INSTRUCTION MANUAL

SSP-10

DIATHERMY MACHINE

Designed and Built by:

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360517-1-T = RL-2534

INTRODUCTION

The "SSP-10" (Solid State Power--10 watts) is a custom-designed diathermy machine designed for RF/DC hair removal. Operating is initiated by the footswitch, and control is either manual (foot) or automatic (timers). The unit is designed to provide 0-45 volts DC into "any" impedance (with built in current limiting for a maximum of about 6 m a). Automatic squelch is provided by a timer with a range of 0.1 second to 100 seconds. The RF section provides 0-60 volts peak into 200-300Ω (optimum) or about 9 watts. If current (RF m a) is to be properly monitored, the special four-wire probe (with current sampling resistor) must be used.

Caution Notes

The RF output will sustain "short term" short circuits (a few seconds), but long term shorts at high power will destroy the current sampling resistor and may produce lower lifetime of the power output transistor.

The DC section will sustain long term shorts.

Mixing of RF and DC signals is accomplished by first inserting a DC block capacitor at the tip of the RF probe and connecting the DC output to the tip of the DC block capacitor (see Fig. 1).

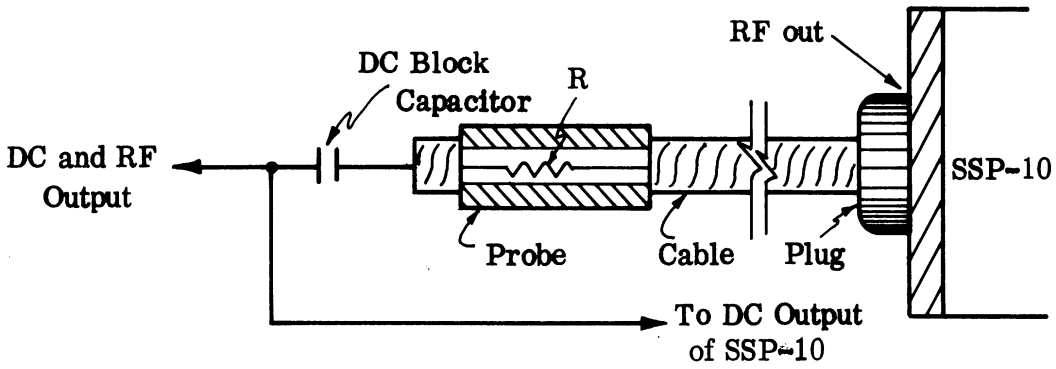


Figure 1

OPERATION

DC Output

Connect the proper plug and cable to the "DC Output" jack (amphenol plug No. 31-202; Mil. No. UG-88CU). Turn power switch ("line") to on. If the RF section is not to be used turn "RF trigger" to off. On the DC section, flip the "DC trigger" to "auto" or "man". "Man" will turn the DC on as long as the footswitch is closed. "Auto" will turn the DC on as long as the footswitch is closed, or the self timer runs out, whichever occurs first. Timing is accomplished by setting the "multiplier" to the proper range. (x1 provides 0.1 to 1.0 second; x10 is 1.0 to 10.0 seconds; x100 gives 10.0 to 100.0 seconds.) The "time" dial sets the time within the range as set by the multiplier. So time, T, is given by:

$$T = (t) \times M \quad ,$$

where t is time dial setting (continuous from 0.1 to 1.0),

M is multiplier dial setting (x1; x10; or x100).

The DC voltage is varied by the "level" control and is continuous from 0-45 volts. The output impedance is low (100 ohms), until current limiting results (attempt to draw more than 5 ma).

RF Output

The timing is obtained in the exact manner as outlined in the "DC Output" section above.

RF level control is accomplished by the "RF level" control and can be varied from zero to maximum. The actual RF current (calibrated in RMS) is shown on the "RF MA" meter (display is up to 500 ma RMS). About 300 ma is the maximum available current under any normal (or shorted) loading. The RF current is sampled at the probe tip by a 12 ohm resistor. Shielded

or unshielded loads may be used on the probe. The required plug for connection is an amphenol 126-217. If shielded leads are used the shield to the main RF output buss ("B" terminal on plug) may be grounded (to pin "D") or left floating (pin "C").

RF Probe Modification

Unshielded Leads

If unshielded leads are used, connect the probe as in the schematic "RF Ammeter and Output Circuit"; pins "D" and "C" may be left open (see Fig. 2).

2 Coax Lines

If 2 miniature coax lines are used, see the schematic and use pin "D" or pin "C" for shield of main ("B") (see Fig. 3).

1 Coax - 1 Balanced Shielded

Connect the coax shield to pin "D". Connect main center conductor to "B". On the balanced line, ground the shield to "D", and connect lines to "A" and "E". This should give maximum reduction of undesirable radiation but some reduction in power output if a high impedance coax (300Ω) is not available (Fig. 4).

CIRCUIT DESCRIPTION

The footswitch bounce action is removed by R_1 and C_1 in the Schmidt trigger circuit. The S. T. output drives the timer triggering circuits which properly connect and charge C 8 in the timer circuits.

