

MAINTENANCE MANUAL

9084

SYNTHESIZED SIGNAL
GENERATOR

RACAL-DANA

RACAL

The Electronics Group



RACAL

Synthesized Signal Generator 9084

TOXIC HAZARD

BERYLLIUM COMPOUNDS

THIS EQUIPMENT INCLUDES COMPONENTS CONTAINING BERYLLIUM COMPOUNDS

1. Beryllium compounds, the most commonly met being beryllium oxide, are dangerous only when in the form of dust. This may be inhaled or ingested, or may enter the body through cuts or abrasions.
2. Beryllium compounds may be found in this equipment in the following places:
 - (1) In RF transistors
 - (2) In heat sink insulating washers
 - (3) As a corrosion product on metallic beryllium alloys.
3. There is no hazard from the beryllium which is incorporated in many RF transistors provided the case is not damaged. Unserviceable transistors should not, however, be disposed of in normal waste containers whose contents may subsequently be incinerated. They should be disposed of as toxic waste.
4. There is no hazard from beryllium insulating washers provided these are undamaged. They should be stored in sealed containers in a manner which prevents them being scratched or broken. As a precaution gloves should be worn, and tweezers used when practicable, when the washers are handled. Scratched or broken washers may present a hazard, and should be disposed of as toxic waste. After handling beryllium oxide washers, whether broken or not, the hands should be thoroughly washed.
UNDER NO CIRCUMSTANCES SHOULD BERYLLIUM OXIDE WASHERS BE DRILLED, FILED OR MACHINED IN ANY WAY.
5. Beryllium oxide occurring as a corrosion product on beryllium alloys should be removed using a damp cloth, once the equipment has been rendered electrically safe. The cloth used must be disposed of as toxic waste.
UNDER NO CIRCUMSTANCES SHOULD THE OXIDE BE BRUSHED OR WIPED OFF DRY.
6. If beryllium oxide is believed to have been inhaled or ingested, or to have entered the skin through cuts or abrasions, medical treatment should be sought as soon as possible.

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For Service Manuals
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PART 1

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TECHNICAL SPECIFICATION

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TECHNICAL SPECIFICATION

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RF CHARACTERISTICS

Frequency Range:

10 kHz to 104 MHz in 7 bands:-

Band 1	10 kHz to	1.4 MHz
Band 2	1 MHz to	2.6 MHz
Band 3	2 MHz to	5.2 MHz
Band 4	4 MHz to	10.4 MHz
Band 5	10 MHz to	26 MHz
Band 6	20 MHz to	52 MHz
Band 7	40 MHz to	104 MHz

Frequency Step Size:

The frequency step size is governed by the tuning control sensitivity. Three sensitivities are provided, giving frequency step sizes as follows.

Sensitivity	Bands 7,6 and 5	Bands 4,3,2 and 1
Fast	100 kHz	10 kHz
Slow	1 kHz	100 Hz
Fine	0 Hz	1 Hz

Frequency Indication:

The tuning control is electronically isolated when the SENSITIVITY switch is put to the HOLD position.

The output frequency is displayed on an 8 digit LED display.
The resolution is the same as the frequency step size.

Frequency Stability:

The output is phase locked to the frequency standard.

FREQUENCY STANDARD

Internal Frequency Standard
Frequency:

5 MHz

Type:

A choice of two ovened, crystal controlled oscillators from the Racal-Dana range are offered. The specifications of these oscillators will be found under the headings OPTION 04A and OPTION 04B at the end of this technical specification.

External Frequency Standard
Frequency:

1 MHz

Minimum Level:

100 mV r.m.s.

Maximum Level:

10 V r.m.s. The peak signal plus DC level must not exceed 100 V.

Connection:

Connection is to a BNC socket on the rear panel (input impedance 1 k Ω , AC coupled). Selection of the internal or external standard is by means of a switch.

RF OUTPUT

Level:

- (1) The maximum output level is 1 volt r.m.s. (+13 dBm) into 50 Ω . The minimum output is 71 nV r.m.s. (-130 dBm) into 50 Ω .
- (2) The stepped output level switch provides attenuation from 0 dB to 130 dB in 10 dB steps. The switch is calibrated in dBm and voltage units into 50 Ω .
- (3) The vernier control provides continuous variation of the output level from -10 dB to +3 dB relative to the output level switch setting. The output level is indicated on the front panel meter.

Attenuator Accuracy:

± 0.1 dB per 10 dB step (cumulative with reference to 0 dB) ± 0.2 dB.

Output Level Flatness:

± 0.5 dB relative to the 10 MHz level.

Output Level Accuracy:
(Including flatness)

As indicated on the meter, to within the following tolerances, with the attenuator in the +10 dBm (zero attenuation) position and the OUTPUT switch at NORMAL.

± 0.5 dB	at	25 $^{\circ}$ C	$\pm$	5 $^{\circ}$ C
± 1.2 dB	at	55 $^{\circ}$ C	and	0 $^{\circ}$ C

Output Impedance:

50 Ω

Output Connector:

BNC Socket

Output VSWR:

1.1 with not less than 10 dB of attenuation selected.

Output Protection:

The output is protected against RF inputs up to 1 watt.

SPECTRAL PURITY

Harmonics:

At least 40 dB below carrier level when the OUTPUT switch is set to NORMAL. At least 34 dB below carrier level when the OUTPUT switch is at X2.

Sub-Harmonically Related Signals: None

Discrete Spurious:

At least 70 dB below carrier level 20 kHz or more off carrier frequency.

SSB Phase Noise:

More than 125 dB/Hz below carrier level at 20 kHz off carrier frequency.

Amplitude Noise:

At least 70 dB below carrier level in a 0.3 kHz to 3 kHz bandwidth.

Residual FM on CW:

Less than 5 Hz r.m.s. in a 0.3 kHz to 3 kHz bandwidth at 100 MHz.

AM on FM:

1% for deviations of 100 kHz or less.

Carrier Leakage:

The e.m.f. induced in a two turn 25 mm loop 25 mm away from any surface is less than 0.5 μ V into 50 Ω .

FREQUENCY MODULATION

Frequency Ranges:

- (1) 400 Hz, 1 kHz and 3 kHz by means of internal oscillators.
- (2) 20 Hz to 20 kHz (-3 dB bandwidth) using an external modulating signal source.

Deviation Range:

Frequency Band	Maximum Peak Deviation
1*	10 kHz
2	10 kHz
3	10 kHz
4	30 kHz
5	100 kHz
6	100 kHz
7	300 kHz

* FM is not available below 100 kHz on Band 1

External Input Level:

1 Volt r.m.s. into 600 Ω gives the selected peak deviation (f.s.d. on front panel meter).

Distortion: Less than 3% at maximum deviation using an external oscillator with THD of less than 0.5%.

Accuracy: $\pm 5\%$ of meter f.s.d. at 1 kHz.

AMPLITUDE MODULATION

CW Modulation

Frequency Range: (1) 400 Hz, 1 kHz and 3 kHz by means of internal oscillators.

(2) DC to 20 kHz (-3 dB bandwidth).

Modulation Depth:

Frequency Band	Modulation Frequency	Maximum Modulation Depth
1*	DC to 5 kHz	30%
2 to 7	DC to 20 kHz	90%

* AM is not available below 100 kHz. Modulation depth is monitored on the front panel meter for modulating frequencies from 20 Hz to 20 kHz.

External Input Level: 800 mV r.m.s. into 600 Ω gives 80% modulation depth.

Distortion: Less than 3% at 80% modulation depth and less than 1% (2% on Band 1) at 30% modulation depth using an external oscillator with THD of less than 0.5%.

Accuracy: $\pm 3\%$ of meter f.s.d. $\pm 2\%$ of meter reading for modulation depths of less than 80%.

Pulse Modulation

External Input Level: Transition from -26 dB to 0 dB relative to the selected output level is provided by an input step from -1.4 V to 0 V into 600 Ω . An input level of +1.4 V gives an output of +6 dB relative to the selected output level.

Rise and Fall times (10% to 90% of output variation):

Frequency Band	Rise and Fall Time
1*	200 μ s
2 to 7	20 μ s

* Pulse Modulation is not available below 100 kHz.

Carrier Suppression Ratio:

OFF to ON ratio is at least -26 dB.

Meter Indication:

The meter reading is proportional to the mean carrier level during pulse modulation.

MULTIPLE MODULATION

Arrangements Available:

Simultaneous AM and FM are available using either one internal and one external oscillator or two external oscillators.

INTERNAL MODULATION OSCILLATORS

Frequencies:

400 Hz, 1 kHz or 3 kHz

Frequency accuracy:

±5%

Distortion:

THD not more than 1%

Output:

1 V r.m.s. ±0.5 dB is available from a 600 Ω output impedance BNC socket on the rear panel.

REMOTE OPERATION

Facilities Controlled:

- (1) Frequency
- (2) Carrier ON/OFF
- (3) AM ON/OFF
- (4) FM ON/OFF

Remote Control Inputs:

The logic '1' control level must exceed +3.5 V and the logic '0' level must lie between 0 V and +0.5 V.

POWER SUPPLY

AC Voltage Ranges:

Four ranges selected by rear panel switches:

99 V to 121 V	198 V to 242 V
108 V to 132 V	216 V to 264 V

Frequency:

45 Hz to 66 Hz

Power Consumption:

Approximately 100 VA

MECHANICAL PARAMETERS

Dimensions:

Height	Width	Depth
133 mm	420 mm	525 mm

Weight:

16 kg

ENVIRONMENTAL CONDITIONS

Operating Temperature Range: 0°C to 55°C (but internal frequency standard to 45°C)

Storage Temperature Range: -40°C to $+70^{\circ}\text{C}$

Safety: The instrument meets the safety requirements of IEC publication 348.

ACCESSORIES

Accessories Supplied: Power Lead.
Supply fuse for 99 V to 132 V operation
Operator's manual.

Optional Accessories: $50\ \Omega$ to $75\ \Omega$ adaptor, (10 dB attenuation),
Racal-Dana part number 23-3291.

Protector muff,
Racal-Dana part number 15-0512.

19 inch rack mounting kit,
Racal-Dana part number 11-1272.

External Store Assembly
Racal-Dana part number 11-1407.

Extender boards, (set of 13)
Racal-Dana part number 19-0966 to 19-0978.

Reverse power protection unit kit, (50 watt)
Racal-Dana part number 11-1384.

RF reverse power protection fuse.
Racal-Dana part number 11-1565.

OPTION 04A FREQUENCY STANDARD 9442

Type: A fast warm up ovened oscillator suitable for the majority of applications.

Frequency: 5 MHz

Ageing Rate: ± 3 parts in 10^9 /day averaged over a minimum of 10 days after 3 months continuous operation.

Warm-up Time: Better than ± 2 parts in 10^7 within 6 minutes.

Temperature Stability: Better than ± 6 parts in 10^9 per $^{\circ}\text{C}$ averaged over the range -10°C to $+45^{\circ}\text{C}$, but operable to $+55^{\circ}\text{C}$.

OPTION 04B FREQUENCY STANDARD 9421

Type: An ovened oscillator of the utmost precision for use when the highest long term accuracy is essential.

Frequency: 5 MHz.

Ageing Rate: Initial: ± 2 parts in 10^9 per day averaged over a minimum of 10 days at shipment.

Long Term: ± 5 parts 10^{10} /day averaged over a minimum of 10 days after 3 months continuous operation.

Warm-up Time: Better than ± 1 part in 10^7 within 20 minutes.

Temperature Stability: Better than ± 6 parts in 10^{10} per $^{\circ}\text{C}$ averaged over the range -10°C to $+45^{\circ}\text{C}$, but operable to $+55^{\circ}\text{C}$.

PART 2

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DESCRIPTION

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OPERATION & MAINTENANCE

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CHAPTER 1

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GENERAL DESCRIPTION

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INTRODUCTION

1. The Racal-Dana signal generator Model 9084 is designed for use over the range 10 kHz to 104 MHz. It provides the precision of a synthesized system locked to a high stability frequency standard, yet retains the versatility of analogue type tuning.

RF TUNING

2. Tuning is effected by rotation of a single control knob. Three rates of tuning can be selected, the size of the tuning step depending on the tuning rate chosen. The step size during fine tuning is 1 Hz over the four bands from 10 kHz to 10.4 MHz and 10 Hz over the three bands from 10 MHz to 104 MHz.
3. The frequency selected is displayed on an eight digit seven segment LED display. A HOLD control is provided to isolate the tuning control once the required frequency is set.

RF OUTPUT

4. Automatic level control maintains the output typically within ± 0.5 dB over the entire frequency range. A switched attenuator and a vernier control provide a range of output level from 1 V r.m.s. (+13 dBm) to 71 nV (-130 dBm). The attenuator is calibrated in dBm and in volts into 50 Ω .
5. A switched multiply-by-two facility is provided which doubles the output level. AM is not available when this facility is in use.

MODULATION FACILITIES

6. AM and FM facilities are provided for carrier frequencies above 100 kHz. Three spot modulating frequencies (400 Hz, 1 kHz and 3 kHz) are available from an internal oscillator. External modulating sources may also be used. Details of the permissible range of modulating frequencies, and of the modulation depths and peak deviations which can be obtained, are to be found in the Technical Specification section of this manual.
7. The AM facility can be used for pulse modulation, the off to on ratio being at least -26 dB. Simultaneous AM and FM is also possible, using either the internal and one external oscillator or two external oscillators.

REMOTE OPERATION

8. Remote control of frequency and of carrier, AM and FM on/off switching is available. The logic '1' control level must exceed +3.5 volts, and the logic '0' level must lie between 0 volts and +0.5 volts.

FREQUENCY STORES

9. External frequency stores, holding 32 or 96 frequencies, are available as optional accessories. When a frequency store is in use, control of frequency, and of carrier, AM and FM on/off switching are by switches on the external frequency store.

REVERSE POWER PROTECTION

10. A reverse power protection unit, offering protection against reverse powers of up to 50 watts is available as a factory fitted option or as a kit for fitting by the customer. The unit is contained within the instrument case. Fitting instructions are given in the Operator's Handbook.

POWER SUPPLIES

11. The instrument operates from nominal 115 volt or 220 volt supplies, 45 to 66 Hz. Voltage selection is made by means of two rear panel switches which provide four possible voltage ranges. The switches can be locked to the chosen setting.

MAINTENANCE

12. The customer is recommended to take advantage of the servicing and calibration service offered by Racal-Dana Instruments Limited, and their agents.

CHAPTER 2

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PREPARATION FOR USE

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AND OPERATING INSTRUCTIONS

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POWER SUPPLY

AC Voltage Range Setting

1. The supply voltage setting is made by means of two switches on the rear panel. The switches are covered by a clear plastic plate.
2. The upper switch positions are marked W (to left) and X, while the lower switch positions are marked Y (to left) and Z. The voltage range for each of the four possible combinations of switch positions is marked on the rear panel adjacent to the switches, and is also given in Table 1.

TABLE 1

AC Voltage Range Selection

Switch Settings		Supply Voltage Range
Upper	Lower	
W	Z	
X	Z	
X	Y	
X	Y	

3. To change the setting proceed as follows:
 - (1) Unplug the power cable from the supply.
 - (2) Remove the two Pozidriv screws securing the plastic cover plate. Note the positions of the washers.
 - (3) Set the switches to the positions which suit the local supply voltage.
 - (4) Replace the cover plate and secure it with the screws and washers removed in (2).

AC Power Fuse

4. Check that the power fuse rating is correct for the local AC supply voltage. The fuse is a 5 mm x 20 mm, glass cartridge, anti-surge type. Racal-Dana part numbers for replacement fuses are:

198 V to 264 V supply:	750 mA	23-0023
99 V to 132 V supply:	1.5 A	23-0024

DC Fuse

5. A 2 A, 5 mm x 20 mm, glass cartridge, normal quick action fuse is fitted in the +15 V supply. It is mounted on the power supply sub chassis, and is accessible when the top instrument cover is removed (see Chapter 5, paragraph 168). The Racal-Dana part number for replacement fuses is 23-0008.

Power Lead

6. The power lead must be fitted with a suitable connector in accordance with the standard colour code.

	<u>European</u>	<u>American</u>
Live	Brown	Black
Neutral	Blue	White
Earth(Ground)	Green/Yellow	Green

FREQUENCY STANDARD

7. If it is intended to use an external frequency standard this should be connected at the EXT. STANDARD I/P socket on the rear panel. The STANDARD switch on the rear panel should be set to EXT.
8. If the internal frequency standard is to be used ensure that the STANDARD switch is set to INT.

REMOTE CONTROL

9. When remote control is to be exercised via a Racal-Dana External Frequency Store the following procedure should be followed:

(1) Set the External Frequency Store switches as follows:

- (a) STORE/RECALL switch to STORE
- (b) NORMAL/OFF/X2 switch to OFF
- (c) AM and FM switches to OFF.

- (2) Plug the connector of the ribbon cable assembly into the CONTROL BUS socket on the rear panel of the 9084.

CAUTION: Take care not to press the red STORE button, as this will result in the frequency set on the signal generator being written into store location 00, and the original contents of that location will be lost.

- (3) Check that the store location digital indicator reads 00.
- (4) Set the STORE/RECALL switch to RECALL. Check that the REMOTE PROGRAMMING indicator lights. The signal generator display will indicate the frequency stored in location 00 and will flash because the carrier is switched off. All the switch button indicators except the selected internal modulation frequency, METER switch and PEAK DEVIATION switch will be extinguished.

10. If the customer's own remote control system is to be used the signal generator will switch to remote control immediately if the connection to the REMOTE CONTROL BUS socket is made with the remote/local control line (pin 31) at logic '1'. Connections to the socket should be made in accordance with Table 2. The codings to be used are given in Tables 3 and 4. The mating plug for the REMOTE CONTROL BUS socket is a 50-way ribbon connector, 3M Type 3488 1001, Racal-Dana part number 23-3276. The matching strain relief is the 3M Type 3448 15, Racal-Dana part number 23-3277.

NOTE: (1) The frequencies which can be called up by applying BCD signals to the frequency control lines are limited to the range of the frequency synthesizer, 40 to 104 MHz. The output frequency will depend upon the frequency called up and the division ratio appropriate to the range in use. For example, a frequency of 5 MHz can be obtained by calling up a frequency of 100 MHz and selecting band 3, or by calling up a frequency of 50 MHz and selecting band 4.

- (2) The frequencies in band 1 are obtained by mixing the signals derived for band 4 with 5 MHz. The frequency to be called up can be calculated from:

$$\text{Synthesizer Frequency} = (\text{Required Frequency} + 5 \text{ MHz}) \times 10$$

The demanded synthesizer frequency is limited to the range 50.1 MHz to 64 MHz.

TABLE 2

Connections to REMOTE CONTROL Bus Socket

Pin	Facility	Pin	Facility
1	A3 } Band	26	A0 } Band
2	A1 } Band	27	A2 } Band
3	D AM Switching	28	E FM Switching
4	J Carrier Switching	29	C AM Switching
5	F FM Switching	30	I Carrier Switching
6	100 MHz	31	REMOTE. LOCAL
7	C } 10 MHz BCD	32	D } 10 MHz BCD
8	A } 10 MHz BCD	33	B } 10 MHz BCD
9	C } 1 MHz BCD	34	D } 1 MHz BCD
10	A } 1 MHz BCD	35	B } 1 MHz BCD
11	C } 100 kHz BCD	36	D } 100 kHz BCD
12	A } 100 kHz BCD	37	B } 100 kHz BCD
13	C } 10 kHz BCD	38	D } 10 kHz BCD
14	A } 10 kHz BCD	39	B } 10 kHz BCD
15	C } 1 kHz BCD	40	D } 1 kHz BCD
16	A } 1 kHz BCD	41	B } 1 kHz BCD
17	C } 100 Hz BCD	42	D } 100 Hz BCD
18	A } 100 Hz BCD	43	B } 100 Hz BCD
19	C } 10 Hz BCD	44	D } 10 Hz BCD
20	A } 10 Hz BCD	45	B } 10 Hz BCD
21		46	
22		47	
23	-15 V	48	
24	+5 V	49	+5 V
25	0 V	50	0 V

TABLE 3

Remote Control Switching Codes

Function	Setting	Control Line Status	
		C	D
AM	Internal	1	1
	Off	0	0
	External	0	1
		E	F
FM	Internal	1	1
	Off	0	0
	External	0	1
		I	J
Carrier	Normal	1	1
	Off	0	0
	X2	0	1

TABLE 4

Band Switching Codes

Band	A0	A1	A2	A3	Division Ratio
7	1	1	1	0	1
6	0	1	1	0	2
5	1	0	1	0	4
4	1	1	0	1	10
3	0	1	0	1	20
2	1	0	0	1	40
1	0	0	0	1	See NOTE (2)

OPERATION INSTRUCTIONS

Warm Up Time

11. After connecting the instrument to the AC supply and setting the POWER switch to ON, allow sufficient time for the frequency standard to reach operating temperature before measurements are made. The time required for the internal frequency standard is:

Racal-Dana model 9442: 6 minutes
Racal-Dana model 9421: 20 minutes.

Controls

12. Until familiarity with the controls is gained the operator is advised to refer to the description given at the end of this chapter.

RF Tuning

13. (1) Select the required frequency band.
(2) Operate the spin wheel to set the frequency required. Select the SLOW and FINE tuning rates as the required frequency is approached to permit final accurate tuning.
(3) If required select the HOLD condition to prevent accidental change in the frequency set.

Setting Output Level

14. (1) Select CW on the meter function switch bank.
(2) Select NORMAL or X2 on the carrier level control switch bank, as required.
(3) Set the OUTPUT LEVEL control (attenuator) to the output range required. The voltage markings represent f.s.d. on the appropriate black scale on the meter. The dBm markings represent the level when the meter reads 0 dBm on the red scale.
(4) Adjust the VERNIER control until the meter indicates the level required. Note that, if X2 is selected the meter reads half the true output level.

Amplitude Modulation

15. (1) If an external modulating source is to be used attach it to the AM audio input socket and select EXT on the AM selection switch bank. Otherwise select INT. The modulation selection switch indicators will flash if the carrier frequency set is less than 100 kHz or if X2 is selected.

NOTE: The AM audio input socket is direct coupled. Any direct voltage level on the audio signal to be used will affect the mean level and modulation depth.

- (2) If internal modulation is to be used select the required modulating frequency.
- (3) Select AM on the meter function switch bank. The indicator will flash if the AM selection switches are at OFF.
- (4) Adjust the MODULATION LEVEL control (for internal modulating source only) or the amplitude of the external modulating signal to obtain the required depth of modulation measured on the black 0-10 scale.

Pulse Modulation

16. Pulse modulation is possible using an external source applied to the AM audio input socket and with EXT selected on the AM selection switch bank.
17. During pulse modulation the meter will indicate the average carrier level, the reading depending upon the mark/space ratio as well as the amplitude of the modulating waveform. If the carrier level is set with 0 volts at the AM audio input socket a modulating waveform transition from -1.4 volts to 0 volts will give a carrier level change from -26 dB to 0 dB relative to the level set. A transition from -1.4 volts to +1.4 volts will give a carrier level change from -26 dB to +6 dB relative to the level set.
18. The carrier level required to correspond to the peak value of the modulating waveform may also be set with that peak value applied to the AM audio input socket. The modulating waveform must reach a value of -1.4 volts to reduce the carrier level to 26 dB below the level set.

Frequency Modulation

19.
 - (1) If an external modulating source is to be used attach it at the FM audio input socket and select EXT on the FM selection switch bank. Otherwise select INT. The modulation selection switch indicators will flash if the carrier frequency set is less than 100 kHz.
 - (2) If internal modulation is to be used select the required modulating frequency.
 - (3) Select FM on the meter function switch bank. The indicator will flash if the FM selection switches are at OFF.
 - (4) Select the deviation required to represent f.s.d. on the meter on the PEAK DEVIATION switch bank. The REDUCE DEVIATION indicator will light if the peak deviation chosen is incompatible with the frequency band in use. If this warning is ignored the indicators on the PEAK DEVIATION switch bank will be seen to 'step down', the REDUCE DEVIATION indicator being extinguished when a suitable setting is reached.

- (5) Set the required deviation by adjustment of the MODULATION LEVEL control (for internal modulating source only) or the amplitude of the external modulating signal. The deviation is measured on the black scale of the meter appropriate to the peak deviation selected.

Multiple Modulation

20. Simultaneous FM and AM (including pulse modulation) is possible using either:
 - (1) One internal and one external modulating source.
 - (2) Two external modulating sources.
21. Simultaneous FM and AM (excluding pulse modulation) is also possible using a single frequency from the internal modulating source.
22. The AM and FM selection switches should be set according to the modulating source combination in use. The MODULATION LEVEL control is effective on the internal modulating source only. Where AM and FM are both derived from the internal source this control adjusts the modulation depth and deviation simultaneously. Some variation of the deviation can be achieved by use of the PEAK DEVIATION switches.

REVERSE POWER PROTECTION UNIT (OPTION)

23. When the Reverse Power Protection Unit is fitted the application of reverse power in excess of the triggering level will result in the open circuiting of the 9084 output line and the sounding of a warning buzzer.
24. The operation of the 9084 is not affected by operation of the protection unit. Once the reverse power is removed the protection unit will reset and the 9084 output will be restored at the original values.

OPERATION USING EXTERNAL FREQUENCY STORE

25. Connect the External Frequency Store as instructed in paragraph 9.

Control of Carrier

26. The carrier ON/OFF switching is controlled by the NORMAL/OFF/X2 switch on the External Frequency Store. The carrier level is controlled by the vernier and attenuator controls on the 9084 front panel.
27. The carrier frequency may be set to any of those stored by setting the appropriate store location on the External Frequency Store digital indicator. This may be done using the numeric buttons (pressing the more significant digit first) or the increment and decrement buttons. The 9084 will be set to the stored frequency when the second digit button or the increment or decrement button is pressed.

NOTE: (1) A false store content is indicated when only one store location indicator is lit. To select locations 00 to 09 the 0 must be entered as the more significant digit.

(2) If, when using the 32 location External Frequency Store, a location from 32 to 95 is selected the 9084 display will show two decimal points.

Setting of AM

28. To set the 9084 for AM proceed as follows:

- (1) Set the External Frequency Store STORE/RECALL switch to STORE.
- (2) Select the required internal modulation frequency on the 9084.
- (3) Connect the external modulation source, and set the modulation frequency.
- (4) Set the STORE/RECALL switch to RECALL.
- (5) Select the required carrier frequency store location.
- (6) Set the External Frequency Store NORMAL/OFF/X2 switch to NORMAL.
- (7) Set the 9084 meter switch to AM.
- (8) Set the External Frequency Store AM switch to INT or EXT as required.

NOTE: AM is not available with carrier frequencies below 100 kHz or with the carrier level at X2. When the External Frequency Store is in use the indicators in the 9084 AM selection switches are switched off, and will not flash to give warning of unsuitable switch settings.

- (9) Set the modulation to the required level as indicated on the 9084 meter. The 9084 MOD LEVEL control is used to set the level of the internal modulation source.

29. The internal modulation frequency selection switches are inoperative when the STORE/RECALL switch is at RECALL. To change the internal modulation frequency the switch must be set to STORE. This will result in the carrier being set to the frequency stored in the 9084 control logic. When the modulation frequency has been changed and RECALL is selected the carrier will be reset to the frequency in the store location shown on the External Frequency Store indicator.

Setting of FM

30. To set the 9084 for FM proceed as follows:

- (1) Set the External Frequency Store STORE/RECALL switch to STORE.
- (2) Select the required internal modulation frequency on the 9084.

- (3) Connect the external modulation source, and set the modulation frequency.
- (4) Set the STORE/RECALL switch to RECALL.
- (5) Select the required carrier frequency store location.
- (6) Set the External Frequency Store NORMAL/OFF/X2 switch to NORMAL or X2 as required.
- (7) Set the 9084 meter switch to FM.
- (8) Set the 9084 PEAK DEVIATION switches as required.
- (9) Set the External Frequency Store FM switch to INT or EXT as required.

NOTE: FM is not available with carrier frequencies below 100 kHz. When the External Frequency Store is in use the indicators in the 9084 FM selection switches are switched off, and will not flash to give warning of unsuitable switch settings.

- (10) Set the peak deviation to the required level as indicated on the 9084 meter. The 9084 MOD LEVEL control is used to set the deviation given by the internal modulation source.

31. The internal modulation frequency selection switches are inoperative when the STORE/RECALL switch is at RECALL. To change the internal modulation frequency the switch must be set to STORE. This will result in the carrier being set to the frequency stored in the 9084 control logic. When the modulation frequency has been changed and RECALL is selected the carrier will be reset to the frequency in the store location shown on the External Frequency Store indicator.

Loading the Frequency Store

32. To load a frequency into a store location proceed as follows:
 - (1) Connect the External Frequency Store to a 9084 as described in paragraph 9.
 - (2) Set the STORE/RECALL switch to STORE.
 - (3) Using the digit buttons, or the increment or decrement button, set the store location to be loaded on the External Frequency Store digital indicator.
 - (4) Set the required frequency on the 9084 display, using the spin wheel.
 - (5) Press the red STORE button. The frequency will now be entered in the selected store location. The previous contents of the store location are over-written, and lost.

33. The stores are non-volatile. The stored information is retained both when the 9084 is switched off with the External Frequency Store connected, and when the External Frequency Store is disconnected. The store may, therefore, be set up on one 9084 and transferred to another for use.

DESCRIPTION OF CONTROLS, INDICATORS AND CONNECTIONS

34. In this section each control is numbered to correspond to an indicator in Fig.2.1 (front panel) or Fig.2.2 (rear panel).
35. With the exception of the POWER switch the front panel switches are non latching, and are fitted with light emitting diode (LED) indicators which light when the switch is selected. Some of these indicators flash when facilities beyond the range of the instrument's capabilities have been demanded. The conditions under which this occurs are given in the description of the appropriate switch.

Front Panel Items

36. (1) Display: This is an eight digit LED numerical indicator display which indicates the frequency called for. The display reads in MHz, the decimal point being automatically positioned. The leading digit is required for frequencies of 100 MHz and above only, and is suppressed when not required.
- (2) RANGE Switch Bank: A set of seven switches allowing the selection of the seven frequency bands.
- | <u>Band</u> | <u>Frequency</u> |
|-------------|-------------------|
| 1 | 10 kHz to 1.4 MHz |
| 2 | 1 MHz to 2.6 MHz |
| 3 | 2 MHz to 5.2 MHz |
| 4 | 4 MHz to 10.4 MHz |
| 5 | 10 MHz to 26 MHz |
| 6 | 20 MHz to 52 MHz |
| 7 | 40 MHz to 104 MHz |
- (3) Meter Function Switches: These switch the meter to read modulation depth, for AM, carrier output level or frequency deviation, for FM. The switch indicators of the AM and FM switches flash if they are selected when the Modulation Selection Switches are at OFF.
- (4) Meter: The meter carries three scales. The two black scales are used to read the carrier level in volts, AM depth and FM deviation. The red scale is used to read the carrier level in dBm.

For Service Manuals
MAURITRON SERVICES
8 Cherry Tree Road, Chinnor
Oxfordshire, OX9 4QY.
Tel (01844) 351694
Fax (01844) 352554
email:- mauritron@dial.pipex.com

- (5) VERNIER Control: This is the fine control for output level. It provides control of the carrier level over a range of 13 dB, (-10 dB to +3 dB relative to the OUTPUT LEVEL switch setting).
- (6) RF Output Socket: The socket is a 50 Ω BNC type.
- (7) OUTPUT LEVEL Control: This is the switched attenuator control. The attenuation range is from 0 to 130 dB in 10 dB steps. It is scaled in dBm and voltage units into 50 Ω .
- (8) Carrier Level
- (1) NORMAL: When selected the maximum carrier level is +13 dBm, or 1 volt r.m.s. into 50 Ω .
 - (2) OFF: When selected the carrier is switched off the display will flash to indicate that the instrument is out of lock.
 - (3) X2: When selected the maximum carrier level is +19 dBm or 2 volts r.m.s. into 50 Ω . AM is not available when this switch is in use.
- (9) AM Audio Input Socket: The socket is a BNC type. The input is direct coupled and has an input impedance of 600 Ω . 800 mV r.m.s. input gives 80% modulation depth.
- (10) REDUCE DEVIATION Indicator: This indicator will light if the maximum deviation selected is incompatible with the carrier frequency band in use. If this warning is ignored the instrument will step down automatically to the highest peak deviation setting which may be used with the frequency band in use.
- (11) PEAK DEVIATION Switches: These switches allow one of five deviation ranges to be selected. The system is such that the meter, when reading deviation, will show full scale deflection at the peak deviation level selected.
- (12) MODULATION FREQUENCY Switches: These switches provide a choice of 400 Hz, 1 kHz or 3 kHz as the internal modulating frequency.
- (13) Modulation Selection Switches: Separate switch banks are provided for AM and FM. When INT is selected on either bank a modulating signal is derived from the internal

oscillator. When EXT is selected modulation by a signal applied at the appropriate audio input socket is possible. The OFF condition should be selected if modulation is not required. The indicators on the INT and EXT switches will flash if they are selected when a frequency below 100 kHz is in use. The indicators on the AM INT and EXT switches will flash if they are selected when the X2 level control switch is selected.

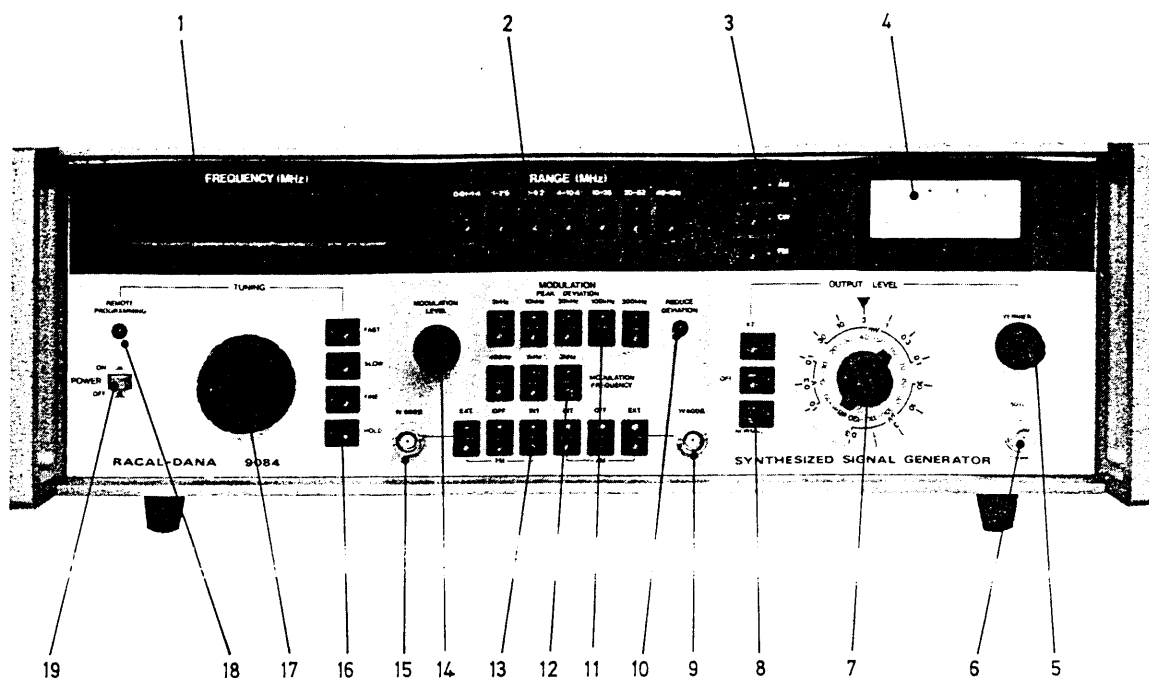
- (14) MODULATION LEVEL Control: This control allows the depth of modulation on AM and deviation on FM to be set. It is effective on the signal from the internal modulating source only.
- (15) FM Audio Input Socket: The socket is a BNC type. The input is a.c. coupled and has an input impedance of 600 Ω . 1 Volt r.m.s. input will provide peak deviation of the range selected on the PEAK DEVIATION switches.
- (16) Tuning Sensitivity Switches: These switches control the tuning step size, and provide three sensitivities. The display resolution matches the step size in use.

A HOLD position is provided. This electronically isolates the tuning control to prevent accidental alteration of frequency.
- (17) Tuning Control: This provides control of the r.f. tuning except when HOLD is selected on the tuning sensitivity switches or when remote control is in use.
- (18) REMOTE PROGRAMMING Indicator: This indicator lights when the instrument is under remote control.
- (19) POWER Switch: This switch controls the a.c. power to the instrument. In the OFF position the internal frequency standard is switched off.

Rear Panel Items

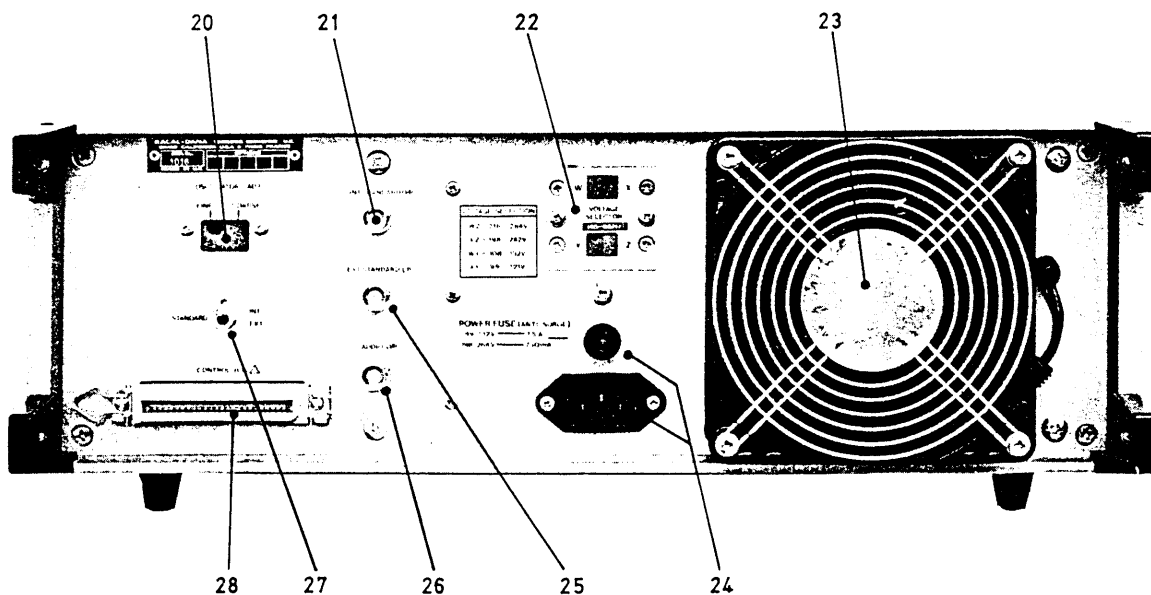
- 37. (20) Frequency Standard Adjustment: This aperture in the rear panel allows access to the tuning control of the internal frequency standard. The COARSE and FINE, markings apply to the optional frequency standard, Racal-Dana model 9421 only.
- (21) INTERNAL STANDARD Output: The BNC socket provides a TTL compatible sample of 1 MHz derived from the frequency standard in use.
- (22) Line Volts Selection Switches: These two switches allow the instrument to be operated from power supplies of 99 volts to 132 volts and 198 volts to 264 volts AC.

- (23) Fan: It is important that the free flow of air should not be obstructed.
- (24) Power Input and Fuse: The power input plug incorporates a filter, and external supply filtering should be unnecessary. The fuse is a 20 mm x 5 mm glass cartridge, and should be of the anti-surge type.
- (25) EXT.STANDARD I/P Socket: This is a BNC socket for the application of 1 MHz from an external frequency standard. The input is AC coupled and has an input impedance of 1 k Ω .
- (26) AUDIO OUTPUT Socket: The audio signal from the internal modulating oscillator is available at this socket. The output is independent of the MODULATION LEVEL control.
- (27) INT/EXT STANDARD Switch: This switch allows selection of the internal or external frequency standard.
- (28) Remote Control Socket: This socket allows connection of the lines necessary for remote control of the equipment. Carrier frequency changing and carrier, AM and FM on/off switching can be remotely controlled.



Front Panel

Fig. 2.1



Rear Panel

Fig. 2.2

RACAL

CHAPTER 3

=====

PRINCIPLES OF OPERATION

=====

INTRODUCTION

1. The explanation of the principles of operation of the 9084 in this chapter is written to block diagram level only. Detailed descriptions of the circuits employed are given in Chapter 4. Circuits, component layouts and parts lists are to be found in Part 3 of this manual.

FREQUENCY SYNTHESIS RANGE

2. The frequency synthesizer operates over the range from 40 MHz to 104 MHz. The lower frequencies of the instrument's range are obtained by dividing the synthesizer output, and, in the case of band 1, by taking the difference between a signal derived from the synthesizer and a 5 MHz reference frequency.

FREQUENCY STANDARD AND REFERENCE SOURCE (Fig.3.1)

3. The frequency synthesizer used to generate the instrument output frequency requires signals at 10 MHz, 5 MHz, 1 MHz and 1 kHz, all locked to the frequency standard in use. These signals are generated in a phase locked loop on the reference source assembly. The use of the phase locked loop provides signals of considerably greater amplitude than that available directly from the frequency standard, giving an improved signal/noise ratio.
4. The output frequencies are derived from a 10 MHz crystal controlled oscillator, the output of which is divided successively by 2, 5 and 1000. The 1 MHz output is applied to the phase sensitive detector, where it is compared with 1 MHz derived from the frequency standard to provide the frequency control voltage for the oscillator.

1 MHz COMB LOOP (Fig.3.2)

5. The 1 MHz comb loop generates a frequency f_M , which can be at any multiple of 1 MHz between the limits of 31 MHz and 95 MHz. This is done by means of a phase locked loop containing a programmable divider. The reference frequency for the loop is the 10 MHz from the reference source. Two phase sensitive detectors are provided. When the loop is in lock this condition is maintained by means of a phase sensitive detector operating at 10 MHz. The use of this frequency allows the loop to operate with a low division ratio, giving a low noise multiplication factor. The detector used is only able to pull the loop into lock over a limited range. If lock is lost a second detector, operating at 1 MHz and able to pull the loop into lock over a wide range, is automatically brought into use. The switching of control between the two detectors is carried out by a monostable circuit triggered by the out-of-lock signal.

6. Three oscillators are provided to cover the frequency range. The appropriate oscillator is enabled by the instrument control logic. If the division ratio is set to N_M the loop will lock with the oscillator frequency at $10^7 N_M$ Hz (when the two input frequencies to the phase sensitive detector are the same).
7. The division ratio of the divider lies between the limits of 4.1 and 9.5, allowing oscillator frequencies of 41 MHz to 95 MHz. Frequencies from 31 MHz to 40 MHz are achieved by operating the oscillator over the range 62 MHz to 80 MHz and dividing the output by two.

1 kHz COMB LOOP (Fig.3.3)

8. The 1 kHz comb loop generates a frequency f_K , which can be any multiple of 1 kHz between the limits of 7 MHz and 7.999 MHz. This is done by means of a phase locked loop containing a programmable divider. The reference frequency for the loop is the 1 kHz from the reference source.
9. A single oscillator covers the required range. If the division ratio is set to N_K the loop will lock with the oscillator frequency at $10^3 N_K$ Hz (when the two input frequencies to the phase sensitive detector are the same).
10. The division ratio limits are 7000 to 7999, all the required frequencies being obtained directly.

TRANSFER LOOP (Fig.3.4)

11. The transfer loop generates a frequency f_T , which can be any multiple of 10 Hz between the limits of 9 MHz and 10 MHz. Provision is also made for the insertion of an audio signal to provide FM.
12. Two phase locked loops are used. The loops contain identical programmable dividers. The input to the first loop is the frequency f_K ($10^3 N_K$ Hz) from the 1 kHz comb loop. This is divided by one of the programmable dividers to give a frequency of $10^3 N_K / N_T$ Hz which is applied to the phase sensitive detector.
13. The loop oscillator output and the 1 MHz standard from the reference source are applied to a mixer. The difference output is applied to the phase sensitive detector, so the loop locks with the oscillator frequency at $(10^6 + 10^3 N_K / N_T)$ Hz.
14. The frequency derived in the first loop is divided by 100 to give $(10^4 + 10 N_K / N_T)$ Hz. This is applied to the phase sensitive detector of the second loop. When this loop locks the two frequencies applied to the phase sensitive detector are the same. Because of the divider between the oscillator and phase sensitive detector this occurs at an oscillator frequency f_T of $(10^4 + 10 N_K / N_T) N_T$ Hz, or $(10^4 N_T + 10 N_K)$ Hz.

15. When the frequency f_T is at its minimum value of 9 MHz the frequency f_K is also at a minimum of 7 MHz ($N_K = 7000$).

$$\begin{aligned} \text{Thus} \quad 9 \times 10^6 &= 10^4 N_T + 7 \times 10^4 \\ \text{from which} \quad N_T &= 893 \end{aligned}$$

16. Similarly, when f_T is at its maximum value of 9.999990 MHz the frequency f_K is also at a maximum of 7.999000 MHz ($N_K = 7999$)

$$\begin{aligned} \text{Thus} \quad 9.99999 \times 10^6 &= 10^4 N_T + 7.999 \times 10^4 \\ \text{from which} \quad N_T &= 992 \end{aligned}$$

17. To simplify the loading of the programmable dividers the number loaded varies from 900 to 999, the count being stopped at 7 on each division cycle.
18. The audio signal for FM is applied to the varactor of the oscillator in the second loop, and produces a frequency deviation about the loop locked frequency set by the dividers.

OUTPUT LOOP AND LF COMBINER (Fig. 3.5)

19. The output loop generates the final synthesizer output frequency. A phase locked loop is used to generate a frequency which is the sum of f_M and f_T . This can lie between 40 MHz ($f_M = 31$ MHz and $f_T = 9$ MHz) and 104 MHz ($f_M = 95$ MHz and $f_T = 9$ MHz).
20. Four oscillators are provided to cover the frequency range. The appropriate oscillator is enabled by the instrument control logic. The loop locks when the two frequencies applied to the phase sensitive detector are the same (f_T). This occurs when the input to the mixer from the oscillator is $f_T + f_M$.
21. A sweep circuit is provided to sweep the oscillators through the loop frequency band until the locked state is detected in the lock detection circuit.
22. The synthesized frequency is used directly for band 7. For other bands division of the synthesized frequency takes place in the programmable divider, the division ratio of which is controlled from the band selection controls.
23. The level of the output signal is controlled in an amplitude modulator. The setting of the required output level, the automatic level control and the application of the audio signal for AM, if required, all occur at this stage.
24. The signal is filtered in one of a bank of twelve elliptical response filters. Two filters are provided for each of bands 2 to 7, switching being performed by diode switches under the control of the band selection and the tuning controls. The filters are within the ALC loop, which compensates for differences in pass band attenuation.

25. The frequencies for band 1 are produced by mixing frequencies between 5.01 MHz and 6.4 MHz from band 4 with the 5 MHz standard from the reference source. The difference frequency output provides the band 1 signal, the restriction in tuning range being provided by the instrument control logic.

RF AMPLIFIER AND ALC (Fig. 3.6)

26. A single, wideband amplifier is used to provide the RF output power over the complete frequency range of the instrument.
27. The output level of the amplifier is sensed in the ALC circuit which provides a control voltage for the modulator (see paragraph 23). This controls the amplitude of the input to the RF amplifier.
28. The ALC detector is provided with variable time constant circuitry. Longer time constants are automatically introduced at the low frequency end of the instrument's range to improve the ripple level within the ALC loop.
29. The level about which the ALC is to operate is required to be variable and under the control of the output level VERNIER control. This is achieved by generating a reference voltage which is applied to the vernier. The fraction of this voltage picked off the vernier is applied within the ALC loop. Provision is made for doubling the reference level when the X2 position of the carrier level control switches is selected.
30. The audio signal for amplitude modulation is applied at the same point in the system as the level setting voltage. To maintain constant depth of modulation as the carrier level is varied it is necessary for the modulating signal amplitude to vary at the same rate. This is achieved by adding the modulating signal to the level setting reference and applying the total to the VERNIER control.
31. The output of the ALC detector and the voltage picked off the VERNIER control are compared at the input to an integrating stage. Any voltage difference is integrated, varying the voltage on the modulator control line. This adjusts the input to the RF amplifier such that the ALC detector output changes and reduces the voltage difference at the integrator input.

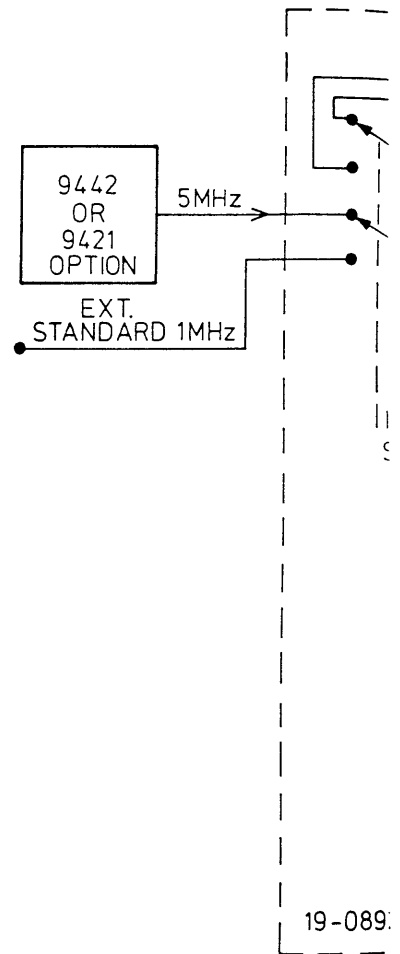
FREQUENCY MODULATION LOOP (Fig. 3.7)

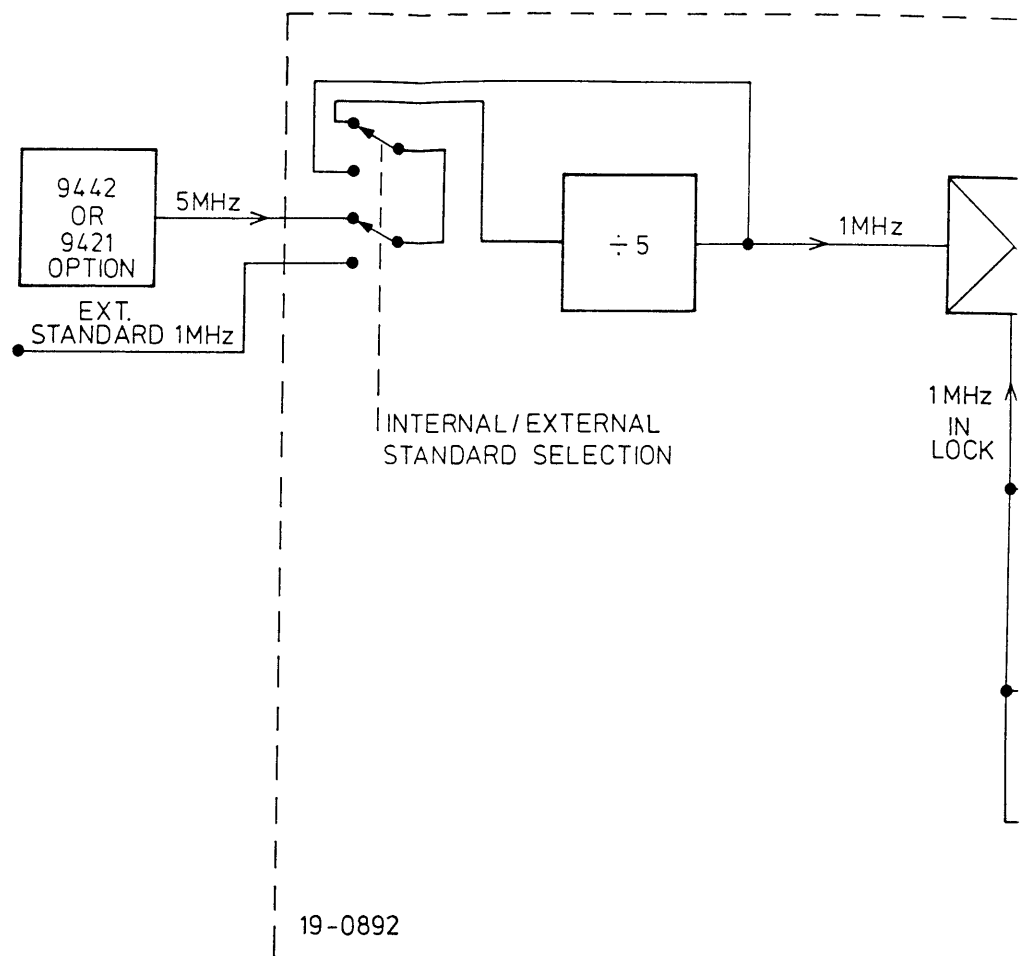
32. Frequency modulation is effected by adding a modulating voltage to the varactor control signal for the transfer loop oscillator. The resulting deviation therefore appears on the reference for the output loop, and is tracked by the output loop oscillator.
33. The deviation indicated on the meter is a measure of the modulating signal generated. Attenuators are provided to adjust the proportion of the modulating signal applied to the loop, allowing the peak deviation represented by full scale deflection of the meter to be set, and maintaining the peak deviation constant irrespective of the frequency band selected.

34. The voltage/frequency characteristic of the voltage controlled oscillator is non-linear. The closed loop FM system is used to overcome this, making the frequency deviation obtained for a given amplitude of modulating signal independent of the carrier frequency.
35. A signal from the output loop mixer ($f_T + \Delta f$) is mixed with 11.4 MHz to give a frequency which carries the deviation Δf , and has its centre frequency between 1.4 MHz and 2.4 MHz, according to the value of f_T . This signal is applied to a frequency discriminator. That part of the output signal due to Δf is compared with the modulating audio signal. The difference between these signals forms the modulating audio applied to the varactor.

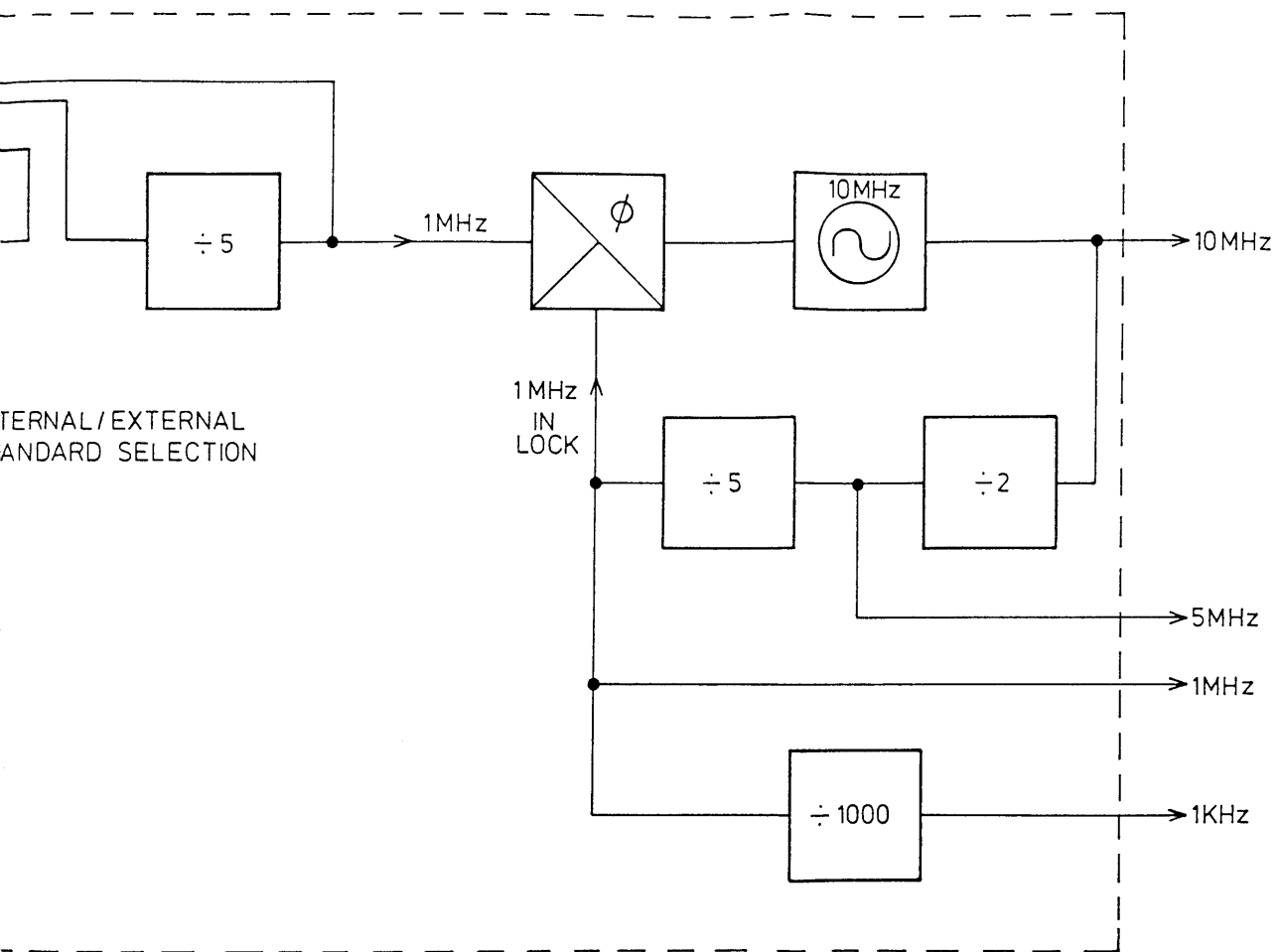
INSTRUMENT CONTROL LOGIC

36. Control of the instrument is exercised via a control logic system which makes use of large scale integration circuits and ROM's as well as TTL and CMOS circuits. The functions performed by the logic circuits include:
- (1) Setting of the display to the demanded frequency.
 - (2) Selection of the correct oscillator in the output and 1 MHz comb loops.
 - (3) Setting of the programmable dividers.
 - (4) Selecting the $\div 2$ function when the 1 MHz comb loop output is between 31 and 40 MHz.
 - (5) Selecting the LF combiner for band 1 frequencies.
 - (6) Setting appropriate ALC time constant for output level control.
 - (7) Preventing modulation being applied for output frequencies below 100 kHz.
 - (8) Preventing AM being applied when X2 is selected on the carrier level control switches.
 - (9) Adjusting the synthesizer output step size to maintain the required output step size when switching between bands.
 - (10) Checking that the called for peak deviation is compatible with the demanded frequency.
 - (11) Checking that modulation is demanded when the meter function switches are set to read modulation.
 - (12) Checking for lock in all phase locked loops.



