1. INTRODUCTION

The Dynaload is a precision instrument which simulates electrical loads to test power supplies, generators, servo systems, batteries, and similar electrical power sources. It simulates, at the option of the user, resistive loads (amps/volt) or may be switched to a constant current load characteristic (current regulated at a preselected value) or a constant voltage type of load (similar to a battery or a zener diode.) Provision is also made for external programming in automated test set-ups. The external programming voltage is from 0-6V with an input impedance of 5K minimum. Load current is directly proportional to programming voltage and the sensitivity is adjustable with the front panel current adjustments.

2. SPECIFICATIONS

The following ratings apply:

Load Voltage: 0-50V

Load Current: 0-60A

Power Dissipation: 1-1000W

Overload Rating: 10%

Self-Protection: Overvoltage: Less than 60V
Overcurrent: Less than 65A
Overpower: Less than 1300W

Mode Selector Switch Positions: From left to right

Position # 1: Constant resistance 0-1 A/V as determined by the front panel DC load adjust.

Specifications Continued

Position #2: Constant resistance 0-10 A/V as determined by the front panel DC load adjust.

Position #3: Constant current 0-10A as determined by the front panel DC load adjust.

Position #4: Constant current 0-60A as determined by the front panel DC load adjust.

Position #5: Constant voltage load. In this position, the load is similar to a battery being charged or a constant voltage zener diode; i.e., no current is drawn until the source voltage reaches the regulating voltage. The voltage at which theDynaload regulates is adjustable by the front panel volts control.

Position #6: External modulation- Will program from 0-60A with 0-6V applied to the external modulation terminals (TB-1). Modulation sensitivity is directly adjustable by the front panel DC load adjust control.

Position #7: A square wave pulse load which may be varied from 0-50A and 500-5,000 Hz as desired by the front panel Pulse Control.

Position #8: A short circuit which is applied in series with the ammeter across the input allowing short circuit current tests.

Front Panel Controls:

S115: AC on-off switch and indicator lamp

M1: Load voltage range as selected by the voltmeter range selector switch, 0-6V, 0-18V, or 0-60V

M2: Load current range as selected by front panel current range select switch, 0-6A, 0-18A, or 0-60A

Caution: The meter range selector switch should always be maintained in the highest voltage or highest current position except when readings are being taken; i.e., although the meters have high overload capability, they may be damaged by overloads in the lower range positions.

CB-1: Load on-off circuit breaker. For absolute no load tests, this circuit breaker should be opened and the circuit breaker will automatically open in the event of an over-voltage, overcurrent condition; i.e., the circuit breaker is rated at 60A and will open up if more than 60A is sustained through the Dynaload. In the event that an overvoltage condition is applied, an overvoltage SCR will fire, protecting the Dynaload, and if the source has more than a 60A capability, the circuit breaker will open.

Note: When testing low current sources, it may be advisable to use am external fuse or circuit breaker to protect the source.

Provision is made to connect the load by front panel binding posts for load currents of less than 15A. In the event of load currents greater than 15A, the studs on the rear of the unit should be used.

Current Sample:

This is provided for measuring the pulse current amplitude when operating in the pulse mode. There will be approximately .0167 Volts for each amp of current.

Pulse: Sinc. Out, this is a pulse output, which is the same frequencey as the pulse load, and may be used to trigger an osciloscope.

Rear Panel Connections:

E+ : Plus load-Connect to positive terminal of source to be tested.

E- : Minus load-Connect to minus terminal of source to be tested.

TB1-1 : 0 to + 6V programming voltage input.

TB1-2 : Programming voltage return internally connected to the minus terminal of the Dynaload.

TB1-3 : +6V which may be used as a source for programming.

F101 : AC line fuse 1A SB

3. OPERATING INSTRUCTIONS

The following procedure is recommended for hooking up the Dynaload: The AC and DC Dynaload switches should be turned off so that the load is inherently disconnected. The meter range switches should be set in their maximum voltage and current positions, and the load ajustments controls should be set in the conterclockwise position. The mode selector switch should be set to the appropriate mode to be used. The Dynaload should be plugged into standard 115V, 50-60 Hz power* and connections should be made from the source to be tested to the appropriate load terminals of the Dynaload. (E+ and E- on the rear of the unit. Two terminals are provided in parallel for each polarity for simplified connections. Parallel + and - terminals are provided on the front panel for convenience but should only be used where the load currents are 15A or less.)

* Optional input voltage ranges are available.

If external modulation is to be used, the external programming voltage should also be connected. The AC-on switch should now be turned on and the AC-on indicator lamp should light. The DC-on circuit breaker should now be closed and the front panel Dynaload voltmeter should indicate the source voltage. If the circuit breaker kicks out or if there is no indication of source voltage, check the external hook-up wiring to see that it is of the proper polarity and that all connections are tight and secure. The load may now be increased by turning the load adjust controls slowly clockwise until the appropriate load is obtained. The meter range switches may be switched to the lower scale positions if greater accuracy is required, and external instrumentation may be used to obtain greater accuracy and eliminate the effects of leakage currents in the Dynaload or line voltage drops at high currents.

