton switch must be pushed again.

A feature of the synchronizer option is the intensification blip of each R-wave on the cardioscope (CRT) trace. The 200 m sec pulse is differentiated and divided down by C1, R5 and R4, then applied to pin 1 of U3. In the synchronized mode, pin 2 of U3 is high and a low level pulse appears at pins 3 and pin 13 of U3 each time an R-wave is detected. This sets latch gates of U3 so that pins 10 and 11 of U3 and pin 6 of U4 are high. U4 is a 512 bit shift register and runs essentially in parallel with the no-fade shift registers. Thus, whenever an R-wave is detected, a high level is written into U4 by a high level write pulse at pin 5 of U4. The latched gates of U3 are then reset by a low level pulse to pin 9 of U3. The clock pulses are applied to pins 1 and 7 of U4. 512 clock pulses after the high level pulse is written in and it appears at pin 2 of U4 and



Circuitry - Schematic Drawing

turns on Q2, causing a 12 volt negative going pulse to be coupled through C28 to the cathode of the CRT causing beam intensification (blip).

This intensification blip cannot occur if the cardioscope/recorder module is not connected to a defibrillator module with the synchronization option and placed in the sync mode. Transistor in U2 would be off and R3 would hold pin 2 of U3 low and inhibit U3's output, pin 3, from going low and setting latch gates of U3. Similarly, U1 is inactive as pin 5 of U3 is also held low by R3, disabling pin 6 of U3.

3-43. ACCESSORY EQUIPMENT
The following paragraphs provide the circuit description for the accessory equipment available for the LIFEPAK 5 Cardioscope/Recorder and DC Defibrillator Modules.

3-44. BATTERY/PAK CHARGER
The LIFEPAK 5 Battery/Pak Charger circuit description is presented by individual circuit function. Figure 3-14 provides a complete schematic of the battery/pak charger circuitry. The function of the battery/pak charger is to simultaneously charge two one ampere/hour battery/paks at a 300 milliampere rate.

3-45. AC Supply Circuitry. The battery/pak charger is capable of operating with either 115 volt 50-60 Hz; 220 volt 50-60 Hz; or 11-15 VDC. S1 provides the facility to manually switch the primary terminals of transformer T1 from 115 volt to 230 volt AC input. Full wave rectification of the input voltage is accomplished using CR7 through CR10.

3-46. DC to DC Converter Circuitry. The DC to DC circuitry converts a 12 VDC input to a voltage high enough to operate two separate battery/pak chargers circuits. U1-A is one-half of a dual timer which operates as a free running oscillator at a frequency of approximately 4KHz. U1-B functions as an inverter/buffer which is driven by U1-A. Q1 through Q4 are driven by U1-A and B and operate in a push-pull fashion to charge doubler capacitors C8 and C9 and discharge them into the filter capacitor C11 in the voltage regulator circuitry. When U1-B's output is high, transistor Q4 is on and C9 charges up through CR5. When U1-B's output goes low, transistor Q3 turns on and saturates, and the charge stored on capacitor C9 is transferred to C11 through CR6. Diode CR1 and the 2 amp fuse function to protect the circuitry should the input voltage be inadvertently connected in the wrong polarity.

3-47. Voltage Regulator Circuitry. C11 provides capacitor filtering for the outputs of the bridge rectifier or the DC to DC converter. Transistor Q5 functions as an emitter follower voltage regulator protecting the integrated circuits U2, 8 and 10 from unloaded high line voltages of AC operation. Zener diode CR11 limits the supply voltages on these integrated circuits to 28 volts or less. U2 provides a 15 volt reference and supply voltage for the various CMOS integrated circuits.

NOTE: IN THE FOLLOWING PARAGRAPHS OF 3-48, 3-49 AND 3-50, REFERENCE DESIGNATORS OUTSIDE OF PARENTHESIS CORRESPOND TO THE CIRCUITRY ASSOCIATED WITH THE RIGHT HAND BATTERY POSITION (AS VIEWED FROM THE FRONT OF THE CHARGER) AND THOSE INSIDE PARENTHESIS CORRESPOND WITH THE LEFT HAND BATTERY POSITION.

3-48. Battery Charging Current Source Circuitry. Two identical circuits regulate charging current to the two batteries under charge. The resistor ladder comprised of R27, R29, R30, and R31 (R57, 58, 59, and 60) divides the 15V reference to provide certain reference voltages at the output of voltage follower U8B (U10B). This reference voltage will take on two values, depending upon whether Q11 (Q17) is off or saturaged. When Q11 (Q17) is on, R29 (R58) is effectively shorted, providing approximately 3.3 V, adjusted by R31 (R60), at the output of U8B (U10B). When Q11 (Q17) is off, this reference voltage drops to approximately 0.77V, which corresponds to the charge current value for "sustaining charge" after the charging timer cycle has been completed.

The reference voltage at the output of U8B (U10B) is applied to the precision sense amplifier comprised of U8A, R21, R22, R23, R25, R26, Q9 and Q10 (U10A, R51, R52, R54, R56, Q15, Q16). This amplifier supplies a charging current through Q9 (Q15) such that the voltage across the sense resistor R23 (R52) is 15/110=0.136 times the reference voltage. This corresponds to a charge current of 300mA for a reference voltage of 3.3 V, and 70mA for 0.77 V. While the battery is being charged at a 300mA rage, if the terminal voltage begins to exceed the 15 V reference, the output of comparator U8C (U10C) takes over control of the base of Q11 (Q17), acting through CR14 (CR21). The comparator thus tends to increase the effective shunt resistance of Q11 (Q17) so as to reduce the charging current to the point where the battery terminal voltage does not increase significantly beyond the 15 V reference.

CR23 (CR22) prevents a charged battery from discharging into the charger circuitry if the charger is disconnected from the power source. Q6 (Q7) provides an "on-off" switch for the current source, controlled by the circuitry described in paragraph 3-49.

3-49. Charge Indicator Control Circuitry. Two identical circuits electronically sense when a battery has been placed in the charger. These circuits limit the risk current present at the charger terminals when no battery is present and control the CHARGING indicators. When no battery is present in the right hand (left hand) position, the non-inverting input of U8D (U10D) is held high (around 18-28V) through R28 (R61). The inverting input of U8D (U10D) is referenced from a diode drop (approximately 0.6V) above the 15 V reference. Thus the output of U8D (U10D) is high, ensuring that the "D" flip-flop of U6A (U6B) is reset, i.e., that the Q output of U6A (U6B) is low. The high output of U8D (U10D) also causes the output of U5B (U5D) to be low, which, in turn, turns on Q14 (Q20), thus charging up C18 (C24) and thereby causing the output of U5A (U5C) to be low. The low output of U5A (U5C) causes Q13 (Q19) to be turned off, which, in turn, shuts down the current source by turning off switch Q6 (Q7). Therefore, when no battery is installed, only a trickle of leakage current (less than 100 uA) can flow from the positive charger terminal.

When a battery is inserted into the right hand (left hand) position, the voltage at the non-inverting input of U8D (U10D) will be pulled below 15V, (since the terminal voltage of an undamaged battery cannot exceed 15V except under charge) causing the output of U8D (U10D) to go low. When this occurs, and after a delay of approximately 5 mSec due to the time constant of R47 (R66) and C20 (C26), the output of U5B (U5D) goes high, because the Q output of U6A (U7B) had previously been reset low. Q14 (Q20) is thereby turned off allowing C18 (C24) to discharge through R41 (R78). After approximately 2.6 seconds, the output of U5A (U5C) goes high turning on Q13 (Q19), which, in turn, lights the CHARGING indicator and turns on switch Q6 (Q7), through R20 (R50) allowing the current source to charge the battery at 300 mA. If, instead of a battery, a relatively low resistive load (225 ohms - 500 Kohms) is placed across the battery terminals, the charger will turn on as described above. However, the moment the charger turns on, voltage at the positive battery terminal will rise well above 15.6 volts. This has an immediate effect of causing the output of U8D (U10D) to go high and clocking U6A (U6B).

Since the D output of U6A (U6B) will be high under these conditions, the Q output will immediately go high. The resetting of U6A (U6B), when the output of U8D (U10D) goes high, occurs only after a delay of approximately 5 mSec., set by R45 (R64) and C19 (C25). Thus, the Q output of U6A (U6B) will be high for a period of time. However, during this period, the charger is turned off in the manner described above since the output of U5B (U5D) has gone low. With the resistive load still connected across the battery charger terminals, and with the charging current off, the voltage at the positive battery charger terminal will drop close to zero volts. This will cause the output of U8D (U10D) to again go low, which occurs before U6A (U6B) has been reset. This is a stable condition, with the charger latched off until the resistive load is removed. Therefore, with the exception of a very brief (less than 5 mSec.) spike, a resistive load greater than 225 ohms will not draw more than a trickle (less than 100 uA) of current from the charger terminals. A very high resistive (greater than 500 Kohms) will not cause the charger to be turned on at all if placed across the battery terminals.

The one-way RC delay caused by R43 (R72), CR25 (CR26) and C21 (C27) prevents the D input of U6A (U6B) from going high until a battery is well established in the charger, thus preventing the charger from latching off if contacts between the charger and battery terminals are intermittent during insertion.

3-50. Charger Timer Circuitry. Two identical circuits count a common clock to time the duration of charge for each battery, and control the charging rate, and the TIME indicators. U7 (U9) is a 12 stage binary ripple counter which counts the clock pulses generated by the clock circuit (see paragraph 3-51). From a state of being reset (all outputs low) to the point where the MSB output (pin 1) goes high, U7 (9) will count 2^{11}=2048 clock pulses. When the charger current source is turned off, the output of U4B (U4D) will go high since the input at pin 9 (pin 6) will be low.

With the charger current source turned off, the output of U5B (U5D) will be low. The output of U4A (U4C) will then go high thus resetting U7 (U9). When a battery/pak is placed in the charger, the output of U5B (U5D) will go high causing the output of U4A (U4C) to go low, removing the reset from U7 (U9) and allowing it to count. Due to the RC delay of R43 (R72) and C21 (C27), about 0.2 second later the input at pin 9 (pin 6) of U4B (U4D) will go high. However, since the input at pin 8 (pin 5) is low, the output of U4B (U4D) will remain in high. This situation will persist until either the battery/pak is removed (resetting the timer as noted above) or U7 (U9) counts 2048 clock pulses. At this time, pin 1 of U7 (U9) will go high, causing the output of U4B (U4D) to go low. This in turn causes the output of U4A (U4C) to go high, turning on Q12 (Q18) and thereby illuminating the TIME indicator, also turning off Q11 (Q17), thus reducing charge current to the sustaining rate (approximately 70 mA). This condition is stable and will remain unchanged until the battery/pak under charge is removed from the charger, resetting the timer as noted above.

3-51. Clock Circuitry. A common clock for charger timing is provided by U3 operating as an astable multivibrator at a frequency of 0.128 Hz ± 10% which is set by R15, R17, and C15. The clock duty cycle, which is approximately 33%, is not critical to the operation of the timer circuit. The clock waveform may be ovserved at TP-1. This clock frequency yields a 2048 pulse timer cycle of 4 hours, 27 minutes ± 10%.

3-52. Power-Up Reset Circuitry. When the battery charger is connected to an AC or 12 VDC source, the rapidly rising voltage on C13, (the filter capacitor for the 15V reference), acting through the RC delay of R12 and C14, causes Q8 to be turned on and in saturation for a period of approximately 0.25 seconds. Through CR16 and CR20, the outputs of U8D and U10D are thereby overridden by a high voltage, duplicating condition of an absence of batteries from both left and right hand positions. This effectively resets all functions of both systems so that if the charger is connected to the power source while one or two batteries are inserted, proper operation is ensured.

SECTION 4
MAINTENANCE

4-1. INTRODUCTION

This section provides maintenance procedures for the LIFEPAK 5 Cardioscope/recorder, DC Defibrillator Modules and accessory equipment available. The section is organized into four major parts. The first major division provides general information applicable to all units. The subsequent parts are presented by cardioscope/recorder module, DC defibrillator module and accessory equipment. Troubleshooting, repair, test and calibration, and component removal should be attempted only by persons thoroughly familiar with the circuit description presented in section 3.

4-2. GENERAL

The following paragraphs provide general information applicable to the cardioscope/recorder and DC defibrillator modules and accessory equipment. This section is divided into four major topics which include warranty, test equipment, repair techniques and cleaning information.

4-3. WARRANTY

LIFEPAK 5 is warranted against all defects in parts and workmanship for a period of one year from the date of delivery; patient cables and stylus - 90 days. Physio-Control will repair or replace any products which prove to be defective during the warranty period, provided proper use and maintenance procedures are followed as prescribed in the operating and service manual.

All defective products or components must be returned to Physio-Control, or its authorized service center, with a detailed explanation of the failure. Transportation charges must be prepaid.

Service performed, other than stylus replacement by other than Physio-Control or its authorized agents may, at the discretion of Physio-Control be cause to void this warranty.

No other party is authorized to make any other warranty, or to assume any liability for Physio-Control products. No other warranty, either implied or in writing will be recognized.

4-4. TEST EQUIPMENT

Test instruments suitable for maintenance and calibration of the LIFEPAK 5 modules are listed in table 4-1. Although specific, commercially available test instruments are recommended, other test equipment with specifications equivalent to those listed may be used. A USED ON column is provided to allow for determination of what test equipment is used for what module. When the test equipment is used in a test, the nomenclature and table 4-1 item number is supplied.

4-5. REPAIR TECHNIQUES

The following techniques should be used when repairing the printed circuit boards used in the LIFEPAK 5 modules.

TABLE 4-1.

TEST EQUIPMENT REQUIRED

ITEM NO.	TEST EQUIPMENT	SPECIFICATIONS	*USED ON
1.	DC Power Supply Deltron Model SP20-10	Output Voltage Variable: 0 to 20 VDC Output Current: Variable 0 to 10 Amperes	1, 2, 3
2.	Digital Multimeter, Fluke Model 8000A with High Voltage Probe	Range: 0 to 1500 volts full scale Accuracy: 0.5% of full scale on DC volt and resistance ranges, 1% of reading on AC voltages Input Resistance: 10 Megohms	1, 2, 3
3.	DC ammeter, VOM, Triplett 630	Sensitivity: 20 Kohms per volt ±3% 10 amp DC and 5 KVDC	1, 2, 3
4.	Oscilloscope, Tektronix Model 7603 with Dual Trace Amplifier 7A18N and Dual Time Base 7B53AN	Bandwidth: DC to 10 MHz Vertical Sens: 1mV/div to 10V/div Sweep Range: 0.05 microsec/div to 5 sec/div	1, 2, 3
5.	Function Generator, Wave-Tek Model 130 with 1000:1 Attenuator.	Frequency Range: 1 to 400 Hz Accuracy: ±2% Power Output: 160 mW(10 volts) into a 600 ohm load	1
6.	Defibrillator Energy Meter, Dempsey Model 429.	Power Range: 0-400 watt-seconds Load Resistance: 50 ohms ±1% Accuracy: ±3% of full scale for pulse width of 5 millisecond	2
7.	Stop Watch	Accuracy: ±0.25 seconds	1, 2, 3
8.	Variable Resistor	40-60 Ohms 40 watts	3
9.	Variable Autotransformer	0-130V 0-240V	3

* 1 is used for cardioscope/recorder module; 2 for DC defibrillator module; and 3 for battery/pak charger.

1. Use a soldering pencil with a rating of 25 watts. A bulky soldering gun is too hot to use on the printed circuit boards.
2. Use only 60/40 solder for low melting temperature. If needed, a liquid flux can be used to aid in solder flow. Board should be thoroughly cleaned afterwards.
3. A heatsink or similar device should be used in soldering semiconductor components. This also helps prevent burning the printed circuit board.
4. Another method of preventing printed circuit board burning is to remove the defective component without removing the leads from the board. First, cut the leads as close as possible to the defective component. Using pliers, straighten the leads from the board. Clean the end of each lead with an abrasive soldering tool. Solder the leads of the new component to the leads from the board.
5. Breaks in the printed circuit board lands are repaired by bridging with wire from pad to pad, and not by laying solder across the break. The heat from the iron may cause the land to dislodge from the board.
6. Before removing a circuit board for repair or replacement, label each lead or draw a sketch showing the location of cables and wires.

> CAUTION
>
> Use protective clothing and safety glasses when removing or handling the CRT. Rough or improper handling can result in sudden implosion, causing flying glass particles. Use extreme caution.

4-6. CLEANING TECHNIQUES

Use soap and water to clean external covers, patient cable, and CRT face. Do not use alcohol, solvents or cleaning solutions. These cleaning agents may damage the surfaces of the instrument. For interior cleaning, use dry, compressed air. A dry, flexible paint brush can be used to dislodge thick dust.

Remove electrode paste from paddle surfaces after each use with d.sposable tissues. Use a soft cloth with soap and water to clean paddles. If paddle electrodes become pitted, use 3M Scotchbrite (abrasive pads) to smooth pits out. Toothpaste may be used to remove any discoloration. Do not use steel wool or autoclave, and do not immerse in fluids.

4-7. CARDIOSCOPE/RECORDER MODULE

Maintenance procedures in this section are divided into four topics: component identification, trouble analysis, calibration and testing, and major component removal and installation.

4-8. COMPONENT IDENTIFICATION

> WARNING
>
> Terminals and wires carrying high DC voltages are exposed when the LIFEPAK 5 covers are removed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TESTS AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

Figure 4-1 provides an overall open view of LIFEPAK 5 Cardioscope/Recorder Module with key components and test points or adjustments indexed to a legend. Refer to paragraph 4-17 for major component removal and installation, and information on how to open module for test. Refer to Section 5 for an interconnecting wiring diagram.

Controls and connectors located on the Cardioscope/Recorder top panel are designated in the text by the exact name shown on the instrument and appear in capital letters with the component number following. For example: MAIN PWR switch S2. Refer to section 5 for complete component PCB location.

4-9. TROUBLESHOOTING

Observe the Cardioscope/Recorder for obvious symptoms such as odors from overheated components, or mechanical malfunctions. Use Table 4-2, Troubleshooting, to isolate specific malfunctions. If corrective action refers to a particular test or calibration, find the reference in paragraphs 4-10 through 4-16. Refer to paragraph 4-18 if module is to be opened.

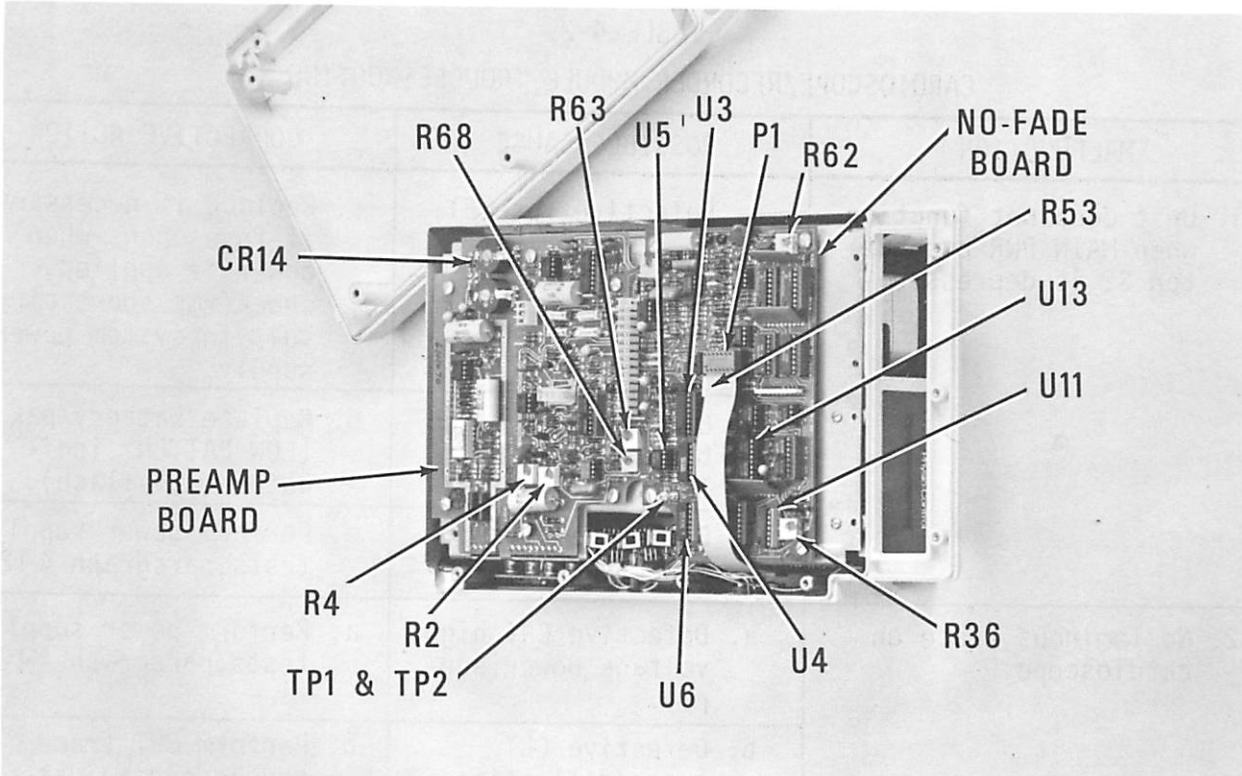
4-10. TESTS AND CALIBRATION

> WARNING
>
> Terminals and wires carrying high DC voltages are exposed with the LIFEPAK 5 covers removed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TESTS AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

Procedures given here are used to verify that the cardioscope/recorder is operating within specifications. Table 4-2, Troubleshooting, contains references to these procedures. If the instrument is not functioning properly, locate the malfunction before attempting circuit calibration or adjustment. Refer to paragraph 4-8 for information concerning component location.

