

**Radio Systems'**  
**Phase II Transmission System Manual**  
**for the**

**TR-20 TRANSMITTER**  
**&**  
**CP-15 COUPLER**



**RADIO**  
DESIGN &  
MANUFACTURING **SYSTEMS**

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## MOUNTING INSTRUCTIONS

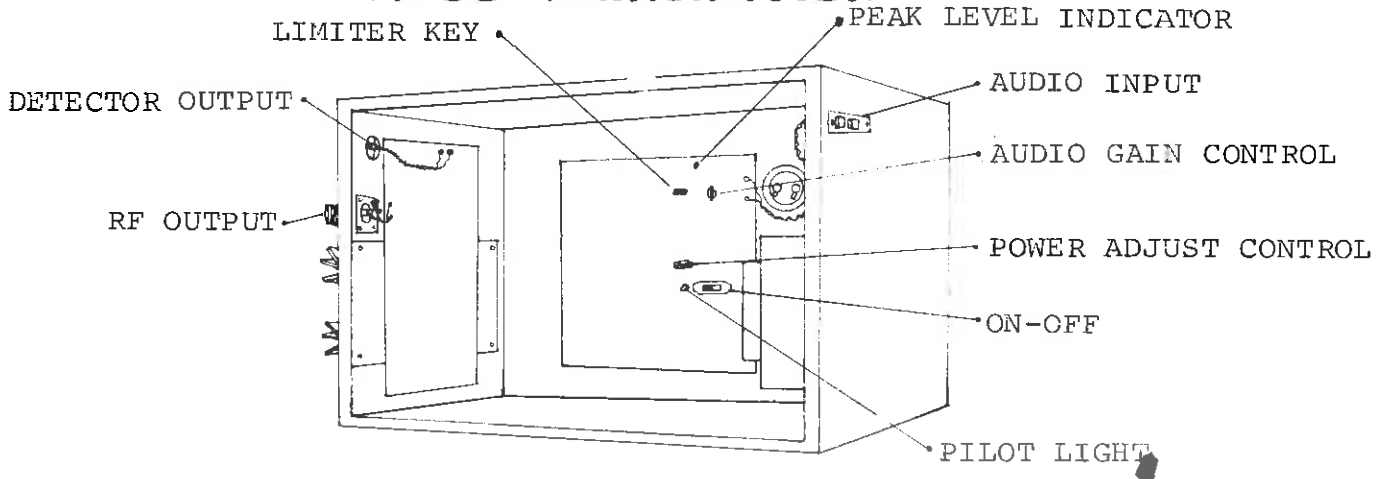
The TR-20 and CP-15 are designed for wall mounting. Both units have holes in the back that will accept various size screws. The spacing for the screws is 8.25 inches apart for the TR-20 and 6 inches apart for the CP-15.

For best possible performance and long life, mount the transmitter as far as possible from heat sources such as boilers, steam-pipes, etc. It is also important that none of the ventilation holes or the heat sink is blocked. It is normal for the heat sink to run hot, so adequate air circulation is a must.

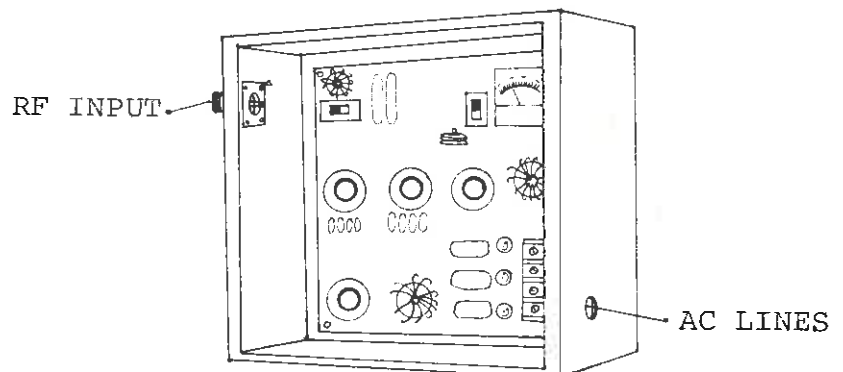
The coupler should be mounted as close to the coupling point as possible and connected to the transmitter by 50 ohm coax. Use as much coax as necessary to accomplish the above, because the loss in coax at these frequencies is negligible.

Transmitter and coupler location and settings should be fully documented. Sheets for this purpose are included in the back of this manual. One copy should be kept on file and the other, if desired, returned to Radio Systems.