3.1 Constant Resistance Mode (Amps/Volt)

Two scales are provided: i.e., 0-1 A/V and 0-10 A/V. Minimum resistance on the 0-1 A/V is one ohm and minimum resistance on the 0-10 A/V is .lohm. Let us assume that we wish to test a 12V battery with a two ohm resistive load. We would accordingly set the mode selector switch to the 0-1 A/V position and connect the source as previously described.

After checking the initial readings of the meters, we would then adjust the voltmeter scale to the 0-18V scale and the ammeter scale to the 0-6A scale. We would then slowly turn the coarse and fine DC load adjusts to obtain the 6A load while monitoring the battery voltage on the front panel voltmeter. For precision settings at high load currents, it is desirable to use an external voltmeter connected at the source terminals to elimate the effects of lead drops.* Similarly, it may be desirable to use external ammeters for particular tests to supplement the scales of the Dynaload or for use at very low currents.**

The resistive load characteristics of the Dynaload simulate a pure resistance down to approximately 1 to 2V input; i.e., for a given resistance setting, the current is directly proportional to the voltage over wide dynamic ranges. In the very low voltages, the power transistors will saturate.

3.2 Constant Current Mode

Some power sources, such as variable power supplies, are rated at a fixed maximum load current and adjustable over a predetermined voltage range; i.e., 5-30V @ 20A. If the resistive load characteristic were used for this type of test, it would be necessary to reset the load each time the power supply voltage were changed in order to maintain the full load current. Accordingly, the following procedure should be used:

With the load adjustments turned counterclockwise and the DC load switch off and the Dynaload meters in their maximum voltage and current positions, switch the mode selector switch to the constant amperes position, 0-60A. Turn on the power source and the Dynaload and set the power source to the desired output voltage (let us assume 30V). Turn the coarse and fine DC load adjusts until 20A of load current is achieved. The power supply may now

* Lead drop at 50A may well be .25 to .5V if substantial lead lengths are used, and there is a moderate voltage drop internal to the Dynaload due to the circuit breaker and internal power wiring.

** There are minor leakage currents of a few MA in the Dynaload instrumentation which do not pass through the Dynaload ammeter (voltmeter current, voltage sensing network).

be programmed from 5-30V and the load current will be maintained constant at 20A. This constant current characteristic is maintained down to one or two volts or until the A/V exceeds ten; i.e., it will maintain 50A constant current down to less than 5V or 20A down to less than 2V,etc.

It should be noted that many solid state power supplies are designed for short circuit protection by internal current limiting and bendback, and accordingly, may not start up into a constant current type of load. Accordingly, the constant resistance characteristic should be used as a load when simulating short circuit protection and recovery of most solid state power supplies unless otherwise specified by the manufacturer.

3.3 EXTERNAL MODULATION

In the external mod mode, the Dynaload acts as a constant current load with the constant current proportional to the external voltage applied to TB1-1 and TB1-2. (TB1-2 is the return of the external modulating voltage and is internally connected to the negative lead of the Dynaload.)

The Dynaload will program from 0-60A as the external modulation voltage is programmed from 0-6V if the DC load adjustments are set in the maximum clockwise position. The programming sensitivity may be reduced proportionately by the front panel DC load adjust controls; i.e., turning the load adjust counterclockwise reduces the programming sensitivity. The input impedance of the external modulation terminals is approx. 5K ohms.

The transient response of the Dynaload is determined by the feedback loop characteristics of the constant current regulator to achieve precision programming.

3.4 PULSE MODE

In the pulse mode the Dynaload places a pulsating square wave load on voltage source. This pulse load may be varied from 0-50A peak current by the pulse amplitude control on the front panel. The frequency may be varied from approx. 500-5000 Hz by the pulse frequency contro on the front panel.
This pulse load may be superimposed on top of a constant DC load which may be selected by the DC load control on the front panel.

If the pulse is to be used down to a no load state the DC load controls should be turned fully counterclockwise. The maximum total of the pulse and DC load will be limited around 65A by the internal current limit protection.

3.5 SHORT CIRCUIT

This is for checking short circuit and recovery from a short. It places a short in series with the ammeter across the input.
It should not be used directly on a large capacative voltage source as the relay contacts may be welded shut.
For testing short circuit of a large capacative source the Dynaload should be placed in the 10 A/V position and the DC load adjust turned fully clockwise; then the short circuit button may be pressed.
The short circuit relay will cause the circuit breaker to trip if more than 60A of current is drawn.

3.6 CONSTANT VOLTS MODE

In the constant volts mode, the Dynaload acts as an adjustable power zener diode. The regulating voltage is programmable from approximately 2-50V by the front panel volts adjust control. The constant volts position is used to simulate a battery to a battery charger, or the Dynaload may also be used as a shunt voltage regulator for special applications.