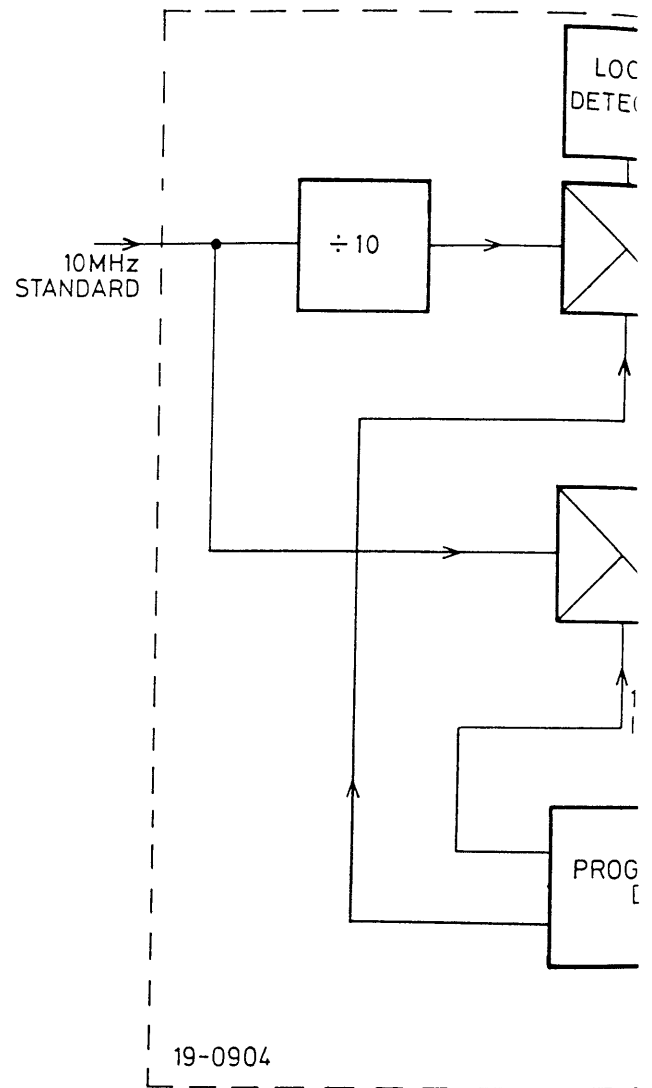


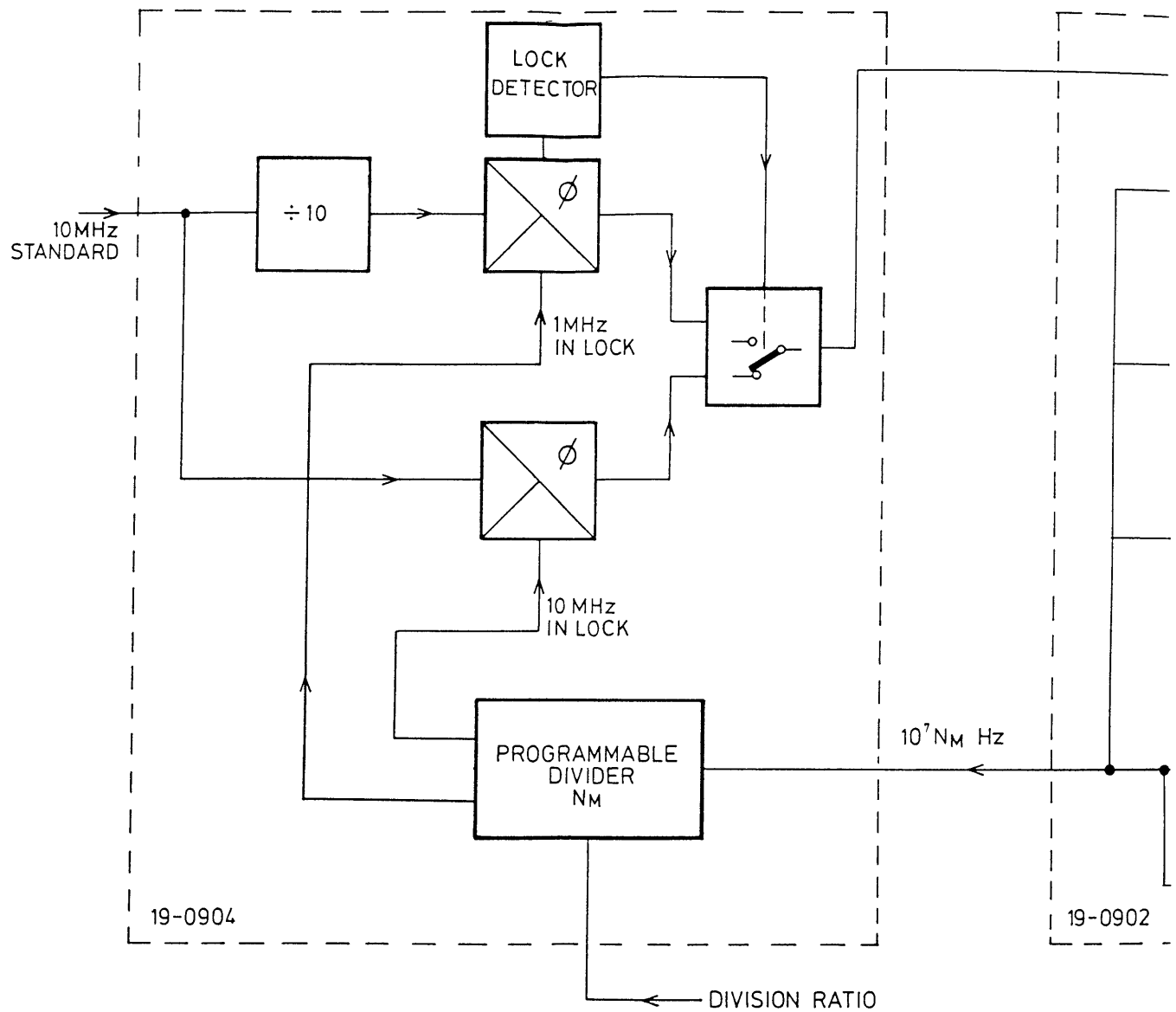
Reference Source



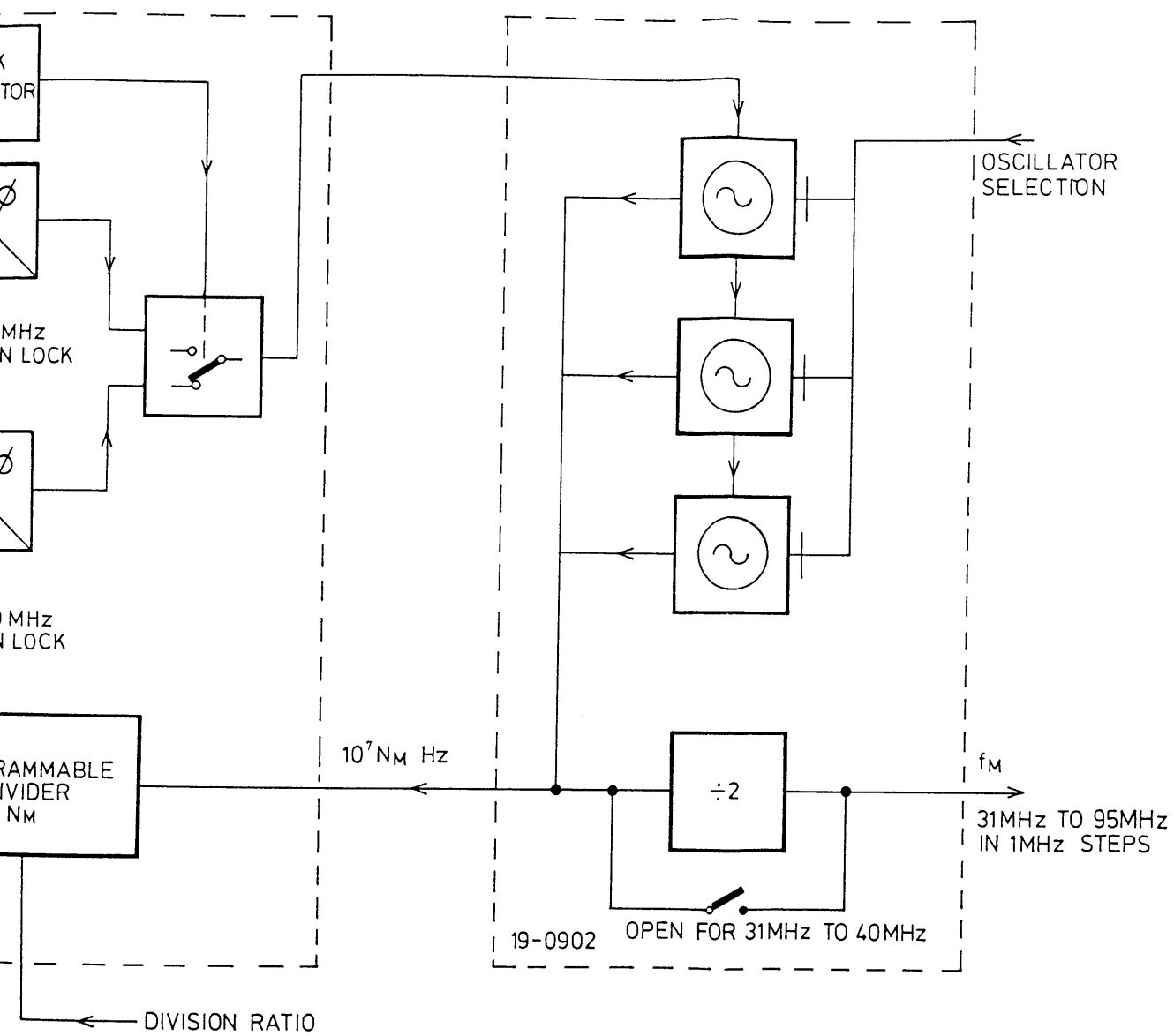
Reference Source

Fig.3.1



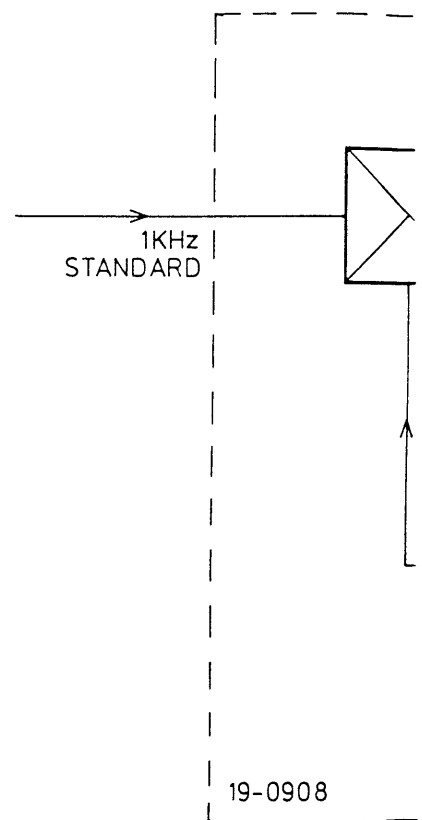


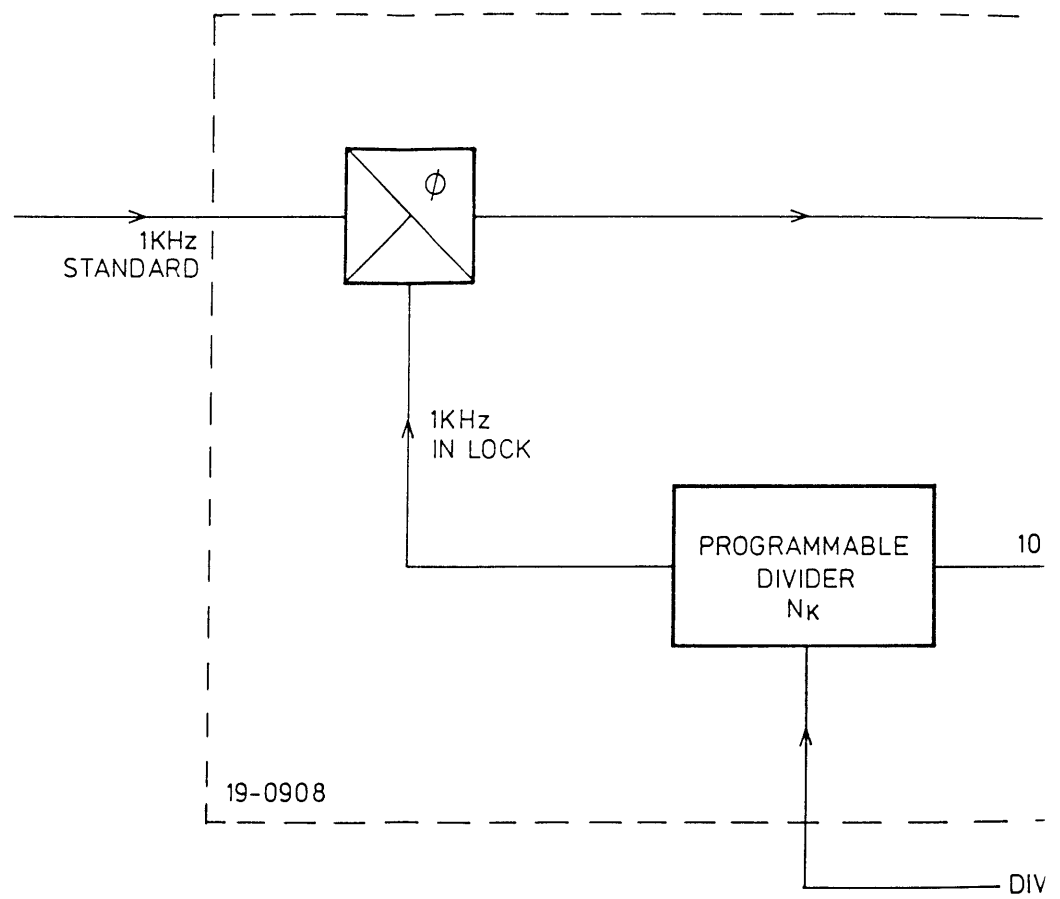
1MHz Comb Loop



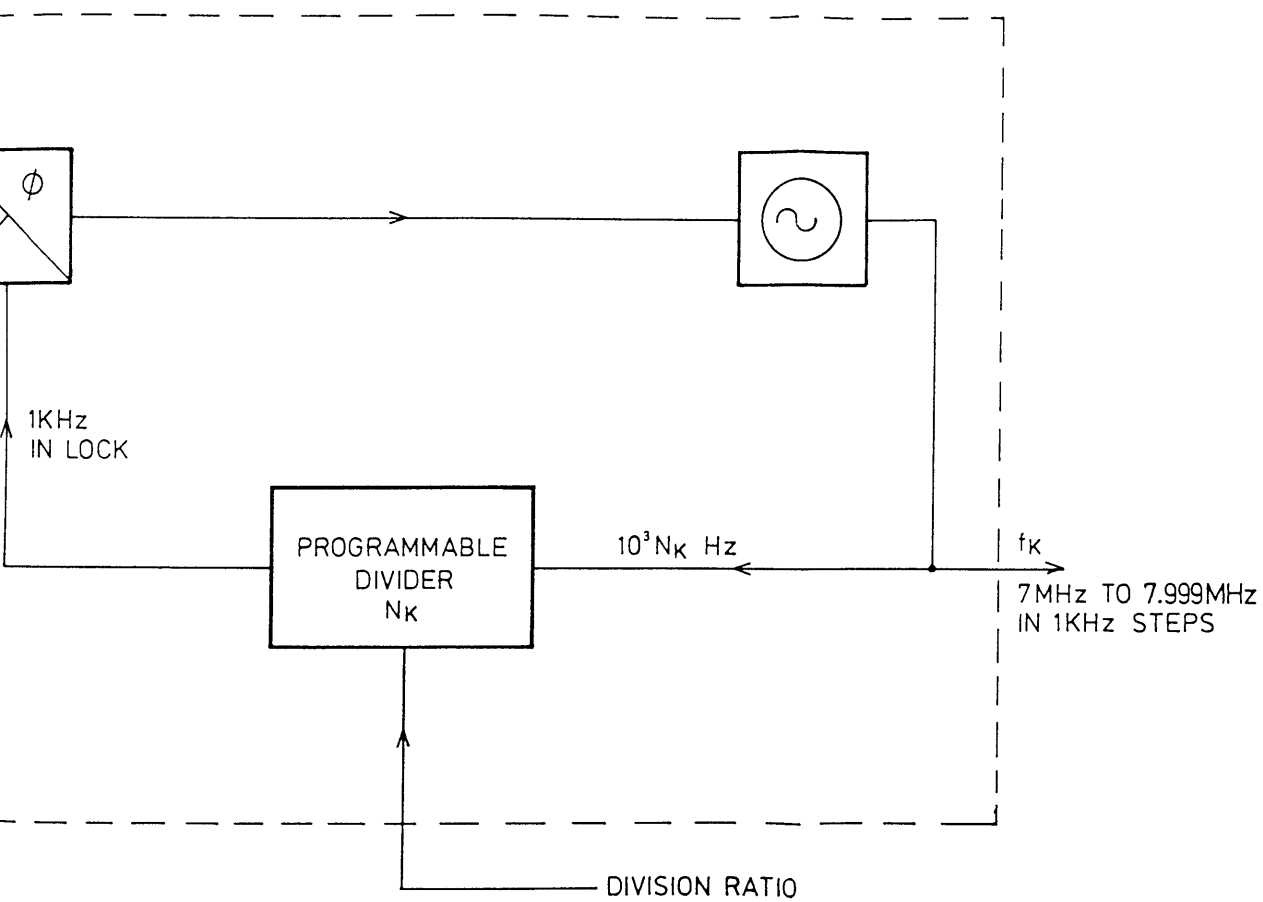
1MHz Comb Loop

Fig.3.2



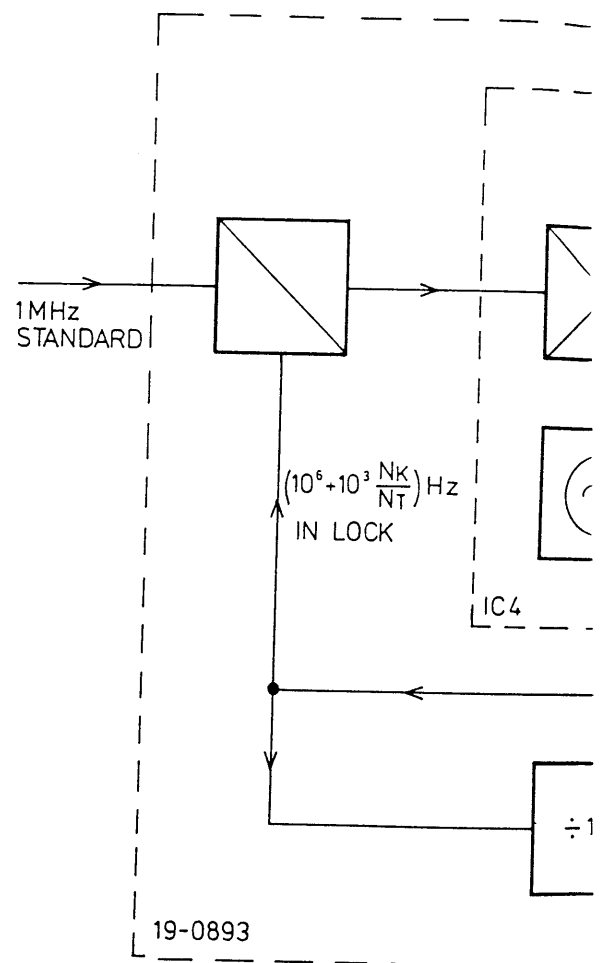


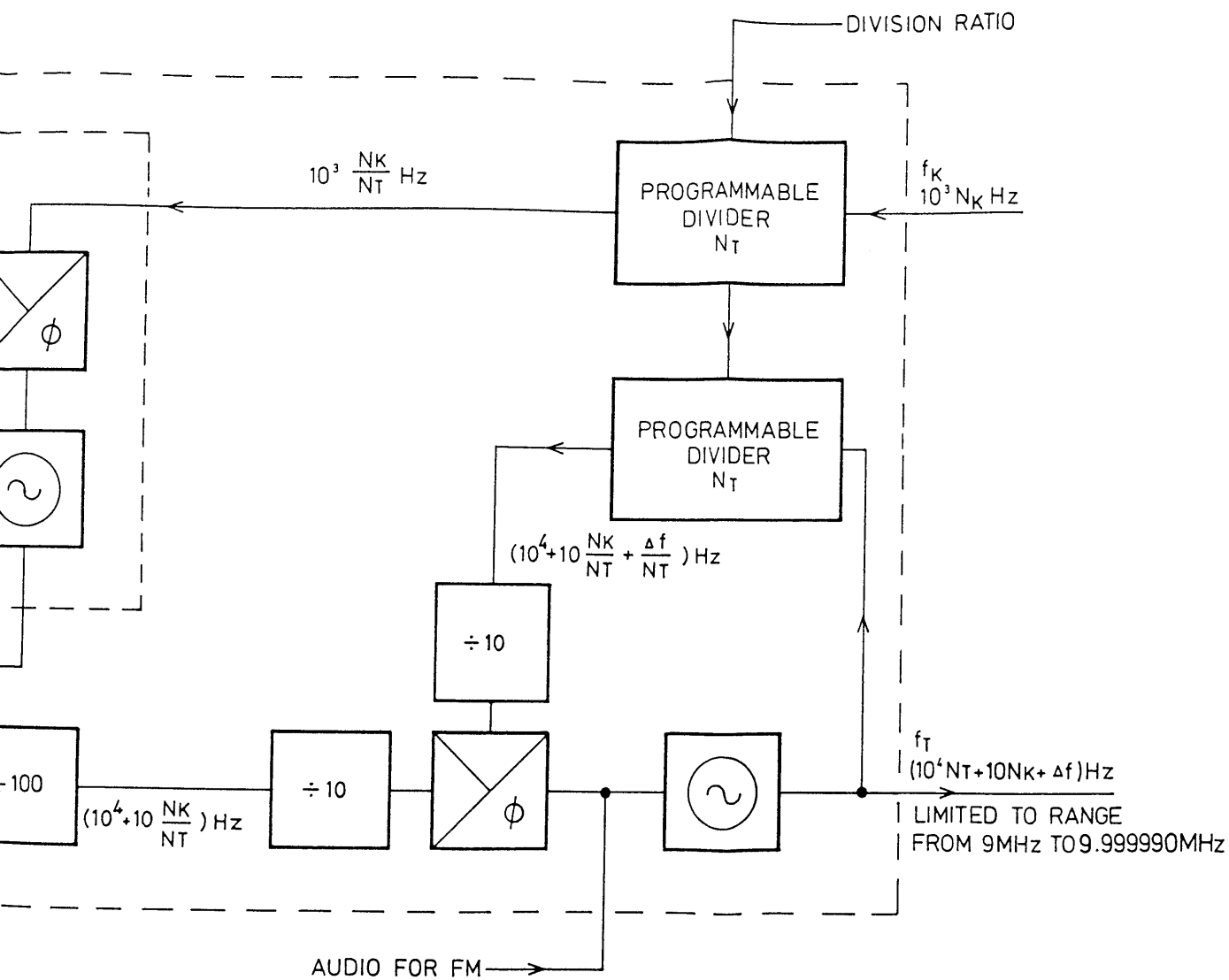
1 kHz Comb Loop



1 kHz Comb Loop

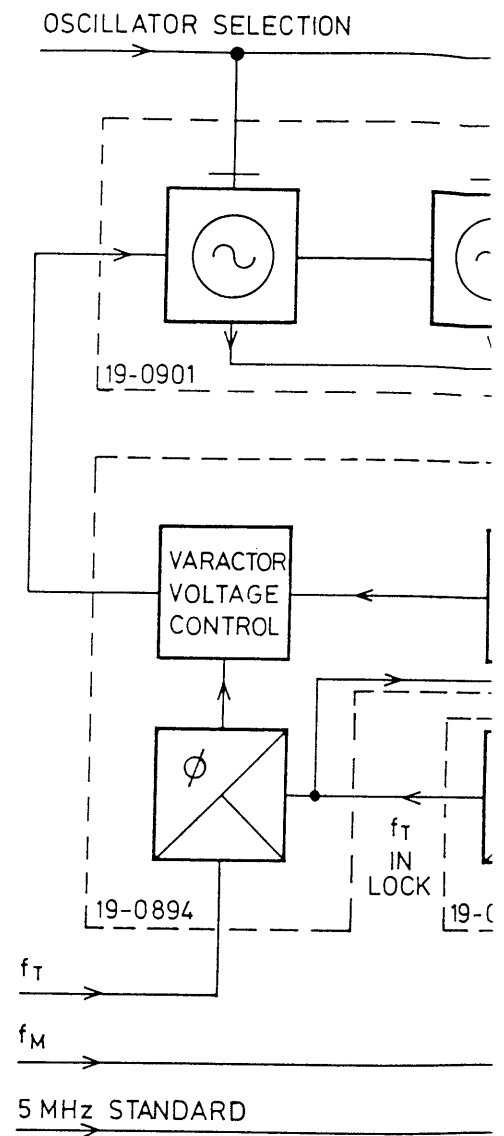
Fig.3.3

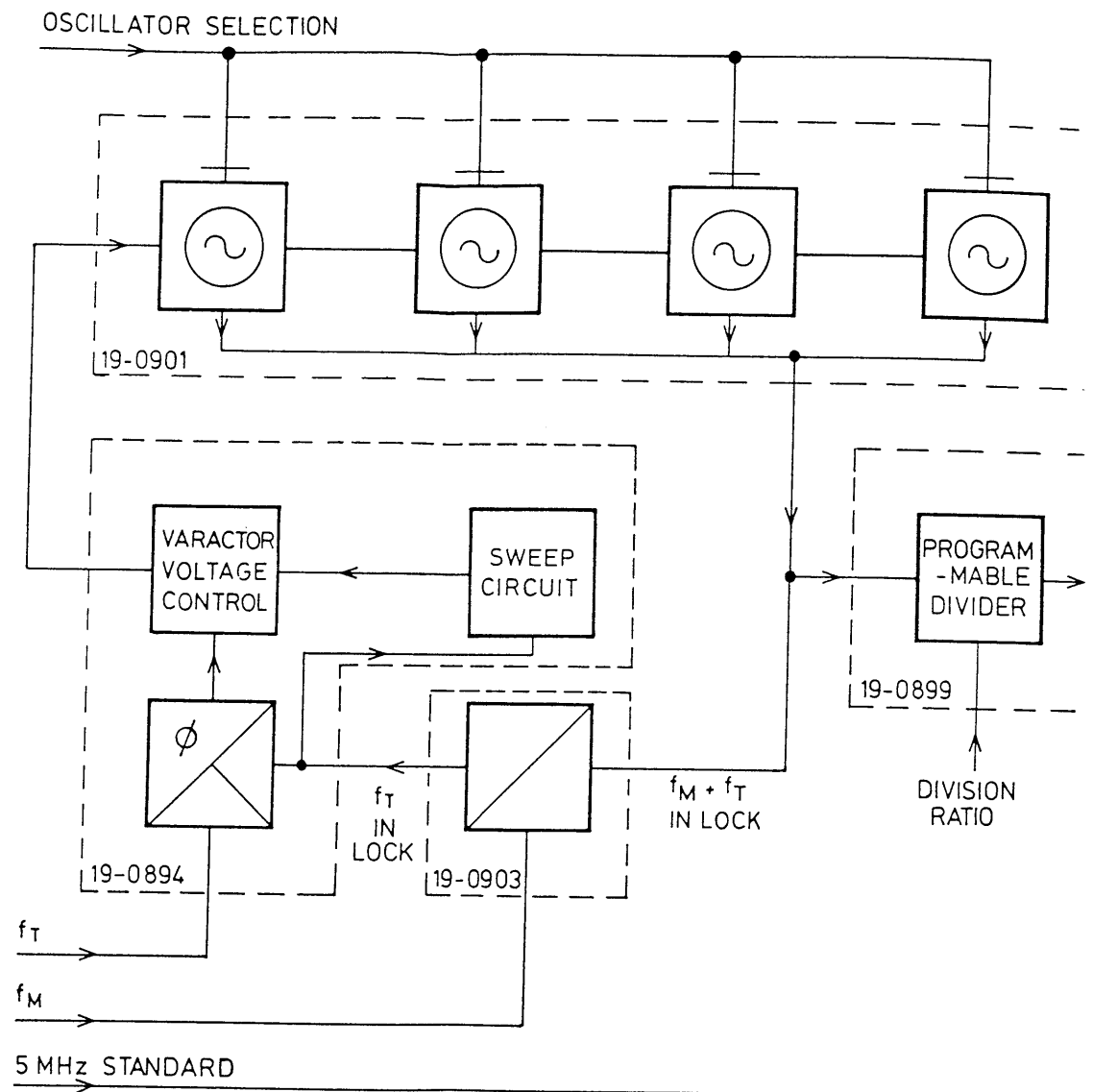




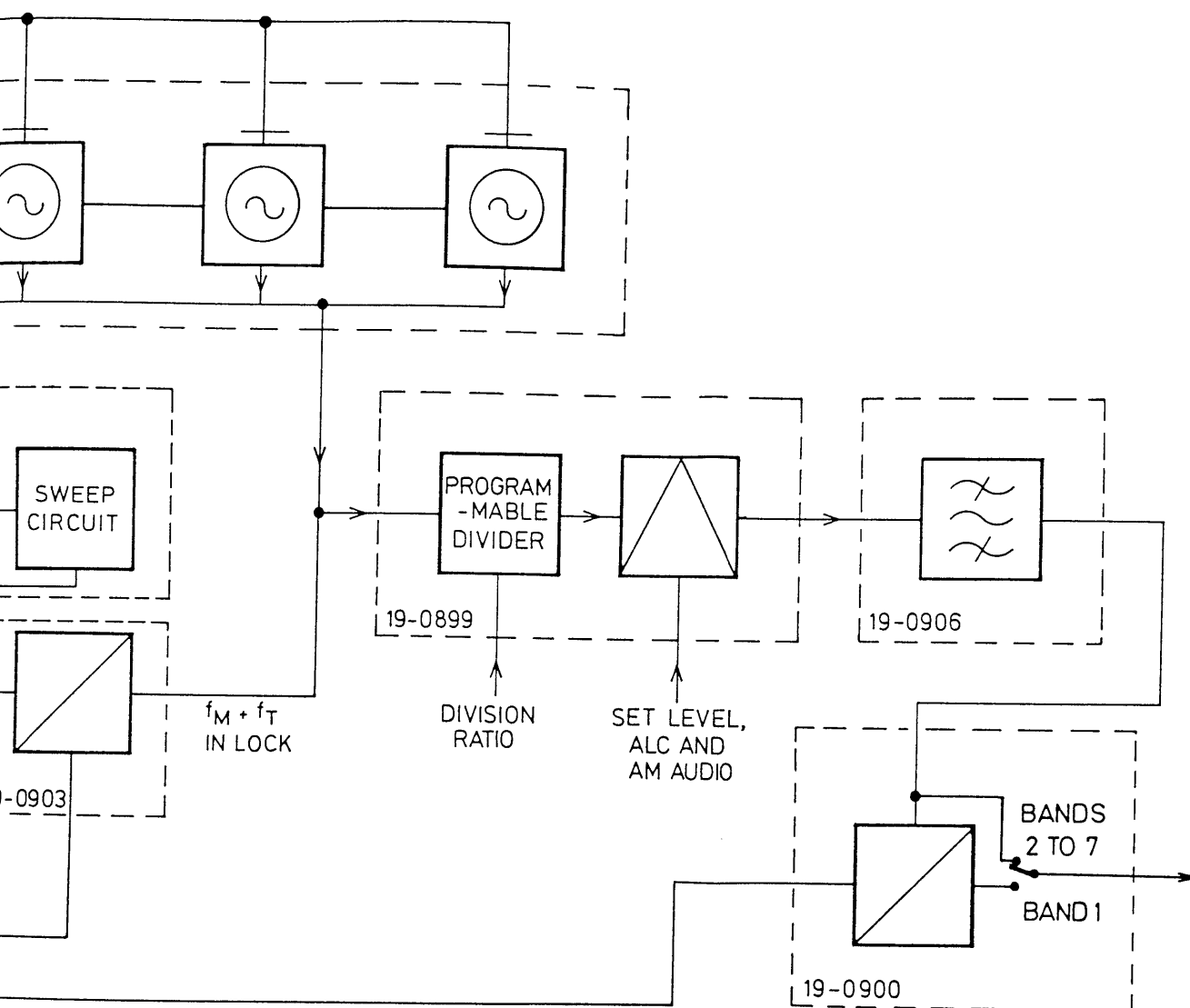
Transfer Loop

Fig.3.4



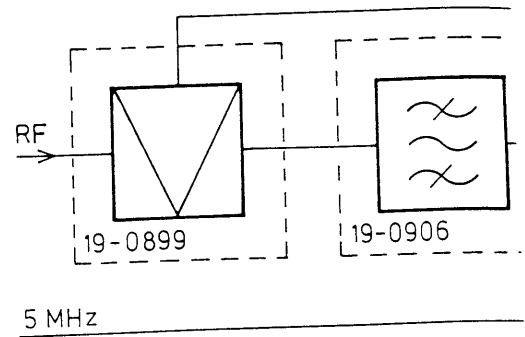


Output Loop and LF Comb

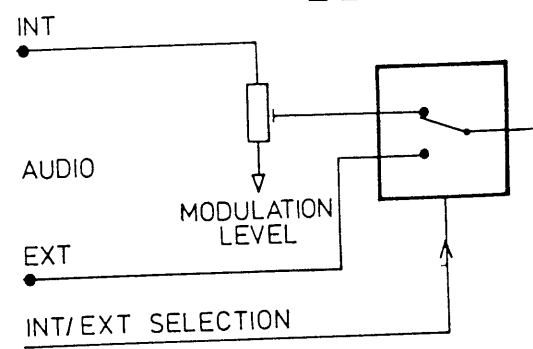
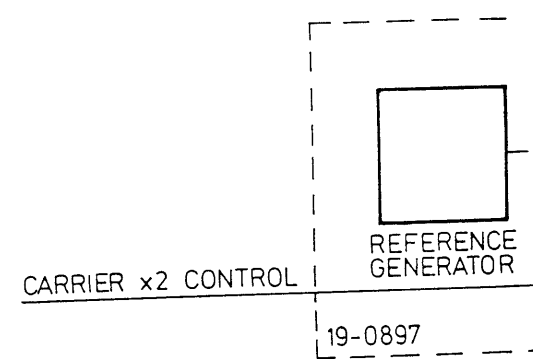


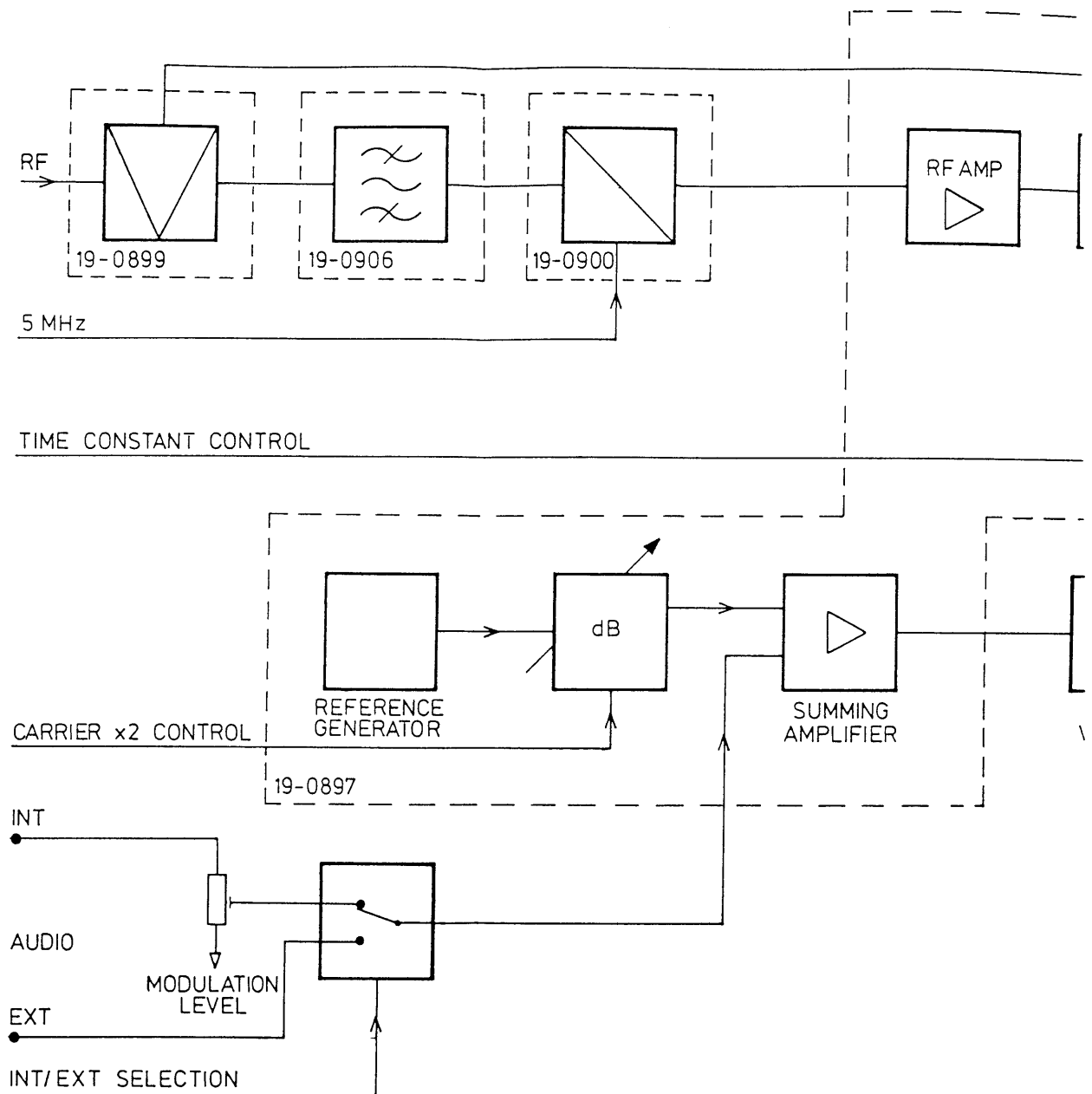
Output Loop and LF Combiner

Fig.3.5

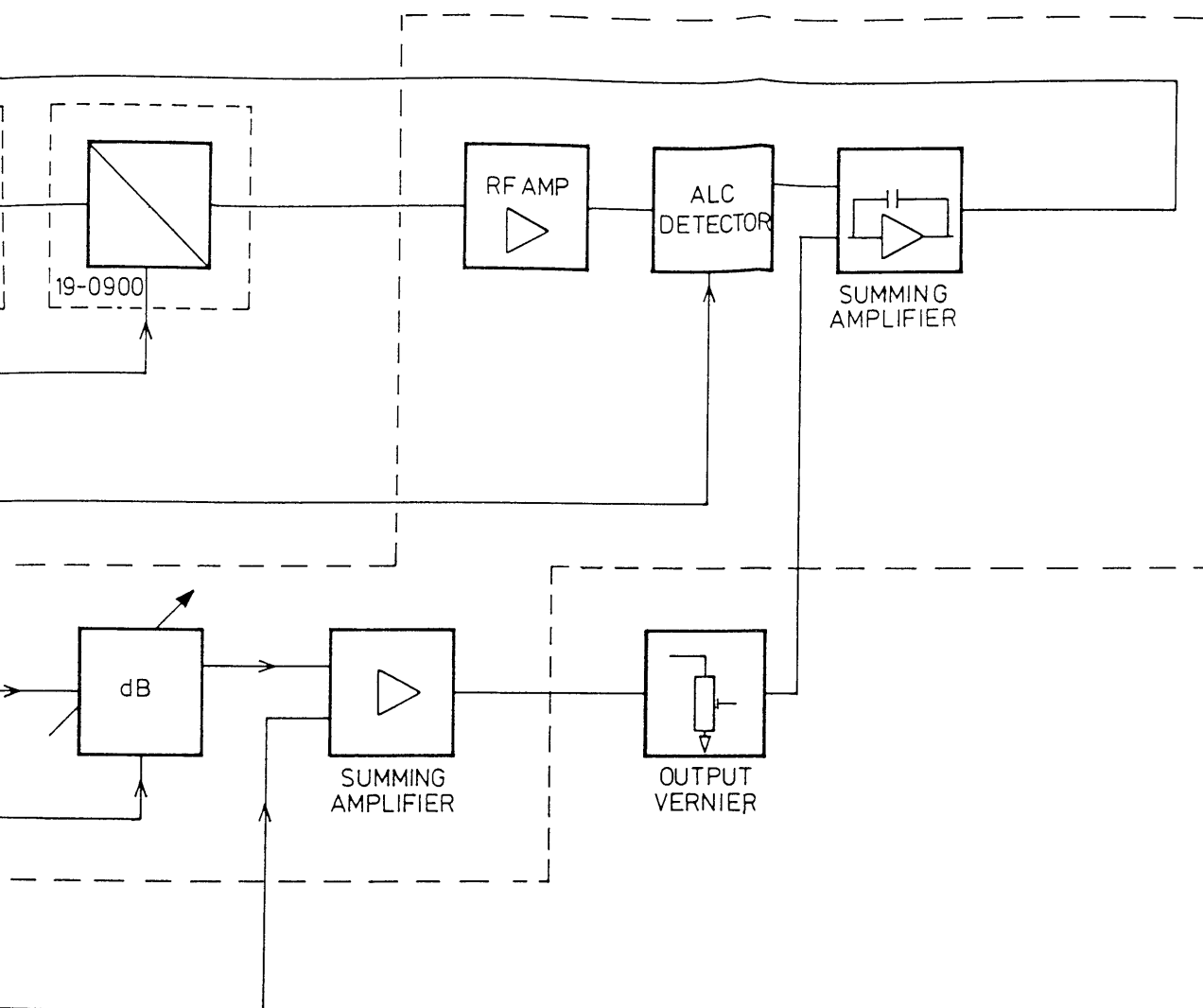


TIME CONSTANT CONTROL



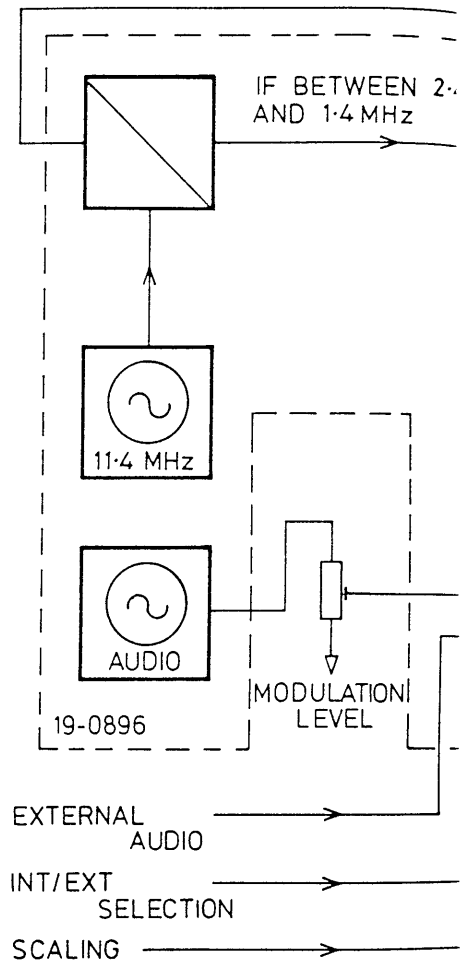


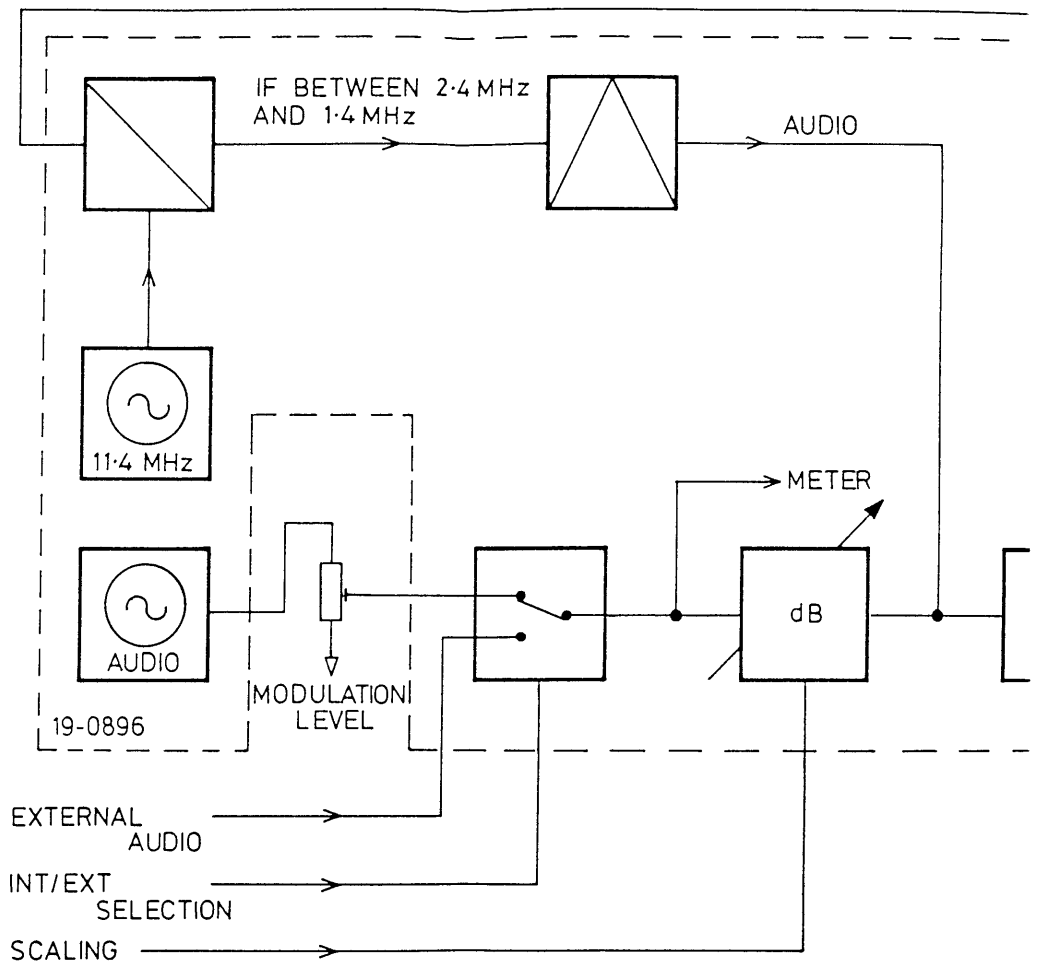
ALC System



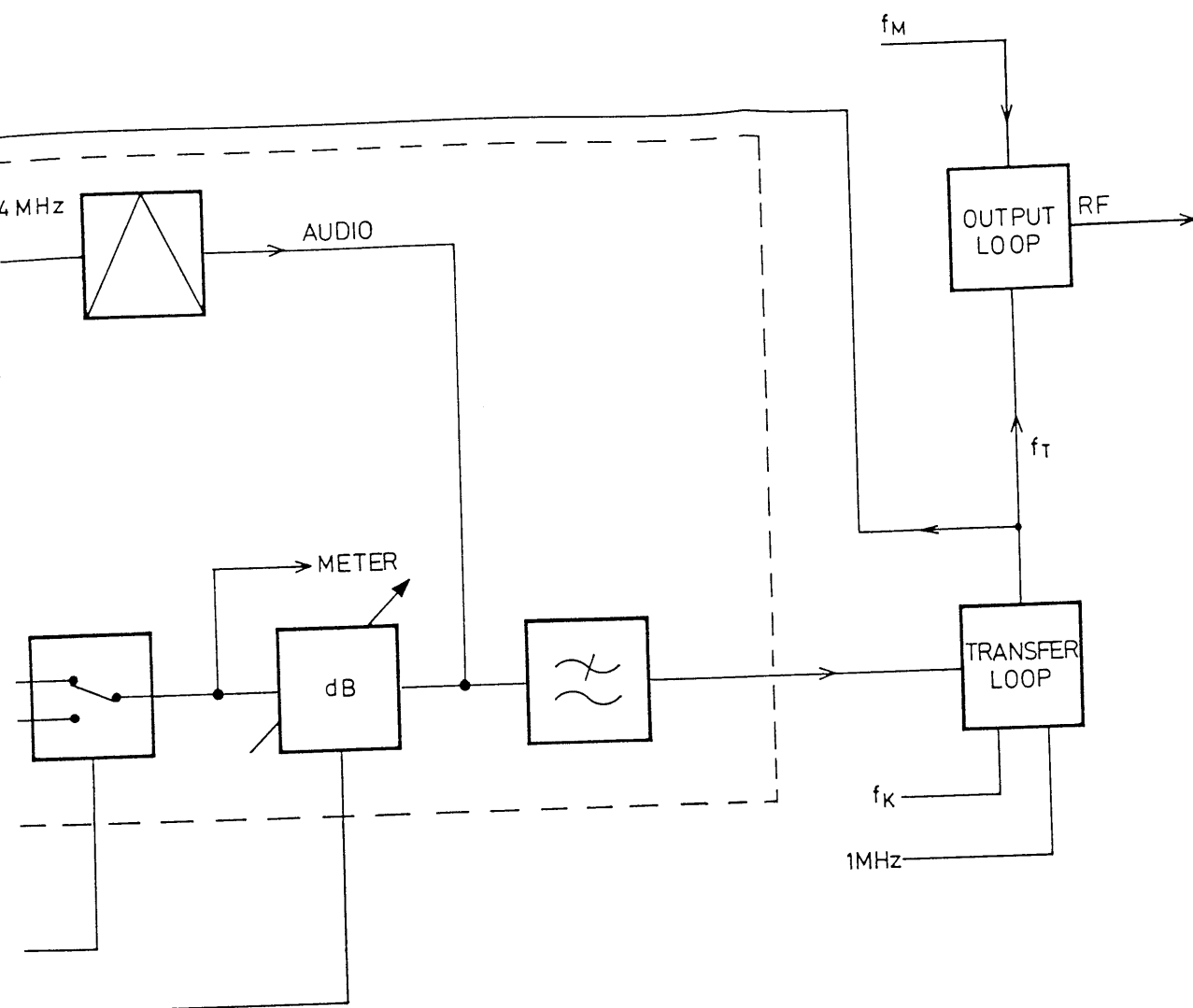
ALC System

Fig.3.6



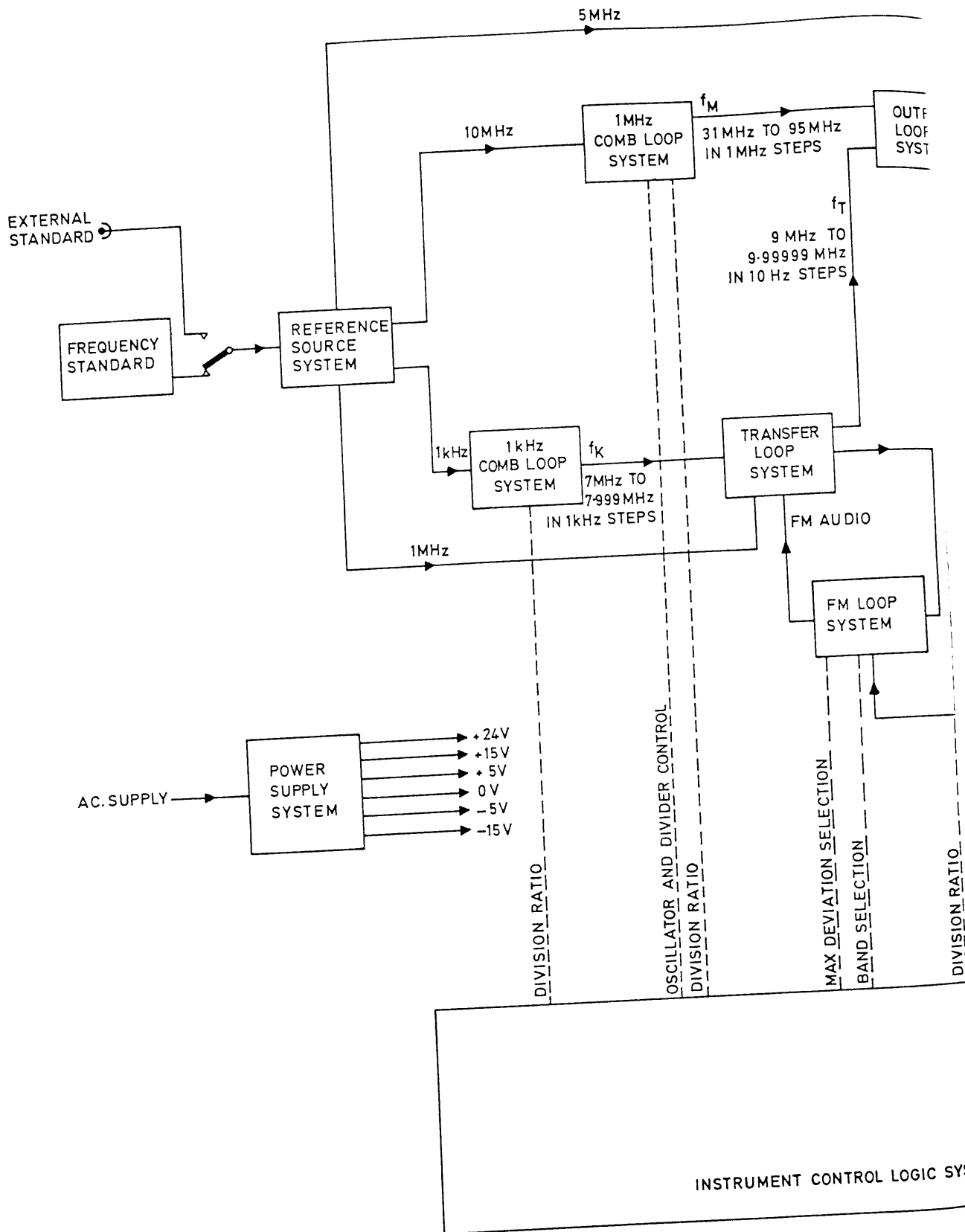


FM Loop

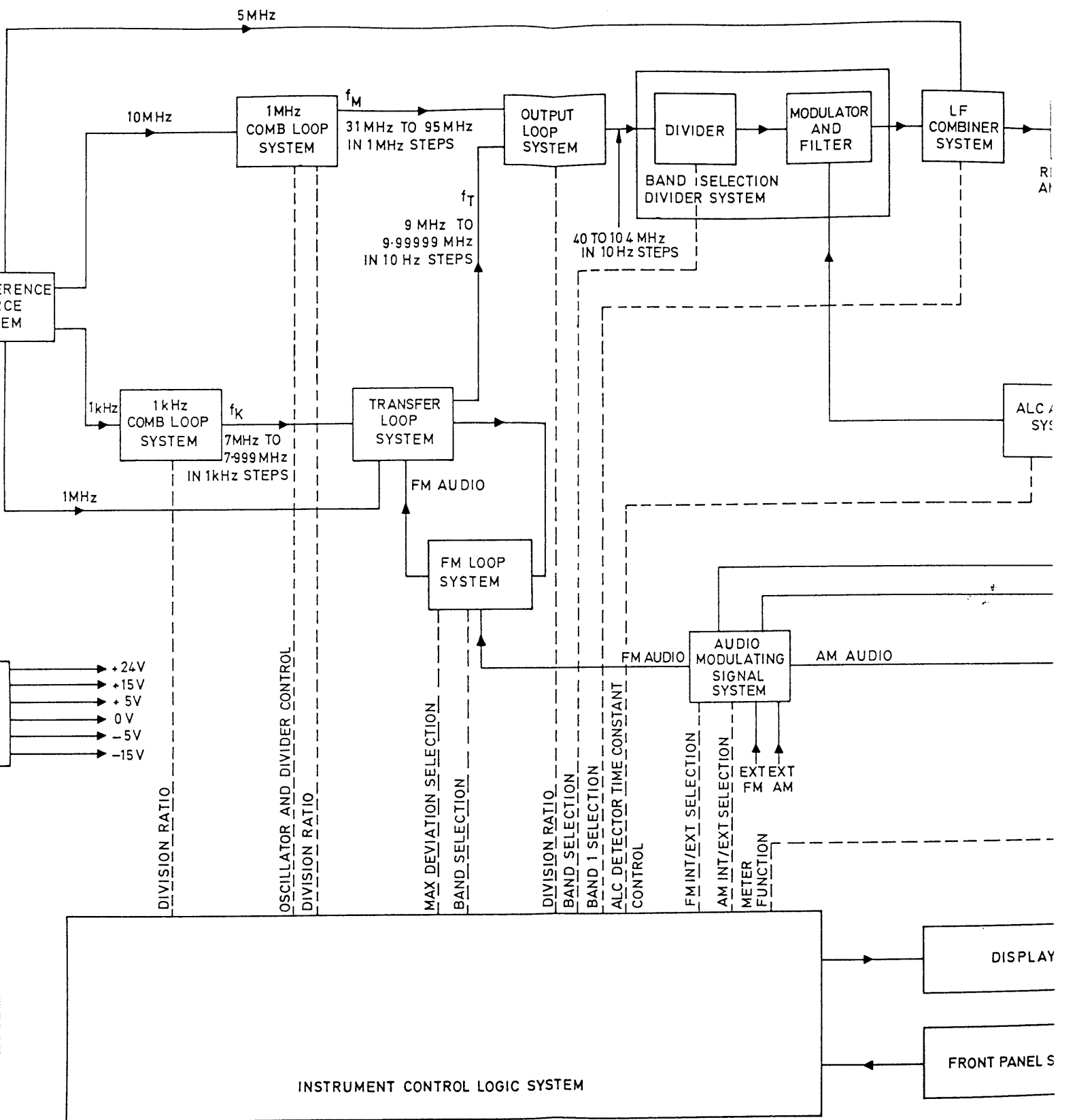


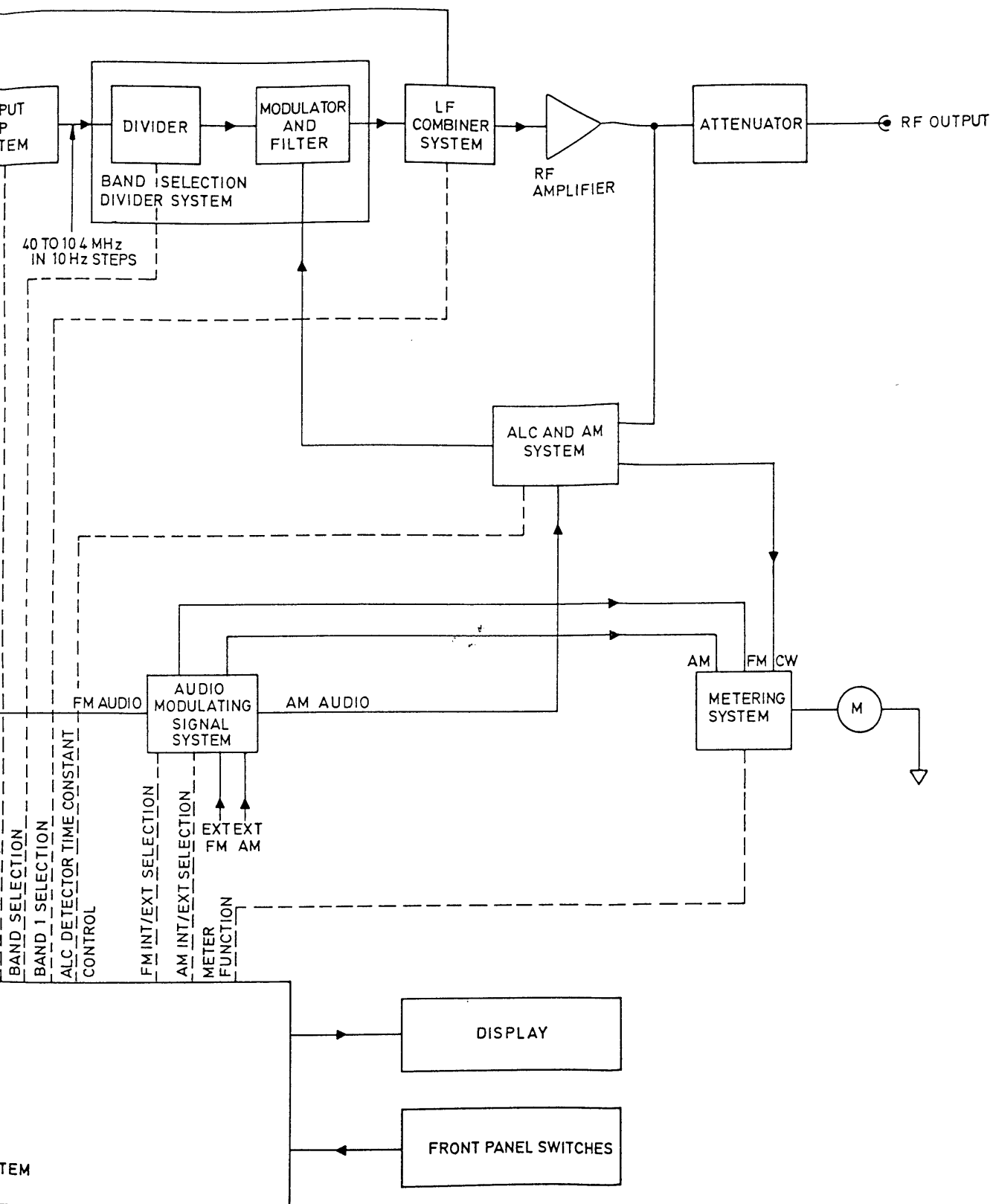
FM Loop

Fig.3.7



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Functional Block Diagram Fig. 3.8

CHAPTER 4

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TECHNICAL DESCRIPTION

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INTRODUCTION

1. This chapter provides a detailed explanation of the operation of circuits used in the synthesized signal generator, model 9084. The principles of operation of the systems within the instrument are given in Chapter 3. These principles should be understood before any study of the circuit details is made.
2. To assist the reader in relating the detailed explanations given in this chapter to the more general treatment given in Chapter 3, the systems within the instrument are covered in the same order in both chapters.
3. The circuit diagrams, component layouts and parts lists are to be found in Part 3 of this manual.

INTERCONNECTIONS

4. The signal generator circuits are mounted on printed circuit boards, each of which has an assembly number. The boards are mounted by means of edge connectors to a motherboard. The edge connectors carry the majority of the power supply distribution wiring and the control wiring. The RF connections between the boards and the motherboard are made via coaxial flying leads. A functional block diagram is shown at Fig.3.8, and the interconnections between assemblies are shown in Fig.41 Fig.42 and Fig.43

INTEGRATED CIRCUIT IDENTIFICATION

5. Each integrated circuit is numbered, a separate series of numbers, commencing at IC1, being allocated to each assembly. Where an integrated circuit package contains more than one circuit suffix letters are used to distinguish between them. Where it is required to identify a particular pin of an integrated circuit the integrated circuit number, with suffix letter if appropriate, is followed by an oblique stroke and the required pin number.

LOGIC LEVELS

6. Throughout this chapter logic '1' refers to the more positive and logic '0' to the more negative logic level. Since assemblies may carry some circuits operating between 0 volts and +5 volts and others operating between 0 volts and -5.2 volts, both logic '1' and logic '0' may have different measured levels at different points in a circuit.

REFERENCE SOURCE SYSTEM

7. The whole of the reference source system is mounted on assembly 19-0892. The circuit is shown in Fig.3.

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Oscillator and 10 MHz Output

8. The oscillator active element is Q12. The oscillation frequency is controlled primarily by the crystal XL1 and the varactor diode D3. The oscillator operates in a phase locked loop, the phase sensitive detector output controlling the voltage applied to D3. When the loop is locked the oscillator frequency is at an exact multiple of the input from the frequency standard.
9. The oscillator output is taken from the C37/C38 junction and buffered by the FET Q9. It is then applied to Q13 which drives the impedance matching transformer T1. Control of the amplitude of the 10 MHz output from the assembly is exercised by R32.
10. The 10 MHz output is taken from the secondary of T1 via pin 2 and a coaxial flying lead terminating in SK50. The output forms the reference frequency for the phase locked loop in the 1 MHz comb loop assembly. The waveform is sinusoidal.

1 MHz and 1 kHz Outputs

11. The oscillator output at the C37/C38 junction is also applied to the FET buffer Q8. The buffered output is applied via C23 and IC1d to a divider IC3. The feedback resistor R9 has the effect of decreasing the difference between the triggering levels of IC1d, giving more positive triggering by the small available signal.
12. IC3 contains two stages. The first is between pin 14 and 12, and divides by two to give 5 MHz. This is passed, via IC2a to the second stage. Here division by five occurs, giving a 1 MHz signal at IC3/11. This is passed via IC8d to pin 4 of the board and a flying lead terminating in SK46. This output forms the reference frequency for the transfer loop assembly. The waveform is rectangular.
13. The 1 MHz output from IC3 is also taken via IC8c to the dividers IC6 and IC7. The total division ratio is 1000, and the resulting 1 kHz, after buffering by IC8b, is taken from the board via pin 6 and a flying lead terminating in SK47. This output forms the reference frequency for the 1 kHz comb loop assembly. The waveform is rectangular.

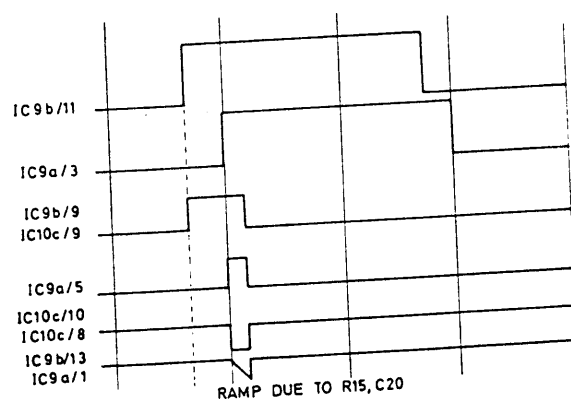
5 MHz Output

14. The 5 MHz at IC3/12 is passed via IC2d (when this gate is enabled) and the low pass filter C21, L10 and C28 to the amplifier stages Q4 and Q3. The signal is passed off the board, via pin 1 and a coaxial flying lead terminating in SK51, to the low frequency combiner. The low pass filter results in the waveform being sinusoidal. Q3 is operated in the common base mode to ensure good isolation of the oscillator from any spurious signals generated in the low frequency combiner.

15. The 5 MHz is only required when the low frequency combiner is in use, i.e. when band 1 is selected. When bands 2 to 7 are selected IC2c/9 and 10 are held at logic '1' via R10, and the resulting logic '0' at IC2c/8 holds IC2d disabled. With band 1 selected IC2d is enabled by a logic '1' at IC2c/8, produced by a logic '0' applied via the 5 MHz output line and R12 to IC2c/9 and 10.

Phase Sensitive Detector

16. The phase sensitive detector consists of two D-Type bistable circuits, contained in IC9, and IC10c. It compares the phase (time of occurrence) of the positive going edges of the 1 MHz from IC3/11 and a 1 MHz waveform derived from the frequency standard.
17. The signals to be compared are applied to the clock inputs of the bistables. The first positive going edge to occur will result in the Q output of one bistable going to logic '1', putting one input of IC10c to logic '1'. The occurrence of a positive going edge in the other waveform will clock the Q output of the second bistable to logic '1'. Both inputs to IC10c will now be at logic '1', and the resulting logic '0' at IC10c/8 puts both bistables back to the cleared state. A delay is introduced into the reset signal by R15 and C20 to ensure that the second bistable to be clocked remains in the set state for approximately 20 ns.
18. The output from the phase sensitive detector is taken from the $\bar{Q}$ outputs of the bistables. The output from the second bistable clocked is a negative going pulse of approximately 20 ns, as set by R15 and C20. The output of the first bistable clocked, however, is a negative going pulse of duration equal to the time interval (phase difference) between the waveforms plus approximately 20 ns. In this way the output contains information as to both the magnitude and sense of the phase difference. When the waveforms are in phase the output pulses are of equal duration. Idealised waveforms are shown in Fig.4.1.



PSD - Idealised Waveforms Fig.4.1

Varactor Voltage Control

19. The phase sensitive detector output is used to control the varactor control voltage via Q5, Q10 and Q11. When the $\bar{Q}$ outputs of IC9 are at logic '1' all the transistors are off, and the varactor voltage is the voltage across the loop filter C42, C43, R44.
20. A negative going pulse from IC9a/6 will turn on Q5 and Q10, while a negative going pulse from IC9b/9 will turn on Q11. If these pulses are of equal duration equal amounts of charge are passed by Q10 and Q11, and there is no change in varactor control voltage. If a phase difference is detected, however, the pulses are not of equal duration and the amounts of charge passed by Q10 and Q11 differ. The charge on C42 and C43 will be reduced if Q11 conducts more than Q10, and increased if Q10 conducts more than Q11. This serves to adjust the varactor control voltage, adjusting the oscillator frequency in the direction which reduces the phase difference between the waveforms applied to the discriminator. When the waveforms are of equal frequency and in phase (loop locked condition) the oscillator frequency is held at ten times the reference signal which is applied to the phase sensitive detector.

Reference Frequency Input

21. The 1 MHz reference frequency may be derived from a 5 MHz internal frequency standard or from a 1 MHz external standard. Selection between the frequency standards is made by means of a rear panel mounted switch.
22. The waveform from the selected frequency standard enters the board at pin 3 via a coaxial lead, and is amplified and shaped in the stages containing Q1 and Q2. The output of these stages is applied directly to IC5c/9, and, after division by five in IC4, to IC5a/1.
23. If the 5 MHz internal frequency standard is selected the board edge connector A1 is held at logic '1' by the rear panel switch. The resulting logic '0' at IC5d/11 disables IC5c, giving a logic '1' at IC5c/8 which enables IC5b. At the same time IC5a/2 is at logic '1', allowing the 1 MHz at IC5a/1 to pass to IC5b and the phase sensitive detector. When the external frequency standard is selected IC5c is enabled and IC5a disabled. It is then the 1 MHz at IC5c/9 which is passed via IC5b to the detector.
24. The 1 MHz signal at IC5b/6 is passed via IC10d, C13 and R8 to a BNC socket on the rear panel. This provides a reference frequency output derived from the frequency standard in use.

Lock Detector

25. The negative going pulses from the phase sensitive detector are applied to IC10b/4 and 5. This will result in positive pulses at IC10b/6. The duration of the pulses will be proportional to the phase difference between the waveforms applied to the phase sensitive detector. When the waveforms are in phase the pulses are of short duration, and do not charge C25 sufficiently to trigger IC10a. IC10a/3 is therefore held at logic '1', and IC1a/3 at logic '0'. Q7 is switched off, and the lock indicator line edge connector A2 is at a high impedance to 0 volts. The longer pulses at IC10b/6 which are associated with the detection of significant phase differences result in C25 charging to a level which will trip IC10a.

Under these circumstances Q7 will be switched on and the lock indicator line will be pulled to 0 volts.

1 MHz COMB LOOP SYSTEM

26. The 1 MHz comb loop system is mounted on assemblies 19-0902 and 19-0904. Assembly 19-0902 carries the three oscillators necessary to cover the range from 41 MHz to 95 MHz, the oscillator selecting circuit, and the divide-by-two circuit used in the generation of output frequencies in the range from 31 MHz to 40 MHz. Assembly 19-0904 carries the loop divider, the two phase sensitive detectors, the loop filter and the lock detector. The circuits are shown in Fig.5 and Fig.7.

Oscillators and Oscillator Selection

27. The active elements of the three oscillators are Q5 (41 MHz to 53 MHz), Q11 (54 MHz to 71 MHz) and Q9 (72 MHz to 95 MHz). The oscillators are of similar circuit configuration, and are connected in parallel, via dual gate FET isolation circuits, to a common output line. Frequency control of the oscillators is by means of varactor diode pairs, which are connected in parallel to a common varactor control line.
28. The oscillator appropriate to the required frequency is enabled by its connection to the +12 volt supply from Q6. The connection is made via Q5, Q4 or Q2. These are switched by signals derived from the 1/2, 1/4 and 1/8 octave line signals originating in the instrument control logic circuits. The coding used is given in Table 5.

TABLE 5

Oscillator Control Coding

Synthesizer Frequency Range MHz	Coding of Octave Lines 1/8 1/2 1/4	Comb Loop Oscillator Range MHz
40 - 43	1 1 0	62 - 71
44 - 49	0 1 0	72 - 80
50 - 62	0 1 1	41 - 53
63 - 80	0 0 0	54 - 71
81 - 104	0 0 1	72 - 95

29. The 1/2, 1/4 and 1/8 octave line signals enter the board at edge connectors A1, A2 and B2, and are applied to the BCD to decimal decoder IC2. The decimal output corresponding to the BCD input goes to logic '0' and switches on the positive supply to the required oscillator.

30. For the comb loop output range from 31 MHz to 40 MHz an additional code is produced for each of the 54 MHz to 71 MHz and 72 MHz to 95 MHz oscillators. These codes also enable the divide by two circuit which is used for this output range.
31. The selected oscillator output is passed via C40, the cascode circuit containing Q20 and Q19, pin 3 and a coaxial flying lead terminated in SK45. This output forms the input to the loop divider on assembly 19-0904. The waveform is sinusoidal.

Output Switching

32. The selected oscillator output is taken, via C38 and the buffer stage Q18, to the output switch formed by Q16 and Q17, which are controlled by Q1 and Q3. For the comb loop output range from 41 MHz to 95 MHz the base of Q1 is pulled towards +12 volts via R2, and Q1 is switched off. This allows the bases of Q16 and Q3 to be pulled towards -4.3 volts, via R33, resulting in Q16 being switched off and Q3 being switched on. The switching on of Q3 switches on Q17. The loop output then passes via Q17 and C36, leaving the board via pin 2 and a flying coaxial lead terminated in SK44. This output forms one of the inputs to the output loop system. The waveform is sinusoidal.
33. For the comb loop output range from 31 MHz to 40 MHz the base of Q1 is held low, via D4 or D5, by the output at IC2/3 or IC2/7. This will result in Q1 and Q16 being switched on, and Q3 and Q17 being switched off. The output from Q18 will then pass via Q16 to IC1a, a JK bistable connected to divide by two (J and K both at logic '1'). The output of IC1a is passed through a low pass filter to restore the waveform to sinusoidal form, and amplified in Q15 and Q14 before leaving the board via C36 pin 2 and SK44.

Programmable Divider

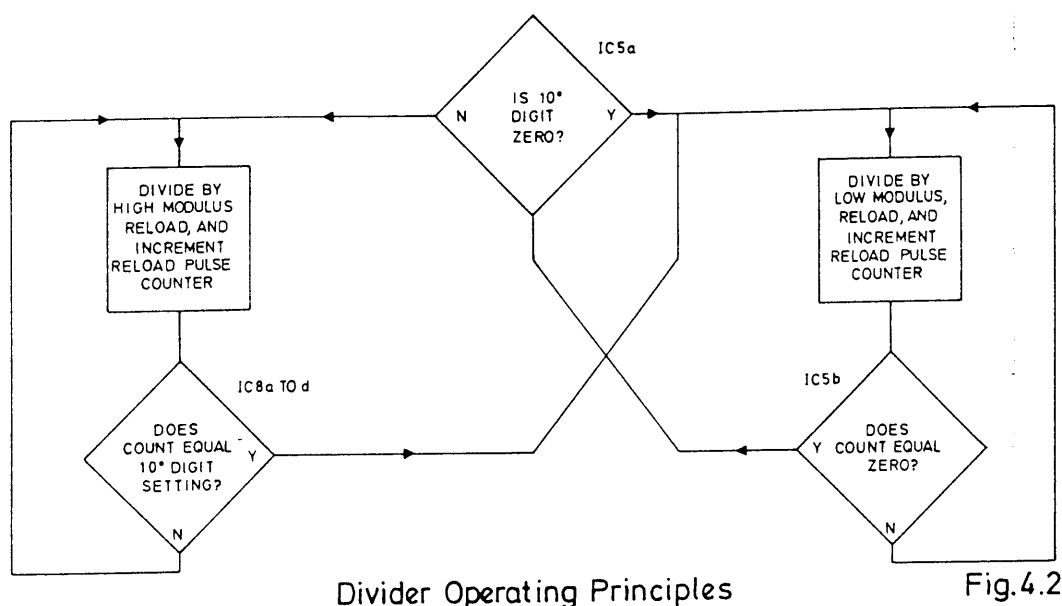
34. The programmable divider is constructed from discrete components to achieve the required counting speed. It is a dual modulus divider, in which the value of the moduli and the number of divisions by each are variable. The lower modulus is always one less than the higher, and the total number of divisions, by both moduli, in one division cycle is always 10. Table 6 shows the moduli used and the number of divisions by each in a cycle.
35. It can be seen that:
- (1) The value of the lower modulus equals the 10^1 digit of the division ratio
 - (2) The number of divisions by the high modulus equals the 10^0 digit of the division ratio.

TABLE 6

Programmable Divider Division Cycles

Division Ratio	Higher Modulus	Counts	Lower Modulus	Counts
41	5	1	4	9
42	5	2	4	8
43	5	3	4	7
44	5	4	4	6
45	5	5	4	5
46	5	6	4	4
47	5	7	4	3
48	5	8	4	2
49	5	9	4	1
50	6	0	5	10
51	6	1	5	9
⋮				
59	6	9	5	1
60	7	0	6	10
61	7	1	6	9
⋮				
69	7	9	6	1
70	8	0	7	10
71	8	1	7	9
⋮				
79	8	9	7	1
80	9	0	8	10
81	9	1	8	9
⋮				
89	9	9	8	1
90	10	0	9	10
91	10	1	9	9
92	10	2	9	8
93	10	3	9	7
94	10	4	9	6
95	10	5	9	5

36. The principle of operation of the divider is shown in Fig.4.2.



At the start of each division cycle the divider is loaded with the lower modulus, but set to divide by the higher modulus. After each division by the higher modulus the divider is reloaded and an up counter is incremented. The output of the up counter is compared with the input on the 10⁰ digit control lines. When the counter output equals the input on the 10⁰ digit control lines (paragraph 35 condition (2) satisfied), the divider is reset to divide by the lower modulus. Division by the lower modulus continues until a total of ten divisions have taken place. The divider is then reset to divide by the higher modulus and a new cycle commences.

37. For a 10⁰ control line input of zero the higher modulus is not used. A gate is used to detect this condition and set the modulus to the low value even when the counter indicates the end of a division cycle.

38. For each division by the low modulus the contents of the divider are clocked down by the oscillator output until the contents reach two. The next oscillator output pulse, which clocks the counter to one, generates a reload pulse. The divider is reloaded, but inhibited from counting. The oscillator output pulse which would clock the counter to zero removes the inhibit, preparing the divider for the next cycle. For division by the higher modulus the reloading is not commenced until a divider content of one is detected. The reloading cycle still takes two oscillator output pulses, so the division ratio is increased by one.
39. The divider down counter is made up of the four JK bistable circuits in IC4 and IC7. The down counter is loaded via the gates of IC11 and IC12, and the contents progressively reduced by the RF input from the comb oscillator, applied to the down counter via SK39, pin 1, C1 and IC2c.

NOTE: For both IC4 and IC7 the clock input at pin 9 is common to both bistables in the package. The $\bar{J}$ and $\bar{K}$ inputs are pulled down internally in IC4a and IC7a.
40. If the divider is set to divide by the lower modulus, achieved by having IC6b in the reset state, IC3a will detect when the down counter contents reach binary 0010. If the divider is set to divide by the higher modulus, with IC6b in the set condition, IC3a/6 is held at logic '1'. IC3a will not then detect when the down counter contents reach binary 0010, and the contents will subsequently be clocked to binary 0001. This state will be detected by IC3b.
41. Setting all the inputs of IC3a or IC3b to logic '0' results in IC6a/7 going to logic '1'. The succeeding oscillator output pulse, applied at IC6a/6 will clock IC6a/2 to logic '1'. This output is fed to IC3a/4 and IC3b/13, and results in IC6a/7 reverting to logic '0'. At the same time the logic '0' which occurs at IC6a/3 is applied to the gates in IC11 and IC12 as a RELOAD instruction. The gate outputs will then take up levels which are the inverse of those applied at their inputs, either directly from the 10^1 digit control lines or via the inverting gates in IC10. This reloads the down counter with the lower modulus, and holds it inhibited from counting.
42. The next oscillator output pulse will clock IC6a/2 back to logic '0'. This returns IC3a and IC3b to the state where they are able to detect binary 0010 or 0001 in the down counter. At the same time IC6a/3 reverts to logic '1', putting the outputs of the gates in IC11 and IC12 to logic '0'. The inhibit is removed from the down counter so that counting can commence when the next oscillator output pulse occurs.
43. The RELOAD instruction pulses from IC6a/3 are applied to the up counter, IC9, via the shaping circuit Q2 and Q1. The up counter output is applied to a comparison circuit, comprising the EXCLUSIVE OR gates of IC8, where it is compared with the 10^0 digit control line settings. When the up counter output and the control line settings are equal the input to IC2a/5 is '0'.

44. The input at IC2a/4 is at logic '0', since while the input to IC2a/5 was '1', (before coincidence of the up counter output and the 10^0 digit control lines), IC1a/7 was at logic '0' and IC1a/2 was clocked to logic '0' by the trailing edge of the RELOAD instruction pulses. With both inputs to IC2a/5 at logic '0' IC1a/7 is at logic '1', and IC1a/2 is clocked to logic '1'. This level is applied to IC2a/4, and results in IC1a/7 returning to logic '0'. IC2a/2 is then clocked back to logic '0', so that the waveform at IC1a/2 is a positive going pulse of duration equal to the interval between RELOAD pulses.
45. The pulse at IC1a/2 puts IC6b into the reset state. IC6b/15 goes to logic '0' which enables IC3a and sets the divider to divide by the lower modulus.
46. The output of the up counter continues to be incremented at each RELOAD instruction until a count of 10 (binary 0000) is reached. At this point all the input to IC5b are at logic '0'. Both inputs to IC2b will now be at logic '0', so IC1b/10 will be at logic '1' and IC1b/5 is clocked to logic '1'. This level is applied to IC2b/6 and results in IC1b/10 returning to logic '0'. IC1b/15 is then clocked back to logic '0', so that the waveform at IC1b/15 is a positive going pulse of duration equal to the interval between RELOAD pulses.
47. The pulse at IC1b/15 puts IC6b into the set state. IC3a is disabled by the logic '1' level from IC6b/15, leaving the divider set to divide by the higher modulus.
48. If the 10^0 digit control lines are set to 0000 the outputs from the coincidence gate, IC8, and the up counter zero output detector, IC5b, occur at the same time. When the 10^0 digit is zero all ten divisions of the cycle are required to be at the lower modulus, so the output from IC5b must be suppressed. This is done by IC5a, which holds IC2b/7 at logic '1' and prevents IC6b being put to the set state.
49. Two outputs are taken from the divider. One is from IC6a/2 and consists of ten pulses for each division cycle. The division ratio to this output is one tenth of that set by the control lines, and the in lock frequency will be 10 MHz. The second output is taken from IC9/11, and consists of one pulse for each division cycle. The in lock frequency will be 1 MHz. The outputs are used as the inputs to the phase sensitive detectors. Because of the changes of modulus within the division cycle the 10 MHz output is not a perfectly regular pulse train.

Phase Sensitive Detectors and Varactor Control

50. Two phase sensitive detectors are used. One, consisting of the two bistable circuits contained in IC14, and IC15b operates at 1 MHz. It compares the phase (time of occurrence) of the positive going edges of a 1 MHz signal from the divider, taken from the counter IC9, and a 1 MHz signal derived from the 10 MHz output of the reference source by shaping in IC15a and dividing by ten in IC13. This detector has a wide pull in range, and is used to pull the loop into lock.

51. The operation of the circuit is the same as that of the phase sensitive detector of the reference source system (see paragraph 16). The varactor control voltage is also derived in a similar manner to that used on the reference source assembly, using Q4, Q5 and Q6, when Q12 is switched off. This occurs for a period of approximately 2 ms after the out of lock condition is sensed. With Q12 switched on Q4 and Q6 are cut off, and although the phase sensitive detector still functions its output does not affect the varactor control voltage.
52. The second phase sensitive detector operates at 10 MHz. It has only a narrow pull in range, but has good noise performance, and is used when the loop is in, or close to, lock. The detector samples the 10 MHz sinusoidal signal from the reference source once in every cycle of the 10 MHz output of the divider, taken from IC4b/15. The sample size depends upon the duration and amplitude of the sampling waveform, the amplitude of the sampled waveform and the phase difference between the waveforms. The sampled waveform is maintained constant by the reference source, and any variation due to sampling waveform duration and amplitude is balanced out within the detector circuit, leaving an output depending upon phase difference only.
53. The sampling signal used is a negative going pulse, generated in the circuit containing Q7 and amplified by Q9, for as long as Q8 is switched off. This is the case when the loop is in lock, but Q8 is switched on for a period of approximately 2 ms when the out of lock condition is sensed, and the pulses are suppressed.
54. The pulses are applied to the emitters of Q10 and Q11. Q10 (and therefore Q5) and Q11 conduct for the duration of the pulse. In the absence of any other signal Q11 and Q5 carry equal currents, and there is no change of charge on the capacitors of the loop filter, C10 and C11. This situation is independent of variations in the pulse amplitude and duration.
55. The waveform to be sampled is applied to the base of Q10. If the sampling pulse straddles the zero crossing point, the condition when the divider output and reference signal are considered to be in phase, there will be no variation in the average current carried by Q11 during the pulse. However, when the waveforms are out of phase, the current carried by Q10 will be increased or decreased, according to the direction of the phase error. There will be a resulting change of charge, dependent on the magnitude and direction of the phase error, on the capacitors of the loop filter.

Lock Detector and Phase Sensitive Detector Selection

56. The outputs at IC14a/6 and IC14b/8 consist of negative going pulses. When the loop is in lock the outputs are identical, but when a phase difference occurs the pulses in one waveform will increase in width, the width being proportional to the phase difference.

57. The two output waveforms are applied to IC15c/9 and 6, resulting in a series of positive going pulses at IC15c/8, the width of which is proportional to the phase difference. When a significant phase difference exists the pulses produce sufficient charge on C18 to turn on Q13 and hold the lock indicator line at 0 volts.
58. The pulses from IC15c/8 when the loop is out of lock also charge C19 and raise IC15d/12 and 13 to the logic '1' level. This causes a logic '0' to exist at IC15d/11 and IC16/2. IC16 is a monostable circuit, with a quasi-stable state, set by R43 and C20, of approximately 2 ms. The circuit is triggered by the logic '0' at IC16/2, and a positive going pulse of 2 ms duration occurs at IC16/3. This switches on Q14, the potential change at Q14 collector switching Q12 off and Q8 on. This puts the loop under the control of the low frequency phase sensitive detector when lock is lost.

1 kHz COMB LOOP SYSTEM

59. The whole of the 1 kHz comb loop system is mounted on assembly 19-0908. The circuit is shown in Fig.9.

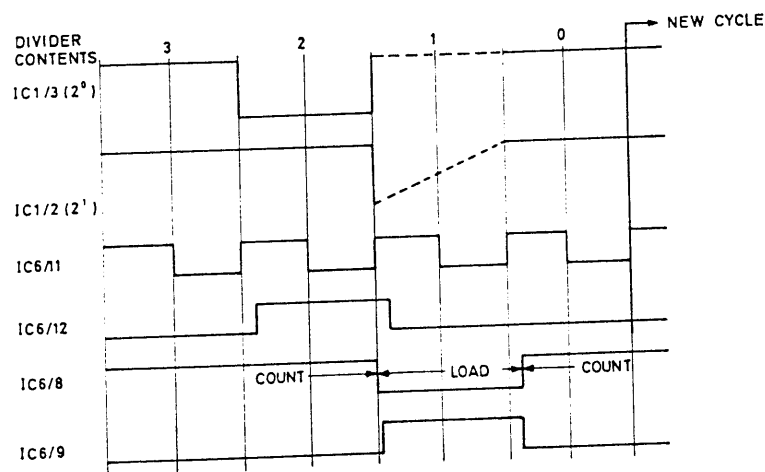
Oscillator

60. The oscillator used in this phase locked loop is the integrated circuit voltage controlled oscillator, IC10. The operating frequency is controlled by C15, the voltage applied from potentiometer R5 and the voltage applied at IC10/1 from the phase sensitive detector in IC9. The frequency will be a multiple of the 1 kHz standard, restricted to the range from 7 MHz to 7.999 MHz.
61. The oscillator output is amplified in the transistor stage Q1, and passes off the board via pin 4 and a coaxial flying lead terminated in SK41. The output forms one input to the transfer loop. The waveform is rectangular. The oscillator output is also applied to the waveform shaper IC7a, the output of which is applied to the programmable divider.

Programmable Divider

62. The programmable divider consists of a series of presettable counters, IC1, 2, 3 and 4, a gate to detect when the content of the divider is two (binary 10), and a bistable circuit, IC6, which controls the reloading of the counters.
63. The four counters are connected as a BCD counter chain, wired to count down. The three less significant digits of the required division ratio are loaded into ICs 1, 2 and 3 from the frequency selection lines of the logic system. The most significant digit is wired to be loaded with seven (binary 0111).
64. The output of the 1 kHz comb loop is divided by 100 in the transfer loop. Changes of 1 kHz in the comb loop output thus produce only 10 Hz changes in the transfer loop output and, subsequently, the synthesizer output. For this reason the division ratio least significant digit is set by the 10 Hz frequency control lines.

65. If the contents of the divider is other than 2, the gate formed by ICs 5a, 5b, 8a, 5b and 6b will hold IC6/12 at logic '0'. IC6/8 will be clocked by the oscillator output to logic '1', which will set the counters in the divider to the count mode. The divider will then count down, clocked by the output of IC7a.
66. When the contents of the divider have been reduced to 2 (binary 10) all the divider outputs except IC1/2 will be at logic '0'. All the inputs to IC5a will be at logic '0', so IC5a/5 and IC6/12 will be at logic '1'. The next pulse from IC7a, which reduces the contents of the divider to 1, clocks IC6/8 to logic '0'. This puts the counters into the load state, and the divider is reloaded but inhibited from counting. At the same time IC6/9 is clocked to logic '1'. This puts IC5a/5, and therefore IC6/12 back to logic '0'.
67. The next pulse from IC7a, which would have reduce the contents of the divider to zero, clocks IC6/8 to logic '1'. This releases the counters from the load state, and prepares the divider for the next counting cycle. At the same time IC6/9 is clocked to logic '0', and the gate is again prepared to detect when the divider contents reaches 2. Idealised waveforms are shown in Fig. 4.3.



Counter Reloading

Fig.4.3

68. The output from the divider is taken from IC4/6. This goes to logic '1' when the counter is loaded, and the logic '0' when the counter is loaded, and to logic '0' when the count goes from 4000 to 3999. The width of the output pulse thus depends on the division ratio in use, the mark to space ratio varying from 1 to 0.75.

Phase Sensitive Detector

69. The phase sensitive detector is a section of IC9. This integrated circuit also contains a voltage controlled oscillator and a second phase sensitive detector which are not used.
70. The output from the divider is applied to IC9/3, while a 1 kHz signal derived from the frequency standard is applied at IC9/14. The phase sensitive detector compares both frequency and phase (time of occurrence of positive going edge) of these two waveforms. If the frequencies at IC9/14 and IC9/3 differ, IC9/13 sinks or sources current continuously, according to whether the frequency at IC9/14 is the lower or the higher. If the frequencies are the same, but the waveforms are not in phase, IC9/13 will sink or source current for a fraction of each cycle proportional to the phase difference. When the waveforms are of equal frequency and in phase IC9/13 goes to a high impedance state.
71. R8, R7 and C19 form the loop filter. The current flowing into or out of IC9/13 during periods when the required frequency and phase relationships do not exist is used to decrease or increase the charge on C19. The resulting voltage at the junction of R7 and R8 is buffered by a source follower connected FET in IC9, the buffered output being available at IC9/10. This output is filtered by R6 and C14 and applied, as the frequency controlling signal, to the oscillator in IC10. The oscillator frequency is adjusted until the output of the divider and the 1 kHz reference are equal in frequency and in phase. When this condition is achieved (loop locked condition) the oscillator frequency will be the division ratio multiplied by the frequency of the reference signal applied to the phase sensitive detector.

Lock Detector

72. An indication of the phase difference between the signals applied to the phase sensitive detector is available at IC9/1. When the applied waveforms are in phase this pin is held at logic '1', but when a phase difference exists negative going pulses, of duration proportional to the phase difference appear.
73. When the loop is in lock C21 is charged via D2, and transistor Q2 is switched on. This switches off Q2, and as a result the lock indicator line is at a high impedance to 0 volts. When a significant phase difference exists C21 loses charge and the current in Q2 is reduced. This increases the potential at Q3 base, and Q3 pulls the lock indicator line to 0 volts.

TRANSFER LOOP SYSTEM

74. The whole of the transfer loop system is mounted on assembly 19-0893. The circuit is shown in Fig.11.

First Loop Input

75. The input to the first phase locked loop is derived by dividing the output f_K from the 1 kHz comb loop, in a programmable divider. The signal enters the board via a coaxial flying lead and pin 4, and is applied to the divider via the amplifier Q1 and shaper IC10c. The divider is constructed from the programmable counters IC19, IC15 and IC11, the bistable IC18a and the gates IC14b, IC12b and IC10d.
76. The required division ratio, N_T , lies in the range 893 to 992, as explained in Chapter 3. A unity change in the division ratio gives a change in synthesizer output frequency of 10 kHz, so the division ratio is set by the 10 kHz and 100 kHz control lines. The division ratio of 893 corresponds to a transfer loop system output frequency between 9 MHz and 9.00999 MHz, when the 100 kHz and 10 kHz control lines are at zero, while the division ratio of 992 corresponds to a transfer loop system output frequency between 9.99000 and 9.99999 MHz, when the 100 kHz and 10 kHz control lines are at 99. The two less significant digits of the division ratio can be seen to be seven less than the control line setting. The counters are therefore set from the control lines, but the down count is stopped when the counter contents equal seven.
77. Because the down count is stopped at seven the number loaded into the counters must lie in the range 900 to 999. The loading inputs of the counter for the most significant digit are therefore permanently wired to load binary 1001.
78. After the divider is loaded the contents are clocked down by the signal f_K until the counters for the two more significant digits contain zero. At this point the counter for the least significant digit contains 9. This state is detected by the gates IC14b, IC12b and IC10d, and results in a logic '1' at IC18a/12. The next input pulse, which reduces the divider contents to 8, clocks IC18a/8 to '0'. This provides a RELOAD instruction pulse for the counters, which are reloaded, but inhibited from counting. At the same time the logic '1' at IC18a/9 is applied to IC14b and results in IC18a/12 reverting to logic '0'.
79. The next input pulse, which would have reduced the divider contents to 7, clocks IC18a/8 back to '1'. This removes the inhibit from the down counters ready for the next division cycle. At the same time IC18a/9 reverts to logic '0', putting IC14b back to the state where it is able to sample the divider contents.
80. The divider output, which forms one input to the phase sensitive detector, is taken from IC11/7.

First Phase Locked Loop

81. The voltage controlled oscillator and phase sensitive detector for the first loop are contained in IC4. An integrated circuit mixer, IC1, is included in the loop. This subtracts 1 MHz, obtained from the reference source assembly, from the frequency applied to the phase sensitive detector from the voltage controlled oscillator. This results in the loop output frequency being offset by 1 MHz from the input frequency obtained from the divider.