4-11. Initial Control and Test Equipment Setup

1. Split module upper and lower cases according to paragraph 4-18.
2. Set controls to the positions shown in Table 4-3.
3. If installed, remove battery/pak.
4. Connect the DC supply (1, table 4-1) and digital multimeter (2) to the battery/pak input terminals.



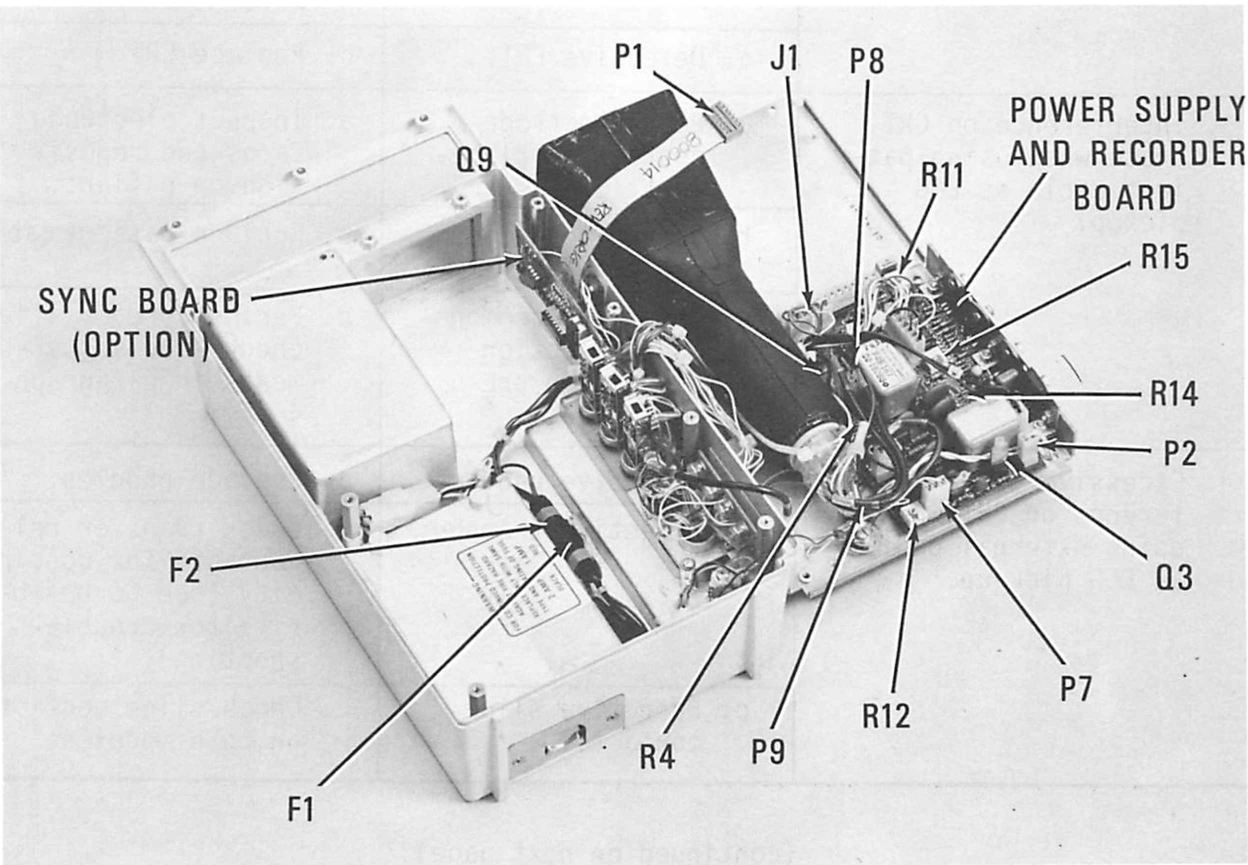


Figure 4-1. Cardioscope/Recorder Module Component Identification

TABLE 4-2.

CARDIOSCOPE/RECORDER MODULE TROUBLESHOOTING

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Unit does not function when MAIN PWR pushbutton S2 is depressed.	a. Defective fuse F1.	a. Replace if necessary. If fuse opens when power is applied, check for short circuit in system power supply.
	b. Battery discharged below operating level.	b. Replace battery/pak (LOW BATTERY indicator will flash).
	c. Defective system power supply.	c. Perform power supply tests, paragraph 4-12.
2. No luminous trace on cardioscope.	a. Defective CRT high voltage power supply.	a. Perform power supply tests, paragraph 4-12.
	b. Defective CRT sweep/deflection circuits.	b. Perform CRT trace checks and adjustments, paragraph 4-14.
	c. Defective CRT.	c. Replace CRT.
3. Interference on CRT trace when using patient cable as ECG pickup.	a. Poor electrode contact or placement.	a. Inspect electrode faces and reposition on patient.
	b. Defective patient cable.	b. Replace patient cable.
	c. Defective common mode rejection circuit in preamplifier.	c. Perform preamplifier checks and adjustments in paragraph 4-15.
4. Excessive 60 Hz interference on CRT when using external paddles as ECG pick-up.	a. Defective paddles.	a. Replace paddles.
	b. Defective transfer.	b. Check transfer relay contacts for continuity (see DC Defibrillator troubleshooting).
	c. Defective slide contacts.	c. Check slide contacts on both modules.

(continued on next page)

TABLE 4-2

CARDIOSCOPE/RECORDER MODULE TROUBLESHOOTING (CONTINUED)

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
5. No ECG signal on cardioscope when using patient cable, but CAL display is available.	a. Defective patient cable.	a. Check continuity of patient cable, or replace.
	b. Defective preamplifier circuits.	b. Perform preamplifier adjustments and checks, paragraph 4-15.
6. No ECG signal on cardioscope when using paddles for ECG pickup, but CAL display is available.	a. Defective paddles.	a. Replace paddles.
	b. Defective transfer relay.	b. Replace transfer relay.
	c. Defective CABLE/ PADDLES switch.	c. Replace switch.
7. Fuzzy or dim CRT trace.	Misadjusted CRT operating voltages Poor connection at CRT connector.	Perform CRT adjustments paragraph 4-14. Clean CRT pins.
8. Recorder does not run.	a. Defective fuse F2.	a. Replace if necessary. If fuse opens when power is applied, check for short circuit in recorder power supply.
	b. Defective system power supply.	b. Perform power supply tests, paragraph 4-12
	c. Defective paper drive motor.	c. Replace motor. Refer to paragraph 4-25.
9. Recorder motor runs but no trace on paper.	a. Stylus HEAT set too low.	a. Perform recorder stylus replacement or adjustment in section 2.
	b. Stylus bent or maladjusted.	b. Same as a.
	c. Defective heat circuit.	c. Check stylus heat circuit.
10. Recorder runs but stylus stays deflected to one side or does not respond and stays at center.	a. Defective pen drive motor.	a. Replace pen drive motor.
	b. Defective drive circuit.	b. Check drive transistors.

(continued on next page)

TABLE 4-2.

CARDIOSCOPE/RECORDER MODULE TROUBLESHOOTING (CONTINUED)

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
11. No deflection when CAL switch depressed, but normal trace on CRT and signal when applied to patient cable.	a. Defective switch.	a. Replace switch.
	b. Defective voltage divider in CAL circuit.	b. Check voltage divider.
12. No signal on CRT or recorder when signal is applied or CAL switch is depressed. Normal trace on CRT.	a. Defective preamplifier circuit.	a. Perform preamplifier checks, paragraph 4-15.
	b. Defective No-Fade circuit.	b. Perform digital circuit checks, paragraph 4-17.
13. ECG signal does not hold with No-Fade test points 1 and 2 shorted.	Defective no-fade circuit.	Check U6-A and U4-A on no-fade board.
14. No systole sound.	a. Defective SYST VOL pot.	a. Replace SYST VOL pot.
	b. Defective operational amplifier or transistor.	b. Check components in systol sound circuit.
	c. Defective sonalert.	c. Replace sonalert. Refer to paragraph 4-25.
15. Incorrect ECG display. Information is lost or distorted on cardioscope display.	No-fade circuit.	Perform digital circuit checkout paragraph 4-17.
16. Incorrect ECG display in presence of transmitting equipment	Loss of RFI Shielding.	Open unit and inspect conductive coating. If scratches or chips are apparent contact Physio-Control Service Department.

4-12. Power Supply Tests. After completing initial setup of paragraph 4-11, proceed as follows to accomplish power supply testing. Refer to Figure 3-9 for a schematic of the power supply.

TABLE 4-3.

CARDIOSCOPE/RECORDER MODULE INITIAL CONTROL SETTINGS

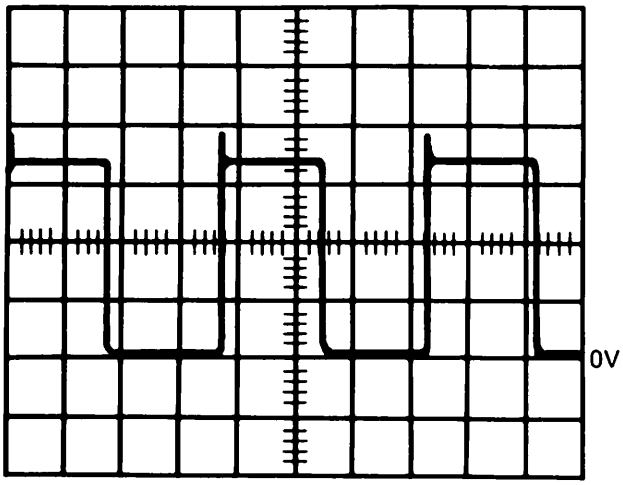
NOMENCLATURE	POSITION
MAIN PWR	OFF
RECORD	OFF
CABLE/PADDLES	CABLE
ECG SIZE	CCW
HEAT	CCW
SYST VOL	CCW

CAUTION

Replacing a blown fuse will often restore the unit to its full capability. Nevertheless, replacing a blown fuse should always be followed by a measurement of power supply voltages.

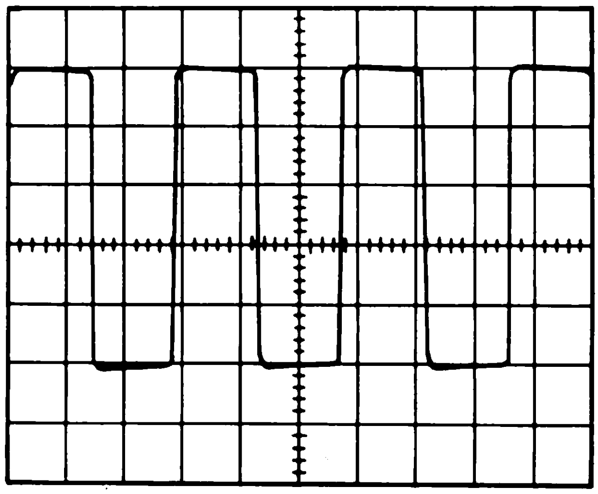
1. Locate and remove fuses F1 and F2. (Refer to figure 4-1.)
2. Set the DC ammeter (3) to read one ampere full scale. Connect the DC ammeter (3) between the MAIN PWR fuse F2 holder terminals.
3. Connect the X10 probe of the oscilloscope (4) to Q3 collector on power supply and recorder board. Set the oscilloscope (4) vertical sensitivity to 5V/div.
4. Adjust the DC power supply (1) to 12.6 volts using the digital multimeter (2) as a monitor.
5. Depress MAIN PWR switch S2 and verify power is applied to the cardioscope/recorder.
6. Verify that the waveform observed on the oscilloscope closely matches that of figure 4-2. The specification is a 12 KHz squarewave ±15% with less than 20% overshoot.
7. Verify that the DC ammeter (3) indicates less than 350 milliamperes. If the current exceeds 350 milliamperes, an attempt must be made to isolate and correct the cause of the abnormal current drain. If cause is not isolated, contact the Physio-Control Service Department for instructions.
8. Depress MAIN PWR S2 and verify power is removed from cardioscope/recorder circuitry. Remove DC ammeter (3) connections from F2 and reinstall across F1 holder terminals. Reinstall F2.

9. Connect the X10 probe of the oscilloscope (4) to Q9 collector on power supply and recorder board.
10. Depress MAIN PWR switch S2 and verify power is applied to the cardioscope/recorder.
11. Depress RECORD power switch S3 and verify that the recorder runs.
12. Verify that the waveform observed on the oscilloscope (4) closely matches that of figure 4-3. The specification is a 16 KHz squarewave ±20% with less than 30% overshoot.



5V/div
20 microsec/div

Figure 4-2. Main Power Supply Waveform



5V/div
20 microsec/div

Figure 4-3. Recorder Power Supply Waveform

13. Verify that the DC ammeter (3) indicates less than 400 milliamperes with the stylus HEAT control S3 maximum CCW (minimum heat).
14. Depress MAIN PWR switch S2 and RECORD power S3 and verify power is removed from the cardioscope/recorder.
15. Remove DC ammeter (3) connections from F1 fuse holder and reinstall F1.
16. Remove oscilloscope (4) connections.
17. Connect digital multimeter (2) between J1-8(+) and J1-11 (power ground). This is the output of the cardioscope/recorder 12 volt supply.
18. Depress MAIN PWR switch S2 and verify power is applied to system.
19. Vary DC power supply (1) output from 10 VDC to 15 VDC and verify that the digital multimeter (2), connected to the cardioscope/recorder 12 volt supply, indication does not change by more that ±1%.

20. Readjust the DC power supply (1) to 12.6 VDC.

21. Consecutively connect the digital multimeter (2) to the test points indicated in table 4-4 and verify that the individual power supplies are within the tolerances noted.

TABLE 4-4.

CARDIOSCOPE/RECORDER MODULE POWER SUPPLY VOLTAGE CHECKS

LOCATION		NOMINAL VOLTAGE (VDC)	LIMITS (VDC)
+	COMMON		
J1-6	J1-11 (PWR GND)	+5	+4.75 to +5.25
J1-7	J1-11	-5	-4.75 to -5.25
J1-8	J1-11	+12	+11.40 to +12.60
J1-9	J1-11	-12	-11.40 to -12.60
J1-15	J1-11	+120	115 to 125
P8-1	J1-11	ASTIG	Variable from 0 to 120
P9-3	J1-11	-1300 (GRID)	-1200 to -1400
P9-2	J1-11	-1275 (CATHODE)	Variable from approximately -1160 to -1392
P9-1	J1-11	-1113 (FOCUS)	Variable from approximately -986 to -1240
P2-1	P2-2	6.3 VAC (CRT FILAMENT)	6.0 to 6.6
P7-1	P7-2	ROTATING COIL	Variable from 0 to 8
CR14 (Preamp board)	P10-1 (ISO. GRD, Preamp Board)	+12 (ISOLATED)	11.40 to 12.60

4-13. Low Battery Level Check. After completing the initial setup and power supply tests, proceed as follows to test the low battery level circuitry. Refer to figure 3-10 for a schematic of the low battery level circuitry.

1. Adjust the external DC power supply (1) to 12.6 volts using the digital multimeter (2) as a monitor.

2. With all controls set to a minimum or off, depress the MAIN PWR switch S2. Verify power is applied to the cardioscope/recorder circuitry.

3. Gradually reduce the DC power supply (1) voltage in 0.1 volt increments until the LOW BATTERY indicator begins to flash.

4. Verify that the supply voltage at this point is between 10.0 to 10.3. If necessary adjust R24 to accomplish this.

4-14. CRT Tests and Adjustments. After completing the initial setup and power supply tests, proceed as follows to test the CRT circuitry. Refer to figure 3-6 for a schematic of the cardioscope circuitry and figure 3-9 for the power supply and CRT operating voltage circuitry.

1. Trace and Sweep.

   a. Depress MAIN PWR switch S2 and verify a trace appears on CRT. Verify ECG SIZE control is at maximum CCW.

   b. Adjust R4 (Focus) and R14 (astigmatism) on power supply board for a sharp trace with a maximum width of one millimeter.

   c. Adjust R12 (horizontal tilt) on the power supply and recorder board so that the CRT trace is horizontal to within ± one degree. If unable to obtain horizontal trace, reverse P7 on power supply board.

   d. Connect the oscilloscope (4) to J1-1 on the power supply board or P1-2 on the preamp board.

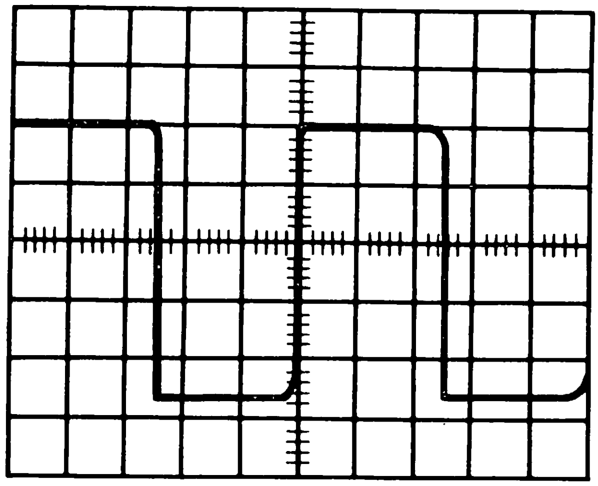
   e. Adjust R36 (hroizontal sweep) on the no-fade board to obtain a 10 millisecond squarewave. Verify that this waveform closely matches that of figure 4-4. The waveform should be symmetrical and approximately 5 volts peak-to-peak.

   f. Adjust R68 (horizontal positioning) on the preamp board, so that the trace is centered horizontally.

   g. Connect the patient cable to the PATIENT CABLE input connector P10. Connect the function generator (5) between the white and red leads of the patient cable.

   h. Set the function generator (5) to obtain a 10 millivolt peak-to-peak 1.0 Hz squarewave.

   i. Adjust R63 (horizontal gain) for a display on the cardioscope of one squarewave per 25mm ± 1mm. Short TP1 and TP2 to freeze display.



1V/div

2 millisec/div

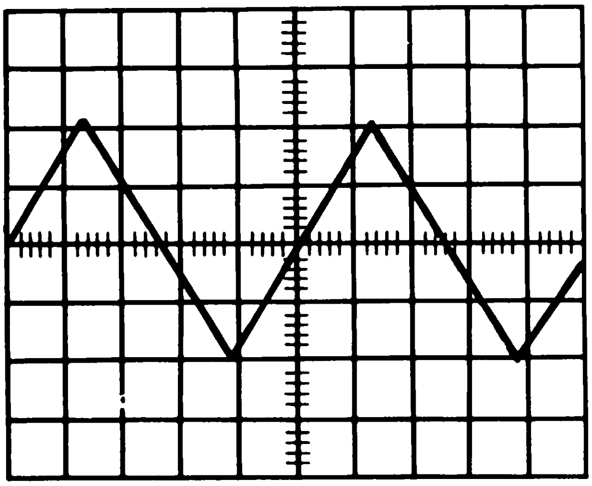
Figure 4-4. Horizontal Sweep Waveform

j. Adjust R53 (CRT centering), on the no-fade board, so that the trace is centered between top and bottom edges of mask to within ±2mm.

k. Disconnect the function generator (5).

l. Reconnect the oscilloscope (4) to the wiper of R63 (horizontal sweep gain) and verify that the signal closely matches that of figure 4-5. The waveform should be approximately four volts peak-to-peak, symmetrical and have a duration of 10 milliseconds.