The timers consist of a squelchable clock (IC 1), a staircase timer (IC 2), and a comparator (Latch (IC 3)). Upon resetting the latch (IC 3), IC 1 produces a square wave of frequency determined by C 9, 10, or 11. C 3, 4 and D 2, 3 and IC 2 produce a negative staircase at the "-" input

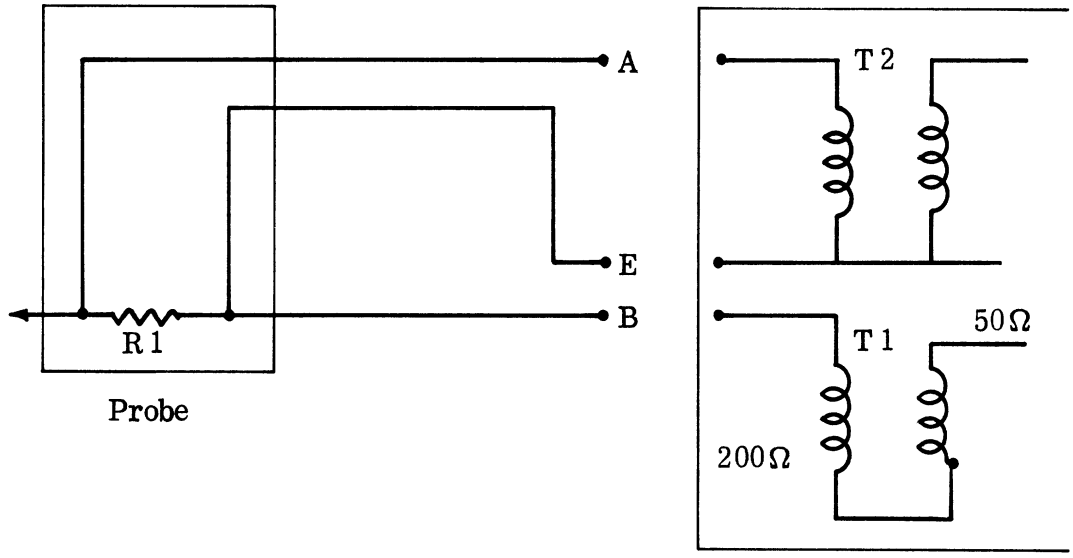


Figure 2: Unshielded Leads

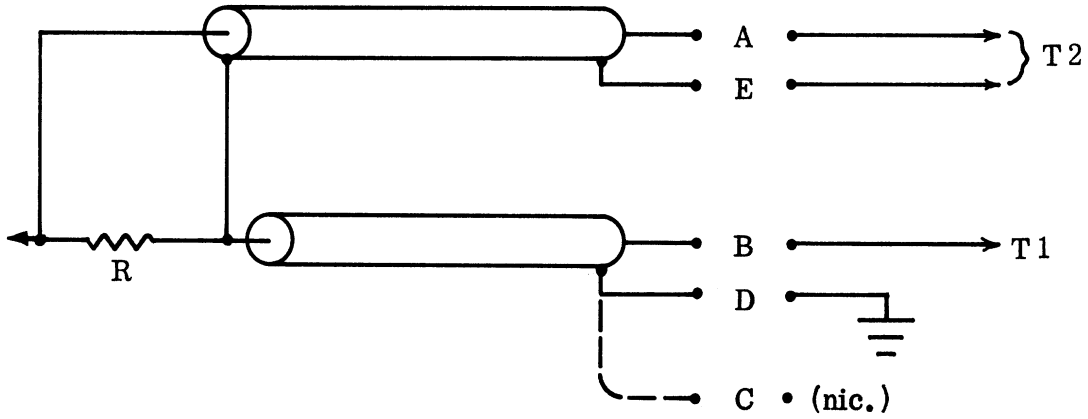


Figure 3: Two Coax Lines

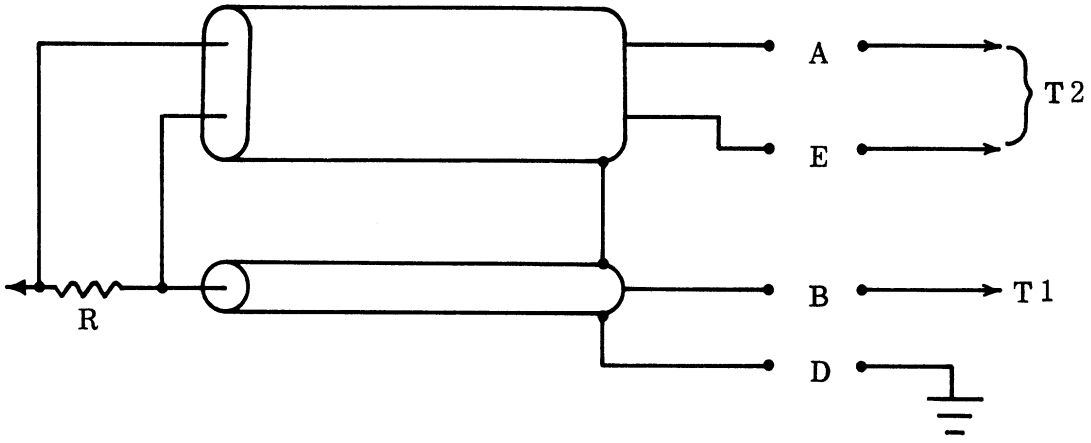


Figure 4: One Coax -- One Balanced Line

of the comparator (IC 3). The "time" dial establishes the voltage and time that IC 3 will flip states. If the voltage at pin 6 (IC 2) is more negative than V at R 14, IC 3 output will go to a positive (high) state. D 5 allows latching action and Q_1 discharges timing integrator C 4.