### TR 20 Transmitter



### CP 15 Coupler



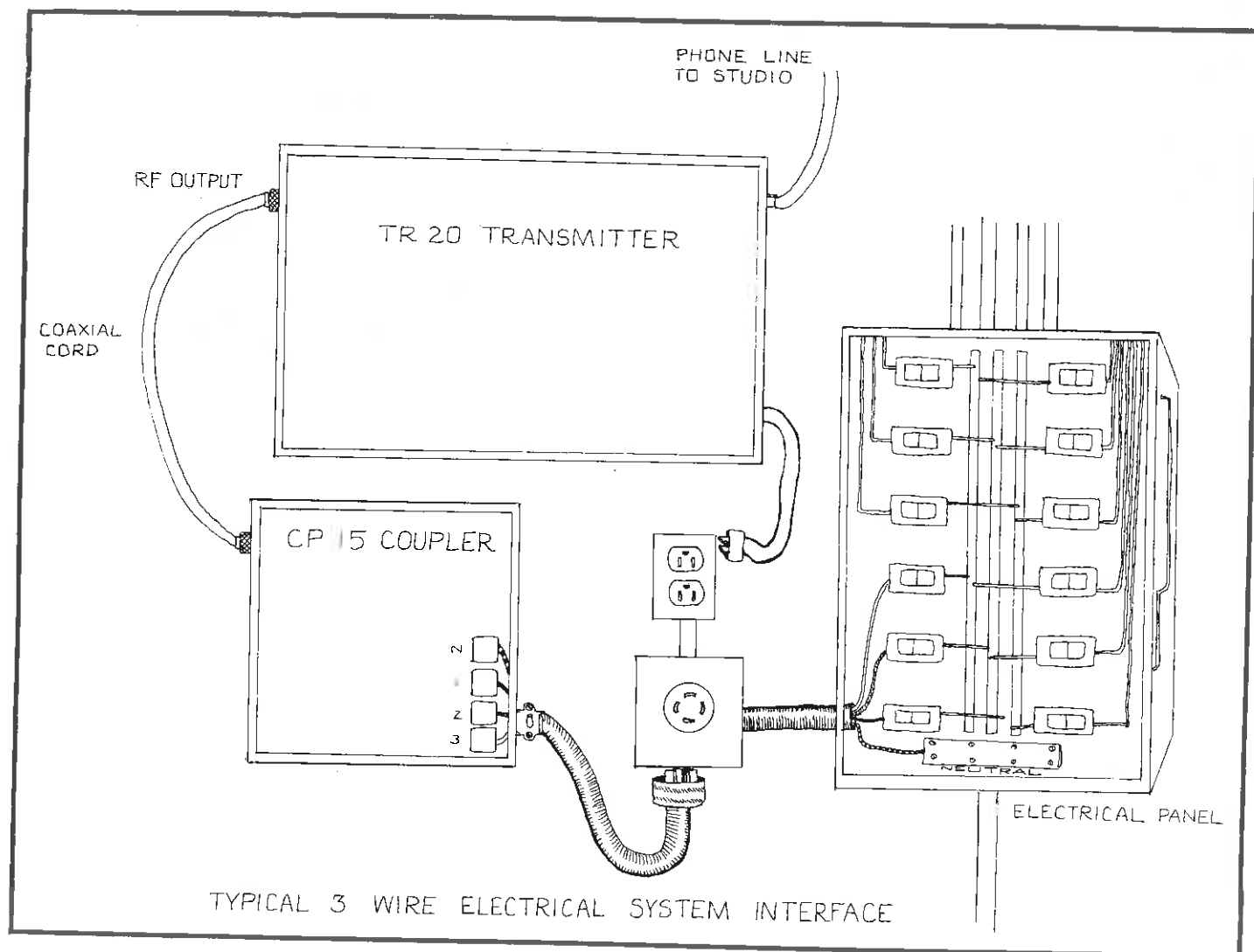
## INSTALLATION AND INTERCONNECTION

A standard installation to a 3 wire fuse box is shown. If only 2 wire power is available, simply eliminate the third wire connection.

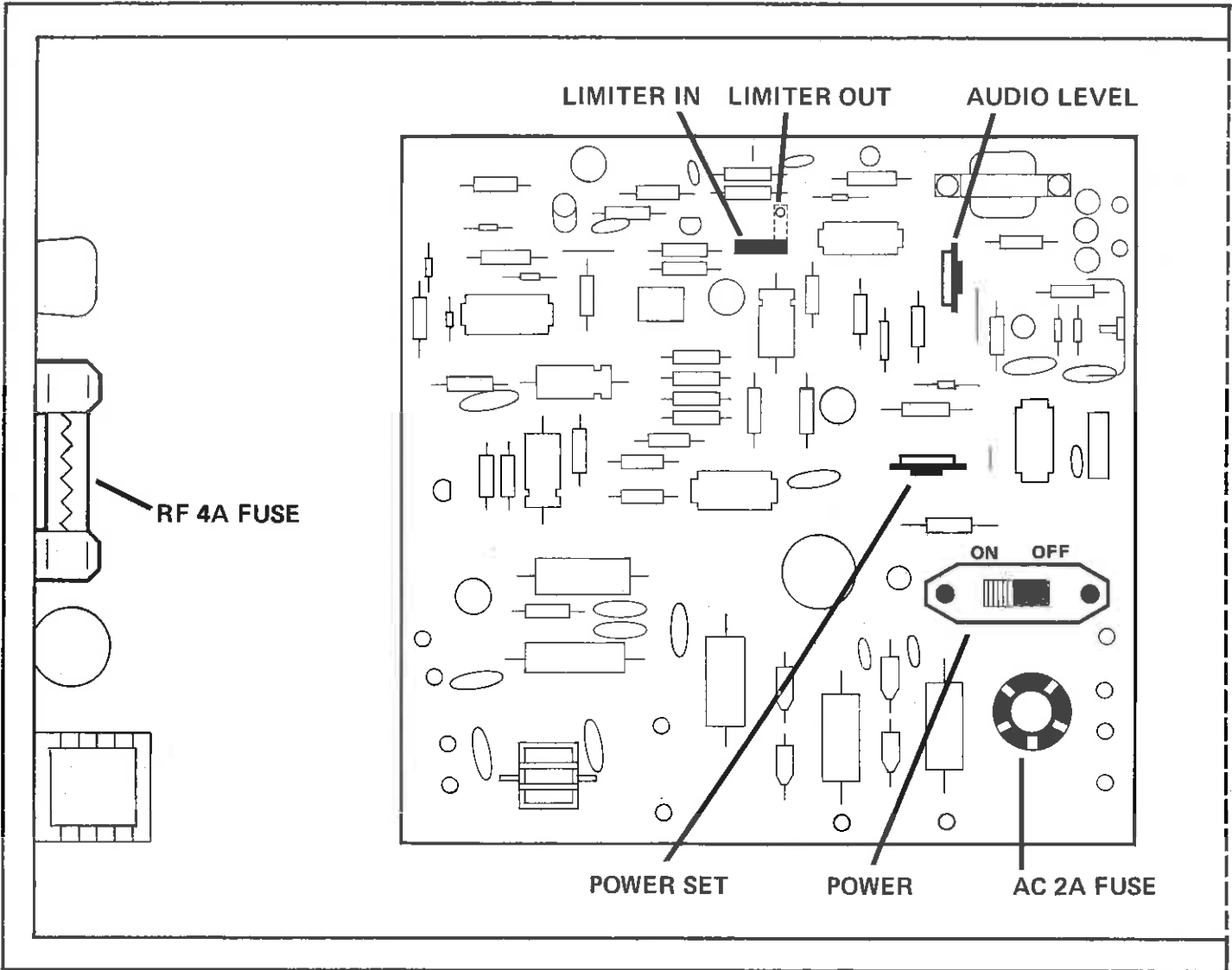
Use of a disconnect plug between the coupler and fuse box is shown in this illustration and is recommended for easy servicing.