3.7 POWER RATING

The Model DLP 50-60-1000 will dissipate 1000 W continuously. in order to assure that overheating does not occur, the rear of the Dynaload should be clear for the air intake and the air exhaust; i.e., the cooling air enters and leaves from the rear. If there is a heavy dust accumulation, the Dynaload should periodically be checked, and if the Dynaload is run on a continuous duty basis, the cooling fan should be oiled at six-month intervals by removing the small plug on the inner surface.

3.8 PROTECTIVE CIRCUITS

The Dynaload has internal current limiting at approximately 65A maximum and also has a circuit breaker which disconnects at somewhat over 60A. The Dynaload also incorporates reverse voltage protection by reverse diode; i.e., if the input is hooked up backwards, the source will be shorted and the circuit breaker will trip if the source current capability is sufficient. In the event that an overvoltage is applied to the Dynaload (approximately 55V), an overvoltage SCR will crowbar across the Dynaload, thereby protecting all internal circuits. If the source current is large enough, the front panel circuit breaker will trip. If the source should be damaged by a 60A load or is not short circuit proof, it may be desirable to incorporate an external fuse or circuit breaker to protect the source.

The voltage current product is also monitored to prevent an overpower condition from happenting. Accordingly, the current limit characteristics are set at approximately 65A, which are maintained to approximately 16V, at which time the current limit characteristic is reduced as the input voltage is increased, thereby limiting the maximum power which may be peogrammed into the Dynaload.

3.9 SPECIAL APPLICATIONS

The Dynaload may be used for AC load testing within its ratings by the use of an external bridge rectifier so that the Dynaload sees pulsating DC but the AC source sees an AC load. The effect of the rectifier is to slightly distort the Dynaload characteristics at low voltages and currents. The Dynaload is not normally recommended for testing AC sources above 60 cycles due to its limited speed of response unless the user specifically recognizes the load characteristics at higher frequencies.

The Dynaload may also be used as a current or voltage regulator rather than a load for special applications as illustrated in Sections 3.2 and 3.6.

4.CALIBRATION PROCEDURES

4.1 VOLTMETER CALIBRATE

With the Dynaload set for no load, place an external calibrated voltmeter across the input terminals of the Dynaload and program the input voltage to obtain 5, 15, and 50A, respectively. With the voltmeter range selector switch in the 6V position and 5V applied, adjust resistor R32 so that the front panel voltmeter reads 5. With the meter selector switch in the 18V position and 15V applied, adjust resistor R34 until the front panel voltmeter reads 15. With the meter range selector switch in the 60V position and 50V applied, adjust resistor R36 until the front panel meter reads 50.

4.2 AMMETER CALIBRATE

Use an external 5V source and an external ammeter for calibration. Turn the Dynaload adjust to the minimum counterclockwise position and set the mode selector switch to the constant current 0-60A position. With the ammeter range selector switch at 6A, increase the load until the external ammeter reads 5A. Adjust resistor R38 so that the front panel ammeter also reads 5A. Switch the ammeter selector switch to 18A and adjust the load current until the external ammeter reads 15A. Adjsut resistor R40 until the front panel ammeter also reads 15A. With the ammeter range selector switch set at 60A, increase the load current to 50A as indicated on the external ammeter and adjust resistor R42 unti the front panel ammeter also reads 50A.

4.3 AMPERES PER VOLT CALIBRATE

With the Dynaload in the 0-1 A/V position and the DC load adjust in the maximum clockwise position, apply a voltage of 5V to the input terminals of the Dynaload and adjust the A/V calibrate potentiometer R54 so that between 5 and 5.5A of load current is obtained.

With the Dynaload in the 0-10A/V position and the load adjust in the maximum clockwise position apply a voltage of 5V to the input terminals of the Dynaload and adjust the 10 A/V calibrate potenttiometer R30 so that between 50 and 55 A of load current is obtained.

Note: Make sure that the current limit setting is not interacting in any way.

4.4 CURRENT CALIBRATE

Set the mode selector switch to the 0-10A constant current position. Using a 5V source, turn the DC load potentiometer in the maximum clockwise position and adjust resistor R56 to obtain between 10 and 11A.

Set the mode selector switch to the 0-60A constant current position. Using a 5V source, turn the DC load potentiometer in the maximum clockwise position and adjust resistor R19 to obtain between 60 and 65A.

Note: Make sure that the current limit setting is not interacting in any way.

4.5 CURRENT LIMIT CALIBRATE

Place the Dynaload in the 0-10 A/V position. Using a 10V source increase the load current to approximately 65A or until current limiting is achieved. Readjust resistor R50 as appropriate.

4.6 OVERPOWER PROTECTION

Apply a 50V source to the Dynaload and increase the load current either to its maximum counterclockwise position or 25A, whichever occurs first. Adjust R7, the bendback resistor, to limit the current at 50V to between 21 and 25A.