82. The oscillator output frequency is controlled by C42, C43 and the voltage applied at IC4/9 from the loop filter. The output is available at IC4/4, and is applied to the mixer at IC1/7. The 1 MHz from the reference source assembly, after filtering in the low pass filter between R5 and R8, is applied to the mixer at IC1/1.
83. The mixer in IC1 is of the double balanced type. The output is a waveform composed almost entirely of the sum and difference frequencies, the applied frequencies having been balanced out. The composite waveform is applied to the two stage active filter provided by IC3a and IC3b, which selects the difference frequency. An active filter is used to achieve a frequency response with a high enough roll off rate, to reject unwanted mixer products. The filter output is applied via the buffer IC2b to IC4/3. Within IC4 the phase of this signal is compared with the phase of the divider output, applied at IC4/14.
84. The phase sensitive detector output is available at IC4/13. This is applied to the loop filter R62, R57 and C39, the filter output from the R57/R62 junction being applied to IC4/9 to control the oscillator frequency.
85. The oscillator output is divided by 100 in IC5, which reduces the frequency applied to the second phase locked loop. This sets the scale of the frequency steps available from the loop. The oscillator output is further divided by 10 in IC6 before it is fed to the phase sensitive detector of the second phase locked loop. This division is compensated by division by 10 of the second phase sensitive detector input, permitting the detector to operate at a lower frequency without affecting the frequency step size of the loop.

Sweep Circuit

86. The loop is required to lock with the oscillator output approximately 8 kHz above 1 MHz. On switching on, or if lock is lost, the loop could attempt to lock with the oscillator approximately 8 kHz below 1 MHz. To prevent this a sweep circuit is used to ensure that, if lock is lost with the demodulator output too low, the oscillator output is taken to its highest frequency and then swept down. The oscillator frequency thus always approaches the loop locked frequency from above 1 MHz, and locks at the required frequency before reaching the unwanted image frequency.
87. A source follower buffered sample of the oscillator control voltage at IC4/9 is obtained from IC4/10. This is compared with a voltage level of +7.5 V, obtained from the junction of R59 and R55, in the Schmitt trigger IC2a. For as long as the voltage at IC2a/3 is more positive than that at IC2a/2, the level at IC2a/1, augmented by the voltage across D6, will hold Q10 cut off.
88. If the loop loses lock with the oscillator control voltage low, IC2a/3 will be negative with respect to IC2a/2 and IC2a/1 will be switched to its low level. Q10 will conduct, charging C39 in the loop filter and sweeping the oscillator output to a frequency above that at which the loop is required to lock. The voltage level at IC4/10 rises until the Schmitt

trigger input reaches the higher trigger level. IC2a/1 is switched to its high level, cutting of Q10 and terminating the frequency sweep. The oscillator frequency will now fall, as the loop filter capacitors discharge, until it lies within the capture range of the phase sensitive detector, when the loop will be pulled into lock.

89. The fall back in frequency is accompanied by a fall in the voltage level at IC4/10, but IC2a will not be retriggered unless this fall is to a level below the lower trigger level.

Second Phase Locked Loop

90. The second phase locked loop is a comb loop, having a frequency step size given by First loop oscillator frequency. The frequency range is restricted by the ¹⁰⁰ loop division ratio (N_T) limits of 893 to 992 and the frequency limits of the signal fed in from the first loop. Variation of the first loop oscillator frequency by variation of f_K and variation of N_T allows the selected second loop output frequency to be any multiple of 10 Hz between 9.0 MHz and 9.999990 MHz.
91. A single oscillator, the active element of which is the FET Q15, is used to cover the required frequency range. The output frequency is controlled by the potential applied to the varactor diodes, D15 and D16, from the phase sensitive detector.
92. If frequency modulation is required an audio signal from the modulating source is applied to the assembly via SK34, a coaxial connector and pin 3. The modulating signal is applied to the varactor diodes in parallel with the controlling voltage from the phase sensitive detector.
93. The oscillator output is buffered by Q16 and fed to the output circuit Q17, Q18 and Q19. The signal is passed off the board on two separate lines, via pin 2 and SK35 to the output loop assembly, and via pin 13 and SK93 to the FM and audio assembly. The first of these outputs is used as one element of the final synthesized frequency, while the second provides feedback for the FM loop.
94. The oscillator output is also applied, via the amplifier and shaper stages Q13 and IC10a, to the loop programmable divider. This consists of the programmable counters, IC20, IC16 and IC17, the gates IC12a, IC14a and IC10b, and the bistable circuit IC18b. The operation of the circuit is identical to that of the divider in the first phase locked loop input, described in paragraphs 75 to 80. The division ratio of the divider, N_T , is the same as that for the divider in the first phase locked loop input.
95. The output of the divider is divided by 10 in IC13, before application to the phase sensitive detector. This compensates for the division by 10 in IC6 of the other input to the phase sensitive detector. The division of both inputs allows the phase sensitive detector to be operated at approximately 1 kHz. The phase deviation seen by the phase sensitive detector at this frequency is only one tenth of that which would be seen if the 10 kHz waveforms were compared. This enables the phase sensitive detector to cope with the comparatively large phase deviations which occur when frequency modulation is applied to the oscillator.

96. The phase sensitive detector consists of the two bistable circuits contained in IC7 and IC8b, and operates in the same manner as that in the reference source system (see paragraph 16). The varactor control voltage is also derived in a similar manner to that used on the reference source assembly, using Q2, Q3 and Q4 to control the charge on the loop filter capacitors C34 and C35.

Speed Up Circuit

97. When the instrument is being tuned it may be necessary to change the operating frequency of the loop quickly over a wide range. The normal loop bandwidth is small, and in such a system high rates of change of oscillator frequency are not possible. The speed up circuit increases the loop bandwidth while tuning is taking place.
98. Operation of the circuit is initiated by any demand for a change in instrument output frequency of 100 kHz or 10 kHz during fast tuning. The demand for change is detected as a change in level of the least significant digit (A) lines of the BCD instructions to the display circuit.
99. The 100 kHz A line enters the board at pin 9. The logic level carried is applied to the gate IC21d, which acts as a driver for the trigger circuit of a retriggerable monostable circuit, IC9b. The - trigger input, IC9b/11 is held at logic '1' by R71, while the + trigger input, IC9b/12, is held at logic '0' by R73. The output of IC21d is applied to both trigger inputs via C53 and C54, so that transitions from '1' to '0' will trigger at IC9b/11 and transitions from '0' to '1' will trigger at IC9b/12. The diodes D10 and D11 prevent the trigger inputs from being affected by the non-triggering transitions, protecting them against being driven to damaging reverse voltage levels.
100. During tuning a series of triggering pulses is generated. The monostable circuit is put to the quasi-stable state by the first of the series. The duration of the quasi-stable state is 100 ms, but if a further trigger occurs before the circuit returns to the stable state the time interval is restarted. Thus the circuit goes to the quasi-stable state at the first trigger pulse, and remains in that state until 100 ms after the last trigger occurs. IC9a is driven in a similar manner by pulses occurring on the 10 kHz A line, which enters the board at pin 10.
101. The output from IC9/9 or IC9/7 is applied via D8 or D7 to the base of Q11, the collector of which is driven positive while IC9 is in the quasi-stable state. The positive voltage level is applied to the junction of R47 and R48, and results in an increased current in Q8. This switches on Q6, inserting R43 into the loop filter circuit to increase the loop bandwidth.
102. The positive potential applied at the junction of R47 and R48 also switches on Q7, which in turn switches on Q5 and inserts R39 in parallel with R38. This increases the current which can be supplied to the loop filter capacitor when Q3 conducts.

103. The positive potential from the collector of Q11 is applied to IC8a/2. During the period that Q4 conducts IC8a/1 is held at logic '1' by IC7a/5. This inserts R36 in parallel with R37, and increases the rate at which charge can be drawn from the loop filter capacitor when Q4 conducts. D5 prevents the logic '1', which exists at IC8a/3 when speed up conditions are not required, from affecting the operating of Q4.
104. When fast tuning takes place the change of frequency is applied to the FM loop from the transfer loop system output. From this the FM loop will generate a modulating signal, the sense of which is such as to oppose the change of frequency of the second phase locked loop oscillator. This signal is prevented from reducing the rate of change of frequency by means of RLA. The positive potential from Q11 is applied to Q21, which switches on and holds the base of Q20 low. RLA is de-energised, breaking the FM audio input signal line. When FM is not selected RLA is permanently de-energised, since control line F, which enters the board at pin 5, is at logic '0'.
105. Speed up conditions are also required when switching the instrument on. On switching on Q12 conducts, holding the base of Q11 low until C52 charges from the -15 volt rail. D9 discharges C52 on switching off to prevent a voltage surge being applied to the -15 volt rail.

Lock Indicators

106. A lock indicator is provided for each phase locked loop. When the first loop is in lock IC4/1 is held at logic '1'. If a phase difference exists, negative pulses of duration proportional to the phase difference occur. A voltage proportional to the mean level of the output from IC4/1 appears across C37, and holds IC8c/9 at logic '1' when the loop is in lock.
107. In the second loop negative going pulses occur at IC7/5 and IC7/8. When the loop is in lock these are of short duration and of equal pulse width. If one bistable is clocked in advance of the other the pulse width of the output from that bistable will be increased. The width of the negative going pulses at the output of the AND gate, formed by D2 and D3, is equal to the width of the longer of the pulses at IC7/5 and IC7/8. The mean level of this waveform appears across C38, and holds IC8c/10 at logic '1' when the loop is in lock.
108. When the loops are both in lock IC8c/8 is held at logic '0', Q9 is cut off and the lock indicator line is at high impedance to ground. If either loop loses lock one input to IC8c will go to logic '0' and IC8c/8 will go to logic '1', switching on Q9 and holding the lock indicator line to 0 volts.

OUTPUT LOOP SYSTEM

109. The output loop system is carried on assemblies 19-0901, 19-1069, 19-0903 and 19-0894. Assembly 19-0901 carries the four oscillators required to cover the full synthesizer range from 40 MHz to 104 MHz. Assembly 19-0903 carries the mixer and buffers for the loop, while assembly 19-0894 carries the phase sensitive detector, the loop filter, the varactor voltage control circuit and a sweep circuit. On early model equipments the ALC circuit is carried on a piggy-back board 19-1069, mounted on 19-0901. The circuits are shown in Fig.13, Fig.15, Fig.17 and Fig.19.

Oscillators and Oscillator Selection

110. The active elements of the four oscillators are Q14 (40 MHz to 49.999990 MHz), Q12 (50 MHz to 62.999990 MHz), Q10 (63 MHz to 80.999990 MHz) and Q8 (81 MHz to 104 MHz). The oscillators are of similar circuit configuration, and are connected in parallel, via dual gate FET isolation circuits, to a common output line. Frequency control of the oscillators is by means of varactor diode pairs, which are connected in parallel to a common varactor control line.
111. The oscillator appropriate to the required frequency is enabled by its connection to the +12 volt supply from Q6. The connection is made via Q5, Q4, Q3 or Q2. These are switched by signals derived from the $\frac{1}{2}$ and $\frac{1}{4}$ octave lines originating in the instrument control logic circuits.
112. The $\frac{1}{2}$ and $\frac{1}{4}$ octave line signals enter assembly 19-0901 at edge connectors B1 and A1, and are applied to the BCD to decimal decoder IC1. The coding used is given in Table 7. The decimal output corresponding to the BCD input goes to logic '0', and switches the positive supply to the required oscillator.

TABLE 7

Oscillator Control Coding

Synthesizer Frequency Range MHz	Coding of Octave Lines	
	$\frac{1}{2}$	$\frac{1}{4}$
40 - 49	1	0
50 - 62	1	1
63 - 80	0	0
81 - 104	0	1

113. To switch the RF output off the supply is disconnected from all the oscillators. This is done by holding the base of Q1 low by means of the input at edge connector A2. This holds Q1 cut off, and applies a logic '1' level to IC1/13. The BCD input to IC1 will then be not less than 4 (binary 100), and none of the used decimal outputs will be at logic '0'.

ALC and Buffer Amplifiers

114. The output of the oscillator in use is passed to an ALC circuit in the form of a PIN diode attenuator, the value of which is varied to provide a stabilised signal amplitude at pins 2 and 3 of assembly 19-0901.

115. The oscillator output passes via C32 to the PIN diode D12. The diode forms the series arm of an L attenuator, the shunt arm being formed by the input impedance of the buffer amplifiers Q16/Q17 and Q18/Q19.
116. The buffer amplifiers are cascode connected to ensure a high degree of isolation from unwanted signals arising in the later mixing and dividing stages. The RF output from Q16 and Q17 passes off the board via C21, pin 2 and a flying coaxial lead terminated in SK60. The output goes to the final divider, and, after filtering and amplification, forms the RF output of the instrument. The output from Q18 and Q19 passes off the board via C30, pin 3 and a coaxial flying lead terminated in SK59. This output is passed to assembly 19-0903, where it is mixed with the output of the 1 MHz comb loop, f_M .
117. The signal at pin 2 of assembly 19-0901 acts as the ALC control signal and is applied to the ALC detector formed by D14, C36 and R58. A small forward bias is applied to D14 by R62 and R63 to reduce the conduction threshold.
118. The potential across C36, which is proportional to the amplitude of the RF at pin 2 is applied to the inverting input of the integrator containing IC2. An increase in the RF level results in an increase in the potential across C36, a decrease in the potential at IC2/6 and a reduction in the current in D12. The dynamic impedance of a PIN diode is inversely proportional to the current carried, so the attenuation is increased.
119. The potential at the non-inverting input of IC2 is set by a circuit having a similar temperature coefficient to that of the ALC detector. This provides temperature compensation to the system.

Low Pass Filters and Mixer

120. The oscillator output from assembly 19-0901 SK59 enters assembly 19-0903 via SK53, a coaxial flying lead and pin 1. R1 and C3 provide input matching for the RF signal, which is amplified in the cascode stage containing Q1 and Q2.
121. The amplifier output is applied to a 10 dB attenuator and matching network. This reduces the signal to a level which suits the power handling capability of the mixer, X1, and maintains the matching between the output of Q2 and the input to the low pass filters throughout the frequency range. The low pass filter reduces the level of the harmonics in the signal prior to its application to the mixer, so reducing the intermodulation products in the mixer output. Two filters are provided to

cover the frequency range from 40 MHz to 104 MHz. The correct filter is selected by means of diode switches controlled by the $\frac{1}{2}$ octave line level. For the frequency range from 40 MHz to 62.999990 MHz the $\frac{1}{2}$ octave line is at logic '1'. This level is applied to the assembly at edge connector A1, and results in Q3 being in the conducting state. As a result Q4 conducts and Q5 is cut off. The junction of R22 and R24 is held at approximately +15 volts, and D1 and D3 are forward biased, while the junction of R23 and R25 is held at approximately -5 volts, reverse biasing D2 and D4. This inserts the filter between D1 and D3 into the signal path. With the $\frac{1}{2}$ octave line at logic '0' Q3 is cut off. This results in D1 and D2 being reverse biased and D2 and D4 forward biased. It is then the filter between D2 and D4 which is inserted into the signal path. L1, L10 and L11 complete the d.c. path for the diode currents.

122. The two inputs to the mixer are the low pass filter output, connected via a 1 dB matching pad, and the output of the 1 MHz comb loop, f_M . This last signal enters the assembly via SK54, a coaxial flying lead and pin 4. A 2 dB pad provides a 50 Ω termination to the line. The amplifier stage containing Q6 increases the signal level to that required for it to act as the chopping, or switching input to the mixer. Matching between the output of Q6 and the mixer input is maintained by a 1 dB pad.
123. The mixer output frequencies will be the sum of and the difference between the oscillator frequency and f_M . The difference frequency, which will lie between the limits of 9 MHz and 10 MHz when the loop is in lock, is selected by the 10 MHz low pass filter. The selected frequency is amplified in Q8, and buffered in the stage containing Q10 and Q9. The output leaves the assembly via pin 2, a coaxial flying lead and SK55. It forms one of the inputs to the phase sensitive detector on assembly 19-0894.

Phase Sensitive Detector

124. The phase sensitive detector consists of the two D-type bistable circuits in IC2 and IC1b. It compares the phase of the output of the mixer and the output of the transfer loop system, f_T . The input from the mixer enters assembly 19-0894 via SK56, a coaxial flying lead and pin 1. The signal is amplified in the common base stage Q1 and in the amplifier containing Q2. The DC level of the signal is changed across the capacitor C4 in the between stage coupling. The amplified signal is shaped in IC1d, and is connected to the phase sensitive detector at IC2a/3.
125. The input from the transfer loop system enters assembly 19-0894 via SK58, a coaxial flying lead and pin 2. The signal is amplified in the stage containing Q3. The DC level of the signal is changed across C13. The amplified signal is shaped in IC1a and is connected to the phase sensitive detector at IC2b/11.
126. The phase sensitive detector operates in the same manner as that on the reference source assembly (see paragraph 16). Note that the connection of IC2a/2 and IC2b/12 to 0 volts is a connection to a logic '1' level, since IC2 operates with supply rails of 0 volts and -5.2 volts.

127. The varactor control voltage is also derived in a similar manner to that used in the reference source system, using Q4, Q5 and Q6. The varactor control voltage is held on the capacitors of the loop filter, C22 and C21. The loop filter values are chosen to provide a wide loop bandwidth. This is necessary to permit the loop to track the frequency variation which occurs when the loop input, f_T , carries frequency modulation.

Sweep Circuit

128. The circuit is required to lock with the oscillator at a frequency of $f_M + f_T$, giving a mixer output of f_T for comparison with the output of the transfer loop in the phase sensitive detector. On switching on, or when changing oscillators, it is possible for the oscillator frequency to be so far above the required value that the mixer output frequency is outside the pass band of the 10 MHz low pass filter following Q7. Under these circumstances there will be only one input to the phase sensitive detector, the oscillator frequency will be driven to its extreme value, and the loop will remain in the unlocked condition.
129. The sweep circuit is incorporated to ensure that, if lock is lost, the oscillator frequency is taken to its high limit and then swept down until a frequency of $f_M + f_T$ is reached. The sweep is initiated if the signal received from the mixer on assembly 19-0903 falls below a pre-set level.
130. The input to assembly 19-0894 from the mixer is amplified in the stage containing Q11 and passed, via a low pass filter to the peak-to-peak detector C37, D8, D9, C38 and R57. The output level from the detector is applied to IC5/2, and compared with the level at IC5/3, which is preset by means of R44.
131. If the input signal level is above the threshold IC5/2 will be positive with respect to IC5/3, and IC5/6 will be at logic '0'. IC3a/1 will be at logic '0', and as a result Q10 will be cut off. The logic '0' at IC5/6 also cuts off Q12. Q13 emitter is pulled towards +15 volts by R47. Q13 is switched on, and the current in R49 switches on Q14 and Q15. With Q14 conducting IC4/4 will be at logic '0' and IC4 will be held in the reset state. With Q15 switched on the base of Q17 is pulled towards 0 volts and Q17 is switched off, as is Q7. With Q7 and Q10 switched off the sweep circuit has no effect on the varactor control line.
132. If the output of the detector falls below the threshold, IC5/6 will be at logic '1'. Q12 will be switched on, and Q13, Q14 and Q15 switched off. IC4/4 will be pulled up towards 0 volts by R51, and IC4 operates as an asynchronous oscillator circuit, the frequency and mark/space ratio being set by R52, R53 and C42. The output waveform at IC4/3 has a mark/space ratio of approximately 6, and a frequency of approximately 2 kHz.
133. When IC4/3 is at logic '0', IC3a/2, and therefore IC3b/4, are at logic '0', and Q10 is cut off. Q16 is also cut off, and Q17 base is pulled up towards 0 volts by R55. Q17 conducts, switching on Q7. For as long as Q7 conducts it supplies charge to the loop filter capacitors, causing the varactor control line to ramp up.

134. When IC4/3 goes to logic '1', IC3a/3 will go to logic '0', since IC3a/1 is held at logic '1' by IC5/6. As a result IC3b/4 will be at logic '1' and Q10 will be switched on. For as long as Q10 conducts it will draw charge from the loop filter capacitors via Q6, so that the varactor control line is ramped downwards. During this period Q16 conducts due to the logic '1' at IC4/3, holding Q17, and therefore Q7 cut off.
135. As the varactor control line voltage varies, the oscillator frequency will change until the detector output is again above the threshold. IC5/6 will then go to logic '0', and this will result in Q10 being cut off via IC3a and IC3b. This stops the downward sweep of the varactor line, allowing the phase sensitive detector to pull the loop into lock. The logic '0' at IC5/6 will also result in a logic '0' at IC4/4, so that IC4 is held in the reset state at the end of the cycle.

Lock Detector

136. When the phase sensitive detector is functioning the output at IC1c/8 consists of narrow negative going pulses. These are passed via R26 to the peak-to-peak detector C25, D5, D6, C26, R27. The negative going peaks of the waveform at the junction of D5 and D6 are clamped to -5.2 volts by D5. C26 is charged positive with respect to -5.2 volts by the more positive level existing between pulses. This level is applied to Q8 base and results in Q8 conducting, cutting off Q9. This puts the lock indicator line to a high impedance state.
137. If either input to the phase sensitive detector fails, IC1c/8 will remain at logic '1'. The charge on C26 will leak away through R27, and Q8 will be cut off. The base of Q9 will be pulled up by R30 and R31, so Q9 will conduct, holding the lock indicator line at 0 volts.

BAND SELECTION DIVIDER SYSTEM

138. The whole of the band selection divider system is mounted on assembly 19-0899. The circuit diagram is shown in Fig.21.
139. This system contains the dividers to produce the output frequencies for bands 2, 3, 4, 5 and 6 (1 MHz to 52 MHz) from the synthesizer output (40 MHz to 104 MHz). The undivided synthesizer output is used for band 7. Band 1 output signals are produced from the band 4 signals in the LF combiner on assembly 19-0900.

Divider Chain

140. Three integrated circuit dividers are used, IC4a and IC4b, which are D-type bistable circuits both wired to have a division ratio of 2, and IC8, a modulus 10/11 divider wired to have a division ratio of 10. The signal path can be selected to pass through all, two, one or none of the dividers, to provide ratios of input to output frequency of 40, 20, 10, 4, 2 or 1, by means of a gating system. The gates are controlled by signals from the output frequency band control lines.

141. The input signal from the output loop oscillator enters the assembly via SK66, a coaxial flying lead and pin 1. The signal is applied directly to IC3c/11 and IC3d/12. It is also divided by 2 in IC4a and applied to IC3b/6 and IC7b/6. The output of IC4a is further divided by 2 in IC4b, the output being applied to IC3a/5 and IC7a/5.
142. The A_0 , A_1 and A_3 control lines enter the assembly at edge connectors A_9 , A_7 and A_8 . The coding is given in Table 4, and is not the band number in BCD. A_0 is connected as the least significant and A_3 as the most significant digit input to the binary to decimal decoder IC5. Connection to IC5 is made via diodes D1, D2 and D3. These provide a shift in the control line levels to give the CMOS levels required by IC5.
143. The decimal output of IC5 corresponding to the binary input goes to logic '1'. In the case of bands 7, 6 or 5 the output level from IC5, after inversion in IC6e, IC6c or IC6f, will enable gate IC3d, IC7b or IC7a. The frequency applied to IC7d/13 will be f , $f/2$ or $f/4$.
144. In the case of bands 4, 3, 2 or 1 the output level from IC5, after inversion in IC2b, IC6a, IC6b, or IC2b will enable gate IC3c, IC3b, IC3a or IC3c. Frequencies of f , $f/2$, $f/4$ or f will be applied to IC8/1, giving frequencies of $f/10$, $f/20$, $f/40$ or $f/10$ at IC8/8 and IC7c/11. When band 1 is selected the output level from IC5/1 is made available at edge connector A5. This acts as a control signal for the LF combiner on assembly 19-0900.
145. In addition to enabling the gates feeding IC8, an output from IC5 which corresponds to band 4, 3, 2 or 1 will be applied to IC2a. IC2a/1 will go to logic '0', enabling IC7c and allowing the output of IC8 to pass to IC7d/13.
146. IC4a and IC4b are held in the set state when they are not required to form part of the divider chain. IC4a is controlled by IC1b and IC4b by IC1a. For band 1, 4 or 7 all the inputs to IC1b will be at logic '0', putting IC1b/13 and IC4a/5 to logic '1'. This puts IC4a to the set state, and inhibits division. For other bands one input of IC1b will be at logic '1', putting IC1b/13 and IC4a/5 to logic '0'.
147. IC4b is controlled by IC1a in a similar manner, being held in the set state except when band 2 or 5 is selected.

Modulator and Output Buffer

148. The output of the divider chain drives the primary circuit of T1 via IC7d and Q2. T1 is the input transformer of a double balanced ring modulator, in which the divider output signal is amplitude modulated by the potential difference between the centre taps on transformers T1 and T2. This voltage enters the assembly via SK65, a coaxial flying lead and pin 2. The mean level is set by the VERNIER control and the ALC circuit. When AM is in use the modulating audio signal is added to the mean level. The derivation of the composite signal is covered in paragraphs 179 to 190, relating to the ALC system.

149. The output of the modulator is taken from T2, and buffered in the stage containing Q1 before passing off the assembly via pin 3, a coaxial flying lead and SK67.

RF FILTERS

150. The RF filters and the filter selection circuit are mounted on assembly 19-0906. The circuit diagram is given in Fig.23.
151. The output from the modulator on assembly 19-0899 is at the required instrument output frequency, and is controllable in amplitude over a range of 13dB by means of the VERNIER control. The RF filters reduce the harmonic content of the waveform to the required level.
152. Two filters are provided for each of bands 2 to 7. Band 1 signals are generated from the band 4 signals in the LF combiner system on assembly 19-0900.
153. The required filter is selected by means of a diode switching system, controlled by the output frequency band control lines and the $\frac{1}{2}$ octave line.
154. The twelve filters are mounted between two parallel lengths of 50 Ω strip line. The lines are terminated by L44 and R23, and by L47 and R24. The five highest frequency filters are of the 5th order elliptical response type, while the seven lowest frequency filters are a combination of 5th order elliptical response and 3rd order Butterworth response types.
155. The $\frac{1}{2}$ octave line enters the assembly at edge connector A4. The control voltage levels are shifted by D1 to give the CMOS levels required by the buffer IC3a. The output at IC3a/11 and its complement at IC3a/12 are connected to the most significant bit inputs of the BCD to decimal decoders, IC1 and IC2. These inputs are used to select one or other of the decoders to operate the filter selection gates, according to whether the output frequency is in the upper or lower half of the selected band. IC2 is used in the upper half of each band.
156. The A₀, A₁ and A₃ control lines enter the assembly on edge connectors A, A2 and A3. The coding is given in Table 4, and is not the band number in BCD. The control voltage levels are connected to the inputs of the BCD to decimal decoders, IC1 and IC2. The connections are made via D2, D3 and D4, which shift the control voltage levels to the CMOS levels required by IC3, and the buffers IC3b, IC3c and IC3d. The A₀ line is connected in the least significant bit position.
157. The BCD to decimal decoder which receives logic '1' from IC3a will have a total input greater than 8 (binary 1000). The decimal outputs for 8 and 9 are not used, and any input greater than 9 will not be decoded. This decoder therefore plays no part in the filter selection.
158. The BCD to decimal decoder which receives logic '0' from IC3a as its most significant input bit will have a total input less than 8 (binary 1000). The decimal output which corresponds to the binary number on the output frequency band control lines will go to logic '0'. This output level is used to select the required filter.

159. In the non-selected condition, the lowest frequency filter has its signal line pulled up towards approximately 9 volts through one of the resistors in R5, R22 and L40. This reverse biases D44 and D46, isolating the filter from the strip lines, and forward biases D45, providing a low impedance path to earth to any RF leakage on the filter signal line.
160. The lowest frequency filter is selected when IC1/6 goes to logic '0'. The voltage level at IC1/6 is then approximately -5 volts, which forward biases D44 and D46, and reverse biases D45. This connects the filter between the strip lines.
161. In the non-selected condition the highest frequency filter has the junction of D6 and D7 and the junction of D8 and D9 pulled towards approximately 9 volts through one of the resistors in R5, R6 and R7. The signal line of the filter is held at earth to DC by L1, so the four diodes are all reverse biased.
162. The highest frequency filter is selected when IC2/4 goes to logic '0'. The voltage level at IC2/4 is then approximately -5 volts, which forward biases all four diodes and connects the filter between the strip lines.
163. The other filters are selected in the same manner as either the highest or lowest frequency filter when the appropriate output of IC1 or IC2 goes to logic '0'.
164. When the higher output frequency bands are in use harmonics of the output frequency outside the operating range of the instrument may occur. The level of these is reduced by the filter section L45, L46, C95.

LF COMBINER SYSTEM

165. The LF combiner is mounted on assembly 19-0900. The circuit diagram is shown in Fig. 25.
166. The LF combiner produces the output frequencies for band 1 by combining a selected range of frequencies from band 4 with 5 MHz derived in the reference source assembly. For bands 2 to 7 the combining circuit is bypassed. The signal switching is performed by two relays controlled by a band 1 selection signal derived in the instrument control logic. A super alpha pair is used as the input to the relay switching stage to reduce the loading of the signal line. Only one relay is energised at a time, which balances the loading of the +15 volt supply.
167. The band 1 selection signal enters the assembly at edge connector A2. The input level is at logic '1' to select band 1. With band 1 selected Q1 will conduct, pulling the 5 MHz input line towards -5.2 volts. This DC level is fed back to the reference source system to enable the 5 MHz output.
168. The band 1 selection signal is also applied to the super alpha pair Q4 and Q5. With band 1 selected these conduct, energising relay B and holding the base of Q6 low. With Q6 in the non conducting state relay A is de-energised. The RF signal path then includes the mixer and band pass filter circuits.

169. With the band 1 selection line at logic '0' Q4 and Q5 are in the non conducting state, and relay B is de-energised. Q6 base is connected to +15 volts via R14, R13 and relay B, so Q6 conducts and relay A is energised. The RF signal path now bypasses the mixer and band pass filter circuits, but includes the high pass filter C21, C23 and L3. This suppresses audio signals which may appear on the modulator output when AM is in use.
170. With band 1 selected the output loop system operates over that part of band 4 between 5.01 MHz and 6.4 MHz. The tuning range is restricted by the instrument control logic.
171. The RF, from the filters on assembly 19-0906, enters the assembly via SK64, a coaxial flying lead and pin 2. It is connected by the contact of relay A to the base of Q2. R6 provides the required terminating impedance for the input.
172. The output of Q2 forms one input of the double balanced ring modulator, formed by T1, T2 and D1 to D4. The second input is a 5 MHz signal derived in the reference source system. This enters the assembly via SK63, a coaxial flying lead and pin 3. The output of the modulator is taken from the centre taps of T1 and T2 and is amplified in the stage containing Q3. The gain of this amplifier can be varied by adjustment of R11 to permit setting of the band 1 output level.
173. The amplifier output will contain signals at both the frequencies applied to the modulator, as well as signals at the sum and difference frequencies. The required difference frequency is selected by means of a 10 kHz to 1.4 MHz band pass filter. This filter has a passive low pass section, between C14 and C20, an active high pass section, between C24 and the output of the unity gain amplifier, formed by Q7 and Q8, and an additional low pass section, between L4 and C31. The high order low pass sections are used to provide a rapid increase in attenuation above 1.4 MHz. This is necessary to reduce the components of the signal at the frequencies applied to the modulator to a suitably low level.
174. The RF leaves the assembly via pin 1, a coaxial lead and SK62, and is connected to the final RF amplifier on assembly 19-0897.

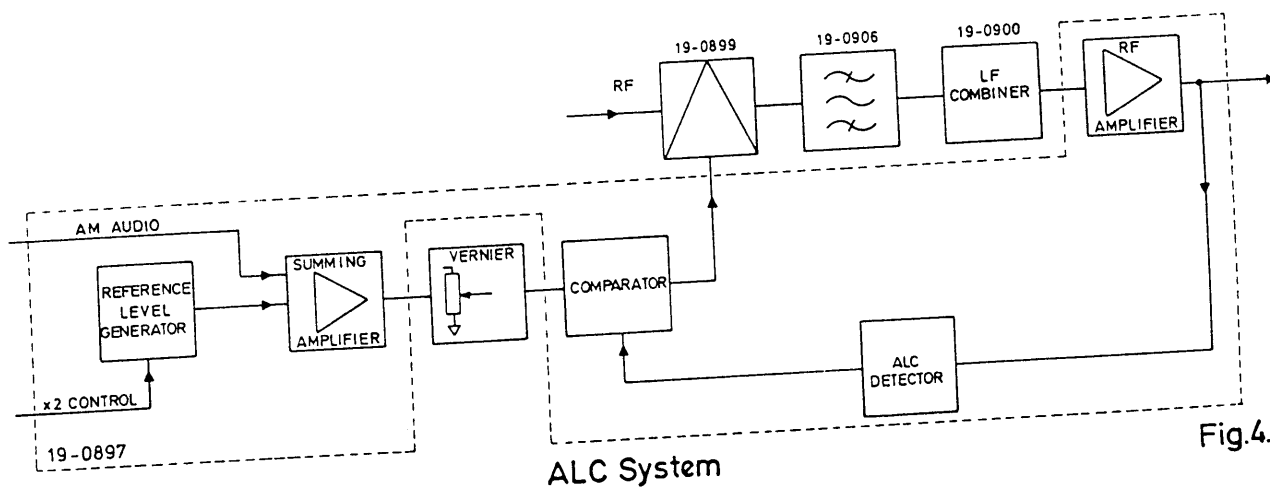
RF OUTPUT AMPLIFIER

175. The final RF output amplifier is mounted on assembly 19-0897. The circuit diagram is shown in Fig. 27.
176. The RF from assembly 19-0900 enters assembly 19-0897 via SK70, a coaxial flying lead and pin 1. Correct termination of the input lead is provided by R1. The signal is applied to the common emitter stage, Q1, the output of which is further amplified by the feedback pair Q2/Q3.

177. The three final stages of the amplifier are symmetrical complementary pair circuits. The output of the feedback pair is applied to the bases of Q4 and Q5 in the same phase, but with a DC level difference set by the voltage drop across R20. The signals at Q4 and Q5 emitters are in phase, but have a DC level difference set by the voltage drop across R26. The coupling between the first and second complementary pair circuits consists of the filter circuits, formed by C26, L1, R25, L2 and R27, and a balanced capacitive bridge C31, C37, C33 and C34. The filter circuits suppress high frequency parasitic oscillation, while the bridge circuit ensures that any change of potential across R26 is prevented from appearing across R30.
178. The output of the Q6/Q7 stage is developed across R34, and applied in the same phase to the bases of Q8 and Q9. Two outputs are taken from this stage. One is taken via R49 to the manual attenuator and eventually to the instrument RF output socket. The other is taken via C56, C57 and C58 to the ALC detector.

ALC AND AM SYSTEM

179. The ALC system is mounted mainly on assembly 19-0897, but the modulator on assembly 19-0899, the filters on assembly 19-0906 and the LF combiner on assembly 19-0900 all form part of the forward section of the loop. A simplified block diagram is given in Fig. 4.4, and the circuit diagrams are shown in Fig.27, Fig.21, Fig.23, and Fig.25.

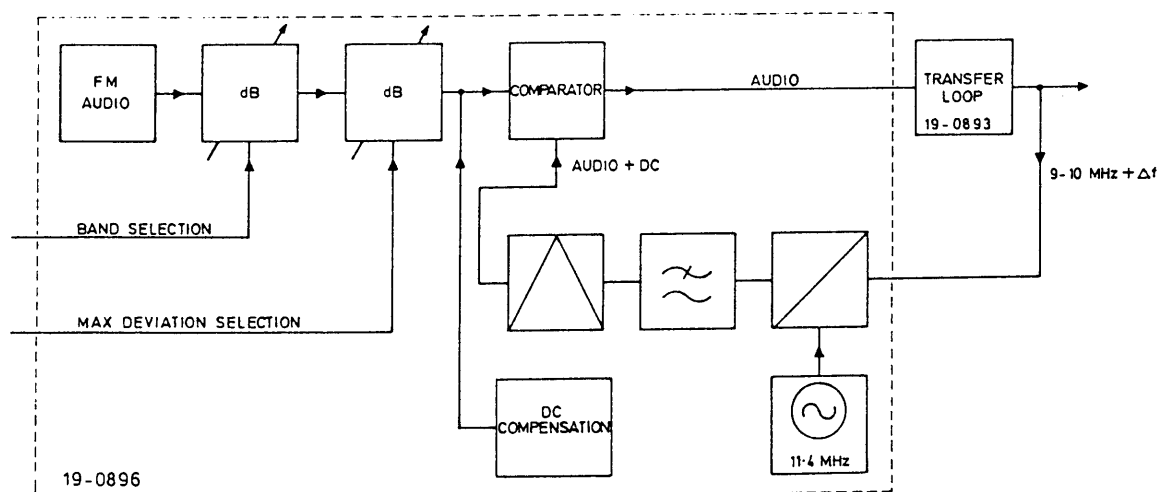


180. The reference level is set by the zener diode D1 on assembly 19-0897. With NORMAL selected on the carrier level control switches the reference is reduced by the potential divider R62, R63, R66 and applied to the summing amplifier IC1b. This amplifier adds the AM audio signal, which is selected in assembly 19-0896 and enters assembly 19-0897 via SK73 and pin 5, to the reference level. The gain of the amplifier with respect to the reference level can be set by adjustment of the input resistor R69, while the gain with respect to the combined signal can be set by adjustment of the feedback resistor R79. Because the signal is connected at the inverting input to IC1b the output is negative with respect to 0 volts.
181. When X2 is selected on the carrier level control switches the instrument control logic line I, which enters the assembly at edge connector A2, is at logic '0'. This level, applied to IC2b/14, puts the bilateral switch (transmission gate) to its low impedance state. This bypasses the attenuator, and doubles the reference level applied to IC1b/6.
182. The combined reference level and audio signal leaves the assembly via pin 2, a coaxial flying lead and SK71, and is applied to the front panel VERNIER control. The signal returns to assembly 19-0897, at a level determined by the VERNIER control setting, via SK72, a coaxial lead and pin 4, and is applied to a comparator circuit. Combining the reference and modulating signals before setting the level by means of the VERNIER control maintains the percentage modulation depth set as the output level is changed.
183. The comparator circuit consists of a resistive difference circuit and an integrator. The reference signal is applied to one end of the resistor chain R89, R84, R77, and the output of the ALC detector to the other. Since the signals have opposite polarities equal amplitude signals will result in IC3b/6 being at 0 volts.
184. IC3b is connected as an integrator. If IC3b/6 is not at 0 volts IC3b/7 will ramp up or down, varying the control signal to the modulator on assembly 19-0899. The integrator feedback capacitor is increased when band 1 is selected, and again if the RF output frequency is below 100 kHz, by putting C71 and C70 in parallel with C69. For bands 2 to 7 the band 1 select line at edge connector A3 is negative. The transistors in the DC level shifting stage, Q10 and Q11, conduct, and the gate of Q19 is held low via D9. This puts Q19 to the high impedance state, and C71 is ineffective. With band 1 selected the band 1 select line is at logic '1' (0 volts), and Q19 goes to the low impedance state. C70 is inserted into the circuit in a similar manner when the BELOW 100 kHz line is at logic '1', since this level, entering the assembly at edge connector A1 and applied to IC2a/1, puts the bilateral switch (transmission gate) to its high impedance state and allows Q18 to conduct.
185. The modulator control line is normally more positive than 0 volts, but can be driven to 0 volts at the peak of a modulating waveform giving 100% AM. If system transients or over modulation result in the line being driven below 0 volts the negative excursion is limited by D14. When forward biased this provides a feedback path which limits the gain of IC3b to unity.

186. Any imbalance in the modulator diodes will give an offset at the modulator control line input. This can be offset by applying a compensating bias to the control line from R82.
187. The ALC loop is closed by developing a voltage proportional to the RF output amplitude and feeding this to the comparator. The voltage is produced by the ALC detector D4, C61, and is applied to the buffer amplifier IC3a. The charge on C61 is reduced as the RF output increases, so that the voltage applied to the comparator from IC3a/1 increases, and the modulator control line potential decreases.
188. On band 1 the level of ripple in the ALC system increases, and it is necessary to increase the value of the capacitor in the detector circuit. This reduces the maximum modulating frequency which can be employed. When band 1 is selected a logic '1' (0 volts) is applied at edge connector A3 by the instrument control logic. This is applied via the DC level changing stage containing Q10 and Q11 to D2 and the gate of Q12. This puts Q12 to the low impedance state and connects C62 in parallel with C61.
189. Below 100 kHz, when no modulation is employed, an additional capacitor C63 is connected in parallel with C61. For frequencies below 100 kHz, the bilateral switch (transmission gate) in IC2a is put to its high impedance state by a logic '1' applied at edge connector A1 from the instrument control logic. The gate of Q13 is no longer held negative, so Q13 conducts, inserting C63 in the circuit.
190. The potential at IC3a/3 can be adjusted by means of R52. This allows compensation for any offset in IC3a. Variations in the performance of the circuit R61, D4, R56 and R55 due to temperature changes are compensated for by changes in the matching circuit R58, D3, R54.

FM LOOP SYSTEM

191. The FM loop system is mounted mainly on assembly 19-0896, but part of the transfer loop on assembly 19-0893 is included in the forward section of the loop. A simplified block diagram is given in Fig. 4.5, and the circuit diagrams are shown in Fig.11 and Fig.29.



FM Loop System

Fig.4.5

192. The audio signal for FM is selected from the internal oscillator output or the external audio signal applied at the front panel FM audio input socket. The chosen signal is available at IC5/6 and 9, and is buffered in the voltage follower IC14b. The output for the metering system is taken from IC14b/7, so that subsequent attenuation of the audio signal will affect the frequency deviation obtained, but will not reduce the meter reading. By this means the meter is made to read the deviation at the RF output, not the deviation of the synthesizer output, which has to be adjusted to suit the frequency band in use. It also permits variation of the scaling of the meter, so that full scale deflection can represent the maxima of more than one deviation range.

Band Switching Attenuator and FM Audio Calibration

193. On band 7 the synthesizer output is used directly for the instrument RF output. The output deviation is therefore the synthesizer deviation. For other bands, however, the synthesizer output is divided to provide the instrument RF output. The synthesizer deviation is also divided, so that the output deviation is less than the synthesizer deviation. The maximum deviation on each band, and the required synthesizer deviation are shown in Table 8.

TABLE 8

Synthesizer and Output Deviation Ratios

Band	Max Output Deviation	Division Ratio	Synthesizer Deviation
7	300 kHz	1	300 kHz
6	100 kHz	2	200 kHz
5	100 kHz	4	400 kHz
4	30 kHz	10	300 kHz
3	10 kHz	20	200 kHz
2	10 kHz	40	400 kHz
1	10 kHz	10	100 kHz

194. It can be seen that the maximum synthesizer deviation is required for band 5 and band 2. The deviation, and therefore the modulating audio signal, require to be reduced by factors of $\frac{3}{4}$ for bands 1 and 4, $\frac{1}{2}$ for bands 6 and 3 and $\frac{1}{4}$ for band 1. A four state variable attenuator, consisting of R27, R17, R22 and R23 is provided to do this.
195. The audio output from IC14b is applied to the variable gain amplifier IC16a. The gain is set by adjustment of R114, varying the amount of feedback obtained. This allows calibration of the audio signal applied to the attenuator.
196. The attenuation ratio is controlled by the insertion in the circuit of R17, R22 or R23 by the bilateral switches (transmission gates) in IC2b and IC17. The switches are in the high impedance state when a logic '1' level is applied at the relevant control input. Switching is controlled by the SW1, SW2 and SW3 control lines, which carry logic levels set by the instrument control logic. The lines enter the assembly at edge connectors A15, B5 and A4. The coding used is shown in Table 9.

TABLE 9

Band Attenuator Control Coding

Band	SW1	SW2	SW3
7	0	1	1
6	1	0	1
5	1	1	1
4	0	1	1
3	1	0	1
2	1	1	1
1	1	1	0

Maximum Deviation Scaling

197. To permit accurate setting of the lower levels of output frequency deviation, the sensitivity of the meter may be increased at the expense of a reduced maximum of the deviation obtainable. This is achieved by attenuating the audio signal producing deviation without reducing the audio signal to the meter. The maximum deviations of the available deviation ranges, and the division ratios of the audio attenuator required for different ranges are given in Table 10.

TABLE 10

Deviation Attenuator Division Ratios

Band	Available Deviation Ranges				
	300 kHz	100 kHz	30 kHz	10 kHz	3 kHz
7	1	3	10	30	100
6 and 5		1	3.33	10	33.3
4			1	3	10
3,2 and 1				1	3.33

198. The band switching attenuators ensure that the maximum audio signal level available will give the maximum deviation available on the band in use, where a division ratio of 1 is required. For other deviation ranges additional attenuation is provided by means of a four state attenuator, giving division ratios of 1, 3, 3.3 and 10, and an additional two state attenuator giving division ratios of 1 and 10.

199. The audio output from the band switching attenuators is buffered in the voltage follower IC6b, and is applied to the four state attenuators comprising R31, R32, R33 and R39. The attenuator output is buffered in the voltage follower IC19b and applied to the two state attenuator comprising R43 and R44. The required division ratio is obtained by inserting R32, R33, R39 or R44 into the circuit by means of the bilateral switches (transmission gates) in IC18 and IC21. The switches are in the high impedance state when a logic '1' level is applied at the relevant control input. Switching is controlled by the SW1', SW2', SW3' and SW5' control lines, which carry logic levels set by the instrument control logic. The lines enter the assembly at edge connectors B11, A5, B7 and B6. The coding used is given in Table 11.

TABLE 11
Deviation Control Line Coding

Band	Maximum Deviation	SW1'	SW2'	SW3'	SW5'
7	300 kHz	1	1	1	1
	100 kHz	0	1	1	1
	30 kHz	1	0	1	1
	10 kHz	0	1	0	1
	3 kHz	1	0	0	1
6 and 5	100 kHz	1	1	1	1
	30 kHz	1	1	1	0
	10 kHz	1	0	1	1
	3 kHz	1	1	0	0
4	30 kHz	1	1	1	1
	10 kHz	0	1	1	1
	3 kHz	1	0	1	1
3, 2 and 1	10 kHz	1	1	1	1
	3 kHz	1	1	1	0

200. After the final scaling of the modulating signal has been performed it is buffered in the voltage follower IC20.

Discriminator DC Output Compensation

201. The audio signal from IC20 is compared with the audio signal retrieved from the frequency modulated output of the transfer loop. The comparator output forms the modulating signal for the transfer loop.

202. The frequency discriminator used to retrieve the audio from the transfer loop output is of the diode pump type, and its output contains a DC level inversely proportional to the mean frequency applied, as well as the audio signal. The DC level must not appear as part of the modulating signal for the transfer loop, but simple capacitor blocking at the discriminator output leads to instability of the FM loop at low modulating frequencies. Some compensation for the change in DC level is necessary at the discriminator output, however, to keep the total signal level within the operating range of the comparator, and this is achieved by shunting current away from the discriminator charging path R67, R62, Q16 as the frequency applied to the discriminator decreases. A series of shunting resistors, R50, R52, R58 and R63, having values weighted 8, 4, 2, 1 is employed. The resistors are switched into the circuit by the transistors Q9, Q10, Q13 and Q15. These are controlled by the logic levels on the 100 kHz control lines, which represent the synthesizer 100 kHz frequency step selected in BCD.

Comparator and Audio Signal Switching

203. The difference between the current drawn from C32, due to the audio retrieved from the transfer loop, and the current supplied to C32 by Q16, due to the modulating audio signal, results in a variation, at the modulating frequency, in the potential at the base of Q14. This difference signal is amplified in Q14 and passed via a low pass filter to the amplifier IC19a. The filter is required to eliminate spikes in the waveform due to the switching action in the discriminator. Q24 provides a stable supply at approximately -12 V for the emitter of Q14, necessary because of the sensitivity of the oscillator frequency to voltage changes at this point in the circuit.
204. The amplifier IC19a operates in the inverting mode, with a gain of 15. Bias is provided from the mean level of the input signal, which is filtered by R69, R71, C40 and applied to the non-inverting input.
205. The audio signal leaves the assembly via pin 8, a coaxial lead and SK75. The removal of any remaining DC level occurs at C58 on assembly 19-0893.

Backward Path of Loop

206. The audio signal fed to the comparator to close the loop is derived from the output of the transfer loop, which is fed back to assembly 19-0896 via SK77 a coaxial flying lead and pin 5. The signal, which lies in the frequency range from 9 MHz to 10 MHz and carries the frequency modulation which will appear at the synthesizer output, is fed to one input of the balanced mixer in IC13.

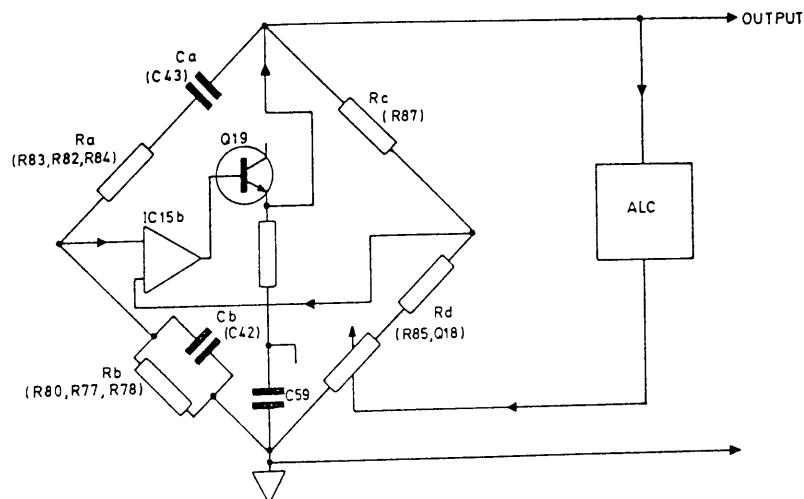
207. The second input to the mixer is from the 11.4 MHz, crystal controlled, Colpitts oscillator, the active element of which is Q4. The oscillator output is buffered and amplified in Q2 and Q1. To maintain amplitude stability the oscillator is provided with a stabilised supply by Q3.
208. The mixer output from IC13/9, containing the sum and difference of the applied frequencies, is applied to the emitter follower Q6 and the low pass filter between Q6 emitter and C17. The filter removes the sum frequency. The difference frequency is amplified in Q7 and applied to the inputs of the Schmitt trigger NAND gate IC22. The output at IC22/8 has a rectangular waveform of unity mark/space ratio and a frequency within the limits of 2.4 MHz and 1.4 MHz. This is amplified in the pulse amplifier Q8 to give the discriminator pumping signal.
209. The pumping waveform is applied to C27. The negative going edge will result in Q12 emitter going more negative than -15 V, so that Q12 conducts while D4 is back biased. Charge is transferred from C32 to C27, reducing the potential across C32, and changing the potential across C27 until Q12 emitter is again at -15 V. The charge transfer is completed within the duration of the negative going pulse, even at the highest frequency encountered, so the amount of charge transferred does not depend on the frequency. The positive going edge cuts off Q12, but forward biases D4.
210. During the remainder of the cycle C32 recharges. The system will settle at a point where the charge replaced during this period equals that removed during the negative pulse. The charging rate depends on the potential on C32, increasing as the potential on C32 decreases. As the frequency increases the time available for recharging becomes less, and the potential on C32 decreases to a new balance point. Due to the FM the potential on C32 will vary at the modulation rate. This variation would be about a DC level inversely proportional to the mean frequency applied to the discriminator, were it not for the action of the discriminator DC output compensation circuit described earlier.

AUDIO MODULATING SIGNAL SYSTEM

211. The circuit for selecting the internal or external audio signals for both the AM and FM systems, and the oscillator for generating the internal audio signals, are mounted on assembly 19-0896. The circuit diagram is shown in Fig.29.

Internal Audio Oscillator

212. The internal audio oscillator is of the Wien bridge type, the active element being the operational amplifier IC15b. An emitter follower, Q19, acts as a buffer on the amplifier output and provides the low output impedance required in this form of oscillator.
213. The arrangement of the bridge is shown in Fig.4.6. When R_a equals R_b and C_a equals C_b oscillation occurs at a frequency $f = \frac{1}{2\pi CR}$. This is the frequency at which the signals at the amplifier input and output are in phase. Changes in operating frequency are obtained by changing the value of R.



Audio Oscillator

Fig.4.6

214. It will be seen that the amplifier output is applied across two corners of the bridge, while the amplifier input is taken across the other two corners. When R_c is twice R_d the bridge is balanced and there is no input to the amplifier. The value of R_d is controlled by the ALC circuit, and the system operates at a point where the bridge is not quite balanced and a small amplifier input exists. Changes detected in the output level cause variation in the value of R_d , the balance of the bridge, and thus the amplifier input, in a manner which opposes the detected change in output.
215. The oscillator frequency is controlled by means of the front panel MODULATION FREQUENCY switches, operation of which cause the instrument control logic to provide binary coding on two lines. The coding used is given in Table 12.

TABLE 12

Modulation Frequency Control Coding

Frequency	Control Line Coding	
	A	B
3 kHz	0	1
1 kHz	1	0
400 kHz	1	1

216. The control lines enter assembly 19-0896 at edge connectors B10 and A6. The signals on the lines set the state of the bilateral switches (transmission gates) in IC10, IC9b and IC2a. The switches are in the open, high impedance, state when the associated control line is at logic '1'. For a frequency of 400 Hz the frequency controlling resistors are R83 and R80. For a frequency of 1 kHz line B is at logic '0', and the switches in IC10 are in the low impedance state. This connects R84 in parallel with R83 and R78 in parallel with R80. For a frequency of 3 kHz R82 is connected in parallel with R83 via IC9b and R77 is connected in parallel with R80 via IC2a.
217. The oscillator output is applied to the ALC detector, consisting of D6 and C45. The potential across C45 is proportional to the oscillator output amplitude, and is compared with 0 volts in IC15a. The output of IC15a is used to set the gate potential of, and therefore the resistance added to the bridge by, Q18, a FET operated in the variable resistance mode. The ALC stabilises with IC15a/2 positive with respect to IC15a/3, and IC15a/1 negative with respect to 0 volts. The stabilised output level can be set by adjustment of R95, which sets the potential at IC15a/2 independently of the ALC detector output.

Audio Output and Modulation Index Control

218. The output of the internal audio oscillator is available at a rear panel BNC socket. This output is buffered in the emitter follower stage containing Q20, and leaves the assembly via pin 7, a coaxial flying lead and SK78. R101 and R102 set the output impedance at 600 Ω .
219. A further output is taken from the oscillator via C50. This leaves the assembly via pin 6, a coaxial flying lead and SK76. This output is applied to the front panel MODULATION LEVEL potentiometer, the proportion of the oscillator output selected by this control being returned to assembly 19-0896 via SK79, a coaxial flying lead and pin 4. It is fed to bilateral switches (transmission gates) in IC5 and IC9a where it is available, if required, for injection into the ALC system for AM or the FM loop system for FM. The MODULATION LEVEL control thus sets the depth of modulation for AM and the frequency deviation for FM when the interval modulation source is used.

Modulating Signal Control

220. The selection of the internal or external modulating sources, as required, and the inhibition of the modulating signal when the RF output frequency is below 100 kHz or when X2 is selected on the carrier level control switches, is performed by means of four bilateral switches (transmission gates) in IC5, IC1b and IC9a. The switches are in the open, high impedance, state when the associated control line is at logic '1'.
221. The external modulating signal for AM enters the assembly via SK81, a coaxial flying lead and pin 1. The input impedance is set to 600 Ω by R74 and R76. The signal is passed via a low pass filter section to IC1b/10. The internal modulating signal is applied to IC9a/5.

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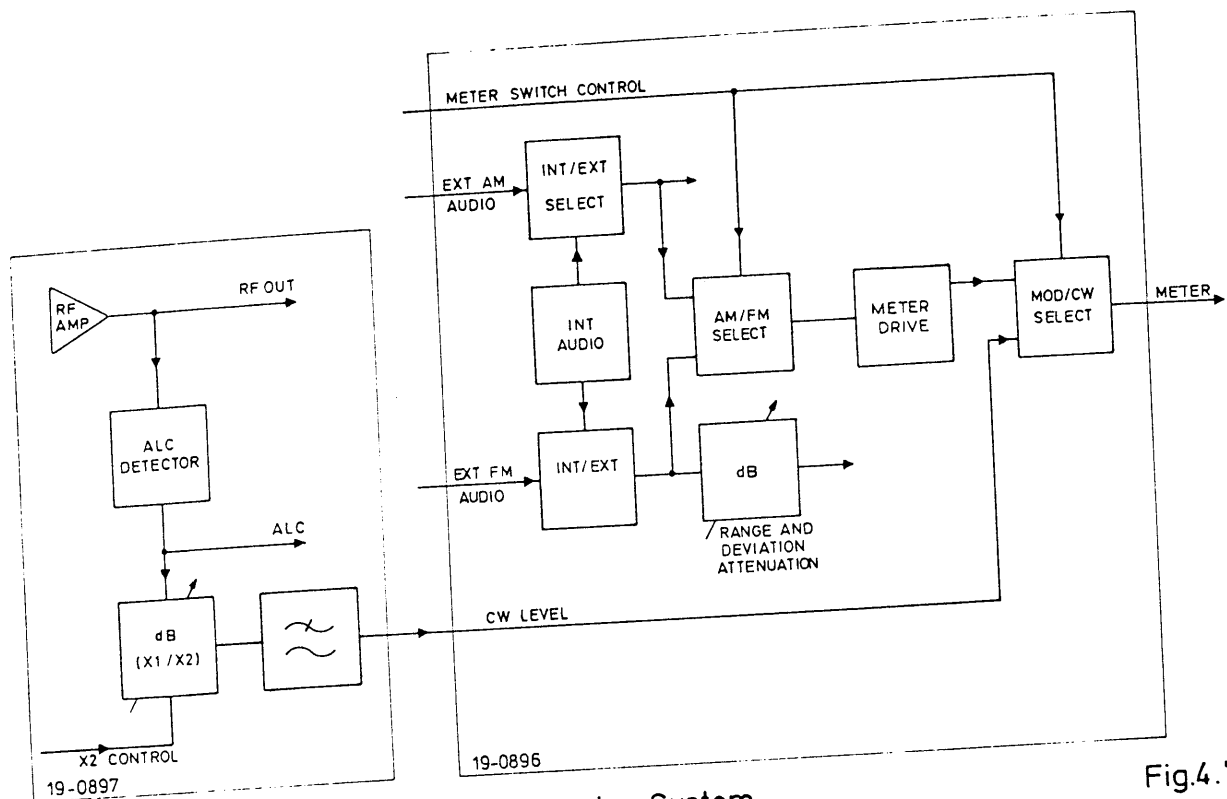
222. Selection of the internal or external modulating signals is controlled by the instrument control logic line C. The coding used is given in Table 3. The logic level present is applied directly to IC6b/6, and via inverter IC7b to IC6c/8 to put IC1b or IC9a to the low impedance state. The selected modulating signal is buffered by the voltage follower IC11b, and leaves the assembly via pin 2, a coaxial flying lead and SK82.
223. Inhibition of the audio signal for AM occurs when the AM is switched off, when the carrier is switched off or X2 is selected on the carrier level control switches, or when the RF output frequency is below 100 kHz. The inhibiting signal is derived from the instrument control logic lines D and I and the BELOW 100 kHz control line. The coding for lines D and I is given in Table 3. The logic levels on the three control lines are fed to IC4a, which puts both IC1b and IC9a to the high impedance state, via IC6b and IC6c, if a logic '1' level occurs at any of its inputs.
224. The external modulating signal for FM enters the assembly via SK80, a coaxial flying lead and pin 3. The input impedance is set to 600 Ω by R73 and R75. The signal is passed via a low pass filter section to IC5/5. The internal modulating signal is applied to IC5/10.
225. Selection of the internal or external modulating signals is controlled by the instrument control logic line E. The coding used is given in Table 3. The logic level present is applied directly to IC6a/1, and via inverter IC7c to IC6d/12, to put one or other of the switches in IC5 to the low impedance state.
226. Inhibition of the audio signal for FM occurs when the FM is switched off or when the RF output frequency is below 100 kHz. The inhibiting signal is derived from the instrument control logic line F and the BELOW 100 kHz control line. The coding for line F is given in Table 3. The logic levels on the two control lines are fed to IC4c, which puts both switches in IC5 to the high impedance state, via IC6a and IC6d, if a logic '1' level occurs at any of its inputs.

Internal Audio Oscillator Inhibition

227. The internal audio oscillator is inhibited when it is not required. Inhibition is controlled by the instrument control logic lines C and E. The coding used is given in Table 3. The control lines are connected to IC3b, IC3b/6 being at logic '1' if all of its inputs are at logic '0'. Under these conditions Q17 is in the conducting state, the input to the oscillator amplifier, IC15b/5, is held at 0 volts, and the oscillator is inhibited. A logic '1' on either line C or line E will result in Q17 being held in the non-conducting state, allowing the oscillator to operate.

METERING SYSTEM

228. The front panel meter function switches can be used to make the meter indicate CW level, AM depth or FM deviation. The CW level indication is derived on assembly 19-0897, and the AM depth and FM deviation indications on assembly 19-0896. A block diagram is given in Fig. 4.7, and the circuit diagrams are shown in Fig. 27 and Fig. 29.



Metering System

Fig.4.7

CW Level Indication

229. The CW level indication is derived from the output of IC3a, the buffer following the ALC detector. The signal here consists of a DC level proportional to the average carrier level and an audio signal related to the AM. The signal is applied to the X1/X2 attenuator via Q15 or Q16. R73 and R75 allow adjustment for meter calibration. With Q15 conducting the meter and R85, in series, are shunted by R86, R98, R99 and R90. The current in the meter is twice that in the shunting resistors. With Q16 conducting R86 and R98 are added in series with R85 and the meter, while the shunt is reduced to R99 and R90. This doubles the current in the shunt and halves the current in the meter, so that the sensitivity of the meter is reduced by a factor of 2. This condition is used when X2 is selected on the carrier level control switches.
230. The switching of Q15 and Q16 is performed by Q20 and Q17 according to the logic level on control line I. This enters assembly 19-0897 at edge connector A2, the logic levels being shifted by D7 before they are applied to Q17. When NORMAL is selected on the carrier level control switches, control line I is at logic '1' and Q17 conducts. D11 and D12 will be forward biased, cutting off Q16 and Q20. As Q20 collector goes more positive D10 is reverse biased and Q15 conducts. With X2 or OFF selected Q17 is cut off and both D11 and D12 are reverse biased, allowing Q16 and Q20 to conduct. Q15 is put into the high impedance state, as its gate is pulled negative via D10. The audio frequency variation due to AM at all except the lowest frequencies is removed by C68. The signal leaves the assembly at edge connector B3.

AM and FM Indication

231. Both the AM and FM indications are obtained by measurement of the modulating audio signals. The measurement points are on assembly 19-0896, for AM at the output of IC11b and for FM at the output of IC14b. The audio signals are applied to the bilateral switches (transmission gates) in IC1a and IC12a. The switches are in the high impedance state when logic '1' is applied at the relevant control input. Switching is controlled by control lines G and H. The coding used is given in Table 13. Signals selected by the switches are applied to the input of the amplifier IC11a.

TABLE 13

Meter Function Control Coding

Function	Control Line Coding	
	G	H
FM	1	0
CW	0	0
AM	0	1

232. The modulation depth for AM is always read on the 0 - 10 meter scale, and for AM the gain of IC11a is set to unity by R110 and R112. The FM deviation may be read on the 0 to 3 or the 0 to 10 scale, according to the range selected. Attenuation of the meter drive signal is required on ranges where the 0 to 3 scale is used to allow for the displacement between the scales.
233. The required attenuation is achieved by applying a logic '0' to IC12b/14, inserting R106 into the circuit. The required control signal is derived in IC8b, IC7a, IC3c and IC3a from the logic levels on the SW1', SW5' and SW1 control lines from the instrument control logic. The coding used is given in Table 9 and Table 11.
234. The output of IC11a is amplified in the meter drive circuit containing IC14a. The base/emitter junction of Q23 and C58 form a rectifier circuit to give a DC meter drive. This is connected to RLB via R123, which provides meter calibration adjustment.

Signal Selection

235. The CW level indication enters assembly 19-0896 at edge connector A8, and is fed to the contact of RLB which is closed when the relay is de-energised. If FM or AM is selected on the front panel meter selection switches either control line G or control line H will be put to a logic

'1' level by the instrument control logic. This will give a logic '1' at IC8c/10, causing Q22 to energise relay B. The signal selected by RLB leaves the assembly via edge connector B8.

INSTRUMENT CONTROL LOGIC SYSTEM

236. The control of the internal functioning of the instrument is exercised by means of 14 sets of control lines. With the exception of the remote control line, which is set from an external source via the remote control bus socket, the logic levels on the control lines are set by the circuitry on assemblies 19-0907, 19-0909 and 19-0911. The circuit diagrams of these assemblies are given in Fig. 31, Fig.33 and Fig. 35.

BELOW 100 kHz Line

237. The BELOW 100 kHz control line is required to be at logic '1' when the output frequency demanded is below 100 kHz. This can occur only when band 1 is selected, and requires that the demanded synthesizer frequency is less than 51 MHz. The setting of the logic level on this line is performed on assembly 19-0907.
238. The selection of band 1 is detected by combining the logic levels on the A₀ and A₁ band selection lines in IC17b. With band 1 selected both lines are at logic '0', giving a logic '0' at IC10b/6.
239. In band 1 the synthesizer frequency is restricted to the range 50.1 MHz to 64 MHz. For an output frequency less than 100 kHz the synthesizer frequency must be less than 51 MHz. This situation is detected by combining the logic levels of the four 1 MHz frequency control lines with that of the 10 MHz frequency control line B in the OR gate D16, D17, D18, D19 and D20. Within the synthesizer frequency range available with band 1 selected, the 10 MHz frequency control line B is at logic '0' only in the range from 50 MHz to 59 MHz. The 1 MHz frequency control lines are simultaneously at logic '0' only when the MHz units figure is zero. The five lines are therefore simultaneously at logic '0' when the synthesizer frequency is below 51 MHz, giving a logic '0' at IC10b/5. For a demanded output frequency of below 100 kHz both inputs to IC10b are at logic '0', and IC10b/4 is at logic '1'.

Half Octave Line

240. The $\frac{1}{2}$ octave line goes to a logic '0' level when the synthesizer frequency demanded is 63 MHz or above. The setting of the logic level on this line is performed on assembly 19-0907. The level is controlled by Q1, which is switched via the OR gate formed by D21, D22 and D23. The switching signal in the range from 100 MHz to 104 MHz is derived from the 100 MHz frequency control line via D23, and for the range from 80 MHz to 99 MHz from the 10 MHz frequency control line D via D22.
241. The signal for the range 63 MHz to 79 MHz is derived from the 10 MHz frequency control A, B and C and the 1 MHz frequency control lines. The 10 MHz lines B and C are combined in IC20d, and give a logic '1' at IC1b/4 over the 60 MHz and 70 MHz decades. This logic level is gated in IC2b to give a logic '1' at IC2b/4 over the range 63 MHz to 79 MHz. The gating signals are derived as shown in Table 14.

TABLE 14

Half Octave Line Control Signals

Frequency Range	Gating Signal at IC2b/6
63 MHz	1 MHz A and 1 MHz B via IC20b, IC19a and D14
64 MHz to 67 MHz	1 MHz C via D12
68 MHz to 69 MHz	1 MHz D via D15
70 MHz to 79 MHz	10 MHz A via D13

Quarter Octave Line

242. The logic level on the $\frac{1}{4}$ octave control line is set by the 1 MHz comb loop decode PROM on assembly 19-0907.

One Eighth Octave Line

243. The $\frac{1}{8}$ octave control line is required to be at logic '1' when the demanded synthesizer frequency is in the range from 40 MHz to 43 MHz. The setting of the logic level on this line is performed on assembly 19-0907. A demand for a synthesizer frequency below 43 MHz is detected by combining the logic levels of the 10 MHz frequency control lines A, B and C with those of the 1 MHz frequency control lines C and D in the gating system comprising IC19b, IC19c, IC19d, IC2a and IC20c.
244. The output at IC19d/11 is required to be at logic '1' when the logic levels on the 10 MHz and 1 MHz frequency control lines are in one of the patterns shown.

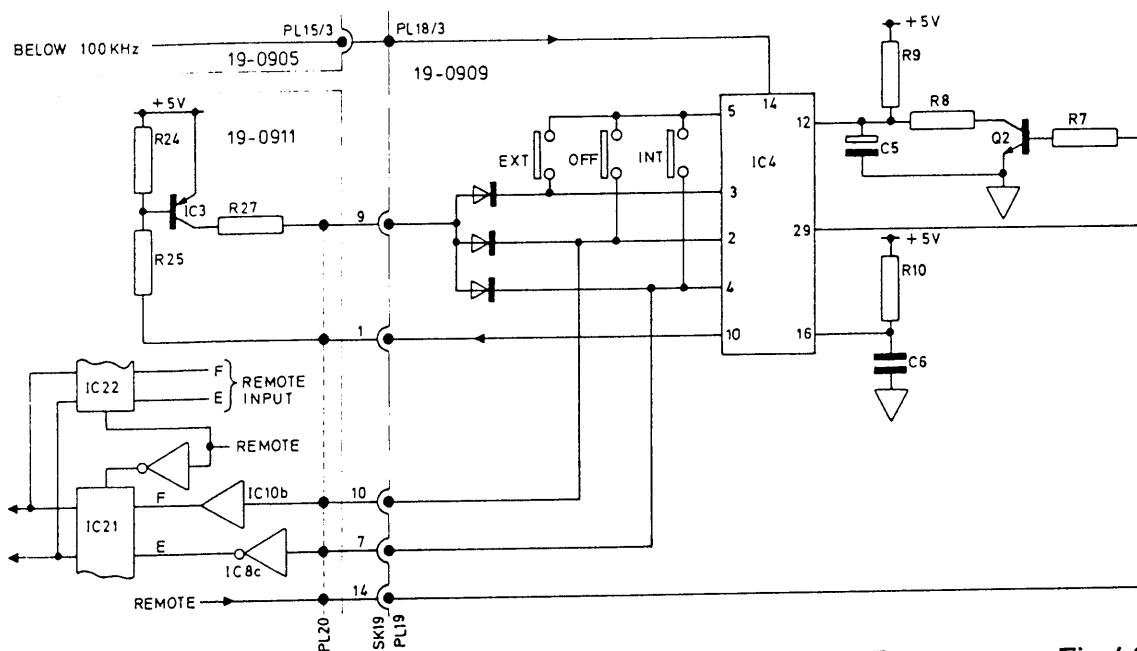
<u>10 MHz Lines</u>				<u>1 MHz Lines</u>				<u>Frequency</u>
D	C	B	A	D	C	B	A	
0	1	0	0	0	0	0	0	40 MHz
0	1	0	0	0	0	0	1	41 MHz
0	1	0	0	0	0	1	0	42 MHz
0	1	0	0	0	0	1	1	43 MHz

245. The 10 MHz control line D cannot be at logic '1' if the 10 MHz control line C is at logic '1', and its state need not be sampled. The four possible states of the 1 MHz control lines A and B are all included, so sampling of these lines is also unnecessary. The required logic '0' levels on the 1 MHz control lines C and D are detected in IC19b, and give a logic '1' at IC19b/4. The required logic '0' levels on the 10 MHz control lines A and B are detected in IC19c and give a logic '1' at IC19c/10. These two outputs are combined in IC20a to give a logic '0' at IC20a/3, and IC19d/12, when all four lines are at logic '0'.

246. When the 10 MHz control line C is at logic '1', as required, IC20c/10 and IC19d/13 will be at logic '0'. Thus, for demanded synthesizer frequencies less than 44 MHz, both inputs to IC19d are at logic '0' and IC19d/11 is at logic '1'.

Control Lines C,D,E,F,G,H,I and J

247. When the instrument is in local control the logic levels on the control lines for AM, FM, meter function and carrier level are set by IC4 on assembly 19-0909 under the control of the front panel switches. The operation of the circuit is the same for each pair of control lines. A diagram of the system for lines E and F (FM) is given in Fig. 4.8.



Functional Diagram for Control Lines E and F

Fig.4.8

248. When one of the switches is closed, a logic '1' is applied to IC4/5 via a transistor in IC3 of assembly 19-0911 and the LED associated with the switch. This enables an internal 10 kHz clock, which causes an internal ring counter to apply logic '0' to pins 2, 3 and 4 in turn. When the pin associated with the closed switch is located the logic '0' level is fed back to IC4/5, stopping the internal clock. The counter will remain latched at this location when the switch is released, and the LED will light to indicate the FM mode which has been selected.
249. If FM is selected when the BELOW 100 kHz line at IC4/14 is at logic '1', a 1 Hz internal clock will be enabled. This will switch IC4/10 between the logic '1' and logic '0' levels, and the LED supply will be interrupted by the transistor in IC3 on assembly 19-0911 to indicate that a prohibited setting has been demanded.

250. Control line E is held at logic '0' when FM INT is selected, and control line F is a logic '0' when OFF is selected. This gives the required logic level on line F, but the inverse of that required on line E. The two lines are buffered on assembly 19-0911 in IC10b and IC8c. An inverting buffer is used for IC8c to give the required logic levels, which are shown in Table 3. These logic levels are applied to the remote/local switching circuit, at the tri-state buffers in IC21, as the local information.
251. The remote logic levels are applied at the tri-state buffers in IC22, the buffered outputs being connected in parallel with the outputs of IC21. One or other of the sets of outputs will be held in the high impedance state according to the logic level on the remote control line. This enters assembly 19-0911 at pin 11 of SK22, is passed via a buffer in IC20 and two Schmitt inverters in IC27 to control IC21. The inverse of this control signal, produced by IC11e, is used to control IC22. Remote information from IC22 is selected when the remote control line is at logic '1'.
252. The frequency controlling components for the internal clocks of IC4 are R10/C6 (10 kHz) and R9/C5 (1 Hz). When remote operation is selected a logic '1' is applied to IC4/29 and the base of Q2. With Q2 conducting the 1 Hz clock is disabled, and the LEDs will not flash if prohibited settings are demanded. The logic '1' at IC4/29 gives a logic '1' level at the cathodes of the AM, FM, TUNE, MODULATION FREQUENCY and CARRIER switch LEDs inhibiting the operation of these indicators.
253. The systems controlling lines C,D,G,H,I and J are similar to that controlling lines E and F. Internal connections within IC4 result in IC4/11 being switched between logic '1' and logic '0' by the 1 Hz clock, resulting in the AM LEDs flashing, if AM is selected when the demanded frequency is below 100 kHz or if X2 is selected on the carrier level switches. Similarly the meter switch LEDs will flash if the meter is set to read AM depth or FM deviation when OFF is selected on the AM or FM switches.
254. The positive supply to the LEDs and oscillator enable for the carrier level switches is switched by a transistor in IC3 on assembly 19-0911, and is not available when remote control is selected. This extinguishes the LEDs and renders the switches ineffective.
255. The logic levels set on control lines G and H by IC4 are the inverse of those required for control of the meter. The lines are buffered on assembly 19-0911 by the inverting buffers IC8a and IC8c. For the C,D,I and J lines one inverting and one non inverting buffer for each pair is used on assembly 19-0911 to give the required logic levels, as with lines E and F.

Control Lines A and B

256. The principle of the circuit which sets the logic levels on the internal oscillator frequency control lines is the same as that of the circuit for lines E and F previously described. The control lines are taken from IC4/23 and 24. The positive supply for the LEDs and oscillator enable

input is switched by Q1 on assembly 19-0909. The supply is available only when control line C or control line E is at logic '1', giving a logic '0' at IC2c/10 (when internal AM or FM is required). The enabling signal for the 10 kHz internal clock is applied to IC4/25 via IC2a, and is connected only if IC2a/2 is at logic '1' (when local control is selected). With remote control selected the last internal oscillator frequency selected is held.

257. When remote control is selected the logic '1' at IC4/29 results in IC4/26, 27 and 28 being at logic '1', so that the normal supply path for the LEDs is broken. The logic levels on control lines A and B are decoded in IC2b, IC1a, IC1b and IC1c, and the appropriate LED is lit via D2, D3 and D4. The coding used on control lines A and B is given in Table 12.

Control Lines T1 and T2

258. The principle of the circuit which sets the logic levels on the tuning sensitivity control lines is the same as that of the circuit for lines E and F previously described. The control lines are taken from IC4/36 and 35. The positive supply for the LEDs and the oscillator enable is switched by a transistor in IC3 on assembly 19-0911, and is not available when remote control is selected. This extinguishes the LEDs and renders the switches ineffective.
259. The logic levels at IC4/36 and 35 are given in Table 15. These levels are passed to the motherboard, assembly 19-0905, and so to the logic assembly 19-0907, which they enter at edge connectors B18 and A18.