The coupler does not draw any power, but rather, injects radio energy, so low current (#16 or #18) wire and 15 amp breakers are acceptable. However, larger cable and breakers will do no harm, and local electrical codes should be followed wherever applicable.

For important information on interfacing the transmitter to the building's electrical system, consult Radio Systems' Carrier Current Application notes.



# TR-20 TRANSMITTER CONTROL LOCATIONS



## OPERATING INSTRUCTIONS TR-20 TRANSMITTER

- Note #1 - A technical description of this unit's operation is included in this manual.
- Note #2 - Transmitter performance and audio quality are highly dependent on proper system design and pre-installation tests. Application notes outlining these procedures are available from Radio Systems.
- Step #1 - CONNECT AC, AUDIO AND RF CABLES as described on installation and interconnection sheet.
- Step #2 - TURN AUDIO LEVEL AND POWER ADJUST CONTROLS TO MINIMUM (fully CCW)
- Step #3 - LOAD THE TRANSMITTER. If a CP-15 coupler is being used this may be accomplished by setting the coupler in the "match" position.
- Step #4 - TURN ON POWER SWITCH. The LED will light.
- Step #5 - SET AUDIO LEVEL. Note - your TR-20 transmitter contains an automatic level control circuit. Follow these set-up procedures for automatic or manual operation.

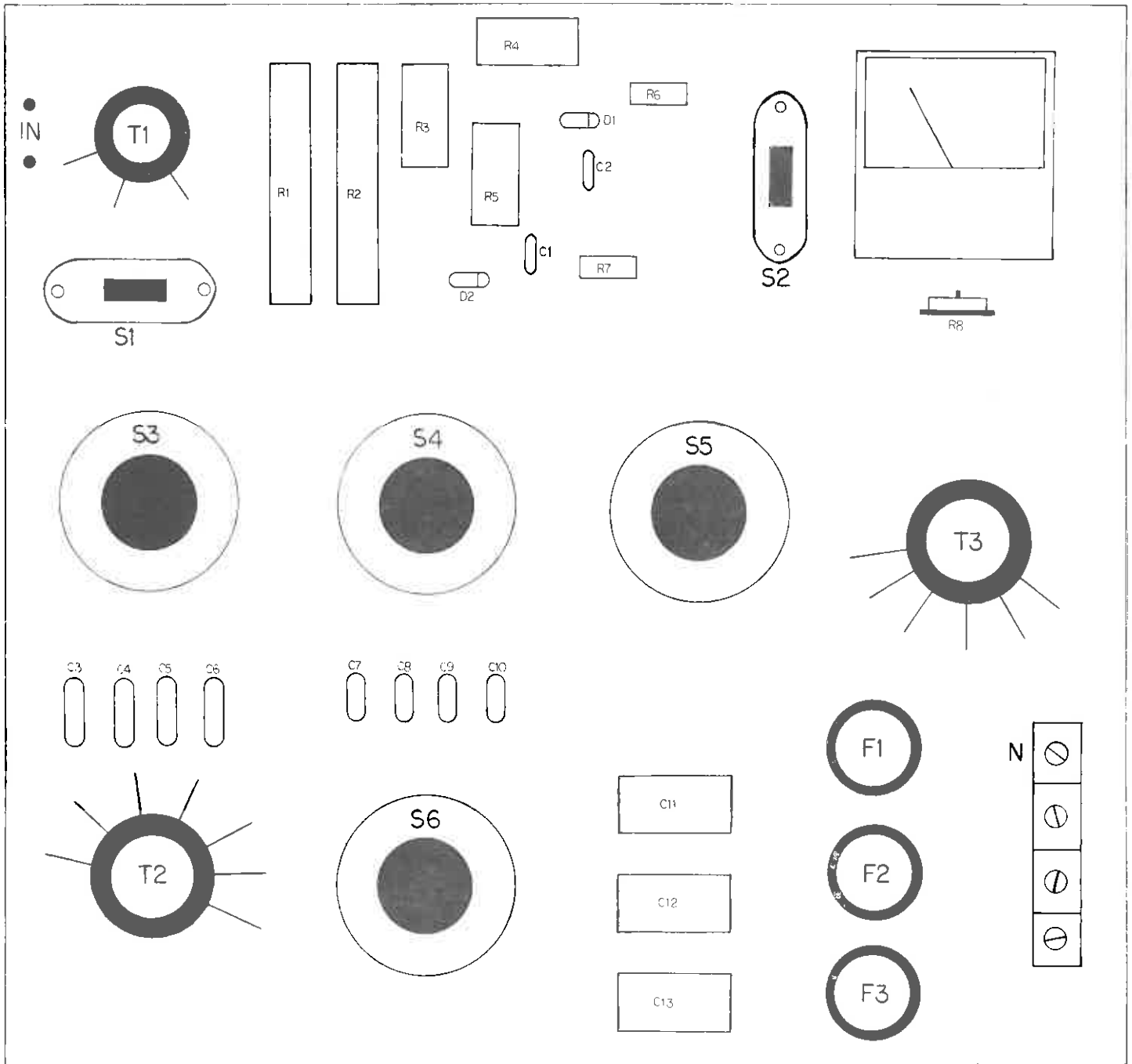
### AUTOMATIC LEVEL CONTROL

- a - Set the limiter key in the horizontal (limiter in) position.
- b - Provide the transmitter with audio at standard studio levels.
- c - Set audio level control for occasional to frequent peak indicator flash. Each flash indicates 100% modulation and limiter activation. The higher the flash rate, the greater the limiting and higher the overall audio level. Use a high quality portable radio to determine the amount of limiting desired.