5. THEORY OF OPERATION

5.1 INPUT CIRCUITS

A schematic diagram is shown in Figure 1. AC power is applied through the line cord, through fuse F101 and AC on-off switch

S115 to the AC indicator lamp, blowers B101 and B102, and the primary of transformer T1 thru CB101 when in "on" position. The secondary of T1 is rectified and filtered in both the positive and negative directions compared to the center tap, generating approximately +25V and -25V on capacitors C1 and C2, respectively. The negative voltage is regulated to 5.6V by constant current source transistor Q5 and associated components R12, VR7, R13, and zener diode VR6. The +25V is regulated to +16V by constant current source transistor Q1 and its associated components R1, VR5, and R2 and zener diodes VR2 and VR3, which generate +16 and +8V.

5.2 0-1 A/V Mode

The input voltage is divided through a divider consisting of R24, R54 and the DC load adjust controls R125A & R125B. A portion of the input voltage is fed through R49 to the non inverting input of U1 (Pin 5).

The inverting input of U1 (Pin 4) is connected thru R27 to the top of Shunt SH 101 (+).

As R125 is turned clockwise the non inverting input (Pin 5) becomes more positive than inverting input (Pin 4) causing U1 to turn on its output transistor allowing current to flow from VC (Pin 11) to Vout (Pin 10) which in turn drives Q101 & Q102 and consequnetly the pass transistors Q103-Q122.

As current flows through the pass transistors the top of SH101 (+) becomes more and more positive until the voltage at pin 4 becomes equal to that at pin 5 causing U1 to regulate the drive to the pass transistors.

As the input voltage rises the voltage at pin 5 rises proportionaly causing more current to flow until the voltage drop across SH101 is high enough to create an equilibrium between the inverting and non inverting inputs of U1.

The maximum voltage that can be applied to the non inverting input is limited by resistors R24 and R54 so that only approximately one amp of current can be drawn for each volt at the input.

5.3 0-10 A/V Mode

In this position the circuit operates the same as in the 0-1 A/V mode with the exception that the input voltage is now devided by R23, R30 and R125. This new divider allows more voltage to be applied to the non inverting input of U1 (Pin 5) causing a much higher current to flow through shunt SH101 before the voltage at the inverting input is sufficient to cause U1 to regulate the pass structure.

R23 and R30 are set so that about 10A of current can be drawn for each volt of input.

5.4 0-10A Mode

An internal voltage reference (5V) is generated by series dropping resistor R14 and zener diode VR8 which in turn is reduced by the voltage divider network of R56, R21 and R125A & B. A portion of this voltage determined by the DC load adjust control is fed into the non inverting input of U1 (pin 5).

The inverting input (pin 4) is connected to the top (+) of shunt SH101.

The pass structure is turned on by U1 until the voltage drop across the shunt is sufficient to equalize the voltage on the inverting and non inverting inputs of U1.

These two points are controlled only by the voltage reference supplied to pin 5 and the current through the shunt, which means a

5.7 EXT Mod MODE

The ext. mod. mode provides for the use of an external voltage reference in place of zener diode VR8 when external modulation or programming of the Dynaload is desired. The coarse and fine DC load adjusts on the front panel can then be used to define the programming sensitivity of the external modulation signal.

5.8 Pulse

This mode converts the dynaload into a pulse load, which may be varied in amplitude and frequency as well as superimposed upon a fixed DC load.

The pulse is generated by a unijunction oscilator circuit. The frequency is varied by R126B, pulse frequency control, which controls the charging rate of C9. The output of this oscilator is used to trigger a bistable multivibrator Q8-Q9. The output of the multivibrator is taken from the collector of Q9 and fed to R126A the pulse amplitude control. This feeds a portion of the pulse to the base of Q11, and emmiter follower which then pulses the non-inverting input of U1 causing the pass structure to pulse. The DC load control is still connected as in the 0-60A mode and will operate in the same manner, with the pulse been added to the DC level at the non-inverting input. This allows the dynaload to draw a constant DC load and add a pulse load on top of it up to a total of 60A.

The sync output is provided by Q10 an amplifier which is fed from the collector of Q8 in the multivibrator. This causes the sync output frequency to coinside with that of the pulser.

5.9 Short Circuit

This is a relay that places a short across the pass structure placing the ammeter directly across the input. This is done after the circuit breaker to prevent any current in excess of 60A.

If the relay is energised when a large capacative source is connected to the input it may cause the relay contacts to'weld'together. If this occurs it may be necessary to separate and clean them. To prevent this from occuring, the DC load should be increased to maximum current and the relay then energised by the short circuit button.

5.10 Current Limit Protection

The voltage proportional to load current generated across SH1 is applied through R7 to the base of transistor Q3. The voltage reference generated by zener diode VR8 is reduced by divider network R15-R50 (current limit adjust) and applied to the base of transistor Q4. Accordingly, Q4 will normally conduct, thereby turning on transistor Q2 and permitting it to drive the Dynaload. When the load current reaches the current limit point, transistor Q3 conducts, thereby turning off transistor Q4, which turns off transistor Q2, and restricts the drive to the Dynaload in a constant current regulating characteristic. It should be noted that zener diode VR1 begins to conduct when the input voltage is approximately 16 V and accordingly R5-R6-R7 divider network comes into play as the voltage is increased by adding a voltage to the current signal so that the current limit point is reduced as the input voltage rises. To make a more accurate constant power curve VR4 is introduced when the voltage across R6-R7 reaches approximately 8.2 V. This draws some of the introduced signal away from Q3 preventing excessive reduction in the current limit point at high voltages. This results in approximately a constant power limitation; i.e., the Dynaload is rated at 60A up to 17V, and the bendback is normally set so that at 50V input, it is impossible to draw more than 25A.