TABLE 15

Tuning Sensitivity Control Logic

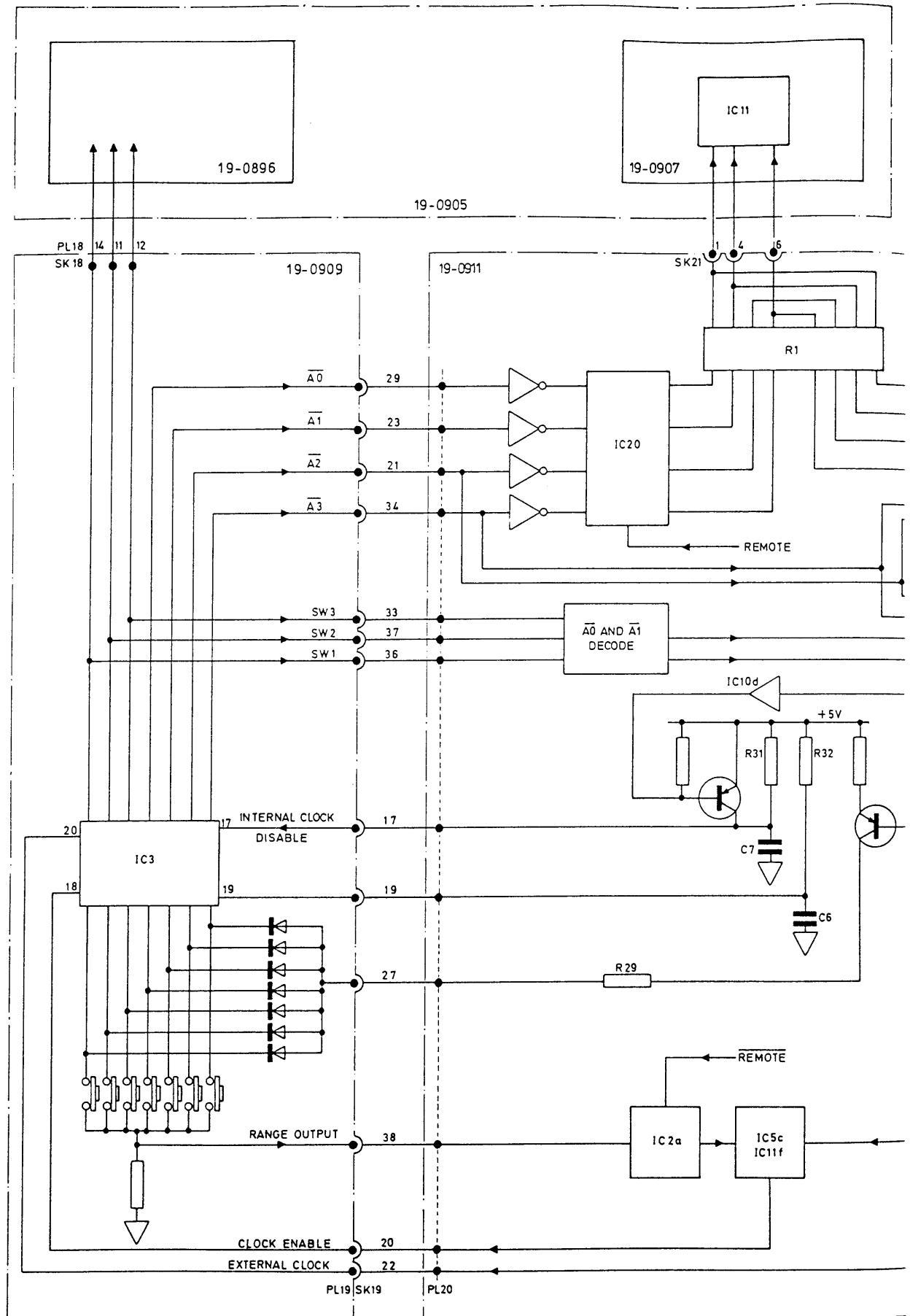
	Control Line Coding	
	T1	T2
Fast	1	1
Slow	1	0
Fine	0	1
Hold	0	0

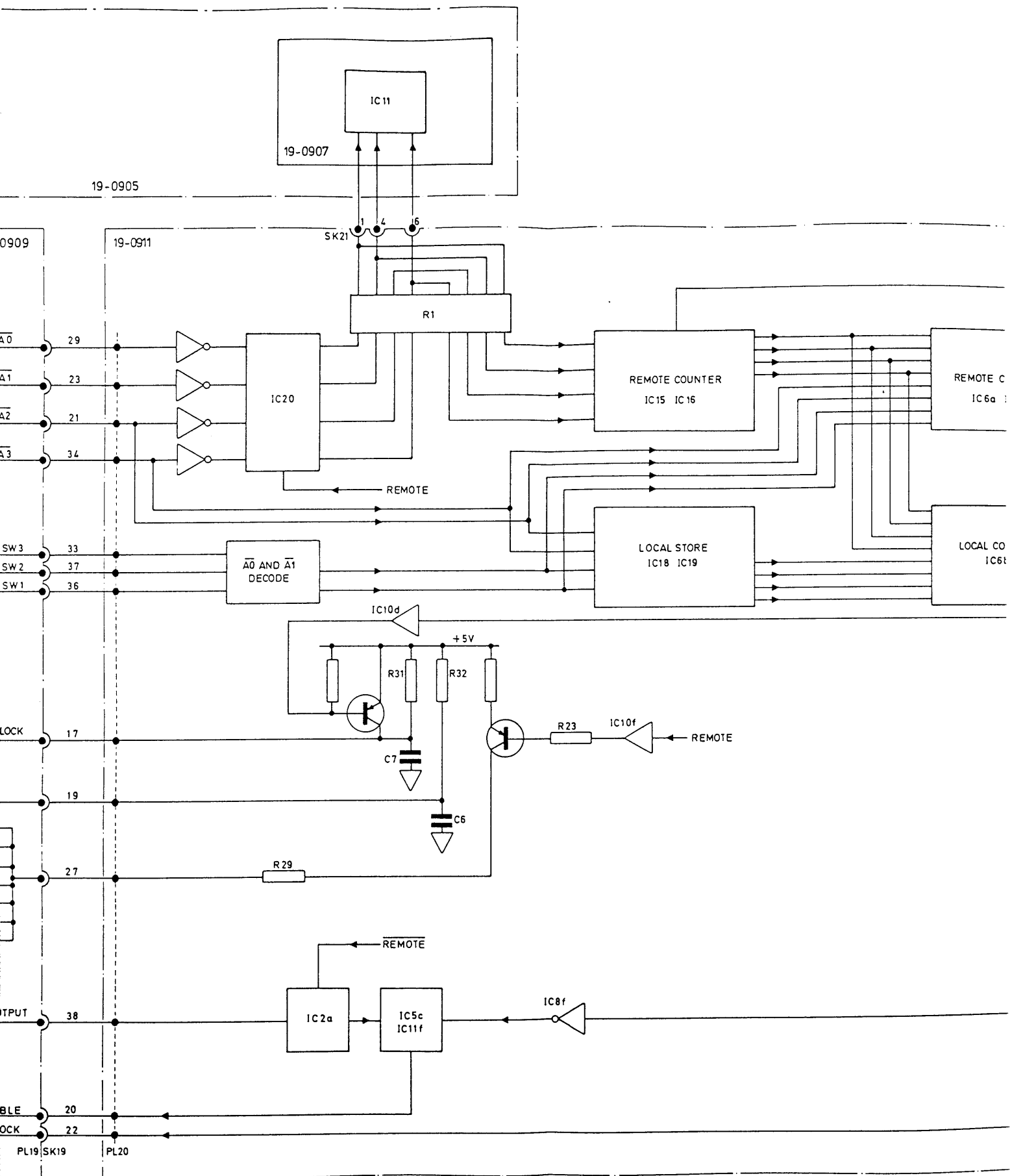
260. The control line logic levels are connected to IC11 via IC2d and IC2c. When local control is selected the levels at IC2d/11 and IC2c/10 are those of the control lines. When remote control is selected IC2d/12 and IC2c/9 are held at logic '0', via IC3e, by the logic '1' on the remote control line. The logic levels at IC2d/11 and IC2c/10 then represent a demand for hold conditions irrespective of the logic levels on lines T1 and T2.

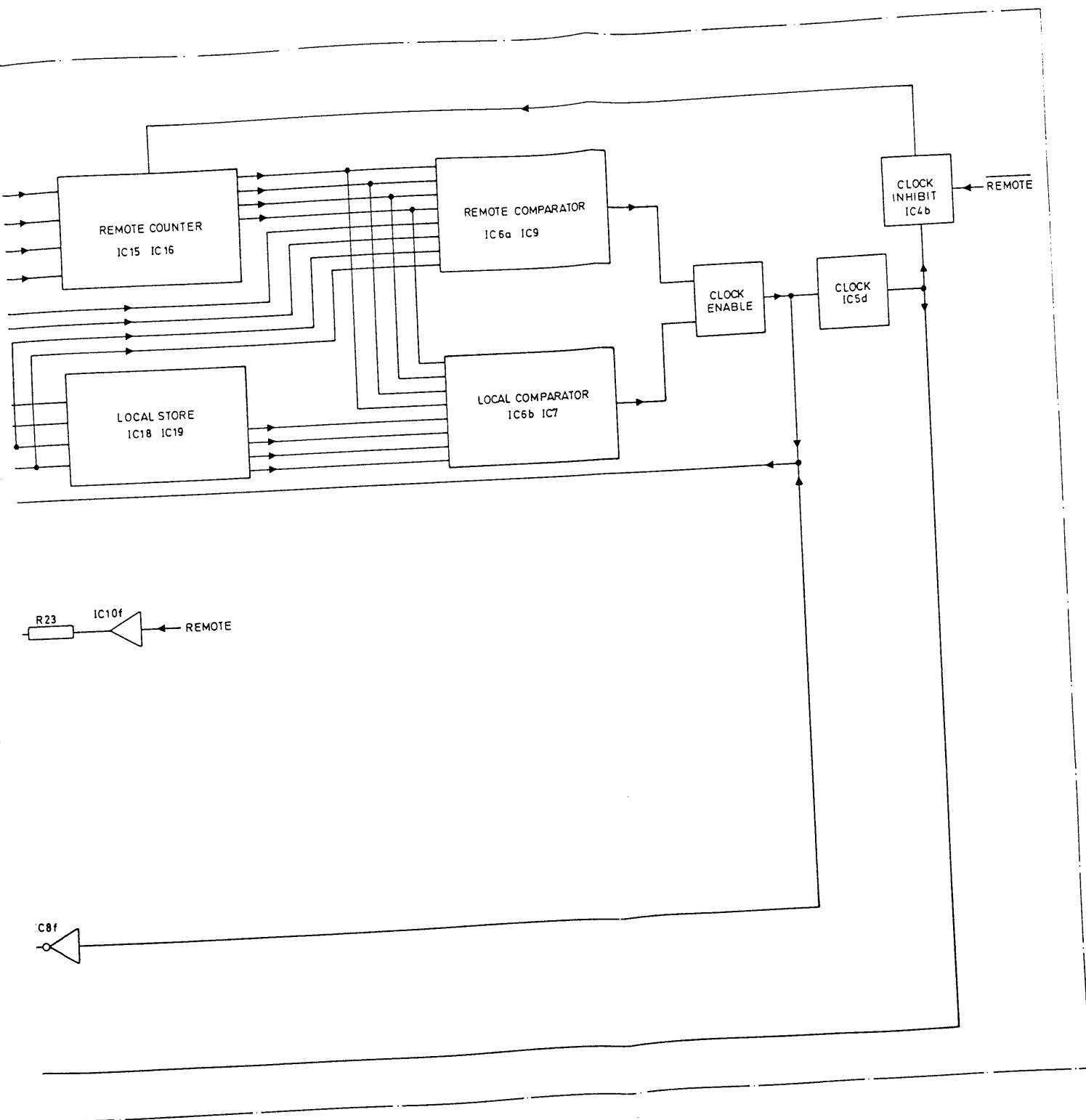
Control Lines A0,A1,A2,A3, SW1,SW2 and SW3

261. Two separate sets of control lines are used to carry information on the RF frequency band selected, since different parts of the instrument require different codings. The codes used are given in Table 4 and Table 9. When the instrument is in local control the required logic levels are set by IC3 on assembly 19-0909 under the control of the front panel switches. A diagram of the system is given in Fig. 4.9.
262. When one of the switches is closed, a logic '1' is applied to IC3/18 via a transistor on assembly 19-0911, the LED associated with the switch, and IC2d, IC5c and IC11f on assembly 19-0911. This enables an internal 10 kHz clock, which causes an internal counter to apply a logic '0' to pins 25,24,23,22,32,33 and 35 in turn. When the pin associated with the closed switch is located the logic '0' level is fed back to IC3/18, stopping the internal clock. The counter will remain latched at this location when the switch is released, and the LED will light to show the band selected.
263. The logic levels set at IC3 pins 30,31,34 and 26 are the inverse of the logic levels finally required. The levels are inverted in the inverting buffers, IC11a, IC11b, IC11c and IC11d on assembly 19-0911. The corrected levels are fed to the motherboard, assembly 19-0905, and thence to IC11 on assembly 19-0907, where they are used in the derivation of the frequency control line logic levels. These levels are also passed, via IC20 on assembly 19-0911, to the rear panel CONTROL BUS socket, for use in setting the External Frequency Store.
264. The logic levels set at IC3 pins 29, 28 and 27 are the final required levels. These are fed to the motherboard, assembly 19-0905, and thence to assembly 19-0896, to control the band attenuator selection.
265. When operating under remote control the required logic levels for control lines A0, A1, A2, and A3 are fed in at the rear panel CONTROL BUS socket. The circuit stores the logic levels in use at the time of changeover from local to remote, so that these can be returned to when switching back to local control, and then forces IC3 to track the remote information. This allows the logic levels for control lines SW1, SW2 and SW3 to continue to be produced in IC3, and also retains the facility for checking the compatibility of band selected and frequency deviation range called for, which is a further function of IC3.
266. The logic levels on the $\overline{A2}$ and $\overline{A3}$ lines from IC3 on assembly 19-0909 are presented at the D inputs of IC18 on assembly 19-0911. The logic levels on the A0 and A1 lines are decoded from the SW1, SW2 and SW3 control line levels in IC2a, IC2b, IC2c, IC5a and IC5b, and presented to the D inputs of IC19 on assembly 19-0911. On switching from local to remote the logic levels at the inputs are clocked, by the positive going transition of the remote control line, to the Q outputs and stored.

267. When the remote control line is at logic '1' the gates of IC25 and IC26 are enabled, and the Q outputs of IC15 and IC16 are set to the inverse of the remote A0, A1, A2 and A3 lines. These outputs are compared with the corresponding outputs from IC3 on assembly 19-0909 in the remote comparator, IC9 and IC6a. If the comparator inputs are different IC6a/1 will be at logic '0', giving a logic '0' at IC1a/3.
268. A logic '0' at IC1a/3 will perform the following functions:
- (1) It will turn on, via IC10d, one of the transistors in IC3 on assembly 19-0911. This inhibits the 10 kHz internal clock in IC3 on assembly 19-0909 by clamping the frequency control line (the junction of R31 and C7) to +5 volts.
 - (2) It provides a logic '1' level at IC8f/15, and thus at IC3/18 on assembly 19-0909. This puts IC3 to the state in which it can be clocked.
 - (3) It will enable the astable clock formed by IC5d, IC24e, C2, R17 and R18 on assembly 19-0911.
269. The output of the clock is applied to both IC3/20 on assembly 19-0909 and the clock inhibit gate, IC4b, on assembly 19-0911. Since IC4b/6 will be held at logic '0' when remote control is selected the clock output will not affect IC15 or IC16, but the input to IC3 will result in the circuit being clocked until the inputs to the remote comparator are equal. At this point IC6a/1 goes to logic '1', giving a logic '1' at IC5d/13, disabling the clock.
270. An identical sequence of events occurs if the remote band control line logic levels are changed while remote control is selected. Although the local comparator, IC7 and IC6b continuously compares the last control line setting made in local control, stored in IC18 and IC19, with the setting in use, any output is inhibited by IC4c, since IC4c/8 is at logic '0' when remote control is selected.
271. On switching back to local control, IC4d/12 goes to logic '0' and IC4c/8 goes to logic '1'. This transfers control of the clock from the remote to the local comparator. If the control line setting is not the same as the last setting made in local control, stored in IC18 and IC19, IC6b/13 will be at logic '0' and the clock will be enabled. Since IC4b/6 is at logic '1' when local control is selected the clock output is applied to the clock inputs of IC15 and IC16 as well as IC3 on assembly 19-0909. The remote control lines are disconnected from IC15 and IC16, since the gates in IC25 are disabled, so both IC3 and the counter formed by IC15 and IC16 are clocked simultaneously until the inputs to the local comparator are equal and the clock is disabled by the logic '1' at IC6b/13. It should be noted that the counter does not count in binary code, but goes through the same code sequence as IC3, given in Table 4, due to the feedback applied via the gates of IC17 and IC23c.
272. For as long as local control remains selected, changes in the control line logic levels will not affect the inputs to the local comparator, and the clock will remain disabled.







Functional Diagram for
Frequency Band Selection

Fig.4.9

Frequency Deviation Control Lines

273. The logic levels on control lines SW1', SW2', SW3' and SW5' are set in IC3 on assembly 19-0909. The coding used is given in Table 11. When one of the switches is closed a logic '1' is applied to IC3/16 via the LED associated with the switch. This enables an internal 10 kHz clock which causes an internal counter to apply a logic '0' to pins 8, 9, 10, 11 and 12 in turn. When the pin associated with the closed switch is located the logic '0' is fed back to IC3/16, stopping the internal clock. The counter will remain latched at this location when the switch is released, and the LED will light to show the deviation range selected.
274. The deviation ranges available with each frequency band are shown in Table 10. If the deviation range selected is incompatible with the frequency band in use, all the control lines are forced to logic '1'. As can be seen from Table 11, this provides the maximum deviation permitted for the range in use. At the same time the REDUCE DEVIATION indicator is lit by IC3/5 going to logic '0'.
275. If either the deviation range or frequency band is changed to give an acceptable relationship IC3/5 will revert to logic '1' and the REDUCE DEVIATION indicator will be extinguished. If not C2 will discharge through R2, and after a period of approximately 5 seconds IC3/21 will be at logic '0'. Once this state is reached the deviation range selected will be stepped down by the 1 Hz internal clock until the highest acceptable deviation range is selected. The level at IC3/5 will then revert to logic '1', extinguishing the REDUCE DEVIATION indicator and recharging C2 via D1.

Frequency Control Lines

276. A set of four control lines, carrying BCD information, is provided for each of the 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz and 10 MHz digits of the demanded synthesizer frequency. A single control line is used for the 100 MHz digit since only two states are required. The control lines are used to set the programmable dividers in the phase locked loops and to drive the display system. When local control is selected the logic levels are set by IC11 on assembly 19-0907. For remote control the required logic levels are applied to the lines at the rear panel CONTROL BUS socket.
277. When the equipment is switched on the synthesizer frequency control line outputs of IC11 are set to a pattern governed by its internal construction. The output pattern is changed by applying a pulse train and an up/down instruction, generated by the spin wheel circuitry, at IC11/22 and IC11/30.
278. The change of output pattern required for a given pulse train input at IC11/22 is governed by the following factors:

- (1) Different tuning sensitivities, i.e. variation in the number of pulses required to give one frequency step, can be selected by means of front panel switches. Information regarding the sensitivity chosen enters IC11 on control lines T1 and T2 at pins 26 and 27.
 - (2) If the synthesizer frequency step size was the same for all bands, the variation in division ratio, used in assembly 19-0899 to derive the output frequency from the synthesizer frequency, would result in different output frequency step sizes occurring on different bands. The synthesizer frequency step size is therefore doubled for bands 6 and 3, and increased by a factor of four for bands 5 and 2. Since the frequency division ratios for bands 4, 3, 2 and 1 are 10, 20, 40 and 10, the output frequency step size on these bands is one tenth of that for bands 7, 6 and 5. Information on the step size multiplication required enters IC11 on control lines A0 and A1 at pins 29 and 28.
 - (3) When band 1 is selected the frequency available from the synthesizer is restricted to the range from 50.1 MHz to 64 MHz. Control lines A0 and A1 are both at logic '0' when band 1 is selected.
279. The selection of remote or local information on the frequency control lines is carried out in a series of tri-state buffers, IC6, IC12, IC13, IC21 and IC22 on assembly 19-0907 and IC12, IC13, IC14, IC28 and IC29 on assembly 19-0911. One or other set of buffers is put to the high impedance state according to the logic level on the remote control line.
280. The buffers on the remote range control line input are bypassed by resistors. This allows the control line logic levels in use when under local control to be available at the rear panel CONTROL BUS socket. These logic levels are used for setting the contents of the External Frequency Store.
281. For synthesizer frequencies between 50 MHz and 104 MHz the counter setting required for the 1 MHz comb loop is 9 less than the frequency MHz digit. For synthesizer frequencies between 40 MHz and 49 MHz the counter setting required is 18 less than double the frequency MHz digit. The necessary changes to the 1 MHz and 10 MHz control line logic levels is made in the read only memory (ROM), IC23.

Spin Wheel System

282. The spin wheel system provides the demand for a change in frequency to IC11 on assembly 19-0907. The signal consists of a train of pulses, which continues for as long as a frequency change is required, and an increase/decrease signal to indicate the sense of the required change.
283. The spin wheel consists of a transparent disc with two concentric bands of opaque radial strips. An LED and photosensitive transistor are located on opposite sides of each band, rotation of the disc being sensed by the varying light level falling on the photo transistors. During rotation a

pulse train occurs at the emitter of each transistor, the printing of the opaque strips on the disc being positioned such that these have a 90° phase difference. The two pulse trains are connected to assembly 19-0907 at edge connectors A16 and A19.

284. The pulse train at edge connector A19 is fed to the Schmitt trigger formed by IC18a, the shaped output being applied to IC26a/5. The second pulse train is shaped by IC18b, and used to clock the level at IC26a/5 to IC26a/1. Because of the phase difference between the pulse trains IC26a/5 will be at logic '1' for one direction of rotation and logic '0' for the other direction of rotation when the clocking action occurs. The level at IC26a/1 therefore depends upon the direction of rotation, and is used as the increase/decrease frequency signal for IC11.
285. The output of IC18b is also fed, via IC25a and IC25b, to IC11/22, to act as the demand for a change in frequency. The delay introduced by R20 and C10 ensures that IC11/30 is correctly set before the first pulse is received at IC11/22.

DISPLAY SYSTEM

Introduction

286. The numerical indicators forming the display, each of which incorporates a BCD to 7-segment decoder, are mounted on assembly 19-0895. Each indicator except the most significant receives a BCD input of the digit to be displayed, read from a read only memory (ROM) on assembly 19-0907. The most significant indicator, which either displays 1 or is blank, is driven from the 100 MHz synthesizer frequency control line. The circuit diagrams are given in Fig.31 and Fig.37.
287. The BCD input to the numerical indicators is required to be:
- (1) Identical to the synthesizer frequency control line data on bands 7 and 4.
 - (2) The frequency control line data divided by 2 on bands 6 and 3.
 - (3) The frequency control line data divided by 4 on bands 5 and 2.
 - (4) Identical to the frequency control line data for all digits except the 10 MHz digit, which must be reduced by 5, on band 1.

The additional division by 10 required for bands 4, 3, 2 and 1 is achieved by moving the display decimal point.

ROM Addressing

288. The required data for each display digit is stored in a ROM (IC7, IC14, IC24, IC16, IC8, IC15 and IC9) at an address composed partly of the frequency control line data, partly of a binary statement of the selected band and partly of an output from the ROM relating to the next more significant digit. This last part of the address is necessary because:

- (1) If the frequency control lines for a digit carry an odd number, and a range requiring division by 2 is in use, a remainder of 1 is carried to the next less significant digit.
- (2) If the digit represented by the frequency control line information (together with the remainder carried in from the next more significant digit, if present) is not divisible by 4, and a range requiring division by 4 is in use, a remainder of 1, 2 or 3 is carried to the next less significant digit.

289. It should be noted that, although the term 'carry' is used, there is no arithmetic addition of a carried in number. The requirement for a carry in is used to modify the ROM address to that of a location holding the required data.
290. That part of the address derived from the synthesizer frequency control lines is applied at pins 7, 9, 10 and 11 on each ROM. The part carrying information on the band in use is applied at pins 3 and 4 of each ROM, and at IC7/2 for the 10 MHz digit. The logic levels are derived from the A0 and A1 control lines in IC1a, IC1c and IC1d. The code for the ROM addresses is given in Table 16. The logic '1' at IC7/2 when band 1 is selected results in the data read from IC7 being reduced by 5.

TABLE 16

ROM Address - Band Selection

Band	Pin 3	Pin 4	IC7 Pin 2
7 and 4	0	0	0
6 and 5	0	1	0
5 and 2	1	0	0
1	0	0	1

291. The 'carry' information part of the address is applied at pins 5 and 6. The coding is given in Table 17.

TABLE 17

ROM Address - Carry

Remainder	Pin 5	Pin 6
0	0	0
1	0	1
2	1	0
3	1	1

In the case of IC7 the carry can only be 0 or 1 because the most significant digit is limited to 0 and 1. The carry information is derived in IC5b and IC4d. IC5b/4, and therefore IC4d/12 will be at logic '1' when band 2, 3, 5 or 6 is selected, when a carry may be required. This logic '1' is applied to IC7/6 only if IC4d/13 is held at logic '1' by the 100 MHz frequency control line, indicating that a synthesizer frequency of 100 MHz or above has been demanded.

Numerical Indicator Drive

292. The drive signals for each numerical indicator, except the most significant, are taken from the appropriate ROM, in BCD, at pins 19, 20, 21 and 22. The drive signal for the most significant indicator is derived in IC2a. When a synthesizer frequency of 100 MHz or more is demanded IC2a/2 is held at logic '1' by the 100 MHz frequency control line. If band 4 or 7 is also selected IC2a/1 is held at logic '1', this level being derived from two of the ROM address lines by IC5b and IC3f. Under these conditions IC2a/3 will be at logic '1', switching on Q1 on assembly 19-0895 to give the required drive to DI.8.

Rounding Down

293. Under certain circumstances switching between bands will result in the display being unable to display the true output frequency. For example, if the least significant displayed digit is odd when band 7 is in use, halving the displayed frequency, by switching to band 6, would require an additional indicator to show the carry out. Similar problems arise with the 1 kHz digit and the 100 kHz digit when the slow and fast tuning rates are selected, since under these conditions the less significant digits are required to be zero.
294. This problem is overcome by feeding the unwanted demand for a carry out back to IC11, causing the RF output frequency to be rounded down to the next value which can be correctly displayed. The feedback is via IC5a, IC5c or IC5d, the three feedback paths being disconnected by IC4a, IC4c and IC4b when remote control is selected. Each line is provided with a variable time constant circuit, which allows the feedback signal to rise rapidly from logic '0' to logic '1', but delays the return to logic '0'.

Decimal Point Drive

295. Two decimal point positions are used, the point being moved to the left or bands 4, 3, 1 and 1. This permits the same ROM outputs to be used as on bands 7, 6 and 5 although the RF output frequency is a factor of 10 less.
296. The decimal point drive is obtained from control line A3. This enters assembly 19-0907 at edge connector B21 and is connected to the base of Q2. The line is at logic '1' when bands 1, 2, 3 and 4 are selected, when Q2 conducts and holds IC3a/3 and SK83 pin 6 at logic '0'. This switches on decimal point C, which is positioned ahead of the 1 MHz digit. For other bands Q2 is switched off. IC3a/3 and SK83 pin 6 are pulled to logic '1' by R28, and IC3a/2 goes to logic '0'. This switches on decimal point B, which is positioned ahead of the 100 kHz digit. IC10a ensures that IC3c/7 is permanently at logic '0', and decimal point A is therefore off.

Out of Lock Indication

297. All the lock indicator lines are connected in parallel at the junction of R18 and D26 on assembly 19-0907. When all the loops are in lock the lines are at high impedance to 0 volts, and IC10d/13 is at logic '1'. This inhibits the astable circuit containing IC10d and IC3b, holding it in the condition where IC10d/11 is at logic '0'.
298. Should any loop go out of lock the appropriate lock indicator line is pulled to 0 volts. Once C9 has discharged, IC10d/13 will be at logic '0' and the astable circuit will oscillate. Every time IC10d/11 goes to logic '1' both the band information address lines to the display ROMs are put to logic '1' by IC17c and IC17d. At all addresses for which these two lines are at logic '1' the output from the ROM will give a blank display, so the display flashes in synchronism with the astable circuit output.

POWER SUPPLY SYSTEM

299. The power supply system is mounted on assembly 11-1328, with the exception of the front panel mounted power switch and the rear panel mounted power input plug, power fuse, supply voltage range selection switches and rectifier and reservoir capacitor for the +5 V supply. The circuit is shown in Fig.39.
300. DC supply rails at +24 V, +15 V, +5 V, -5.2 V and -15 V with respect to chassis earth are provided. A separate power transformer secondary winding, bridge rectifier, reservoir capacitor and integrated circuit voltage regulator are used for each supply rail. The +15 V rail is individually fused. The +5 V rail potential can be accurately set by adjustment of R3.
301. The supply rails are connected to the motherboard assembly 19-0905 via SK16. The AC supply connections to the POWER switch are made via a 4-way in line connector SK29.

CHAPTER 5

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MAINTENANCE

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INTRODUCTION

1. This chapter contains four sections which relate to
 - (1) An overall operational check, which will establish whether all the equipment functions are operating.
 - (2) The procedure for setting up the assemblies within the equipment, to be followed after repair.
 - (3) A series of checks to prove that the equipment is meeting its specification.
 - (4) Dismantling and reassembly of the equipment for repair.

TEST EQUIPMENT REQUIRED

2. The test equipment required to carry out the tests described in this chapter is listed in Table 18. The procedures described may need some modification if test equipment other than the suggested model is used.

OPERATIONAL CHECK

3. Test equipment required

<u>Item</u>	<u>Table 18 Item No.</u>
Counter - timer	1
Modulation meter	2

4. The following procedure gives a check of the functioning of the equipment. It provides a basis for fault location, and does not prove that the equipment is performing fully to specification.
5. Prepare the 9084 for use according to the instructions given in Chapter 2. Connect the frequency counter to monitor the RF output. Operate the counter in the external frequency standard mode, using the output from the 9084 INTERNAL STANDARD OUTPUT socket as the external standard for the counter. Set the counter to give 10 Hz resolution.
6. (1) Set the POWER switch to ON. A seven digit display reading 1.000 000 should be obtained. The in-button indicators should light to indicate fast tune, frequency band 1, 3 kHz peak deviation, FM and AM off, meter indicating CW and normal output.

Flashing of the display indicates failure of one or more of the phase-locked-loops to lock.

TABLE 18

Test Equipment Required

Item No.	Equipment Type Suggested Model	Required Parameters
1	Counter - timer Racal-Dana 9906	10 Hz resolution to 104 MHz. 1 Hz resolution 380 Hz to 5 MHz. Interval timing 80 ms to 100 ms.
2	Modulation meter Racal-Dana 9008, and HP 8901A	300 kHz peak deviation on 104 MHz carrier. 100% modulation depth on carrier from 1 MHz to 104 MHz. 30% modulation depth on carrier from 0.1 MHz to 1 MHz.
3	Digital multimeter Racal-Dana Model 5000	DC volts, 1.4 V to 24 V with resolution of 10 mV at 4 V. Resistance, 4 Ω to 27 Ω .
4	Oscilloscope	Bandwidth 20 MHz. Y sensitivity 10 mV/cm.
5	RF signal generator Racal-Dana 9084	1 MHz to 104 MHz at an output level of +3 dBm into 50 Ω .
6	Audio signal generator Racal-Dana 9083	20 Hz to 20 kHz at an output level of 1 V into 600 Ω . Less than 0.3% THD.
7	Spectrum analyser HP 141T with RF unit HP 8554 RF unit HP 8553B IF unit HP 8552B	DC to 500 MHz. Bandwidth 1 kHz to 300 kHz.

Item No.	Equipment Type Suggested Model	Required Parameters
8	Tracking generator	
9	Millivoltmeter Racal-Dana 9300	To measure true RMS up to 2 V from 20 Hz to 20 kHz.
10	Power meter HP 435A with sensor 8481A or Racal-Dana 9301A with T piece accessory.	To measure power levels between -7 dBm and +19 dBm over the frequency range from 10 kHz to 10 ⁴ MHz (see NOTE).
11	DC power supply	Variable, 0.5 V to 6 V.
12	Distortion Analyser HP 333A	Fundamental frequency range 20 Hz to 20 kHz. Resolution better than 1%.
13	T piece	BNC, 50 Ω .
14	Notch filters	To provide at least 50 dB attenuation at 1.4 MHz and 10 ⁴ MHz.
15	Load	BNC, 50 Ω .

NOTE: The suggested power meter will not function over the whole of the frequency range over which measurements are to be made. A millivoltmeter may be used over that part of the frequency range not covered. The measurement must be made across a 50 Ω load, if necessary, to maintain a 50 Ω load at the point of measurement. Comparison must be made between the power meter and millivoltmeter (with 50 Ω load, if applicable) at a point within their common measurement bandwidth at all power levels to be measured.

- (2) Set the output attenuator to +10 dBm. Adjust the VERNIER control to ensure that the meter reading can be varied over the range +3 dB to -10 dB. Set the meter reading to +3 dB.
- (3) Select band 7. Check that both 9084 and counter read 60.00000 MHz.

NOTE: With the counter synchronized to the 9084 internal standard the counter should indicate the same frequency as the 9084 display ± 1 count. The possible difference in the least significant digit is due to the operating principle of the counter, and does not indicate an error in the 9084.

- (4) Tune the 9084, and check that the display and output frequency change progressively in steps of 100 kHz.
- (5) Select SLOW on the tuning sensitivity switches. Tune over the range 60.00000 MHz to 60.09900 MHz, and check that the display and output frequency change progressively in 1 kHz steps.
- (6) Select FINE on the tuning sensitivity switches. Tune over the range 60.09900 MHz to 60.09999 MHz, and check that the display and output frequency change progressively in 10 Hz steps.
- (7) Select HOLD on the tuning sensitivity switches, and check that the spinwheel is inoperative.
- (8) Re-select FINE. The display and output frequency should remain at 60.09999 MHz.
- (9) Re-select SLOW. The display and output frequency should change to 60.09900 MHz.
- (10) Re-select FAST. The display and output frequency should change to 60.00000 MHz.
- (11) Select FINE on the tuning sensitivity switches. Tune to the frequencies shown in Table 19, and check that the display and output frequency agree at each of the settings. While tuning in bands 4, 3, 2 and 1 check that the output frequency changes in steps of 10 kHz with FAST selected, 100 Hz with SLOW selected and 1 Hz with FINE selected. Check that, when selecting band 4 after band 5, the decimal point moves one place to the left.
- (12) With the frequency set below 100 kHz select AM INT, AM EXT, FM INT and FM EXT in turn. Check that the in-button indicator flashes in each case, and that for the two INT conditions the 1 kHz MODULATION FREQUENCY switch indicator lights. Select OFF on both the AM and FM switch banks.
- (13) Set the INT/EXT STANDARD switch to the EXT position. Check that the display flashes. Connect the INTERNAL STANDARD OUTPUT socket of the counter to the EXT STANDARD socket of the 9084. The 9084 display should stop flashing, and the display and RF output frequency should agree.

TABLE 19

Frequency Check

Range 7 40 to 104 MHz	104.00000 MHz 81.00000 MHz 80.99996 MHz 63.00000 MHz 62.99996 MHz 50.00000 MHz 49.99996 MHz 40.00000 MHz	Range 6 20 to 52 MHz	52.00000 MHz 40.40000 MHz 40.49998 MHz 31.50000 MHz 31.49998 MHz 25.00000 MHz 24.99998 MHz 20.00000 MHz
Range 5 10 to 26 MHz	26.00000 MHz 20.20000 MHz 20.24999 MHz 15.70000 MHz 15.74999 MHz 12.50000 MHz 12.49999 MHz 10.00000 MHz	Range 4 4.0 to 10.4 MHz	10.400000 MHz 8.080000 MHz 8.099996 MHz 6.280000 MHz 6.299996 MHz 5.000000 MHz 4.999996 MHz 4.000000 MHz
Range 3 2 to 5.2 MHz	5.200000 MHz 4.040000 MHz 4.049998 MHz 3.140000 MHz 3.149998 MHz 2.500000 MHz 2.499998 MHz 2.000000 MHz	Range 2 1 to 2.6 MHz	2.600000 MHz 2.020000 MHz 2.024999 MHz 1.570000 MHz 1.574999 MHz 1.250000 MHz 1.249999 MHz 1.000000 MHz
Range 1 0.01 to 1.4 MHz	1.400000 MHz 1.000000 MHz 0.999999 MHz 0.100000 MHz 0.999999 MHz 0.010000 MHz		

NOTE: If the frequency counter used does not have a 1 MHz standard output suitable for connection to the 9084 EXT STANDARD socket, the counter should be left in the external frequency standard mode, connected to the 9084 INTERNAL STANDARD OUTPUT socket. A signal generator, with its output set to 1 MHz at a level between 100 mV r.m.s. and 10 V r.m.s. should be used to supply the 9084 EXT STANDARD socket.

- (14) Disconnect the counter, and return the 9084 INT/EXT STANDARD switch to INT.

7. Connect the modulation meter, set to read FM of 100 kHz peak deviation, to the 9084 RF output socket.
8. Set the 9084 controls as follows:
 - (1) Band 6 selected and tuned to 30.00000 MHz.
 - (2) FM selected on the meter function switches. The switch indicator should flash because both modulation selection switch banks have OFF selected.
 - (3) FM INT selected on the modulation selection switches.
 - (4) 100 kHz selected on the PEAK DEVIATION switches.
9.
 - (1) Adjust the MODULATION LEVEL control and ensure that the 9084 meter reading can be varied over the full scale.
 - (2) Check that the deviation obtained, as measured on the modulation meter, agrees with the 9084 meter reading.
 - (3) Set the 9084 meter reading to 10.
 - (4) Select 30 kHz, 10 kHz and 3 kHz in turn. Check that the meter reading changes to 3, to 1 and to 3 as this is done, and that the deviation indicated on the modulation meter reduces to agree with the selected peak deviation.
 - (5) Select band 1 and 300 kHz on the PEAK DEVIATION switches. Check that the REDUCE DEVIATION indicator lights, and that, after about five seconds, the indicators in the PEAK DEVIATION switches step down until 10 kHz is selected.
10. Select FM OFF on the modulation selection switches. Set the modulation meter to read AM at a depth of 100%. Set the 9084 controls as follows:
 - (1) Band 6 selected and tuned to 30.00000 MHz.
 - (2) AM selected on the meter function switches. The switch indicator should flash because both modulation selection switch banks have OFF selected.
 - (3) AM INT selected on the modulation selection switch banks.
11.
 - (1) Adjust the MODULATION LEVEL control and ensure that the 9084 meter reading can be varied over the full scale.
 - (2) Check that the modulation depth obtained, as measured on the modulation meter, agrees with the 9084 meter reading.
 - (3) Select OFF on the carrier level control switches. The display should flash as the output loop is out of lock in this condition.

- (4) Select X2 on the carrier level control switches.

CAUTION: The RF output level will be +19 dBm. If this is outside the input level range of the modulation meter, reduce the output level of the 9084 using the manual attenuator.

Check that the modulation depth, as indicated on the modulation meter and the 9084 meter, is now zero. The AM INT switch indicator should flash.

- (5) Select NORMAL on the carrier level control switches. Switch off and disconnect the modulation meter.

12. Connect the frequency counter to monitor the AUDIO OUTPUT socket. Select each modulating frequency in turn, and check that frequencies of 380 Hz to 420 Hz, 950 Hz to 1050 Hz and 2850 Hz to 3150 Hz are present.

ASSEMBLY SETTING UP PROCEDURES

Introduction

13. The procedures given in this section should be carried out on any assembly on which repairs have been carried out. All the assemblies should be set up if the equipment functions, but fails the specification tests. The instructions given assume that the assembly to be set up is mounted, on an extender board where necessary, in the parent 9084. The top and bottom covers should be removed as instructed in paragraph 168.

Power Supply Plate 11-1328

14. Test equipment required:

<u>Item</u>	<u>Table 18</u>	<u>Item No.</u>
Multimeter		3
Oscilloscope		4

15. Set the POWER switch to OFF, and disconnect the 9084 from the AC supply. Disconnect SK16 between the power supply plate and the motherboard.
16. Set the front panel POWER switch to ON. Using the multimeter, measure the resistance between the line and neutral pins on the rear panel power input plug, and ensure that the values obtained are within the limits given in Table 20. Check that the value obtained for 99 V to 121 V is lower than that obtained for 108 V to 132 V.
17. Reset the switches to suit the local supply and replace the plastic switch cover plate. Check that the fuse fitted suits the voltage range selected. Set the front panel POWER switch to OFF. Reconnect the 9084 to the AC supply and set the POWER switch to ON. Using the multimeter check that the off load voltages at SK16 are correct. Set the POWER switch to OFF and reconnect SK16 to the motherboard.

TABLE 20

Power Supply Resistance Measurements

Voltage Range Selected	Resistance
216 V to 264 V	20.4 Ω to 27.8 Ω
198 V to 242 V	18.3 Ω to 25 Ω
108 V to 132 V	4.8 Ω to 7.2 Ω
99 V to 121 V	4.4 Ω to 6.6 Ω

18. Set the POWER switch to ON. Use the multimeter to monitor the on load voltages on the underside of the power supply connector to the motherboard assembly. The voltages with respect to ground (pin 6) should be within the limits shown in Table 21. Using the oscilloscope, monitor the +5.1 V supply at pin 3. The ripple level should not exceed 12 mV peak-to-peak.

TABLE 21
Power Supply Voltages

Pin Number	Voltage
1	-5 V to -5.4 V
2	+23 V to +24 V
3	+5.1 V (set by R3)
4	+14.4 V to +15.6 V
5	-14.4 V to -15.6 V

Reference Source Assembly 19-0892

19. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1
Oscilloscope	4
RF signal generator	5

20. Remove assemblies 19-0893, 19-0894, 19-0904 and 19-0908 from the 9084. Set the INT/EXT STANDARD switch to INT and set the POWER switch to ON.
21. (1) Ensure that the display does not flash to indicate that the assembly is out of lock.
- (2) Set the INT/EXT STANDARD switch to EXT. The display should now flash.

- (3) Connect the signal generator output, set to 1 MHz at a level of 100 mV r.m.s, to the EXT STANDARD socket. Check that the display does not flash.
 - (4) Set the INT/EXT STANDAD switch to INT. Disconnect the signal generator.
22. Set the frequency counter to operate in the external standard mode, using the output from the 9084 INTERNAL STANDARD OUTPUT socket as the external standard for the counter. Set the counter to give 1 Hz resolution.
 23. Short circuit test point 2 to 0 V. Monitor the coaxial sockets listed in Table 22. Check that the frequencies shown are obtained. A tolerance of ± 1 count is permissible on all readings. Disconnect the frequency counter.

TABLE 22

Reference Source Frequencies

Socket	Frequency
46	1.000000 MHz
47	1.000 kHz
48	1.000000 MHz
50	10.000000 MHz
51	5.000000 MHz

24. Terminate SK50 in a 50 Ω load. Monitor pin 2 with the oscilloscope and adjust R32 to give an output of 3 V peak-to-peak. Terminate SK51 with a 50 Ω load. Monitor pin 1 with the oscilloscope and ensure that the waveform is at least 1.3 V peak-to-peak. Remove the short circuit between test point 2 and 0 V, and ensure that no 5 MHz signal is present at pin 1.
25. Monitor pins 4, 6 and 5 using the oscilloscope. Check that the amplitude of the waveforms is at least 2 V peak-to-peak.
26. Set the POWER switch to OFF. Disconnect the test equipment and reconnect the coaxial sockets to the 9084. Insert assemblies 19-0893, 19-0894, 19-0904, and 19-0908.

Transfer Loop Assembly 19-0893

27. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1
Multimeter	3
Spectrum analyser	7

28. Remove assembly 19-0894 from the 9084. Connect the frequency counter to monitor the frequency on LK1. Connect the multimeter to monitor the voltage at pin 10 of IC4.
29.
 - (1) Set the POWER switch to ON.
 - (2) Select band 7 and tune to 60.00000 MHz.
 - (3) Adjust C43 until the frequency at LK1 is 1.0078 MHz.
 - (4) Further adjust C43 to obtain a reading of 9 V on the multimeter.
30. Connect the frequency counter to monitor the frequency at pin 2. Connect the multimeter to monitor the voltage on C34 (Q3/Q4 collectors).
31.
 - (1) Adjust L8 to obtain a reading of 9.000 MHz on the frequency counter.
 - (2) Adjust L8 further to obtain a reading of 6 V ± 0.1 V on the multimeter.
 - (3) Tune the 9084 to 59.999000 MHz. Check that the multimeter indicates less than 12 V.
32. Set the 9084 tuning sensitivity to SLOW, and tune through the range 60.00000 MHz to 60.99000 MHz. Check that the 100 kHz and 10 kHz digits shown on the frequency counter agree with the corresponding digits on the 9084 display.
33. Set the spectrum analyser to measure absolute power at a level of 0 dBm at a frequency in the range 9 MHz to 10 MHz. Measure the power at SK35, and check that this exceeds 0 dBm. Reset the spectrum analyser to measure power at a level of -6 dBm. Check that the output at SK93 exceeds -6 dBm.
34. Set the counter-timer to measure negative going pulses of 100 ms. Select FAST on the tuning sensitivity switches. Measure the pulses which occur at IC9/7 and IC9/9 on tuning from 60.00000 MHz to 60.100000 MHz and from 60.10000 MHz back to 60.00000 MHz. The pulse duration should be 100 ms ± 20 ms. Select SLOW on the tuning sensitivity switches and check that the same duration pulses occur at IC9/7 and IC9/9 on tuning from 60.00900 MHz to 60.01000 MHz and back.
35. Set the POWER switch to OFF. Reconnect SK35 and SK93, and replace assembly 19-0894.

Output Loop Assembly 19-0894

36. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1
Multimeter	3

37. Connect the multimeter to measure the voltage at IC5/3. Connect the frequency counter to monitor the frequency at the 9084 RF output socket.
38. (1) Set the POWER switch to ON.
- (2) Adjust R44 until a reading of 1.2 V is obtained on the multimeter. Disconnect the multimeter.
- (3) Select band 7. Select FINE on the tuning sensitivity switches.
- (4) Tune through the band, checking that the frequency counter indication agrees with the display. Check particularly that lock is not lost at the following changeover points:
- 49.99999 MHz to 50.00000 MHz
62.99999 MHz to 63.00000 MHz
80.99999 MHz to 81.00000 MHz
- (5) Tune to the frequencies shown below in turn. Select OFF and NORMAL on the carrier level control switches several times at each frequency, and check that lock is not lost.
- 40.00000 MHz
49.99999 MHz
50.00000 MHz
62.99999 MHz
63.00000 MHz
80.99999 MHz
81.00000 MHz
104.00000 MHz
- (6) Set the POWER switch to OFF and disconnect the frequency counter.

FM Loop and Audio Oscillator Assembly 19-0896

39. Test equipment required:

<u>Item</u>	<u>Table 18</u>	<u>Item No.</u>
Counter-timer		1
Modulation meter		2
Audio signal generator		6
Millivoltmeter		9
T piece		13

40. Connect the frequency counter to measure the frequency at the AUDIO OUTPUT socket on the 9084 rear panel.

41. (1) Set the POWER switch to ON.
- (2) Select FM INT on the modulation selection switches. Check that the frequency counter reads 1 kHz $\pm$ 50 Hz.
- (3) Select 400 Hz on the modulation frequency switches. Check that the frequency counter reads 400 Hz $\pm$ 20 Hz.
- (4) Select 3 kHz on the modulation frequency switches. Check that the frequency counter reads 3 kHz $\pm$ 150 Hz.
- (5) Disconnect the frequency counter and connect the millivoltmeter to measure the voltage at the AUDIO OUTPUT socket.
- (6) Select 1 kHz on the modulation frequency switches and adjust R95 until the millivoltmeter reads 1.10 V.
- (7) Select 400 Hz and 3 kHz in turn. Check that the millivoltmeter reading remains within the limits 1.03 V and 1.17 V.
- (8) Disconnect the millivoltmeter.
42. Connect the T piece to the FM audio input socket. Connect the audio signal generator and the millivoltmeter to the T piece. Set the signal generator output frequency to 1 kHz at a level of 1.00 V as indicated on the millivoltmeter.
43. Set the 9084 controls as follows:
- (1) Band 7 selected, tuned to 60.00000 MHz.
- (2) FM EXT selected on modulation control switches.
- (3) 300 kHz selected on PEAK DEVIATION switches.
- (4) FM selected on the meter function switches.
44. (1) Adjust R123 until the 9084 meter indicates 300 kHz peak deviation.
- (2) Select 100 kHz on the PEAK DEVIATION switches, and ensure that the 9084 meter indicates 100 kHz peak deviation.
45. Lift assembly 19-0894 to disconnect it from the motherboard at the edge connector. Set the modulation meter to read 300 kHz peak deviation about a carrier in the range 9 MHz to 10 MHz, and connect it to SK35 on assembly 19-0893.
46. Set the 9084 controls as follows:
- (1) Select 300 kHz on the PEAK DEVIATION switches.
- (2) Select FM INT on the modulation control switches.

- (3) Tune to 60.60000 MHz.
 - (4) Adjust the MODULATION LEVEL control to obtain an indication of 300 kHz peak deviation on the 9084 meter.
 - (5) Adjust R114 to obtain a reading of 300 kHz peak deviation on the modulation meter.
47. Tune the 9084 to 60.00000 MHz. Select each PEAK DEVIATION switch in turn and check that the peak deviations obtained, as indicated on the modulation meter, are 300 kHz, 100 kHz, 30 kHz, 10 kHz and 3 kHz. Repeat the test with the 9084 tuned to 59.99999 MHz.
48. Repeat the test in paragraph 47 with the 9084 tuned to the other frequencies shown in Table 23, checking that the peak deviations shown against those frequencies are obtained. Check that the 9084 meter indicates 10 or 3, as appropriate to the peak deviation expected. In each case select 300 kHz peak deviation first, and check that the REDUCE DEVIATION indicator lights and the peak deviation setting steps down automatically until a permitted setting is reached. The limits permitted on the measured modulation are given in Table 24.

TABLE 23

Peak Deviation Test

Band	Frequency	Peak Deviation
7	60.00000 MHz	300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz 200 kHz 120 kHz 300 kHz 200 kHz 400 kHz 100 kHz
6	29.99999 MHz	
5	15.00000 MHz	
4	5.999999 MHz	
3	3.000000 MHz	
2	1.499999 MHz	
1	1.000000 MHz	

TABLE 24

Peak Deviation Limits

Nominal Peak Deviation	Limits of Measured Value
400 kHz	380 kHz to 420 kHz
300 kHz	285 kHz to 315 kHz
200 kHz	190 kHz to 210 kHz
120 kHz	114 kHz to 126 kHz
100 kHz	95 kHz to 105 kHz
30 kHz	28.5 kHz to 31.5 kHz
10 kHz	9.5 kHz to 10.5 kHz
3 kHz	2.85 kHz to 3.15 kHz

49. Tune the 9084 to 0.099999 MHz. Check that the modulation meter and 9084 meter indicate zero.
50. Set the controls of the 9084 as follows:
 - (1) Band 7 selected and tuned to 59.99999 MHz.
 - (2) FM EXT selected on the modulation selection switches.
 - (3) 300 kHz selected on the PEAK DEVIATION switches.
51. Set the output of the audio signal generator to the frequencies given in Table 25 in turn, maintaining an output level of 1 V as measured on the millivoltmeter. Check that the peak deviation, measured using the modulation meter, is within the limits shown.

TABLE 25

External FM Frequency Response

Modulating Frequency	Peak Deviation Limits
20 Hz	212 kHz to 424 kHz
100 Hz	285 kHz to 315 kHz
1 kHz	285 kHz to 315 kHz
5 kHz	285 kHz to 315 kHz
20 kHz	212 kHz to 424 kHz

52. Tune the 9084 to 60.00000 MHz and repeat the test given in paragraph 51.
53. Select FM INT on the modulation control switches and 1 kHz on the MODULATION FREQUENCY switches. Adjust the MODULATION LEVEL control to give 300 kHz peak deviation as measured on the modulation meter.
54. Connect the distortion analyser to the AUDIO OUTPUT socket of the 9084. Check that the distortion is less than 1%. Transfer the distortion meter to the audio output socket of the modulation meter. Check that the distortion is less than 3%. Repeat the check with the 9084 tuned to 59.99999 MHz.
55. Set the POWER switch to OFF and disconnect the test equipment. Reconnect SK35 on assembly 19-0893, and reconnect assembly 19-0894 to the motherboard.

Output Amplifier Assembly 19-0897

56. Test equipment required:

<u>Item</u>	<u>Table 18</u>	<u>Item No.</u>
Multimeter		3
Spectrum analyser		7
Tracking generator		8
DC power supply		11

57. Disconnect SK70, SK71, SK72, SK73 and SK74 from the motherboard. Disconnect the RF input to the manual attenuator at the attenuator. Set the power supply to 1.40 V, as measured with the multimeter, and connect this between pin 5 (SK73) and 0 V, negative to pin 5. Connect the multimeter to measure the voltage on pin 2 (SK71).
58. (1) Select NORMAL on the carrier level control switches.
(2) Adjust R69 to give a reading of 0 V on the multimeter.
(3) Disconnect the power supply from pin 5.
(4) Adjust R79 to give -2.10 V at pin 2.
(5) Select X2 on the carrier level control switches and check that the multimeter reading is -4.33 V $\pm$ 0.05 V.
59. Using a tracking generator and spectrum analyser, or other normally accepted method, obtain the gain/frequency characteristic of the amplifier between SK70 (input) and the coaxial input connector to the manual attenuator (output). The input signal level used should be such as to give an output level of +19 dBm. Check that the amplifier gain at 10 MHz is 20 dB $\pm$ 1 dB, and that the response is flat to within $\pm$ 2 dB between 4 MHz and 104 MHz.
60. Obtain the voltage/frequency response between SK70 (input) and TP1 (output) with the same input signal level as was used to obtain the amplifier gain/frequency response. Check that the response is flat, to within $\pm$ 20% of the voltage at an input frequency of 10 MHz, over the frequency range from 4 MHz to 104 MHz.
61. Connect the multimeter to measure the voltage at edge connector B3 at an input frequency of 10 MHz. Select X2 on the 9084 and check that the voltage is halved.
62. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK70, SK71, SK72, SK73 and SK74.

NOTE: Some adjustments made on assembly 19-0897 interact with those made on assembly 19-0899. After the individual assemblies are set up the output loop setting up, commencing at paragraph 104, must be carried out.

Band Selection Divider Assembly 19-0899

63. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1
Multimeter	3
Spectrum analyser	7
Tracking generator	8
DC power supply	11

64. Disconnect SK65 and SK67. Connect the power supply to SK65 and the multimeter to monitor pin 2. Connect the frequency counter to monitor the frequency at SK67. Set the power supply to give a voltage of +0.5 V ± 0.01 V at pin 2.
65. Set the POWER switch to ON. Select the bands and tune to the frequencies given in Table 26, and ensure that the frequency counter indicates the corresponding frequency.

TABLE 26

Division Ratio Check

Range	9084 Frequency	Frequency Counter Indication
1	1.0 MHz	6.0 MHz
2	2.5 MHz	2.5 MHz
3	5.0 MHz	5.0 MHz
4	10.0 MHz	10.0 MHz
5	25.0 MHz	25.0 MHz
6	50.0 MHz	50.0 MHz
7	100.0 MHz	100.0 MHz

66. (1) Disconnect the frequency counter.
- (2) Set the spectrum analyser to measure absolute power at a level of 0 dBm at a frequency of 10 MHz.
- (3) Connect the spectrum analyser to SK67.
- (4) Select band 4 on the 9084 and tune to 10 MHz. Check that the signal level at SK67 is approximately 0 dBm.
- (5) Disconnect SK66. Connect the tracking generator to SK66 and adjust the output level to give an output level of exactly 0 dBm at SK67.

- (6) Reset the spectrum analyser to measure absolute power at a level of 0 dBm over the frequency range from 40 MHz to 110 MHz.
 - (7) Select band 7 on the 9084, and check that the signal level at 104 MHz is not less than -3 dBm.
 - (8) Reduce the voltage applied at SK65 and ensure that the signal level at SK67 can be reduced to less than -25 dBm.
67. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK65, SK66 and SK67.

NOTE: Some adjustments made on assembly 19-0899 interact with those made on assembly 19-0897. After the individual assemblies are set up the output loop setting up, commencing at paragraph 104, must be carried out.

LF Combiner Assembly 19-0900

- | <u>Item</u> | <u>Table 18 Item No.</u> |
|---------------------|--------------------------|
| RF signal generator | 5 |
| Spectrum analyser | 7 |
69. Disconnect SK62 and SK64. Connect the signal generator to SK64 and the spectrum analyser to SK62. Set the signal generator to give an output of 6 MHz at a level of -1 dBm. Set the spectrum analyser to measure absolute power at a level of -1 dBm at a frequency of 6 MHz.
 70. Set the POWER switch to ON. Select a band other than band 1, and check that the signal at SK62 has a frequency of 6 MHz at a level of -1 dBm ± 0.5 dBm. Adjust the signal generator output to give a level of exactly -1 dBm.
 71. Set the spectrum analyser to measure absolute power at a level of -1 dBm over the frequency range 0.1 MHz to 1.4 MHz.
 72. Select band 1. Check that the signal at SK62 is at a frequency of 1 MHz. Adjust R11 to obtain an output level of -1 dBm. Tune the signal generator over the range from 5.01 MHz to 6.4 MHz, and check that the output level is -1 dBm ± 1.5 dBm over the range 0.1 MHz to 1.4 MHz.
 73. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK62 and SK64.

Output Oscillator Assembly 19-0901

74. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1
Multimeter	3
Power meter	10
Power supply	11

75. Disconnect SK59, SK60 and SK61. Connect the frequency counter to monitor the frequency at SK59, and the power meter to monitor SK60. Connect the power supply to SK61 and the multimeter to monitor the voltage at pin 1. Set the power supply to give +5 V at pin 1.
76.
 - (1) Set the POWER switch to ON. The 9084 display will flash to indicate that the equipment is out of lock.
 - (2) Adjust L5 to obtain a frequency at SK59 of 50 MHz ± 0.1 MHz.
 - (3) Reset the power supply to give +6 V at pin 1.
 - (4) Select band 7 and tune the 9084 to display the frequencies shown in Table 27 in turn. At each frequency adjust the appropriate coil to get the frequency at SK59 within the limits shown.

TABLE 27

Output Oscillator Adjustment

Frequency Displayed	Coil to Adjust	Frequency at SK59
40.00000	L7	40.0 MHz ± 0.1 MHz
63.00000	L3	63.0 MHz ± 0.1 MHz
81.00000	L1	81.0 MHz ± 0.1 MHz

- (5) Disconnect the frequency meter and reconnect SK59. Ensure that the 9084 display ceases flashing as the loop locks.
- (6) Connect the multimeter to monitor the voltage at test point 1.
- (7) Tune over the range from 40 MHz to 104 MHz. Ensure that the 9084 stays in lock and that the signal level at SK60 is not less than -2 dBm over the whole range. Check that the voltage at test point 1 is less than 20 V throughout the range.
- (8) Select OFF on the carrier level control switches. Check that the power meter reads zero and that the 9084 display flashes.
- (9) Select NORMAL on the carrier level control switches and check that the power meter indication is restored. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK59, SK60 and SK61.

1 MHz Comb Loop Oscillator Assembly 19-0902

77. Test equipment required:

<u>Item</u>	<u>Table 18</u>	<u>Item No.</u>
Counter-timer		1
Multimeter		3
Power meter		10

78. Remove assembly 19-0894 from the 9084. Disconnect SK44 on assembly 19-0902. Connect the multimeter to monitor the voltage on test point 1, and the frequency counter to monitor the frequency at SK44. Note that the oscillator coils L5 and L7 do not have cores fitted.
79. (1) Set the POWER switch to ON, select band 7 and tune to 81.00000 MHz.
(2) Adjust L3 until the frequency meter reads 72 MHz.
(3) Further adjust L3 until the multimeter indicates 2 V.
80. (1) Tune through the displayed range from 40.00000 MHz to 104.00000 MHz, and ensure that the frequency counter reads exactly 9 MHz less than the display.
(2) Disconnect the frequency counter. Connect the power meter to monitor the signal level at SK44 and the multimeter to monitor the voltage at test point 1.
(3) Tune through the displayed range from 40.00000 MHz to 104.00000 MHz. Ensure that the signal level at SK44 is not less than -2 dBm and the voltage at test point 1 is less than 20 V throughout the range.
(4) Set the POWER switch to OFF. Disconnect the test equipment, and reconnect SK44. Replace assembly 19-0894.

Mixer and Buffer Assembly 19-0903

81. Test equipment required:

<u>Item</u>	<u>Table 18</u>	<u>Item No.</u>
RF signal generator		5
Spectrum analyser		7
Tracking generator		8

82. Remove assembly 19-0894 from the 9084. Remove link LK1 and disconnect SK53 and SK55. Set the POWER switch to ON, and select band 7. Using a tracking generator and spectrum analyser, or other normally accepted method, obtain the amplitude/frequency characteristic of the circuit between SK53 (input) and pin 5 of LK1 (output). The input signal level should be approximately -4 dBm. Adjust L4 and L6 to obtain the response shown in fig. 5.1.

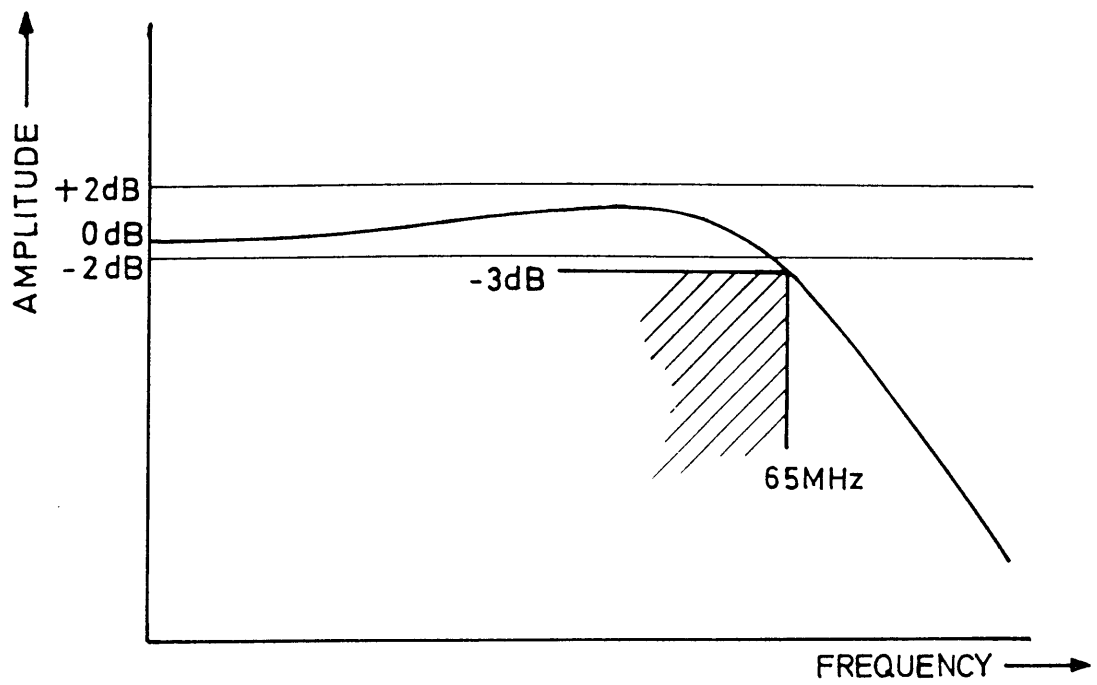
83. Tune the 9084 to 63 MHz and again obtain the amplitude/frequency response between SK53 and pin 5. Adjust L5 and L7 to obtain the response shown in fig. 5.2.
84. Set the POWER switch to OFF. Disconnect the test equipment and reconnect LK1. Set the spectrum analyser to measure absolute power at a level of -5 dBm at a frequency of 9 MHz, and connect it to measure the signal level at SK55. Connect the signal generator to SK53.
85.
 - (1) Set the POWER switch to ON.
 - (2) Select band 7 and tune to 104 MHz on the 9084 display.
 - (3) Set the signal generator output to a frequency of 104 MHz at a level of -4 dBm.
 - (4) Check that the signal level at SK55 at 9 MHz is greater than -5 dBm.
 - (5) Retune the 9084 and the signal generator to 62 MHz. Check that the signal level at SK55 at 9 MHz is greater than -5 dBm.
86. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK53 and SK55. Replace assembly 19-0894 in the instrument.

1 MHz Comb Loop Assembly 19-0904

87. Test equipment required:

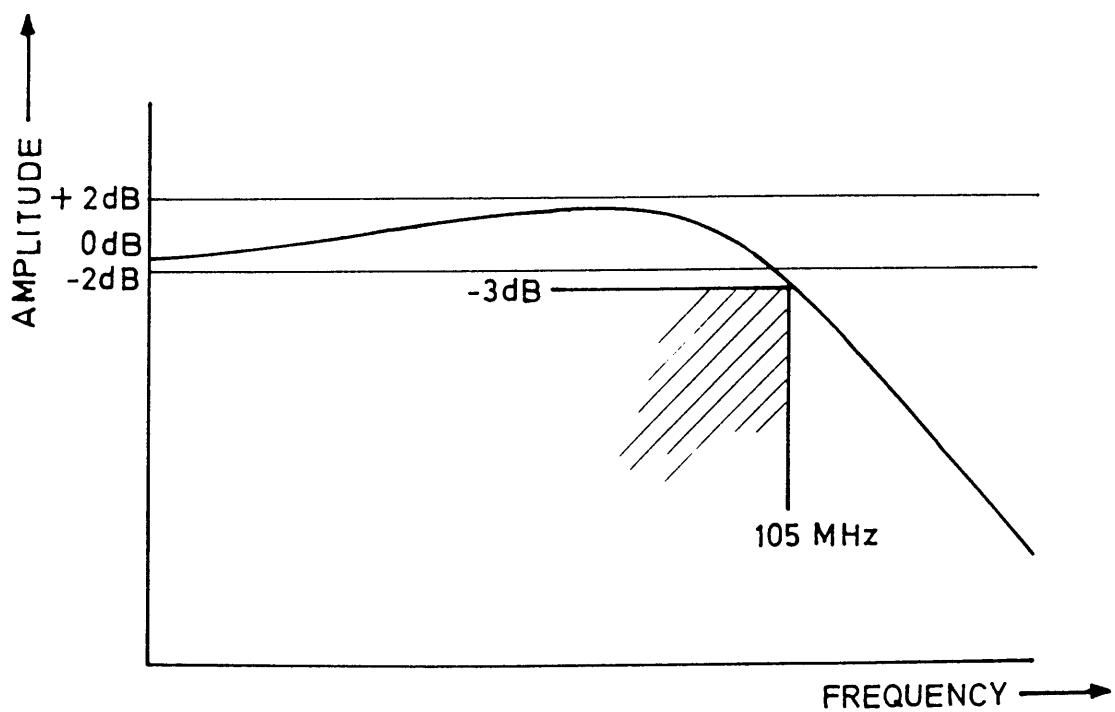
<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1

88. Remove assembly 19-0894 from the 9084. Disconnect SK44 on assembly 19-0902. Connect the frequency counter to monitor the frequency on this socket.
89. Set the POWER switch to ON, and select band 7. Check that the display indicates 60.00000 MHz and that the frequency counter indicates 51.00000 MHz. Tune the 9084 upwards in frequency to 104 MHz, checking that the frequency measured at SK44 increases in 1 MHz steps coincident with the change of the 9084 display 1 MHz digit.
90. Select band 1 and reselect band 7. Check that the 9084 display and the frequency counter read 60.00000 MHz and 51.00000 MHz. Tune the 9084 downwards in frequency to 40 MHz, checking that the frequency measured at SK44 decreases in 1 MHz steps coincident with the change of the 9084 display 1 MHz digit.
91. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK44 on assembly 19-0902. Replace assembly 19-0894 in the 9084.



1/2 Octave Filter Response

Fig.5.1



1/2 Octave Filter Response

Fig.5.2

RF Filter Assembly 19-0906

92. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Spectrum analyser	7
Tracking generator	8

93. Disconnect SK68 and SK69. Set the POWER switch to ON. Using a tracking generator and spectrum analyser, or any other normally accepted method, obtain the amplitude/frequency response of each filter between SK68 (input) and SK69 (output). The input signal level should be 0 dBm. The filters are selected by selecting the band and tuning the 9084 to the corner frequencies given in Table 28.
94. Examine the filter responses obtained and ensure that, for each filter,
- (1) The output at the corner frequency is not less than -7 dBm.
 - (2) The output at all frequencies greater than the stop frequency is not greater than -30 dBm.
 - (3) The part of each filter characteristic between the corner frequency and the corner frequency of the next lower frequency filter, lies within ± 3 dB of the mean level of the characteristic in this range.
95. If minor adjustment of a filter characteristic is necessary adjustment of the corner frequency and stop frequency adjusting components given in Table 28 may be made. The adjustments are interactive to some degree, and the complete filter characteristic must be checked after adjustment.
96. If major adjustment of a filter characteristic is required the initial setting of the adjusting components should be carried out as follows:
- (1) Select the band and tune to the corner frequency given in Table 28 for the filter to be adjusted.
 - (2) Inject a signal at the first notch frequency given for that filter, at a level of 0 dBm, into SK68.
 - (3) Monitor the output at SK69. Adjust the corner frequency adjusting component for minimum output.
 - (4) Change the input frequency to the second notch frequency quoted for the filter.
 - (5) Adjust the stop frequency adjusting component for minimum output.
 - (6) Repeat (2) to (5) until minimum output is obtained at both notch frequencies. The additional adjustment required to get the filter to meet the requirements of paragraph 94 should be small.
97. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK68 and SK69.

98. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Counter-timer	1
Multimeter	3
Oscilloscope	4

99. Remove assemblies 19-0895, 19-0904 and 19-0894 from the 9084. Disconnect SK41 on assembly 19-0908. Connect the frequency counter to monitor the frequency at SK41. Connect the multimeter to monitor the voltage at IC10/14.

TABLE 28
RF Filter Characteristics

Band	Corner Frequency (MHz)	Corner Frequency Adjustment	Stop Frequency (MHz)	Stop Frequency Adjustment	Notch Frequency (MHz)
7	104	L2	126	L3	201 139
	62.99999	L5	80	L6	123 85.3
6	52	L8	63	L9	100 69.6
	31.49999	L11	40	L12	61.5 42.7
5	26	L14	31.5	L15	50.2 34.8
	15.74999	C33	20	C37	30.7 21.3
4	10.4	C42	12.6	C46	20.1 13.9
	6.299999	C49	8.0	C55	12.3 8.53
3	5.2	C60	6.3	C64	10.0 6.96
	3.149999	C69	4.0	C73	6.15 4.27
2	2.6	C78	3.15	C82	5.02 3.48
	1.574999	C87	2.0	C91	3.07 2.13

100. (1) Set the POWER switch to ON.
- (2) Adjust R5 to obtain a multimeter reading of 3.0 V.
- (3) Select band 1 and tune to 1.000000 MHz.
- (4) Transfer the multimeter to monitor the voltage at LK1.
- (5) Adjust C15 to obtain a peak indication on the multimeter (typically 0.7 V).
- (6) Check that the frequency counter indicates 7000 kHz.
- (7) Tune the 9084 to 0.999999 MHz. Check that the frequency counter indicates 7.999 kHz and that the multimeter indicates less than 1.5 V.

NOTE: It may be necessary to make a further slight adjustment to R5 to maintain lock at both ends of the loop frequency range.

101. Disconnect the frequency counter from SK41 and monitor the output with the oscilloscope. Ensure that the signal level is TTL compatible, approximately 3 V peak-to-peak, over the loop frequency range.
102. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK41.

Output Loop Level, AM and Meter Drive

103. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Modulation meter	2
RF signal generator	5
Audio signal generator	6
Spectrum analyser	7
Tracking generator	8
Millivoltmeter	9
Power meter	10

104. Mount assemblies 19-0897 and 19-0899 on extender cards. Disconnect SK66 and SK67 on assembly 19-0899, and SK70 on assembly 19-0897. Set the spectrum analyser to measure power levels of +10 dBm over the frequency range from 0 MHz to 100 MHz, and connect it to monitor SK67 on assembly 19-0899. Set the tracking generator to give an output of 0 dBm, and connect it to SK66 on assembly 19-0899. Set the signal generator to give an output frequency of 6 MHz at a level of +3 dBm and connect it to SK70 on assembly 19-0897. Switch the signal generator off.

105. (1) Set the POWER switch to ON and select band 7.
- (2) Set the TRACK ADJUST control on the tracking generator to give maximum height of trace on the spectrum analyser. Adjust the spectrum analyser vernier to set the trace to the reference graticule.
- (3) Switch on the signal generator. The signal level seen on the spectrum analyser should drop by about 55 dB.
- (4) Adjust R82 on assembly 19-0897 to give minimum overall signal at SK67. Using a non-metallic adjusting tool, adjust the wire capacitive trim tabs on the modulator to minimise the high frequency breakthrough. The adjustments are interactive, and an overall level at least 55 dB down on that set in (2) must be attained before locking compound is applied to the trim tabs. A compound of the silicone rubber type should be used. The application of the locking compound should be expected to affect the results obtained, and final correction must be made before the compound sets.
106. Set the POWER switch to OFF. Disconnect the test equipment and reconnect SK66 and SK67 on assembly 19-0899 and SK70 on assembly 19-0897. Connect the 9084 output to the power meter.
107. (1) Set the POWER switch to ON, select band 4 and tune to 10.000000 MHz.
- (2) Set the OUTPUT LEVEL control to +10 dBm and the VERNIER control fully clockwise.
- (3) Adjust R79 on assembly 19-0897 to give an output of +13 dBm.
108. Disconnect the power meter, and connect the modulation meter to the 9084 output. Connect the audio signal generator and the millivoltmeter to the 9084 AM audio input socket. Set the signal generator output to 1 kHz at a level which gives an indication of 80% on the modulation meter.
109. (1) Set the VERNIER control fully anticlockwise.
- (2) Adjust R52 on assembly 19-0897 to obtain an indication of 80% on the modulation meter.
- (3) Set the VERNIER control fully clockwise and adjust the audio signal generator output level to give an indication of 80% on the modulation meter.
- (4) Repeat steps (1) to (3) until an indication of 80% is obtained at both extremities of the VERNIER range.
110. Set the audio signal generator to a level of 800 mV as measured on the millivoltmeter. Adjust R69 on assembly 19-0897 to obtain an indication of 80% on the modulation meter. Select OFF on the AM selection switches. Disconnect the modulation meter and connect the power meter to the 9084 output.

111. (1) Set the VERNIER control fully clockwise.
- (2) Set R79 to obtain an indication of +13.2 dBm on the power meter.
- (3) Turn the VERNIER control anticlockwise until the power meter reading is reduced to +13 dBm.
- (4) Adjust R75 on assembly 19-0897 until the 9084 meter reads +3 dB.
- (5) Turn the VERNIER control anticlockwise until the power meter reads 0 dBm.
- (6) Adjust R72 on assembly 19-0897 until the 9084 meter indicates -10 dB.
- (7) Turn the VERNIER control clockwise until the 9084 meter reads +3 dB. Check that the power meter indicates +13 dBm. If it does not repeat steps (1) to (7) until the 9084 meter reads correctly at +13 dBm and 0 dBm.
112. Select X2 on the carrier level control switches. Set the VERNIER control to give an indication of +3 dB on the 9084 meter. Check that the 9084 meter reads +3 dB ± 0.3 dB and that the output power is +19 dBm ± 0.3 dBm.
113. (1) Select NORMAL on the carrier level control switches, and set the VERNIER control to give an indication of +3 dB on the 9084 meter.
- (2) Select EXT AM on the modulation control switches, and check that the audio signal generator is still set to 1 kHz at a level of 800 mV.
- (3) Disconnect the power meter, and connect the modulation meter to the 9084 output.
- (4) Check that the modulation meter indicates 80% $\pm 1\%$. If not repeat the setting up in paragraphs 107 to 113.
- (5) Turn the VERNIER control anticlockwise until the 9084 meter indicates -10 dB. Check that the modulation meter indicates 80% $\pm 2\%$.
114. Select AM OFF and EXT FM on the modulation selection switches. Transfer the audio signal generator output and millivoltmeter input to the FM audio input socket. Set the signal generator output to 1 kHz at a level of 1.00 V as monitored on the millivoltmeter.
115. (1) Select band 7 and tune to 60.00000 MHz.
- (2) Select 300 kHz on the PEAK DEVIATION switches.
- (3) Select FM on the meter function switches, and adjust R123 on assembly 19-0896 to obtain an indication of 3.0 on the 9084 meter 0-3 scale.

- (4) Select 100 kHz on the PEAK DEVIATION switches and check that the meter indicates 10 on the 0-10 scale.
116. Set the POWER switch to OFF. Disconnect the test equipment and replace the equipment covers as instructed in paragraph 169.