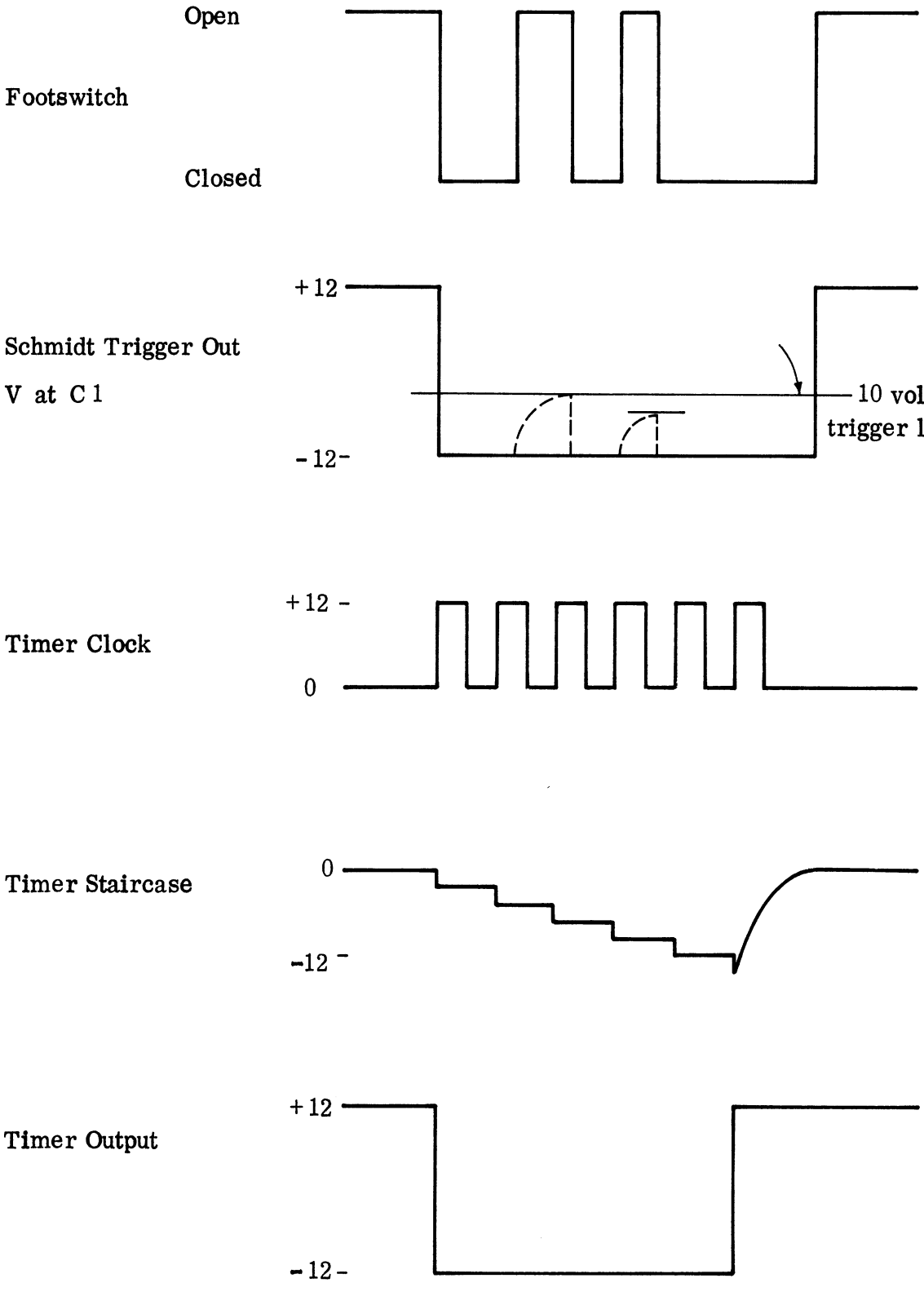
Squelch voltages are derived from the timer or Schmidt-trigger outputs (auto or manual, respectively) and turn off the DC output and RF oscillator when the outputs are high.

The DC power supply voltage is varied by R 24. Current limiting is performed by R 5 and Q 2. Q 3 squelches the DC output.

RF level adjusts the quiescent current in Q 3 and Q 2 in the oscillator, thus providing variable gain and output voltage.

The RF Power Amplifier is courtesy of RCA (RCA Solid State Power Circuits SP-52). It is designed to drive 50-75 ohm loads from 2-30 MHz. Impedance translation to 200 ohms is obtained by T 1 in the RF output circuit. RF output current reading is detected by R 1 and associated transformers and rectifier circuits. The chokes L 1 and L 2 remove RF voltage from the RF MA meter which floats on the RF output.

TIMER WAVEFORMS



SSP-10 CALIBRATION

I. RF Current Meter Calibration

Load = 330Ω 5 percent carbon resistor

RMS Milliamps[1]	SSP-10 RF MA Meter
108	100
99	90
89	80
79	70
70	60
59	50
50	40
38	30
28	20
17	10

II. RF Current Meter Calibration

Load = 150Ω (47 x 3 10 percent)

RMS Milliamps[1]	SSP-10 RF MA Meter
154	160 (*)
145	150
135	140
126	130
118	120
109	110
100	100
53	50

*Maximum undistorted current into 150 ohms.

III. Peak-to-Peak Voltage vs. Level Control

Load = 330Ω

Volts Peak-to-Peak[2]	RF Level
102	10
100	9
99	8
95	7
88	6
82	5
68	4
42	3
20	2
4.2	1
0.7	0

Notes: (1) Measured using Hewlett-Packard 8405A vector voltmeter with Tektronics P6022 current probe with termination (in 1 ma/mv position).

(2) Measured with Tektronics Model 545B oscilliscope (type "CA" plug in unit) with x 10 attenuator probe (P 6006 - 10 MEG 7pF).

Engineer: C. B. Loftis, Jr.