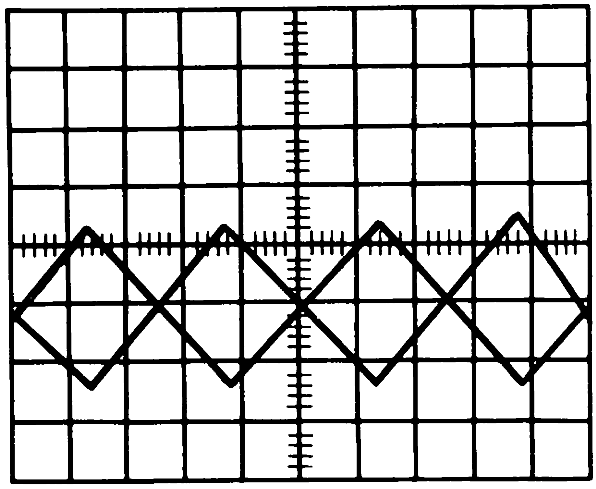
m. Reconnect the oscilloscope consecutively to the horizontal deflection amplifier outputs and verify that they closely match those of figure 4-6. These outputs are available at J8-3 and J8-4 on the preamp board. The waveforms should be 180° out of phase, with equal amplitudes (approximately 60 volts peak-to-peak).



1V/div

2 millisec/div

Figure 4-5. Horizontal Sweep Generator Waveform



10V/div

2 millisec/div

Figure 4-6. Horizontal Deflection Amplifier Waveform

2. Linearity

   a. Connect the function generator (5) between the white and red leads of the patient cable. Adjust the function generator to obtain a 2.0 Hz triangle wave at two millivolts.

   b. Depress RECORD power pushbutton S3 and adjust ECG SIZE for full scale deflection.

   c. After obtaining the recording, trace a straight line joining the 90% points on the waveform.

   d. Verify that no part of the display between the 90% points deviate vertically from the straight line by more than ±5% of the peak-to-peak amplitude.

   e. Check cardioscope linearity by shorting TP-1 and TP-2 (freeze) on the no-fade board.

4-15. Preamplifier and Recorder Gain and Frequency Response. After completing initial setup of paragraph 4-11, proceed as follows to accomplish preamplifier testing. Refer to figure 3-2 for a schematic of the preamplifier circuitry and figure 3-7 for the recorder circuitry.

1. Gain and CAL Check and Adjustment.

   a. Connect the patient cable to the PATIENT CABLE input connector.

   b. Connect the function generator (5) between the white and red leads of the patient cable.

   c. Connect the oscilloscope (4) to the ECG OUT connector.

   d. Adjust the function generator (5) to obtain a 10 Hz, one millivolt peak-to-peak sinewave.

   e. Observe the oscilloscope (4) display and verify that the ECG OUT signal is one volt peak-to-peak and is clean and undistorted. If necessary, adjust R4 (gain) on the preamp board for proper amplitude.

   f. Adjust the function generator (5) output to 0.5 millivolts.

   g. Adjust the ECG SIZE to maximum gain (cw).

   h. Observe the cardioscope display and verify that the pattern fills at least 80% of CRT screen from top to bottom. Adjust the ECG SIZE control to fill 1 cm on the CRT screen.

   i. Depress the RECORD power pushbutton S3 and adjust stylus HEAT control for a satisfactory trace. Verify that the display fills 1 cm of the graphic area of the paper. If necessary adjust R11 (gain) on the power supply and recorder board so that the display fills 1 cm of the graphic area of the paper.

   j. Increase input to get 3 cm P-P sinewave (10Hz) on the CRT. Adjust R49 to give a 2.8 cm ±1 mm display on recorder.

   k. Adjust the ECG SIZE control to minimum (CCW).

   l. Increase the function generator (5) output voltage to five millivolts.

   m. Verify that the cardioscope and recorder displays fills at least 50% of CRT screen and graphic area of the recorder.

   n. Change the function generator (5) output frequency to 2.0 Hz and verify that no distortion or clipping occurs.

   o. Depress RECORD power pushbutton S3 to shut off recorder.

   p. Remove the function generator (5) and oscilloscope (4).

   q. Depress the CAL pushbutton and observe waveform. Verify that the peak-to-peak value of the positive step is one volt. If necessary, adjust R2 (1mv adjust) on the preamp board.

2. Recorder Offset and Timing

   a. Depress RECORD Power pushbutton S3.

   b. Adjust stylus HEAT for a satisfactory trace.

   c. Verify trace is centered on graphic area of paper to within $\pm$ 1mm. If necessary adjust R62 (Recorder offset adjust) on the no-fade board.

   d. Connect the function generator (5) between the white and red leads of the patient cable.

   e. Adjust the function generator (5) for a 1.0 Hz squarewave at one millivolt.

   f. Verify that the squarewave display on the recorder repeats every 25mm $\pm$0.75mm. If necessary adjust R15 (recorder sweep).

3. Frequency Response

   a. With the function generator (5) connected as in step 1b, proceed as follows.

   b. Adjust the function generator (5) for a 10 Hz sinewave at one millivolt.

   c. Adjust the ECG SIZE control so that the pattern fills about two thirds of the cardioscope ($\approx$2 centimeters peak-to-peak).

   d. Maintaining a one millivolt output from the function generator (5), vary the frequency from 1 to 40 Hz. Note the frequency of maximum amplitude, if any.

   e. At the frequency of maximum amplitude, adjust the ECG SIZE control for a pattern height of 1 centimeter peak-to-peak.

   f. Vary the frequency of the function generator (5) from 1 to 40 Hz noting the area of minimum amplitude. Verify that the amplitude is not less than .7 centimeters.

   g. Repeat steps a through f for the recorder using 1 to 40 Hz.

4. 60 Hz Notch and Noise Check

   a. With the function generator (5) and oscilloscope (4) connected as in steps 1b and c, proceed as follows.

   b. Adjust the function generator (5) for an 60.0 Hz sinewave at one millivolt.

   c. Verify that the output at the ECG OUT, as observed on the oscilloscope (4) is less than 10 millivolts peak-to-peak.

   d. Remove the function generator (5) from the patient cable. Connect the three patient cable leads together.

   e. Verify that the noise observed on the oscilloscope (4) display is less than 10 millivolts peak-to-peak.

5. Common Mode Rejection Check

a. Connect the function generator (5) between the patient cable white and red leads.

b. Adjust the function generator (5) for a 10.0 Hz sinewave at one millivolt. Monitor the function generator (5) output with the oscilloscope (4).

c. Adjust the ECG SIZE control so that the cardioscope pattern is exactly two centimeters.

d. Do not disturb the settling of the ECG SIZE control for the remainder of this test. Remove the function generator (5).

e. With the patient cable attached to the input, attach a 5.1 K resistor to the red patient cable lead and a 10 K resistor to the white lead.

f. Connect these resistors to the high side of the function generator (5). Connect the low side of the function generator (5) output to chassis ground. Connect the oscilloscope (4) to the function generator to monitor its output.

g. Increase the output of the function generator (5) until a two centimeter display is obtained on the cardioscope.

h. Verify that the function generator (5) output voltage is greater than ten volts.

i. Repeat steps f through h with the red and white leads reversed with respect to the 5.1K and 10K resistors. This ensures a common mode rejection ratio of at least 80dB.

j. Remove resistors from patient cable.

6. Input Impedance

a. Connect the function generator (5) between the patient cable white and red leads.

b. Adjust the function generator (5) for a 10.0 Hz sinewave at one millivolt.

c. Adjust the ECG SIZE control for a three centimeter peak-to-peak display on the cardioscope.

d. Insert a one megohm resistor in series with one patient cable lead and note the cardioscope display.

e. Verify that the cardioscope display is 1.5 centimeters minimum.

f. Disconnect and remove function generator.

7. Paddle Noise Test

a. Connect the DC defibrillator module to the cardioscope/recorder module (refer to paragraph 2-8).

b. Disconnect the patient cable, if connected.

c. Depress the cardioscope/recorder MAIN PWR switch.

d. Remove paddles from DC defibrillator and hold them apart in air.

e. Turn ECG SIZE to midrange.

f. Verify that the cardioscope trace width is less than 0.25 inches peak-to-peak.

g. Firmly grasp the APEX paddle contact with the left hand and then the STERNUM paddle contact with the right hand.

h. Verify that cardioscope waveform display is positive.

i. Slightly vary the electrode-palm pressure on one paddle momentarily.

j. Verify that a recognizable waveform is restored on the cardioscope within three seconds.

k. Replace paddles.

4-16. Systole Sound. After completing initial setup of paragraph 4-11, proceed as follows:

1. Connect the function generator (5) between the patient cable white and red leads.
2. Adjust the function generator (5) for a 0.5 Hz squarewave at one millivolt.
3. Depress MAIN PWR switch S2, adjust ECG SIZE control for a one centimeter display.
4. Adjust STYL VOL until audible beep is heard. The ECG SIZE may have to be increased slightly.
5. Using stopwatch (7) verify one beep per second is heard.

4-17. Digital Circuitry Waveforms. There are no adjustments to the digital circuitry, on the no-fade board, except the horizontal sweep covered in paragraph 4-14, step 1. The following steps provide references to figures providing typical waveforms at key points. Using the oscilloscope, (4) observe the waveforms at the points listed. Refer to figure 4-1 for help in locating test points.

1. Clock Pulse at U11-B-12. Refer to figure 4-7. The master clock will be available whenever power is applied to the unit. The waveform should be symmetrical and approximately 5 volts peak-to-peak. The frequency will be approximately 100 KHz. If not present check U11-A and U11-B.
2. Clock Pulse at U13-2 and -4. The clock pulses at the memory clock driver will be available whenever power is applied to the unit and the master oscillator is on. At a -10 volt level they are 180° out of phase and approximately one volt peak-to-peak. If not present check four stages of U22, U11-C and U11-D and master oscillator.
3. Shift Register Clock Pulses at U13-7 and -5. Refer to figure 4-9. The shift register pulses will be available whenever power is applied

to the unit and the master oscillator is on. The pulses are typically 15 volts peak-to-peak with an approximate duration of 0.5 microseconds. If not present check U13, buffers U22, Schmitt triggers U11-C and -D, and master oscillator.

4. Write Recirculate Pulse at U3-5. Refer to figure 4-10. The write recirculate pulse will typically be +5 volts in amplitude and have a duration of approximately four microseconds. If not present check U6-A, U3-A, U4-A and master oscillator.

5. A/D Reset Pulse U3-B-13. Refer to figure 4-11. The A/D reset pulse will typically be +4 volts in amplitude and have a duration of approximately 18-20 microseconds. If not present check U3-B, U6-A thru U6-C and U4-B.

6. Retrace Blanking at U4-A-13. Refer to figure 4-12. The retrace blanking pulse will typically be 5 volts peak-to-peak and have an approximate duration of five milliseconds. If not present check U4-A, U3-A, U7, and U6-A.

7. A/D Compare Latch at U6-4. Refer to figure 4-13. The A/D compare latch will typically be 5 volts in amplitude and have a duration of approximately 10 microseconds. If not present check U6-A to U6-C, U5, U3-B, U4-B and master oscillator.

8. Stairstep at U5-2. Refer to figure 4-14. If not present check output of ladder R76, U10, U5 and U6-A to U6-C.

4-18. MAJOR COMPONENT REMOVAL AND INSTALLATION

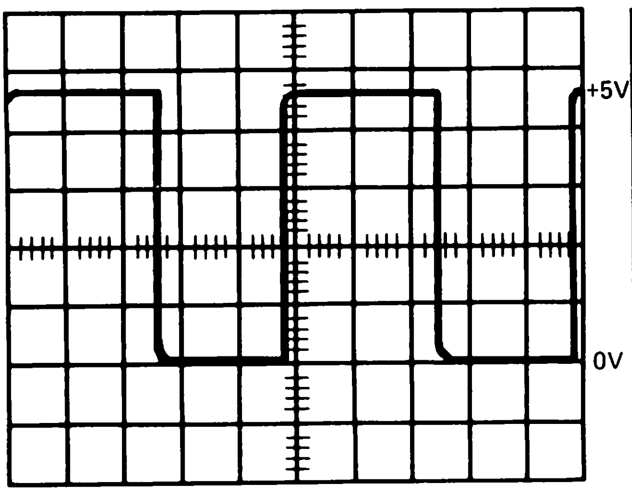
The following procedures provide the sequence of removing and installing the major components of the cardioscope/recorder. Recorder disassembly is presented as part of recorder removal.

Installation is for the most part the opposite of removal so only the removal procedures are provided. Special installation notes as required are provided as part of the removal or disassembly procedure. Remove or disassemble only to the point required. Figure 4-15 provides an exploded view of the cardioscope/recorder to assist in the following procedure.

4-19. Upper and Lower Case Separation. Refer to figure 4-15 and proceed as follows:

> CAUTION
>
> The cardioscope/recorder is coated inside with a special conductive paint to shield the unit from RFI. Use caution so not to scratch or mar the coating, which would degrade the unit's RFI shielding capability.

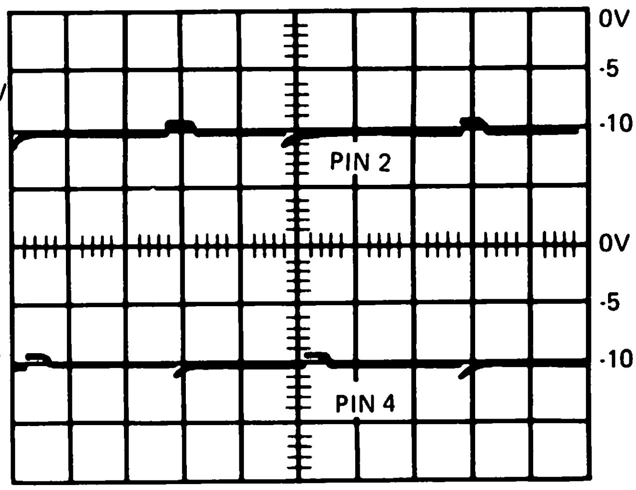
NOTE: Installation procedures at this point are essentially the reverse of the procedures presented below. When installing the two cases together, make sure gasket is positioned correctly.



1 V/div

2 microsec/div

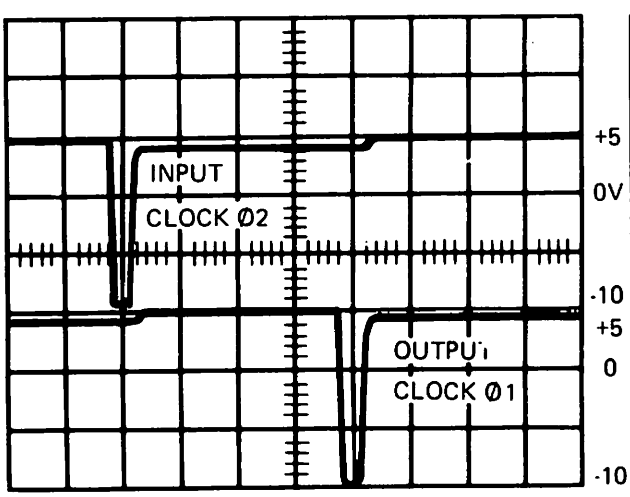
Figure 4-7. Clock Pulse At U11-B-12



5V/div

2 microsec/div

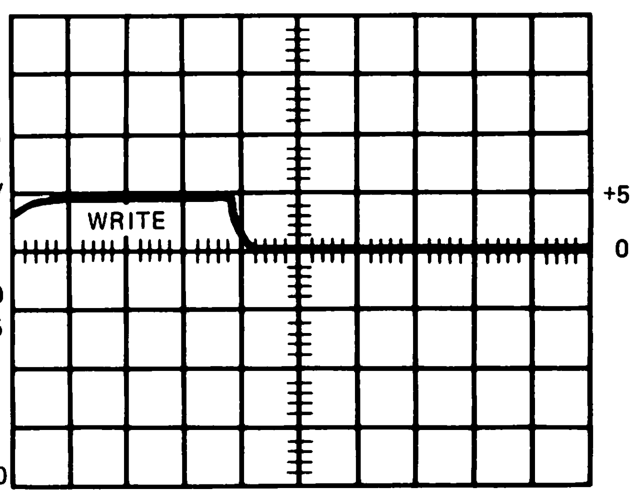
Figure 4-8. Clock Pulses At U13-2 and -4



5V/div

1 microsec/div

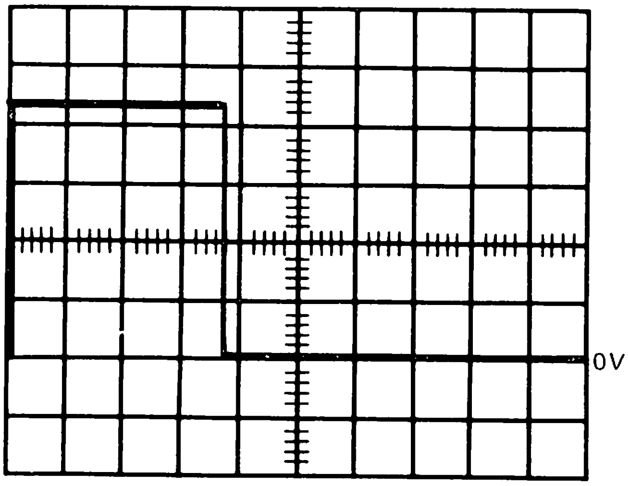
Figure 4-9. Shift Register Pulse At U13-7 and -5



5V/div

1 microsec/div

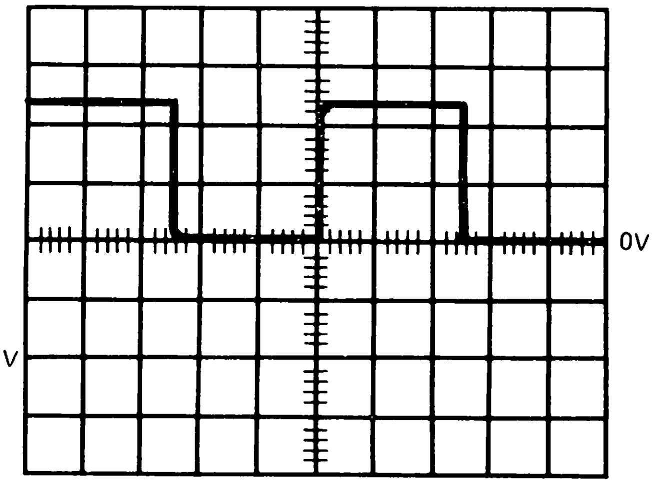
Figure 4-10. Write/Recirculate Pulse At U3-A-5



1 V/div

5 microsec/div

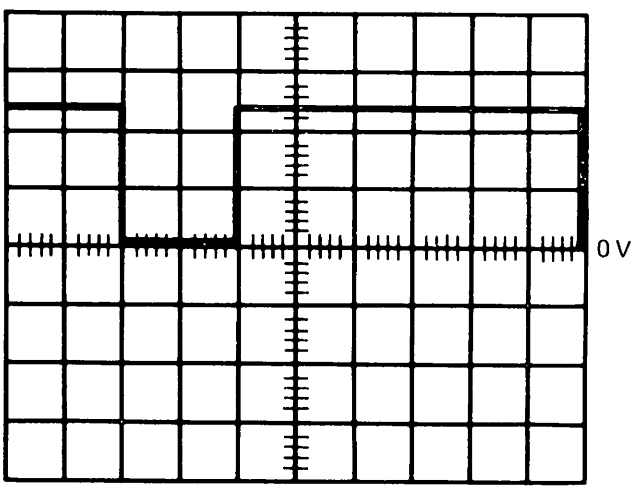
Figure 4-11. A/D Reset Pulse At U3-B-13



2V/div

2 millisec/div

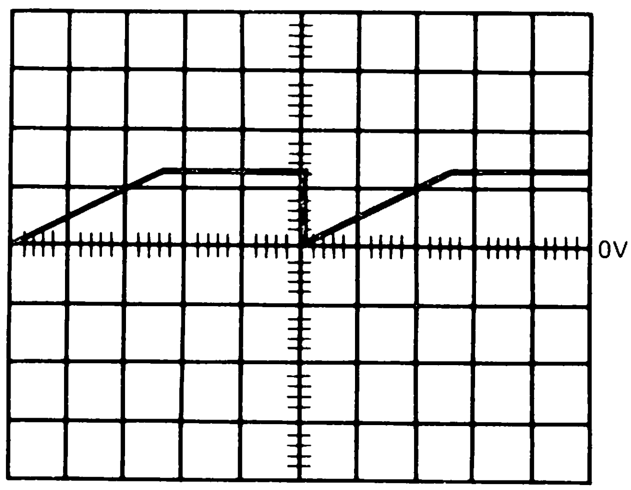
Figure 4-12. Retrace Blanking Pulse At U4-A-13



2V/div

5 microsec/div

Figure 4-13. A/D Compare Latch At U6-4



2 V/div

1 millisec/div

Figure 4-14. Stairstep At U5-2

1. Position Module so upper case (1) is down.

2. Remove 13 screws (2) securing upper case (1) to lower case (3), remove two screws (4) securing PCB chassis (20) to lower case.