SPECIFICATION TESTS

117. Carry out the operational check in paragraphs 3 to 12. This checks the functioning of the equipment control logic, the carrier frequency synthesizer and dividers, the display, the internal modulation oscillator and the functioning of the internal modulation circuits.

Output Level Accuracy Test

118. Test equipment required:

<u>Items</u>	<u>Table 18 Item No.</u>
Power meter	10

NOTE: (1) If the power meter available has a frequency range of 10 kHz to 104 MHz it can be used on all ranges. If not, the true r.m.s. millivoltmeter reading must be compared with the power meter reading at a frequency within the operating range of both instruments to ensure that their calibration agrees. Comparison should be made at power levels of +13 dBm and +19 dBm.

(2) The impedance presented at the 9084 output must be 50 Ω . If it is necessary to use a high impedance millivoltmeter, measurements must be made across a suitable load. This load must be the one used when making the comparison between measuring instruments referred to in NOTE (1).

119. Connect the power meter to monitor the signal level at the 9084 RF output socket.
120. (1) Set the POWER switch to ON.
- (2) Select band 4 and tune to 10.000000 MHz.
- (3) Set the manual attenuator to +10 dBm and adjust the VERNIER control to obtain an indication of +3 dB on the 9084 meter.
- (4) Check that the power meter indicates +13 dBm ± 0.3 dBm.
- (5) Select X2 on the carrier level control switches and adjust the VERNIER control to obtain an indication of +3 dB on the 9084 meter.
- (6) Check that the power meter indicates +19 dBm ± 0.3 dBm.
- (7) Select NORMAL on the carrier level control switches and adjust the VERNIER control to obtain an indication of -10 dB on the 9084 meter.

- (8) Check that the power meter reads 0 dBm ± 0.3 dBm.
- (9) Adjust the VERNIER control to obtain an indication of +3 dB on the 9084 meter.
- (10) Select each band in turn. Tune slowly throughout each band, and ensure that the power meter indicates +13 dBm ± 0.5 dBm (± 0.6 dBm if the reverse power protection unit is fitted) at all frequencies.

NOTE: If necessary, substitute the millivoltmeter and 50 Ω load for the power meter. The millivoltmeter indication should be between the limits of 0.945 V and 1.055 V throughout the frequency range over which it is used.

- (11) Select band 4 and tune to 10.000000 MHz.
- (12) Select X2 on the carrier level control switches and adjust the VERNIER control to obtain an indication of +3 dB on the 9084 meter.
- (13) Check that the power meter indicates +19 dBm ± 0.3 dBm.
- (14) Repeat the procedure given in (10). The power meter should indicate +19 dBm ± 0.5 dBm (± 0.6 dBm if the reverse power protection unit is fitted) at all frequencies. The millivoltmeter, if used, should indicate between 1.89 V and 2.11 V throughout the frequency range over which it is used.

121. Set the POWER switch to OFF and disconnect the test equipment.

Attenuator Test

122. Test equipment required:

Item

Table 18 Item No.

Spectrum analyser

7

123. Set the spectrum analyser to measure absolute power at a level of +19 dBm at a frequency of 1.5 MHz. Connect the analyser to the RF output socket of the 9084.
124. Set the 9084 POWER switch to ON. Select band 2 and tune to 1.500000 MHz. Select X2 on the carrier level control switches and adjust the VERNIER control until the meter indicates +3 dB. Set the manual attenuator to +10 dBm.
125. The output of the 9084, as displayed on the spectrum analyser, should be at the +19 dBm reference level. Select the manual attenuator positions from +10 dBm to -60 dBm, checking that each step gives a 10 dB drop in the 9084 output level.

126. Reset the spectrum analyser to measure absolute power at a level of -51 dBm. The output of the 9084, as displayed on the spectrum analyser, should be at the -51 dBm reference level. Select the manual attenuator positions from -60 dBm to -120 dBm, checking that each step gives a 10 dB drop in the 9084 output level.
127. Select the manual attenuator positions from -120 dBm to +10 dBm, resetting the spectrum analyser reference level to +19 dBm when the -60 dBm position is reached, and check that each step gives a 10 dB increase in the 9084 output level.

NOTE: The attenuator is a high precision assembly. In the event of malfunction it is recommended that the assembly be replaced complete, or that it be sent to Racal-Dana Instruments, or their agents, for repair and calibration.

128. Set the POWER switch to OFF and disconnect the test equipment.

Carrier Harmonic Distortion Test

129. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Spectrum analyser	7

130. Set the spectrum analyser to measure power levels relative to a level of +3 dBm. Connect the analyser to the 9084 RF output socket.
131. Set the 9084 POWER switch to ON and select band 7. Set the manual attenuator to 0 dBm and adjust the VERNIER control to obtain an indication of +3 dB on the meter.
132. Set the spectrum analyser to display the frequency range from 40 MHz to 450 MHz. Tune throughout band 7, and ensure that all harmonics are at least 40 dB below the carrier level. Repeat this test for the other bands, setting the spectrum analyser to monitor the frequency range shown in Table 29 for each range.
133. Set the spectrum analyser reference level to +9 dBm. Select X2 on the carrier level control switches. Repeat the test given in paragraph 132, ensuring that all harmonics are at least 34 dB below the carrier level.
134. Set the POWER switch to OFF and disconnect the test equipment.

TABLE 29

Carrier Harmonic Check

Band	Tuning Range	Monitored Frequency Range	Bandwidth
7	Full Band	40 MHz to 450 MHz	300 kHz
6	Full Band	20 MHz to 300 MHz	300 kHz
5	Full Band	10 MHz to 130 MHz	300 kHz
4	Full Band	4 MHz to 45 MHz	100 kHz
3	Full Band	2 MHz to 30 MHz	100 kHz
2	Full Band	1 MHz to 13 MHz	30 kHz
1	0.2 MHz to 1.4 MHz	0.3 MHz to 8 MHz	30 kHz
1	0.1 MHz to 0.3 MHz	0.1 MHz to 1.5 MHz	10 kHz
1	0.03 MHz to 0.1 MHz	0.03 MHz to 0.5 MHz	3 kHz
1	0.01 MHz to 0.03 MHz	0.01 MHz to 0.2 MHz	1 kHz

Spurious Output Test

135. Test equipment required:

ItemTable 18 Item No.

Spectrum analyser	7
104 MHz notch filter	14
1.4 MHz notch filter	14

136. Set the spectrum analyser to measure power levels relative to +10 dBm over a frequency band of 1 MHz centred on 45 MHz. A filter bandwidth of 3 kHz and video filter bandwidth of 10 kHz should be selected. Connect the spectrum analyser to monitor the 9084 RF output socket.

137. (1) Set the POWER switch to ON.

(2) Select band 7, and tune to 45.00000 MHz.

(3) Set the manual attenuator to +10 dBm.

(4) Centre the displayed signal on the spectrum analyser, and adjust the 9084 VERNIER control to make the displayed signal peak coincide with the reference graticule.

(5) Select SLOW on the tuning sensitivity switches. Tune slowly in each direction, examining the display to see if two moving spurious signals, which coincide with the carrier at exactly 45 MHz, can be identified.

(6) Reset the spectrum analyser controls as necessary to display the larger of the spurious signals. Tune the 9084 to obtain maximum amplitude of the displayed signal. Check that this amplitude is at least 70 dB below the carrier level set in (4).

(7) Repeat steps (4) to (6) at carrier frequencies of:

47.5 MHz	54.0 MHz	55.2 MHz
56.4 MHz	57.6 MHz	58.8 MHz
63.0 MHz	66.5 MHz	72.0 MHz
81.0 MHz	85.5 MHz	90.0 MHz
99.0 MHz	100.1 MHz	101.2 MHz
102.3 MHz	103.4 MHz	

138. Set the spectrum analyser to measure power levels of +13 dBm over a frequency range of 50 MHz centred on a frequency of 104 MHz. Tune the 9084 to 104.00000 MHz and adjust the VERNIER control to bring the displayed output to the reference graticule of the spectrum analyser. Insert a 104 MHz notch filter between the 9084 RF output socket and the spectrum analyser. This should provide at least 50 dB attenuation of the carrier to permit the spectrum analyser reference level to be reset to -17 dBm.
139. Slowly tune the spectrum analyser centre frequency to examine the spectrum from 110 MHz to d.c. Check that all spurious signals are at levels less than -57 dBm (70 dB below carrier level).
140. Set the spectrum analyser to measure power levels of +13 dBm over a frequency range of 10 MHz centred on a frequency of 1.4 MHz. Select band 1 on the 9084 and tune to 1.400000 MHz. Adjust the VERNIER control to bring the displayed output to the reference graticule.
141. Using a 1.4 MHz notch filter to reduce the carrier level, reset the spectrum analyser reference level to -17 dBm and examine the spectrum from DC to 15 MHz. Check that all spurious signals are at levels less than -57 dBm (70 dB below carrier level).
142. Disconnect the notch filter and spectrum analyser. Reset the spectrum analyser to measure power levels of +10 dBm over a frequency range of 10 MHz centred on 40 MHz. Connect the spectrum analyser directly to the 9084 RF output socket.
143. Select band 7 and tune to 40.00000 MHz. Adjust the VERNIER control to bring the displayed output to the reference graticule. Tune the 9084 and spectrum analyser centre frequency simultaneously, to keep the displayed carrier at the centre of the spectrum analyser screen, from 40 MHz to 104 MHz. Check that all sidebands (particularly those at ± 1 MHz) are at least 70 dB below the carrier level.
144. Set the POWER switch to OFF and disconnect the test equipment.

Noise Tests

145. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Spectrum analyser	7
104 MHz notch filter	14
1.4 MHz notch filter	14

146. Set the spectrum analyser to measure power relative to +13 dBm over a frequency range of 20 MHz centred on 104 MHz. Connect the analyser to the RF output socket of the 9084.

147. (1) Set the POWER switch to ON, select band 7 and tune to 104.00000 MHz.

(2) Set the manual attenuator to +10 dBm, and adjust the VERNIER control to give an indication of +3 dB on the 9084 meter.

(3) Adjust the spectrum analyser vernier, if necessary, to bring the displayed carrier to the reference graticule.

(4) Insert a 104 MHz notch filter between the 9084 RF output socket and the spectrum analyser. This must provide at least 50 dB attenuation of the carrier to permit the spectrum analyser reference level to be reset -60 dBm.

(5) Set the spectrum analyser to display a frequency range of 2 MHz centred on 60 MHz. Set the bandwidth to 10 kHz.

(6) Check that the noise level is at least 27 dB below the reference graticule (140 dB/Hz below the carrier level).

(7) Disconnect the spectrum analyser and notch filter.

148. Set the spectrum analyser to display a frequency range of 200 kHz centred on 500 kHz. Reconnect the spectrum analyser to the 9084 RF output socket via a notch filter providing at least 50 dB of attenuation at 1.4 MHz.

149. (1) Select band 1 and tune to 1.400000 MHz.

(2) Check that the noise level is at least -17 dB below the reference graticule (130 dB/Hz below the carrier level).

(3) Set the POWER switch to OFF and disconnect the test equipment.

150. The measurement of noise close to the carrier frequency requires special test equipment and techniques. Customers who have reason to need close in noise testing carried out are advised to take advantage of the testing and calibration service offered by Racal-Dana Instruments and their agents.

Modulation Frequency Response Test

151. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Modulation meter	2
Audio signal generator	6
Millivoltmeter	9
T piece	13

152. Connect the T piece to the 9084 external AM input socket, and connect the audio signal generator and the millivoltmeter to the T piece. Connect the RF output socket to the modulation meter.

153. Set the modulation meter to indicate AM at a depth of 80%. Set the audio signal generator to give an output of 800 mV, as monitored by the millivoltmeter. Maintain this level throughout the test in paragraph 154(5).

154. (1) Set the POWER switch to ON. Select band 7 and tune to 104.00000 MHz.
- (2) Set the manual attenuator to +10 dBm and adjust the VERNIER control to obtain an indication of +3 dB on the meter.
- (3) Select EXT on the AM control switches.
- (4) Select AM on the meter function switches.
- (5) Check the modulation depth at the modulating frequencies shown in Table 30, and ensure that it is within the tolerance shown.
- (6) Select band 1 and tune to 1.000000 MHz.
- (7) Set the audio signal generator to 300 mV, as monitored by the millivoltmeter. Maintain this level throughout the test in (8).
- (8) Check the modulation depth at the modulating frequencies shown in Table 31, and ensure that it is within the tolerance shown.

TABLE 30

Modulation Frequency Response

<u>Modulating Frequency</u>	<u>Modulation Depth</u>
20 Hz	77% to 83%
100 Hz	77% to 83%
500 Hz	77% to 83%
2 kHz	77% to 83%
5 kHz	77% to 83%
10 kHz	72% to 88%
20 kHz	57% to 103%

TABLE 31

Modulation Frequency Response

Modulating Frequency	Modulation Depth
20 Hz	26.5% to 33.5%
100 Hz	26.5% to 33.5%
500 Hz	26.5% to 33.5%
2 kHz	26.5% to 33.5%
5 kHz	21.5% to 38.5%

- (9) Select band 7 and tune to 63.00000 MHz.
- (10) Select OFF on the AM control switches.
- (11) Select EXT on the FM control switches.
- (12) Select FM on the meter function switches.
- (13) Select 100 kHz on the PEAK DEVIATION switches.
- (14) Connect the T piece, audio signal generator and millivoltmeter to the external FM input socket.
- (15) Set the signal generator output level to 1.00 V as monitored by the millivoltmeter. Maintain this level throughout the test in (16).
- (16) Check the deviation obtained at the modulating frequencies shown in Table 32, and ensure that it lies within the tolerance shown.

TABLE 32

Modulation Frequency Response

Modulating Frequency	Maximum Deviation
20 Hz	71 kHz to 129 kHz
50 Hz	93 kHz to 107 kHz
100 Hz	95 kHz to 105 kHz
500 Hz	95 kHz to 105 kHz
2 kHz	95 kHz to 105 kHz
5 kHz	95 kHz to 105 kHz
10 kHz	90 kHz to 110 kHz
20 kHz	71 kHz to 129 kHz

(17) Tune to 62.99999 MHz and repeat step (16).

(18) Set the POWER switch to OFF and disconnect the test equipment.

AM Depth and Distortion Test

155. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Modulation meter	2
Audio signal generator	6
Millivoltmeter	9
Distortion analyser	12
T piece	13

156. Connect a T piece to the external AM input socket, and connect the audio signal generator and the millivoltmeter to the T piece. Connect the modulation meter to the 9084 RF output socket, and connect the distortion analyser to the audio output of the modulation meter.

157. Set the audio signal generator to give an output of 1 kHz at a level of 800 mV, as monitored on the millivoltmeter. Set the modulation meter to read AM at a depth of 80%.

158. (1) Set the POWER switch to ON, select band 7 and tune to 104.00000 MHz.
- (2) Set the manual attenuator to +10 dBm and adjust the VERNIER control to obtain an indication of +3 dB on the meter.
- (3) Select EXT on the AM control switches.
- (4) Select AM on the meter function switches.
- (5) Check that the 9084 meter indicates $80\% \pm 1\%$, that the modulation meter indicates $80\% \pm 3\%$ and that the total harmonic distortion (THD) is less than 3%.
- (6) Select INT on the AM control switches, and adjust the MODULATION LEVEL control to obtain an indication of 80% on the 9084 meter. Check that the modulation meter indicates $80\% \pm 3\%$.
- (7) Select EXT on the AM control switches. Measure the modulation depth and THD at each of the frequencies given in Table 33. Ensure that the modulation depth is $80\% \pm 3\%$ and the THD is less than 3%.

TABLE 33

AM Depth and Distortion Test Frequencies

Band	Frequencies			
7	40.0 MHz	62.99999 MHz	63.0 MHz	104.0 MHz
6	31.4 MHz	52.0 MHz		
5	15.7 MHz	26.0 MHz		
4	6.29 MHz	10.4 MHz		
3	3.14 MHz	5.2 MHz		
2	1.00 MHz	1.57 MHz	1.58 MHz	2.6 MHz

- (8) Reduce the output level of the audio signal generator to 300 mV.
- (9) Select band 1 and tune to 1.40 MHz.
- (10) Check that the 9084 meter indicates $30\% \pm 1\%$ and the modulation meter indicates $30\% \pm 3.5\%$.
- (11) Repeat step (10) at a frequency of 0.15 MHz.
- (12) Select X2 on the carrier level control switches. Check that the modulation depth is zero and that the 9084 meter indicates zero. The indicator in the AM EXT switch should flash.
- (13) Select NORMAL on the carrier level control switches.
- (14) Select FINE on the tuning sensitivity switches and tune to 0.099999 MHz. Check that the modulation meter and 9084 meter indicate zero and that the indicator in the AM EXT switch flashes.
- (15) Set the POWER switch to OFF and disconnect the test equipment.

FM Deviation Test

159. Test equipment required:

<u>Item</u>	<u>Table 18</u>	<u>Item No.</u>
Modulation meter		2
Audio signal generator		6
Millivoltmeter		9
Distortion analyser		12
T piece		13

For Service Manuals
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 Fax (01844) 352554
 email:- mauritron@dial.pipex.com

160. Connect the modulation meter to the RF output socket of the 9084. Connect the distortion analyser to the modulation meter audio output. Connect a T piece to the 9084 external FM input socket, and connect the audio signal generator and the millivoltmeter to the T piece.

161. Set the modulation meter to indicate FM at a maximum deviation of 100 kHz. Set the audio signal generator to give an output frequency of 1 kHz at a level of 1.00 V as monitored on the millivoltmeter.
162. (1) Set the POWER switch to ON, select band 7 and tune to 104.00000 MHz.
(2) Set the manual attenuator to +10 dBm and adjust the VERNIER control to obtain an indication of +3 dB on the meter.
(3) Select EXT on the FM control switches.
(4) Select FM on the meter function switches.
(5) Select 100 kHz on the PEAK DEVIATION switches.
163. (1) Check that the 9084 meter indicates between 9.9 and 10.1.
(2) Check that the modulation meter indicates a peak deviation of between 95 kHz and 105 kHz.
(3) Check that the total harmonic distortion (THD) is less than 3%.
(4) Select INT on the FM control switches, and adjust the MODULATION LEVEL control to obtain an indication of 10 on the 9084 meter.
(5) Check that the modulation meter indicates a peak deviation between 95 kHz and 105 kHz.
(6) Select EXT on the FM control switches. Tune to each of the carrier frequencies given in Table 34 in turn, select the appropriate peak deviation on the 9084 PEAK DEVIATION switches, and check that the modulation meter indication is within the tolerance given. Check that the THD is less than 3% throughout.
(7) Set the POWER switch to OFF and disconnect the test equipment.

TABLE 34

FM Deviation Test

Band	Carrier Frequency	9084 Peak Dev. Range	Modulation Meter Indication Limits
7	104.0 MHz	300 kHz 100 kHz 30 kHz 10 kHz 3 kHz	285 kHz to 315 kHz 95 kHz to 105 kHz 28.5 kHz to 31.5 kHz 9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
	62.9 MHz	300 kHz 3 kHz	285 kHz to 315 kHz 2.85 kHz to 3.15 kHz
6	52.0 MHz	100 kHz 30 kHz 10 kHz 3 kHz	95 kHz to 105 kHz 28.5 kHz to 31.5 kHz 9.5 kHz to 10.5 kHz 28.5 kHz to 3.15 kHz
	31.4 MHz	100 kHz 3 kHz	95 kHz to 105 kHz 2.85 kHz to 3.15 kHz
5	26.0 MHz	100 kHz 30 kHz 10 kHz 3 kHz	95 kHz to 105 kHz 28.5 kHz to 3.15 kHz 9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
	15.749999 MHz	100 kHz 3 kHz	95 kHz to 105 kHz 2.85 kHz to 3.15 kHz
4	10.40 MHz	30 kHz 10 kHz 3 kHz	28.5 kHz to 31.5 kHz 9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
	6.29 MHz	30 kHz 3 kHz	28.5 kHz to 31.5 kHz 2.85 kHz to 3.15 kHz
3	5.20 MHz	10 kHz 3 kHz	9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
	3.15 MHz	10 kHz 3 kHz	9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
2	2.60 MHz	10 kHz 3 kHz	9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
	1.57 MHz	10 kHz 3 kHz	9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
1	1.40 MHz	10 kHz 3 kHz	9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz
	0.15 MHz	10 kHz 3 kHz	9.5 kHz to 10.5 kHz 2.85 kHz to 3.15 kHz

Internal Standard Output Test

164. Test equipment required:

<u>Item</u>	<u>Table 18 Item No.</u>
Power meter	10

165. Connect the power meter to the 9084 INTERNAL STANDARD OUTPUT socket.
166. (1) Set the POWER switch to ON.
- (2) With the INT/EXT switch set to INT check that the power meter indication is between -7 dBm and -3.5 dBm.
- (3) Set the POWER switch to OFF and disconnect the test equipment.

DISMANTLING AND REASSEMBLY

WARNING: DANGEROUS AC VOLTAGES ARE EXPOSED WHEN THE EQUIPMENT COVERS ARE REMOVED AND THE AC SUPPLY IS CONNECTED. THE EQUIPMENT MUST BE DISCONNECTED FROM THE SUPPLY WHILE DISMANTLING AND REASSEMBLY ARE CARRIED OUT. CARE MUST BE EXERCISED WHILE TESTING THE EQUIPMENT WITH THE COVERS REMOVED.

Dismantling of RF Amplifier Assembly 19-0897

167. WARNING: TOXIC HAZARD.
THE TRANSISTORS ON THE HEAT SINK ARE MOUNTED ON BERYLLIUM OXIDE WASHERS. IF DAMAGED IN ANY WAY THESE CAN PRESENT A TOXIC HAZARD. FOLLOW THE INSTRUCTIONS GIVEN ON THE WARNING PAGE AT THE FRONT OF THIS MANUAL.

Removal of Covers

168. (1) Set the POWER switch to OFF. Switch off the AC supply and disconnect the power supply lead from the rear panel power input plug.
- (2) Remove the six screws from each cover to be removed.
- (3) Remove the two blind grommets from the rear end of each side panel. Slacken, by about two turns, the screws revealed.
- (4) Ease back the rear panel by the maximum amount available (about 5 mm). The covers to be removed can now be lifted at the rear edge, and drawn out towards the rear of the instrument.
169. The covers are replaced in the reverse manner. Take care not to displace or damage the RF gasket material, and ensure that the rear panel is butted tightly up to the side frames before tightening the securing screws.

Removal of Rear Panel and Power Supply

170. (1) Remove the upper and lower covers as instructed in paragraph 168.
- (2) Disconnect SK16, between the power supply and the motherboard, and the SK29/PL29 in line connector between the power supply plug and the POWER switch.
- (3) Disconnect coaxial sockets SK48, SK49 and SK78 from the underside of the motherboard.
- (4) Undo the screws securing the DATA BUS socket to the rear panel and pass the socket through the aperture to the inside of the equipment.
- (5) Completely remove the four screws securing the rear panel to the side frames. This allows the rear panel and power supply to be removed as an assembly.
- (6) Remove the four screws at the corners of the power supply. The power supply and rear panel can now be separated to the extent of the fan wiring. This is sufficient to permit repair of the power supply.
171. To reassemble the equipment follow the reverse procedure. Before reconnecting SK16 after repairs have been carried out, check the open circuit voltages at this connector to ensure the supply lines are connected to the correct pins. Check the operation of the cooling fan.

Removal of Front Panel

172. (1) Remove the upper and lower covers as instructed in paragraph 168.
- (2) Remove the screws securing the rear panel. Remove the rear panel to the extent permitted by the wiring and slide out the side trim panels. Replace the rear panel.
- (3) Remove the screws securing the DATA BUS socket and pass the socket through the aperture to the inside of the equipment.
- (4) Disconnect the SK29/PL29 in line connector between the power supply plug and the POWER switch.
- (5) Release the three cable cleats holding the POWER switch cable and coaxial cables to the motherboard.
- (6) Remove the cap from the manual attenuator knob. Slacken the nut revealed and remove the knob and skirt.
- (7) Disconnect coaxial sockets SK71, SK72, SK76, SK79, SK80 and SK81 from the motherboard.

- (8) Remove the nut securing the RF output socket and pass the socket through the front panel aperture. Note the positions of the washers to ensure correct replacement.

- (9) Remove the four screws securing the front panel to the side frames. Pull the front panel forward, and disconnect SK14 and SK15.

To reassemble the equipment follow the reverse procedure. Align the manual attenuator knob to read +10dBm with the attenuator in the fully clockwise position. Ensure that the front panel is butted tightly to the side frames before tightening the securing screws.

Access to Display Assembly 19-0895

173. Access is gained to the display assembly by removing the front panel, as instructed in paragraph 172. The assembly mounting screws can then be removed and the assembly pulled forward to allow access to the rear face.

Removal of Assemblies 19-0911 and 19-0909

174. (1) Remove the front panel as instructed in paragraph 172.
- (2) Remove the five screws securing assembly 19-0911 and lift it away from the front panel. If complete removal is required disconnect SK19 from assembly 19-0909.
- (3) Remove the screws and five screw pillars securing assembly 19-0909. The assembly can now be lifted from the front panel. Take care not to displace any of the LED indicators while the assembly is clear of the front panel.

175. To reassemble the equipment follow the reverse procedure. If the LED indicators are correctly positioned assembly 19-0909 will drop into place. Do not force it into position, as this may bend the leads of the LED indicators and result in short circuits. If an indicator has to be replaced it should be soldered into position with assembly 19-0909 mounted on the front panel, so that the indicator is held in position by the front panel aperture.

PART 3

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PARTS LISTS

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CIRCUIT DIAGRAMS

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AND

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COMPONENT LAYOUTS

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ORDERING OF SPARE PARTS

To be assured of satisfactory service when ordering replacement parts, the customer is requested to include the following information:

- (a) Instrument type and serial number.
- (b) The type reference of the assembly in which the particular item is located (for example, '19-0834').
- (c) The Racal-Dana part number and circuit reference of each item being ordered.

It should be noted that a minimum charge of £10 sterling is applicable to all UK orders.

PARTS LIST

REFERENCE SOURCE ASSEMBLY, 19-0892

Fig 3

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R2	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R3	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R4	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R5	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R6	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R7	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R8	560	Carbon Film	$\frac{1}{4}$	5	20-2561
R9	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R10	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R11	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R12	6.8k	Carbon Film	$\frac{1}{4}$	5	20-2682
R13	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R14	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R15	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R16	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R17	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R18	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R19	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R20	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R21	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R22	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R23	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R24	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R25	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R26	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R27	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R28	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R29	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R30	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R31	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R32	1k	Variable, 25 turn			20-7037
R33	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R34	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R35	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R37	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R38	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R39	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R40	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R41	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R42	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R43	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R44	27k	Carbon Film	$\frac{1}{4}$	5	20-2273
R45	330	Metal Oxide	$\frac{1}{4}$	5	20-3331
R46	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R47	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182

Capacitors

	<u>F</u>		<u>V</u>		
C1	100n	Ceramic	12	+80-20	21-1616
C2	100n	Ceramic	12	+80-20	21-1616
C3	100n	Ceramic	12	+80-20	21-1616
C4	100n	Ceramic	12	+80-20	21-1616
C5	100n	Ceramic	12	+80-20	21-1616
C6	100n	Ceramic	12	+80-20	21-1616
C7	100n	Ceramic	12	+80-20	21-1616
C8	47 μ	Tantalum	6.3	20	21-1038
C9	100n	Ceramic	12	+80-20	21-1616
C10	1n	Ceramic	500	20	21-1532
C11	4.7 μ	Tantalum	35	20	21-1006
C12	100n	Ceramic	12	+80-20	21-1616
C13	100n	Ceramic	12	+80-20	21-1616
C14	100n	Ceramic	12	+80-20	21-1616
C15	4.7 μ	Tantalum	35	20	21-1006
C16	4.7 μ	Tantalum	35	20	21-1006
C17	100n	Ceramic	12	+80-20	21-1616
C18	330p	Ceramic	63	2	21-1698
C19	330p	Ceramic	63	2	21-1698
C20	100p	Ceramic	500	10	21-1520

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C21	330p	Ceramic	63	2	21-1698
C22	10n	Ceramic	25	+80-20	21-1545
C23	10n	Ceramic	25	+80-20	21-1545
C24	100n	Ceramic	12	+80-20	21-1616
C25	100n	Ceramic	12	+80-20	21-1616
C26	4.7μ	Tantalum	35	20	21-1006
C27	1n	Ceramic	500	20	21-1532
C28	220p	Ceramic	63	2	21-1696
C29	100n	Ceramic	12	+80-20	21-1616
C30	10n	Ceramic	25	+80-20	21-1545
C31	100n	Ceramic	12	+80-20	21-1616
C32	10n	Ceramic	25	+80-20	21-1545
C33	150p	Ceramic	63	2	21-1694
C34	10n	Ceramic	25	+80-20	21-1545
C35	220p	Ceramic	63	2	21-1696
C36	4.7μ	Tantalum	35	20	21-1006
C37	12p	Ceramic	63	2	21-1681
C38	10p	Ceramic	63	0.25p	21-1680
C39	100n	Ceramic	12	+80-20	21-1616
C40	4.7μ	Tantalum	35	20	21-1006
C41		Not Used			
C42	100n	Polycarbonate	100	20	21-5501
C43	1μ	Polycarbonate	100	20	21-5507
C44	10n	Ceramic	25	+80-20	21-1545
C45	10n	Ceramic	25	+80-20	21-1545

Inductors

H

L1		Coil to Racal-Dana Specification			17-3166
L2		Coil to Racal-Dana Specification			17-3166
L3		Coil to Racal-Dana Specification			17-3166
L4		Coil to Racal-Dana Specification			17-3166
L5		Coil to Racal-Dana Specification			17-3166
L6		Coil to Racal-Dana Specification			17-3166
L7		Coil to Racal-Dana Specification			17-3166
L8		Coil to Racal-Dana Specification			17-3166
L9	6.8μ	Choke, sub-miniature		10	23-7013
L10	10μ	Choke. sub-miniature		10	23-7014

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Transformer

T1		Transformer to Racal-Dana specification			17-3218
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Diodes

D1		Silicon (1N4149)			22-1029
D2		Silicon (1N4149)			22-1029
D3		Varactor (MV1642)			22-1042

Transistors

Q1		2N2369			22-6017
Q2		2N2369			22-6017
Q3		BC107			22-6068
Q4		2N2369			22-6017
Q5		2N3904			22-6007
Q6		ZTX450			22-6112
Q7		2N2369			22-6017
Q8		W300D			22-6102
Q9		W300A			22-6101
Q10		2N3906			22-6008
Q11		2N3904			22-6007
Q12		ZTX313L			22-6079
Q13		ZTX450			22-6112

Integrated Circuits

IC1		74LS00			22-4531
IC2		74LS00			22-4531
IC3		74LS90			22-4536
IC4		74LS90			22-4536
IC5		74LS00			22-4531

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
IC6		4518			22-4751
IC7		4017			22-4748
IC8		74LS00			22-4531
IC9		74LS74			22-4534
IC10		74LS00			22-4531
<u>Crystal</u>					
XL1	10MHz	Crystal			17-2114

PARTS LIST

1MHz COMB LOOP OSCILLATOR ASSEMBLY 19-0902

Fig 5

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R2	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R3	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R4	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R5	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R6	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R7	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R8	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R9	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R10	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R11	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R12	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R13	12k	Carbon Film	$\frac{1}{4}$	5	20-2123
R14	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R15	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R16	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R17	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R18	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R19	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R20	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R21	100	Carbon Film	0.1	5	20-1514
R22	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R23	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R24	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R25	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R26	100	Carbon Film	0.1	5	20-1514
R27	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R28	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R29	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R30	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R31	100	Carbon Film	0.1	5	20-1514
R32	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R33	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R34	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R35	22	Carbon Film	$\frac{1}{4}$	5	20-2220

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R37	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R38	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R39	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R40	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R41	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R42	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R43	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R44	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R45	5.1k	Carbon Film	$\frac{1}{4}$	5	20-2512
R46	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R47	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R48	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R49	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R50	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R51	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R52	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R53	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R54	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R55	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R56	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R57	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R58	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R59	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R60	82	Carbon Film	$\frac{1}{4}$	5	20-2820
R61	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R62	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R63	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R64	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R65	56	Carbon Film	$\frac{1}{4}$	5	20-2560

Capacitors

	<u>F</u>		<u>V</u>		
C1	100n	Ceramic	12	+80-20	21-1616
C2	47μ	Tantalum	16	20	21-1045
C3	10n	Ceramic	25	+80-20	21-1545
C4	47μ	Tantalum	16	20	21-1045
C5	100n	Ceramic	12	+80-20	21-1616

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C6	47μ	Tantalum	16	20	21-1045
C7	10n	Ceramic	25	+80-20	21-1545
C8	10n	Ceramic	500	20	21-1544
C9	10n	Ceramic	25	+80-20	21-1545
C10	10n	Ceramic	25	+80-20	21-1545
C11	8.25n	Silver Mica	200	1	21-2987
C12	10n	Ceramic	25	+80-20	21-1545
C13	10n	Ceramic	25	+80-20	21-1545
C14	10n	Ceramic	25	+80-20	21-1545
C15	10n	Ceramic	25	+80-20	21-1545
C16	10n	Ceramic	25	+80-20	21-1545
C17	10n	Ceramic	25	+80-20	21-1545
C18	8.25n	Silver Mica	200	1	21-2987
C19	1n	Ceramic	500	20	21-1532
C20	47n	Ceramic	10	+80-20	21-1548
C21	10n	Ceramic	25	+80-20	21-1545
C22	10n	Ceramic	25	+80-20	21-1545
C23	10n	Ceramic	25	+80-20	21-1545
C24	27p	Ceramic	63	2	21-1685
C25	33p	Ceramic	63	2	21-1686
C26	1.8p	Ceramic	63	0.25p	21-1671
C27	33p	Ceramic	63	2	21-1686
C28	27p	Ceramic	63	2	21-1685
C29	10n	Ceramic	25	+80-20	21-1545
C30	10n	Ceramic	25	+80-20	21-1545
C31	47n	Ceramic	10	+80-20	21-1548
C32	15p	Ceramic	500	10	21-1510
C33	47n	Ceramic	10	+80-20	21-1548
C34	10n	Ceramic	25	+80-20	21-1545
C35	10n	Ceramic	25	+80-20	21-1545
C36	10n	Ceramic	25	+80-20	21-1545
C37	10n	Ceramic	25	+80-20	21-1545
C38	10n	Ceramic	25	+80-20	21-1545
C39	10n	Ceramic	25	+80-20	21-1545
C40	10n	Ceramic	25	+80-20	21-1545
C41	10n	Ceramic	25	+80-20	21-1545
C42	10n	Ceramic	25	+80-20	21-1545
C43	15p	Ceramic	500	10	21-1510
C44	10n	Ceramic	25	+80-20	21-1545
C45	10n	Ceramic	25	+80-20	21-1545
C46	3.3n	Polystyrene	30	5	21-3563
C47	1.5μ	Tantalum	35	20	21-1029
C48	10p	Ceramic	63	0.25p	21-1680

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Inductors

	<u>H</u>			
L1	10μ	Choke, sub-miniature	10	23-7014
L2	10μ	Choke, sub-miniature	10	23-7014
L3		Coil		23-7131
L4	10μ	Choke, sub-miniature	10	23-7014
L5		Coil		23-7133
L6	100μ	Choke	10	23-7056
L7		Coil		23-7135
L8	100μ	Choke	10	23-7056
L9		Not Used		
L10	220n	Choke, sub-miniature	10	23-7004
L11	4.7μ	Choke, sub-miniature	10	23-7012
L12	1.0μ	Choke, sub-miniature	10	23-7008
L13	4.7μ	Choke, sub-miniature	10	23-7012

Diodes

D1	Voltage Regulator (BZY88C5V1)	5	22-1808
D2	Silicon (1N 4149)		22-1029
D3	Silicon (1N 4149)		22-1029
D4	Silicon (1N 4149)		22-1029
D5	Silicon (1N 4149)		22-1029
D6	Varactor (ZC804)		22-1071
D7	Varactor (ZC804)		22-1071
D8	Varactor (ZC806)		22-1060
D9	Varactor (ZC806)		22-1060
D10	Varactor (ZC806)		22-1060
D11	Varactor (ZC806)		22-1060
D12	Varactor (ZC804)		22-1071
D13	Varactor (ZC804)		22-1071

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Transistors

Q1		2N3906			22-6008
Q2		2N3906			22-6008
Q3		2N3906			22-6008
Q4		2N3906			22-6008
Q5		2N3906			22-6008
Q6		BC109			22-6041
Q7		BC109			22-6041
Q8		FT0601			22-6106
Q9		W300D			22-6102
Q10		FT0601			22-6106
Q11		W300D			22-6102
Q12		FT0601			22-6106
Q13		W300D			22-6102
Q14		2N2369			22-6017
Q15		2N2369			22-6017
Q16		2N2369			22-6017
Q17		2N2369			22-6017
Q18		2N2369			22-6017
Q19		2N2369			22-6017
Q20		2N2369			22-6017

Integrated Circuits

IC1		10135			22-4544
IC2		74LS145			22-4556

PARTS LIST

1 MHz COMB LOOP ASSEMBLY 19-0904

Fig 7

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	68	Carbon Film	$\frac{1}{4}$	5	20-2680
R2	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R3	15x470	DIL Array		2	20-5511
R4	560	Carbon Film	$\frac{1}{4}$	5	20-2561
R5	560	Carbon Film	$\frac{1}{4}$	5	20-2561
R6	560	Carbon Film	$\frac{1}{4}$	5	20-2561
R7	8x470	DIL Array		2	20-5509
R8	7x1k	DIL Array		2	20-5508
R9	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R10	3.3k	Carbon Film	$\frac{1}{4}$	5	20-2332
R11	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R12	68	Carbon Film	$\frac{1}{4}$	5	20-2680
R13	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R14	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R15	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R16	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R17	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R18	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R19	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R20	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R21	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R22	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R23	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R24	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R25	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R26	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R27	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R28	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R29	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R30	820	Carbon Film	$\frac{1}{4}$	5	20-2821
R31	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R32	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R33	330	Carbon Film	0.1	5	20-1517
R34	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R35	100	Carbon Film	$\frac{1}{4}$	5	20-2101

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	56	Carbon Film	0.1	5	20-1546
R37	47	Carbon Film	0.1	5	20-1531
R38	56	Carbon Film	0.1	5	20-1546
R39	47	Carbon Film	0.1	5	20-1531
R40	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R41	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R42	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R43	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R44	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R45	4.7k	Carbon Film	0.1	5	20-1542
R46	1.0k	Carbon Film	0.1	5	20-1521
R47	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R48	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R49	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R50	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R51	10k	Carbon Film	0.1	5	20-1538
R52	10k	Carbon Film	0.1	5	20-1538
R53	10k	Carbon Film	0.1	5	20-1538
R54	10k	Carbon Film	0.1	5	20-1538
R55	560k	Carbon Film	0.1	5	20-1536
R56	10k	Carbon Film	0.1	5	20-1538

Capacitors

	<u>F</u>		<u>V</u>		
C1	1n	Ceramic	500	20	21-1532
C2	10n	Ceramic	25	+80-20	21-1545
C3	1 μ	Tantalum	35	20	21-1041
C4	1 μ	Tantalum	35	20	21-1041
C5	10n	Ceramic	25	+80-20	21-1545
C6	10n	Ceramic	25	+80-20	21-1545
C7	10n	Ceramic	25	+80-20	21-1545
C8	100n	Ceramic	50	20	21-1708
C9	4.7 μ	Tantalum	35	20	21-1006
C10	1 μ	Tantalum	35	20	21-1041

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C11	2.2n	Ceramic	500	25	21-1536
C12	10n	Ceramic	25	+80-20	21-1545
C13	470p	Ceramic	500	10	21-1528
C14	1n	Ceramic	500	20	21-1532
C15	270p	Ceramic	500	10	21-1525
C16	100n	Ceramic	12	+80-20	21-1616
C17	100n	Ceramic	12	+80-20	21-1616
C18	1n	Ceramic	500	20	21-1532
C19	3.3n	Ceramic	500	25	21-1538
C20	1μ	Tantalum	35	20	21-1041
C21	10n	Ceramic	25	+80-20	21-1545
C22	1.5μ	Tantalum	35	20	21-1029
C23	10n	Ceramic	25	+80-20	21-1545
C24	1.5μ	Tantalum	32	20	21-1029

Inductors

	<u>H</u>				
L1	10μ	Choke, sub-miniature		10	23-7014

Diodes

D1	Silicon (1N4149)				22-1029
D2	Voltage Regulator (BZY88C4V7)				22-1807

Transistors

Q1	BFX48				22-6110
Q2	BFX48				22-6110
Q3	BFX48				22-6110
Q4	ZTX450				22-6112
Q5	BFX48				22-6110

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Q6		2N2369			22-6017
Q7		BFY 90			22-6039
Q8		BFX 48			22-6110
Q9		BFX 48			22-6110
Q10		2N2369			22-6017
Q11		2N2369			22-6017
Q12		2N2369			22-6017
Q13		2N2369			22-6017
Q14		2N2369			22-6017
Q15		J176			22-6140

Integrated Circuits

IC1	10131				22-4507
IC2	1662				22-4033
IC3	10109				22-4573
IC4	10135				22-4544
IC5	10109				22-4573
IC6	10131				22-4507
IC7	10135				22-4544
IC8	10113				22-4574
IC9	74LS90				22-4536
IC10	4049				22-4719
IC11	10102				22-4514
IC12	10102				22-4514
IC13	74LS90				22-4536
IC14	74S74				22-4516
IC15	74LS00				22-4531
IC16	555				22-4206

PARTS LIST

1 kHz COMB LOOP ASSEMBLY 19-0908

Fig 9

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Resistors

	<u>Ω</u>		<u>W</u>		
R1	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R2	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R3	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R4	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R5	10k	Variable			20-7055
R6	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R7	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R8	820k	Carbon Film	$\frac{1}{4}$	5	20-2824
R9	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R10	56k	Carbon Film	$\frac{1}{4}$	5	20-2563
R11	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R12	33k	Carbon Film	$\frac{1}{4}$	5	20-2333

Capacitors

	<u>F</u>		<u>V</u>		
C1	10n	Ceramic	25	+80-20	21-1545
C2	10n	Ceramic	25	+80-20	21-1545
C3	10n	Ceramic	25	+80-20	21-1545
C4	10n	Ceramic	25	+80-20	21-1545
C5	100n	Ceramic	12	+80-20	21-1616
C6	47 μ	Tantalum	6.3	20	21-1038
C7	10n	Ceramic	25	+80-20	21-1545
C8	1n	Ceramic	500	20	21-1532
C9	47 μ	Tantalum	6.3	20	21-1038
C10	10n	Ceramic	25	+80-20	21-1545
C11	1n	Ceramic	500	20	21-1532
C12	47 μ	Tantalum	6.3	20	21-1038
C13	10n	Ceramic	25	+80-20	21-1545
C14	10n	Ceramic	25	+80-20	21-1545
C15	1.8p-10p	Trimmer			21-6038

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C16	10n	Ceramic	25	+80-20	21-1545
C17	10n	Ceramic	25	+80-20	21-1545
C18	10n	Ceramic	25	+80-20	21-1545
C19	1μ	Polycarbonate	100	20	21-5507
C20	100n	Ceramic	12	+80-20	21-1616
C21	47n	Ceramic	12	+80-20	21-1548

Inductors

H

L1	Coil to Racal-Dana specification	17-3166
L2	Coil to Racal-Dana specification	17-3166
L3	Coil to Racal-Dana specification	17-3166

Diodes

D1	Silicon (1N4149)	22-1029
D2	Silicon (1N4149)	22-1029

Transistors

Q1	2N2369	22-6017
Q2	2N2369	22-6017
Q3	2N2369	22-6017

Integrated Circuits

IC1	74LS192	22-4576
IC2	74LS192	22-4576
IC3	74LS192	22-4576
IC4	74LS192	22-4576
IC5	74S260	22-4577

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
IC6		74S74			22-4516
IC7		74S10			22-4124
IC8		74S260			22-4577
IC9		4046			22-4703
IC10		74LS629			22-4688
<u>Miscellaneous</u>					
SK90		Socket, 16-way DIL			23-3259

PARTS LIST

TRANSFER LOOP ASSEMBLY 19-0893

Fig 11

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R2	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R3	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R4	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R5	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R6	6.8k	Carbon Film	$\frac{1}{4}$	5	20-2682
R7	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R8	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R9	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R10	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R11	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R12	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R13	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R14	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R15	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R16	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R17	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R18	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R19	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R20	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R21	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R22	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R23	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R24	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R25	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R26	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R27	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R28	27k	Carbon Film	$\frac{1}{4}$	5	20-2273
R29	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R30	82	Carbon Film	$\frac{1}{4}$	5	20-2820
R31	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R32	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R33	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R34	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R35	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R37	39k	Carbon Film	$\frac{1}{4}$	5	20-2393
R38	39k	Carbon Film	$\frac{1}{4}$	5	20-2393
R39	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R40	12k	Carbon Film	$\frac{1}{4}$	5	20-2123
R41	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R42	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R43	1.5k	Carbon Film	$\frac{1}{4}$	5	20-2152
R44	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R45	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R46	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R47	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R48	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R49	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R50	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R51	820	Carbon Film	$\frac{1}{4}$	5	20-2821
R52	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R53	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R54	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R55	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R56	330k	Carbon Film	$\frac{1}{4}$	5	20-2334
R57	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R58	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R59	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R60	120k	Carbon Film	$\frac{1}{4}$	5	20-2124
R61	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R62	680k	Carbon Film	$\frac{1}{4}$	5	20-2684
R63	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R64	82k	Carbon Film	$\frac{1}{4}$	5	20-2823
R65	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R66	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R67	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R68	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R69	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R70	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R71	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R72	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R73	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R74	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R75	270	Carbon Film	$\frac{1}{4}$	5	20-2271

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R76	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R77	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R78	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R79	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R80	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R81	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R82	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R83	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R84	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R85	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R86	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R87	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R88	18	Carbon Film	$\frac{1}{4}$	5	20-2180
R89	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R90	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R91	33	Carbon Film	$\frac{1}{4}$	5	20-2330
R92	390	Carbon Film	$\frac{1}{4}$	5	20-2391
R93	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R94	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R95	10M	Carbon Film	$\frac{1}{4}$	5	20-2106
R96	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R97	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R98	560	Carbon Film	0.1	5	20-1536

Capacitors

	<u>F</u>		<u>V</u>		
C1	10n	Ceramic	25	+80-20	21-1545
C2	1n	Ceramic	500	20	21-1532
C3	47 μ	Tantalum	6.3	20	21-1038
C4	100n	Ceramic	12	+80-20	21-1616
C5	10n	Ceramic	25	+80-20	21-1545
C6	1.5n	Ceramic	500	20	21-1534
C7	100n	Ceramic	12	+80-20	21-1616
C8	2.2n	Ceramic	500	25	21-1536
C9	2.2n	Ceramic	500	25	21-1536
C10	1.5n	Ceramic	500	20	21-1534
C11	47 μ	Tantalum	16	20	21-1045
C12	47n	Ceramic	10	+80-20	21-1548
C13	47 μ	Tantalum	16	20	21-1045
C14	100n	Ceramic	50	20	21-1708
C15	10n	Ceramic	25	+80-20	21-1545

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C16	100n	Ceramic	12	+80-20	21-1616
C17	22n	Ceramic	25	+80-20	21-1546
C18	470p	Ceramic	500	10	21-1528
C19	68p	Ceramic	500	10	21-1518
C20	1.2n	Ceramic	500	20	21-1533
C21	470p	Ceramic	500	10	21-1528
C22	1.2n	Ceramic	500	20	21-1533
C23	68p	Ceramic	500	10	21-1518
C24	15μ	Tantalum	20	20	21-1003
C25	100n	Ceramic	12	+80-20	21-1616
C26	100n	Ceramic	12	+80-20	21-1616
C27	100n	Ceramic	12	+80-20	21-1616
C28	100n	Ceramic	12	+80-20	21-1616
C29	100p	Ceramic	500	10	21-1520
C30	4.7μ	Tantalum	35	20	21-1006
C31	100n	Ceramic	12	+80-20	21-1616
C32	4.7μ	Tantalum	35	20	21-1006
C33	100n	Ceramic	12	+80-20	21-1616
C34	10μ	Polyester	63	10	21-4537
C35	1μ	Polyester	100	20	21-4512
C36	100n	Ceramic	50	20	21-1708
C37	4.7μ	Tantalum	35	20	21-1006
C38	47μ	Tantalum	6.3	20	21-1038
C39	100n	Ceramic	50	20	21-1708
C40	10n	Ceramic	25	+80-20	21-1545
C41	4.7μ	Tantalum	35	20	21-1006
C42	39p	Silver Mica	125	5	21-2636
C43	14p-115p	Trimmer			21-6033
C44	47μ	Tantalum	6.3	20	21-1038
C45	100n	Ceramic	12	+80-20	21-1616
C46	100n	Ceramic	12	+80-20	21-1616
C47	100n	Ceramic	12	+80-20	21-1616
C48	100n	Ceramic	12	+80-20	21-1616
C49	100n	Ceramic	12	+80-20	21-1616
C50	1μ	Tantalum	35	20	21-1041
C51	1μ	Tantalum	35	20	21-1041
C52	47μ	Tantalum	16	20	21-1045
C53	10n	Ceramic	25	+80-20	21-1545
C54	10n	Ceramic	25	+80-20	21-1545
C55	10n	Ceramic	25	+80-20	21-1545

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C56	10n	Ceramic	25	+80-20	21-1545
C57	10n	Ceramic	25	+80-20	21-1545
C58	1.5μ	Polyester	63	10	21-4570
C59	47μ	Tantalum	16	20	21-1045
C60	100n	Ceramic	12	+80-20	21-1616
C61	4.7μ	Tantalum	35	20	21-1006
C62	10n	Ceramic	25	+80-20	21-1545
C63	10n	Ceramic	25	+80-20	21-1545
C64	10n	Ceramic	25	+80-20	21-1545
C65	100n	Ceramic	12	+80-20	21-1616
C66	10n	Ceramic	25	+80-20	21-1545
C67	680p	Ceramic	500	10	21-1530
C68	100n	Ceramic	12	+80-20	21-1616
C69	10n	Ceramic	25	+80-20	21-1545
C70	680p	Ceramic	500	10	21-1530
C71	390p	Ceramic	500	10	21-1527

Inductors

H

L1		Coil to Racal-Dana specification			17-3166
L2	33μ	Choke, sub-miniature		10	23-7017
L3	47μ	Choke, sub-miniature		10	23-7018
L4	33μ	Choke, sub-miniature		10	23-7017
L5	1m	Choke, sub-miniature		10	23-7086
L6		Coil to Racal-Dana specification			17-3166
L7	1m	Choke, sub-miniature		10	23-7086
L8		Coil to Racal-Dana specification			17-3219
L9	470n	Choke, sub-miniature		10	23-7006
L10	470n	Choke, sub-miniature		10	23-7006

Diodes

D1		Silicon (1N4149)			22-1029
D2		Germanium (AAZ15)			22-0007
D3		Germanium (AAZ15)			22-0007
D4		Silicon (1N4149)			22-1029
D5		Silicon (1N4149)			22-1029
D6		Voltage Regulator (BZY88C5V6)			22-1809
D7		Silicon (1N4149)			22-1029
D8		Silicon (1N4149)			22-1029
D9		Silicon (1N4149)			22-1029
D10		Silicon (1N4149)			22-1029

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
D11		Silicon (1N4149)			22-1029
D12		Silicon (1N4149)			22-1029
D13		Silicon (1N4149)			22-1029
D14		Silicon (1N4149)			22-1029
D15		Varactor (ZC806)			22-1060
D16		Varactor (ZC806)			22-1060

Transistors

Q1	2N2369	22-6017
Q2	2N3904	22-6007
Q3	2N3906	22-6008
Q4	2N3904	22-6007
Q5	2N3906	22-6008
Q6	E109	22-6124
Q7	2N3904	22-6007
Q8	2N3906	22-6008
Q9	2N2369	22-6017
Q10	2N3906	22-6008
Q11	2N3906	22-6124
Q12	E109	22-6017
Q13	2N2369	22-6041
Q14	BC109	22-6102
Q15	W300D	22-6102
Q16	W300D	22-6017
Q17	2N2369	22-6017
Q18	2N2369	22-6017
Q19	2N2369	22-6017
Q20	2N2369	22-6017
Q21	2N2369	22-6017

Integrated Circuits

IC1	1496	22-4091
IC2	TL082	22-4240
IC3	TL082	22-4240
IC4	4046	22-4749
IC5	4518	22-4751

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
IC6		4017			22-4748
IC7		74LS74			22-4534
IC8		74LS00			22-4531
IC9		14538			22-4759
IC10		74S00			22-4505
IC11		74LS192			22-4576
IC12		74S260			22-4577
IC13		4017			22-4748
IC14		74S260			22-4577
IC15		74LS192			22-4577
IC16		74LS192			22-4577
IC17		74LS192			22-4577
IC18		74S74			22-4516
IC19		74LS192			22-4576
IC20		74LS192			22-4576
IC21		4093			22-4750
<u>Relay</u>					
RLA		TO 5, 220Ω coil			23-7519

PARTS LIST

OUTPUT OSCILLATOR ASSEMBLY 19-0901 and 19-1069

Fig 13 and Fig 15

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>OSCILLATOR ASSEMBLY 19-0901</u>					
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R2	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R3	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R4	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R5	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R6	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R7	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R8	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R9	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R10	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R11	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R12	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R13	12k	Carbon Film	$\frac{1}{4}$	5	20-2123
R14	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R15	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R16	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R17	100	Carbon Film	0.1	5	20-1514
R18	39k	Carbon Film	$\frac{1}{4}$	5	20-2393
R19	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R20	68k	Carbon Film	$\frac{1}{4}$	5	20-2683
R21	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R22	100	Carbon Film	0.1	5	20-1514
R23	33k	Carbon Film	0.1	5	20-2333
R24	330	Carbon Film	0.1	5	20-2331
R25	150k	Carbon Film	0.1	5	20-2154
R26	120	Carbon Film	0.1	5	20-2121
R27	100	Carbon Film	0.1	5	20-1514
R28	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R29	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R30	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R31	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R32	100	Carbon Film	0.1	5	20-1514
R33	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R34	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R35	100	Carbon Film	$\frac{1}{4}$	5	20-2101

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R37	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R38	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R39	39	Carbon Film	$\frac{1}{4}$	5	20-2390
R40	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R41	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R42	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R43	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R44	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R45	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R46	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R47	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R48	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R49	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R50	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R51	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R52	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R53	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R54	560	Carbon Film	0.1	5	20-1536
R55	15k	Carbon Film	0.1	5	20-1555
R56	15k	Carbon Film	0.1	5	20-1555
R57	56k	Carbon Film	0.1	5	20-1574
R58	56k	Carbon Film	0.1	5	20-1574
R59	100	Carbon Film	0.1	5	20-1514
R60	12.1k	Metal Film		0.25	20-4919
R61	1k	Metal Film		0.5	20-4921
R62	22k	Carbon Film	0.1	5	20-1563
R63	1k	Carbon Film	0.1	5	20-1521

Capacitors

	<u>F</u>		<u>V</u>		
C1	100n	Ceramic	12	+80-20	21-1616
C2	47 μ	Tantalum	16	20	21-1045
C3	10n	Ceramic	25	+80-20	21-1545
C4	10n	Ceramic	25	+80-20	21-1545
C5	10n	Ceramic	25	+80-20	21-1545
C6	10n	Ceramic	25	+80-20	21-1545
C7	10n	Ceramic	25	+80-20	21-1545
C8	10n	Ceramic	25	+80-20	21-1545
C9	10n	Ceramic	25	+80-20	21-1545
C10	10n	Ceramic	25	+80-20	21-1545

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C11	10n	Ceramic	25	+80-20	21-1545
C12	10n	Ceramic	25	+80-20	21-1545
C13	10n	Ceramic	25	+80-20	21-1545
C14	10n	Ceramic	25	+80-20	21-1545
C15	10n	Ceramic	25	+80-20	21-1545
C16	47μ	Tantalum	16	20	21-1045
C17	10n	Ceramic	25	+80-20	21-1545
C18	47μ	Tantalum	16	20	21-1045
C19	10n	Ceramic	25	+80-20	21-1545
C20	10n	Ceramic	25	+80-20	21-1545
C21	10n	Ceramic	25	+80-20	21-1545
C22	15p	Ceramic	500	10	21-1510
C23	10n	Ceramic	25	+80-20	21-1545
C24	10n	Ceramic	25	+80-20	21-1545
C25	10n	Ceramic	25	+80-20	21-1545
C26	10n	Ceramic	25	+80-20	21-1545
C27	10n	Ceramic	25	+80-20	21-1545
C28	10n	Ceramic	25	+80-20	21-1545
C29	15p	Ceramic	500	10	21-1510
C30	10n	Ceramic	25	+80-20	21-1545
C31	10n	Ceramic	25	+80-20	21-1545
C32	10n	Ceramic	25	+80-20	21-1545
C33	1n	Polystyrene	30	2.5	21-3519
C34	1n	Polystyrene	30	2.5	21-3519
C35	10n	Ceramic	25	+80-20	21-1545
C36	120p	Ceramic	63	2	21-1693
C37	10n	Ceramic	25	+80-20	21-1545
C38	10n	Ceramic	25	+80-20	21-1545

Inductors

	<u>H</u>			
L1		Coil		23-7133
L2	10μ	Choke, sub-miniature	10	23-7014
L3		Coil		23-7132
L4	100μ	Choke	10	23-7056
L5		Coil		23-7134
L6	100μ	Choke	10	23-7056
L7		Coil		23-7134
L8	100μ	Choke	10	23-7056
L9	220n	Choke, sub-miniature	10	23-7004
L10	1μ	Choke, sub-miniature	10	23-7008

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
L11	220n	Choke, sub-miniature		10	23-7004
L12		Ferrite bead			17-3166
L13	10μ	Choke, sub-miniature		10	23-7014
L14	10μ	Choke, sub-miniature		10	23-7014

Diodes

D1	Voltage regulator (BZY88C5V1)	22-1808
D2	Varactor (ZC804)	22-1071
D3	Varactor (ZC804)	22-1071
D4	Varactor (ZC806)	22-1060
D5	Varactor (ZC806)	22-1060
D6	Varactor (ZC806)	22-1060
D7	Varactor (ZC806)	22-1060
D8	Varactor (ZC806)	22-1060
D9	Varactor (ZC806)	22-1060
D10	Varactor (ZC806)	22-1060
D11	Varactor (ZC806)	22-1058
D12	PIN (5082.3379)	22-1033
D13	Hot Carrier (5082.2811)	22-1033
D14	Hot Carrier (5082.2811)	22-1033

Transistors

Q1	ZTX109	22-6122
Q2	2N3906	22-6008
Q3	2N3906	22-6008
Q4	2N3906	22-6008
Q5	2N3906	22-6008
Q6	BC109	22-6041
Q7	FT0601	22-6106
Q8	W300D	22-6102
Q9	FT0601	22-6106
Q10	W300D	22-6102
Q11	FT0601	22-6106
Q12	W300D	22-6102
Q13	FT0601	22-6106
Q14	W300D	22-6102
Q15	BC109	22-6041
Q16	2N2369	22-6017
Q17	2N2369	22-6017
Q18	2N2369	22-6017
Q19	2N2369	22-6017

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Integrated Circuits

IC1		74LS145			22-4556
IC2		TL081			22-4229

ALC ASSEMBLY 19-1069

Resistors

	Ω		$\frac{W}{W}$		
R1	560	Carbon Film	0.1	5	20-1536
R2	15k	Carbon Film	0.1	5	20-1555
R3	56k	Carbon Film	0.1	5	20-1574
R4	15k	Carbon Film	0.1	5	20-1555
R5	100	Carbon Film	0.1	5	20-1514
R6	56k	Carbon Film	0.1	5	20-1574
R7	1k	Carbon Film	0.1	5	20-1521
R8	22k	Carbon Film	0.1	5	20-1563
R9	12.1k	Metal Film		$\frac{1}{4}$	20-4919
R10	1k	Metal Film		$\frac{1}{4}$	20-4921

Capacitors

	F		$\frac{V}{V}$		
C1	10n	Ceramic	25	+80-20	21-1545
C2	1n	Polystyrene	30	$2\frac{1}{2}$	21-3519
C3	1n	Polystyrene	30	$2\frac{1}{2}$	21-3519
C4	120p	Ceramic	63	3	21-1693
C5	10n	Ceramic	25	+80-20	21-1545
C6	10n	Ceramic	25	+80-20	21-1545
C7	10n	Ceramic	25	+80-20	21-1545

Inductors

	H				
L1	10 μ	Choke, sub-miniature		10	23-7014
L2	10 μ	Choke, sub-miniature		10	23-7014
L3	1 μ	Choke, sub-miniature		10	23-7008

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Diodes

D1		PIN (5082.3379)			22-1058
D2		Hot Carrier (5082.2811)			22-1033
D3		Hot Carrier (5082.2811)			22-1033

Integrated Circuits

IC1		TL081			22-4229
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PARTS LIST

OUTPUT LOOP ASSEMBLY 19-0894

Fig 17

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R2	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R3	560	Carbon Film	$\frac{1}{4}$	5	20-2561
R4	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R5	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R6	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R7	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R8	15	Carbon Film	$\frac{1}{4}$	5	20-2150
R9	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R10	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R11	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R12	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R13	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R14	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R15	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R16	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R17	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R18	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R19	1.5k	Carbon Film	$\frac{1}{4}$	5	20-2152
R20	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R21	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R22	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R23	39	Carbon Film	$\frac{1}{4}$	5	20-2390
R24	51	Carbon Film	$\frac{1}{4}$	5	20-2510
R25	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R26	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R27	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R28	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R29	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R30	56k	Carbon Film	$\frac{1}{4}$	5	20-2563
R31	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R32	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R33	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R34	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R35	330	Carbon Film	$\frac{1}{4}$	5	20-2331

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R37	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R38	33	Carbon Film	$\frac{1}{4}$	5	20-2330
R39	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R40	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R41	82k	Carbon Film	$\frac{1}{4}$	5	20-2823
R42	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R43		Not Used			
R44	10k	Variable			20-7004
R45	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R46	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R47	3.3k	Carbon Film	$\frac{1}{4}$	5	20-2332
R48	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R49	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R50	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R51	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R52	4.7k	Metal Oxide	$\frac{1}{4}$	1	20-4075
R53	1k	Carbon Film			20-2102
R54	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R55	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R56	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R57	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R58	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R59	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R60	10k	Carbon Film	$\frac{1}{4}$	5	20-2103

Capacitors

	<u>F</u>		<u>V</u>		
C1	10n	Ceramic	25	+80-20	21-1545
C2	10n	Ceramic	25	+80-20	21-1545
C3	22 μ	Tantalum	16	20	21-1039
C4	10n	Ceramic	25	+80-20	21-1545
C5	47 μ	Tantalum	16	20	21-1045
C6	10n	Ceramic	25	+80-20	21-1545
C7	10n	Ceramic	25	+80-20	21-1545
C8	47 μ	Tantalum	16	20	21-1045
C9	47 μ	Tantalum	16	20	21-1045
C10	10n	Ceramic	25	+80-20	21-1545

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C11	10n	Ceramic	25	+80-20	21-1545
C12	47μ	Tantalum	16	20	21-1045
C13	10n	Ceramic	25	+80-20	21-1545
C14	10n	Ceramic	25	+80-20	21-1545
C15	47μ	Tantalum	16	20	21-1045
C16	10n	Ceramic	25	+80-20	21-1545
C17	4.7μ	Tantalum	35	20	21-1006
C18	10n	Ceramic	25	+80-20	21-1545
C19	4.7μ	Tantalum	35	20	21-1006
C20	10n	Ceramic	25	+80-20	21-1545
C21	6.81n	Silver Mica	200	1	21-2976
C22	150n	Polycarbonate	100	20	21-5502
C23	4.7μ	Tantalum	35	20	21-1006
C24	10n	Ceramic	25	+80-20	21-1545
C25	100p	Ceramic	500	10	21-1520
C26	10n	Ceramic	25	+80-20	21-1545
C27	10n	Ceramic	25	+80-20	21-1545
C28	47μ	Tantalum	16	20	21-1045
C29	10n	Ceramic	25	+80-20	21-1545
C30	10n	Ceramic	25	+80-20	21-1545
C31	10n	Ceramic	25	+80-20	21-1545
C32	10n	Ceramic	25	+80-20	21-1545
C33	10n	Ceramic	25	+80-20	21-1545
C34	82p	Ceramic	63	2	21-1691
C35	10p	Ceramic	63	0.25p	21-1680
C36	82p	Ceramic	63	2	21-1691
C37	10n	Ceramic	25	+80-20	21-1545
C38	10p	Ceramic	500	10	21-1508
C39	10n	Ceramic	25	+80-20	21-1545
C40	47μ	Tantalum	16	20	21-1045
C41	10n	Ceramic	25	+80-20	21-1545
C42	100n	Polycarbonate	100	20	21-5501
C43	82p	Ceramic	500	10	21-1519
C44	220p	Ceramic	500	10	21-1524
C45	10n	Ceramic	25	+80-20	21-1545

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Inductors

	<u>H</u>				
L1	68μ	Choke		5	23-7079
L2		Coil to Racal-Dana specification			17-3166
L3		Coil to Racal-Dana specification			17-3166
L4		Coil to Racal-Dana specification			17-3166
L5		Coil to Racal-Dana specification			17-3166
L6	2.2μ	Choke		10	23-7066
L7		Coil to Racal-Dana specification			17-3166
L8	2.2μ	Choke		10	23-7066

Diodes

D1		Silicon (1N4149)			22-1029
D2		Silicon (1N4149)			22-1029
D3		Silicon (1N4149)			22-1029
D4		Silicon (1N4149)			22-1029
D5		Hot Carrier(5082.2811)			22-1033
D6		Hot Carrier(5082.2811)			22-1033
D7		Silicon (1N4149)			22-1029
D8		Hot Carrier(5082.2811)			22-1033
D9		Hot Carrier(5082.2811)			22-1033
D10		Silicon (1N4149)			22-1029

Transistors

Q1		2N2369			22-6017
Q2		2N2369			22-6017
Q3		2N2369			22-6017
Q4		2N5109			22-6088
Q5		2N5160			22-6089
Q6		2N5109			22-6088
Q7		BFX48			22-6110
Q8		BC109			22-6041
Q9		BC109			22-6041
Q10		BC109			22-6041

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Q11		BC109			22-6041
Q12		BC109			22-6041
Q13		BFX48			22-6110
Q14		BC109			22-6041
Q15		2N2369			22-6017
Q16		BC109			22-6041
Q17		2N4124			22-6009
Q18		2N4124			22-6009

Integrated Circuits

IC1		74S00			22-4505
IC2		74S74			22-4516
IC3		4011			22-4700
IC4		555			22-4206
IC5		TL081			22-4229

PARTS LIST

MIXER & BUFFER ASSEMBLY 19-0903

Fig 19

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	Ω		W		
R1	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R2	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R3	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R4	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R5	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R6	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R7	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R8	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R9	51	Carbon Film	$\frac{1}{4}$	5	20-2510
R10	68k	Carbon Film	$\frac{1}{4}$	5	20-2683
R11	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R12	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R13	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R14	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R15	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R16	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R17	270	Carbon Film	$\frac{1}{4}$	5	20-2271
R18	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R19	820	Carbon Film	$\frac{1}{4}$	5	20-2821
R20	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R21	27k	Carbon Film	$\frac{1}{4}$	5	20-2273
R22	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R23	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R24	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R25	5.6k	Carbon Film	$\frac{1}{4}$	5	20-2562
R26	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R27	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R28	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R29	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R30	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R31	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R32	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R33	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R34	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R35	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R37	51	Carbon Film	$\frac{1}{4}$	5	20-2510
R38	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R39	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R40	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R41	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R42	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R43	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R44	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R45	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R46	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R47	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R48	51	Carbon Film	$\frac{1}{4}$	5	20-2510
R49	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R50	51	Carbon Film	$\frac{1}{4}$	5	20-2510
R51	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R52	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R53	51	Carbon Film	$\frac{1}{4}$	5	20-2510
R54	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R55	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R56	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R57	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R58	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R59	1.5k	Carbon Film	$\frac{1}{4}$	5	20-2152
R60		Not Used			
R61	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R62	1.5k	Carbon Film	$\frac{1}{4}$	5	20-2152
R63	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R64	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R65		Not Used			
R66	15	Carbon Film	$\frac{1}{4}$	5	20-2150

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Capacitors

	F		V		
C1	10μ	Tantalum	25	20	21-1002
C2	10n	Ceramic	25	+80-20	21-1545
C3	10n	Ceramic	25	+80-20	21-1545
C4	10μ	Tantalum	25	20	21-1002
C5	100p	Ceramic	63	2	21-1692
C6	2.2n	Ceramic	500	20	21-1536
C7	10n	Ceramic	25	+80-20	21-1545
C8	10n	Ceramic	25	+80-20	21-1545
C9	10n	Ceramic	25	+80-20	21-1545
C10	10p	Ceramic	63	0.25p	21-1680
C11	1n	Ceramic	500	20	21-1532
C12	47p	Ceramic	63	2	21-1688
C13	1n	Ceramic	500	20	21-1532
C14	47p	Ceramic	63	2	21-1688
C15	47p	Ceramic	63	2	21-1688
C16	10p	Ceramic	63	0.25p	21-1680
C17	12p	Ceramic	63	2	21-1681
C18	6.8p	Ceramic	63	0.25p	21-1678
C19	120p	Ceramic	63	2	21-1693
C20	27p	Ceramic	63	2	21-1685
C21	39p	Ceramic	63	2	21-1687
C22	33p	Ceramic	63	2	21-1686
C23	18p	Ceramic	63	2	21-1683
C24	47p	Ceramic	63	2	21-1688
C25	33p	Ceramic	63	2	21-1686
C26	10p	Ceramic	63	0.25p	21-1680
C27	39p	Ceramic	63	2	21-1687
C28	1n	Ceramic	500	20	21-1532
C29	1n	Ceramic	500	20	21-1532
C30	10μ	Tantalum	25	20	21-1002
C31	10n	Ceramic	25	+80-20	21-1545
C32	10n	Ceramic	25	+80-20	21-1545
C33	10μ	Tantalum	25	20	21-1002
C34	10n	Ceramic	25	+80-20	21-1545
C35	82p	Ceramic	63	2	21-1691

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Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C36	10n	Ceramic	25	+80-20	21-1545
C37	330p	Ceramic	63	2	21-1698
C38	100n	Ceramic	25	+80-20	21-1616
C39	10μ	Tantalum	25	20	21-1002
C40	150p	Ceramic	63	2	21-1694
C41	33p	Ceramic	63	2	21-1686
C42	330p	Ceramic	63	2	21-1698
C43	10μ	Tantalum	25	20	21-1002
C44	10n	Ceramic	25	+80-20	21-1545
C45	10n	Ceramic	25	+80-20	21-1545
C46	150p	Ceramic	63	2	21-1694
C47	100n	Ceramic	25	+80-20	21-1616
C48	10n	Ceramic	25	+80-20	21-1545
C49	10n	Ceramic	25	+80-20	21-1545
C50	10n	Ceramic	25	+80-20	21-1545
C51	470p	Ceramic	500	5	21-1720
C52	1n	Ceramic	500	10	21-1609
C53	120p	Ceramic	63	2	21-1693
C54	47μ	Tantalum	6.3	20	21-1038
C55		Not Used			
C56	120p	Ceramic	63	2	21-1693
C57		Not Used			
C58	100n	Ceramic	12	+80-20	21-1616

Inductors

	<u>H</u>			
L1	2.2μ	Choke, sub-miniature	10	23-7010
L2	2.2μ	Choke, sub-miniature	10	23-7010
L3	2.2μ	Choke, sub-miniature	10	23-7010
L4		Coil		23-7127
L5		Coil		23-7126
L6		Coil		23-7127
L7		Coil		23-7126
L8	2.2μ	Choke, sub-miniature	10	23-7010
L9	2.2μ	Choke, sub-miniature	10	23-7010
L10	2.2μ	Choke, sub-miniature	10	23-7010

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
L11	2.2μ	Choke, sub-miniature		10	23-7010
L12	3.3μ	Choke, sub-miniature		10	23-7011
L13	470n	Choke, sub-miniature		10	23-7006
L14	10μ	Choke, sub-miniature		10	23-7014
L15	1μ	Choke, sub-miniature		10	23-7008
L16	2.2μ	Choke, sub-miniature		10	23-7010

Diodes

D1	Silicon (BA244)	22-1053
D2	Silicon (BA244)	22-1053
D3	Silicon (BA244)	22-1053
D4	Silicon (BA244)	22-1053

Transistors

Q1	2N5109	22-6088
Q2	2N5109	22-6088
Q3	BC109	22-6041
Q4	BC771	22-6038
Q5	BC771	22-6038
Q6	2N5109	22-6088
Q7	BC109	22-6041
Q8	BC109	22-6041
Q9	BC109	22-6041
Q10	2N2369	22-6017

Miscellaneous

X1	Double balanced mixer (SBL-1)	23-9087
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PARTS LIST

BAND SELECTION DIVIDER ASSEMBLY 19-0899

Fig 21

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R2	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R3	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R4	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R5	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R6	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R7	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R8	1.5k	Carbon Film	$\frac{1}{4}$	5	20-2152
R9	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R10	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R11	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R12	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R13	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R14	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R15	39	Metal Film, Chip	75m	5	20-4901
R16	39	Metal Film, Chip	75m	5	20-4901
R17	39	Metal Film, Chip	75m	5	20-4901
R18	39	Metal Film, Chip	75m	5	20-4901
R19	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R20	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R21	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R22	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R23	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R24	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R25	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R26	47	Carbon Film	$\frac{1}{4}$	5	20-2470

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Capacitors

	<u>F</u>		<u>V</u>		
C1	1n	Ceramic	500	20	21-1532
C2	22μ	Tantalum	16	20	21-1039
C3	100n	Ceramic	12	+80-20	21-1616
C4	1n	Ceramic	500	20	21-1532
C5	1n	Ceramic	500	20	21-1532
C6	100n	Ceramic	12	+80-20	21-1616
C7	10n	Ceramic	100	+80-20	21-1709
C8	100n	Ceramic	12	+80-20	21-1616
C9	100n	Ceramic	12	+80-20	21-1616
C10	22μ	Tantalum	16	20	21-1039
C11	100n	Ceramic	12	+80-20	21-1616
C12	100n	Ceramic	12	+80-20	21-1616
C13	10μ	Electrolytic	10		21-0708

Inductors

	<u>H</u>		
L1		Not Used	
L2	47μ	Choke, sub-miniature	23-7018

Transformers

T1	Transformer to Racal-Dana specification	17-3159
T2	Transformer to Racal-Dana specification	17-3159

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Diodes

D1		Voltage Regulator (BZY88C5V6)			22-1809
D2		Voltage Regulator (BZY88C5V6)			22-1809
D3		Voltage Regulator (BZY88C5V6)			22-1809
D4		Batch matched Schottky Barrier (5082.2836)			22-1075
D5		Batch matched Schottky Barrier (5082.2836)			22-1075
D6		Batch matched Schottky Barrier (5082.2836)			22-1075
D7		Batch matched Schottky Barrier (5082.2836)			22-1075
D8		Silicon (IN4149)			22-1029

Transistors

Q1		BFR91			22-6136
Q2		BFR91			22-6136

Integrated Circuits

IC1		4002			22-4709
IC2		4002			22-4709
IC3		10102			22-4514
IC4		10131			22-4507
IC5		4028			22-4745
IC6		4069			22-4715
IC7		10102			22-4514
IC8		8642B			22-4540

PARTS LIST

RF FILTERS ASSEMBLY 19-0906

Fig 23

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Resistors

	<u>Ω</u>		<u>W</u>		
R1	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R2	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R3	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R4	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R5	13x1.8k	DIL Array			20-5510
R6	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R7	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R8	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R9	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R10	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R11	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R12	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R13	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R14	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R15	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R16	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R17	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R18	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R19	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R20	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R21	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R22	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R23	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R24	56	Carbon Film	$\frac{1}{4}$	5	20-2560

Capacitors

	<u>F</u>		<u>V</u>		
C1	100n	Ceramic	12	+80-20	21-1616
C2	56p	Ceramic	63	2	21-1689
C3	8.2p	Ceramic	63	$\frac{1}{4}$ p	21-1679
C4	68p	Ceramic	63	2	21-1690
C5	18p	Ceramic	63	2	21-1683