### MANUAL AUDIO LEVEL OPERATION.

- a - Set the limiter key in the vertical (limiter out) position.
  - b - Provide the transmitter with audio at standard studio levels.
  - c - Set audio level control for occasional peak indicator flash only.
- Step #6 - TURN THE POWER ADJUST CONTROL TO MAXIMUM (fully CW)

# CP-15 COUPLER CONTROL LOCATIONS





## OPERATING INSTRUCTIONS CP-15 COUPLER

- Note #1 - A technical description of the operation of this unit is included in this manual.
- Note #2 - Coupler performance and radio reception are highly dependant on proper system design and pre-installation tests. Application notes outlining these procedures are available from Radio Systems.
- Step #1 - CONNECT RF AND AC CABLES as described on the installation and interconnection sheet. Turn on building circuit breakers.
- Step #2 - S-1 IN MATCH POSITION.
- Step #3 - S-2 IN FORWARD POSITION. Meter should indicate full scale.
- Step #4 - S-2 IN REFLECT POSITION
- Step #5 - SET S3, S4, S5 and S6 FOR MINIMUM METER READING. A patient, systematic approach must be taken to test all possible combinations of impedance compensation and capacitance cancellation settings to achieve the lowest meter reading.
- Step #6 - DETERMINE SWR
- a - Set S-2 in forward.
  - b - Adjust R-8 for full scale (300)
  - c - Set S-2 in reflect, note reading and calculate.
- $$\frac{300 + \text{reading}}{300 - \text{reading}} = \text{Ratio}$$
- For example, if the reflected reading is 100
- $$\frac{300 + 100}{300 - 100} = \frac{400}{200} = 2 \quad \text{SWR is 2:1}$$
- A reading higher than 2:1 (or 100 when reading reflected power) should be treated with suspect and the matching re-done.
- Step #7 - SET S-1 IN "OPERATE".
- Step #8 - REDUCE TRANSMITTER RF POWER to the minimum necessary for full building coverage.

## THEORY OF OPERATION

### Power Supply

The power transformer (T1) feeds a full wave bridge (D1 to D4) through a surge suppression filter (R1, R2, C1, C2). Under normal conditions, the DC voltage across the filter capacitor (C3) is 30 volts. Voltage for the low level circuits is supplied by a three terminal regulator (VRI) and a zener diode (D5). Two resistors (R4 & R5) set the regulator output voltage.

### Audio

An audio transformer (T2) provides a balanced 600 ohm isolated input. One half of a dual OP Amp (1C3A) amplifies the signal which is then routed to the modulator (IC2) or to the limiter when it is switched in circuit.

The limiter provides up to 20 dB of gain reduction to maintain the audio level within a predetermined range and prevent overmodulation. It consists of a full wave active rectifier (IC5), a limiting amp (IC4) and a control element (Q3). Factory sealed pots set the control bias (R17) and output level (R45).

The other half of the dual input OP Amp (IC3) turns on the peak flasher LED (D7) at about 85% modulation. This point is set by R11 and R12.

### Modulator/Amplifier

The modulator IC (IC2) is a fast, switching type device. The input from the oscillator is a square wave at the carrier frequency. The output is an AM signal at low level which feeds an emitter-follower (Q1) for buffering. A class A broadband power amp (Q2) provides drive for the main final amplifier. The modulator is direct coupled to the buffer and broadband amp to set a stable bias.

### Oscillator

To obtain a stable frequency, a hermetically sealed, AT cut, fundamental crystal runs an emitter coupled oscillator (IC2). Binary dividers in the oscillator chip provide either 1/2 or 1/4 the crystal frequency to set the carrier frequency. The oscillator output is a square wave of about 4V P-P.

## THEORY OF OPERATION

### Power Amp/Filter

Two balanced emitter transistors (Q103 & Q104) are push-pull coupled as a linear amplifier. A darlington transistor (Q102) senses heat sink temperature and through a pass transistor (Q101) adjusts the DC bias of the output transistor pair (Q103 & Q104). The output amp is fuse protected (F101) for severe SWR or over-drive conditions.

Coils (L101 & L102) and mica-capacitors (C106 thru C110) are used to provide a sharp cut-off filter for harmonic rejection. Three different sets of components are used to make up this filter depending on whether the transmitter frequency is within the low (530-830 kHz), mid (830-1230 kHz), or high (1230-1610 kHz) portion of the band.

### Detector

To provide a convenient test point and monitor output a detector circuit supplies audio output to a Hi Z load.

### Coupler

The CP-15 coupler is a matching device with impedance compensation and reactance cancellation capability along with a high pass filter for carrier-current operation.

A cascaded impedance correction system uses two high permeability ferrite coils (T2 and T3) to provide 3 and 5 impedance taps for a total of 15 ranges which are selected through two switches (S4 & S5). Exact reactance cancellation is accomplished by selecting combinations of high voltage mica-capacitors (C3 thru C10) which are switched in series with the RF output by two decade-type switches (C3 & C4). Finally, high pass capacitors (C11, C12 & C13) block the 60 cycle energy from entering the coupler and fuses (F1, F2 & F3) protect the line in case of capacitor failure and provide a convenient way of eliminating a phase.

The "match-operate" switch (S1) activates the bridge circuitry and, through a transformer (T1) which lowers the bridge driving impedance, dummies loads 90% of the RF input power for protection during set-up. The "forward-reverse" switch (S2) enables the DC micro-ammeter to look at reflected or forward power through the bridge so that SWR can be optimized by selecting the proper cancellation components. The calibration pot (R8) enables calculation of actual SWR by setting a forward power reading reference point.

## TROUBLE SHOOTING GUIDE

### I. AUDIO PROBLEMS

#### 1. No Audio

- Check for signal on the audio line from the studio with headphones or a meter.
- Adjust the transmitter audio level control setting.
- Note that the audio limiter key is inserted.

#### 2. Audio Distortion

- Ensure that clean, undistorted signal is being fed from the studio.
- Check that the transmitter audio level control is set properly (occasional to frequent L.E.D. flash).

#### 3. Hum

- Ensure that clean, hum free audio is being fed to the transmitter.
- Evaluate the coupling procedure and location (detailed information on carrier noise and coupling techniques is available from Radio Systems).

#### 4. Garble

- Ensure that no other station transmitter on the same frequency can be received in this location.

#### 5. Static

- This indicates low signal strength. Consult "RF Problems".

## TROUBLE SHOOTING GUIDE

### II. RF PROBLEMS

#### 1. No Signal

- Check fuse F-101 on transmitter amplifier board.
- Check coupler fuses.
- Ensure that building circuit breakers for coupler power are on.
- Inspect transmitter to coupler coaxial cable.