   NOTE: If O-ring on screws is damaged replacement screws should be used to reassemble.

3. Separate the upper (1) and lower (3) cases and lay bottom cover aside. At this point the preamp board (21) and no-fade board (19) are accessible for testing (refer to figure 4-1).

4. To obtain access to the power supply and recorder board (6), lay chassis (20) with boards onto bottom cover (3). (Refer to figure 4-1.)

5. If further disassembly is required proceed to the next paragraph.

4-20. Power Supply and Recorder Board Removal. If power supply and recorder board (6) does not require removal proceed to paragraph 4-21. After completing procedures in paragraph 4-19 proceed to the following steps.

   NOTE: Installation of the power supply board at this point is essentially the reverse of removal. When installing take care to properly align the connector pins between the PCBs.

1. To remove power supply and recorder board (6) disconnect harnesses by disconnecting eight connectors (P2,P4,P5,P6,P7,P8,P9 and P10).

2. Remove three screws (7) on side of chassis securing chassis (20) to heat sink.

3. Remove two screws (8) securing board to chassis. Lift up on board to clear pins.

4-21. Harness Removal. After completing procedures in paragraph 4 - 19, proceed as follows:

   NOTE: Installation of the harness at this point is essentially the reverse of removal.

1. Disconnect harness from power supply and recorder board (6) as in paragraph 4-20, step 1. Remove lugs on battery terminals. Remove module interconnect from upper case.

2. Remove screw (14) securing ground ring (15).

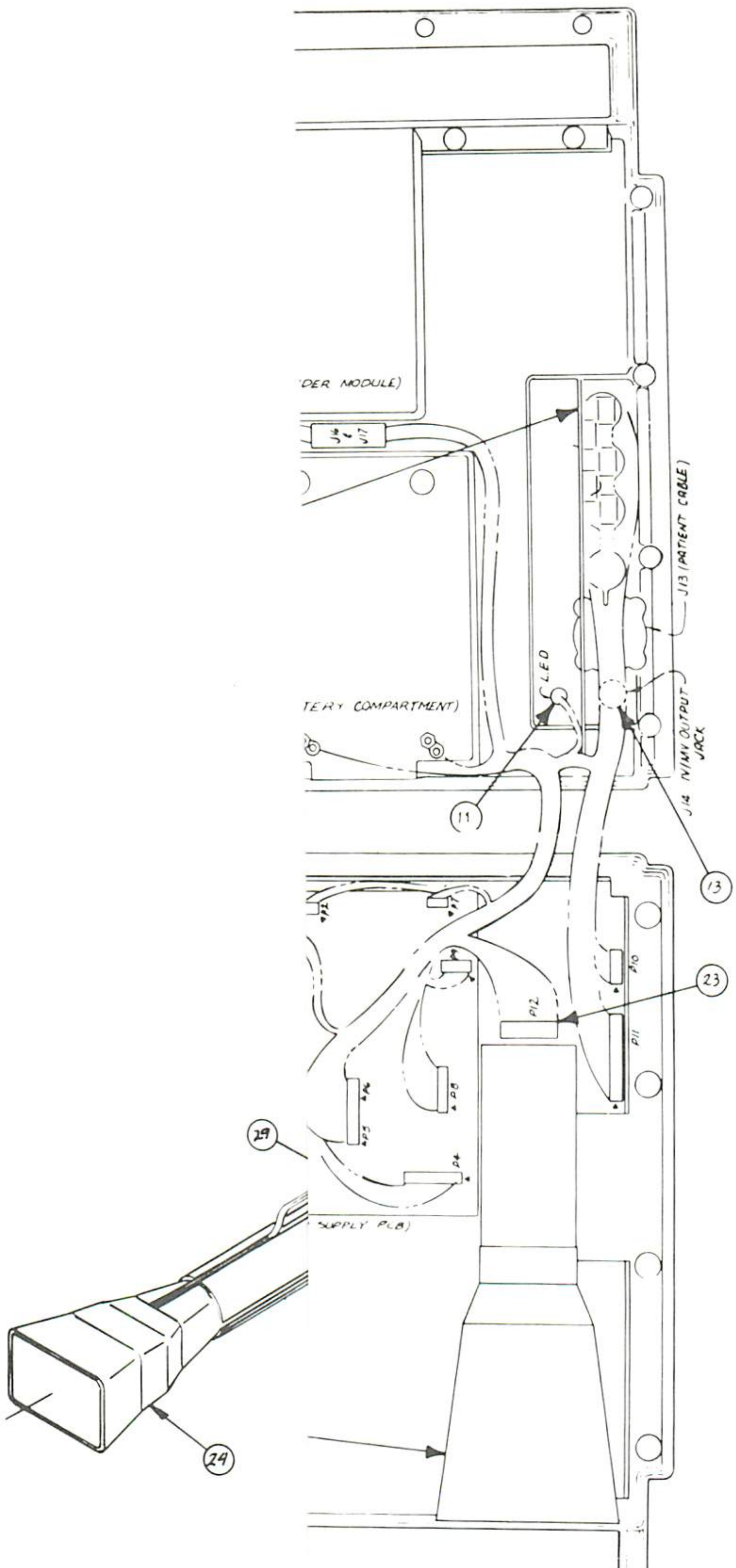
3. Remove screw (16) securing ground ring (17) to upper case (1).

4. Remove attaching hardware from the MAIN PWR, RECORD, CAL, and CABLE/PADDLES controls.

5. Remove four screws (9) securing PATIENT CABLE (10) connector.

6. Remove attaching hardware securing LOW BATTERY LED (11).

7. Remove attaching hardware (12) securing ECG OUT Jack (13).



:ope/Recorder Module Major Component Removal

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4-22. No-Fade Board Removal. After completing procedures in paragraph 4-19 proceed as follows:

> NOTE: Installation preamp board is essentially the reverse of the removal procedures except for preamp board which must be installed before the no-fade board.

1. Remove cable harness connections (if connected) from board connectors on top of chassis.
2. Remove four screws (18) securing no-fade board (19) to bottom of chassis (20).
3. Lift board straight out to remove from connection on preamp board(21).

4-23. Preamp Board Removal. After completing procedures in paragraphs 4-19 and 4-22 proceed as follows:

> NOTE: Installation of the preamp board is essentially the reverse of the removal procedures except the preamp board must be installed before the no-fade board.

1. Remove six screws (22) securing preamp board (21) to chassis (20).
2. Pull board (21) straight out away from chassis removing connection to power supply and recorder board (6), if connected.

4-24. CRT Removal. After completing procedures in paragraph 4-19 disconnect socket (23) from rear of CRT (24) and P7 (29) rotation coil, then slide CRT (24) out of housing (25). To remove housing (25), remove three screws (26).

4-25. Recorder and Sonalert Removal and Disassembly. After completing procedures in paragraph 4-19 proceed as follows:

CAUTION

It is suggested that before any repair other than stylus replacement is started on the recorder that the factory service department be contacted first. The cardioscope/ recorder module is sealed environmentally from the recorder chassis. To remove the recorder the sealed outer recorder cover must first be removed. If facilities are not available to reseal the recorder it is suggested that the module be sent back to the factory. Improper sealing would seriously jeopardize the module and the warranty. The recorder is also aligned to close tolerances and any disassembly would require recorder realignment.

NOTE: Refer to recorder assembly drawing 06-00116 (figure 5-10) to reassemble the recorder. Particular attention must be paid to the notes on drawing 06-00116 during installation. Refer any questions to the factory service department.

1. Remove recorder cable harness connections.
2. Using sharp tool such as an exacto knife cut away RTV sealant from protective environmental cover (26). Remove cover (26).
3. Remove four screws (27) and remove recorder (28).
4. Disassemble the recorder (28) using recorder assembly drawing 06-00116, figure 5-7 in section 5 as a guide.
5. Rubber roller replacement can be accomplished by carefully removing the upper chassis plate (93).

4-26. DC DEFIBRILLATOR MODULE

Maintenance procedures in this section are divided into four areas, component identification, trouble analysis, calibration and testing, and major component removal and installation.

4-27. COMPONENT IDENTIFICATION

WARNING

Terminals and wires carrying high DC voltages are exposed when the LIFEPAK 5 covers are removed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TESTS AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

Figure 4-16 provides an overall view of LIFEPAK 5 DC Defibrillator Module with key components and test points or adjustments indexed to a legend. Refer to paragraph 4-40 for major component removal and installation. Refer to Section 5 for an interconnecting wire diagram.

Controls and connectors located on the paddles are designed in the text by the exact name shown on the paddles and appear in capital letters with the component number following. For example: POWER switch S1.

4-28. TROUBLESHOOTING

Observe the module for obvious symptoms such as odors from overheated components, or mechanical malfunctions. Use table 4-5, Troubleshooting, to isolate specific malfunctions. If corrective action refers to a particular adjustment or calibration, find the reference in paragraph 4-29 through 4-39.

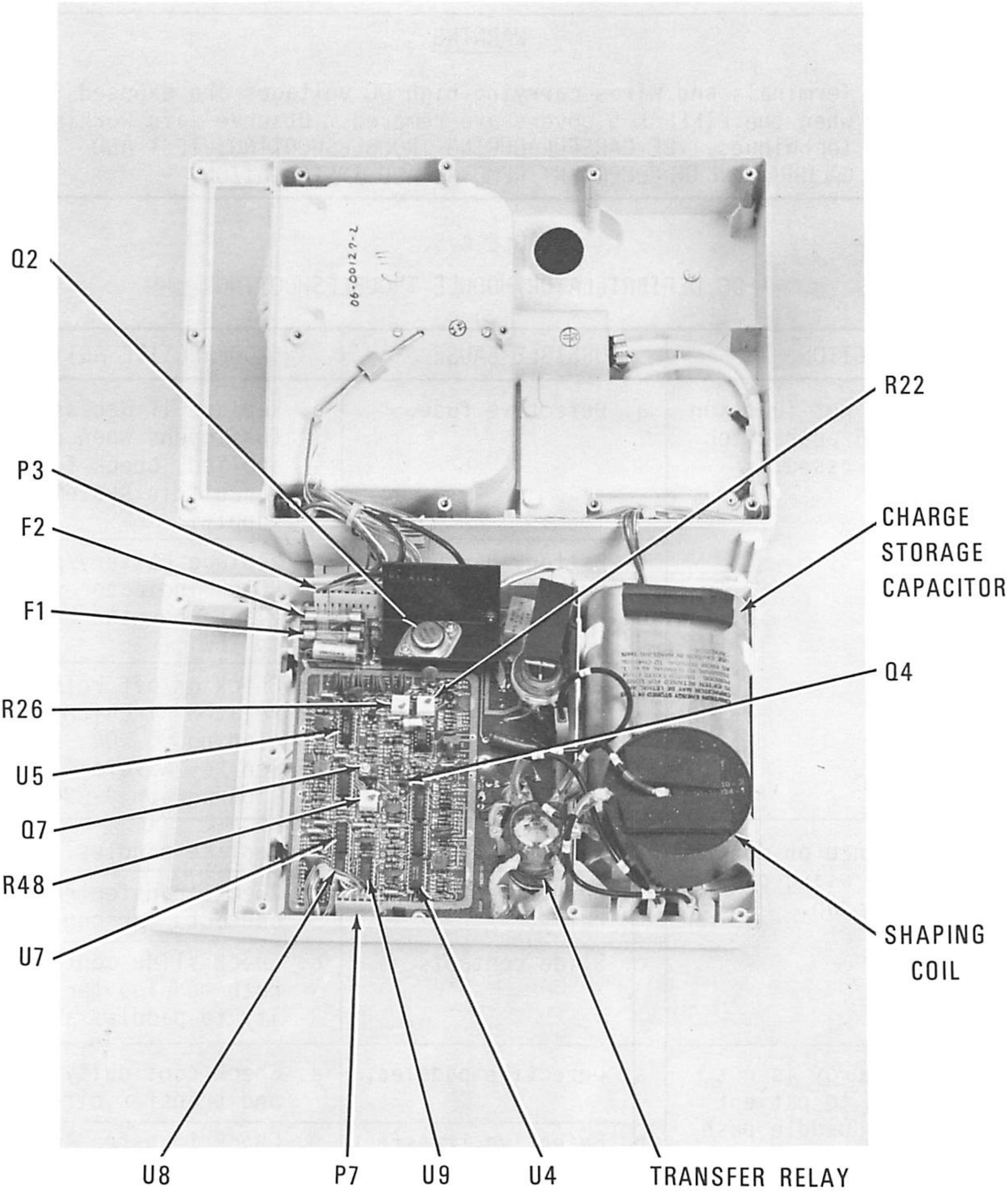


Figure 4-16. DC Defibrillator Module Component Identification

> **WARNING**
>
> Terminals and wires carrying high DC voltages are exposed when the LIFEPAK 5 covers are removed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TEST AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

TABLE 4-5.

DC DEFIBRILLATOR MODULE TROUBLESHOOTING

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Unit does not function when POWER pushbutton S3 is depressed.	a. Defective fuse.	a. Replace if necessary. If fuse opens when power is applied, check for short circuit in system power supply.
	b. Battery discharged below operating level.	b. Replace battery/pak. The POWER indicator will flash when the battery is low.
	c. Defective on/off circuit.	c. Check on/off relay and related circuitry, including U5, Q8, and Q11. See key waveform number 1 paragraph 4-39.
2. Interference on monitor unit when using paddles as ECG pickup.	a. Defective paddles.	a. Replace paddles.
	b. Defective transfer relay.	b. Check transfer relay contacts for continuity.
	c. Slide contacts.	c. Check slide contacts of both modules for continuity to paddles and preamp.
3. Stored energy is not delivered to patient when both paddle pushbuttons are depressed.	a. Defective paddles.	a. Check continuity of paddle and transfer circuit.
	b. Defective transfer relay or transfer logic circuit.	b. Check transfer logic, including Q4,Q5,U2, and U3. See key waveform number 2 paragraph 4-39.
4. Charge indicator shows no response or fails to reach desired stored energy level.	a. Defective charge control circuitry.	a. Check charge control circuitry.

(continued on next page)

TABLE 4-5.

DC DEFIBRILLATOR MODULE TROUBLESHOOTING (CONTINUED)

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
4. (Continued)	b. Defective charge up circuitry.	b. Check charge up circuitry, including Q1, Q2,Q3,Q6,Q9 and U1. See key waveform number 3, paragraph 4-39.
	c. Defective energy select circuitry.	c. Check energy select circuitry, including U6 and CR22.
5. Charge time exceeds 10 seconds to reach 320 joule level.	a. Defective charge up circuitry.	a. Check charge up circuitry, including Q1,2, 3,6,9 and U1. See key waveform number 3, paragraph 4-39.
	b. Low battery.	b. Recharge or replace battery.
6. Stored energy is not dumped instantly when unit is turned off or when paddles are fired in air.	a. Defective dump relay.	a. Replace relay.
	b. Defective dump circuit.	b. Check charge control circuitry, including R3, U2,U3, and U4. See waveform number 4, paragraph 4-39.
7. Charge Indicator on steady but stored energy not available.	a. Defective energy select circuitry.	a. Check energy select circuitry including U6 and CR22.
	b. Defective charge control logic.	b. Check charge control logic including U4,U2A and B, and U7A.
8. Bleed off too short.	a. Defective storage capacitor.	a. Replace storage capacitor.
	b. Recharge circuitry defective.	b. Check recharge circuitry including U4. See key waveform number 5.
	c. 90% energy comparator circuit.	c. Check U3A, Q10, R58 and R57.
9. Low battery indicator does not light when battery/pak is low.	Defective low battery indicator circuitry.	Check low battery indicator circuitry including U6D and U7B.

4-29. TESTS AND CALIBRATION

Procedures given here are used to verify that the LIFEPAK 5 DC Defibrillator Module is operating within specifications. Table 4-5, Troubleshooting, contains references to these procedures. If the instrument is not functioning properly, locate the malfunction before attempting circuit calibration or adjustment. Refer to paragraph 4-27 for information concerning component location.

> WARNING
>
> Terminals and wires carrying high DC voltages are exposed when the LIFEPAK 5 covers are removed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TEST AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

4-30. Initial Control and Test Equipment Setup

1. Set the controls to the positions noted below:

POWER	OFF
ENERGY JOULES	40

2. If installed, remove battery/pak.
3. Refer to paragraph 4-41 and open up the DC defibrillator module, if adjustment is known to be required.
4. Connect the DC power supply (1) and digital multimeter (2) to the battery/pak terminals observing proper polarity.
5. Adjust the DC power supply (1) to 12.6 volts using the digital multimeter (2) as a monitor.
6. Fasten the paddles to the energy meter (6) pads.

> CAUTION
>
> HAZARDOUS VOLTAGE (4300 volts) IS ACROSS THE PADDLES ON DISCHARGE OR COULD BE PRESENT DURING THE CHARGE CYCLE AS THE RESULT OF FAULTY CABLING OR CIRCUITRY. It is recommended that the paddles be fastened to the Energy Meter (6) for all charge and discharge tests except for special requirements.

7. Depress POWER pushbutton S3 and verify that green POWER indicator lights.

4-31. Current Drain. After completing initial setup of paragraph 4-30 proceed as follows to accomplish current drain testing. Refer to figure 3-12 for a schematic of the DC defibrillator.

CAUTION

Replacing a blown fuse will often restore the unit to its full capability. Nevertheless, replacing a blown fuse should always be followed by a careful check of the circuitry.

1. Depress POWER button S3 and verify that green POWER indicator is off indicating power is removed.

2. Set the digital multimeter (2) to ten amps DC scale. Connect it in series with the positive lead of the DC power supply (1) using a maximum of three feet of number 18 wire in each lead.

3. If required, adjust the DC power supply (1) to 11.4 volts using the digital multimeter (2) as a monitor.

4. Depress POWER pushbutton S3 and verify that the green POWER indicator flashes.

5. Set ENERGY JOULES selector S4 to maximum energy.

6. Depress and release CHARGE pushbutton S6 and observe DC ammeter (3). The current will continue to increase during the charge cycle until full charge is reached. At full charge it will drop back to minimum current. Maximum current should not exceed 10 amps and charge time should be less than 10 seconds.

7. Discharge unit into energy meter (6) by depressing both Dicharge buttons S2 and S5 simultaneously.

8. Depress POWER pushbutton S3 and verify that green POWER indicator goes off.

4-32. Low Battery Level Check. After completing the initial setup of paragraph 4-30, proceed as follows to test the low battery level circuitry:

1. Gradually reduce the DC power supply (1) voltage in 0.1 volt increments until the POWER Indicator begins to flash.

2. Verify that the supply voltage at this point is between 10.0 to 10.3V.

4-33. Charge and Automatic Recharge Circuitry. After completing initial setup of paragraph 4-30 proceed as follows:

NOTE: Momentary pressure on CHARGE button S6 starts the charge cycle. The Charge Indicator flashes red while charging and at the end of approximately 30 seconds, indicating the charge has bled off to 90% or less of the initial charge. At 320 joules (or optional 400 joule unit) the Charge Indicator will flash 2 or 3 times after apprxomately 11 seconds of steady red, then steady red again for approximately 20 more seconds. These couple of flashes indicate the automatic recharge is functioning. Automatic recharge occurs several times during each charge cycle. It insures that a minimum of 90% of the initial charge will be available for a period of approximately 30 seconds. To extend the ready period manual recharge is necessary by pressing the charge button. Charge cycle will then be repeated. The Discharge buttons S2 and S5 are disabled at any time the Charge Indicator is flashing or off.

1. Set the ENERGY JOULES selector S4 to 320 (or optional 400 joule).

2. Simultaneously start the stopwatch (7) and press the CHARGE button S6. Stop the stopwatch (7) when the Charge Indicator becomes steady red.