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C6	47p	Ceramic	63	2	21-1688
C7	100n	Ceramic	50	20	21-1708
C8	82p	Ceramic	63	2	21-1691
C9	15p	Ceramic	63	2	21-1682
C10	100p	Ceramic	63	2	21-1692
C11	39p	Ceramic	63	2	21-1687
C12	68p	Ceramic	63	2	21-1690
C13	100n	Ceramic	50	20	21-1708
C14	120p	Ceramic	63	2	21-1693
C15	18p	Ceramic	63	2	21-1683
C16	150p	Ceramic	63	2	21-1694
C17	47p	Ceramic	63	2	21-1688
C18	100p	Ceramic	63	2	21-1692
C19	100n	Ceramic	50	20	21-1708
C20	180p	Ceramic	63	2	21-1695
C21	27p	Ceramic	63	2	21-1685
C22	220p	Ceramic	63	2	21-1696
C23	82p	Ceramic	63	2	21-1691
C24	150p	Ceramic	63	2	21-1694
C25	100n	Ceramic	50	20	21-1708
C26	220p	Ceramic	63	2	21-1696
C27	33p	Ceramic	63	2	21-1686
C28	270p	Ceramic	63	2	21-1697
C29	100p	Ceramic	63	2	21-1692
C30	180p	Ceramic	63	2	21-1695
C31	100n	Ceramic	50	20	21-1708
C32	374p	Silver Mica	350	1	21-2858
C33	14p-115p	Trimmer			21-6033
C34	36.5p	Silver Mica	350	$\frac{1}{2}$ p	21-2756
C35	453p	Silver Mica	350	1	21-2862
C36	105p	Silver Mica	350	1	21-2802
C37	14p-155p	Trimmer			21-6033
C38	301p	Silver Mica	350	1	21-2848
C39	330p	Ceramic	63	2	21-1698
C40	330p	Ceramic	63	2	21-1698
C41	576p	Silver Mica	350	1	21-2873
C42	14p-115p	Trimmer			21-6033
C43	73.2p	Silver Mica	350	$\frac{1}{2}$ p	21-2783
C44	681p	Silver Mica	350	1	21-2880
C45	215p	Silver Mica	350	1	21-2832

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C46	14p-115p	Trimmer			21-6033
C47	464p	Silver Mica	350	1	21-2864
C48	330p	Ceramic	63	2	21-1698
C49	330p	Ceramic	63	2	21-1698
C50	953p	Silver Mica	350	1	21-2894
C51	14p-115p	Trimmer			21-6033
C52	124p	Silver Mica	350	1	21-2809
C53	1.13n	Silver Mica	350	1	21-2905
C54	357p	Silver Mica	350	1	21-2854
C55	14p-115p	Trimmer			21-6033
C56	768p	Silver Mica	350	1	21-2885
C57	330p	Ceramic	63	2	21-1698
C58	330p	Ceramic	63	2	21-1698
C59	1.15n	Silver Mica	350	1	21-2906
C60	14p-115p	Trimmer			21-6033
C61	150p	Silver Mica	350	1	21-2816
C62	1.37n	Silver Mica	350	1	21-2913
C63	464p	Silver Mica	350	1	21-2864
C64	14p-115p	Trimmer			21-6033
C65	931p	Silver Mica	350	1	21-2893
C66	330p	Ceramic	63	2	21-1698
C67	330p	Ceramic	63	2	21-1698
C68	1.87n	Silver Mica	200	1	21-2926
C69	14p-115p	Trimmer			21-6033
C70	237p	Silver Mica	350	1	21-2836
C71	2.26n	Silver Mica	200	1	21-2934
C72	866p	Silver Mica	350	1	21-2890
C73	14p-115p	Trimmer			21-6033
C74	1.54n	Silver Mica	200	1	21-2918
C75	330p	Ceramic	63	2	21-1698
C76	330p	Ceramic	63	2	21-1698
C77	2.32n	Silver Mica	200	1	21-2935
C78	14p-115p	Trimmer			21-6033
C79	332p	Silver Mica	350	1	21-2850
C80	2.74n	Silver Mica	350	1	21-2942
C81	887p	Silver Mica	350	1	21-2891
C82	14p-115p	Trimmer			21-6033
C83	1.87n	Silver Mica	250	1	21-2926
C84	330p	Ceramic	63	2	21-1698
C85	330p	Ceramic	63	2	21-1698

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C86	3.74n	Silver Mica	350	1	21-2954
C87	14p-115p	Trimmer			21-6033
C88	511p	Silver Mica	350	1	21-2866
C89	4.53n	Silver Mica	350	1	21-2967
C90	1.65n	Silver Mica	200	1	21-2921
C91	14p-115p	Trimmer			21-6033
C92	3.01n	Silver Mica	200	1	21-2946
C93	330p	Ceramic	63	2	21-1698
C94	330p	Ceramic	63	2	21-1698
C95	33p	Ceramic	63	2	21-1686
C96	100n	Ceramic	25	+80-20	21-1551
C97	100n	Ceramic	12	+80-20	21-1616
C98	100n	Ceramic	12	+80-20	21-1616
C99	100n	Ceramic	12	+80-20	21-1616
C100	100n	Ceramic	12	+80-20	21-1616
C101	100n	Ceramic	12	+80-20	21-1616
C102	100n	Ceramic	12	+80-20	21-1616
C103	100n	Ceramic	12	+80-20	21-1616

Inductors

	<u>H</u>			
L1	100μ	Choke	10	23-7056
L2		Coil		23-7126
L3		Coil		23-7126
L4	100μ	Choke	10	23-7056
L5		Coil		23-7127
L6		Coil		23-7126
L7	100μ	Choke	10	23-7056
L8		Coil		23-7128
L9		Coil		23-7127
L10	100μ	Choke	10	23-7056
L11		Coil		23-7129
L12		Coil		23-7128
L13	100μ	Choke	10	23-7056
L14		Coil		23-7139
L15		Coil		23-7129

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
L16	150μ	Choke		10	23-7057
L17	470n	Choke, sub-miniature		10	23-7006
L18	330n	Choke, sub-miniature		10	23-7005
L19	470n	Choke, sub-miniature		10	23-7006
L20	150μ	Choke		10	23-7057
L21	680n	Choke, sub-miniature		10	23-7007
L22	470n	Choke, sub-miniature		10	23-7006
L23	470n	Choke, sub-miniature		10	23-7006
L24	150μ	Choke		10	23-7057
L25	1.2μ	Choke		10	23-7152
L26	820n	Choke		10	23-7151
L27	470n	Choke, sub-miniature		10	23-7006
L28	150μ	Choke		10	23-7057
L29	1.5μ	Choke, sub-miniature		10	23-7009
L30	1μ	Choke, sub-miniature		10	23-7008
L31	470n	Choke, sub-miniature		10	23-7006
L32	150μ	Choke		10	23-7057
L33	2.2μ	Choke, sub-miniature		10	23-7010
L34	1.5μ	Choke, sub-miniature		10	23-7009
L35	470n	Choke, sub-miniature		10	23-7006
L36	150μ	Choke		10	23-7057
L37	2.7μ	Choke		10	23-7153
L38	2.2μ	Choke, sub-miniature		10	23-7010
L39	470n	Choke, sub-miniature		10	23-7006
L40	150μ	Choke		10	23-7057
L41	4.7μ	Choke, sub-miniature		10	23-7012
L42	3.3μ	Choke, sub-miniature		10	23-7011
L43	470n	Choke, sub-miniature		10	23-7006
L44	150μ	Choke		10	23-7057
L45	120n	Choke		10	23-7150
L46	120n	Choke		10	23-7150
L47	150μ	Choke		10	23-7057

Diodes

D1	Voltage Regulator (BZY88C5V6)	22-1809
D2	Voltage Regulator (BZY88C5V6)	22-1809
D3	Voltage Regulator (BZY88C5V6)	22-1809
D4	Voltage Regulator (BZY88C5V6)	22-1809
D5	Voltage Regulator (BZY88C6V2)	22-1810

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
D6		Silicon (BA244)			22-1053
D7		Silicon (BA244)			22-1053
D8		Silicon (BA244)			22-1053
D9		Silicon (BA244)			22-1053
D10		Silicon (BA244)			22-1053
D11		Silicon (BA244)			22-1053
D12		Silicon (BA244)			22-1053
D13		Silicon (BA244)			22-1053
D14		Silicon (BA244)			22-1053
D15		Silicon (BA244)			22-1053
D16		Silicon (BA244)			22-1053
D17		Silicon (BA244)			22-1053
D18		Silicon (BA244)			22-1053
D19		Silicon (BA244)			22-1053
D20		Silicon (BA244)			22-1053
D21		Silicon (BA244)			22-1053
D22		Silicon (BA244)			22-1053
D23		Silicon (BA244)			22-1053
D24		Silicon (BA244)			22-1053
D25		Silicon (BA244)			22-1053
D26		PIN (5082.3379)			22-1058
D27		Silicon (1N4149)			22-1029
D28		PIN (5082.3379)			22-1058
D29		PIN (5082.3379)			22-1058
D30		Silicon (1N4149)			22-1029
D31		PIN (5082.3379)			22-1058
D32		PIN (5082.3379)			22-1058
D33		Silicon (1N4149)			22-1029
D34		PIN (5082.3379)			22-1058
D35		PIN (5082.3379)			22-1058
D36		Silicon (1N4149)			22-1029
D37		PIN (5082.3379)			22-1058
D38		PIN (5082.3379)			22-1058
D39		Silicon (1N4149)			22-1029
D40		PIN (5082.3379)			22-1058
D41		PIN (5082.3379)			22-1058
D42		Silicon (1N4149)			22-1029
D43		PIN (5082.3379)			22-1058
D44		PIN (5082.3379)			22-1058
D45		Silicon (1N4149)			22-1029
D46		PIN (5082.3379)			22-1058

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Integrated Circuits

IC1	74LS145	22-4556
IC2	74LS145	22-4556
IC3	4041	22-4753

PARTS LIST

LF COMBINER ASSEMBLY 19-0900

Fig 25

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Resistors

	<u>Ω</u>		<u>W</u>		
R1	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R2	6.8k	Carbon Film	$\frac{1}{4}$	5	20-2682
R3	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R4	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R5	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R6	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R7	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R8	560	Carbon Film	$\frac{1}{4}$	5	20-2561
R9	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R10	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R11	50	Variable			20-7056
R12	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R13	270	Metal Oxide	$\frac{1}{2}$	5	20-3271
R14	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R15	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R16	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R17	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R18	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R19	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R20	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R21	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R22	120	Carbon Film	$\frac{1}{4}$	5	20-2121

Capacitors

	<u>F</u>		<u>V</u>		
C1	100n	Ceramic	25	+80-20	21-1551
C2	22μ	Tantalum	16	20	21-1039
C3	100n	Ceramic	12	+80-20	21-1616
C4	100n	Ceramic	12	+80-20	21-1616
C5	100n	Ceramic	12	+80-20	21-1616

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C6	100n	Ceramic	12	+80-20	21-1616
C7	100n	Ceramic	12	+80-20	21-1616
C8	100n	Ceramic	25	+80-20	21-1551
C9	22μ	Tantalum	16	20	21-1039
C10	100n	Ceramic	12	+80-20	21-1616
C11	22μ	Tantalum	16	20	21-1039
C12	100n	Ceramic	12	+80-20	21-1616
C13	22μ	Tantalum	16	20	21-1039
C14	340p	Silver Mica	350	1	21-2851
C15	22μ	Tantalum	16	20	21-1039
C16	100n	Ceramic	25	+80-20	21-1551
C17	42.2p	Silver Mica	350	1	21-2760
C18	464p	Silver Mica	350	1	21-2864
C19	95.3p	Silver Mica	350	1	21-2793
C20	287p	Silver Mica	350	1	21-2844
C21	6.81n	Silver Mica	200	1	21-2976
C22	100n	Ceramic	25	+80-20	21-1551
C23	6.81n	Silver Mica	200	1	21-2976
C24	10n	Silver Mica	125	1	21-2996
C25	10n	Silver Mica	125	1	21-2996
C26	22μ	Tantalum	16	20	21-1039
C27	2.2p	Ceramic	63	0.25p	21-1672
C28	22μ	Tantalum	16	20	21-1039
C29	2.26n	Silver Mica	200	1	21-2934
C30	22μ	Tantalum	16	20	21-1039
C31	549p	Silver Mica	350	1	21-2871

Transformers

T1	Transformer to Racal-Dana specification	17-3159
T2	Transformer to Racal-Dana specification	17-3159

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Inductors

	<u>H</u>			
L1	47 μ	Choke, sub-miniature	10	23-7018
L2	47 μ	Choke, sub-miniature	10	23-7018
L3	10 μ	Choke, sub-miniature	10	23-7014
L4	6.8 μ	Choke, sub-miniature	10	23-7013
L5	2.2 μ	Choke, sub-miniature	10	23-7010
L6	2.2 μ	Choke, sub-miniature	10	23-7010

Diodes

D1	Hot Carrier	
D2	Matched Set of 4	22-1056
D3	(5082.2815)	
D4		

Transistors

Q1	2N2369	22-6017
Q2	2N2369	22-6017
Q3	2N2369	22-6017
Q4	BC109	22-6041
Q5	BC109	22-6041
Q6	BC109	22-6041
Q7	BC109	22-6041
Q8	BCY71	22-6038

Relays

RLA	DIL reed type, diode protected	23-7518
RLB	DIL reed type, diode protected	23-7518

PARTS LIST

RF OUTFIT AMPLIFIER ASSEMBLY 19-0897

Fig 27

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R2	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R3	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R4	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R5	56	Carbon Film	$\frac{1}{4}$	5	20-2560
R6	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R7	18	Carbon Film	$\frac{1}{4}$	5	20-2180
R8	82	Carbon Film	$\frac{1}{4}$	5	20-2820
R9	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R10	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R11	270	Metal Oxide	$\frac{1}{2}$	5	20-3271
R12	100	Metal Oxide	$\frac{1}{2}$	5	20-3101
R13	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R14	120	Metal Oxide	$\frac{1}{2}$	5	20-3121
R15	100	Metal Oxide	$\frac{1}{2}$	5	20-3101
R16	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R17	33	Carbon Film	$\frac{1}{4}$	5	20-2330
R18	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R19	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R20	390	Carbon Film	$\frac{1}{4}$	5	20-2391
R21	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R22	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R23	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R24	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R25	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R26	82	Carbon Film	$\frac{1}{4}$	5	20-2820
R27	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R28	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R29	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R30	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R31	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R32	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R33	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R34	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R35	47	Carbon Film	$\frac{1}{4}$	5	20-2470

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	820	Carbon Film	$\frac{1}{4}$	5	20-2821
R37	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R38	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R39	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R40	820	Carbon Film	$\frac{1}{4}$	5	20-2821
R41	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R42	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R43	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R44	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R45	82	Carbon Film	$\frac{1}{4}$	5	20-2820
R46	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R47	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R48	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R49	33	Carbon Film	$\frac{1}{4}$	5	20-2330
R50	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R51	6.8k	Carbon Film	$\frac{1}{4}$	5	20-2682
R52	20k	Variable			20-7049
R53	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R54	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R55	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R56	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R57	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R58	2.2M	Carbon Film	$\frac{1}{4}$	10	20-2225
R59	56k	Carbon Film	$\frac{1}{4}$	5	20-2563
R60	56k	Carbon Film	$\frac{1}{4}$	5	20-2563
R61	2.2M	Carbon Film	$\frac{1}{4}$	10	20-2225
R62	10k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4854
R63	10k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4854
R64	56k	Carbon Film	$\frac{1}{4}$	5	20-2563
R65	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R66	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R67	56k	Carbon Film	$\frac{1}{4}$	5	20-2563
R68	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R69	100k	Variable			20-7054
R70	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R71	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R72	20k	Variable			20-7049
R73	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R74	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R75	1k	Variable			20-7048

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R76	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R77	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R78	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R79	100k	Variable			20-7054
R80	10M	Carbon Film	$\frac{1}{4}$	5	20-2106
R81	10M	Carbon Film	$\frac{1}{4}$	5	20-2106
R82	1k	Variable			20-7048
R83	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R84	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R85	1k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4921
R86	1.2k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4922
R87	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R88	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R89	68k	Carbon Film	$\frac{1}{4}$	5	20-2683
R90	1.2k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4922
R91	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R92	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R93	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R94	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R95	22	Carbon Film	$\frac{1}{4}$	5	20-2220
R96	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R97	6.8k	Carbon Film	$\frac{1}{4}$	5	20-2682
R98	68	Carbon Film	$\frac{1}{4}$	5	20-2680
R99	39	Carbon Film	$\frac{1}{4}$	5	20-2390

Capacitors

	<u>F</u>		<u>V</u>		
C1	15 μ	Tantalum	20	20	21-1003
C2	100n	Ceramic	12	+80-20	21-1616
C3	10 μ	Tantalum	20	20	21-1002
C4	15 μ	Tantalum	20	20	21-1003
C5	100n	Ceramic	50	20	21-1708
C6	10 μ	Tantalum	20	20	21-1002
C7	10 μ	Tantalum	20	20	21-1002
C8	100n	Ceramic	12	+80-20	21-1616
C9	100n	Ceramic	50	20	21-1708
C10	10 μ	Tantalum	20	20	21-1002

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C11	10μ	Tantalum	20	20	21-1002
C12	100n	Ceramic	12	+80-20	21-1616
C13	82p	Ceramic	63	2	21-1691
C14	100n	Ceramic	50	20	21-1708
C15	10μ	Tantalum	20	20	21-1002
C16	10p	Ceramic	500	10	21-1508
C17	100n	Ceramic	50	20	21-1708
C18	10μ	Tantalum	20	20	21-1002
C19	100n	Ceramic	50	20	21-1708
C20	10μ	Tantalum	20	20	21-1002
C21	10μ	Tantalum	20	20	21-1002
C22	100n	Ceramic	12	+80-20	21-1616
C23	100n	Ceramic	12	+80-20	21-1616
C24	22μ	Tantalum	16	20	21-1039
C25	22μ	Tantalum	16	20	21-1039
C26	82p	Ceramic	500	10	21-1519
C27	100n	Ceramic	50	20	21-1708
C28	10μ	Tantalum	20	20	21-1002
C29	100n	Ceramic	50	20	21-1708
C30	10μ	Tantalum	20	20	21-1002
C31	100n	Ceramic	12	+80-20	21-1616
C32	10μ	Tantalum	20	20	21-1002
C33	10μ	Tantalum	20	20	21-1002
C34	100n	Ceramic	12	+80-20	21-1616
C35	100n	Ceramic	50	+80-20	21-1708
C36	10μ	Tantalum	20	20	21-1002
C37	100n	Ceramic	50	+80-20	21-1708
C38	10μ	Tantalum	20	20	21-1002
C39	10μ	Tantalum	20	20	21-1002
C40	100n	Ceramic	12	+80-20	21-1616
C41	100n	Ceramic	12	+80-20	21-1616
C42	22μ	Tantalum	16	20	21-1039
C43	22μ	Tantalum	16	20	21-1039
C44	100n	Ceramic	50	+80-20	21-1708
C45	10μ	Tantalum	20	20	21-1002
C46	47μ	Tantalum	6.3	20	21-1038
C47	100n	Ceramic	12	+80-20	21-1616
C48	100n	Ceramic	50	20	21-1708
C49	10μ	Tantalum	20	20	21-1002
C50	22μ	Tantalum	16	20	21-1039

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C51	22 μ	Tantalum	16	20	21-1039
C52	100n	Ceramic	12	+80-20	21-1616
C53	22 μ	Tantalum	16	20	21-1039
C54	22 μ	Tantalum	16	20	21-1039
C55	100n	Ceramic	12	+80-20	21-1616
C56	100n	Ceramic	12	+80-20	21-1616
C57	22 μ	Tantalum	16	20	21-1039
C58	22 μ	Tantalum	16	20	21-1039
C59	100n	Ceramic	25	+80-20	21-1551
C60	15 μ	Tantalum	20	20	21-1003
C61	68p	Ceramic	63	2	21-1690
C62	1n	Silver Mica	350	1	21-2896
C63	220n	Polyester	100	10	21-4550
C64	100n	Ceramic	25	+80-20	21-1551
C65	15 μ	Tantalum	20	20	21-1003
C66	100n	Ceramic	25	+80-20	21-1551
C67	100n	Ceramic	25	+80-20	21-1551
C68	22 μ	Tantalum	16	20	21-1039
C69	332p	Silver Mica	350	1	21-2850
C70	220n	Polyester	100	10	21-4550
C71	825p	Silver Mica	350	1	21-2888
C72	100n	Ceramic	50	20	21-1708
C73	47 μ	Tantalum	16	20	21-1045
C74	22 μ	Tantalum	16	20	21-1039
C75	22 μ	Tantalum	16	20	21-1039
C76	100n	Ceramic	12	+80-20	21-1616
C77	100n	Ceramic	50	20	21-1708

Inductors

	<u>H</u>			
L1	120n	Choke	10	23-7150
L2	120n	Choke	10	23-7150

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Diodes</u>					
D1		Voltage Regulator (BZY88C5V6)			22-1809
D2		Silicon (1N4149)			22-1029
D3		Hot Carrier (5082.2811)			22-1033
D4		Hot Carrier (5082.2811)			22-1033
D5		Silicon (1N4149)			22-1029
D6		Not Used			
D7		Voltage Regulator (BZY88C18)			22-1820
D8		Silicon (1N4149)			22-1029
D9		Silicon (1N4149)			22-1029
D10		Silicon (1N4149)			22-1029
D11		Silicon (1N4149)			22-1029
D12		Silicon (1N4149)			22-1029
D13		Silicon (1N4149)			22-1029
D14		Silicon (1N4149)			22-1029
D15		Silicon (1N4149)			22-1029
<u>Transistors</u>					
Q1		BFR91			22-6136
Q2		2N5109			22-6088
Q3		2N5109			22-6088
Q4		2N5109			22-6088
Q5		2N5160			22-6089
Q6		2N5160			22-6089
Q7		2N5109			22-6088
Q8		2N5109			22-6088
Q9		2N5160			22-6089
Q10		BFX48			22-6110
Q11		BC107			22-6068
Q12		E109			22-6124
Q13		E109			22-6124
Q14		Not Used			
Q15		E108			22-6111
Q16		E108			22-6111
Q17		BC107			22-6068
Q18		E109			22-6124
Q19		E109			22-6124
Q20		BC107			22-6068

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Integrated Circuits

IC1		TL082			22-4240
IC2		DG200			22-4744
IC3		TL082			22-4240

Miscellaneous

FX1		Ferrite Bead			23-8000
FX2		Ferrite Bead			23-8000
FX3		Ferrite Bead			23-8000
FX4		Ferrite Bead			23-8000

PARTS LIST

FM LOOP AND AUDIO OSCILLATOR ASSEMBLY 19-0896

Fig 29

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R2	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R3	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R4	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R5	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R6	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R7	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R8	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R9	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R10	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R11	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R12	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R13	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R14	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R15	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R16	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R17	90.9k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4959
R18	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R19	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R20	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R21	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R22	30.1k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4960
R23	10k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4961
R24	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R25	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R26	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R27	30.1k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4960
R28	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R29	470	Carbon Film	0.1	5	20-1532
R30	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R31	100k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4963
R32	42.2k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4964
R33	49.9k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4958
R34	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R35	470	Carbon Film	$\frac{1}{4}$	5	20-2471

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R37	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R38	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R39	11k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4962
R40	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R41	820	Carbon Film	$\frac{1}{4}$	5	20-2821
R42	47	Carbon Film	$\frac{1}{4}$	5	20-2470
R43	100k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4963
R44	11k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4962
R45	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R46	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R47	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R48	330	Metal Oxide	$\frac{1}{2}$	5	20-3331
R49	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R50	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R51	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R52	75k	Carbon Film	$\frac{1}{4}$	5	20-2753
R53	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R54	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R55	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R56	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R57	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R58	37.4k	Metal Film	$\frac{1}{4}$	1	20-4970
R59	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R60	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R61	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R62	2.7k	Carbon Film	$\frac{1}{4}$	5	20-2272
R63	18k	Carbon Film	$\frac{1}{4}$	5	20-2183
R64	8.2k	Carbon Film	$\frac{1}{4}$	5	20-2822
R65	10k	Carbon Film	0.1	5	20-1538
R66	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R67	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R68	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R69	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R70	470	Carbon Film	$\frac{1}{4}$	5	20-2471
R71	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R72	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R73	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R74	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R75	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R76	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R77	2.7k	Metal Oxide	$\frac{1}{4}$	2	20-4017
R78	12k	Metal Oxide	$\frac{1}{4}$	2	20-4067
R79	12k	Carbon Film	$\frac{1}{4}$	5	20-2123
R80	18k	Metal Oxide	$\frac{1}{4}$	1	20-4108
R81	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R82	2.7k	Metal Oxide	$\frac{1}{4}$	2	20-4017
R83	18k	Metal Oxide	$\frac{1}{4}$	1	20-4108
R84	12k	Metal Oxide	$\frac{1}{4}$	2	20-4067
R85	3.9k	Metal Oxide	$\frac{1}{4}$	2	20-4049
R86	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R87	8.2k	Metal Oxide	$\frac{1}{4}$	2	20-4066
R88	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R89	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R90	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R91	2.2k	Carbon Film	$\frac{1}{4}$	5	20-2222
R92	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R93	15k	Carbon Film	$\frac{1}{4}$	5	20-2153
R94	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R95	50k	Variable			20-7051
R96	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R97	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R98	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R99	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R100	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R101	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R102	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R103	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R104		Not Used			
R105	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R106	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R107	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R108	4.99k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4957
R109	4.99k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4957
R110	10k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4961
R111	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R112	10k	Metal Film	$\frac{1}{4}$	$\frac{1}{2}$	20-4961
R113	47k	Carbon Film	0.1	5	20-1572
R114	50k	Variable			20-7051
R115	56k	Carbon Film	$\frac{1}{4}$	5	20-2563

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R116	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R117	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R118	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R119	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R120	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R121	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R122	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R123	500	Variable			20-7050
R124	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R125	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R126	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R127	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R128	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R129	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R130	27	Carbon Film	0.1	5	20-1540
R131	56	Carbon Film	0.1	5	20-1546
R132	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R133	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182

Capacitors

	<u>F</u>		<u>V</u>		
C1	10n	Ceramic	25	+80-20	21-1545
C2	10n	Ceramic	25	+80-20	21-1545
C3	10n	Ceramic	25	+80-20	21-1545
C4	10n	Ceramic	25	+80-20	21-1545
C5	10 μ	Tantalum	20	20	21-1002
C6	10n	Ceramic	25	+80-20	21-1545
C7	10n	Ceramic	25	+80-20	21-1545
C8	47 μ	Tantalum	16	20	21-1045
C9	100p	Silver Mica	125	5	21-2625
C10	270p	Silver Mica	125	5	21-2630
C11	33p	Silver Mica	350	5	21-2607
C12	10n	Ceramic	25	+80-20	21-1545
C13	82p	Ceramic	63	2	21-1691
C14	100n	Ceramic	50	20	21-1708
C15	270p	Ceramic	63	2	21-1697

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C16	82p	Ceramic	63	2	21-1691
C17	100n	Ceramic	50	20	21-1708
C18	100n	Ceramic	50	20	21-1708
C19	100n	Ceramic	50	20	21-1708
C20	47μ	Tantalum	16	20	21-1045
C21	100n	Ceramic	50	20	21-1708
C22	10n	Ceramic	500	20	21-1544
C23	100n	Ceramic	50	20	21-1708
C24	10n	Ceramic	25	+80-20	21-1545
C25	10n	Ceramic	25	+80-20	21-1545
C26	10μ	Tantalum	20	20	21-1002
C27	100p	Silver Mica	125	5	21-2625
C28	15μ	Tantalum	20	20	21-1003
C29	15μ	Tantalum	20	20	21-1003
C30	47μ	Tantalum	16	20	21-1045
C31	47μ	Tantalum	16	20	21-1045
C32	15n	Polycarbonate	160	5	21-5528
C33	768p	Silver Mica	350	1	21-2885
C34	10μ	Tantalum	20	20	21-1002
C35	47p	Silver Mica	125	5	21-2623
C36	1.13n	Silver Mica	350	1	21-2905
C37	82p	Ceramic	63	2	21-1691
C38	953p	Silver Mica	350	1	21-2894
C39	15μ	Tantalum	20	20	21-1003
C40	100n	Tantalum	35	20	21-1031
C41	100n	Ceramic	50	20	21-1708
C42	22n	Polyester	250	2	21-4561
C43	22n	Polyester	250	2	21-4561
C44	100n	Ceramic	50	20	21-1708
C45	47μ	Tantalum	6.3	20	21-1038
C46	100n	Ceramic	50	20	21-1708
C47	10μ	Tantalum	20	20	21-1002
C48	10μ	Tantalum	20	20	21-1002
C49	220p	Ceramic	63	2	21-1696
C50	1.5μ	Tantalum	35	20	21-1029
C51	100n	Ceramic	50	20	21-1708
C52	1μ	Tantalum	50	20	21-1051
C53	100n	Ceramic	50	20	21-1708
C54	10n	Ceramic	25	+80-20	21-1545
C55	10μ	Tantalum	20	20	21-1002

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C56	100n	Ceramic	50	20	21-1708
C57	22p	Ceramic	63	2	21-1684
C58	470μ	Electrolytic	10		21-0514
C59	47μ	Tantalum	16	20	21-1045
C60	47μ	Tantalum	16	20	21-1045
C61	47μ	Tantalum	16	20	21-1045
C62	47μ	Tantalum	16	20	21-1045
C63	47μ	Tantalum	16	20	21-1045
C64	47μ	Tantalum	16	20	21-1045
C65	15μ	Tantalum	20	20	21-1003
C66	47μ	Tantalum	16	20	21-1045
C67	220p	Ceramic	63	2	21-1696
C68	15p	Ceramic	63	2	21-1682

Inductors

H

L1	47μ	Choke, sub-miniature		10	23-7018
L2	47μ	Choke, sub-miniature		10	23-7018
L3	200μ	Choke		5	23-7084
L4	200μ	Choke		5	23-7084
L5	200μ	Choke		5	23-7084
L6	15μ	Choke, sub-miniature		10	23-7015
L7	100μ	Choke		10	23-7056
L8	100μ	Choke		10	23-7056

Diodes

D1	Voltage regulator(BZY88C5V6)	22-1809
D2	Voltage regulator(BZY88C5V6)	22-1809
D3	Silicon (1N4149)	22-1029
D4	Silicon (1N4149)	22-1029
D5	Silicon (1N4149)	22-1029
D6	Silicon (1N4149)	22-1029
D7	Voltage regulator(BZY88C5V6)	22-1809
D8	Silicon (1N4149)	22-1029
D9	Silicon (1N4149)	22-1029
D10	Silicon (1N4149)	22-1029

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Transistors

Q1		BFX48			22-6110
Q2		W300A			22-6101
Q3		2N2369			22-6017
Q4		W300A			22-6101
Q5		BC107			22-6068
Q6		2N2369			22-6017
Q7		ZTX109			22-6122
Q8		2N2369			22-6017
Q9		BC107			22-6068
Q10		BC107			22-6068
Q11		BFY51			22-6044
Q12		2N3904			22-6007
Q13		BC107			22-6068
Q14		2N4124			22-6009
Q15		BC107			22-6068
Q16		BCY71			22-6038
Q17		W 300A			22-6101
Q18		E108			22-6111
Q19		BC107			22-6068
Q20		BC107			22-6068
Q21		Not Used			
Q22		2N2369			22-6017
Q23		2N2369			22-6017
Q24		BCY 71			22-6038

Integrated Circuits

IC1		DG 200			22-4744
IC2		DG 200			22-4744
IC3		4025			22-4725
IC4		4075			22-4747
IC5		DG 200			22-4744
IC6		HEF 4071			22-4716
IC7		4096			22-4715
IC8		HEF 4071			22-4716
IC9		DG 200			22-4744
IC10		DG 200			22-4744

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
IC11		TLO 82			22-4240
IC12		DG 200			22-4744
IC13		MC 1496			22-4091
IC14		TLO 82			22-4240
IC15		TLO 82			22-4240
IC16		TLO 82			22-4240
IC17		DG 200			22-4744
IC18		DG 200			22-4744
IC19		TLO 82			22-4240
IC20		TLO 82			22-4240
IC21		DG 200			22-4744
IC22		7413			22-4083

Relays

RLA	Not Used	
RLB	DIL reed type, diode protected	23-7518

Miscellaneous

XL1	Crystal, 11.4 MHz	17-2115
Fx1	Ferrite bead	23-8000
Fx2	Ferrite bead	23-8000

PARTS LIST
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Fig 31

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	4.7M	Carbon Film	$\frac{1}{4}$	10	20-2475
R2	2.2M	Carbon Film	$\frac{1}{4}$	10	20-2225
R3	12k	Carbon Film	$\frac{1}{4}$	5	20-2123
R4	10	Carbon Film	$\frac{1}{4}$	5	20-2100
R5	330k	Carbon Film	$\frac{1}{4}$	5	20-2334
R6	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R7	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R8	22k	Carbon Film	$\frac{1}{4}$	5	20-2223
R9	330k	Carbon Film	$\frac{1}{4}$	5	20-2334
R10	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R11	1.8k	Carbon Film	$\frac{1}{4}$	5	20-2182
R12	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R13	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R14	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R15	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R16	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R17	10k	Carbon Film	0.1	5	20-1538
R18	10k	Carbon Film	$\frac{1}{4}$	5	20-2105
R19	1M	Carbon Film	$\frac{1}{4}$	5	20-2103
R20	10k	Carbon Film			
R21	10k	Carbon Film	0.1	5	20-1538
R22	10k	Carbon Film	0.1	5	20-1538
R23	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R24	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R25	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R26	4.7k	Carbon Film	$\frac{1}{4}$	5	20-2472
R27	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R28	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R29	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R30	10k	Carbon Film			
R31	3.9k	Carbon Film	$\frac{1}{4}$	5	20-2392
R32	10k	Carbon Film	0.1	5	20-1538
R33	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R34	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R35	10k	Carbon Film	0.1	5	20-1538

Parts Lis

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
			0.1	5	20-1538
			0.1	5	20-1538
R36	10k	Carbon Film			
R37	10k	Carbon Film			
<u>Capacitors</u>			<u>V</u>		
	<u>F</u>		12	+80-20	21-1616
			6.3	20	21-1038
C1	100n	Ceramic	500	10	21-1524
C2	47μ	Tantalum	500	10	21-1524
C3	220p	Ceramic	500	10	21-1524
C4	220p	Ceramic			
C5	220p	Ceramic	35	20	21-1041
			500	10	21-1525
C6	1μ	Tantalum	500	10	21-1508
C7	270p	Ceramic	35	20	21-1041
C8	10p	Ceramic	500	20	21-1532
C9	1μ	Tantalum			
C10	1n	Ceramic			
<u>Diodes</u>					
D1		Silicon (1N4149)			22-1029
D2		Silicon (1N4149)			22-1029
D3		Silicon (1N4149)			22-1029
D4		Voltage Regulator (BZY88C4V7)			22-1807
D5		Voltage Regulator (BZY88C4V7)			22-1807
D6		Voltage Regulator (BZY88C4V7)			22-1807
D7		Voltage Regulator (BZY88C4V7)			22-1807
D8		Voltage Regulator (BZY88C4V7)			22-1807
D9		Voltage Regulator (BZY88C4V7)			22-1807
D10		Voltage Regulator (BZY88C4V7)			22-0007
D11		Germanium (AAZ15)			22-0007
D12		Germanium (AAZ15)			22-0007
D13		Germanium (AAZ15)			22-0007
D14		Germanium (AAZ15)			22-0007
D15		Germanium (AAZ15)			22-0007
D16		Germanium (AAZ15)			22-0007
D17		Germanium (AAZ15)			22-0007
D18		Germanium (AAZ15)			22-0007
D19		Germanium (AAZ15)			22-0007
D20		Germanium (AAZ15)			22-0007
D21		Germanium (AAZ15)			22-1029
D22		Germanium (AAZ15)			22-1029
D23		Silicon (1N4149)			
D24		Silicon (1N4149)			
D25		Silicon (1N4149)			
D26		Silicon (1N4149)			

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Transistors

Q1		2N2369			22-6017
Q2		2N2369			22-6017

Integrated Circuits

IC1		4001			22-4713
IC2		4081			22-4746
IC3		4049			22-4719
IC4		4081			22-4746
IC5		4071			22-4716
IC6		40097			22-4743
IC7		Programmed ROM			22-8701
IC8		Programmed ROM			22-8701
IC9		Programmed ROM			22-8701
IC10		4001			22-4713
IC11		LSI Circuit to Racal-Dana specification			22-8400
IC12		40097			22-4743
IC13		40097			22-4743
IC14		Programmed ROM			22-8701
IC15		Programmed ROM			22-8701
IC16		Programmed ROM			22-8701
IC17		4071			22-5716
IC18		TL082			22-4240
IC19		4001			22-4713
IC20		4011			22-4700
IC21		40097			22-4743
IC22		40097			22-4743
IC23		Programmed ROM			22-8502
IC24		Programmed ROM			22-8701
IC25		4069			22-4715
IC26		4013			22-4711

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Miscellaneous

SK17		Cable assembly, special			23-9092
		Socket, 40-pin, DIL for IC11			23-3246
SK87		Socket, 16-pin, DIL			23-3259
SK89		Socket, 8-pin, DIL			23-3258

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
S26		Switch, push-button			23-4098
S27		Switch, push-button			23-4098
S28		Switch, push-button			23-4098
S29		Switch, push-button			23-4098
S30		Switch, push-button			23-4098
S31		Switch, push-button			23-4098
LP1		LED, red (5082.4684)			26-5013
LP2		LED, red (5082.4684)			26-5013
LP3		LED, red (5082.4684)			26-5013
LP4		LED, red (5082.4684)			26-5013
LP5		LED, red (5082.4684)			26-5013
LP6		LED, red (5082.4684)			26-5013
LP7		LED, red (5082.4684)			26-5013
LP8		LED, green (HLMP-1502)			26-5015
LP9		LED, red (5082.4684)			26-5013
LP10		LED, yellow (5082.4584)			26-5014
LP11		LED, red (5082.4684)			26-5013
LP12		LED, red (5082.4684)			26-5013
LP13		LED, red (5082.4684)			26-5013
LP14		LED, red (5082.4684)			26-5013
LP15		LED, yellow (5082.4584)			26-5014
LP16		LED, yellow (5082.4584)			26-5014
LP17		LED, yellow (5082.4584)			26-5014
LP18		LED, yellow (5082.4584)			26-5014
LP19		LED, yellow (5082.4584)			26-5014
LP20		LED, red (5082.4684)			26-5013
LP21		LED, red (5082.4684)			26-5013
LP22		LED, red (5082.4684)			26-5013
LP23		LED, yellow (5082.4584)			26-5014
LP24		LED, yellow (5082.4584)			26-5014
LP25		LED, yellow (5082.4584)			26-5014
LP26		LED, green (HLMP-1502)			26-5015
LP27		LED, green (HLMP-1502)			26-5015
LP28		LED, green (HLMP-1502)			26-5015
LP29		LED, red (5082.4684)			26-5013
LP30		LED, red (5082.4684)			26-5013
LP31		LED, red (5082.4684)			26-5013

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
PL19		Socket, 40-pin, DIL for IC2 and IC3			23-3246
PL18		Header, 40-way			23-3267
SK15		PCB connector, 20-way			23-3265
		Socket, 20-way			23-3263
		Cable, ribbon,			25-6036

PARTS LIST

FRONT PANEL LOGIC ASSEMBLY 19-0911

Fig 35

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	8x1k	DIL Array			20-5512
R2	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R3	8x1k	DIL Array			20-5512
R4	8x4.7k	DIL Array			20-5513
R5	8x1k	DIL Array			20-5512
R6	8x4.7k	DIL Array			20-5513
R7	8x1k	DIL Array			20-5512
R8	8x4.7k	DIL Array			20-5513
R9	8x1k	DIL Array			20-5512
R10	8x4.7k	DIL Array			20-5513
R11	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R12	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R13	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R14	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R15	10k	Carbon Film	0.1	5	20-1538
R16	1.5k	Carbon Film	0.1	5	20-1545
R17	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R18	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R19	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R20	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R21	39k	Carbon Film	$\frac{1}{4}$	5	20-2393
R22	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R23	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R24	7x22k	DIL Array			20-5516
R25	7x2.2k	DIL Array			20-5515
R26	150	Carbon Film	$\frac{1}{4}$	5	20-2151
R27	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R28	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R29	68	Carbon Film	$\frac{1}{4}$	5	20-2680
R30	120	Carbon Film	$\frac{1}{4}$	5	20-2121
R31	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R32	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R33	150	Carbon Film	$\frac{1}{4}$	5	20-2151

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
IC16		4027			22-4710
IC17		4081			22-4746
IC18		4013			22-4711
IC19		4013			22-4711
IC20		40097			22-4743
IC21		40097			22-4743
IC22		40097			22-4743
IC23		4071			22-4716
IC24		4069			22-4715
IC25		4081			22-4746
IC26		4081			22-4746
IC27		74LS14			22-4570
IC28		40097			22-4743
IC29		40097			22-4743
<u>Miscellaneous</u>					
PL20		PCB connector, 40-way			23-3269
SK19		Socket, 40-way			23-3268
		Cable, ribbon			25-6037
PL21		PCB connector, 50-way			23-3273
SK14		Socket, 50-way			23-3270
		Cable ribbon			25-6038
PL22		PCB connector, 50-way			23-3273
SK33		Socket, 50-way			23-3292
		Cable, ribbon			25-6039

PARTS LIST

DISPLAY ASSEMBLY 19-0895

Fig 37

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Resistors

	Ω		W		
R1	100	Carbon Film	$\frac{1}{4}$	5	20-2101
R2	560	Carbon Film	$\frac{1}{4}$	5	20-2561

Transistors

Q1	2N2369	22-6017
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Indicators

DI1	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI2	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI3	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI4	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI5	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI6	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI7	Numerical Indicator, BCD Input (5082.7302)	26-1500
DI8	Numerical Indicator (5082.7304)	26-1510

Miscellaneous

PL17	Header, 40-way	23-3327
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Tel (01844) 351694
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email:- mauritron@dial.pipex.com

PARTS LIST

SPIN WHEEL ASSEMBLY 11-1331

Fig 43

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Resistors

	<u>Ω</u>		<u>W</u>		
R14	180	Carbon Film	$\frac{1}{4}$	5	20-2181
R15	180	Carbon Film	$\frac{1}{4}$	5	20-2181
	2.2k				
R16	nominal.	Carbon Film	$\frac{1}{4}$	5	
R17	Possible range 560-5.6k	Carbon Film	$\frac{1}{4}$	5	

Miscellaneous

Q1	Photo-amplifier (ZM100)	22-7000
Q2	Photo-amplifier (ZM100)	22-7000
LP1	LED (5082.4658)	26-5008
LP2	LED (5082.4658)	26-5008
	Knob	24-0504
	Cap for 24-0504	24-0505

PARTS LIST

POWER SUPPLY

Fig 39

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
<u>Resistors</u>					
	<u>Ω</u>		<u>W</u>		
R1	12	Carbon Film			
R2	120	Carbon Film	$\frac{1}{4}$	5	20-2120
R3	1k	Variable	$\frac{1}{4}$	5	20-2121 20-6630
<u>Capacitors</u>					
	<u>F</u>		<u>V</u>		
C1	2200 μ	Electrolytic	40		
C2	100n	Ceramic	25	+80-20	21-0581
C3	4.7 μ	Tantalum	35	20	21-1551
C4	4700 μ	Electrolytic	40		21-1006
C5	100n	Ceramic	25	+80-20	21-0590 21-1551
C6	4.7 μ	Tantalum	35	20	
C7	15000 μ	Electrolytic	16		21-1006
C8	100n	Ceramic	25	+80-20	21-0583
C9	4.7 μ	Tantalum	35	20	21-1551
C10	6800 μ	Electrolytic	16		21-1006 21-0580
C11	100n	Ceramic	25	+80-20	
C12	4.7 μ	Tantalum	35	20	21-1551
C13	3300 μ	Electrolytic	40		21-1006
C14	100n	Ceramic	25	+80-20	21-0589
C15	4.7 μ	Tantalum	35	20	21-1551 21-1006
<u>Diodes</u>					
D1		Bridge rectifier	2A		
D2		Bridge rectifier	2A		22-1650
D3		Bridge rectifier	6A		22-1650
D4		Bridge rectifier	6A		22-1662
D5		Bridge rectifier	2A		22-1662 22-1650

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Integrated Circuits

IC1		Voltage regulator (7824K)			22-4236
IC2		Voltage regulator (LAS 1615)			22-4235
IC3		Voltage regulator (LM323K)			22-4232
IC4		Voltage regulator (LM345K)			22-4233
IC5		Voltage regulator (7915K)			22-4234

Miscellaneous

T1		Transformer			17-4092
FS2		Fuse link 2A			23-0008
		Holder for FS2			23-0018
SK16		Connector shell			23-3286
		Socket for 23-3286			23-3287
		Polarising key for 23-3286			23-3289

PARTS LIST

MOTHERBOARD ASSEMBLY 19-0905

Fig 4

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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Capacitors

	<u>F</u>		<u>V</u>		
C1	100n	Ceramic	50	+80-20	21-1551
C2	1.5 μ	Tantalum	35	20	21-1029
C3	1.5 μ	Tantalum	35	20	21-1029
C4	100n	Ceramic	12	+80-20	21-1616

Connectors

PL14	Header, 50-way	23-3271
PL15	Header, 20-way	23-3264
	Filtercon	21-6503

PARTS LIST

CHASSIS, FRONT AND REAR PANELS

Fig 39, Fig 42 and Fig 43

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
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CHASSIS ASSEMBLY 11-1332

		Manual attenuator assembly			11-1335
		Knob for 11-1335			24-0512
		Cap for 24-0512			24-0508
		Dial for 24-0512			16-0469

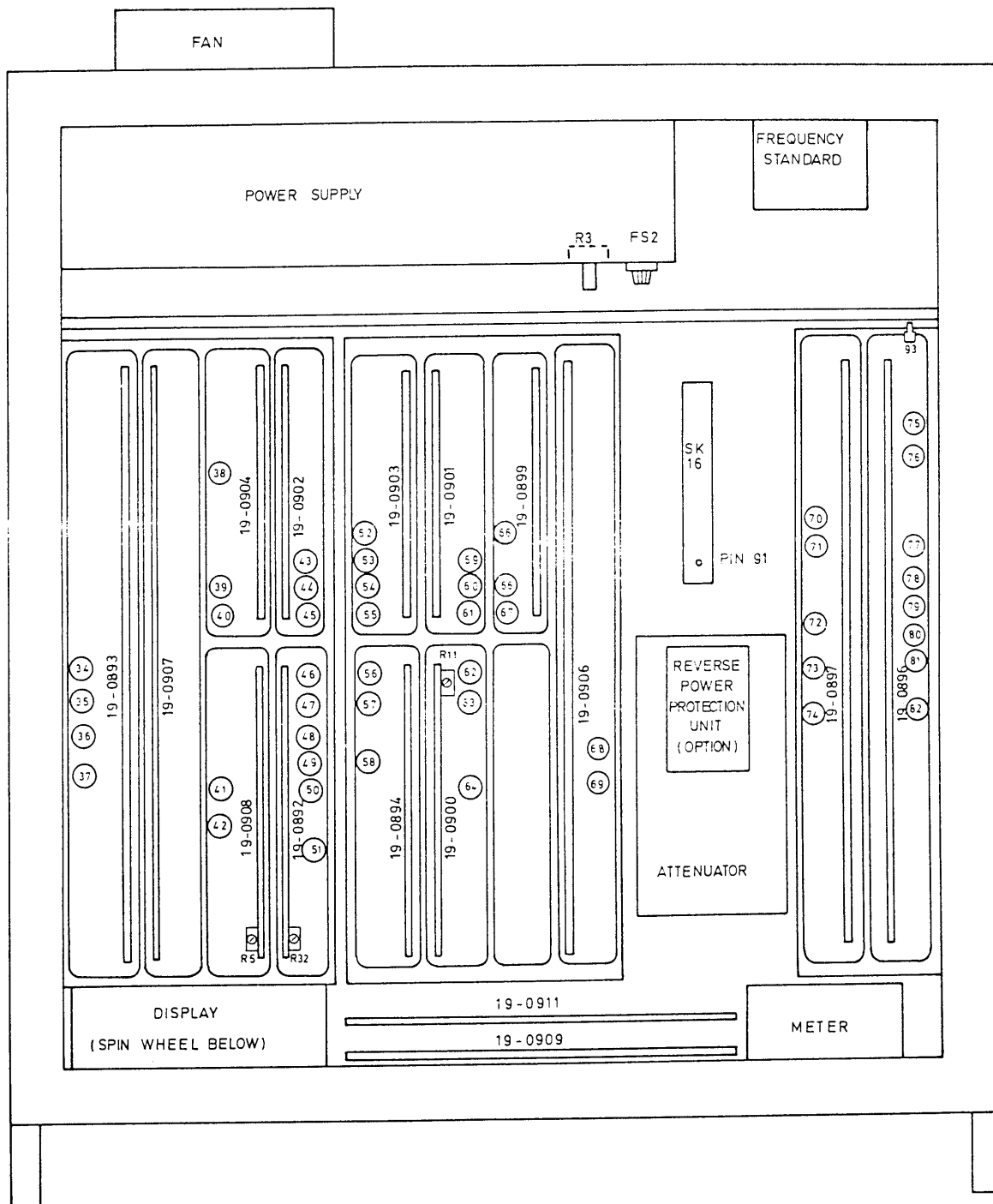
REAR PANEL ASSEMBLY 11-1334

		Fan			23-9091
FS1		Fuse link, (198V to 264V) 750mA, anti-surge,			23-0023
		Fuse link, (99V to 132V) 1.5A, anti-surge,			23-0024
		Holder for FS1			23-0044
SK3		Socket BNC			23-3005
SK30		Socket BNC			23-3005
SK32		Socket BNC			23-3005
		AC supply plug and filter			23-3222
		Power lead for fan			23-3261
S35		Switch, toggle			23-4043
S33		Switch slide			23-4091
S24		Switch slide			23-4091

FRONT PANEL ASSEMBLY 11-1333

Resistors

	<u>Ω</u>		<u>W</u>		
R11	4.7k	Variable			20-6629
R12	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R13	5k	Variable			20-6030

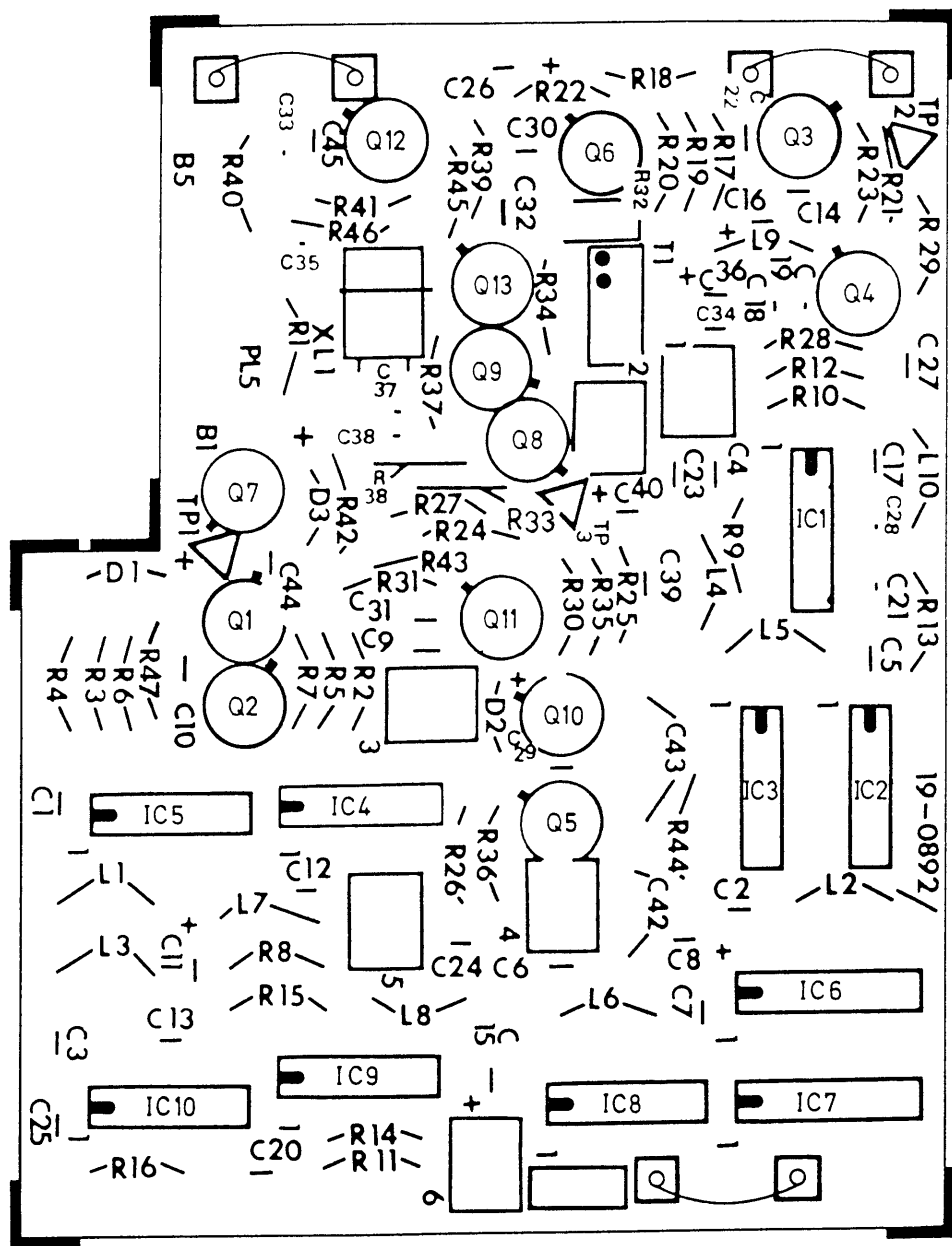


RACAL

TH 1007	9084
1	

Internal Layout

Fig.1

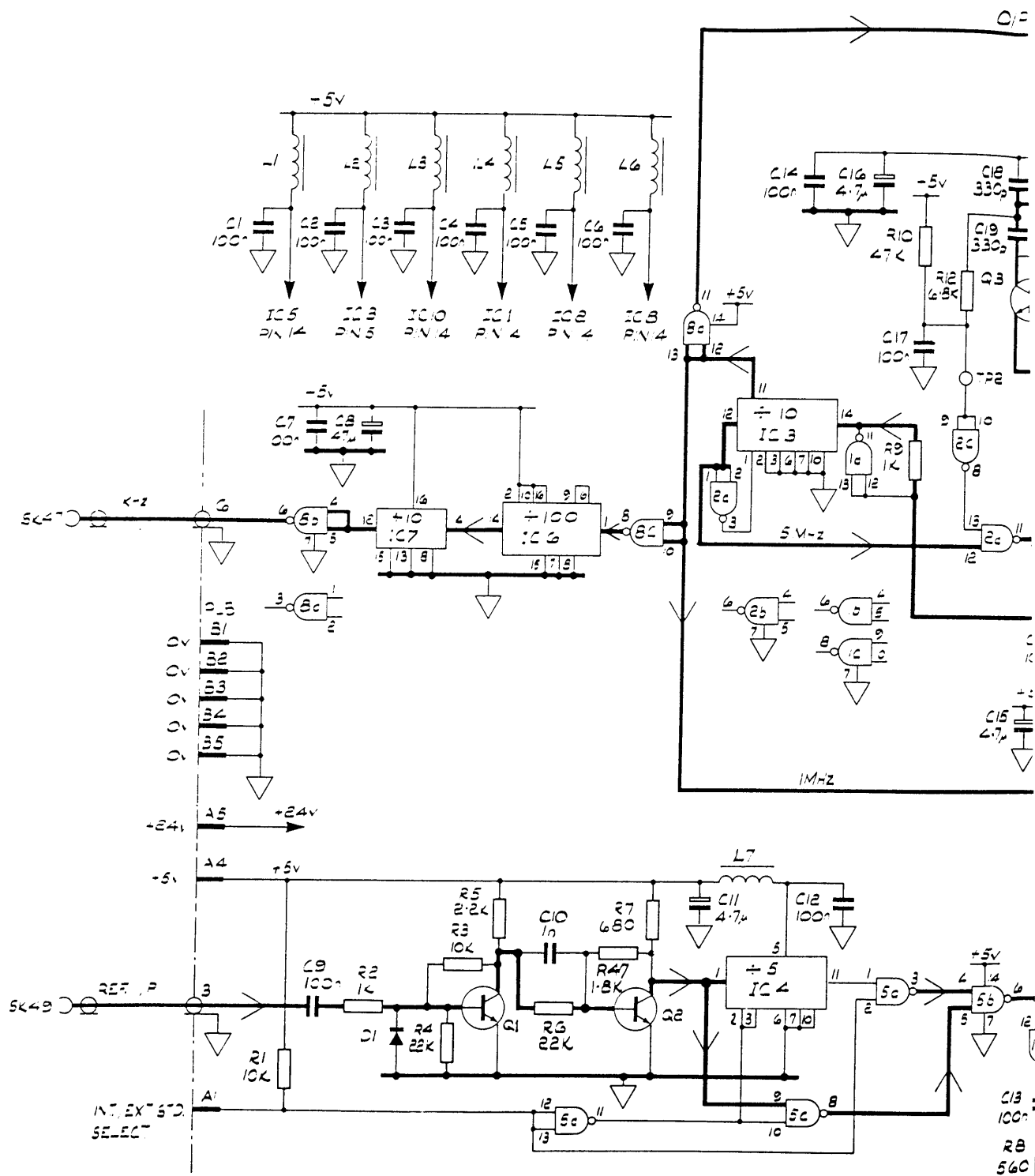


RACAL

TH1007
2

Component Layout:
Reference Source Assembly
19-0892

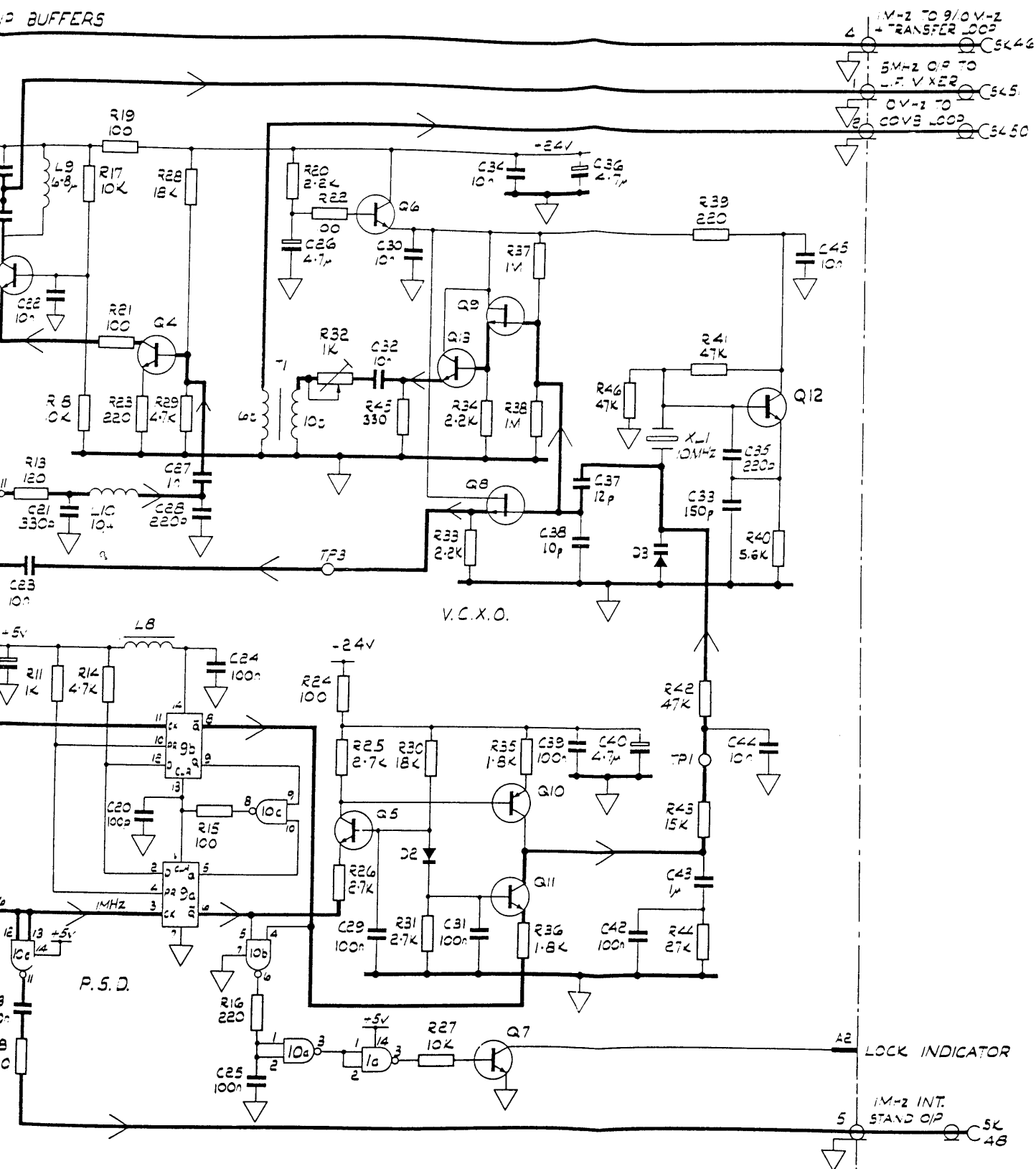
Fig. 2



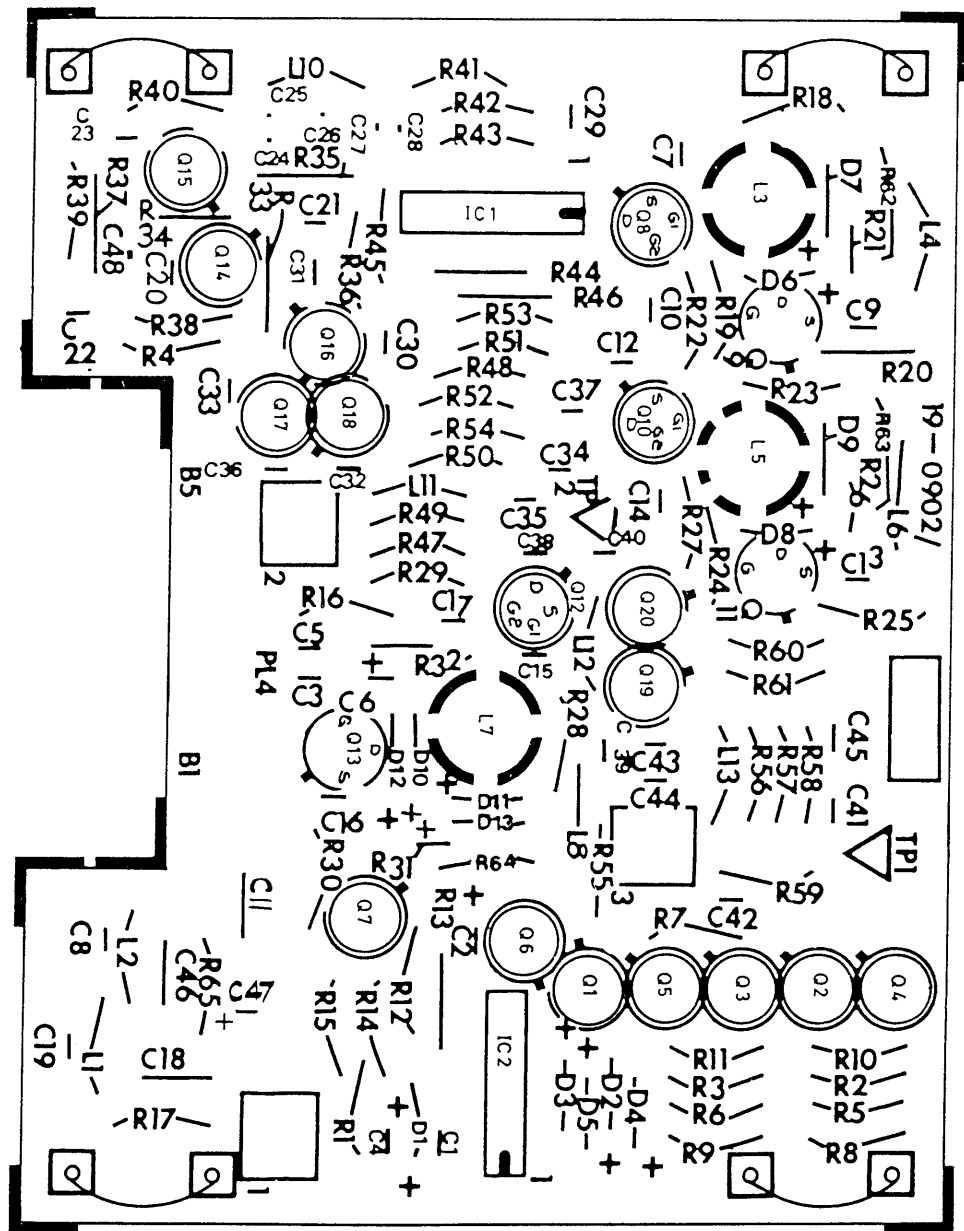
RACAL

TH 1007
213

2 BUFFERS



Circuit Diagram:
Reference Source Assembly 19-0892 Fig. 3

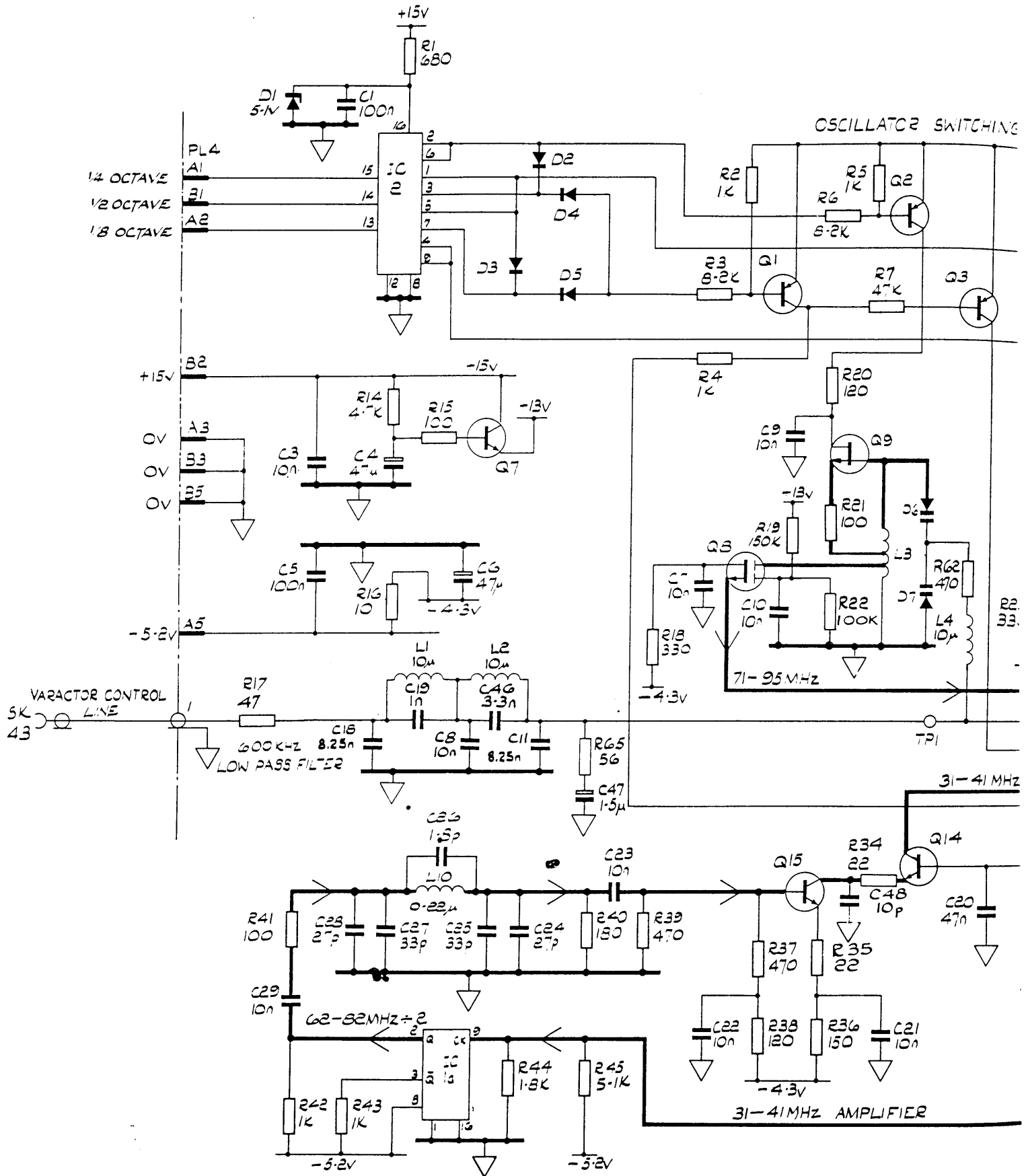


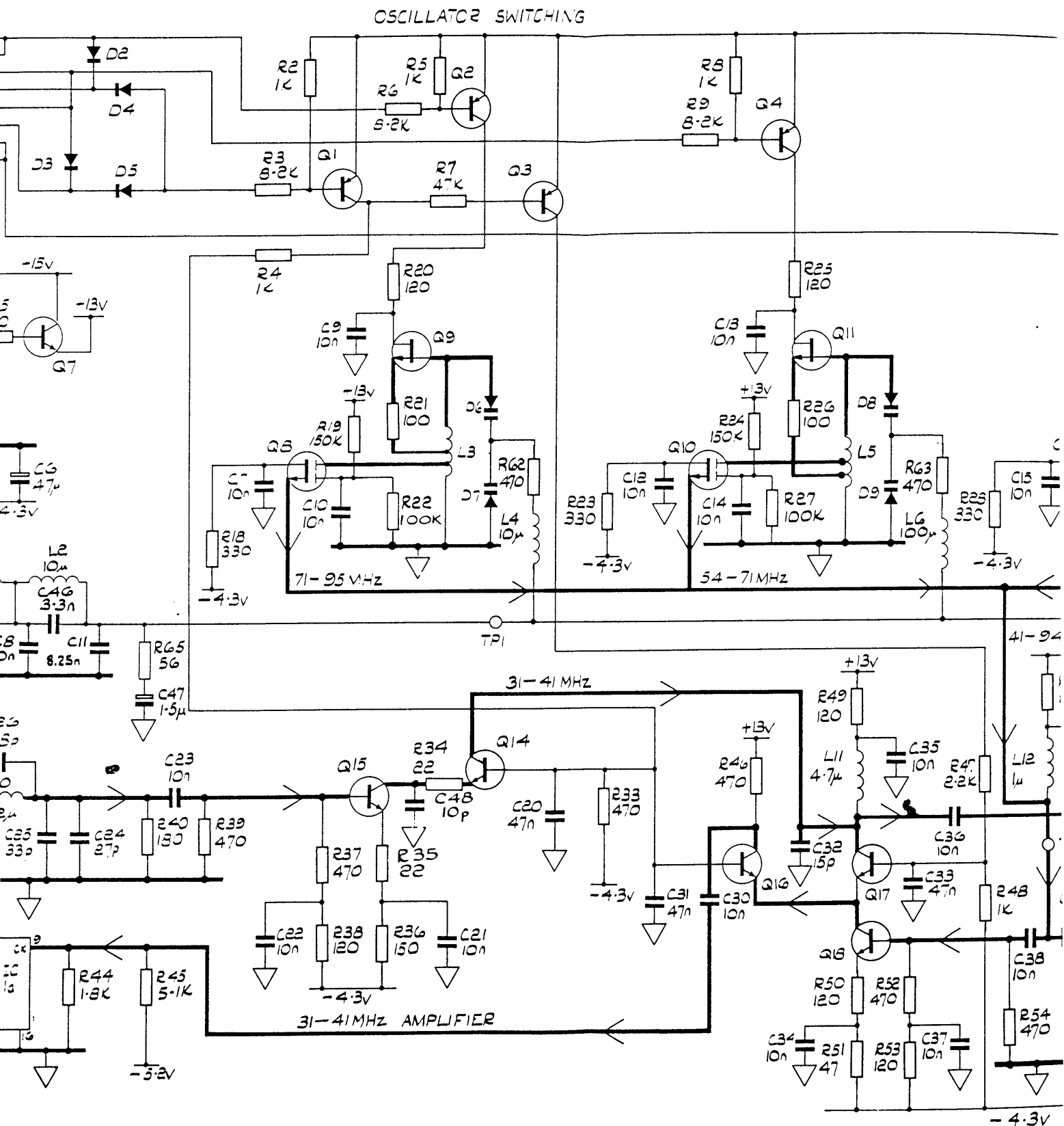
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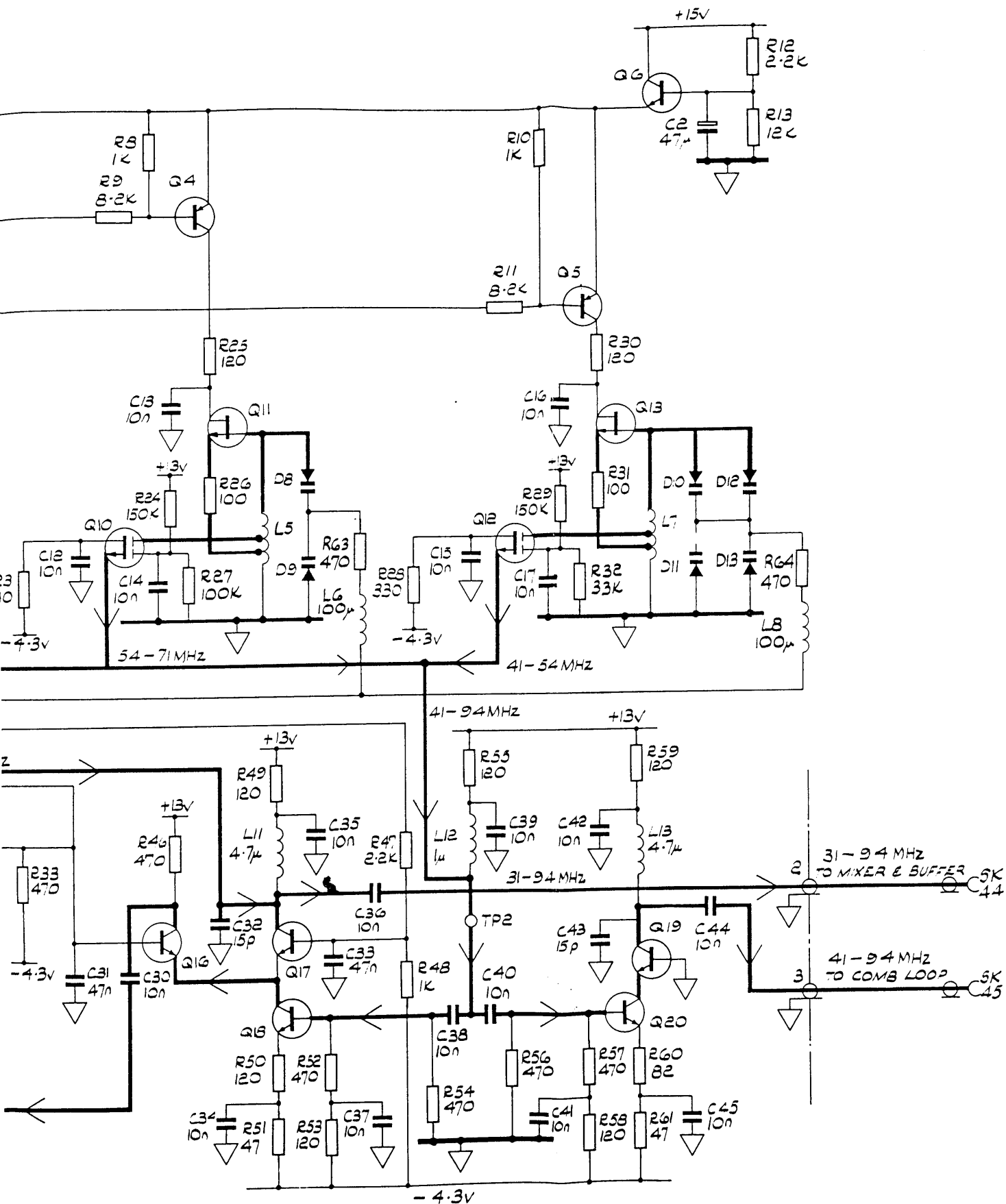
TH1007
2