5.11 Instrumentation Circuits

Range selector switches and calibrating resistors are provided front panel ammeter and voltmeter.

5.12 Overvoltage Protection

If the applied voltage exceeds approximately 55V, divider R44,R45, R46 (overvoltage adjust) causes Q6 to conduct thereby firing SCR101 which crowbars the output and trips circuit breaker CB-1. Reverse voltage protection is provided by CR6.

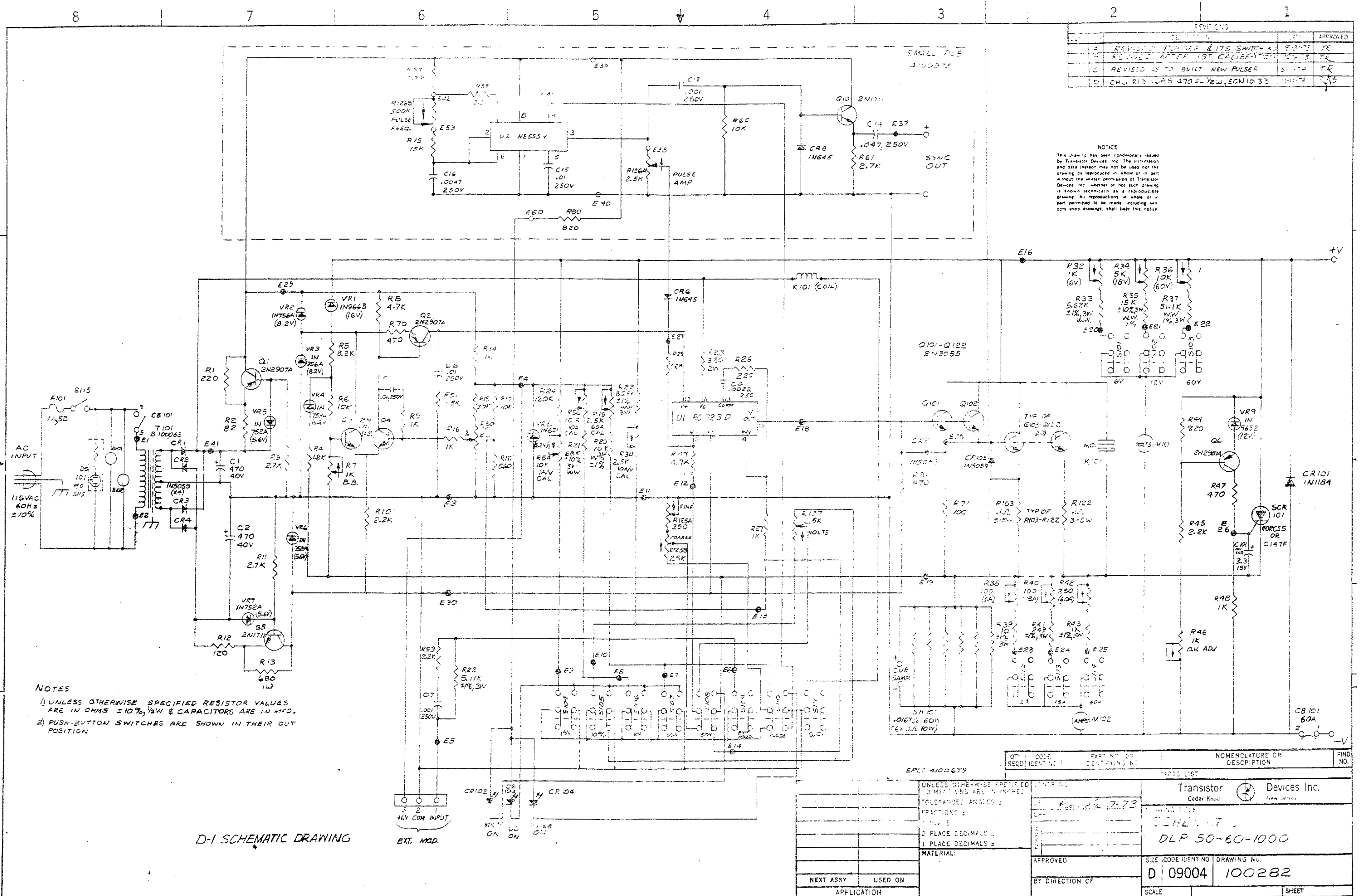
Component layout of the main printed circuit board is shown in Figure 2.