#### 2. Low Signal Strength

- Ensure that coupler switch is in "operate" position.
- Raise transmitter power control setting.
- Re-match coupler to optimise SWR.
- "Survey" other building coupler locations (extensive information on coupling technique is available from Radio Systems).

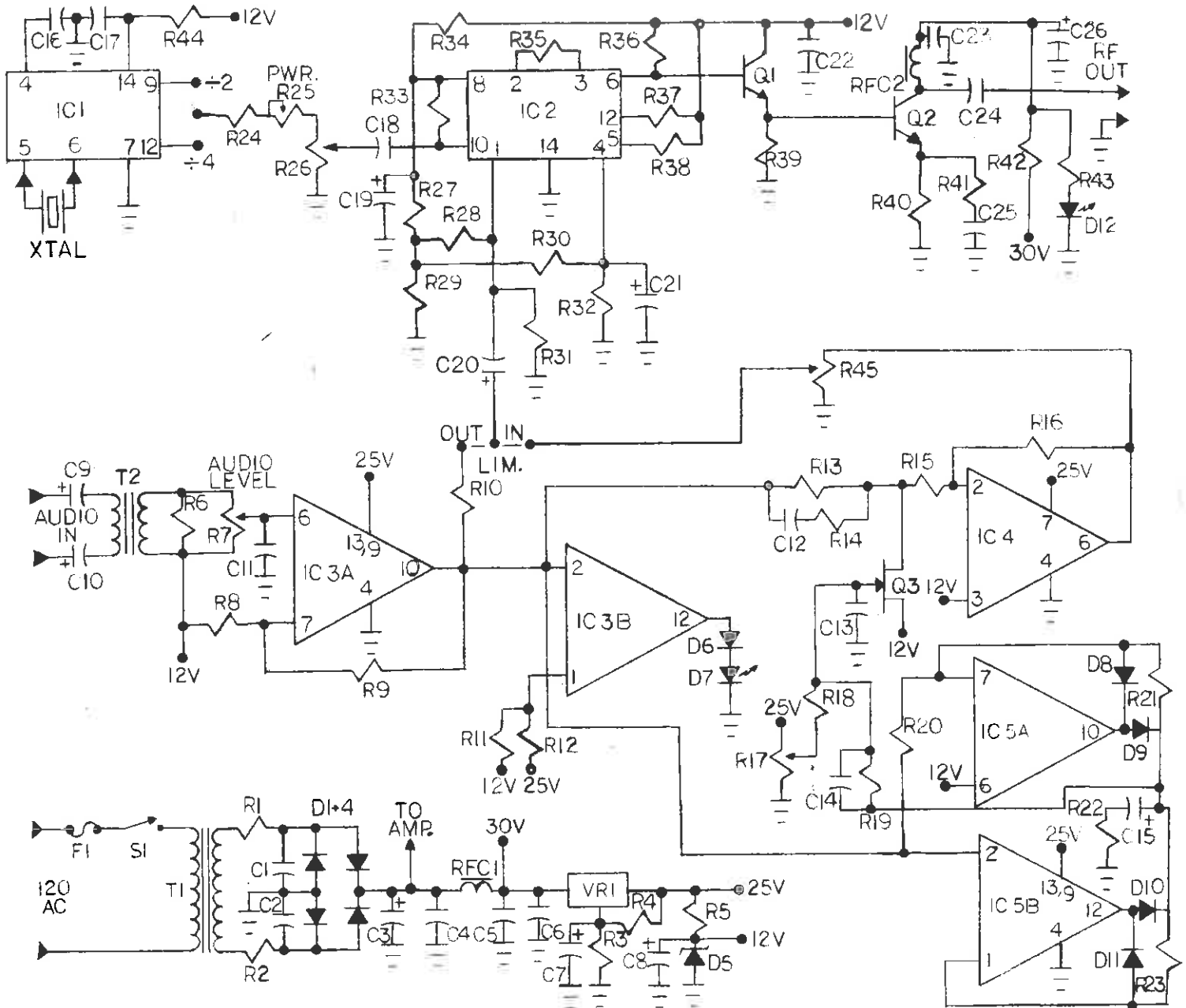
#### 3. Poor Matching

- Check that neutral and hot wires have been properly connected to coupler.
- Try other coupling techniques and locations.