SCHMIDT TRIGGER AND TIMER SETUP

C_1	.1 μf mylar	$Q_{1, 2, 5, 8, 9, 12}$	2N3904
C_2	.01 μf mylar	$Q_{3, 4, 6, 7, 10, 11}$	2N3906
$C_{3, 4}$	.1 μf mylar	$Q_{13, 14}$	
		D_{1-5}	1N914
		Lamp Leecraft	14 v 80 ma

R_1	470 K	R_7	680
R_2	330 K	$R_{8, 12, 15, 19}$	33 K
R_3	4.7 K	$R_{9, 16}$	47 K
R_4	270 K	$R_{10, 13, 17, 20}$	12 K
R_5	82 K	$R_{11, 14, 18, 21}$	18 K
R_6	3.9 K	$R_{22, 23}$	6.8 K

POWER SUPPLY BOARD

$R_{1, 2, 5}$	100 r	$R_{10, 15, 21}$	10 K 1/4ω (Turn Put (DC))
R_3	1.5 K	R_{16}	1 r 5ω ωω
R_4	1 K	R_{18}	2.7 K
R_6	22 K	R_{19}	680
$R_{7, 12}$	10 K	R_{20}	27 K
$R_{8, 13, 16}$	5.6 r 1/4 ω	R_{22}	.33 2ω ωω
$R_{9, 14}$	27 K	R_{23}	470 2ω
		R_{24}	10 K 2ω Put

$D_{1, 2, 5, 6, 7, 8, 9-12, 13-16}$	Mallery M2.5A Power Diode	$C_{4, 6}$	2000 μf 25 v Electrolytic
D_3	IN914 Switching Diode	$C_{5, 7, 9}$	100 pf Ceramic
D_4	47 v 1ω Zener	C_8	4500 μf 50 v Electrolytic
D_{17}	12 v 1ω Zener	IC 1 3	RCA CA3085
$C_{1, 2}$	150 μf 50 v Electrolytic	$Q_{1, 2, 3}$	2N3053
$C_{3, 9}$	.1 μf 100 v Mylar	$Q_{4, 5, 8}$	40409 RCA ω Heat Sink
		Q_6	HEP 248 Mot
		Q_7	2N3904 Mot

RF POWER AMPLIFIER

Q_1	2N3553	TO-5
Q_2	2N3375	TO-60 (heat sink)
Q_3	2N5070	TO-60 (heat sink)

R_1	120
R_2	150
R_3	1.2 K
$R_{4, 6}$	15
R_5	2.7
R_7	1.5 K
R_8	10
$R_{9, 10}$	15
R_{11}	120
R_{12}	820 1ω
R_{13}	180 2ω
R_{14}	10 1ω
R_{15}	7.5 5ω ωω
R_{16}	5.1 1ω
R_{17}	5.1 1ω
R_{18}	27

$C_{1, 2, 19, 8, 12}$ 13, 3	.01 μf Ceramic
$C_{16, 15, 14, 5, 10}$	.1 μf Mylar
$C_{4, 6}$	.001 μf Ceramic
$C_{17, 18, 9}$	5 μf 150 volts
C_{11}	.0033 μf Ceramic
D_{1-3}	IN3193

L_1	25 μh	
L_2	25 μh	
L_3	50 μh	
T_1, T_2	20 turns bifilar wound No. 32 on Q_3 CF105	
L_4	82 μh	

13.56 MHz OSCILLATOR

R_1 10 K 1 turn 14 ω Pot (P.C.)

R_2	10 K	R_8	120	R_{14}	100	Q_1	2N5179	Osc.
R_3	6.8 K	R_9	2.2 K	R_{15}	6.8 K	Q_2	2N5109	Buffer
R_4	330	R_{10}	33 K	R_{16}	10 K 2ω Put	Q_3	2N3053	Gain
R_5	100	R_{11}	22 K	R_{17}	1 K	Q_4	2N3053	
R_6	1 K	R_{12}	22 K			Q_5	2N3393	Squelch
R_7	4.7 K	R_{13}	120R_{13}	D_1	IN914	Q_6	2N3393	

RF AMMETER AND OUTPUT CIRCUIT

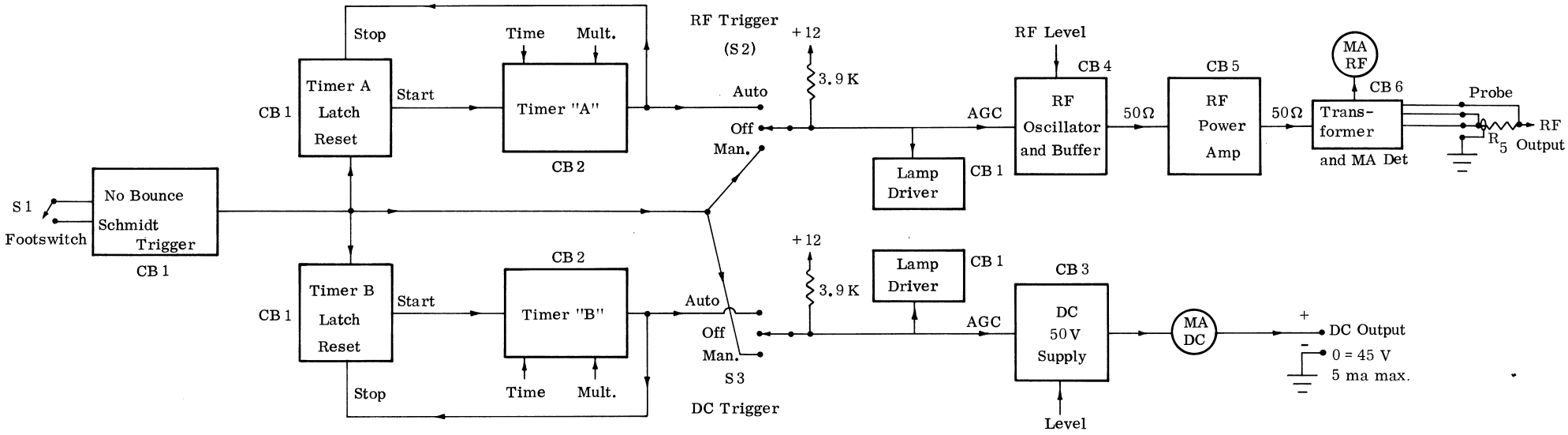
R_3	220 2ω Carbon
R_1	12 Current Sampling Resistor
R_2	5 K 1/5ω 10 Turn Pot (RF MA Calibrate)
C_1	.01 μf Ceramic
C_2	.1 μf Mylar
$C_{3,4}$	.01 μf Ceramic
$L_{1,2}$	82 μh RFC
T_1	Approx. 20T Bifilar Wound No. 28 on Q-3 CF105 Core
T_2	"Vary-L" 5012.5 A Wide Band Transformer
T_3	"Vary-L" 50450 A Wide Band Transformer