3. Verify that the elapsed time is between 9 and 10 seconds (12.5 sec. for 400 joule unit) and charge current is less than 10 amps (refer to paragraph 4-37-7). Depress Discharge buttons S2 and S5 and verify energy is transferred to energy meter (6). If required perform adjustments in step 4 through 9.

4. Set R22 and R26 fully CCW. See figure 4-16 to locate adjustments and test points.

5. Connect the oscilloscope (4) to the collector of Q2 or cathode of CR2.

6. Set ENERGY JOULES selector to 320 (or optional 400 joules). Depress CHARGE button and observe waveform.

7. Adjust R22 to obtain waveform number 3 presented in paragraph 4-39.

8. Dump stored charge and repeat steps 1 through 3. Adjust R26 for charge time of less than 10 seconds (12.5 seconds on 400 joule unit).

9. Repeat steps 6 through 8, adjust if necessary.

4-34. <u>Selected Energy Test</u>. After completing initial setup of paragraph 4-30 proceed as follows to accomplish selected energy:

1. Set the ENERGY JOULES selector S4 to 320 (or optional 400 joules).

2. Depress CHARGE button S6, then immediately press both Discharge buttons S2 and S5 and hold them down until unit discharges.

3. Verify that the energy meter indicates between 288 and 352 joules (320 ±10%) on the standard unit or 375 to 425 joules (400 ±10%) on the optional unit. If necessary, adjust R48 (compensation) for 320 joules ±5%. (400 joules ±5% on optional unit). Record actual reading for use in paragraph 4-35.

4. Repeat test on the five other energy levels and verify indication on energy meter (6) is within ± 10% of the energy level selected as noted in table 4-6.

TABLE 4-6.

ENERGY JOULES SELECTOR TOLERANCES

STANDARD UNIT

ENERGY JOULES	LIMIT (JOULES)
320	288-352
240	216-264
180	162-198
120	108-132
80	72-88
40	36-44

OPTIONAL 400 JOULE UNIT

ENERGY JOULES	LIMIT (JOULES)
400	375-425
300	282-318
200	188-212
100	94-106
50	47-53
20	18-22

5. Repeat step 1 through 3 with the external DC power supply (1) set to 10 volts.

4-35. Bleed Off. After completing initial setup of paragraph 4-30 and selected energy test of paragraph 4-34 proceed as follows:

1. Set ENERGY JOULES selector S4 to maximum energy. Press CHARGE button S6 and allow unit to charge. Start a stopwatch when Charge Indicator first becomes steady red. At 15 seconds discharge unit and observe energy meter (6) indication.

2. Verify that the energy meter indicates at least 90% of the energy recorded in paragraph 4-34 step 3.

4-36. Waveform and Pulse Duration. After completing initial setup of paragraph 4-30 and selected energy test of paragraph 4-34 proceed as follows:

1. Connect the BNC connector (1000:1 oscilloscope output) on the back of the energy meter (6) to the oscilloscope (4). Set oscilloscope to 0.5 v/div, 1 ms/div and positive trigger.

2. Set ENERGY JOULES selector S4 to maximum energy.

3. Depress CHARGE button S6 and allow unit to charge.

4. Depress Discharge buttons S2 and S5 and observe waveform on the oscilliscope (4).

5. The display should closely match that of figure 4-17. The curve should be smooth and continuous, peak at 53 amps (51 to 65 amps for 400 joule unit) and have a half current point at 3.6 $\pm$ 0.3 milliseconds. The entire pulse duration should be less than 10 milliseconds (at 10% of peak value).

6. Disconnect and remove oscilloscope (4).

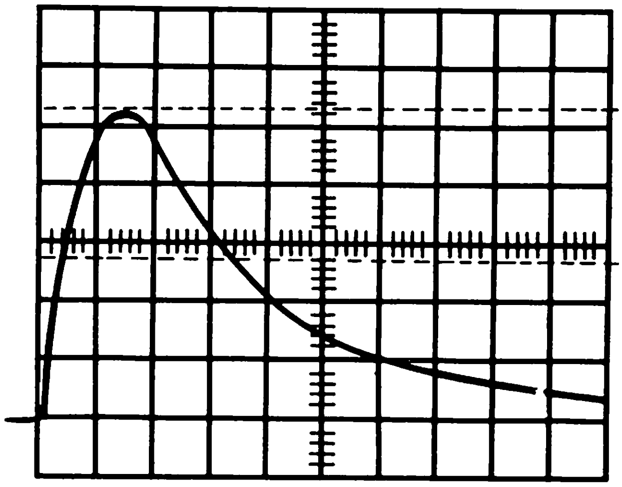


Figure 4-17. DC Defibrillator Output Waveform (50 ohms)

4-37. Internal Discharge (Dump). After completing initial setup of paragraph 4-30 proceed as follows:

1. Set ENERGY JOULES selector S4 to maximum energy.
2. Press CHARGE button S6.
3. When the Charge Indicator becomes steady red turn off unit by pressing POWER button S2.
4. Unit should discharge internally (dump). No reading on the energy meter (6).
5. Depress POWER button S2. Wait 15 seconds and then depress charge button S6.
6. Verify that the Charge Indicator flashes for a minimum of 6 seconds before becoming steady red. If the indicator only flashes for 4 seconds or less the dump circuit is faulty.
7. Remove paddles from energy meter (6). Hold paddles approximately one foot apart and depress Discharge S2 and S5 buttons.
8. Verify that the Charge Indicator goes out indicating the charge was discharged internally (dumped).
9. Fasten paddles on energy meter (6). There should be no evidence of any charge remaining on the contact plates.

4-38. Module Interconnect. Proceed as follows:

1. Fasten DC defibrillator module to cardioscope/recorder module.
2. Remove battery/pak from DC defibrillator.
3. Use digital multimeter (2) to make a continuity check between the negative battery terminal on the DC defibrillator and contact "F" of the PATIENT CABLE connector on the cardioscope/recorder.
4. Verify the less than 0.1 ohms when measured at the contact of the connector.

4-39. Key Waveforms. The following steps provide references to figures providing waveshapes at key points. Using the oscilloscope (4) observe the waveshapes at the points noted. Refer to figure 3-12 and 4-18 for help in locating test points.

1. On Delay Pulse. Check at U5-12, refer to figure 4-18 waveform number 1.
2. Transfer Pulse. Check at Q4 collector, refer to figure 4-18 waveform number 2.
3. Capacitor Charge Circuit Output. Check at Q2 collector, refer to figure 4-18 waveform number 3.
4. Dump Relay Drive Output. Check at Q7 collector, refer to figure 4-18 waveform number 4.
5. Recharge F/F Output. Check at U4-3, refer to figure 4-18 waveform number 5.

4-40. Synchronizer Test.

1. Connect cardioscope/recorder module and defibrillator module together.
2. Connect a 1 mv ECG signal to the patient cable input of the cardioscope/recorder module.
3. Switch cardioscope/recorder module on and adjust ECG size and systole volume to obtain an audible beep with each QRS complex.
4. Switch defibrillator module power on and observe that the synchronizer indicator is off.
5. Depress the sync pushbutton switch. The sync indicator should be lighted except during R-wave detection when it blinks off momentarily and each R-wave on the cardioscope (CRT) should contain an intensification blip.
6. Cycle defibrillator power off and on again. The sync indicator should remain off when the power is reapplied and the intensification blips should not be present on the cardioscope (CRT).
7. Set the energy select on the defibrillator module to 40 joules (or optional 20 joules). Charge the defibrillator and discharge into a 50 ohm load to insure proper operation.

8. Depress the sync pushbutton switch. Charge the defibrillator to 40 joules (or 20 joules on 400 joule unit) and depress the discharge buttons. Discharge should only occur during the R-wave detection as indicated by the sync light blinking.

   NOTE: Be sure to discharge into a 50 ohm load.

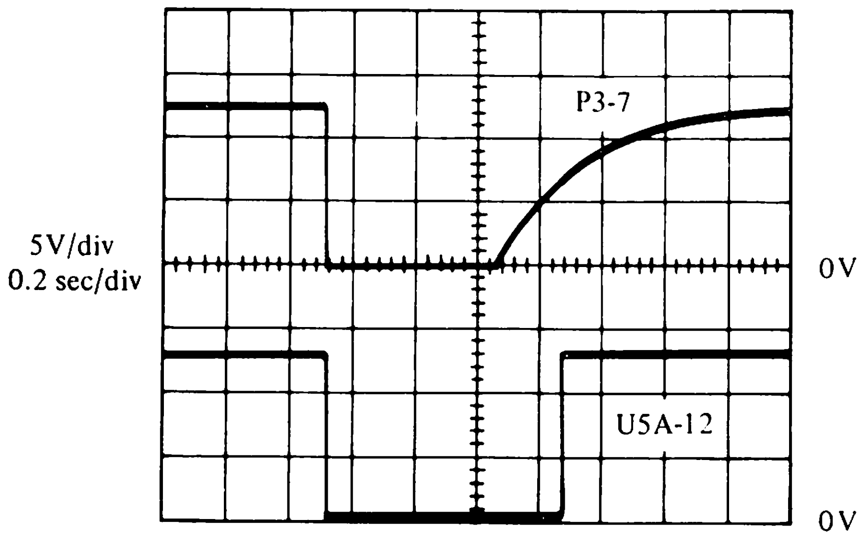
9. Check to be sure that discharging the defibrillator has turned the synchronizer off.

10. Repeatedly depress the sync pushbutton switch on and off and note that the synchronizer indicator toggles on and off.

11. With the instrument in the sync mode, slide the defibrillator module and cardioscope module apart. Verify that the sync indicator turns off and there are no intensification blips on the CRT.

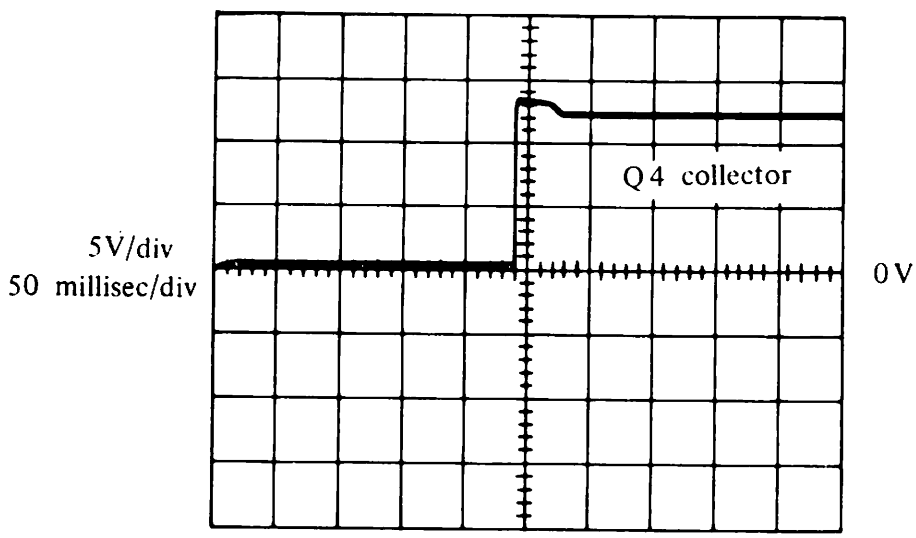
12. Verify that the sync indicator cannot be turned on when defibrillator and cardioscope/recorder modules are separated.

13. Charge the defibrillator to 40 joules (or 20 joules on 400 joule unit) and test fire into a 50 ohm load to insure proper operation.



The delay time is measured from the time the on/off button is released (rise of voltage on P3-7) to the positive transition of U5A-12 (0.2 seconds approximately).

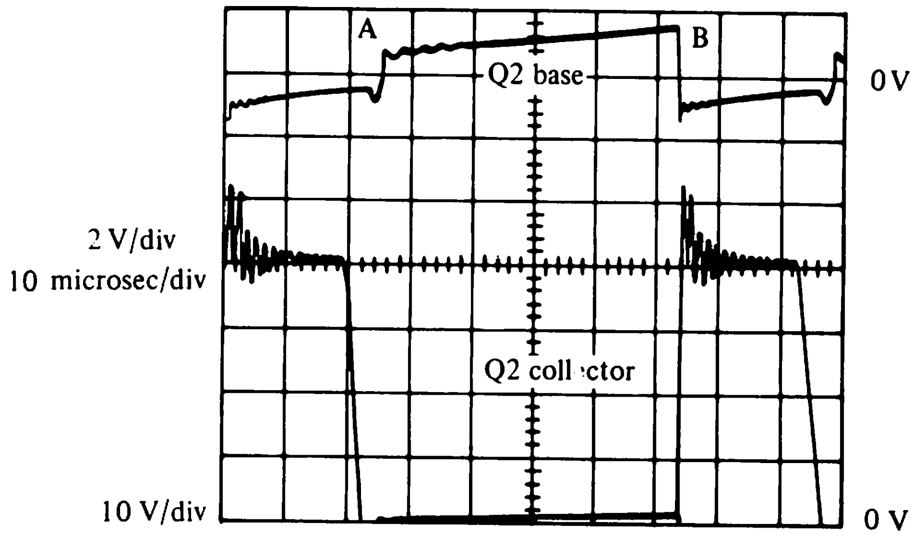
1. On Delay Pulse.



Transfer relay coil drive pulse

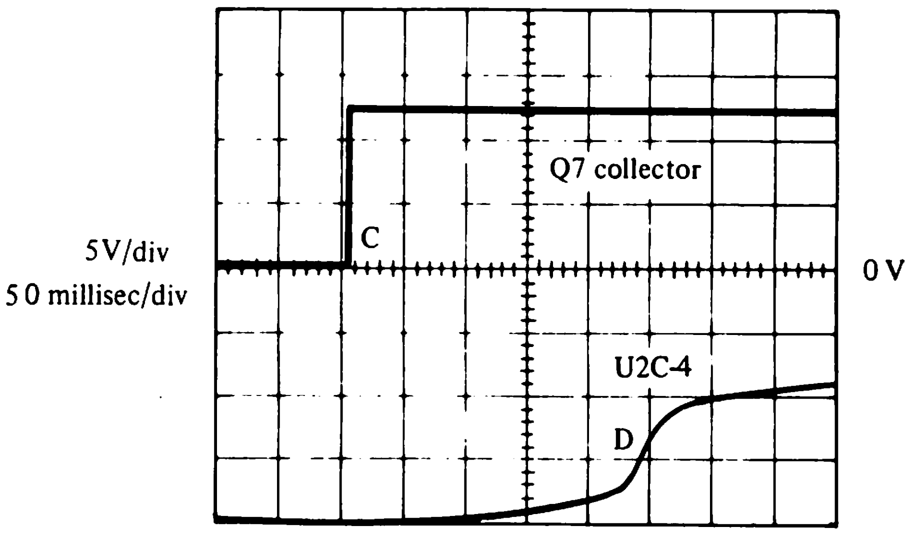
2. Transfer Pulse.

Figure 4-18. DC Defibrillator Key Voltage Waveforms (Sheet 1 of 3)



Period A to B is Q2 on time, base voltage upwards ramp is similar to base current ramp. Base current ramp is similar to collector current ramp. Negative spike at B turns Q2 collector off rapidly.

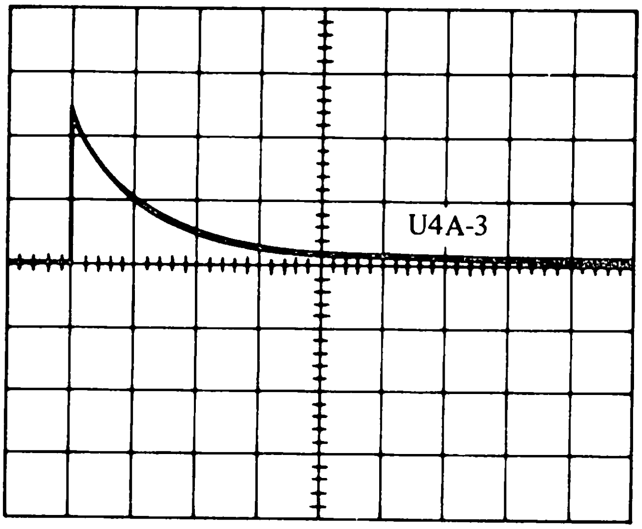
3. Capacitor Charge Circuit Output.



Period C to D is delay allowing dump relay to close before turning on capacitor charge up circuitry.

4. Dump Relay Drive Output.

Figure 4-18. DC Defibrillator Key Voltage Waveforms (Sheet 2 of 3)



Differentiated recharge pulse at clock input to "D" F/F U4-A-3.

5. Recharge F/F Output.

Figure 4-18. DC Defibrillator Key Voltage Waveforms (Sheet 3 of 3)

4-41. MAJOR COMPONENT REMOVAL AND INSTALLATION

The following procedures provide the sequence for removing and installing the major components of the DC defibrillator.

Installation is for the most part the opposite of removal so only the removal procedures are provided. Special installation notes are provided as required. Remove or disassemble only to the point required. Figure 4-19 provides an exploded view of the DC defibrillator to assist in the following procedures.

4-42. Upper and Lower Case Separation. Refer to figure 4-19 and proceed as follows:

> NOTE: Installation procedures are essentially the reverse of the procedures presented below. When joining the two cases, be careful to have gasket positioned correctly.

1. Remove eleven screws (1) securing upper case (2) to lower case (3). Note different length of screws. Use caution when reinserting screws.

> CAUTION
>
> Before removing top cover observe location of charge storage capacitor, coil and transfer relay (refer to figure 4-16). Keep hands clear of those areas.

2. Carefully lift top case (2) straight up and to the side of the lower case. The wiring harness will keep the two halves from being able to be pulled completely apart. Use care not to damage top to bottom cover gasket.
3. Using a 20K, 20W resistor on the end of a high voltage probe, insure that the charge capacitor is discharged. Do not use a screwdriver in place of the above.
4. The unit is now in the test configuration (refer to figure 4-16). If further disassembly is required proceed to paragraph 4-43.

4-43. General Disassembly (figure 4-19.

> NOTE: Installation procedures are essentially the reverse of the procedures presented below.

After completing the procedures in paragraph 4-16A proceed as follows:

1. To remove the PCB board (5) disconnect six connectors J1 through J6 from the PCB board connector. Using tip of screwdriver lift PCB board (5) free of clips (6) and remove from unit.

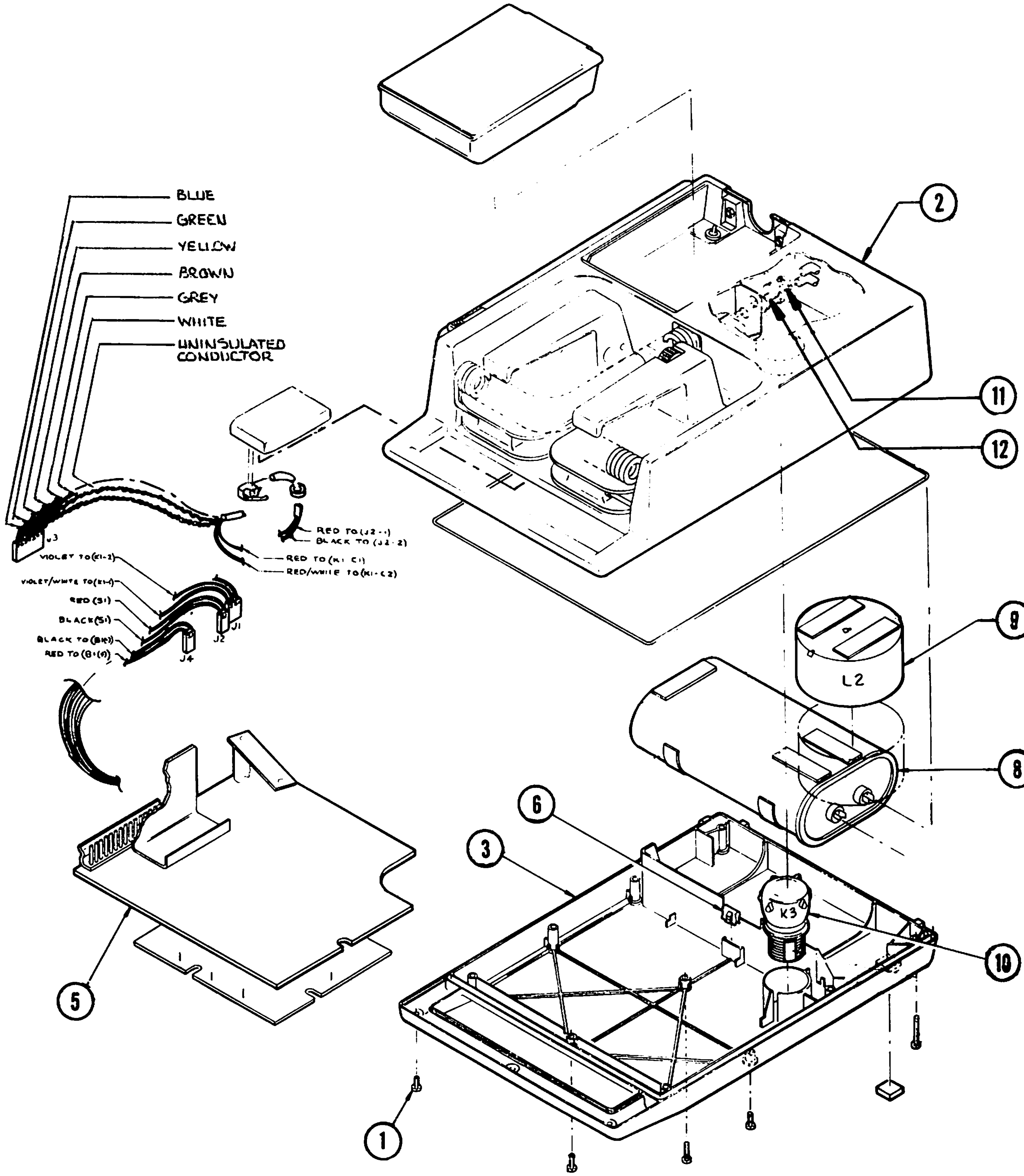


Figure 4-19. DC Defibrillator Major Component Removal

2. To remove charge storage capacitor (8) with coil (9) simply lift unit up and out after disconnecting slide-on clips connected to terminals. The coil (9) is connected to the capacitor (8) with double back tape.