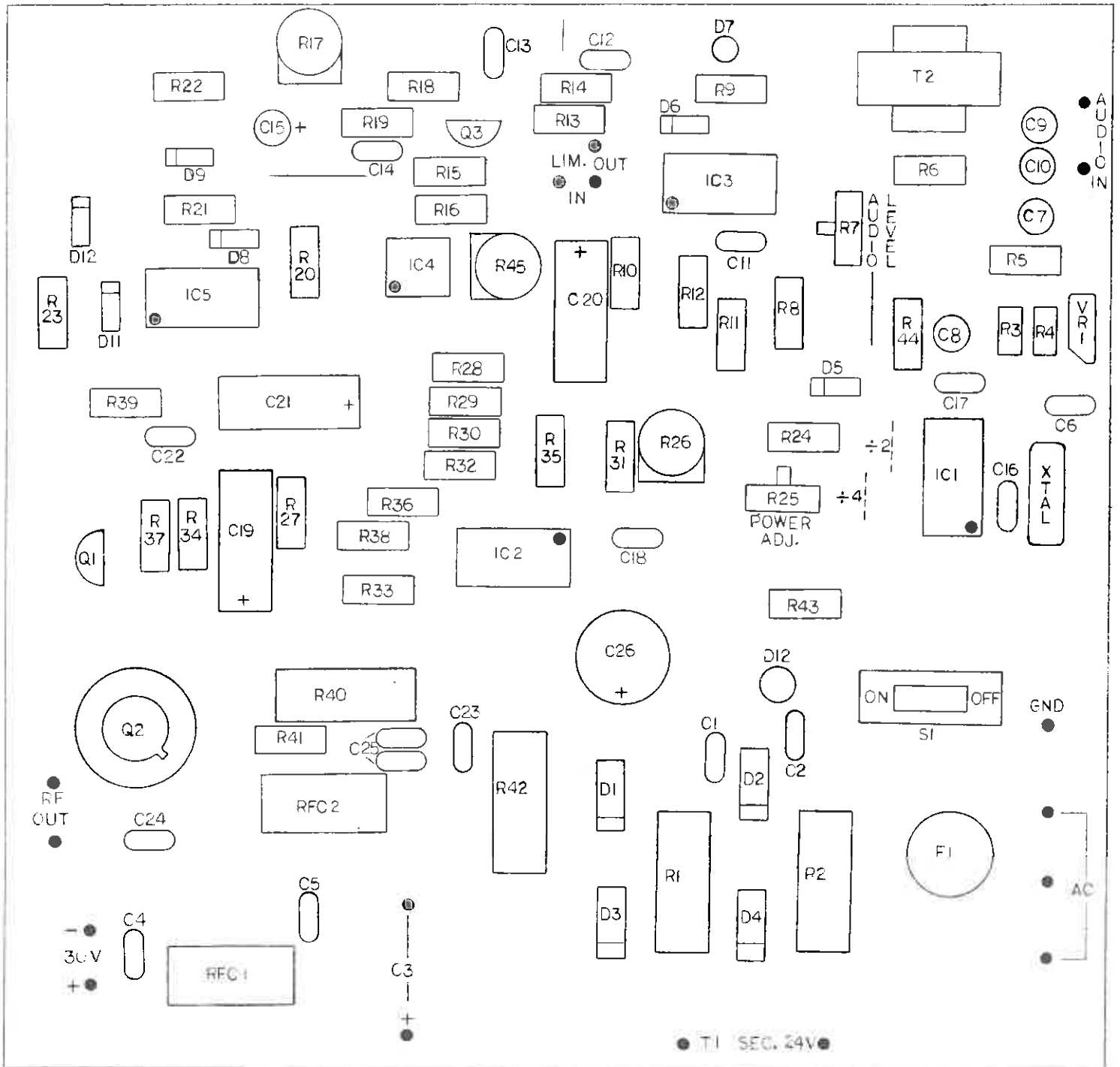
#### 4. Whistle (Heterodyne)

- Check if other stations are broadcasting on or close (within 5 kc) to your operating frequency.
- Check if any other of your transmitters can be received in this building (if so - you should raise or lower the frequency of one transmitter by 10 kc)