UNIVERSAL TIMER CIRCUIT (A or B)

$R_{1,2}$	15 K
R_3	18 K
R_4	8.2 K
R_5	10 K 1 turn pot (time calib.)
$R_{6,8}$	22 K
$R_{7,11}$	1 K
$R_{9,10}$	10 K
R_{12}	8.2 K
R_{13}	2.2 K
R_{14}	10 K 2ω 1 turn pot (time)
R_{15}	1 K
$C_{1,2}$	.001 μf Ceramic
C_3	.022 μf Mylar
C_4	50 μf 25 v Electrolytic
C_5	47 pf CER
C_6	.01 μf CER
C_7	470 PF CER
C_8	.1 μf Mylar
C_9	.022 μf Mylar (Timing)
C_{10}	.22 μf Mylar (Timing)
C_{11}	2.0 μf Mylar (Timing)
D_{1-5}	IN914
IC 1	RCA CA3047
IC 2, 3	μa 741 or CA3741 CT

SSP-10 BLOCK DIAGRAM

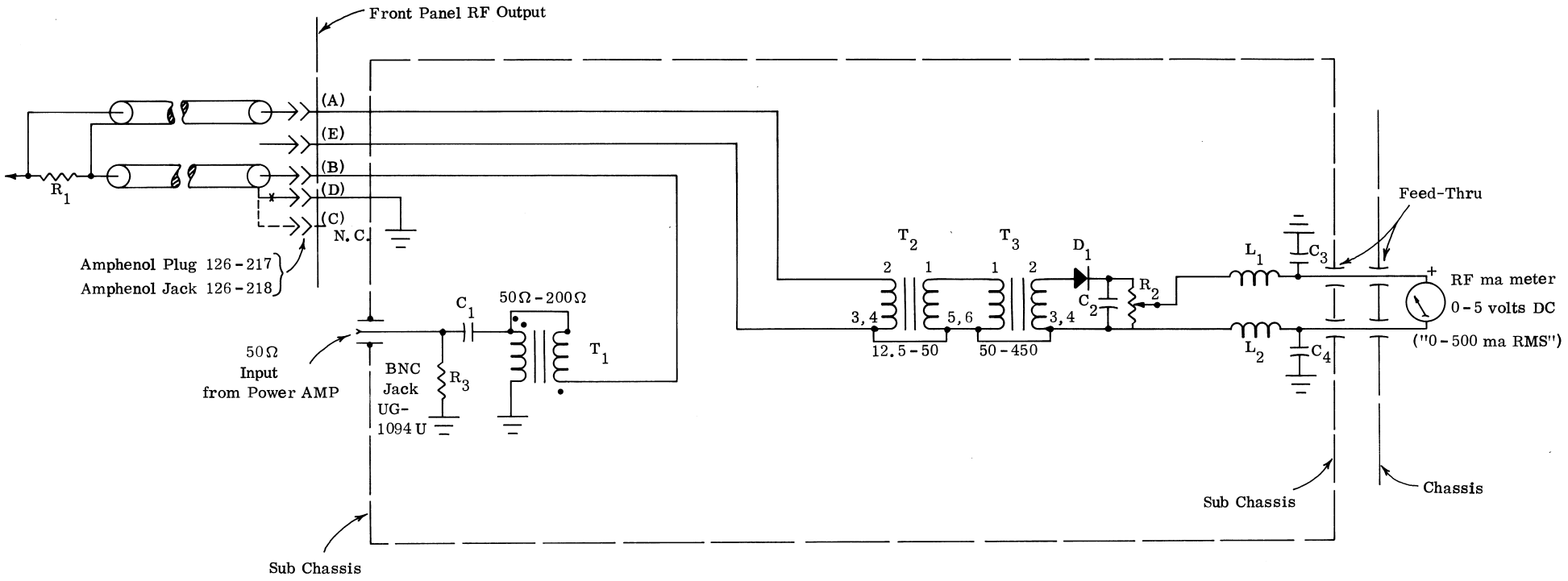
(Solid State Power -- 10 Watts)