3. To remove transfer relay (10) unsolder wires connected to it and lift unit up and out.

4. If paddles require removal refer to paragraph 4-44.

4-44. Paddles Removal (figure 4-19). After completing procedures in paragraph 4-42 proceed as follows:

> NOTE: Installation procedures are essentially the reverse of the procedures presented below.

1. Disconnect connector J3. Remove pins 1 through 7 (with wires connected) from J3.
2. Unsolder wires connected to transfer relay (10) contacts C1 (red) and C2 (red and white).
3. Using small screwdriver from underneath top case push grommet (11) out of hole.
4. Cut tie (12).
5. Pull paddle wiring free of unit.

4-45. ACCESSORY EQUIPMENT

The following paragraphs provide the maintenance procedures for the accessory equipment available for the LIFEPAK 5.

4-46. BATTERY/PAK CHARGER

Maintenance procedures in this section are divided into four parts, component identification, trouble analysis, calibration and testing, and major component removal and installation.

4-47. Component Identification. Figure 4-20 provides an overall view of battery/pak charger module with key components and test points or adjustments indexed to a legend. Refer to paragraph 4-50 for major component removal and installation.

WARNING

Terminals and wires carrying high AC and DC voltages are exposed when the battery/pak charger circuitry is exposed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TESTS AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

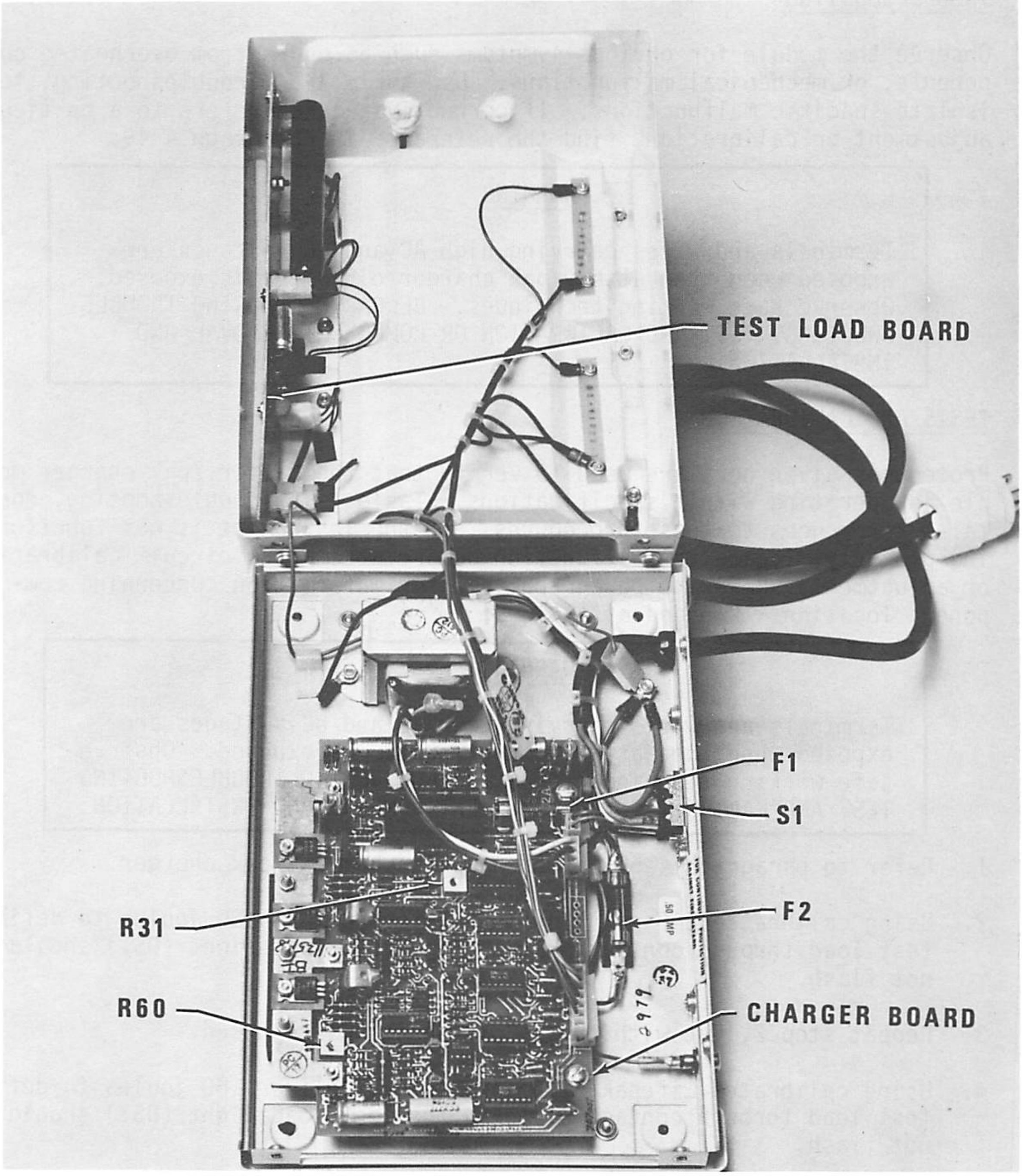


Figure 4-20. Battery/Pak Charger Module Component Identification

TROUBLESHOOTING

4-48. Observe the module for obvious symptoms such as odors from overheated components, or mechanical malfunctions. Use table 4-7, Troubleshooting, to isolate specific malfunctions. If corrective action refers to a particular adjustment or calibration, find the reference in paragraph 4-49.

> **WARNING**
>
> Terminals and wires carrying high AC and DC voltages are exposed when the battery/pak charger circuitry is exposed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TEST AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

TESTS AND CALIBRATION

4-49. Procedures given here are used to verify that the battery/pak charger module is operating within specifications. Table 4-7, Troubleshooting, contains references to these procedures. If the instrument is not functioning properly, locate the malfunction before attempting circuit calibration or adjustment. Refer to paragraph 4-47 for information concerning component location. Proceed as follows:

> **WARNING**
>
> Terminals and wires carrying high AC and DC voltages are exposed when the battery/pak circuitry is exposed. Observe safe working techniques. BE CAREFUL DURING TROUBLESHOOTING, TEST AND CALIBRATION OR COMPONENT REMOVAL AND INSTALLATION.

1. Refer to paragraph 4-50 and open up the battery/pak charger.

2. Using calibrated Lifepak 5 defibrillator, deliver 80 joules to defib test load through contact plates. The test load light (DS1) should not flash.

3. Repeat step 2, but with the paddle positions reversed.

4. Using calibrated Lifepak 5 defibrillator, deliver 180 joules to defib test load through contact plates. The test load light (DS1) should not flash.

5. Repeat step 4, buth with the paddle positions reversed.

6. Connect 20 VDC, 0.5A power supply to power supply input terminals of Variable Test Load. (See figure 4-20A). Connect two DMM's one reading current (2000mA DC scale) and one reading voltage (20 VDC scale), to the appropriate ammeter and voltmeter connections of the Variable Test Load. Switch Load Sleect on Variable Test Load to 40 ohm position.

7. Plug charger under test into a 115 VAC receptacle. (Or 220V receptacle for units so configured). All LED indicators should remain off.

TABLE 4-7

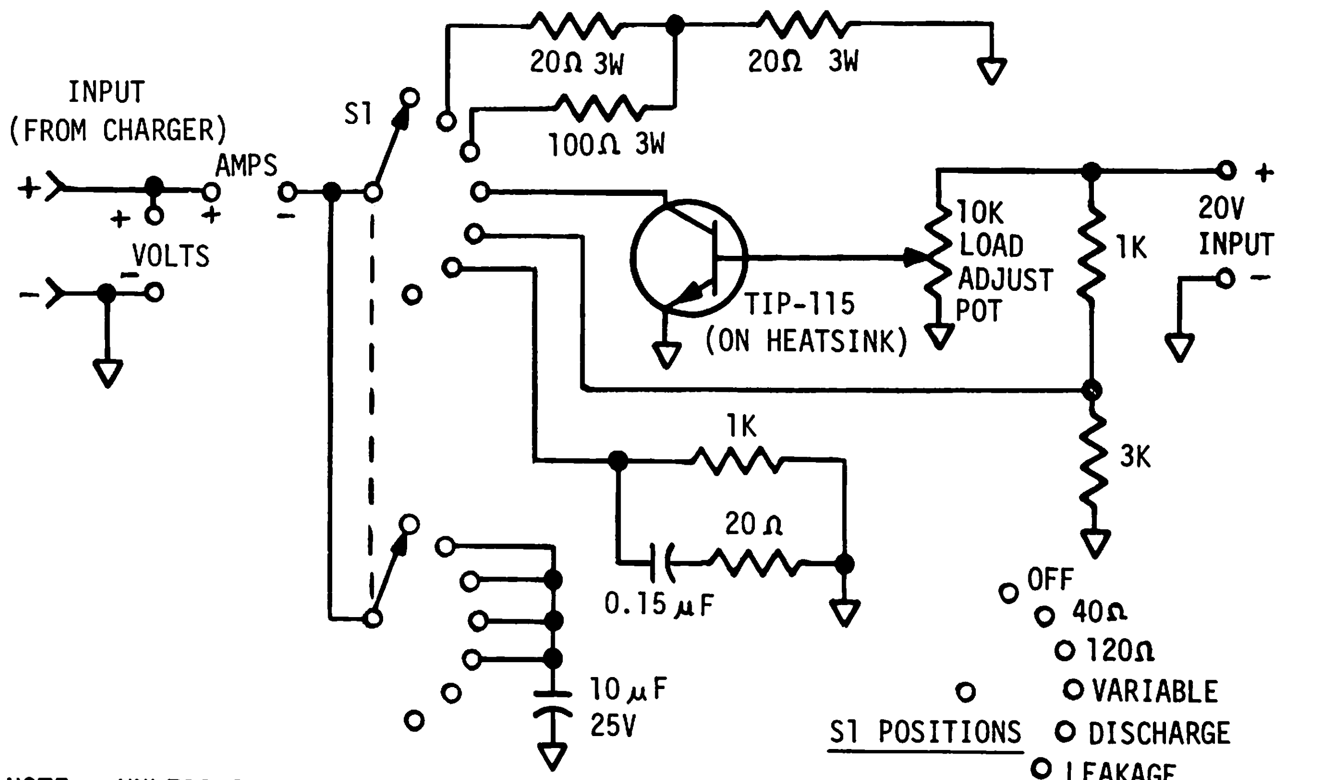
BATTERY/PAK CHARGER TROUBLE SHOOTING

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Test load LED does not flash	Defibrillator inoperative or out of calibration	See Defibrillator Section
	Test load open circuited	Examine test load PCB for open circuit and repair as required.
	Test Load LED defective	Replace LED
2. CHARGING LED fails to come on when battery is inserted	Battery/Pak improperly inserted	Remove and re-insert Battery/Pak
	Fuse blown	Replace ¼/½amp. (115V,220V) or 2 amp (12 VDC) fuse.
	Defective Battery/Pak	Replace Battery/Pak
	Charge Control Logic defective	Replace U5 on Charger PCB
	LED and/or Battery/Pak connectors loose or improperly connected	Check all internal connectors for proper polarity and snug fit.
	CHARGING LED defective	Replace LED
	12 VDC Supply Voltage too low	Increase to specified voltage (11-15 VDC)
3. TIME LED fails to illuminate	Faulty Clock (Check signal at TP1)	Replace U3 on charger PCB and/or associated components as required
	Faulty Timer	Replace U7 or U9 on charger PCB as appropriate
	Timer Control Logic defective	Replace U4 on charger PCB
	TIME LED defective	Replace LED
4. TIME LED illuminates too soon or too late	Faulty Clock (Check signal at TP1)	Replace U3 on charger PCB and/or associated components as required.

TABLE 4-7

BATTERY/PAK CHARGER TROUBLE SHOOTING (continued)

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE ACTION
5. Batteries not charged to full capacity when time LED illuminates	Faulty Battery/Pak	Replace Battery/Pak
	Charger being used in too high or too low ambient temperature	Charge Battery/pak in ambient temperature as close to room temperature (22^{o}C, 70^{o}F) as possible
	Charger source out of adjustment	Adjust R31 or R60 on charger PCB, as appropriate, to obtain charge rate of 300mA
	12 VDC supply voltage too low	Increase to specified voltage (11 - 15VDC)
6. TIME and/or CHARGING LED's illuminate when no battery/pak is inserted	Charger control logic defective	Replace U5 on charger PCB



NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE 1/4W, 5%, CF.

Figure 4-20A, Variable Test Load, Battery/Pak Charger

8. Insert Variable Test Load (See Figure 4-20A), with instrumentation per step 7, into right-hand side battery compartment. Within 3 seconds the right-hand CHARGING LED should be illuminated. All other LED's should remain off. After the CHARGING LED comes on, the DMM current reading should be 300mA ± 6mA. If not, adjust R31 to obtain a reading of 300mA ± 3mA. The DMM voltage reading should be 11.45 to 13.17 VDC.

9. Unplug the charger under test from the 115 VAC (or 220 VAC) receptacle. The CHARGING LED should go out. Wait approximately 5 seconds. Plug the charger back into the receptacle. Within 3 seconds, the right CHARGING LED should go back on. All other LED's should remain off. The DMM current reading should then be 300mA ± 6mA.

10. Unplug charger from 115 VAC (or 220 VAC) receptacle. CHARGING LED should go out. Using cable with phone plug, connect 11 ± 0.1 VDC, 2.5A supply to 12 VDC input jack of charger. Within 3 seconds, right-hand CHARGING LED should go on. All other LED's should remain off. The DMM current reading should be 300mA ± 5mA.

11. Adjust LOAD ADJUST potentiometer on the Variable Test Load to the full counterclockwise position.

12. Switch LOAD SELECT to the VARIABLE position. The right-hand CHARGING LED may go out momentarily, (3 seconds max.) but should again come on. All other LED's should remain off. The DMM current reading should then be 300mA ± 13mA. The DMM voltage reading should be less than 3.0 VDC.

13. Slowly turn LOAD ADJUST potentiometer clockwise until DMM voltage reading is 13.5 - 14.0 VDC. During this adjustment, the right-hand CHARGING LED should remain on, all other LED's should remain off, and the DMM current reading should stay within ± 13mA of 300mA.

14. Switch LOAD SELECT to the 120 ohm position. Again, the right-hand CHARGING LED may go out momentarily, but should be on again within 3 seconds. All other LED's should remain off. The DMM voltage reading should then be between 14.4 and 15.6 VDC.

15. Disconnect 11 VDC supply from charger. CHARGING LED should go out. Switch LOAD SELECT to DISCHARGE position. Adjust ammeter to the 200 uA scale. Current reading should be between -20 and -60 uA.

16. Switch LOAD SELECT to LEAKAGE position. Plug charger into 115 VAC (or 220 VAC) receptacle. Current reading should be less than 80 uA, except that a very brief (approx. 5 msec) current spike occurring about 2½ seconds after unit is plugged in, is acceptable. Current should be observed for at least 7 seconds. All LED's should remain off.

17. Remove Variable Test Load from charger.

NOTE: Steps 18 through 27 call for repeating steps 8 through 17. For steps 17 - 25, all references in steps 8 - 16 to right-hand side should be changed to left-hand side.

18. Repeat step 8, except insert Variable Test Load in left-hand battery compartment, and adjust R60 if current is out of tolerance.

19. Repeat step 9.

20. Repeat step 10.

21. Repeat step 11.

22. Repeat step 12.

23. Repeat step 13.

24. Repeat step 14.

25. Repeat step 15.

26. Repeat step 16.

27. Repeat step 17, and unplug unit from AC receptacle.

28. Connect DMM's so as to read 2000 uA DC, between the positive and negative charger terminals in each battery compartment of the unit under test. Positive terminal of the DMM should connect to the positive charger terminal in each case.

29. Adjust the signal generator to deliver a square wave (duty cycle not critical) of 102.4 ± 1.0 Hz frequency, and 13.5 ± 0.2 V p=p amplitude. Adjust the signal DC offset so that the low level is 0.0 ± 0.1 VDC.

30. Using a cable with phone plug, connect 11 ± 0.1 VDC, 2.5A supply to 12 VDC input jack of charger under test. With 3 seconds, both CHARGING LED's should come on. TIME LED's should remain off. 11VDC supply current should be 1.4 amperes max. The current readinq of each DMM connected across charger terminals should be 300 mA ± 13 mA.

31. Open the case of the charger under test. Connect the signal generator output ground to the charger ground lug. Simultaneously connect the signal output to TP1 on the main charger PCB, and start the stopwatch. Close the charger case as much as possible.

32. Between 5 and 15 seconds after the stopwatch is started, and using a LIFEPAK 5 defibrillator set at the highest joule output available, deliver the defibrillator pulse to the test load contacts of the charger under test. The condition of the charger LED's and charger currents should not change. (A brief flicker on any LED at the time of defibrillator discharge is acceptable, and the test load light should flash).

33. Stop the stopwatch when both TIME LED's come on. They should come on simultaneously within 0.1 seconds. The stopwatch reading should be 20 ± 0.4 seconds. Each charger current reading should then be between 65 and 80 mA DC.

34. Disconnect signal generator output and 11 VDC supply from charger under test. All charger LED's should go out.

35. Repeat step 30.

36. Repeat step 31.

37. Repeat step 32, except reverse the polarity of the defibrillator paddles.

38. Repeat step 33.

39. Repeat step 34.

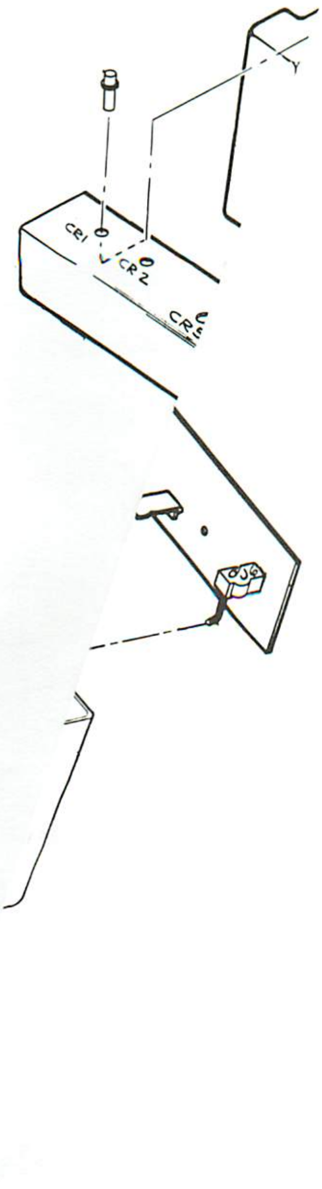
4-50. MAJOR COMPONENT REMOVAL AND INSTALLATION

The following procedures provide the most logical sequence of removing and installing the major components of the battery/pak charger.