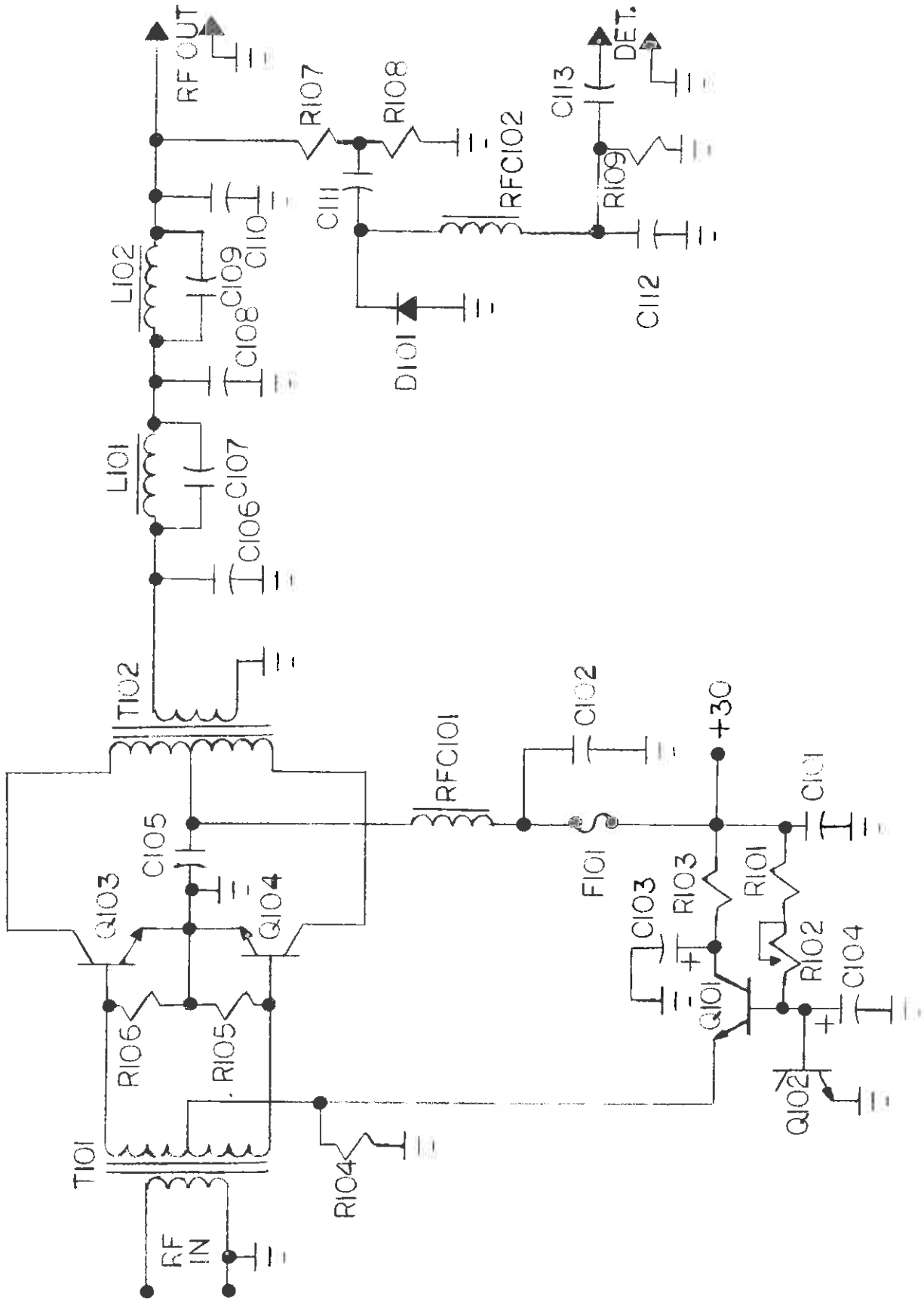
# EXCITER/POWER SUPPLY SCHEMATIC



# EXCITER/POWER SUPPLY PARTS LAYOUT

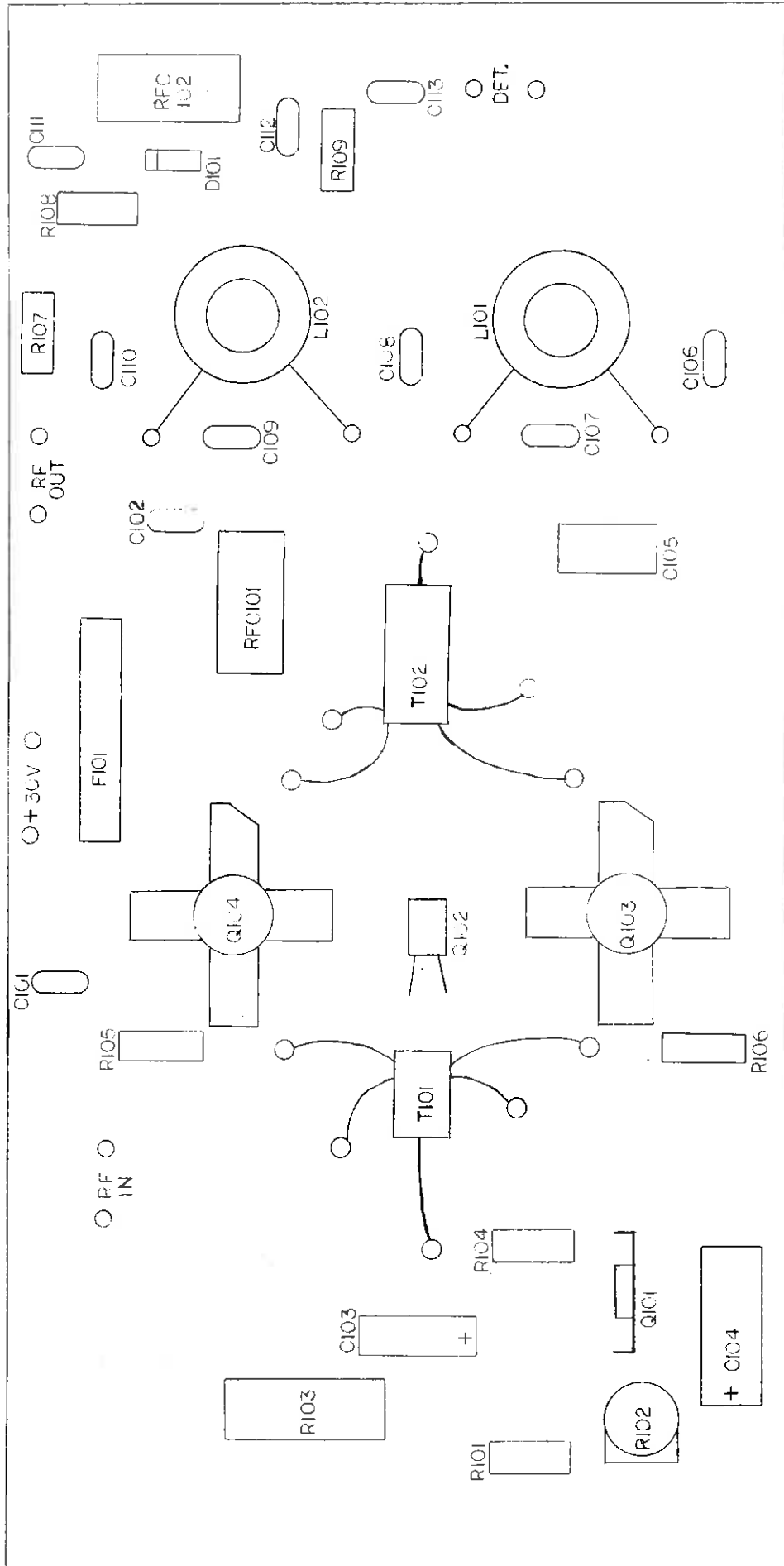


# AMPLIFIER SCHEMATIC





# AMPLIFIER PARTS LAYOUT



## TRANSMITTER PARTS LIST

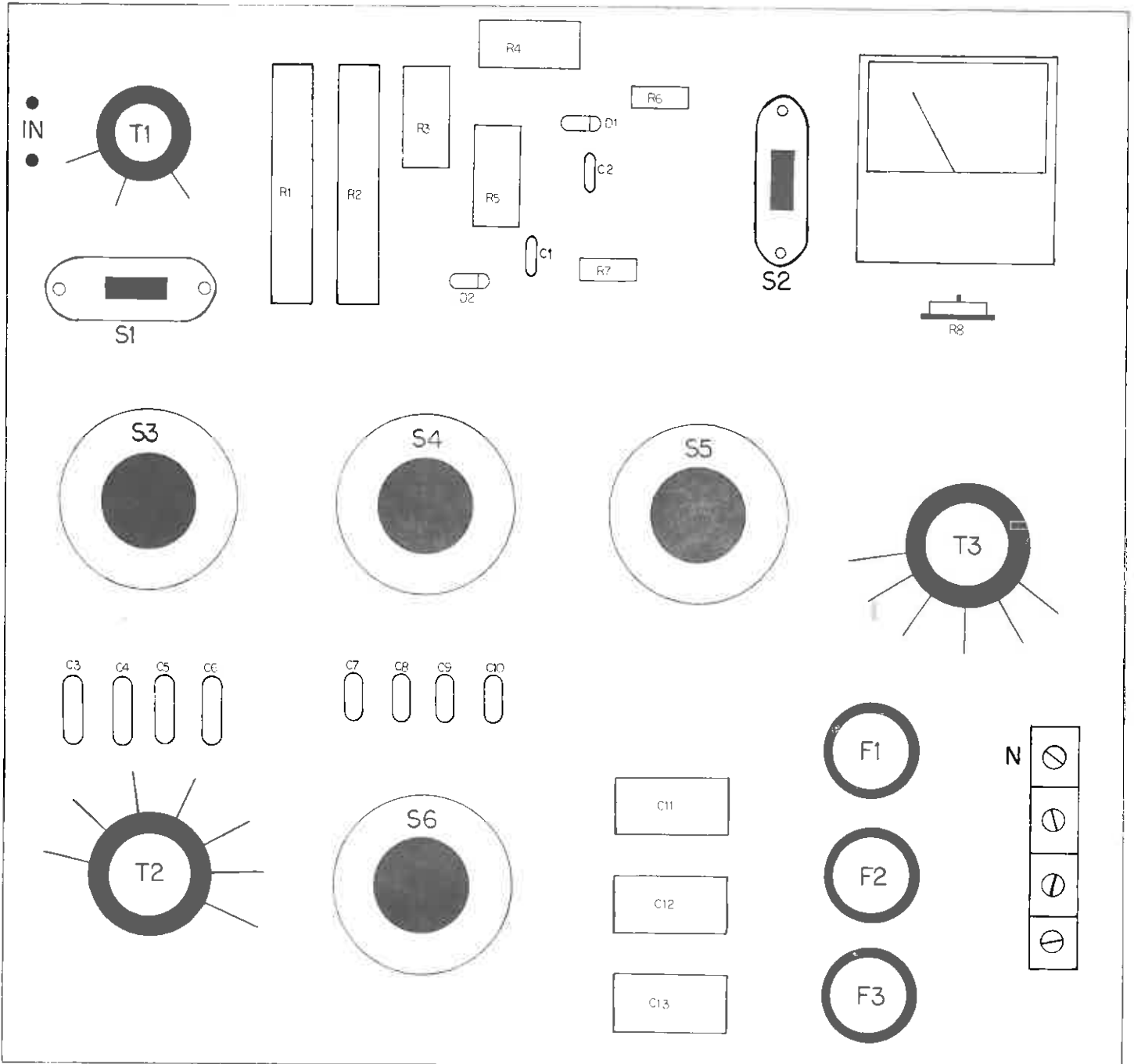
Resistors 1/2w. 5% unless noted  
 Capacitors in MFD. unless noted