The componet layout of the pulser PCB is shown in Fig. 3.

SECTION REPAIR PARTS LIST (CONTINUED)

IT NO.	REF DESIG	(2) SMR CODE	NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION	USABLE ON CODE	(7) UNIT OF MEAS	(8) QTY INC IN UNIT	(9) SPC
						RESISTIVE LOAD BANK DLP 50-60-1000				
	B101 102			SP2A2	82877	BLOWER		EA	2	
	C1,C2		5910-00-342-3660	ET471X040A02	80031	CAP 770 MFD, 40V		EA	2	
				17461-S		AC LINE CORD		EA	1	
	C3,C6, C15*		5910-00-056-1620	C280AE/A10K	73445	CAP .01 MFD, 250V		EA	3	
	C4			C280AE/A2K2		CAP .0022 MFD, 250V		EA	1	
	C7,C12*			C280AE/A1K		CAP .001 MFD, 250V		EA	2	
	C14*		5910-00-080-5377	C280AE/A47K	73445	CAP .047 MFD, 250V		EA	1	
	C16*		5910-00-197-0192	C280AE/A4K7	73445	CAP .0047 MFD, 250		EA	1	
	C101		5910-00-868-6219	M39003/01-2268	81349	CAP 3.3 MFD, 15V		EA	1	
	CB101			UPL1-1REC2-5-1-603	74193	CIRCUIT BREAKER		EA	1	
	CR1-5, 105		5961-00-088-8792	IN5059	80131	DIODE		EA	5	
	CR101		5961-00-752-5395	IN1184	81349	DIODE		EA	1	
	CR102, 104		6240-00-213-7950	#5082-4480	28480	DIODE LED		EA	3	
	CR6 CR8*		5961-00-958-9213	IN645	96214	DIODE		EA	2	
	F101		5940-00-131-9816	MDL-1	71400	FUSE 1A, SB		EA	1	
	K101			MDD-24		RELAY NO		EA	1	
	M101			2-03		VOLTMETER		EA	1	
	M102			2-03		AMPMETER		EA	1	
	Q1,2,6			IN2907A		TRANSISTER		EA	3	
	Q3-5,10*		5961-00-852-5171	2N1711	81349	TRANSISTOR		EA	4	
	Q101-122		5961-00-985-9074	2N3055	80131	TRANSISTOR		EA	22	
	R1,26			RCR20G221KS		RES 220 1/2W 10%		EA	2	
	R2			RCR20G820KS		RES 82 1/2W 10%		EA	1	
	R3,11		5905-00-442-9574	RCR20G272KS	81349	RESISTER 2.7K 1/2W 10%		EA	2	
	R4		5905-00-407-4598	RCR20G182KS	81349	RES 1.8K 1/2W 10%		EA	1	
	R5			RCR20G822GS		RES 8.2K 1/2W 10%		EA	1	
	R6			RCR20G103KS		RES 10K 1/2W 10%		EA	1	
	R7,R32, 46,50		5905-00-134-9885	BK64201	11263	RES 1K, POT		EA	4	
	R8,49			RCR20G472KS		RES 4.7K 1/2W 10%		EA	2	
	R9,14, 16,27			RCR20G102KS		RES 1K 1/2W 10%		EA	4	
	R10,45, 53,57* 58*			RCR20G222KS		RES 2.2K 1/2W 10%		EA	5	
	R12			RCR20G121KS		RES 120 1/2W 10%		EA	1	
	R13			RCR32G681KS		RES 680 1W 10%		EA	1	
	R15			RCR20G392KS		RES 3.9K V2W 10%		EA	1	
	R15*			RCR20G153KS		RES 15K 1/2W 10%		EA	1	
	R17,60*			RCR20G103KS		RES 10K 1/2W 10%		EA	2	
	R18			RCR20G561KS		RES 560 1/2W 10%		EA	1	
	R19,30		5905-00-132-2564	BK64202	11236	RES 2.5K POT		EA	2	
	R20		5905-00-913-8342	RW79V1000F	81349	RES .10K 3W 1% WW		EA	1	
	R21			RW79V6800F		RES .68K 3W 10%		EA	1	
	R22		5905-00-997-8048	RW79V51110F	81349	RES 5.11K 3W 1%		EA	1	
	R23		5905-00-240-8319	RW79V8251F	81349	RES 8.25K 3W 1%		EA	1	
	R24			RCR20G124KS		RES 120K 1/2W 10%		EA	1	
	R25			RCR20G63KS		RES 56K 1/2W 10%		EA	1	
	R28			RCR42G1331KS		RES 330 2W 10%		EA	1	
	R31,47 78			RCR20G471KS		RES 470 1/2W 10%		EA	[illegible]	
	R33		5905-00-865-0361	RW79V5621F	81349	RES 5.62K 3W 1% WW		EA	1	
	R34		5905-00-132-2563	BK64203	11239	RES 5K POT		EA	1	
	R35		5905-00-132-0161	RS-2B	81349	RES 15K 3W 1% WW		EA	1	
	R36,R54		5905-00-001-8685	BK64204	11263	RES 10K POT		EA	2	
	R37		5905-00-069-9928	RN70D5112F	81349	RES 51.1K 3W 1% WW		EA	1	
	R38,R40			BK111-100	71450	RES 100 POT		EA	2	
	R39		5905-00-985-6317	RW79V10R0F	81349	RES 10 3W 1% WW		EA	1	
	R41		5905-00-903-8456	RW79V2490F	81349	RES 249 3W 1% WW		EA	1	
	R42		5905-00-001-8683	13K64199	11236	RES 250 POT		EA	1	
	R43		5905-00-901-7369	RW79V1001	81349	RES 1K 3W 1% WW		EA	1	
	R44		5905-00-215-5910	RCR20G821KS	81349	RES 820 1/2W 10%		EA	1	
	R51			RCR20G152KS		RES 1.5K 1/2W 10%		EA	1	
	R56			BK6204	11263	RES .1K POT BK6204		EA	1	
	R61*		5905-00-215-5899	RCR20G272KS	81349	RES 27K 1/2W 10%		EA	1	
	R71			RCR20G101KS		RES 100 1/2W 10%		EA	1	
	R80*		5905-00-215-5910	RCR20G821KS	81349	RES 820 1/2W 10%		EA	1	
	R103- R122			PW5		RES .1,5W 10%		EA	[illegible]	
	R125A			B100225		RES 250 POT		EA	1	
	R125B			B100225		RES 2.5K POT		EA	1	
	R126A			B100226		RES 2.5K POT		EA	1	
	R126B			B100226		RES 500K POT		EA	1	
	R127			WW-252		RES 2.5K POT		EA	1	
	S101- 103 112-114			65031K-206(3 PB)	82389	PB SWITCH		EA	1	