Installation is for the most part the opposite of removal so only the removal procedures are provided. Special installtion notes are provided as required. Remove or disassemble only to the point required. Figure 4-21 provides an exploded view of the battery/pak charger to assist in the following procedures. Proceed as follows:

NOTE: Installation procedures are essentially the reverse of the procedures presented below.

1. Remove six screws (2) securing upper case (1) to chassis (4).
2. Carefully lift top cover (1) straight up and lay it to the side of the lower case. The wiring harness will keep the two halves from being able to be pulled completely apart. The unit is now disassembled far enough to facilitate testing.
3. If required, the chassis (4) may be removed from the lower case (3) by removing four screws (5).
4. To remove main PCB (6), remove four screws (7) securing board to chassis (4) and three nuts (8) securing it to heat sink. Disconnect three connectors.
5. To remove test load PCB (9), remove two nuts (10) and five connectors. The TEST LOAD lamp may either be unsoldered or removed from the cover by removing attaching hardware.



Battery/Pak Charger Major Component Removal

5

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-10					
1		04-50081-3	ASSY, WIRE HARNESS, STANDARD	REF	A
		04-50081-4	ASSY, WIRE HARNESS, SYNCHRONIZER	REF	B
2	J1	02-20208-0	CONNECTOR, 3 PIN, MOLEX	1	
3	J7	02-20211-0	CONNECTOR, 6 PIN, CABLE	1	B
4	R2,3	02-08168-0	RESISTOR, 10M OHM, 1/4W, 5%	2	
5	S2	200005-00	SWITCH, PANEL MOUNT	1	B
6	VSP1,2	02-16011-0	SURGE PROTECTOR, 90V	2	
7		02-20241-0	CONTACT, CRIMP, MOLEX	3	A
		02-20241-0	CONTACT, CRIMP, MOLEX	9	B
8		02-35527-0	CONTACT, LUG	2	
9		02-35528-0	HOUSING RECEPTACLE	2	
10		02-35535-0	PUSHNUT	1	
11	J11	06-00115-2	ASSY, INTERCONNECT	1	
12	J5,J6	90-06053	HOUSING, 1/4" SPADE LUG	2	
13		90-06063	LUG, SPADE, 1/4"	2	
14		90-07001	TUBING, SHRINK, 1/8 CLEAR	A/R	
15		90-07020	TUBING, #4, PVC, 105 CLEAR x 9.5"	1	B
16		90-07022	TUBING, #8, PVC, 105 CLEAR	A/R	
17		90-07027	TUBING, 20 GA, TEFLON	A/R	
18		90-07053	TUBING, SHRINK, 1/2 CLEAR	A/R	
19		90-10016	CABLE CLAMP	1	
20		90-11012	WIRE, HV, 20KV	A/R	
21		90-11026	WIRE, 2 COND/S	A/R	
22			WIRE, 26 AWG	A/R	B
23			WIRE, 22 AWG	A/R	
24		90-09138	WIRE, BUSS, 22 AWG	A/R	
25			WIRE, 18 AWG	A/R	
26		90-09035	RTV, WHITE	A/R	

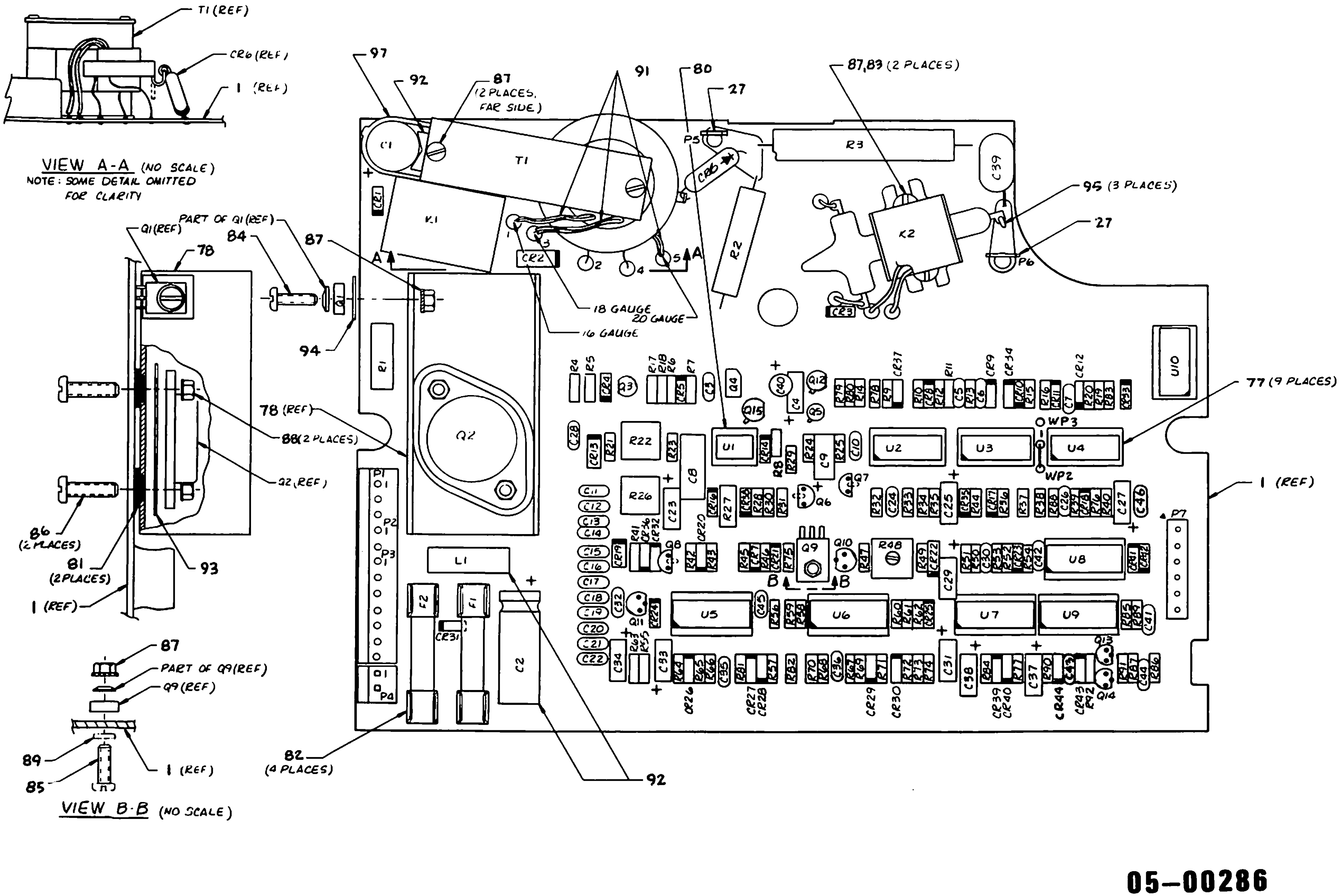


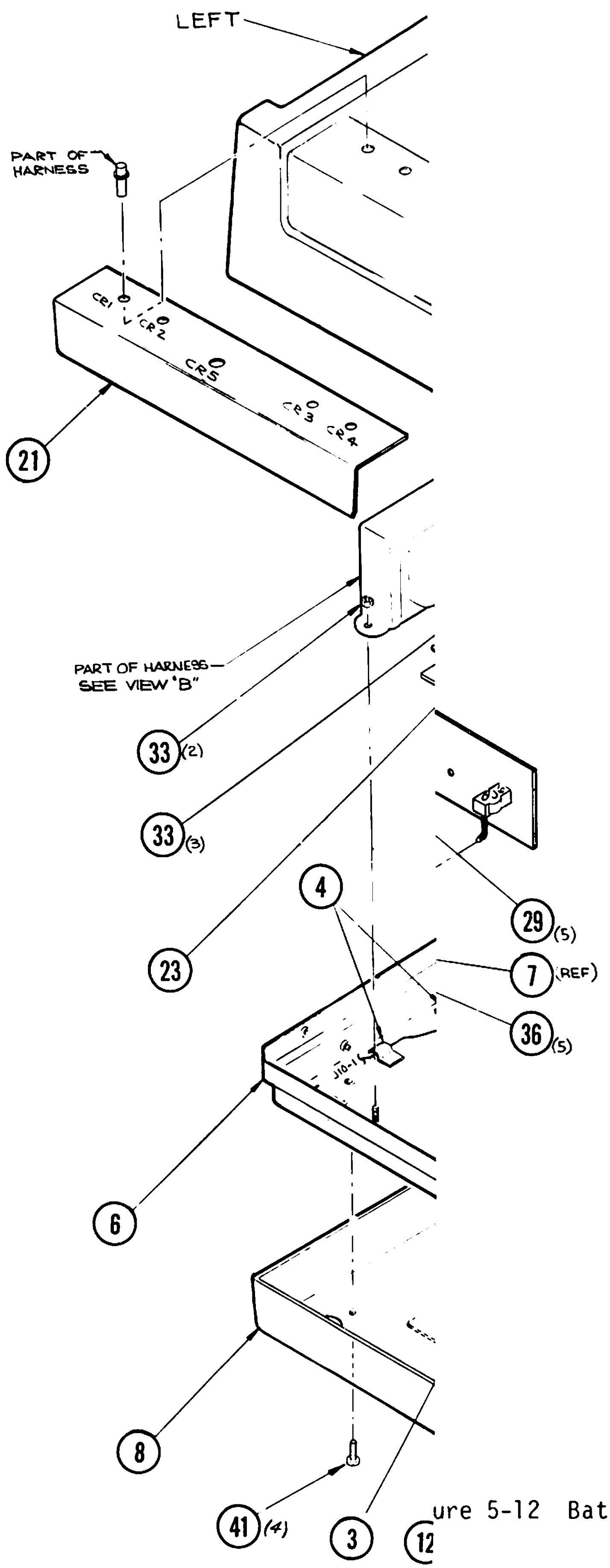
Figure 5-11 DC Defibrillator Board Assembly

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-11 1		05-00286-6	ASSY, P.C.B., DEFIBRILLATOR LP/5	REF.	A
			(HIGH ENERGY-OPTION)	REF.	B
2	C45	02-12011-0	CAPACITOR, 100pf/1KV	1	
3	C41	02-12035-0	CAPACITOR, 1000pf/1KV	1	
4	1	02-12048-0	CAPACITOR, .01/500V	24	
5	C39	02-12103-0	CAPACITOR, 50pf/6KV	1	
6	C8	02-12284-0	CAPACITOR, 2200pf/600V, 5%	1	
7	C42,43, 44	02-12346-0	CAPACITOR, .1/50V	3	
8	2	02-12606-0	CAPACITOR, 2.2/20V	11	
9	C2	02-12654-0	CAPACITOR, 100/25V	1	
10	C40	02-12705-0	CAPACITOR, 10/50V	1	
11	C1	02-12729-0	CAPACITOR, 560/20V	1	
12	3	02-14018-0	DIODE, 1N914B	37	
13	CR37	02-14027-0	DIODE, FDH300	1	
14	CR15	02-14100-0	DIODE, 1N753A	1	
15	CR19	02-14124-0	DIODE, ZENER, 16V, 1N4745	1	
16	CR2	02-14162-0	DIODE, 1N5373B	1	
17	CR6	02-14164-0	DIODE, SFES20K	1	
18	CR22	02-14172-0	DIODE, 6.2V, 1%, 1N821	1	
19	CR13	200034	DIODE, 1N7468	1	
20	F1	02-22032-0	FUSE, 1 AMP	1	
21	F2	02-22056-0	FUSE, 15 AMP	1	
22	K2	02-18566-0	RELAY, DUMP	1	
23	K1	02-18569-1	RELAY, ON/OFF	1	
24	L1	02-18020-0	INDUCTOR, 500uh, .4ohms	1	
25	P5, 6	02-20171-0	CONNECTOR, TERMINAL, MALE	2	
26	P7	02-20214-0	PLUG, 6 PIN, MOLEX	1	
27	P4	02-20323-0	PLUG, 2 PIN, MOLEX	1	
28	P1-3	02-20333-0	PLUG, 12 PIN, MOLEX	1	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-11 29	Q13,14	02-14541-0	TRANSISTOR, EN 3962	2	
30	Q3, 10-12	02-14542-0	TRANSISTOR, EN 2484	4	
31	Q4	02-14568-0	TRANSISTOR, D40D5	1	
32	Q5-8	02-14606-0	TRANSISTOR, PN2907A	4	
33	Q1,9	02-14608-0	TRANSISTOR, MJE223	2	
34	Q2	02-14620-A	TRANSISTOR, SPT5302-S	1	
35	R9	02-06020-0	RESISTOR, 1/4W, 5%, CF, 10 ohm	1	
36	4	02-06034-0	RESISTOR, 1/4W, 5%, CF 39 ohm	5	
37	R8,33	02-06046-0	RESISTOR, 1/4W, 5%, CF, 120 ohm	2	
38	R87	02-06060-0	RESISTOR, 1/4W, 5%, CF 470 ohm	1	
39	5	02-06063-0	RESISTOR, 1/4W, 5%, CF 620 ohm	7	
40	6	02-06068-0	RESISTOR, 1/4W, 5%, CF, 1K	7	
41	7	02-06080-0	RESISTOR, 1/4W, 5%, CF, 3.3K	5	
42	8	02-06092-0	RESISTOR, 1/4W, 5%, CF, 10K	21	
43	R92	02-06095-0	RESISTOR, 1/4W, 5%, CF, 13K	1	
44	R89	02-06101-0	RESISTOR, 1/4W, 5%, CF, 24K	1	
45	9	02-06109-0	RESISTOR, 1/4W, 5%, CF, 51K	11	
46	R86	02-06116-0	RESISTOR, 1/4W, 5%, CF, 100K	1	
47	10	02-06119-0	RESISTOR, 1/4W, 5%, CF, 130K	10	
48	R56,58, 80,83	02-06139-0	RESISTOR, 1/4W, 5%, CF, 910K	4	
49	R79	02-06152-0	RESISTOR, 1/4W, 5%, CF, 3.3M	1	
50	R66	02-07514-0	RESISTOR, 1/8W, 1%, MF, 10K	1	
51	R70	02-07540-0	RESISTOR, 1/8W, 1%, MF, 76.8K	1	
52	R52	02-07541-01	RESISTOR, 1/8W, 1%, MF, 267K	1	
53	R51	02-07541-02	RESISTOR, 1/8W, 1%, MF, 549K	1	
54	R61	02-07543-0	RESISTOR, 1/8W, 1%, MF, 475K	1	
55	R47	02-07544-0	RESISTOR, 1/8W, 1%, MF, 110K	1	A
	R47	02-07540-0	RESISTOR, 1/8W, 1%, MF, 76.8K	1	B
56	R49	02-07545	RESISTOR, 1/8W, 1%, MF, 255K	1	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-11 57	R78	02-08168-0	RESISTOR, 1/4W, 10M	1	
58	R27	02-09031-0	RESISTOR, 1/2W, 5%, CC, 51 ohm	1	
59	R1	02-09500-0	RESISTOR, 2W, 5%, WW, 1.5 ohm	1	
60	R2	02-11189-0	RESISTOR, 1.5W, 1%, EPOXY 52M	1	
61	R48	02-11552-0	RESISTOR, POT, 20K	1	
62	R22,26	02-11553-0	RESISTOR, POT, 50K	2	
63	R3	800185	RESISTOR, 15W, 15%, 50K	1	
64	T1	02-18281-1	TRANSFORMER	1	
65	U1	02-14359-0	I.C. NE555	1	
66	U6	02-14410-0	I.C. LM324	1	
67	U10	02-14426-0	I.C. 74C14N	1	
68	U2,8	02-14436-0	I.C. 74C02	2	
69	U3	02-14437-0	I.C. 74C00	1	
70	U7	02-14438-0	I.C. 556	1	
71	U4,5	02-14439-0	I.C. 4013	2	
72	U9	200011-00	I.C. 74C74	1	
73		01-00286-6	P.C.B., DEFIBRILLATOR	REF	
74		01-41543-0	HEAT SINK	1	
75		02-14311-0	SOCKET, I.C., 14 PIN	9	
76		02-20248-0	SOCKET, I.C., 8 PIN	1	
77		02-35378-0	WASHER, SHOULDER, NYLON	2	
78		02-35464-0	CLIP, FUSE, P.C.B.	4	
79		90-01012	SCREW, #4-40 x 1/4, BH	2	
80		90-01021	SCREW, #4-40 x 3/8, BH	1	
81		90-01027	SCREW, #4-40 x 7/16, BH	1	
82		90-01073	SCREW, #6-32 x 5/8, BH	2	
83		90-03019	KEPNUT, #4-40	6	
84		90-03021	KEPNUT, #6-32	2	
85		90-04004	WASHER, FIBER	1	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-11 86		90-07039	SLEEVING, TEFLON #18	A/R	
87		90-09089	RESISTOR, MOUNT	3	
88		90-09106	INSULATOR	1	
89		90-09107	INSULATOR	1	
90		90-09138	WIRE, BUSS, 22 AWG	A/R	
91		90-10011	TIE WRAP, 4"	1	
		1	C3, 5, 6, 7, 10-22, 24, 26, 28, 30 32, 35, 36		
		2	C4, 9, 23, 25, 27, 29, 31, 33, 34, 37, 38		
		3	CR1, 3-5, 7-12, 14, 16-18, 20, 21, 23-36, 38-44		
		4	R13, 38, 41, 42, 67		
		5	R7, 29, 30, 32, 50, 73, 74		
		6	R4, 14, 23, 31, 65, 77, 91		
		7	R21, 24, 25, 28, 40		
		8	R5, 11, 12, 17, 18, 20, 37, 39, 43, 44, 55, 62, 68, 69, 75, 81, 84, 85, 88, 90		
		9	R10, 15, 16, 19, 34, 36, 53, 57, 64, 72, 76		
		10	R6, 35, 45, 46, 54, 59, 60, 63, 71, 82 (See below for High Energy - Option)		
92	C19	02-12346-00	CAPACITOR, .1/50V	1	B
93	R59	02-06109-00	RESISTOR, 1/4W, 5%, CF, 51K	1	B
94	R82	02-06135-00	RESISTOR, 1/4W, 5%, CF, 620K	1	B

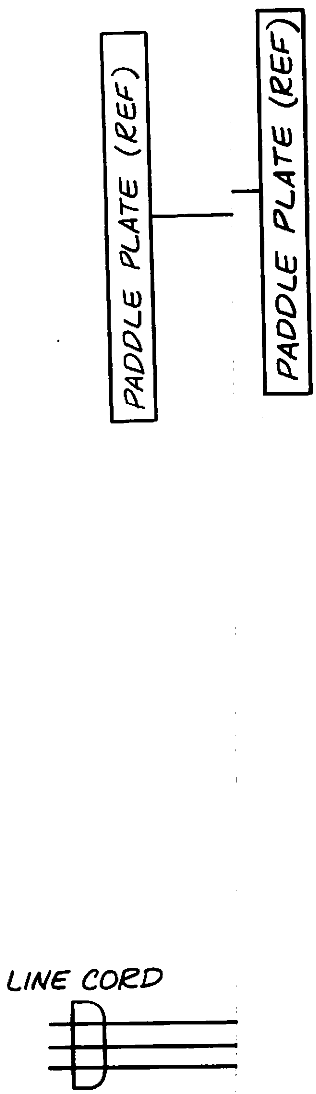


09—00284

ure 5-12 Battery/Pak Charger Final Assembly

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-12					
1		09-00284-08	FINAL ASSY, BATTERY CHARGER (115V)	REF	A
		09-00288-06	FINAL ASSY, BATTERY CHARGER (220V)	REF	B
2		04-50084-06	ASSY, WIRE HARNESS	1	
3		01-41552-2	BRACKET, HEATSINK	1	
4		02-35179-00	CLIP, PRESS HPC-25 HALF	4	
5		02-20190-00	CONN, 110V (CSA LISTED)	1	A
6		01-41527-4	CHASSIS, CHARGER	1	
7		01-41522-06	ENCLOSURE, TOP	1	
8		01-41523-4	ENCLOSURE, BOTTOM	1	
9		02-22040-0	FUSE AGC 1/2 AMP	1	A
10		02-22046-0	FUSE, AGC 1/4 AMP	1	B
11		01-50255-0	LABEL, CLA STICKER	1	A
12		01-50316-02	LABEL, DANGER	1	
13		01-50318-00	LABEL, CAUTION	1	
14		01-50328-01	LABEL, WARNING	1	
15		01-50330-00	LABEL, 12 VDC	1	
16		01-50335-02	LABEL, FUSE .25 AMPS	1	B
17		800417-00	LABEL, FUSE 1/2 AMPS	1	A
18		800518-00	LABEL, CSA, SER. NO.	1	
19		02-35526-0	MTG, FOOT BLACK	4	
20		09-10447-1	KIT, WALL MTG.	2	
21		01-41530-09	PANEL, FRONT	1	
22		01-41565-3	PANEL, BACK	1	
23		800413-00	P.C.B., CHARGER	1	
24		05-00298-05	P.C.B., TEST LOAD	1	
25	J14	02-35493-0	JACK, PHONE	1	
26		01-41531-01	PLATE, PADDLE TEST	2	
27		01-41535-1	PLATE, RETAINER	2	
28		02-35481-0	PLUG, BANANA	4	
29	J5,9,11, 12,13	02-20245-0	SHELL, MOLEX 2 PIN	5	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-12					
30		02-34704-0	STRAIN RELIEF	1	
31		01-50334-0	TAG - SHIPPING	1	A
32		90-03019	KEPNUT, 4-40 x 1/4	3	
33		90-03021	KEPNUT, 6-32 x 1/4	21	
34		90-03004	NUT, 2-56 x 3/16 CP	4	
35		90-03014	NUT, 6-32 x 1/4	2	
36		90-03041	NUT, SPEED TINNERMAN, .187 DIA	5	
37		90-05016	RIVET, MILFORD BLK OXIDE #511X .250	4	
38		90-01030	SCREW, 4-40 x 5/16 FH, P, CP	9	
39		01-50325-00	LABEL, POWER CABLE	1	B
40		90-01058	SCREW, 6-32 x 3/8 BH, S, CP	5	
41		90-01064	SCREW, 6-32 x 3/8, FH, P, CP	4	
42		90-02064	SPACER, 6-32 x 11/16 HHS 8779, BRASS	2	
43		90-07061	TUBING, PVC TEMFLEX	A/R	
44		90-04001	WASHER, #2 I.T.	8	
45		90-04003	WASHER, FLAT, #3	4	
46		90-04010	WASHER, FLAT #6	11	
47		90-06074	LUG, TAB #6	1	