R1	.1	5w	R101	470	pot.
R2	.1	5w	R102	10,000	pot.
R3	2,260	1%	R103	150	5w
R4	118	1%	R104	4.7	
R5	680		R105	22	
R6	680		R106	22	
R7	10,000	pot.	R107	2,200	
R8	10,000		R108	2,200	
R9	220,000		R109	1,500	
R10	820				
R11	10,000	2%	C1	.01	
R12	510	2%	C2	.01	
R13	15,000		C3	12,000	40V
R14	47,000		C4	.1	
R15	2,000		C5	.1	
R16	27,000		C6	.1	
R17	10,000	pot.	C7	10	35V
R18	47,000		C8	10	35V
R19	100,000		C9	10	35V
R20	100,000		C10	10	35V
R21	100,000		C11	220	PF
R22	10		C12	.01	
R23	100,000		C13	.01	
R24	1,000		C14	.001	
R25	10,000	pot.	C15	4.7	16V
R26	1,000	pot.	C16	10	PF
R27	820		C17	.1	
R28	100		C18	.1	
R29	1,000		C19	100	16V
R30	100		C20	100	16V
R31	47,000		C21	100	16V
R32	1,800		C22	.1	
R33	47		C23	.1	
R34	1,300		C24	.1	
R35	1,000		C25	.1+.1	
R36	3,000		C26	470	35V
R37	3,000		C101	.1	
R38	10,000		C102	.1	
R39	10,000		C103	100	16V
R40	100	5w	C104	1,000	6V
R41	6.8		C105	.47	
R42	150	5w	C106-C110	Factory Select	
R43	1,500		C111	.01	
R44	680		C112	.01	
R45	10,000	pot.	C113	.1	

TRANSMITTER PARTS LIST CONT'D.

D1	3amp	100V	T1	6A	24V
D2	3amp	100V	T2	600-600	ohms
D3	3amp	100V	T101	RSMTI1	
D4	3amp	100V	T102	RSMT01	
D5	IN4742A	12V			
D6	IN4148				
D7	LED				
D8	IN4148				
D9	IN4148				
D10	IN4148				
D11	IN4148				
D12	LED				
D101	IN34A				
F1	2amp	SLO-BLO			
F101	4amp				
S1	SPST				
RFC1	RSM RF01				
RFC2	47 microhy.				
RFC101	RSM RF01				
RFC102	1MHY.				
Q1	2N3904				
Q2	2N2868				
Q101	MJE205				
Q102	2N6037				
Q103	RSMQ01				
Q104	RSMQ01				
IC1	SP705B				
IC2	1496				
IC3	747				
IC4	741				
IC5	747				
L101,102	Factory Select				

# COUPLER PARTS LAYOUT



TRANSMISSION COVERAGE REPORT  
(Complete one sheet per coupler location)

College \_\_\_\_\_

Building(s) \_\_\_\_\_

I. TRANSMITTER DATA:

Site \_\_\_\_\_

Split \_\_\_\_\_ Way(s) Phone Line# \_\_\_\_\_

S/N \_\_\_\_\_ Power Set \_\_\_\_\_ Freq. \_\_\_\_\_ Limiter in \_\_\_\_\_ out \_\_\_\_\_

Notes: \_\_\_\_\_

\_\_\_\_\_

II. COUPLER DATA:

Site \_\_\_\_\_

Loading: standard \_\_\_\_\_ neutral \_\_\_\_\_ phase jump \_\_\_\_\_ SWR \_\_\_\_\_

Notes: \_\_\_\_\_

\_\_\_\_\_

III. RECEPTION:

Signal Strength: A+ \_\_\_\_\_ A \_\_\_\_\_ A- \_\_\_\_\_ B+ \_\_\_\_\_ B \_\_\_\_\_ B- \_\_\_\_\_ C+ \_\_\_\_\_ C \_\_\_\_\_ C- \_\_\_\_\_

Comments \_\_\_\_\_

Carrier Noise : A+ \_\_\_\_\_ A \_\_\_\_\_ A- \_\_\_\_\_ B+ \_\_\_\_\_ B \_\_\_\_\_ B- \_\_\_\_\_ C+ \_\_\_\_\_ C \_\_\_\_\_ C- \_\_\_\_\_

Comments \_\_\_\_\_

IV. NOTES: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