UNIT NO.	REF DESIG	(2) SMR CODE	NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION USABLE ON CODE	(7) UNIT OF MEAS	(8) QTY INC IN UNIT	(9) SPC
	S104-111			65081K-206(8 PB)	82389	PB SWITCH	EA	1	
	S115			LRSW-322N-125		SMALL ROCKER SWITCH	EA	1	
	SH101		5905-00-943-3692	RW68VR10	81349	RES .1 10W 5%	EA	6	
	SCR101			40RC5S/C147S		S C R	EA	1	
				10350-B-1032-4	06540	HANDLES	EA	2	
	TB1			601-Y-3	75382	TERMINAL BLOCK	EA	1	
	T101			B100062		TRANSFORMER	EA	1	
	V1			RC723D		1C	EA	1	
	V2*			RC555V		1C	EA	1	
	VR1		5961-00-903-8021	IN966B	81349	ZENNER DIODE	EA	1	
	VR2,3		5961-00-845-6458	IN756A	81349	ZENNER DIODE	EA	1	
	VR4		5961-00-719-4355	IN753A	01295	ZENNER DIODE	EA	1	
	VR5-7		5961-00-106-0520	IN752A	01281	ZENNER DIODE	EA	1	
	VR8		5961-00-866-5454	IN821	81349	ZENNER DIODE	EA	1	
	VR9		5961-00-892-1009	IN96313	01295	ZENNER DIODE	EA	1	
				RED DF-30		BINDING POST	EA	1	
				BLACK DF-30		BINDING POST	EA	1	
				GREEN DF-30		BINDING POST	EA	1	
				RED #1517		BINDING POST	EA	2	
				BLACK #1517		BINDING POST	EA	1	
				REC 209-S		RUBBER FEET	EA	4	
				P.S. 70D-3		CONCENTRIC KNOB TOP	EA	1	
				P.S. 95C-5		CONCENTRIC KNOB BOTTOM	EA	1	
			5355-00-472-9325	P.S. 95D-2	21604	SINGLE KNOB	EA	1	
				8519-PH-0632	09004	PHENOLIC SPACER	EA	1	
						*COMPONENTS ON PCB A100975 (PULSER)			



REVISIONS
A REVISED PULSER & 175 SWITCH
B REVISED AFTER 1ST CALIBRATION
C REVISED AS TO BUILT NEW PULSER
D CHG R13 WAS 470Ω 1/2W, ECN 10133
SMALL P.C.B.
SYNC OUT
PULSE FREQ.
PULSE AMP
115VAC 60Hz ±10%
AC INPUT
+V
-V
EXT. MOD.
NOTES
1) UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10%, 1/2W & CAPACITORS ARE IN MFD.
2) PUSH-BUTTON SWITCHES ARE SHOWN IN THEIR OUT POSITION
D-I SCHEMATIC DRAWING
EPL 4100679
Transistor Devices Inc.
Cedar Knoll New Jersey
DLP 50-60-1000
D 09004 100282
NEXT ASSY
USED ON
APPLICATION