Component Layout:
1 MHz Comb Loop Oscillator Assembly 19-0902

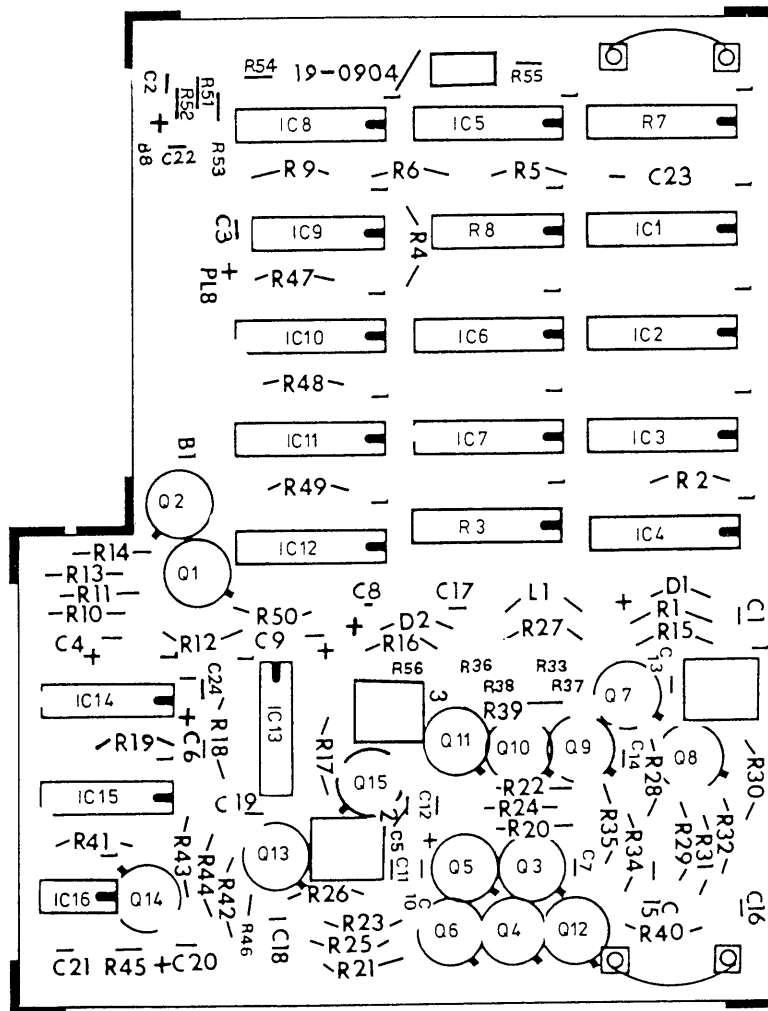
Fig.4



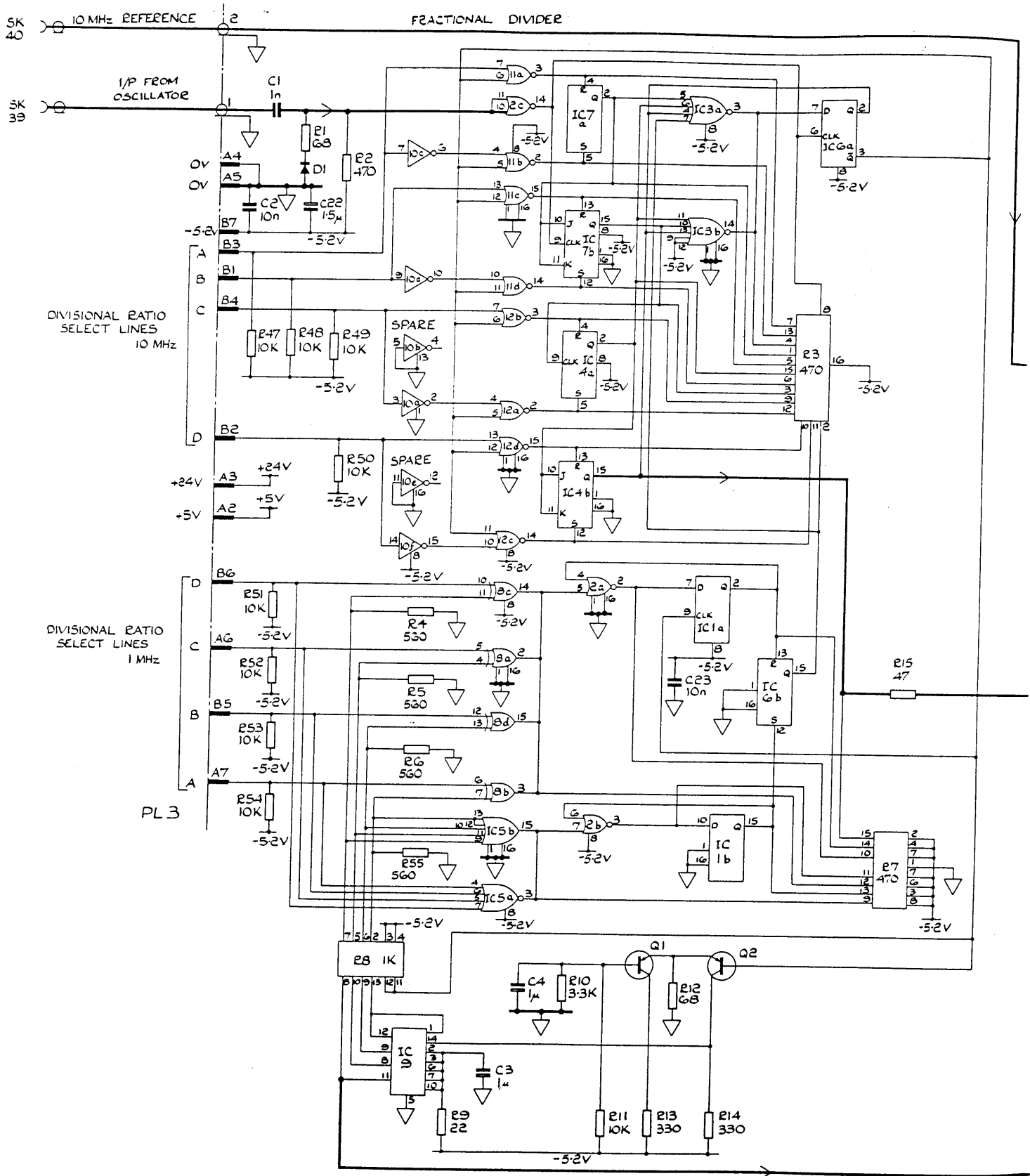




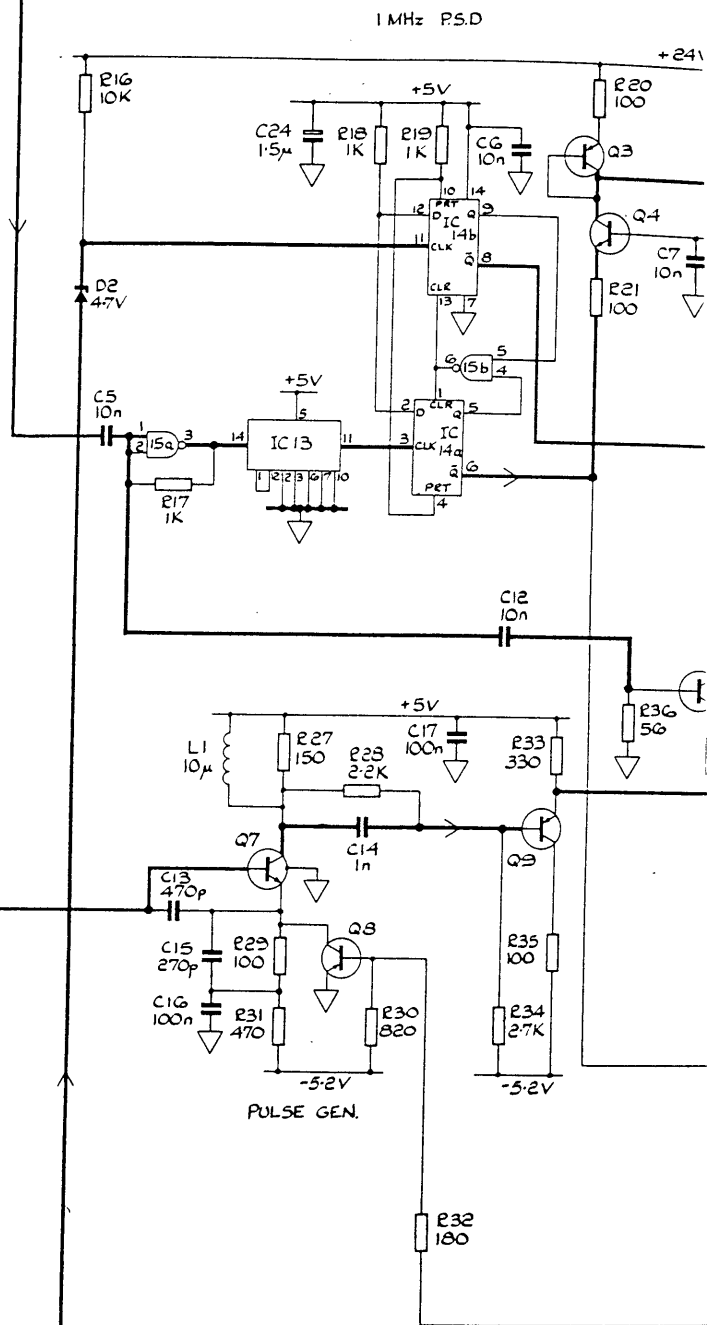
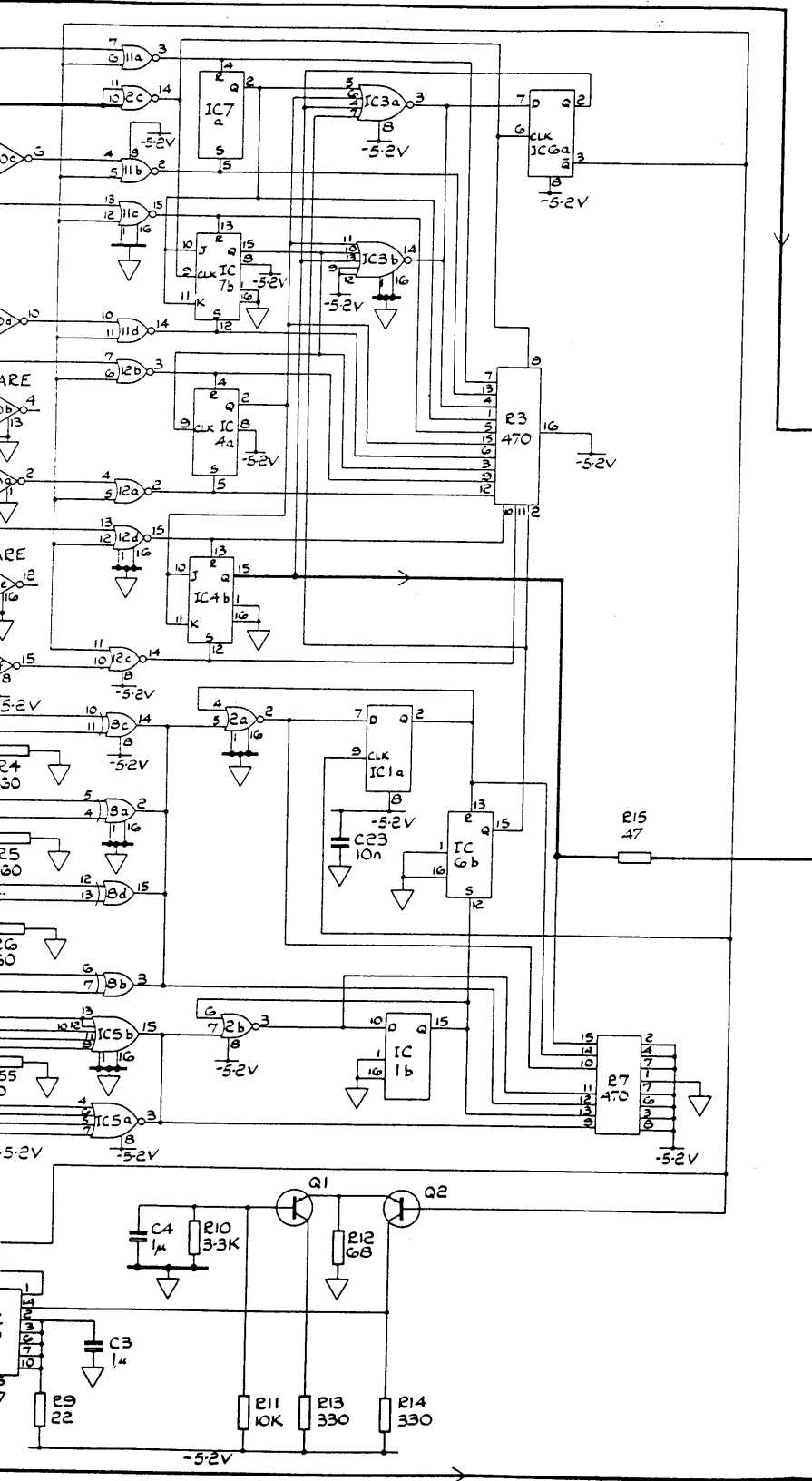
Circuit Diagram: 1MHz Comb Loop
Oscillator Assembly 19-0902

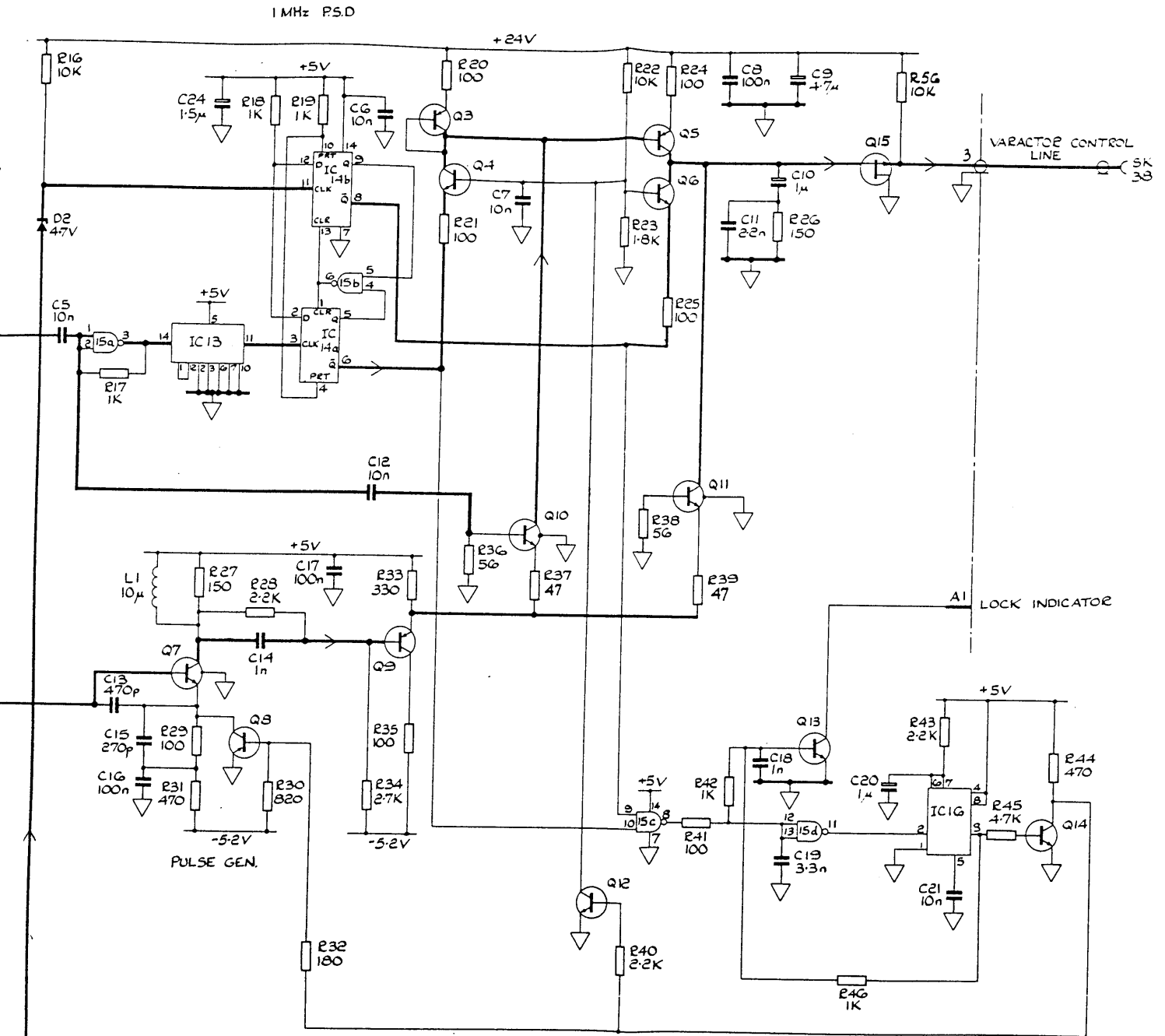


Component Layout :
1 MHz Comb Loop Assembly 19-0904



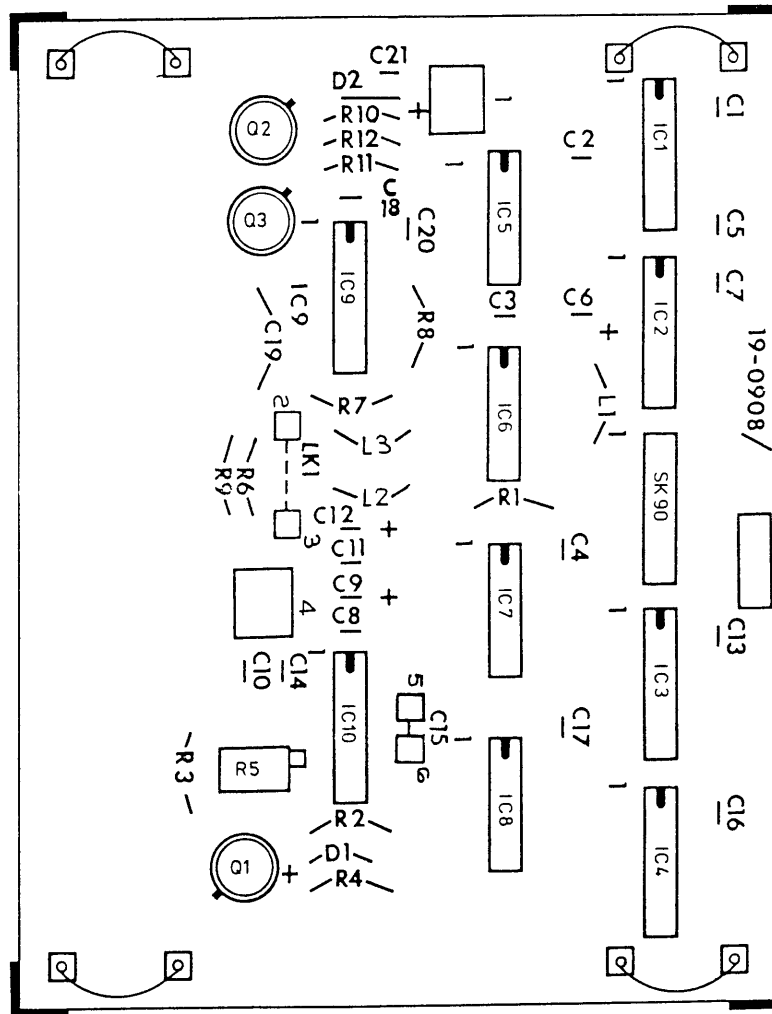
FRACTIONAL DIVIDER





Circuit Diagram :
1MHz Comb Loop Assembly 19-0904

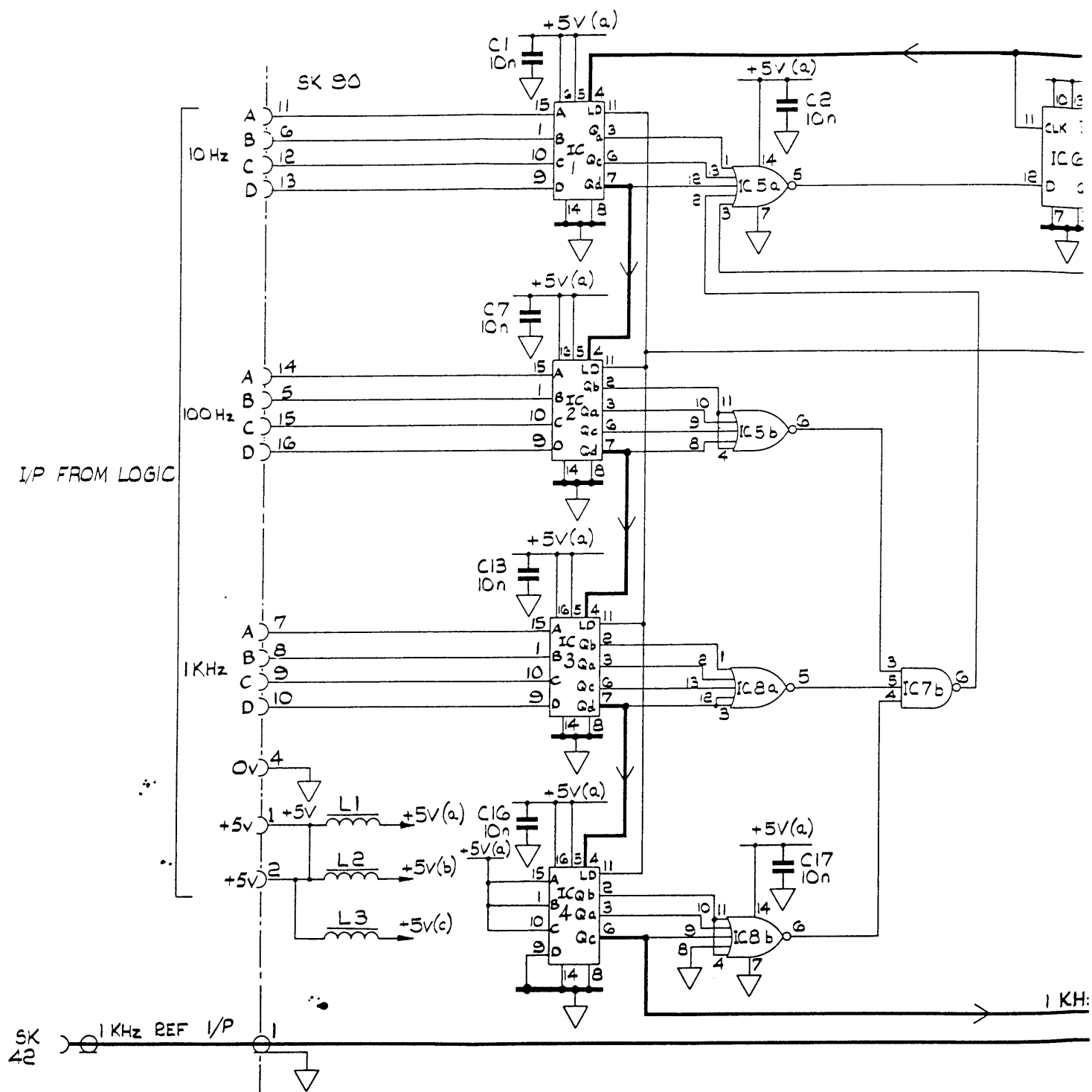
Fig.7

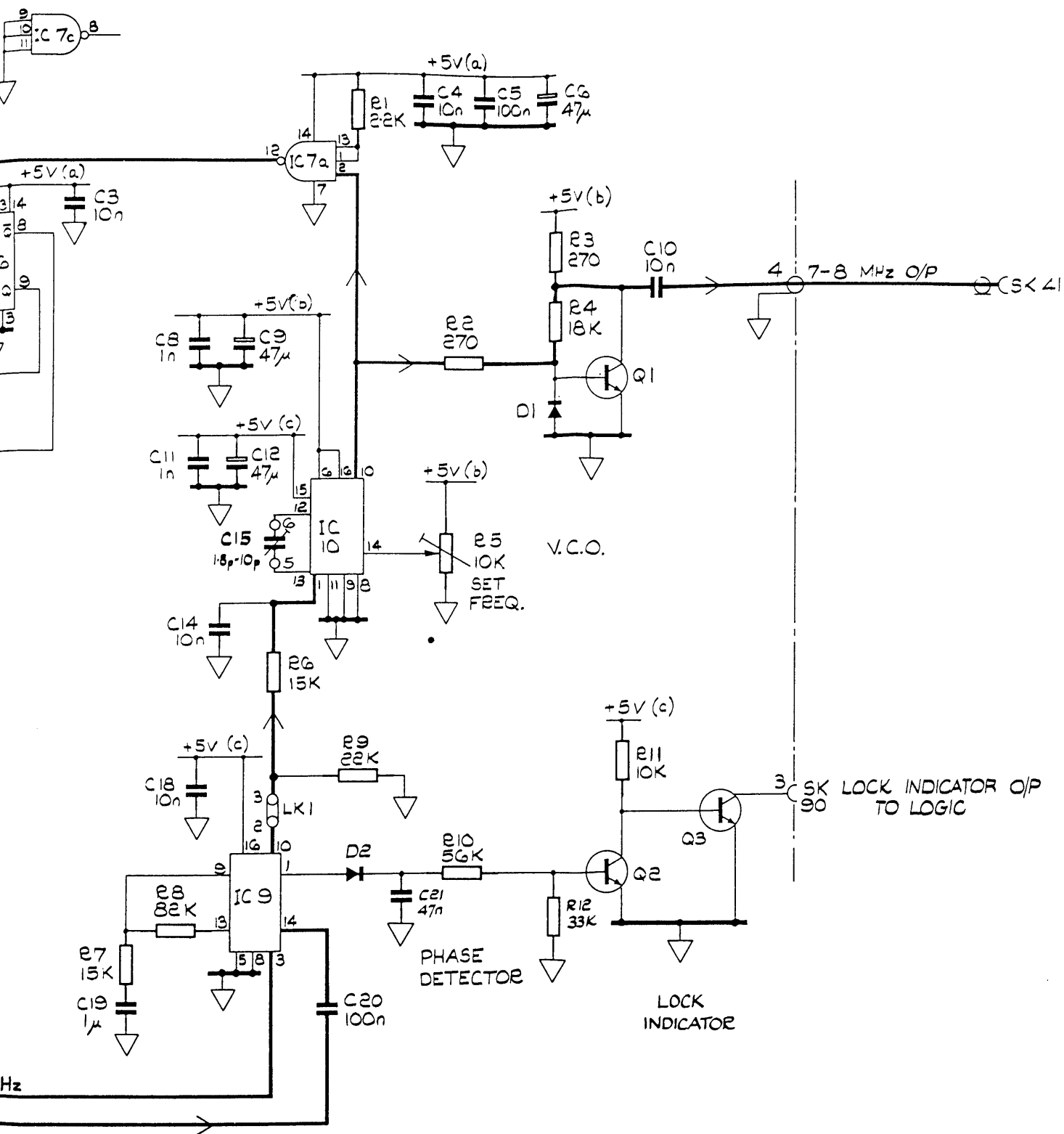


Component Layout:
1 kHz Comb Loop Assembly 19-0908

Fig.8

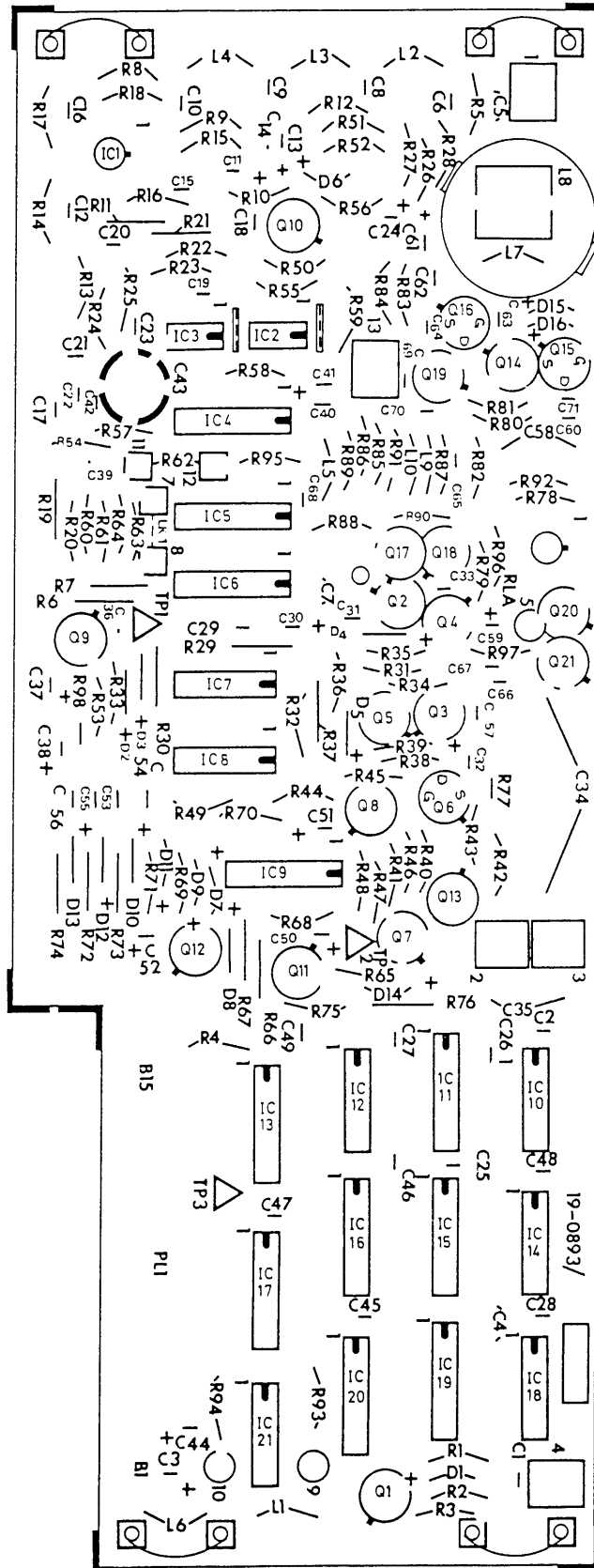
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Circuit Diagram:
1kHz Comb Loop Assembly 19-0908

Fig. 9

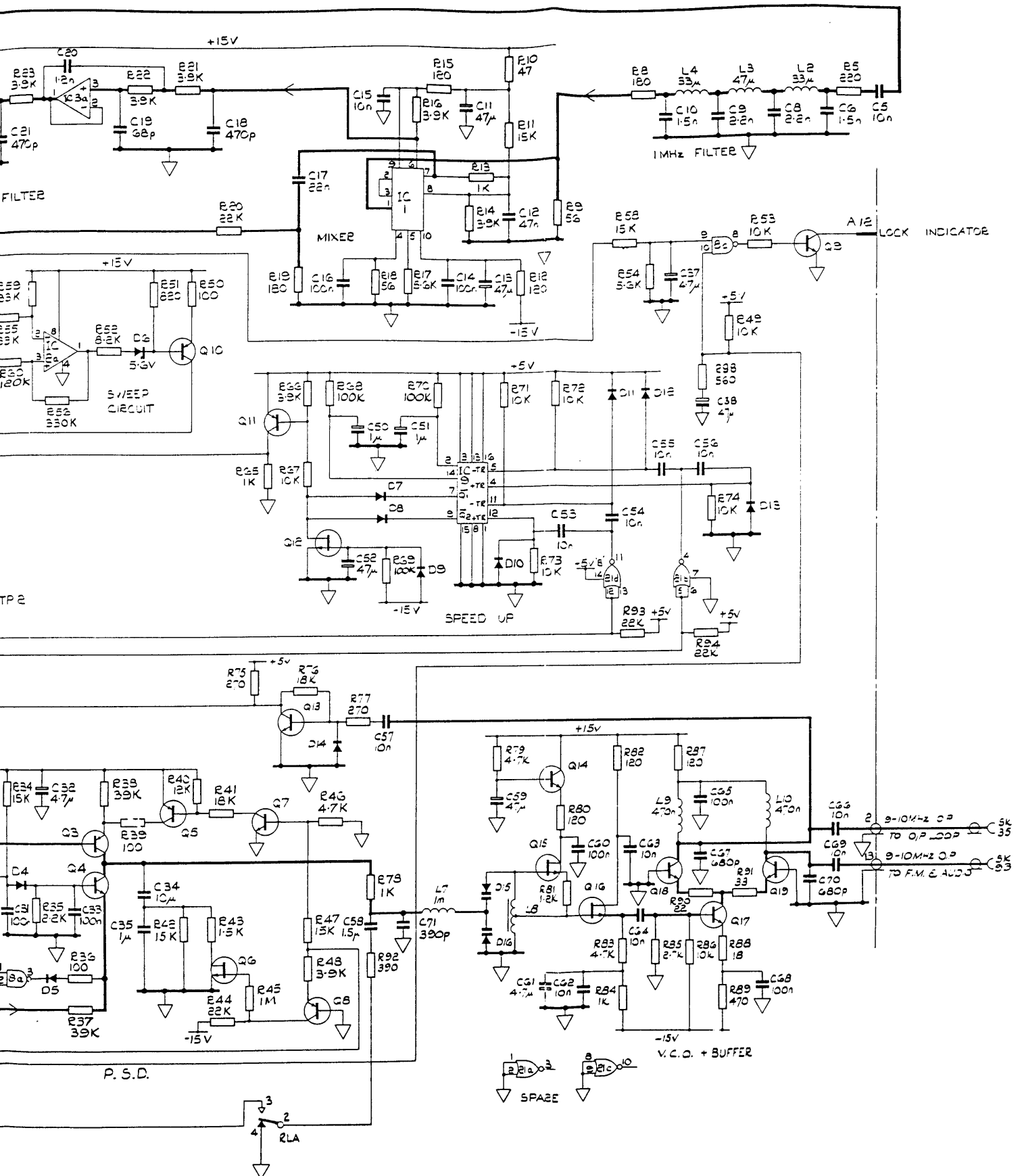


Component Layout
Transfer Loop Assembly 19-0893

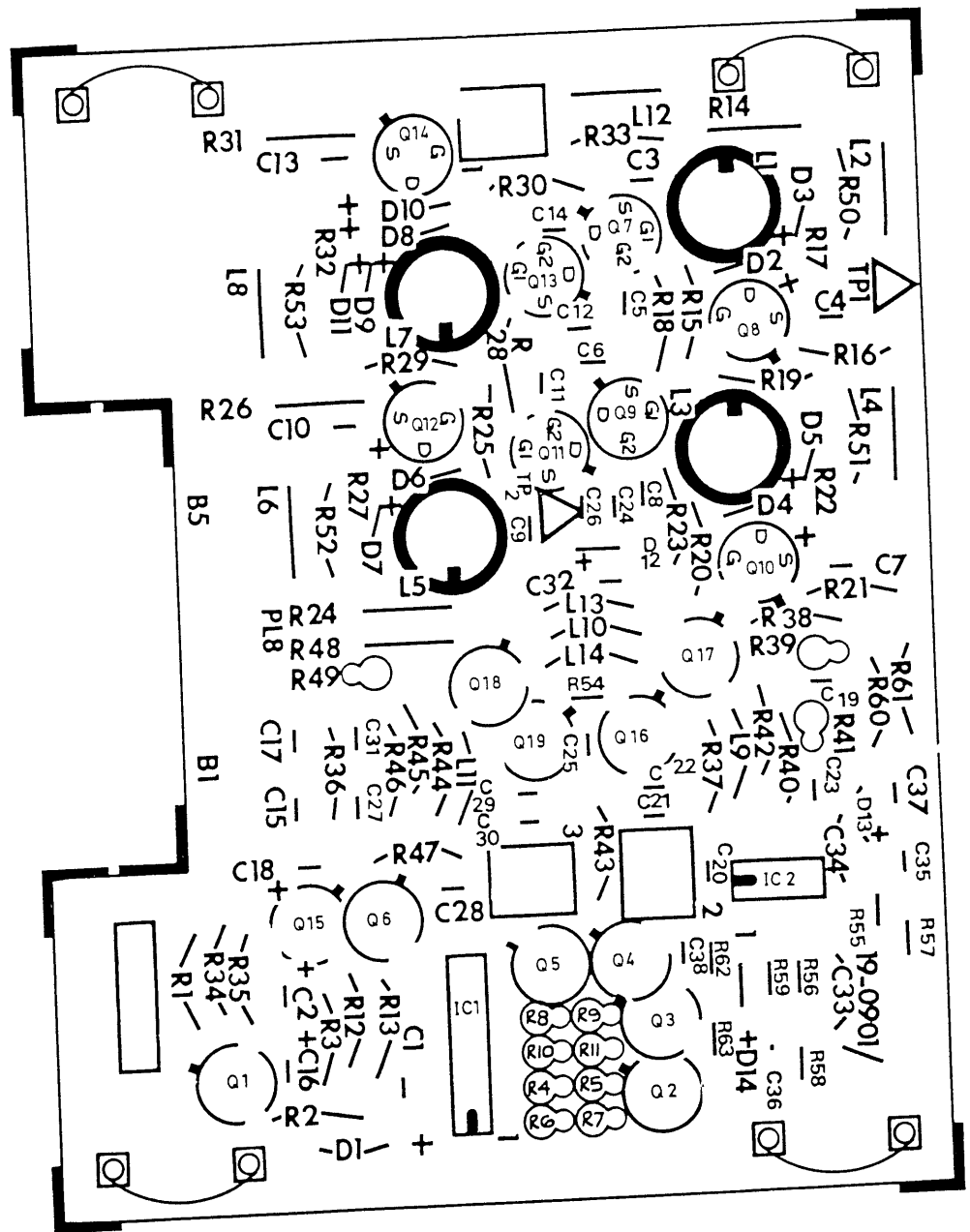
Fig.10

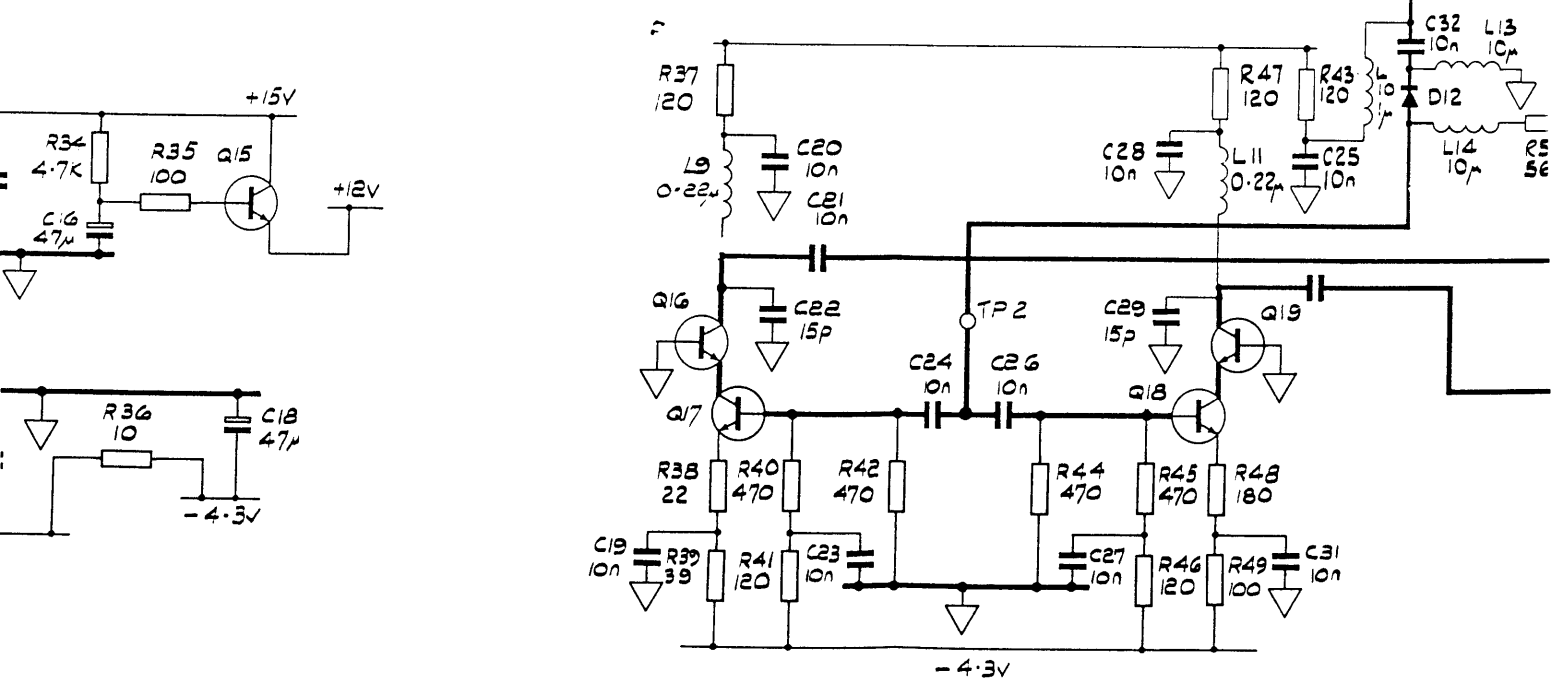
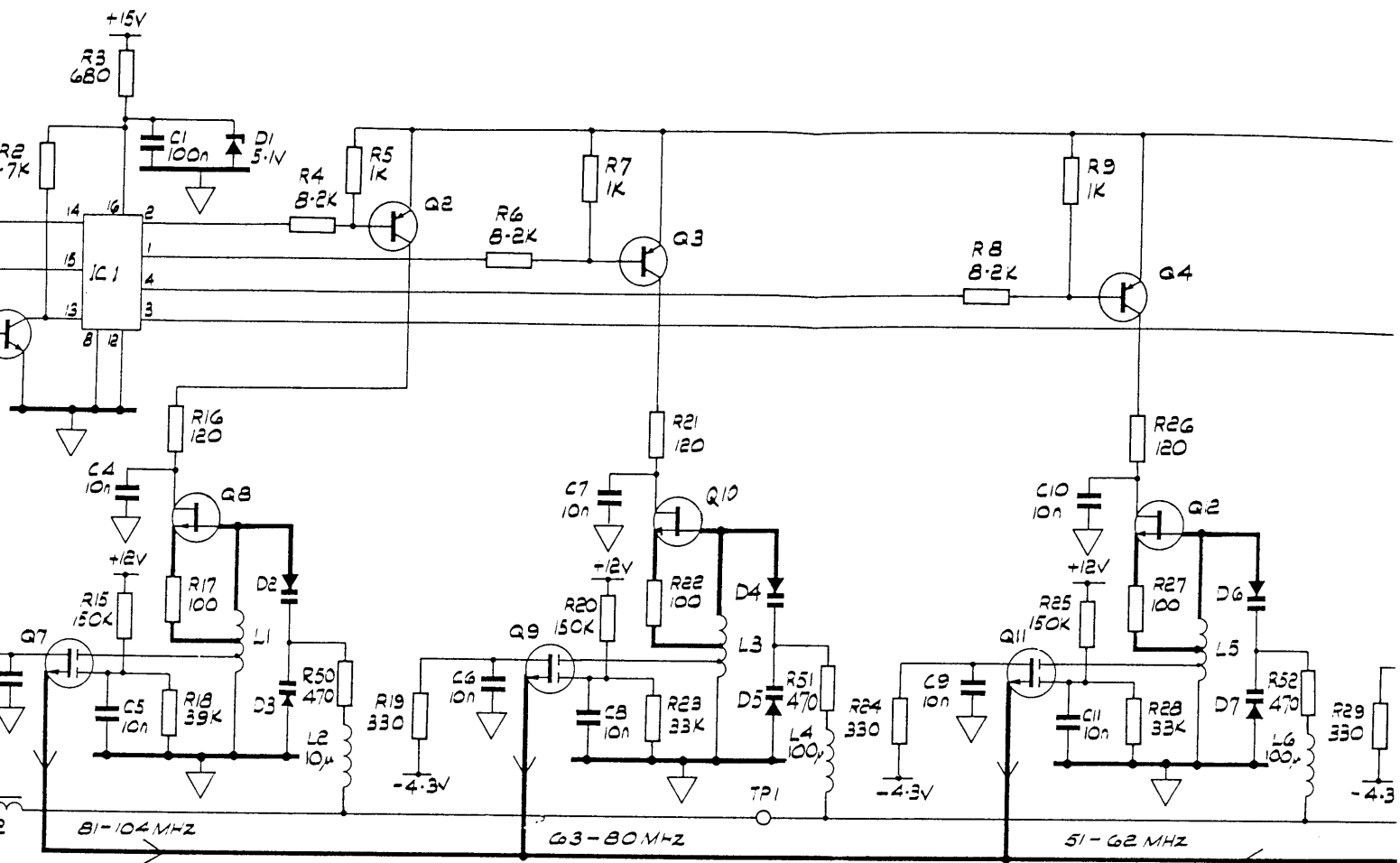


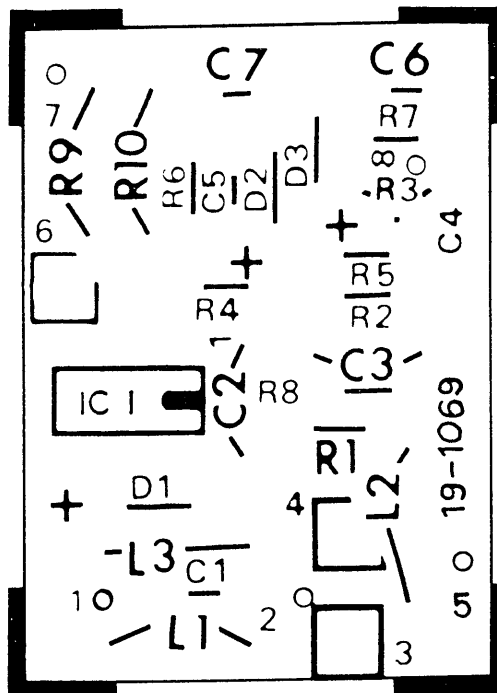
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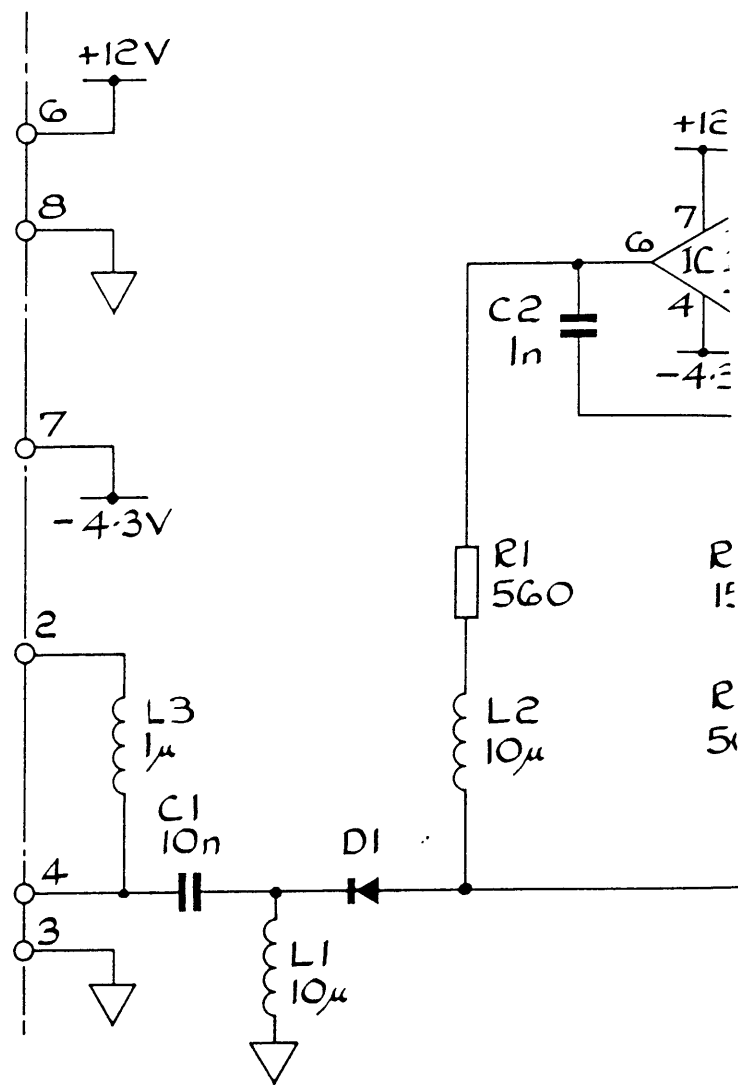


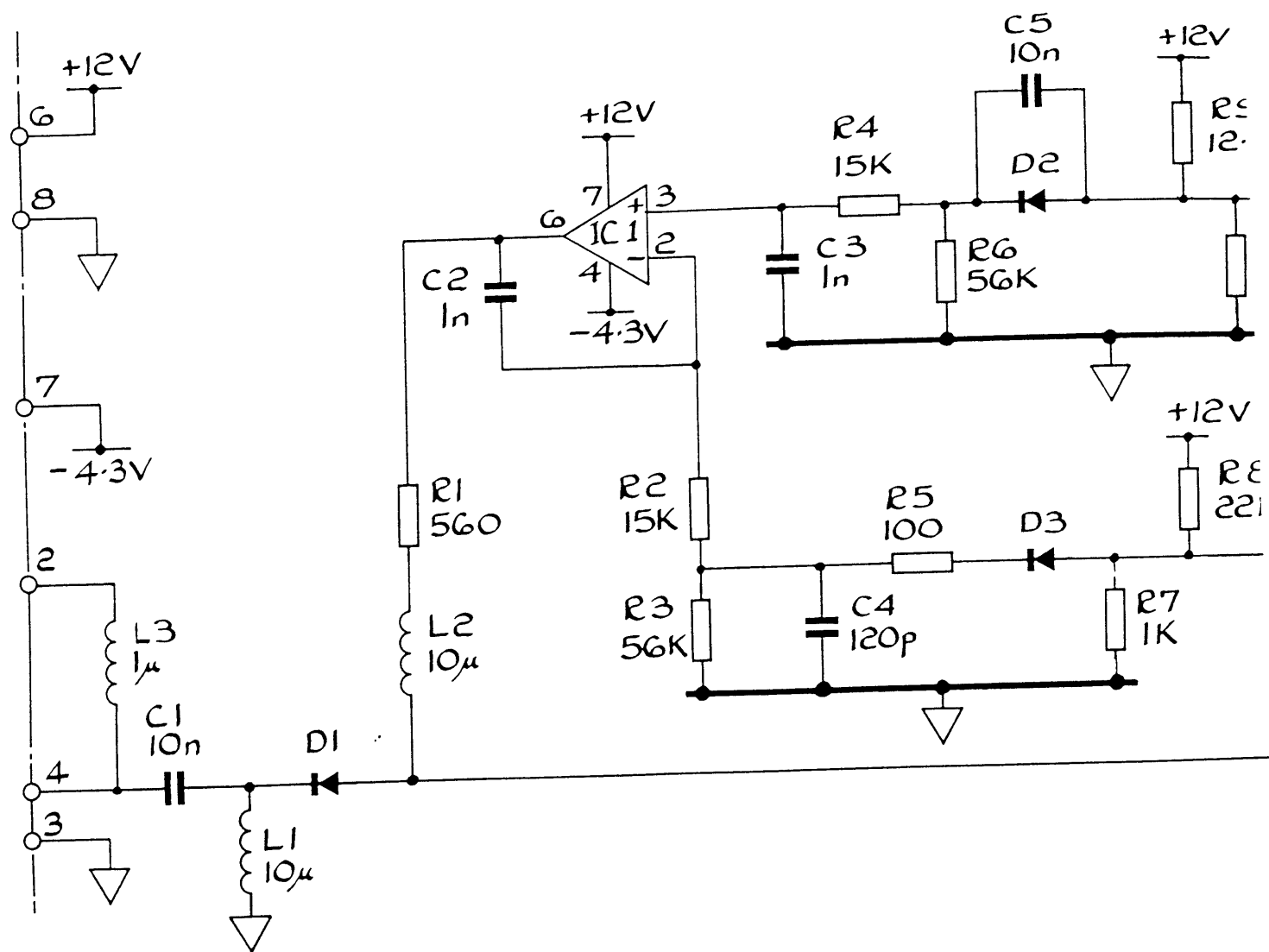
Circuit Diagram:
Transfer Loop Assembly 19-0893



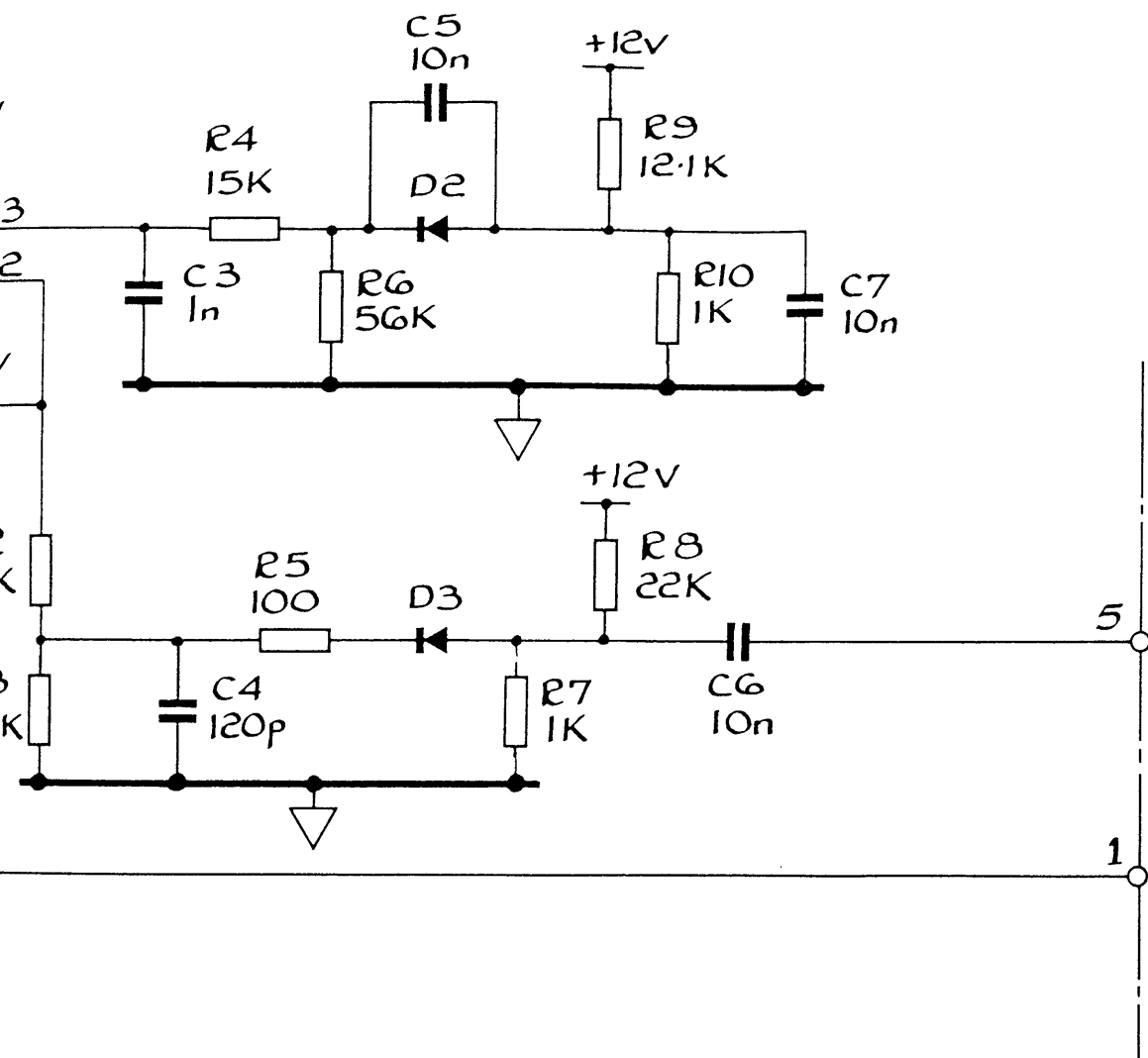




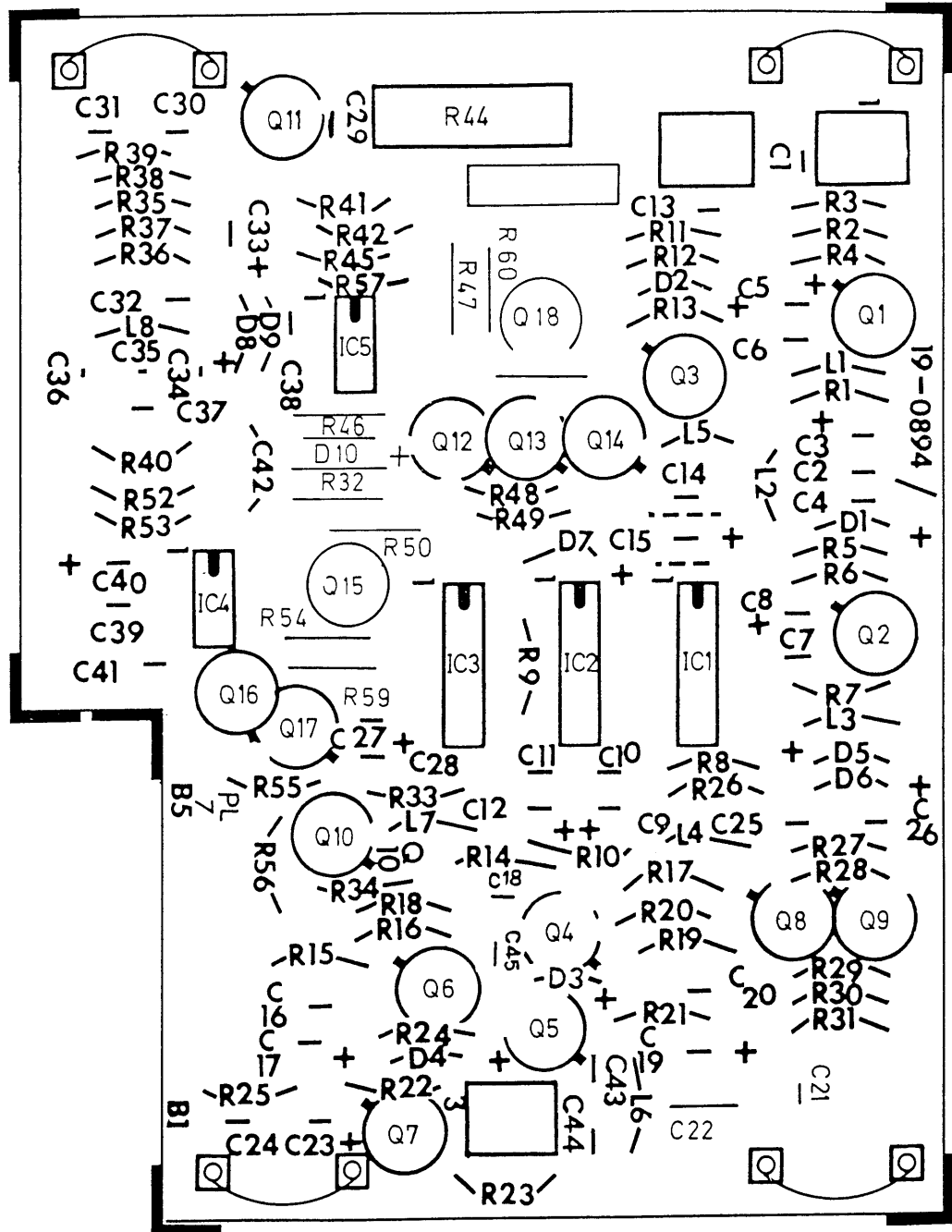


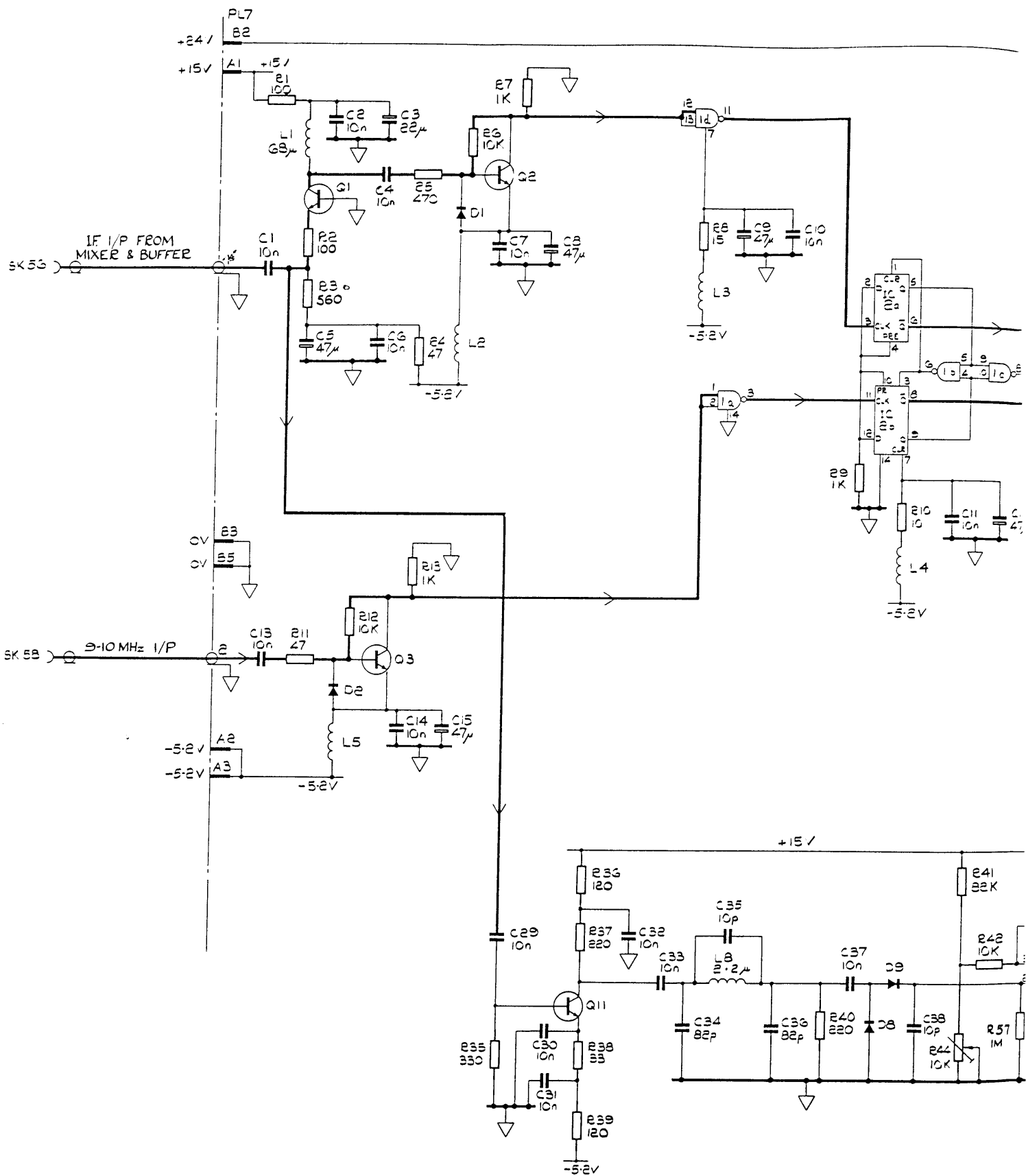


Circuit Diagram
Output Oscilloscope



Circuit Diagram :
Output Oscillator ALC Assembly 19-1069 Fig.15

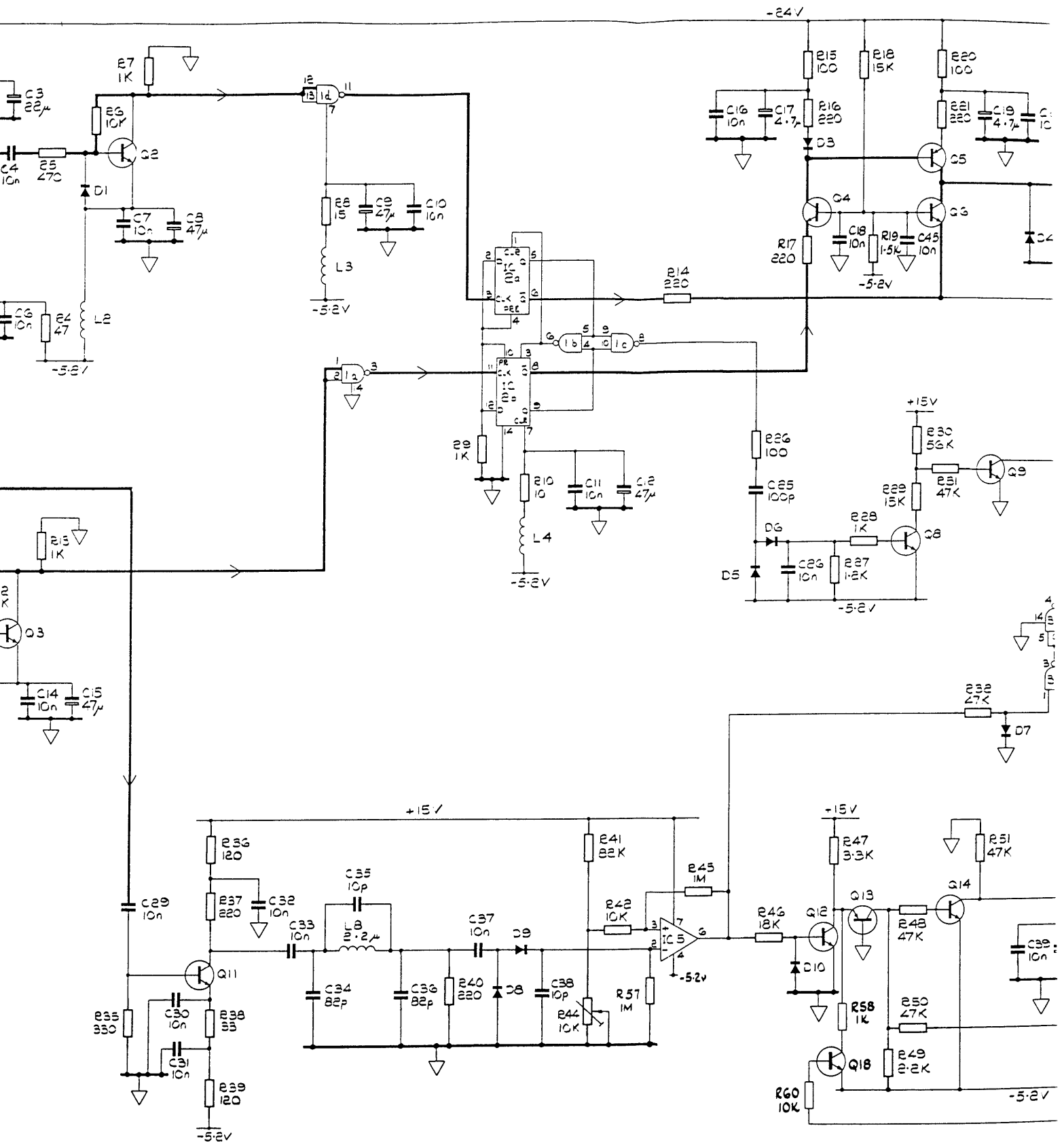


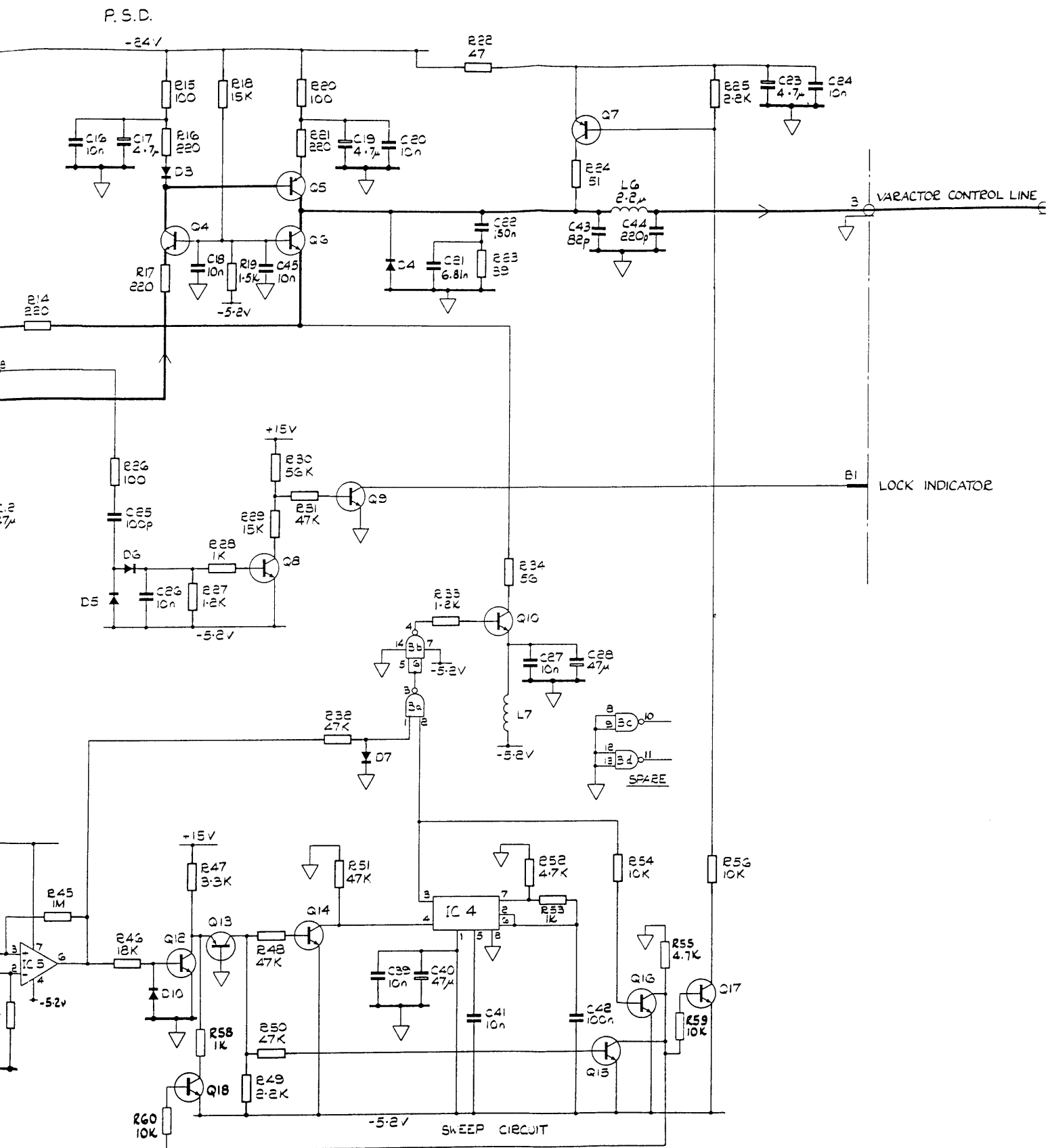


RACAL

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23

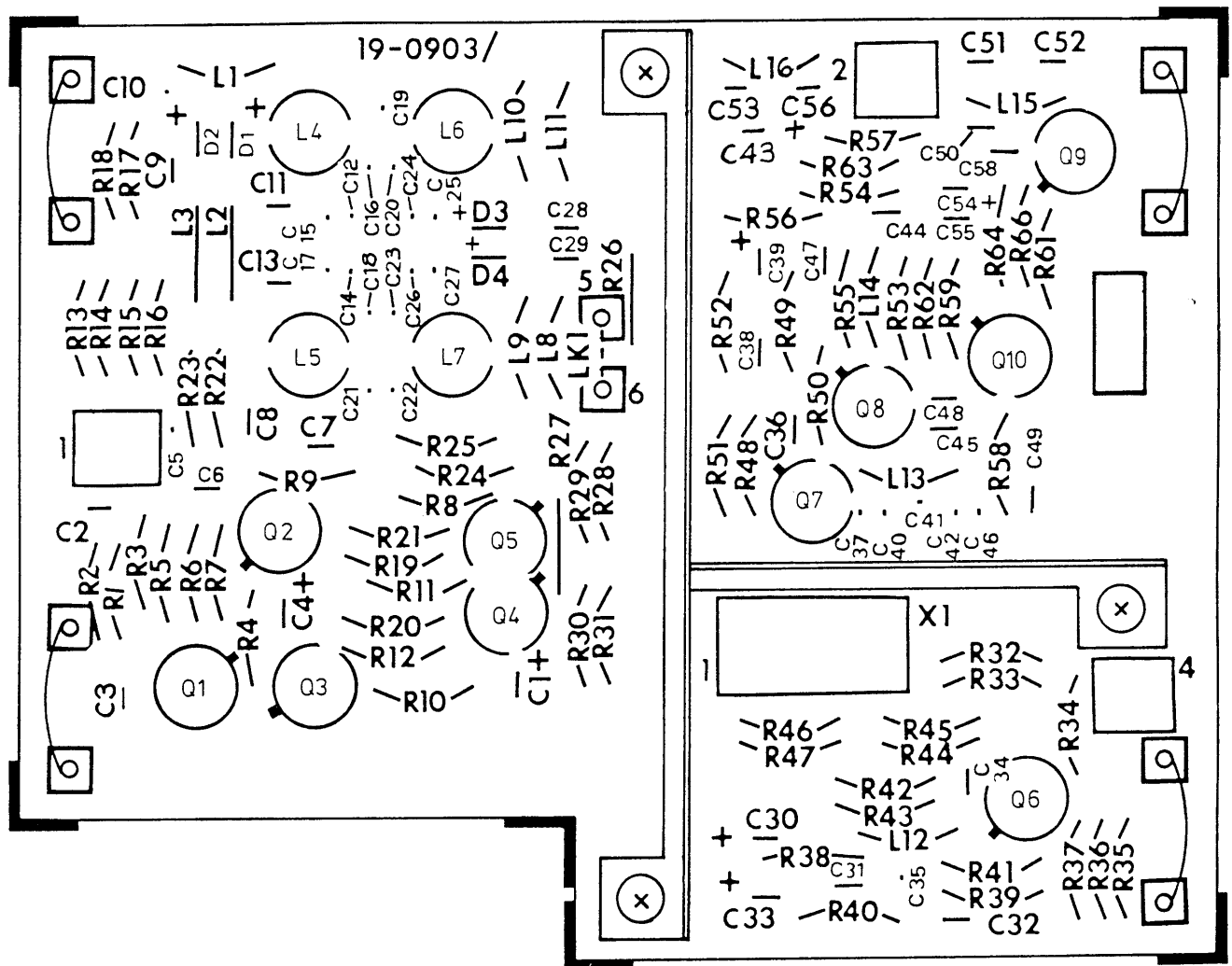
P. S. D.