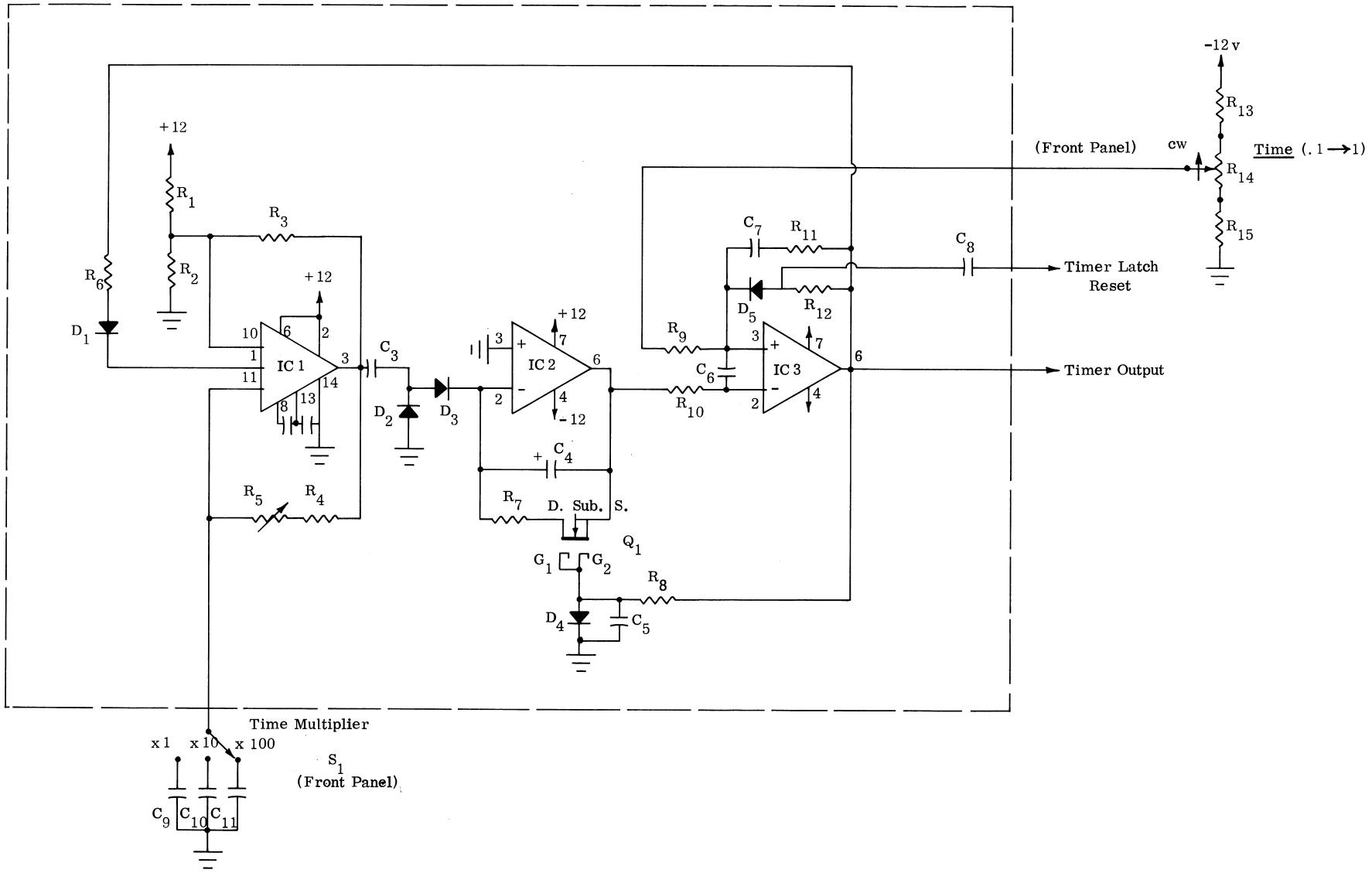
CIRCUIT BOARD LOCATION

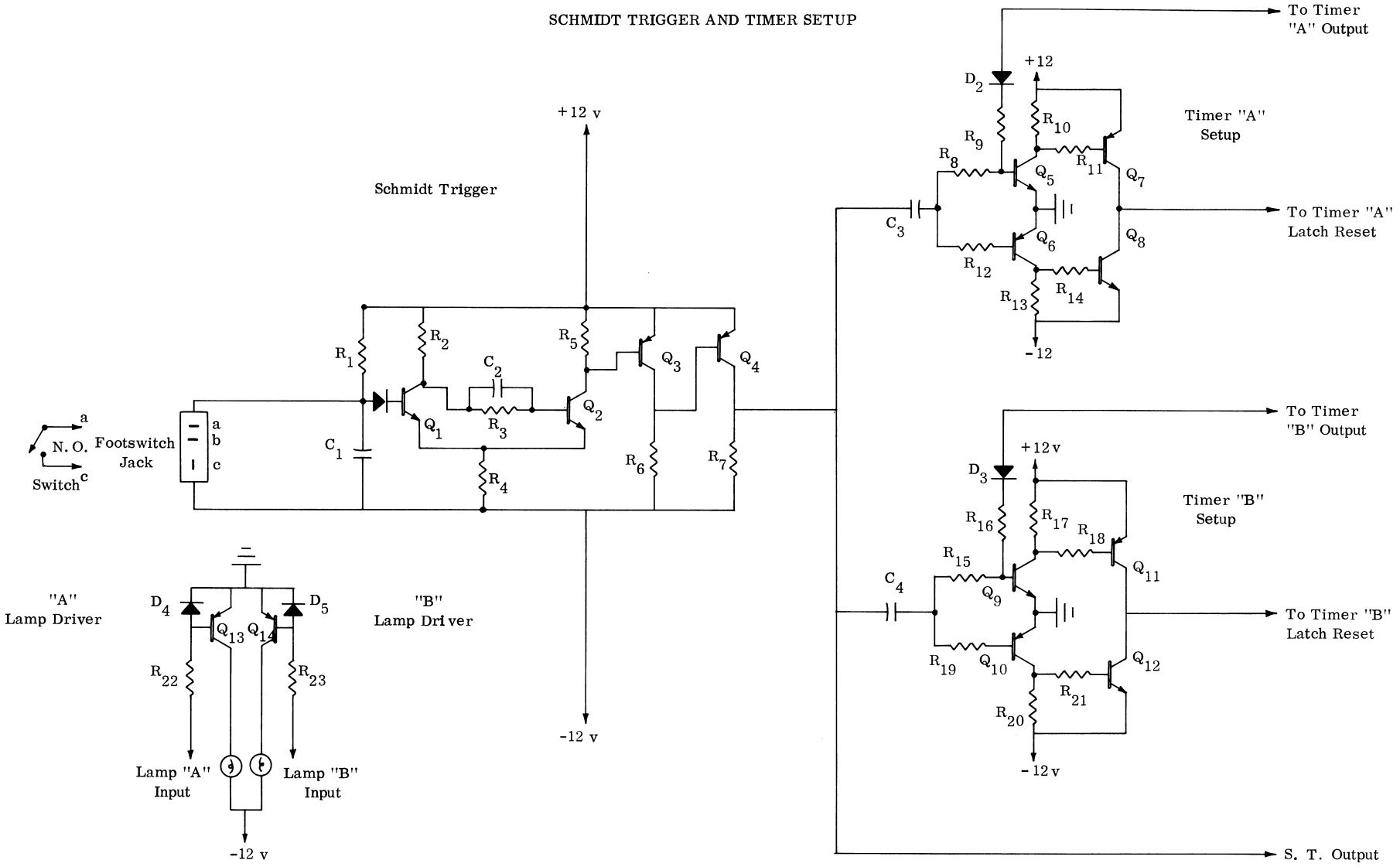
CB 1	Bottom Chassis Left
CB 2	Bottom Chassis Center
CB 3	Bottom Chassis Right
CB 4	Top Chassis Left
CB 5	Top Chassis Center
CB 6	Bottom Chassis by Front Panel