04–50084

Battery/Pak Charger Wire Harness Assembly

5-58/5-59

May 1978

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-13					
1		04-50084-06	ASSY, WIRE HARNESS, CHARGER	REF	
2	CR5	02-14176-00	L.E.D., AMBER	1	
3	CR2,4	02-14178-00	L.E.D., GREEN	2	
4	CR1,3	02-14177-00	L.E.D., RED	2	
5	F1	02-22054-00	FUSE BLOCK (CSA LISTED)	1	
6	J3	02-20208-00	3 PIN MOLEX SHELL	1	
7	J10	02-20210-00	5 PIN MOLEX SHALL	1	
8	J1,8	02-20245-00	2 PIN MOLEX SHELL	2	
9	J2	02-20360-00	7 PIN MOLEX SHELL	1	
10	S1	200010-00	SWITCH, 115-230V (CSA LISTED)	1	
11	T1	02-18214-03	TRANSFORMER (CSA LISTED)	1	
12		02-20241-00	CONTACTS, MINI MOLEX	27	
13		02-35186-00	BLACK TRIANGLE	5/250	
14		02-35527-00	CONTACT	2	
15		02-35528-00	HOUSING, RECEPTACLE	2	
16		90-06069	LUG, RING #6 RED	7	
17		90-06070	TERMINAL, #2, RED, RING	3	
18		90-06073	TERMINAL, #2, BLUE, RING	1	
19		90-07059	TUBING, #4	A/R	
20		90-07060	TUBING, #6	A/R	
21		90-08037	TAPE, ID, "A", "B"	A/R	
22		90-10001	SPLICE, CLOSED END	1	
23		90-11012	H.V. WIRE, CONSOLIDATED #4624	A/R	
24		800553-00	CORD, PWER, 18 AWG -3 (CSA LISTED)	8'6"	
25		90-1105X	WIRE, UL, 22 AWG	A/R	
26		90-11079	WIRE; UL, 18 AWG	A/R	
27		90-06034	LUG, QUICK DISCONNECT	1	
28		90-11100	WIRE, BLACK	A/R	

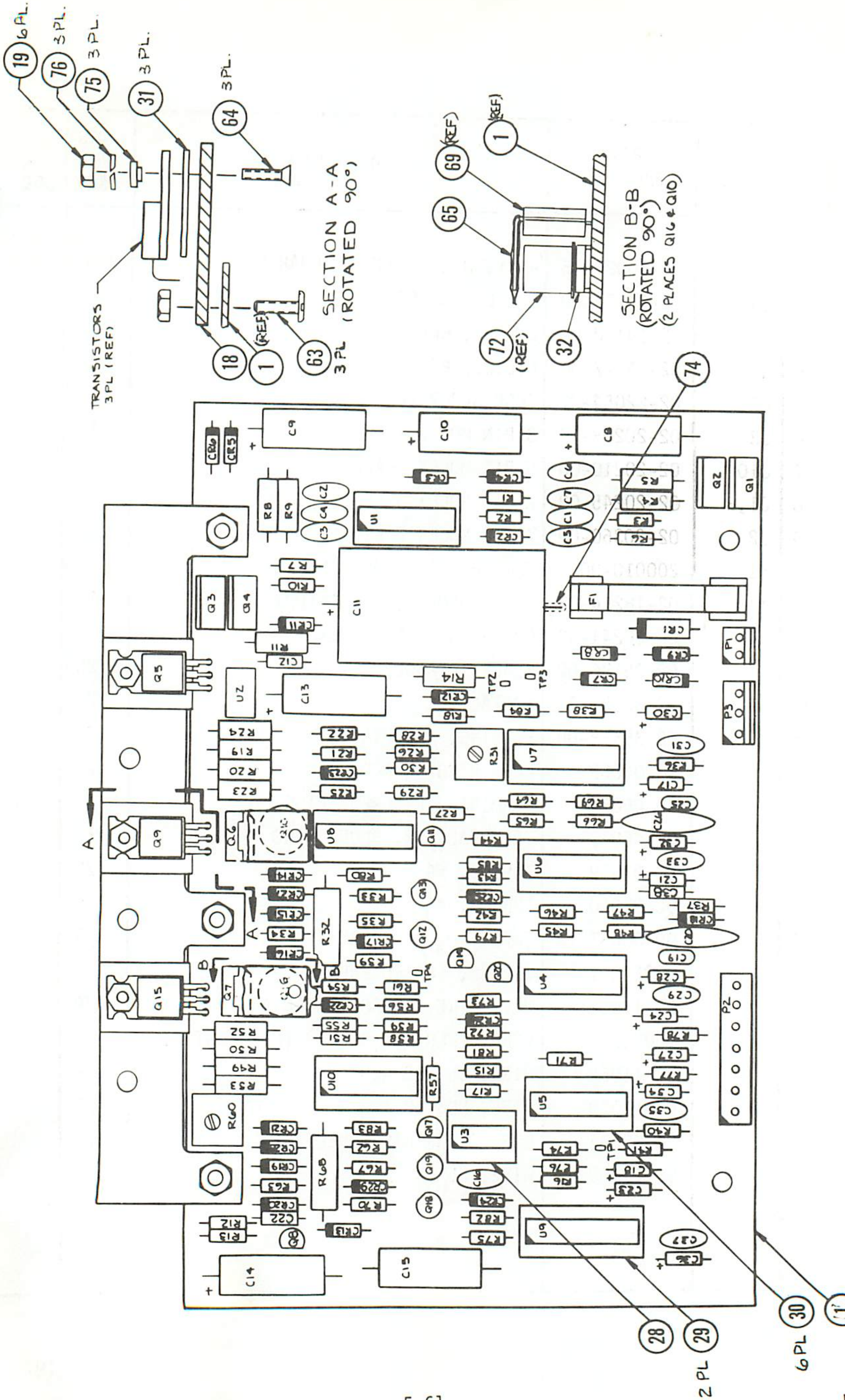


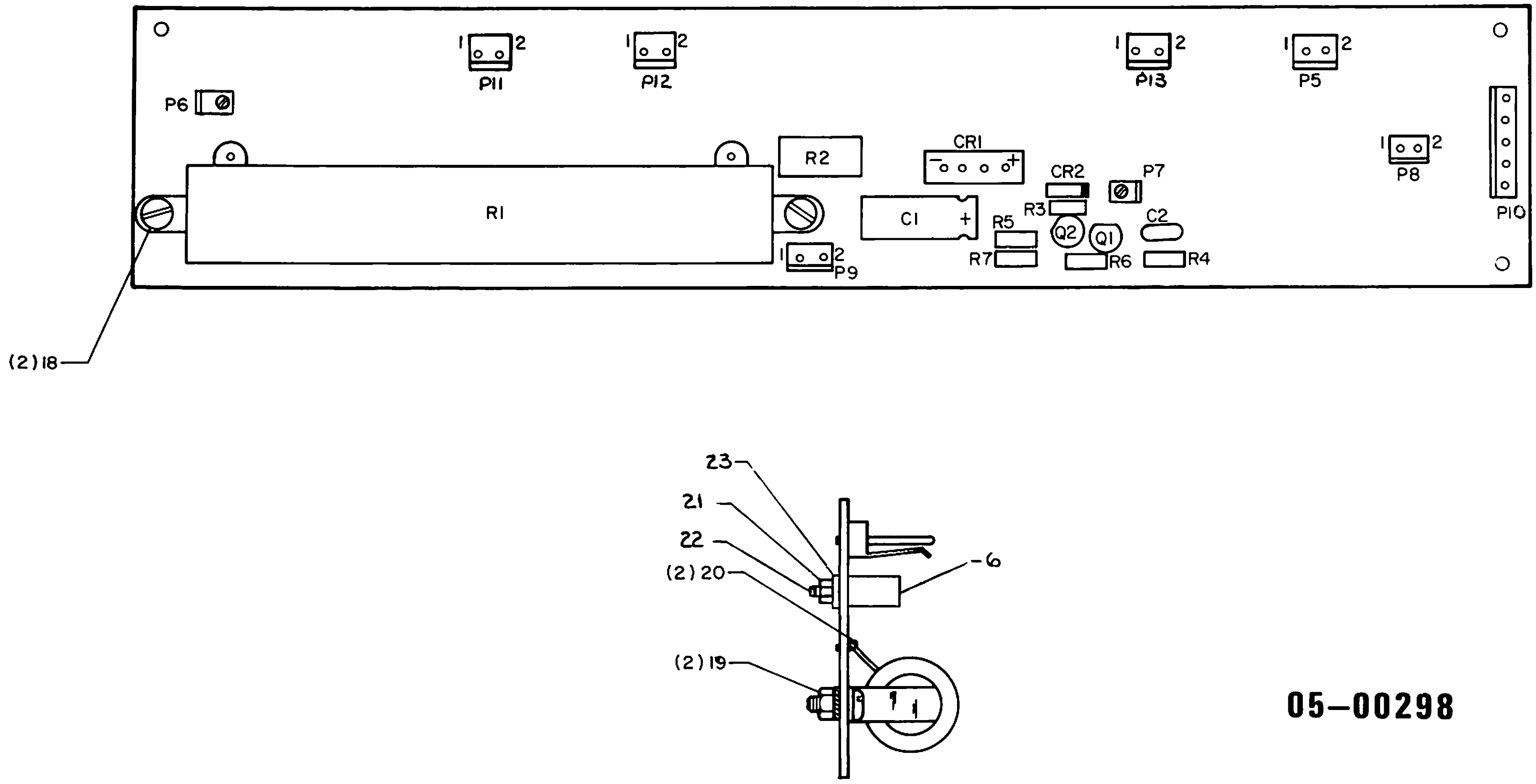
Figure 5-14 Battery/Pak Charger PCB Board Assembly

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-14					
1		800413-00	PCB ASSY - BATTERY CHARGER	REF	
2	1.	02-12048-00	CAPACITOR, .01/500	13	
3	C20,26	02-12054-00	CAPACITOR, .05/500	2	
4	C19,25	02-12346-00	CAPACITOR, .1/50	2	
5	C12,17, 21,23, 27	02-12600-00	CAPACITOR, TANT, 1.0/50	5	
6	2.	02-12606-00	CAPACITOR, TANT, 2.2/20	7	
7	C8,9, 10,13, 14	02-12654-00	CAPACITOR, 100/25	5	
8	C22,38	02-12081-00	CAPACITOR, .1/50V	2	
9	C11	02-12736-00	CAPACITOR, 1000/50	1	
10	C15	02-12742-00	CAPACITOR, 5.0mf ± 5%	1	
11	3.	02-14002-00	DIODE, 1N4385	6	
12	CR1	02-14016-00	DIODE, 30S6	1	
13	4.	02-14018-00	DIODE, 1N914B	17	
14	CR3,4, 5,6	02-14152-00	DIODE, MR812	4	
15	CR11	02-14153-00	DIODE, ZENER 28V, 1N4750A	1	
16	F1	200018-00	FUSE, 2 AMP	1	
17		02-35464-00	FUSE FLIP	2	
18		800447-00	HEATSINK	1	
19		90-03001	HEX NUT, 4-40 x 3/16	6	
20	U1	02-14438-00	I.C., NE556	1	
21	U2	02-14425-00	I.C., MC7815	1	
22	U3	02-14359-00	I.C., LM555	1	
23	U4	02-14440-00	I.C., CD4011	1	
24	U5	200252-00	I.C., CD4001B	1	
25	U6	02-14439-00	I.C., CD4013	1	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-14					
26	U7,9	02-14441-00	I.C., CD4040	2	
27	U8,10	02-14410-00	I.C., 1M324	2	
28		02-20248-00	I.C. SOCKET, 8 PIN	1	
29		02-20266-00	I.C. SOCKET, 16 PIN	2	
30		02-14311-00	I.C. SOCKET, 14 PIN	6	
31		90-09107	INSULATOR	3	
32		90-09097	MOUNT, TRANSISTOR, TO-5	2	
33	P1	02-20323-00	MOLEX CONN., 2 PIN	1	
34	P2	02-20328-00	MOLEX CONN., 7 PIN	1	
35	P3	02-20324-00	MOLEX CONN., 3 PIN	1	
36	R31,60	02-11580-00	POT, 1 TURN, 5K	2	
37	R1,2, 37,74	02-06099-00	RESISTOR, C.F., 5%, 1/4W, 20K	4	
38	R4,5, 8,9	02-09045-00	RESISTOR, C.C., 5%, 1/2W, 200	4	
39	R11	02-09058-00	RESISTOR, C.C., 5%, 1/2W, 680	1	
40	R15,17	200055-468	RESISTOR, 1%, RN55, 750K	2	
41	R18,42 71	02-06092-00	RESISTOR, C.F., 5%, 1/4W, 10K	3	
42	R19,20, 49,50	02-09073-00	RESISTOR, C.C., 5%, 1/2W, 3.0K	4	
43	R21,25, 51,55	02-07537-00	RESISTOR, 1%, RN55, 15,0K	4	
44	5.	02-06037-00	RESISTOR, C.F.,5%, 1/4W, 51	8	
45	R81	02-06020-00	RESISTOR, C.F., 5%, 1/4W, 10	1	
46	6.	02-06068-02	RESISTOR, C.F., 5%, 1/4W, 1.0K	15	
47	R80,83	02-06079-00	RESISTOR, C.F., 5%, 1/4W, 3.0K	2	
48	R35,39, 67,70	02-06103-00	RESISTOR, C.F., 5%, 1/4W, 30K	4	
49	R45,64	02-06108-00	RESISTOR, C.F., 5%, 1/4W, 47K	2	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-14					
50	R47,66	02-06116-00	RESISTOR, C.F., 5%, 1/4W, 100K	2	
51	R43,72	02-06128-00	RESISTOR, C.F., 5%, 1/4W, 330K	2	
52	R28,61	02-06132-00	RESISTOR, C.F., 5%, 1/4W, 470K	2	
53	R33,62	02-06137-00	RESISTOR, C.F., 5%, 1/4W, 750K	2	
54	R36,41, 75,78	02-06140-00	RESISTOR, C.F., 5% , 1/4W, 1.0M	4	
55	R30,59	02-07539-00	RESISTOR, 1%, RN55, 8.66K	2	
56	R22,26, 54,56	02-07544-00	RESISTOR, 1%, RN55, 110K	4	
57	R14	02-09056-00	RESISTOR, C.C., 5%, 1/2W, 560		
58	R27,57	02-07550-00	RESISTOR, 1%, RN55, 34.8K	2	
59	R29,58	02-07570-00	RESISTOR, 1%, RN55, 150K	2	
60	R24,53	02-09059-00	RESISTOR, C.C., 5%, 1/2W, 750	2	
61	R23,52	02-09169-00	RESISTOR, C.C., 5%, 1/2W, 1.5	2	
62	R32,68	200213-00	RESISTOR, C.C., 5%, 1W, 1.5K	2	
63		90-01021	SCREW, #4-40 x 3/8, BH, S, CP	3	
64		90-01019	SCREW, #4-40 x 3.8, FH, P, CP	3	
65		90-07012	SHRINK TUBE	A/R	
66	TP1,2, 3,4	01-41605	TEST POINT	4	
67	Q1,3	02-14625-00	TRANSISTOR, TIP32A	2	
68	Q2,4,5	02-14603-00	TRANSISTOR, TIP31A	3	
69	Q6,7	02-14569-00	TRANSISTOR, D41D5	2	
70	Q8,11, 14,17, 20	02-14541-01	TRANSISTOR, PN3962	5	
71	Q9,15	02-14623-00	TRANSISTOR, TIP30A	2	
72	Q10,16	02-14503-00	TRANSISTOR, 2N2102	2	
73	Q12,13, 18,19	02-14542-00	TRANSISTOR, PN2484	4	

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-14					
74		90-07039	TEFLON SLEEVE #18	A/R	
75		02-35506-00	WASHER, SHOULDER	3	
76		90-04061	WASHER, #14 SPLIT, LOCK MED	3	
		1.	C1,2,3,4,5,6,7,16,29,31,33,35,37		
		2.	C18,24,28,30,32,34,36		
		3.	CR7,8,9,10,22,23		
		4.	CR2,12,13,14,15,16,17,18,19,20,21,24, 25,26,27,28,29		
		5.	R3,6,7,10,79,82,84,85		
		6.	R12,13,16,34,38,40,44,46,48,63,65,69, 73,76,77		



05-00298

Figure 5-15 Battery/Pak Charger Test Load

FIG AND ITEM No.	REF. DES.	PCC PART No.	DESCRIPTION	UNITS PER ASSY	USED ON CODE
5-15					
1		05-00298-5	ASSY - TEST LOAD PCB	REF	
2	C2	02-12048-0	CAPACITOR, .01uf/500V	1	
3	C1	02-12654-0	CAPACITOR, 100uf/25V	1	
4	CR1	02-14011-0	DIODE, BRIDGE	1	
5	CR2	02-14175-0	DIODE, 1N3518	1	
6	P6,7	90-06074	LUG, SPADE	2	
7	P5,8,9, 11,12, 13	02-20323-0	CONNECTOR, MOLEX (2 PIN)	6	
8	P10	02-20326-0	CONNECTOR, MOLEX (5 PIN)	1	
9	Q2	02-14542-0	TRANSISTOR, EN2484	1	
10	Q1	02-14606-0	TRANSISTOR, 2N2907A	1	
11	R1	01-09632-0	RESISTOR, W.W., 50W, 50 ohm	1	
12	R4	02-06024-0	RESISTOR, CF, 1/4W, 5%, 15 ohm	1	
13	R7	02-06048-0	RESISTOR, CF, 1/4W, 5%, 150 ohm	1	
14	R3	02-06058-0	RESISTOR, CF, 1/4W, 5%, 390 ohm	1	
15	R5	02-06060-0	RESISTOR, CF, 1/4W, 5%, 470 ohm	1	
16	R6	02-06068-0	RESISTOR, CF, 1/4W, 5%, 1K	1	
17	R2	02-09593-0	RESISTOR, W.W., 5%, 2W, .39ohm	1	
18		90-01053	SCREW, 6-32 x 1/4, BH	2	
19		90-03021	KEPNUT, 6-32 x 1/4	2	
20		90-09138	BUSS WIRE, 22 AWG	A/R	
21		90-03019	KEPNUT, 4-40 x 1/4	2	
22		90-01040	SCREW, 4-40 x 5/16, PH	2	
23		90-04060	WASHER, #4 FLAT	2	