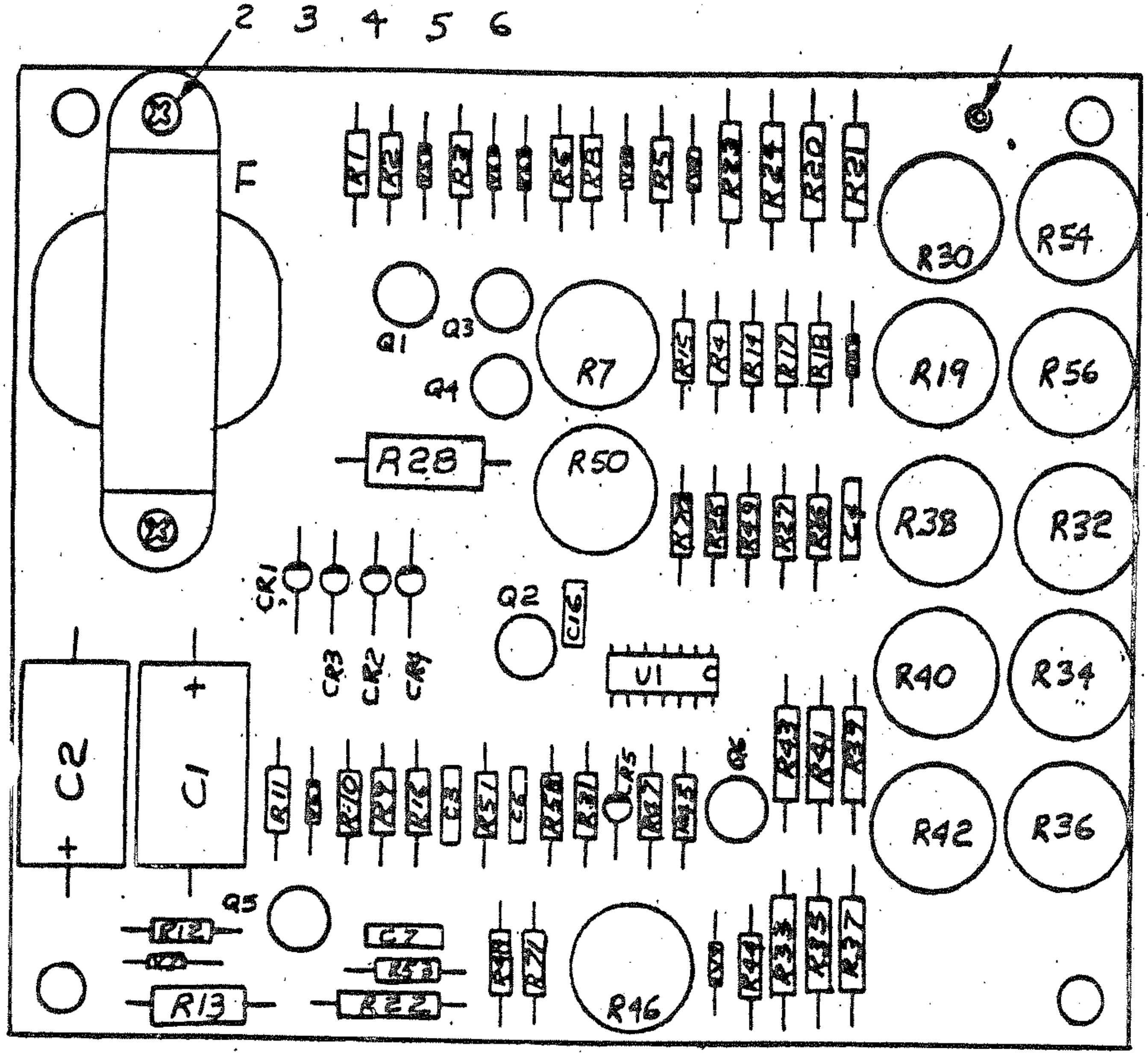


FIGURE D-2. MAIN PCB COMPONENT LAYOUT.

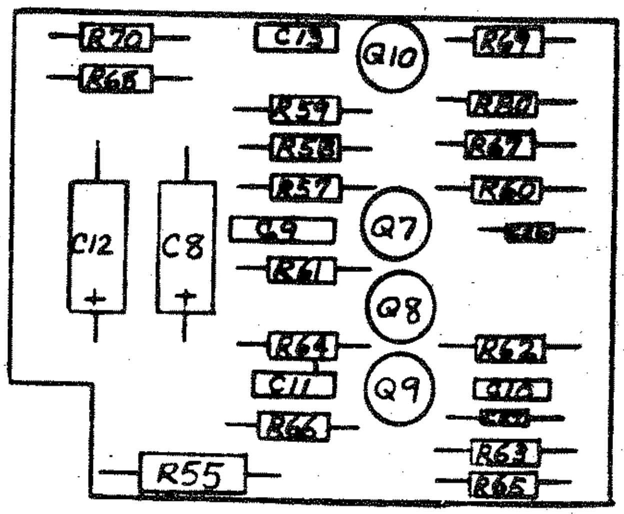


FIGURE D-3. PULSER PCB COMPONENT LAYOUT.