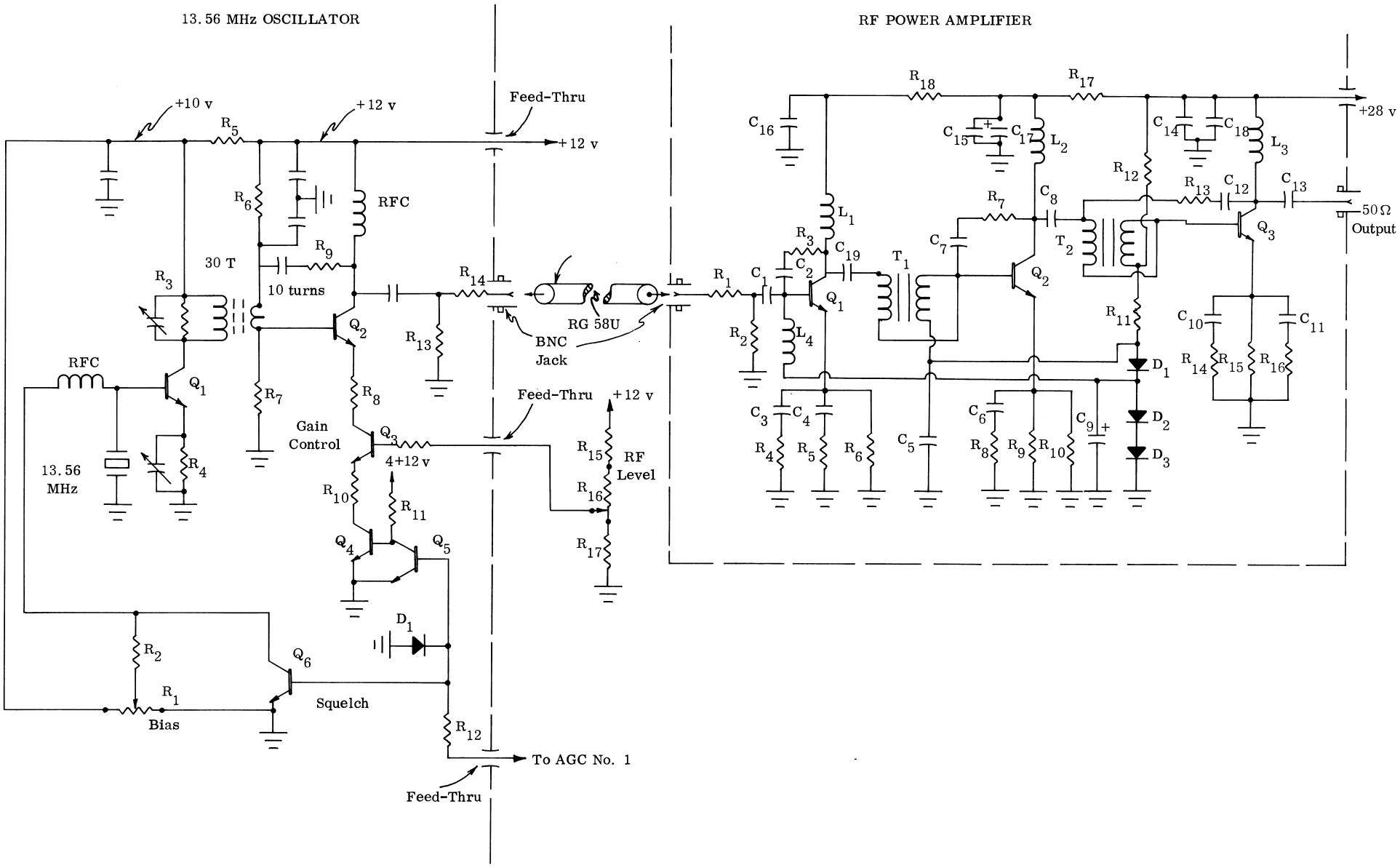
RF AMMETER AND OUTPUT CIRCUIT

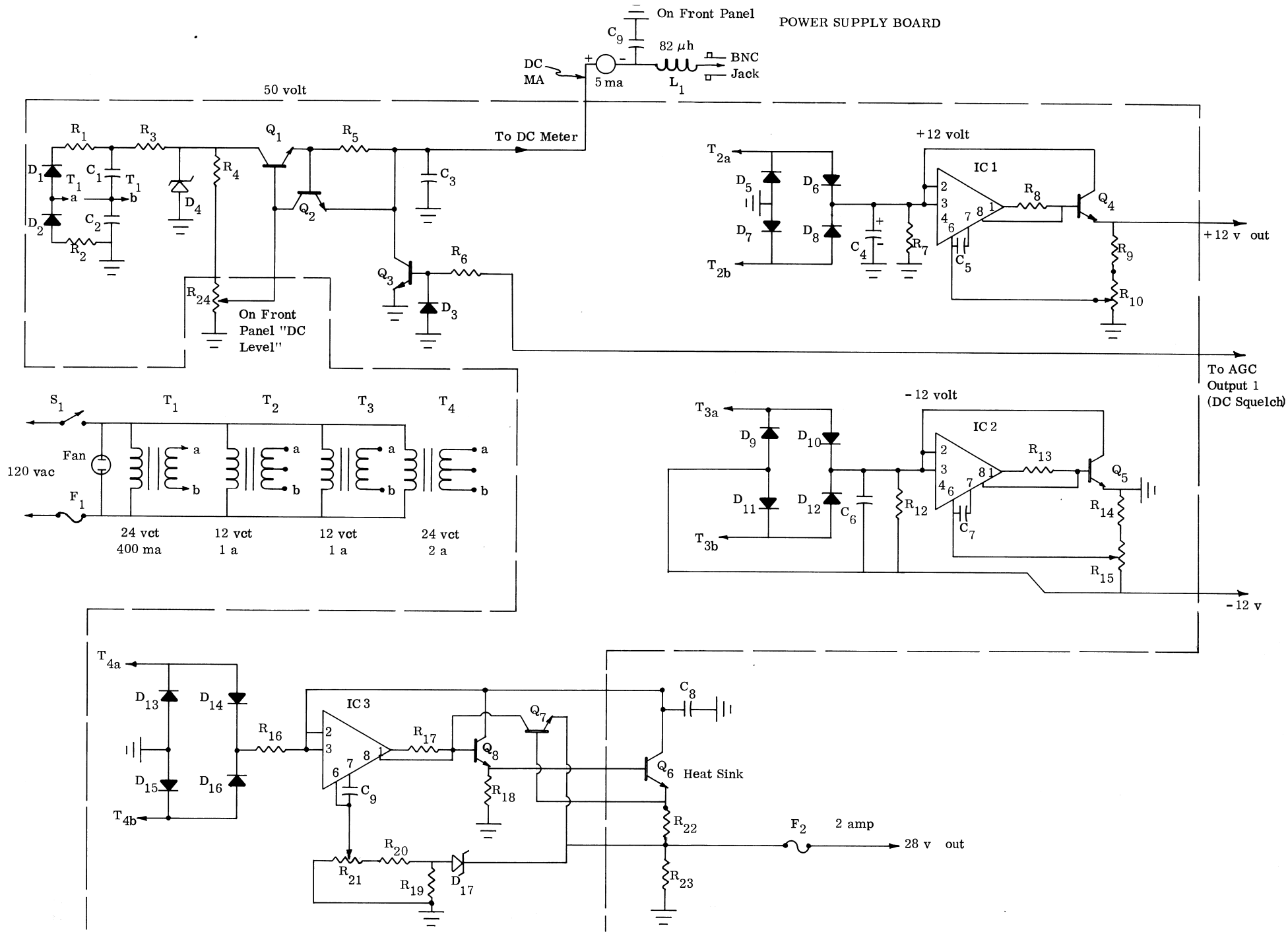


UNIVERSAL TIMER CIRCUIT
(A or B)




SCHMIDT TRIGGER AND TIMER SETUP
Schmidt Trigger
+12 v
-12 v
N. O.
Switch
Footswitch Jack
"A" Lamp Driver
"B" Lamp Driver
Lamp "A" Input
Lamp "B" Input
-12 v
To Timer "A" Output
Timer "A" Setup
To Timer "A" Latch Reset
+12
-12
To Timer "B" Output
Timer "B" Setup
To Timer "B" Latch Reset
+12 v
-12 v
S. T. Output


13.56 MHz OSCILLATOR
RF POWER AMPLIFIER
+10 v
+12 v
Feed-Thru
+12 v
+28 v
50Ω Output
RFC
30 T
10 turns
BNC Jack
RG 58U
13.56 MHz
Gain Control
4+12 v
RF Level
Squelch
Bias
To AGC No. 1
Feed-Thru
Feed-Thru


POWER SUPPLY BOARD
On Front Panel
C_9
82 μh
BNC Jack
DC MA
5 ma
L_1
50 volt
To DC Meter
R_1
R_3
Q_1
R_5
C_3
D_1
T_1
C_1
T_1
a
b
D_2
C_2
R_2
D_4
R_4
Q_2
R_6
Q_3
D_3
R_{24}
On Front Panel "DC Level"
+12 volt
T_{2a}
D_5
D_6
D_7
D_8
T_{2b}
IC 1
R_8
Q_4
C_4
R_7
C_5
R_9
R_{10}
+12 v out
To AGC Output 1 (DC Squelch)
S_1
T_1
T_2
T_3
T_4
Fan
120 vac
F_1
24 vct 400 ma
12 vct 1 a
12 vct 1 a
24 vct 2 a
-12 volt
T_{3a}
D_9
D_{10}
D_{11}
D_{12}
T_{3b}
IC 2
R_{13}
Q_5
C_6
R_{12}
C_7
R_{14}
R_{15}
-12 v
T_{4a}
D_{13}
D_{14}
D_{15}
D_{16}
T_{4b}
R_{16}
IC 3
R_{17}
Q_7
Q_8
C_8
Q_6 Heat Sink
C_9
R_{18}
R_{22}
F_2 2 amp
28 v out
R_{20}
R_{21}
R_{19}
D_{17}
R_{23}