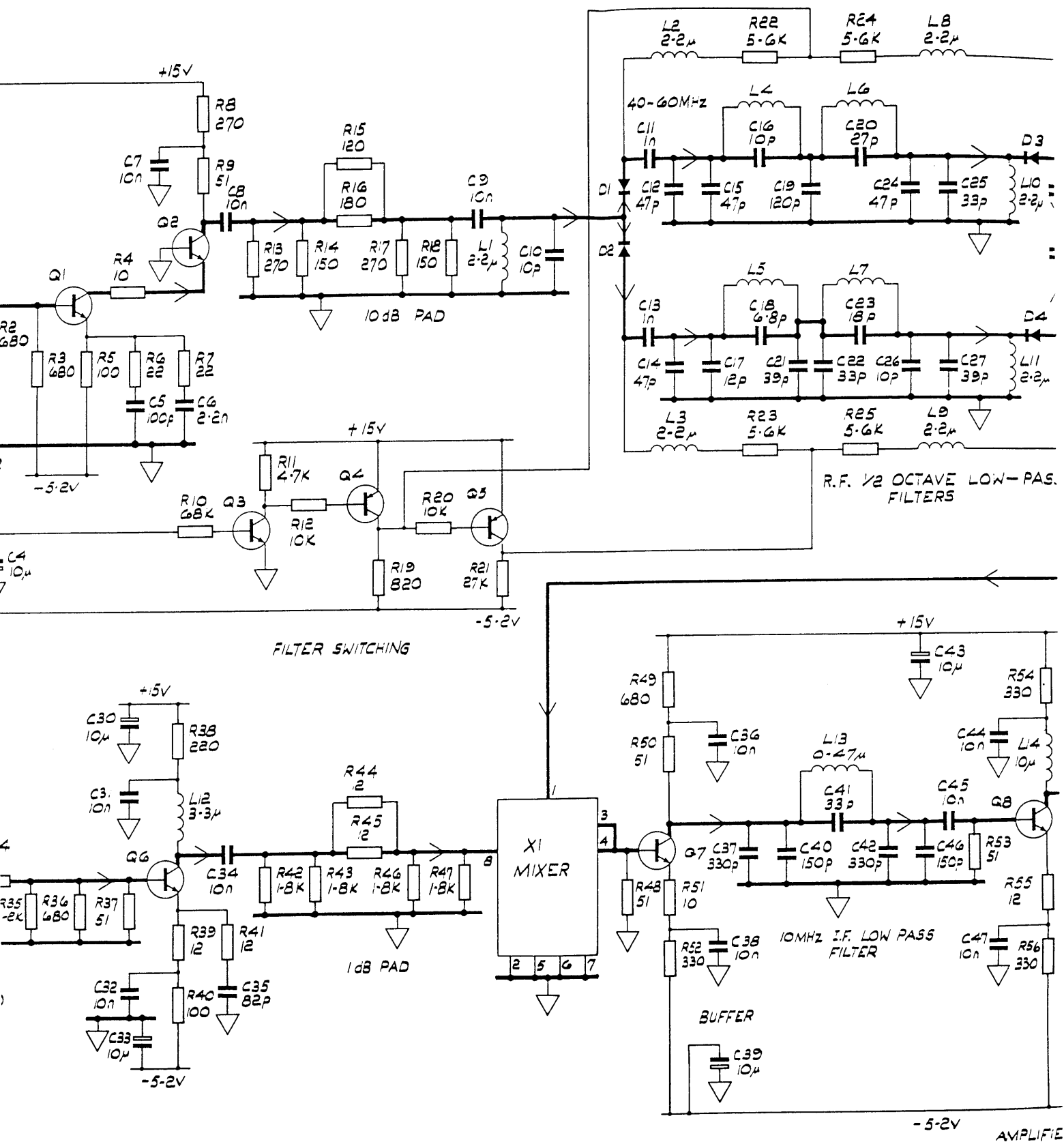
Circuit Diagram: Output
Loop Assembly 19-0894

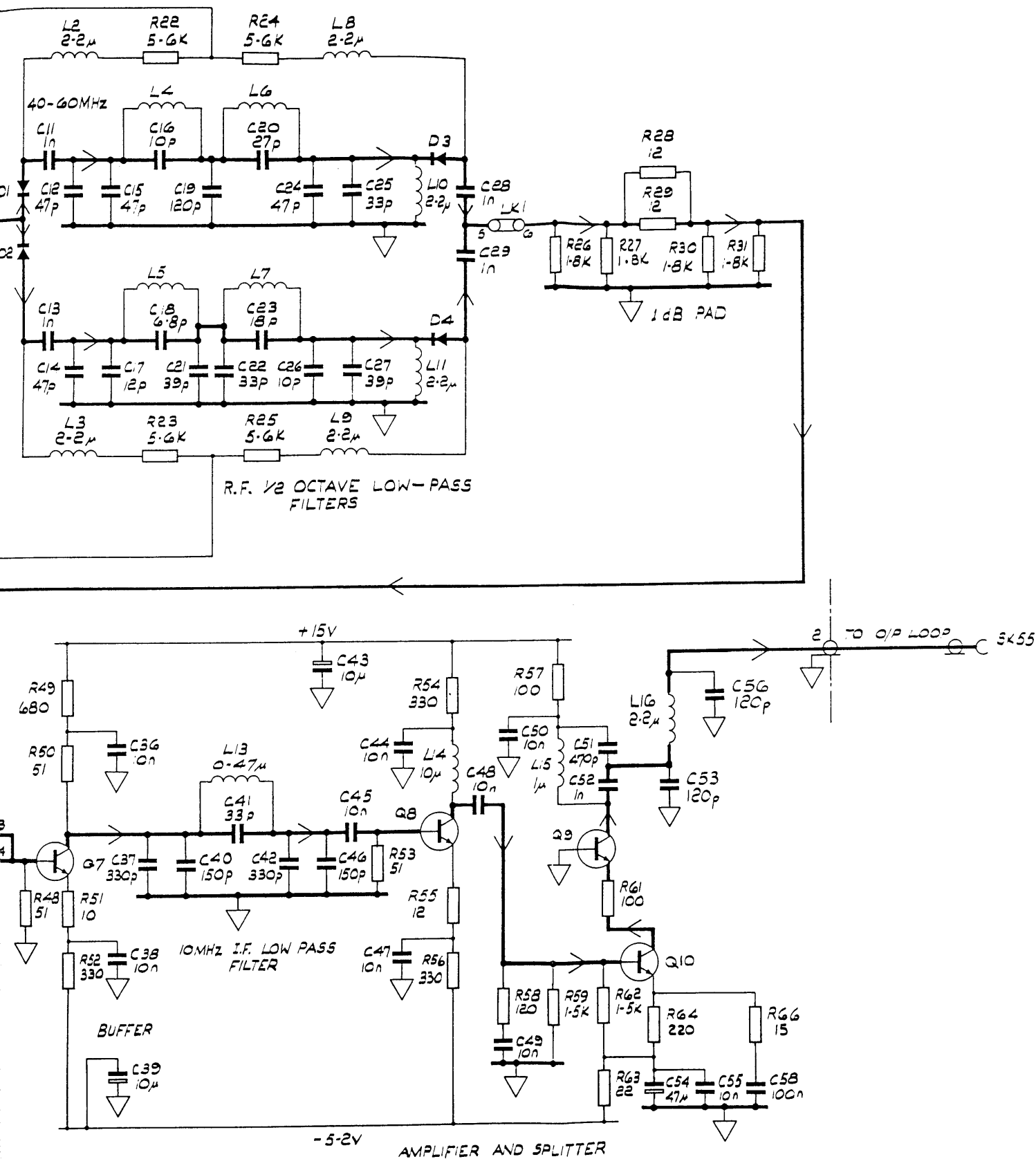
Fig



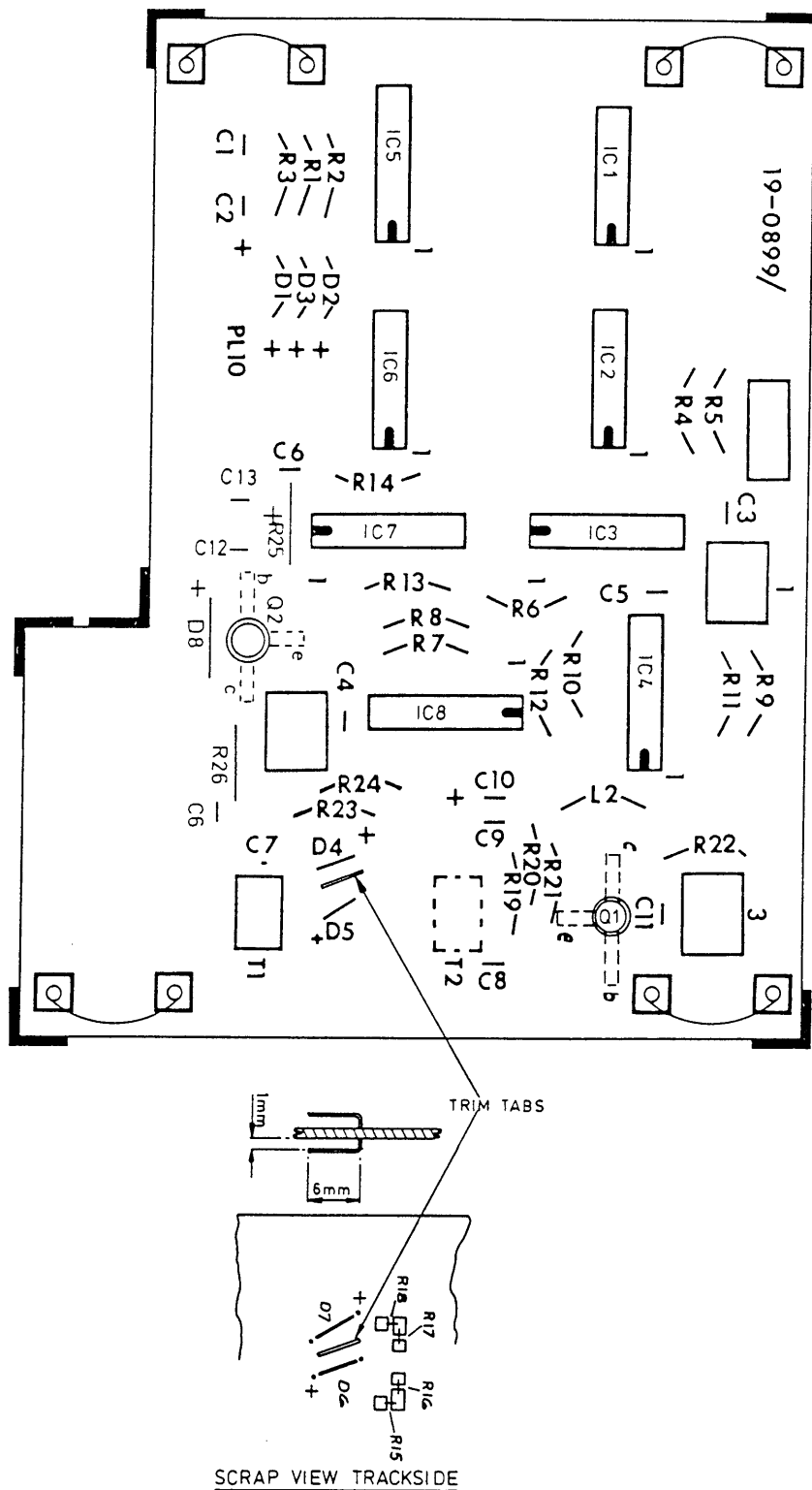
Component Layout
Mixer and Buffer Assembly
19-0903



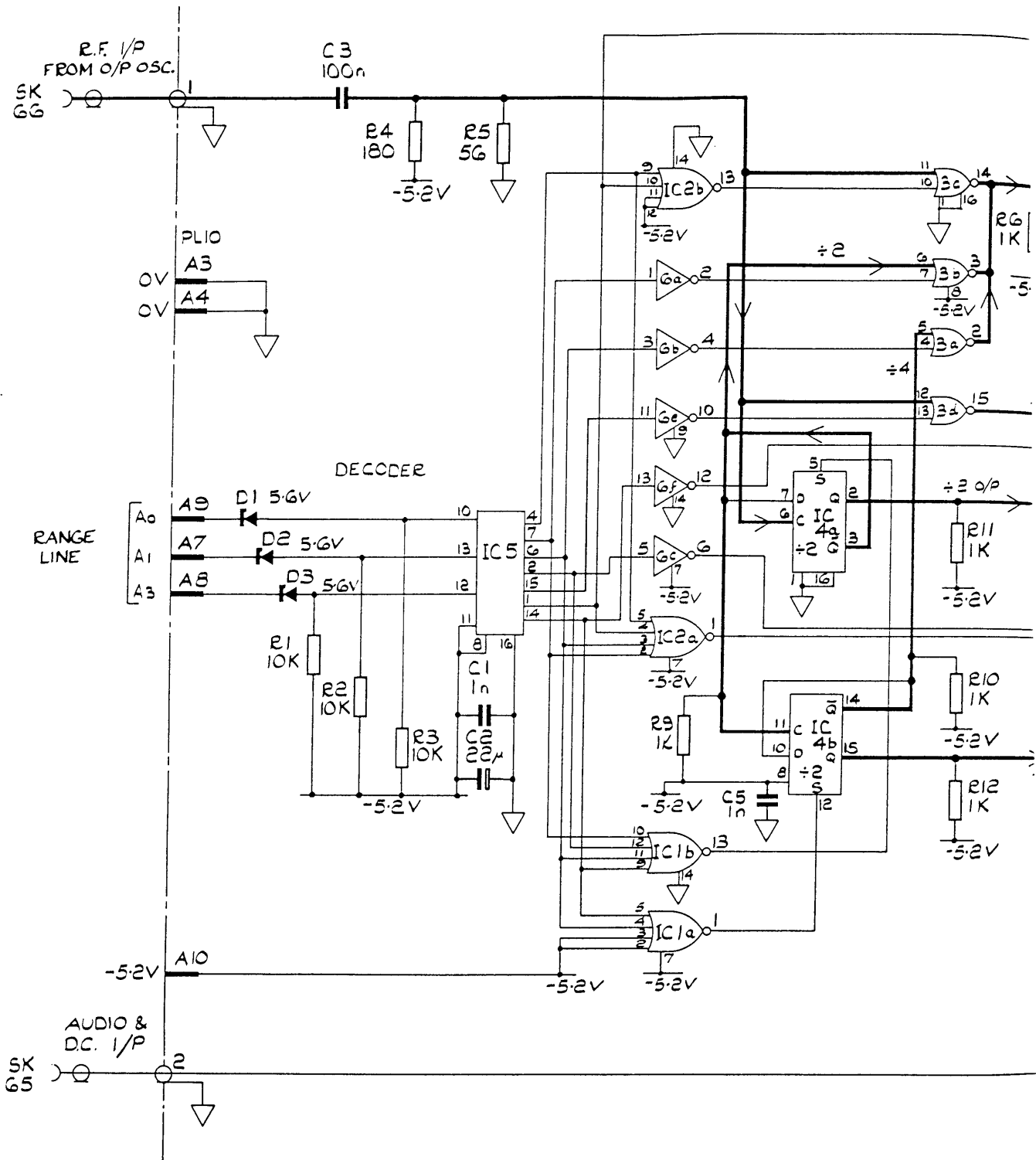




Circuit Diagram: Fig. 19
Mixer and Buffer Assembly 19-0903

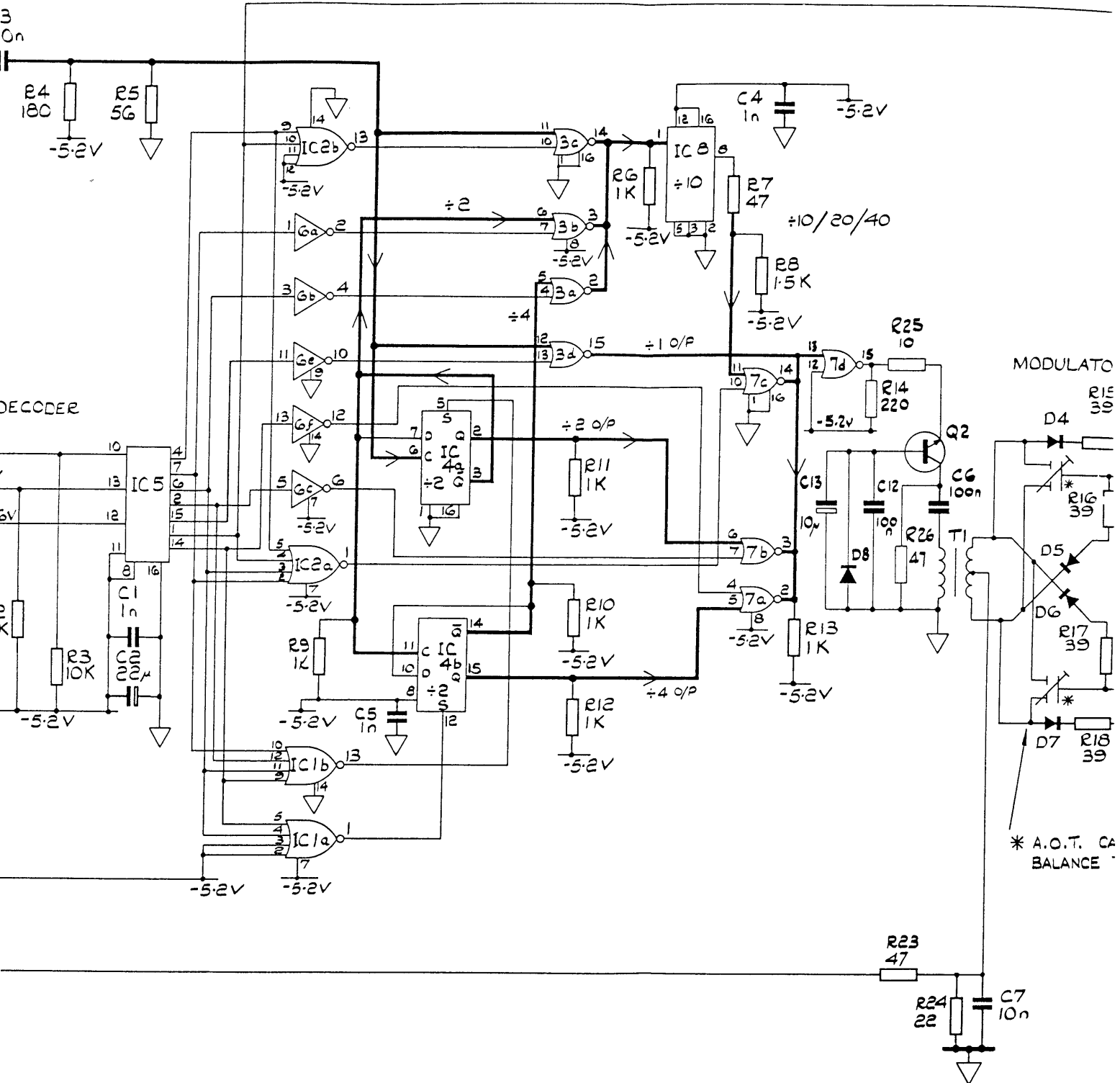


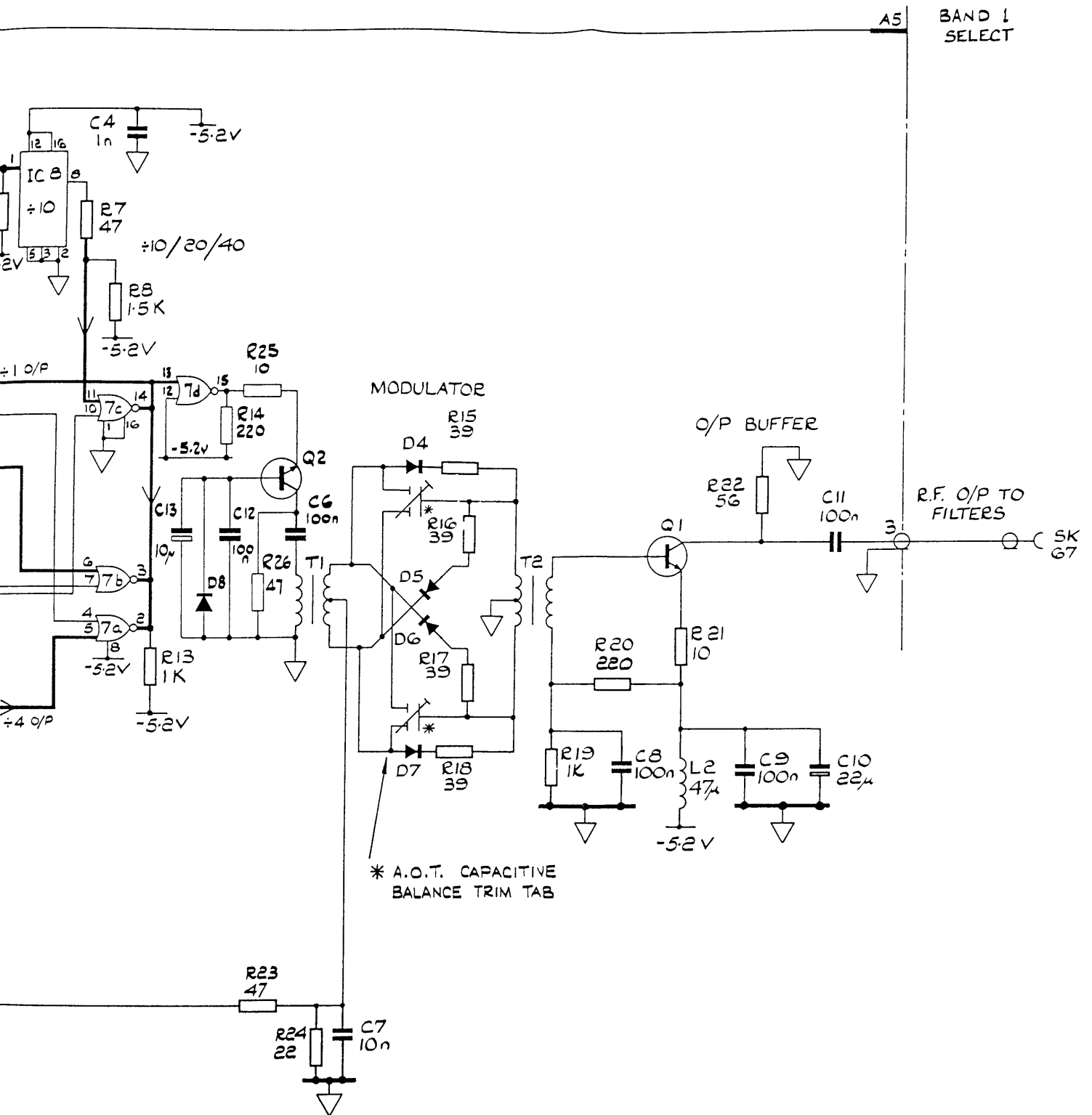
Component Layout:
Band Selection Divider Assembly 19-0899



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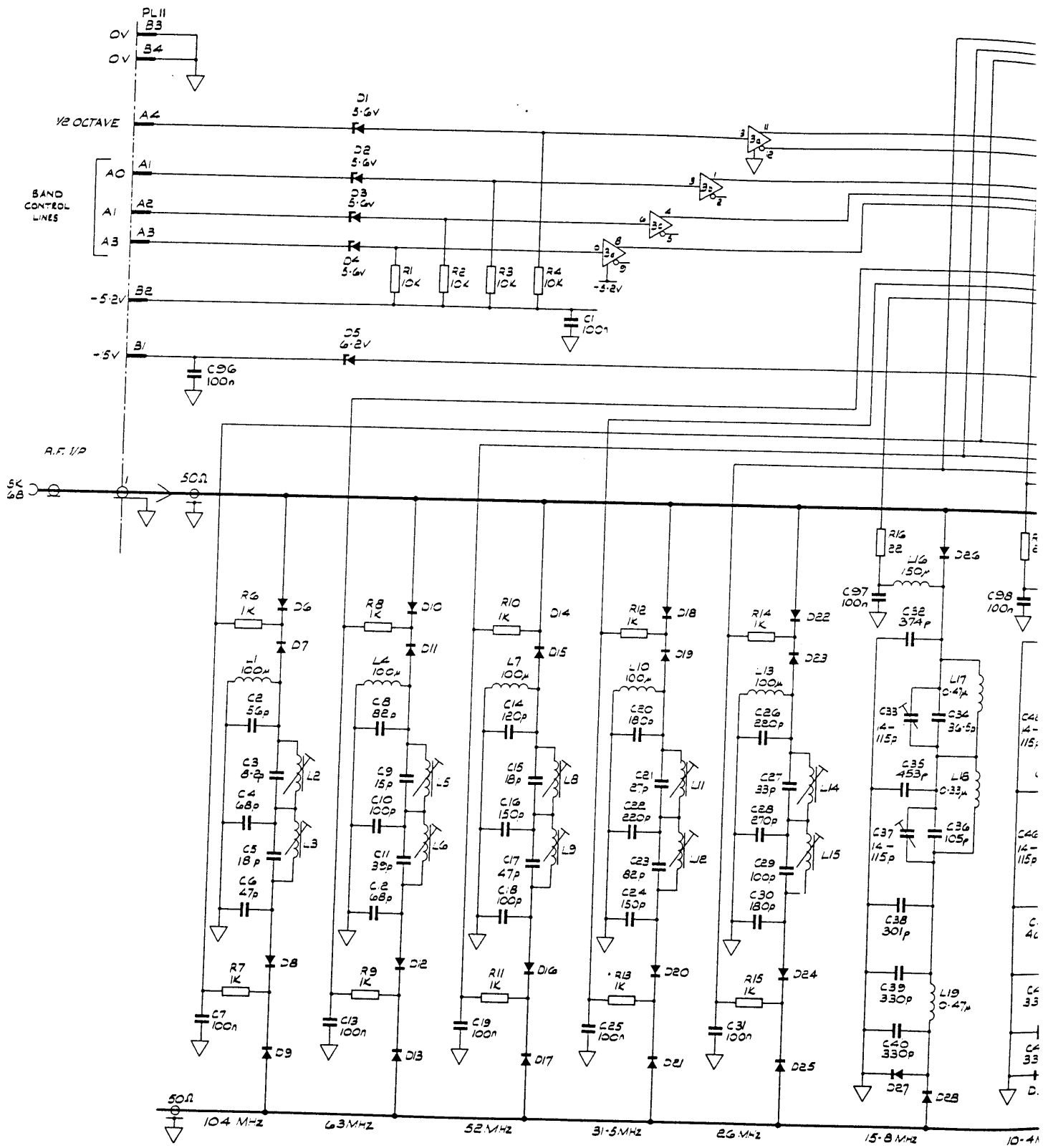


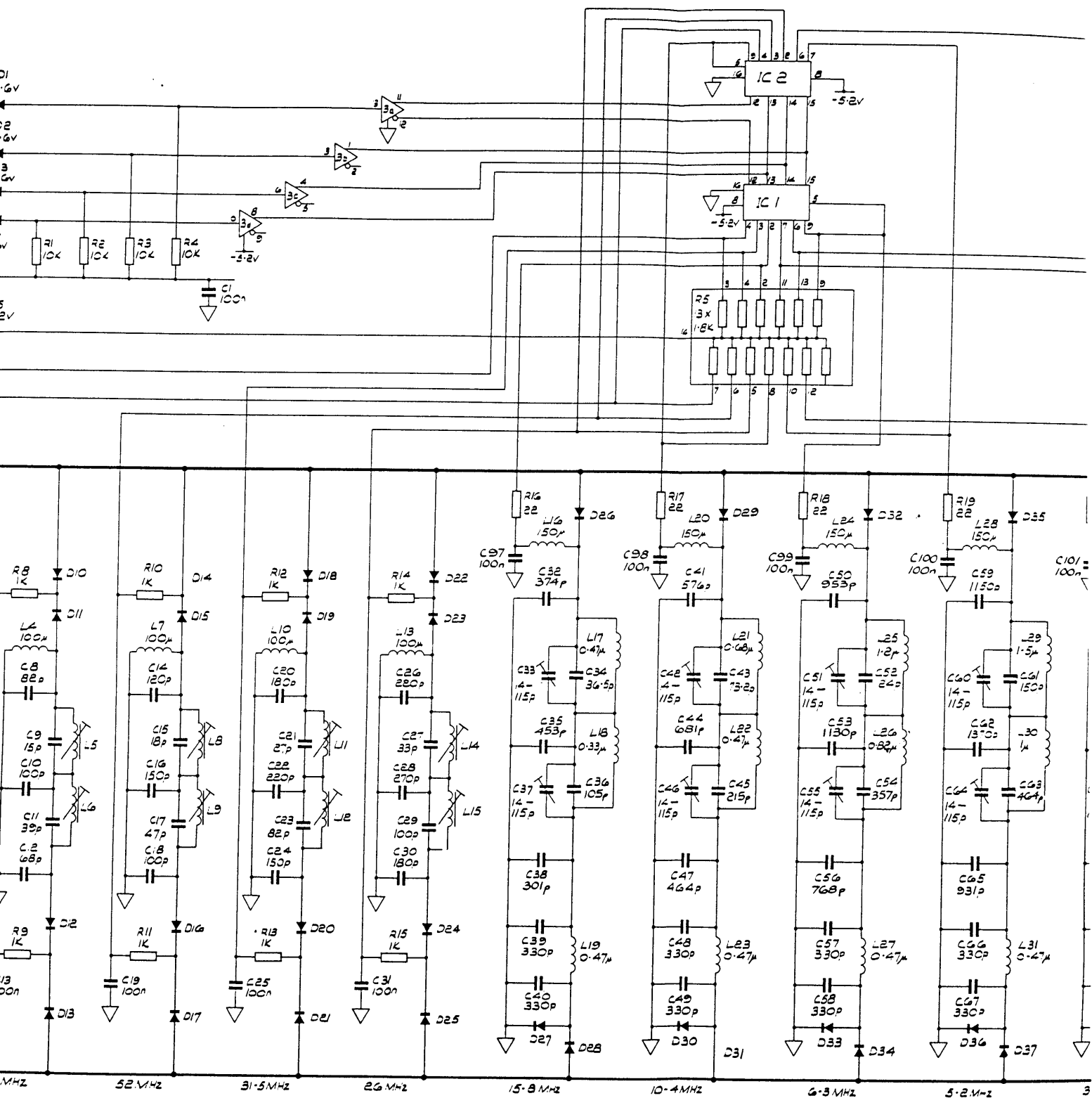
Circuit Diagram: Band Selection
Divider Assembly 19-0899

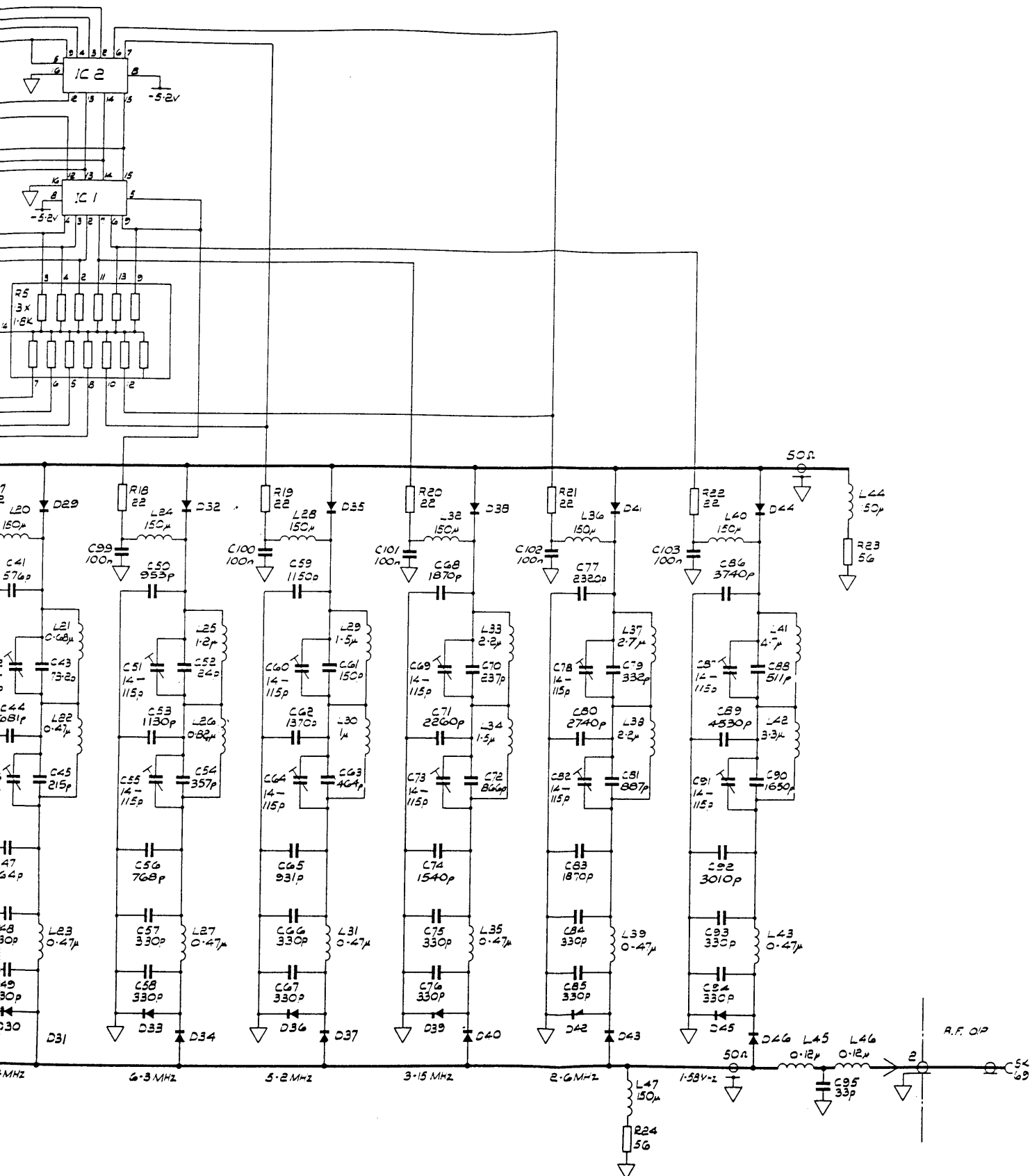
Fig.21



Component Layout :
RF Filters Assembly 19-0906

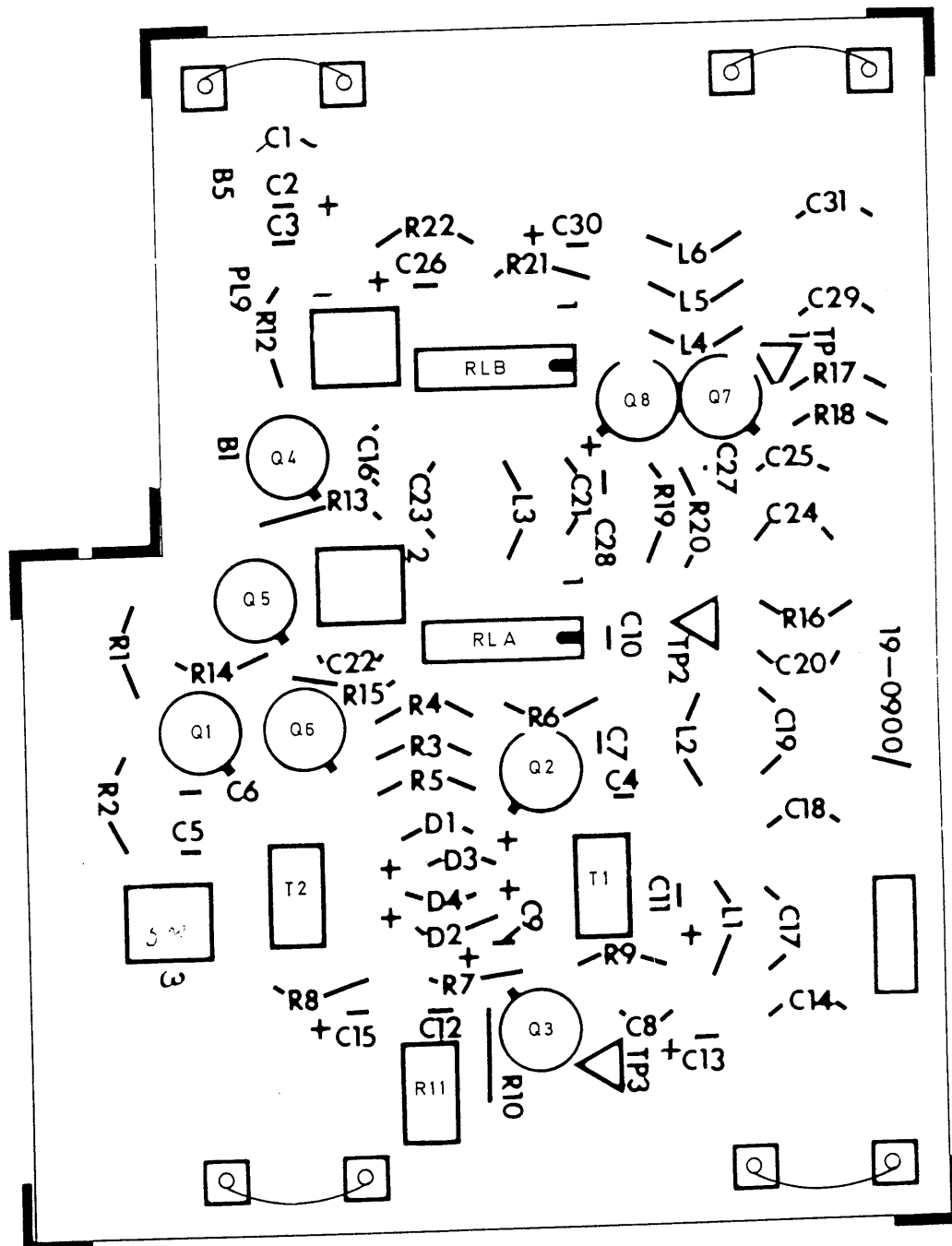


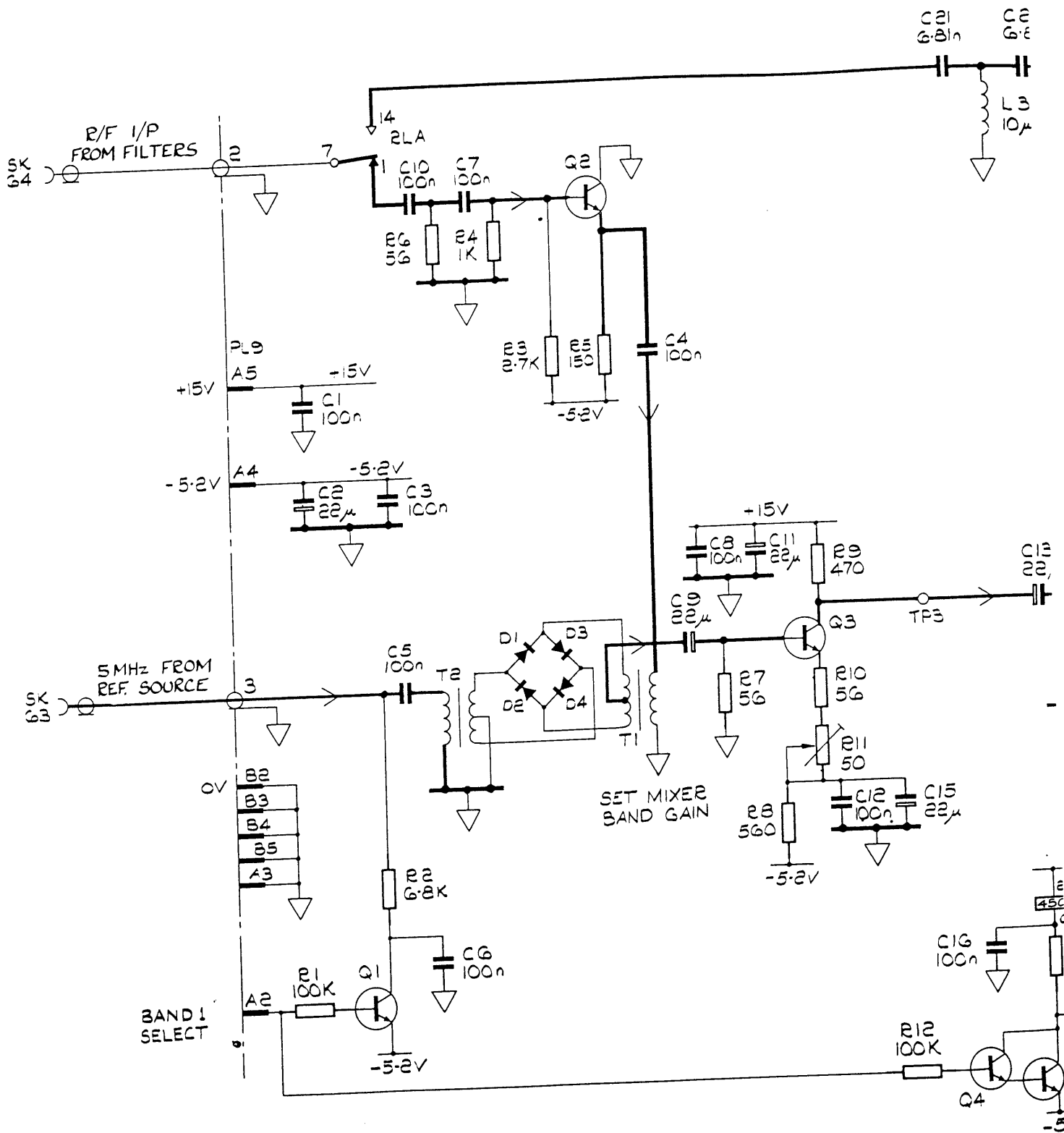


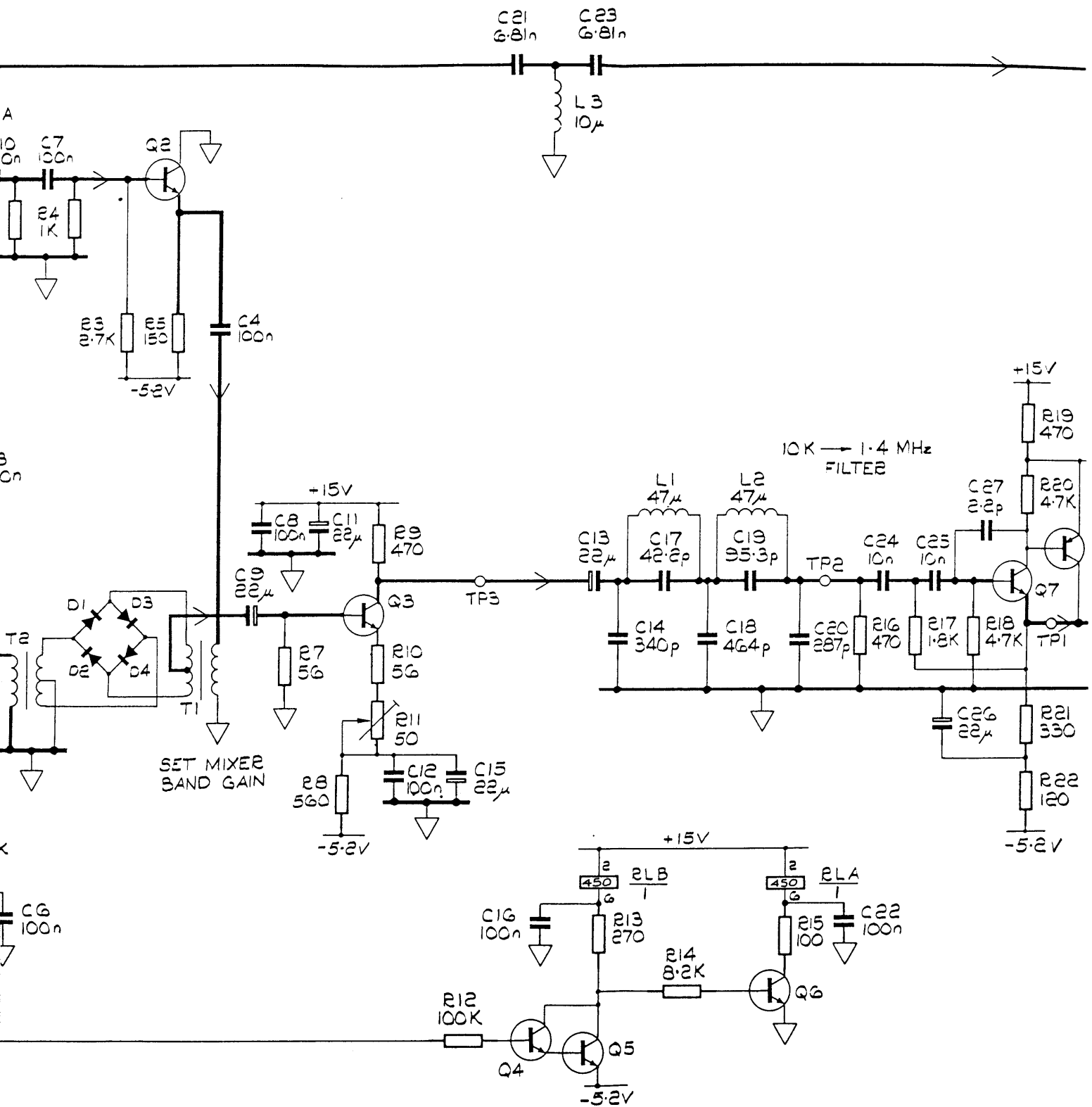


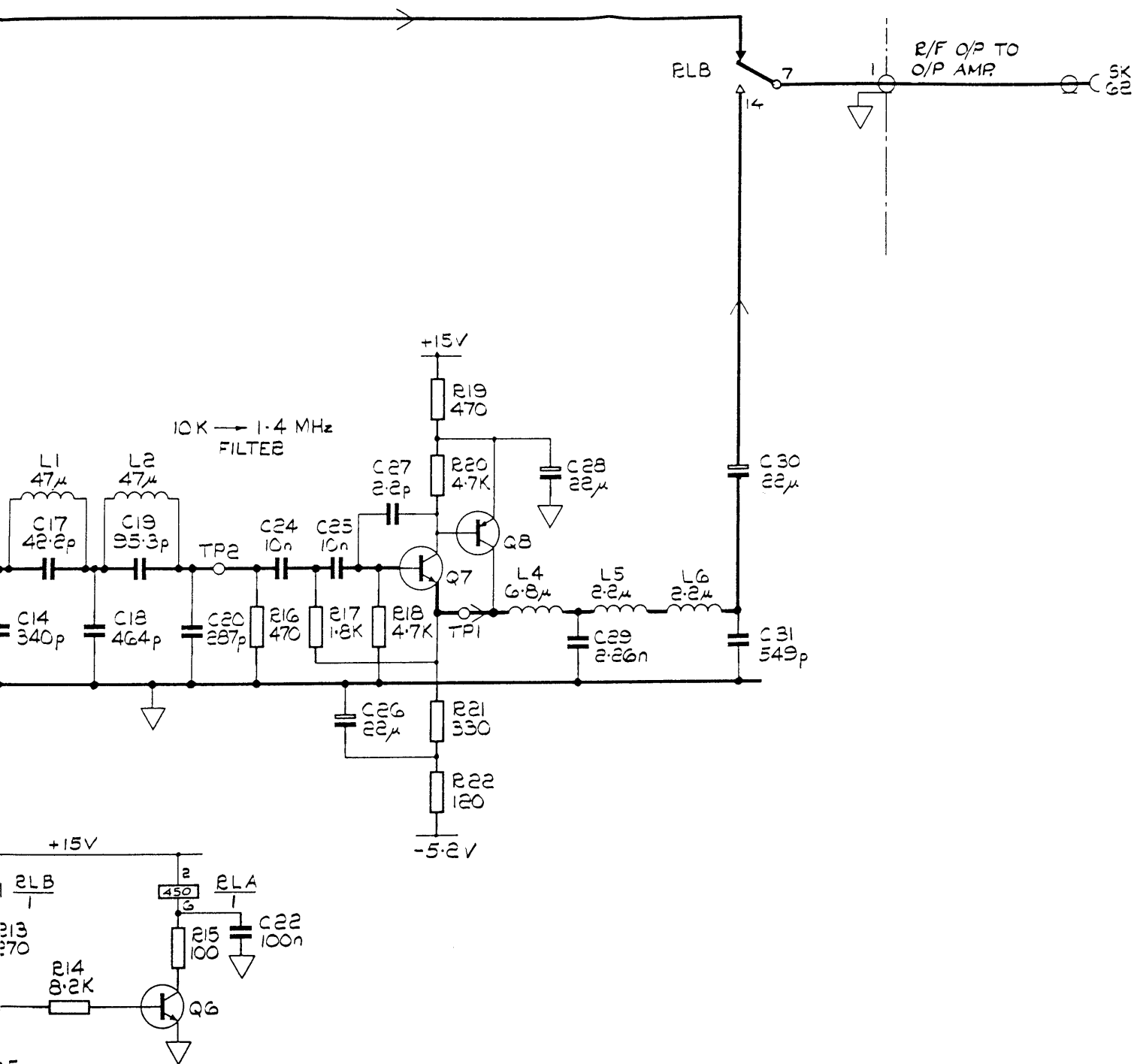
Circuit Diagram:
RF Filters Assembly 19-0906

Fig.23



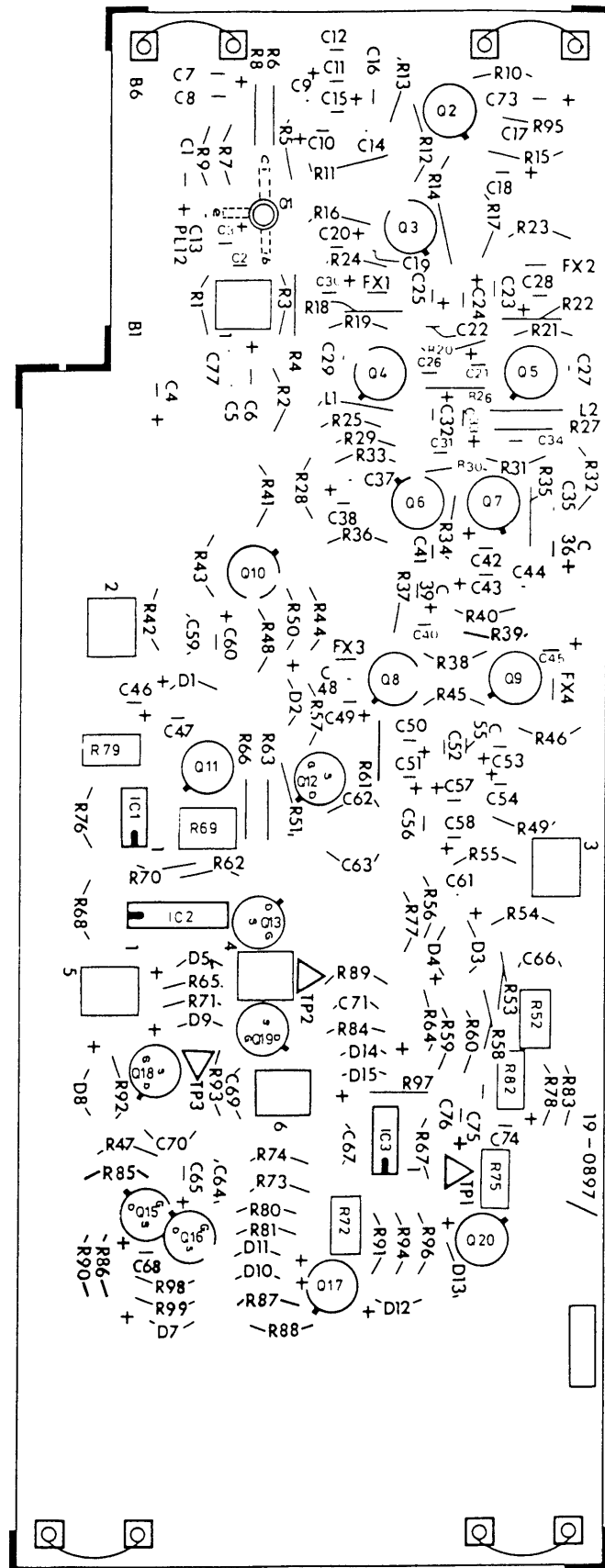


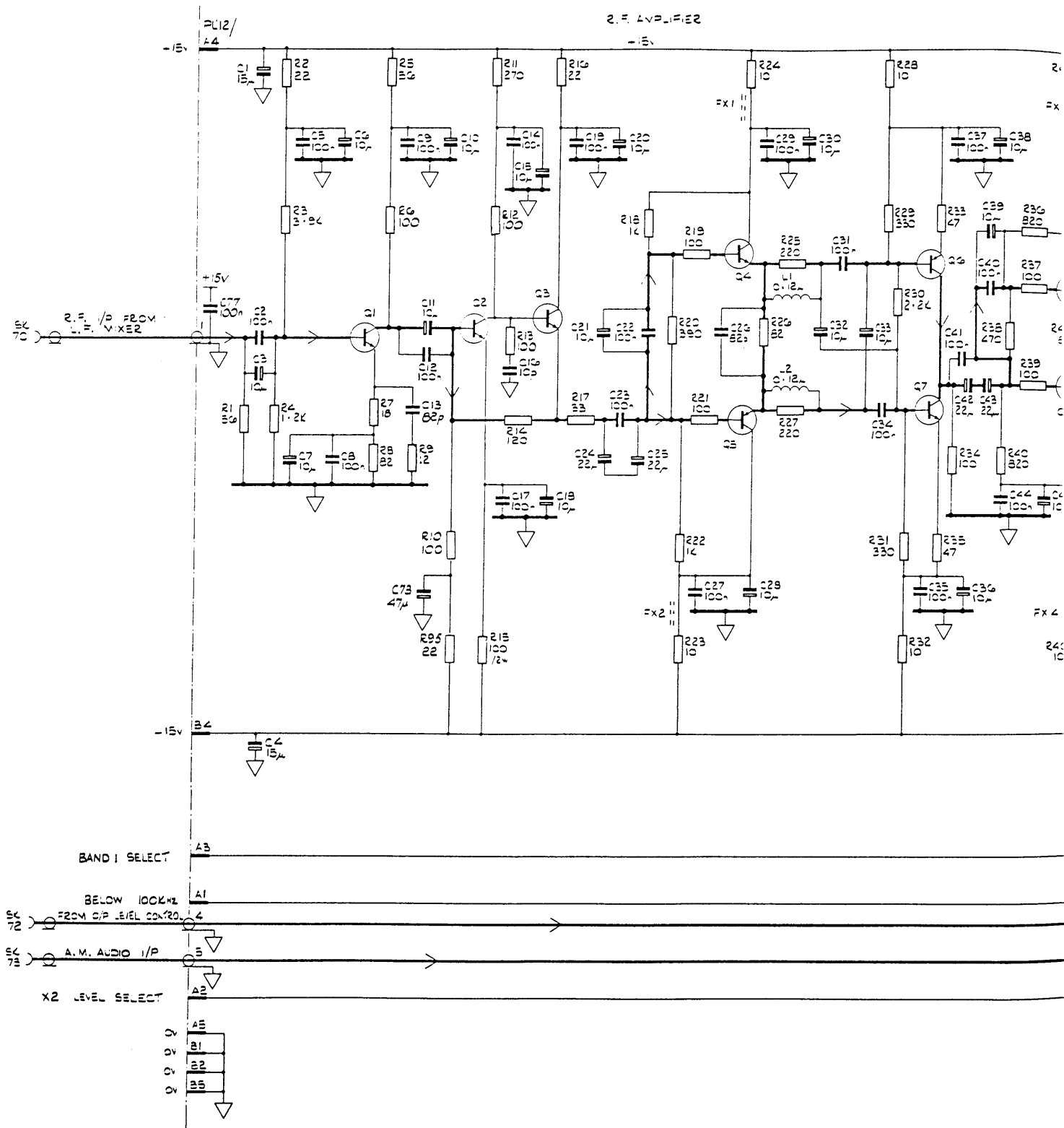


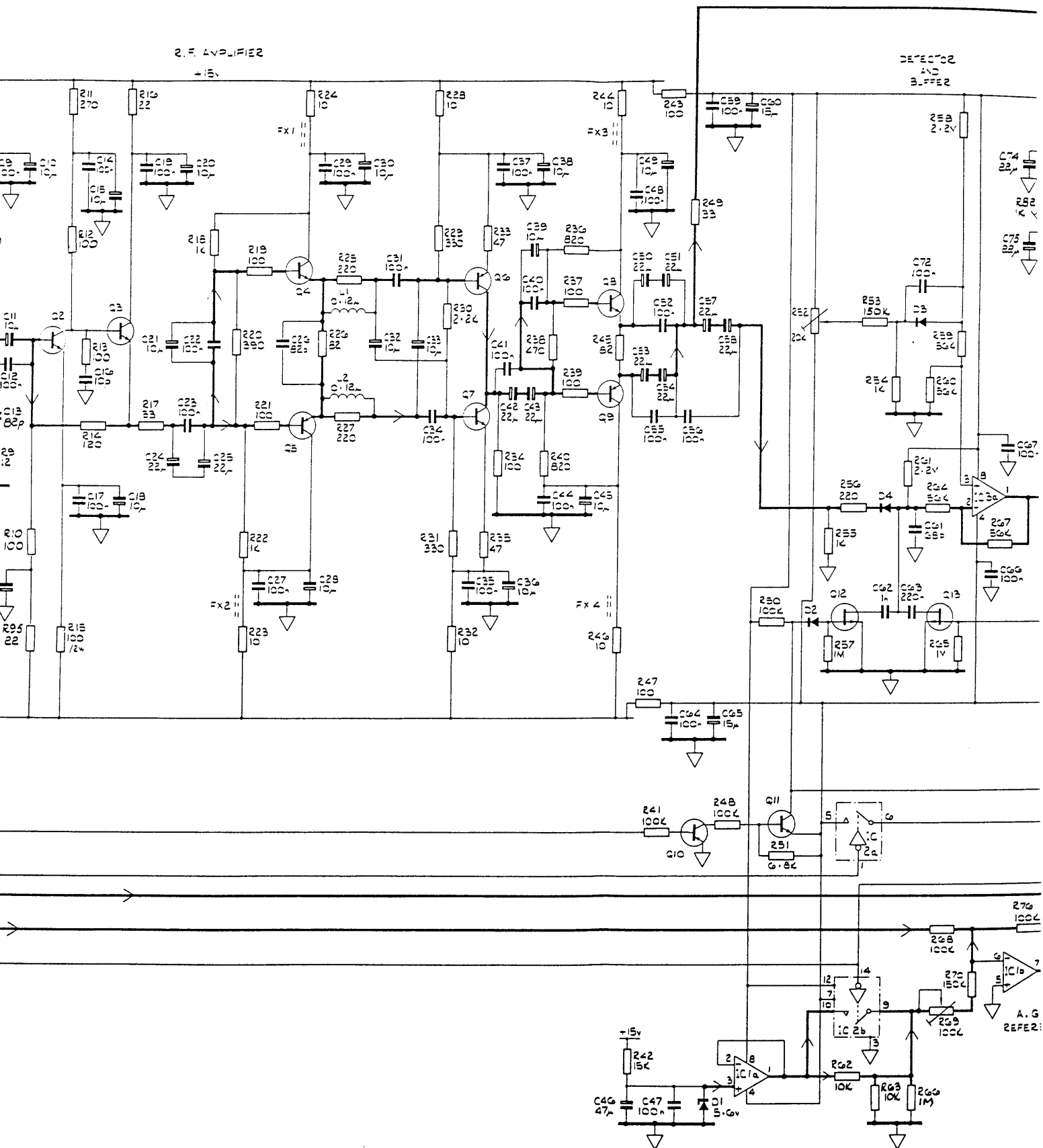


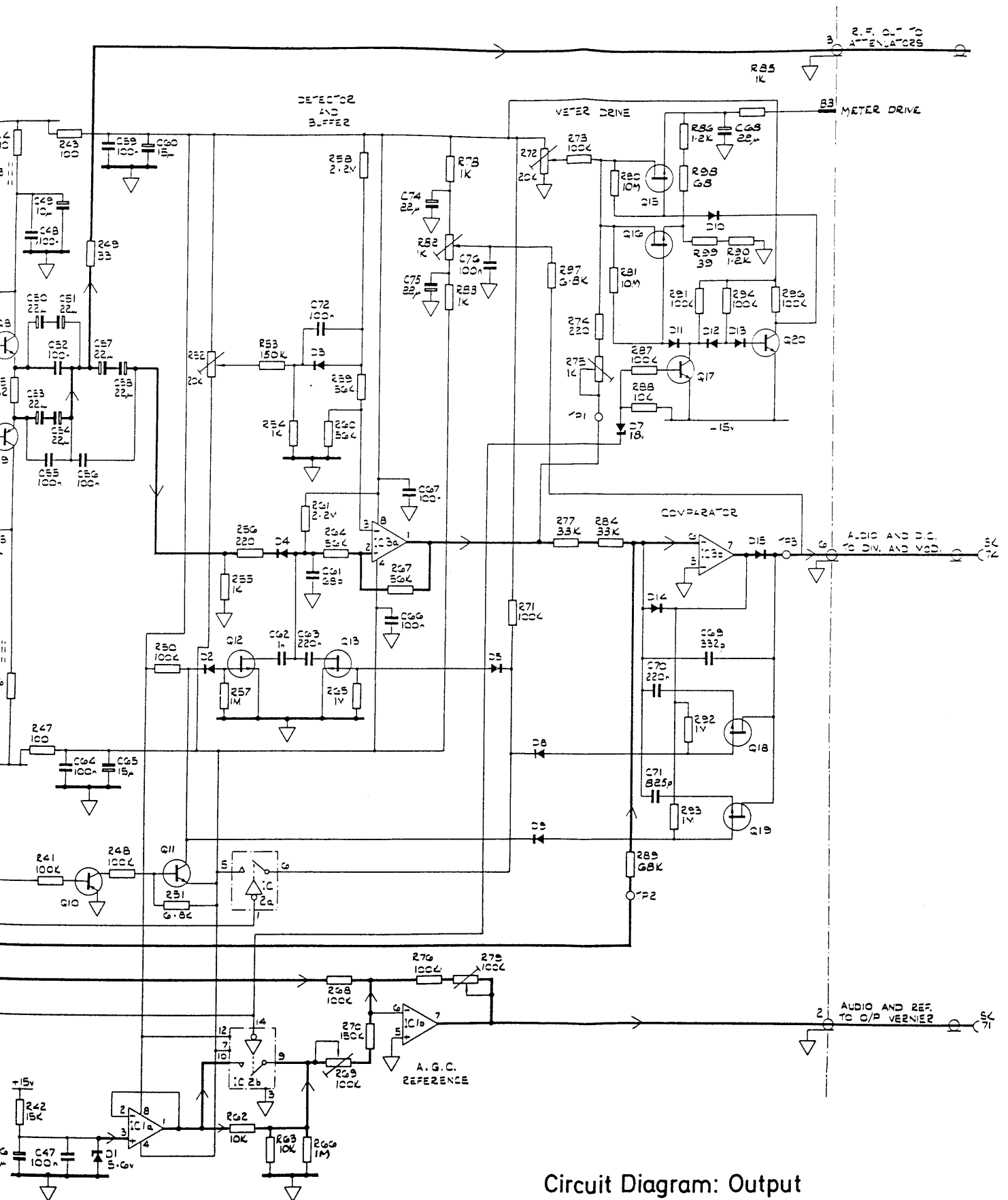
Circuit Diagram:
LF Combiner Assembly 19-0900

Fig.25

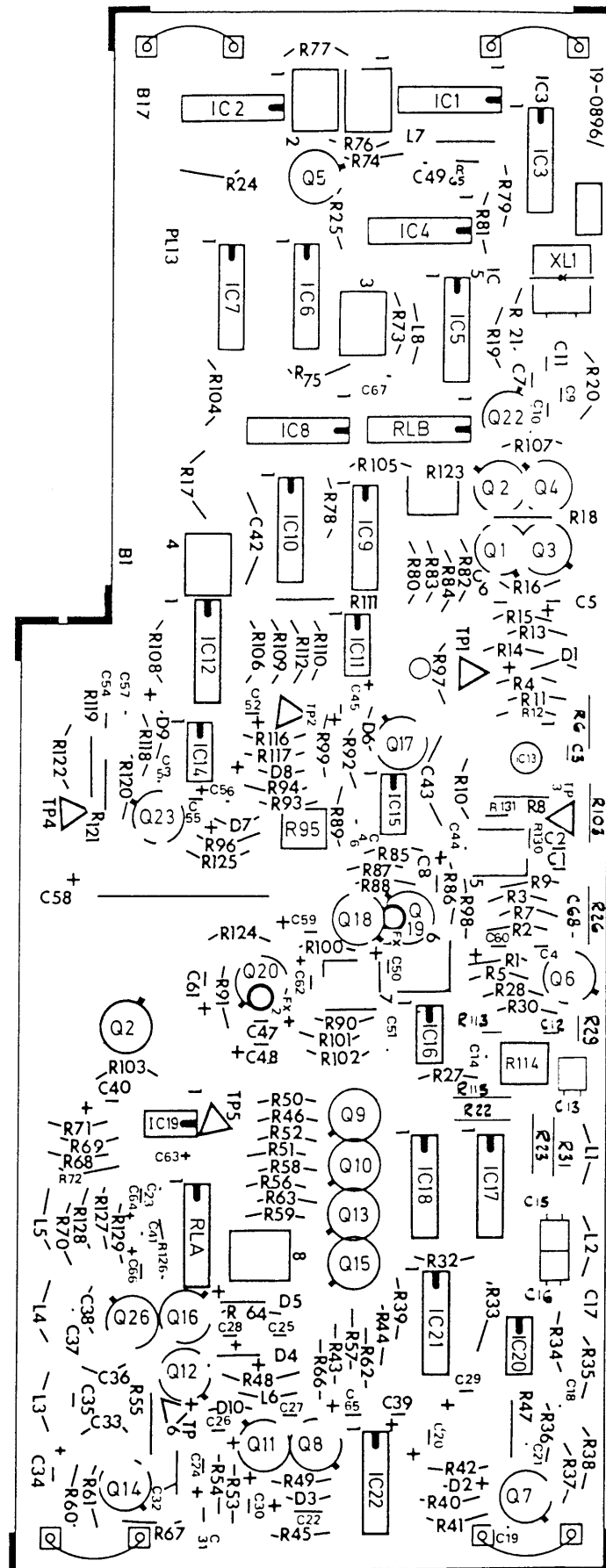


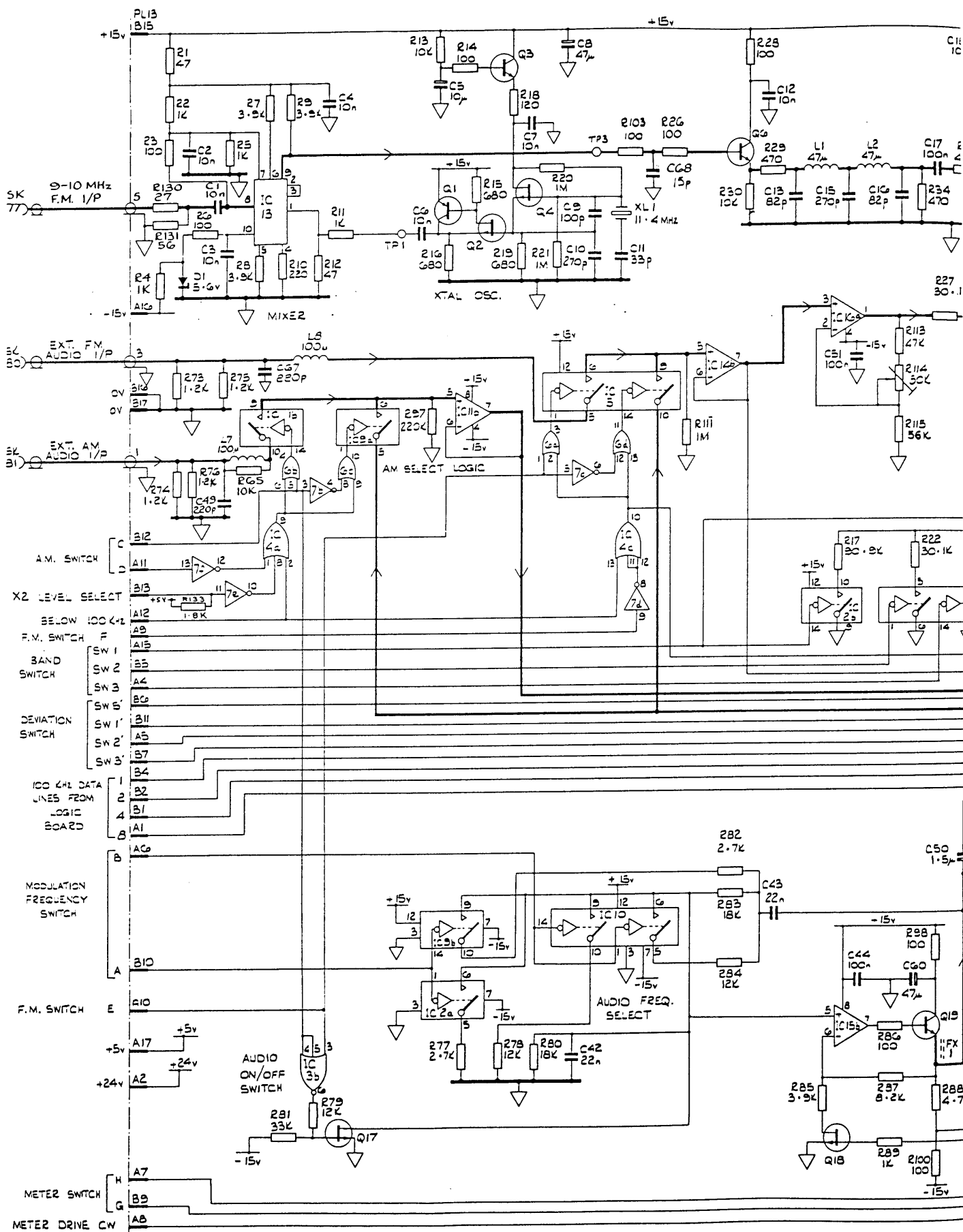






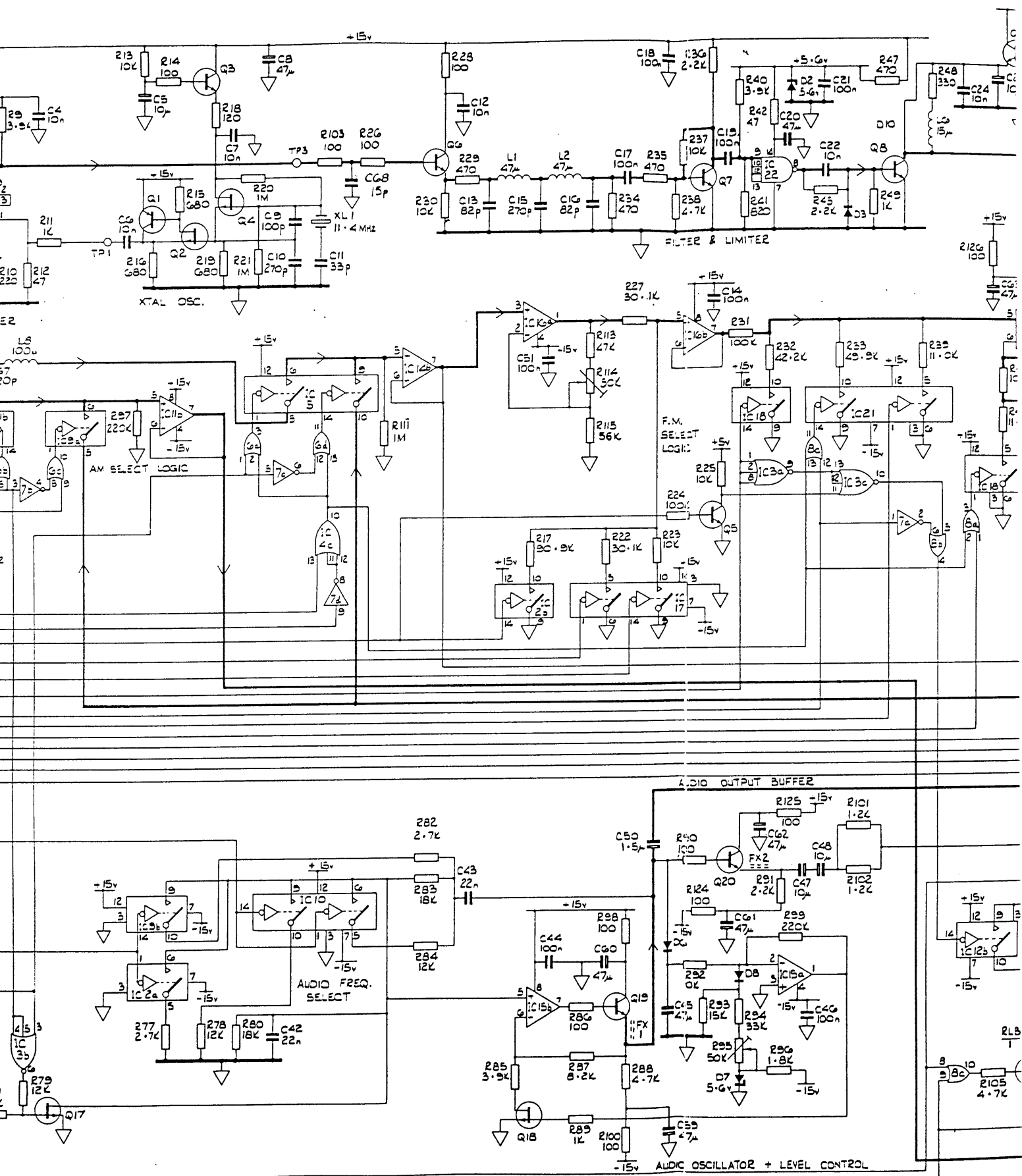
Circuit Diagram: Output
Amplifier Assembly 19-0897

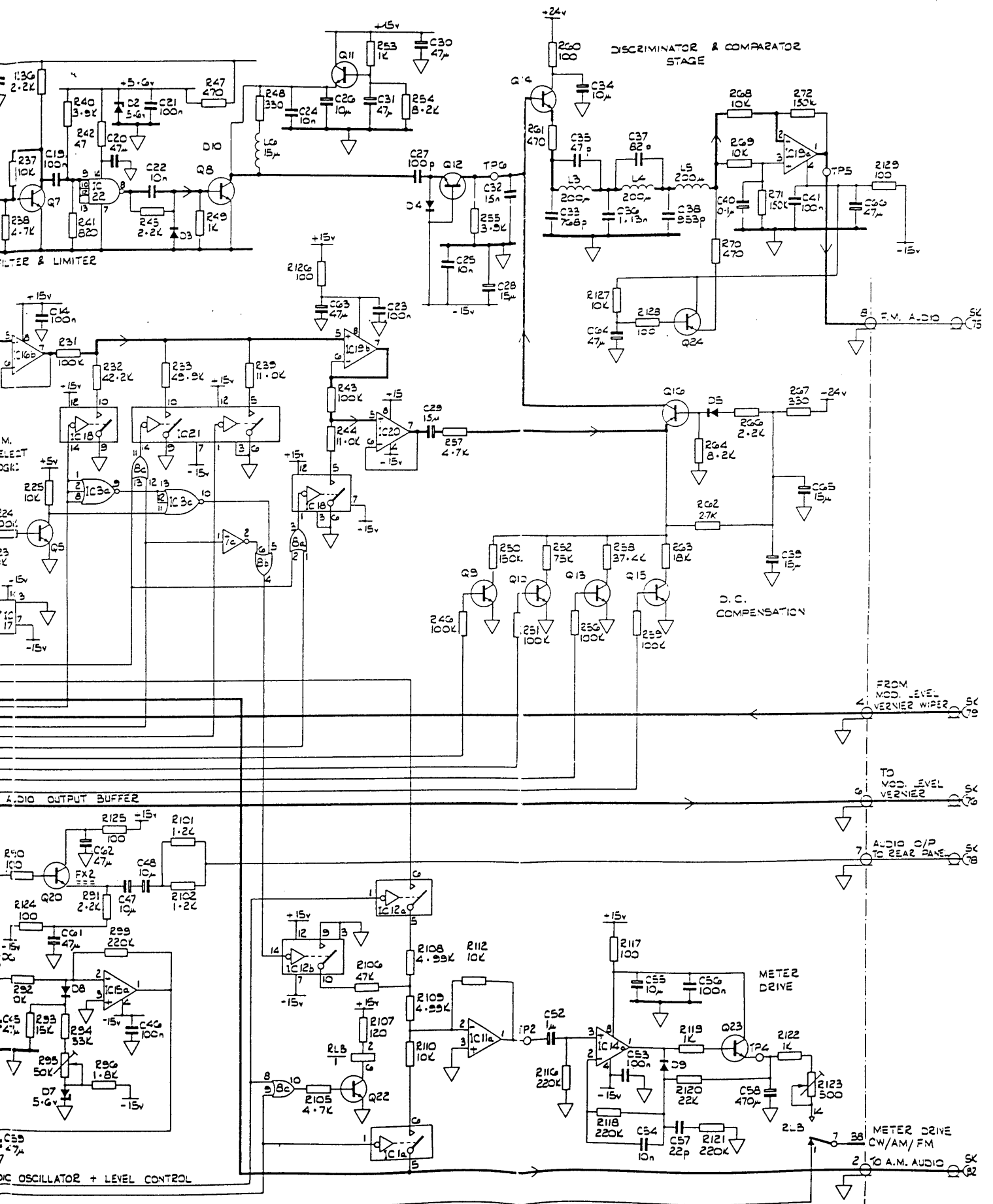




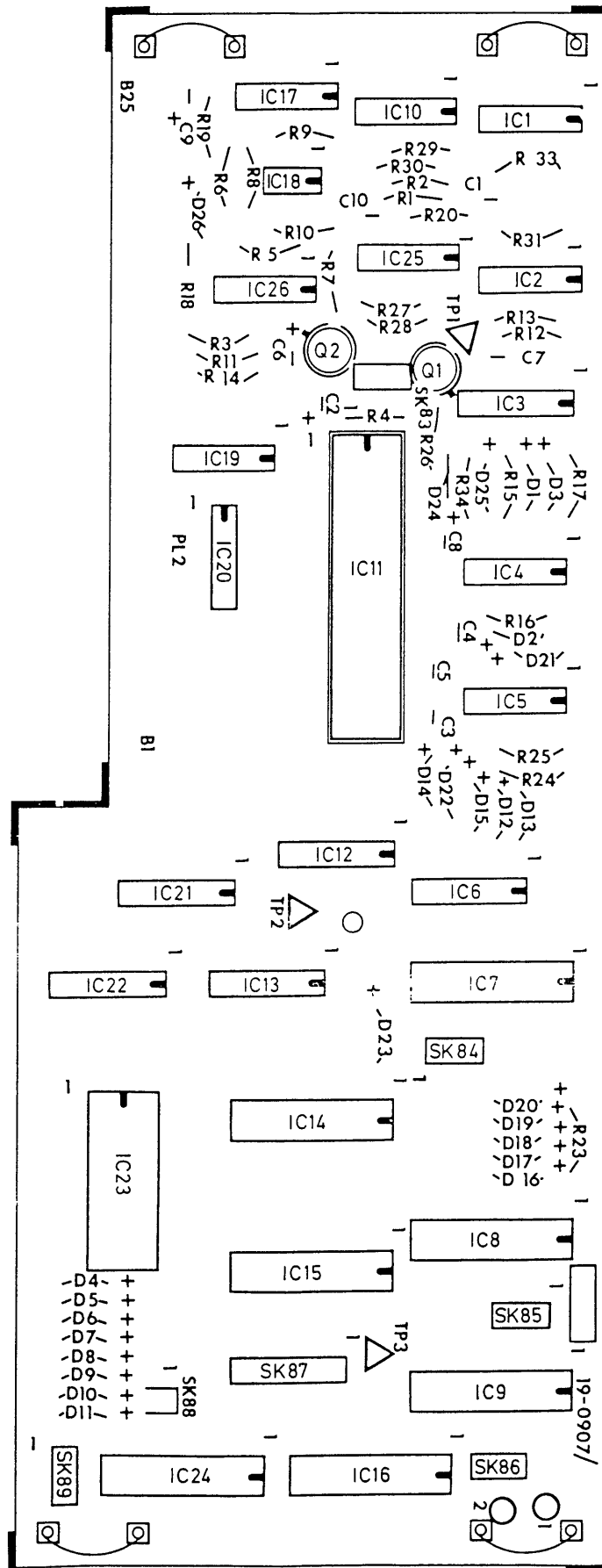
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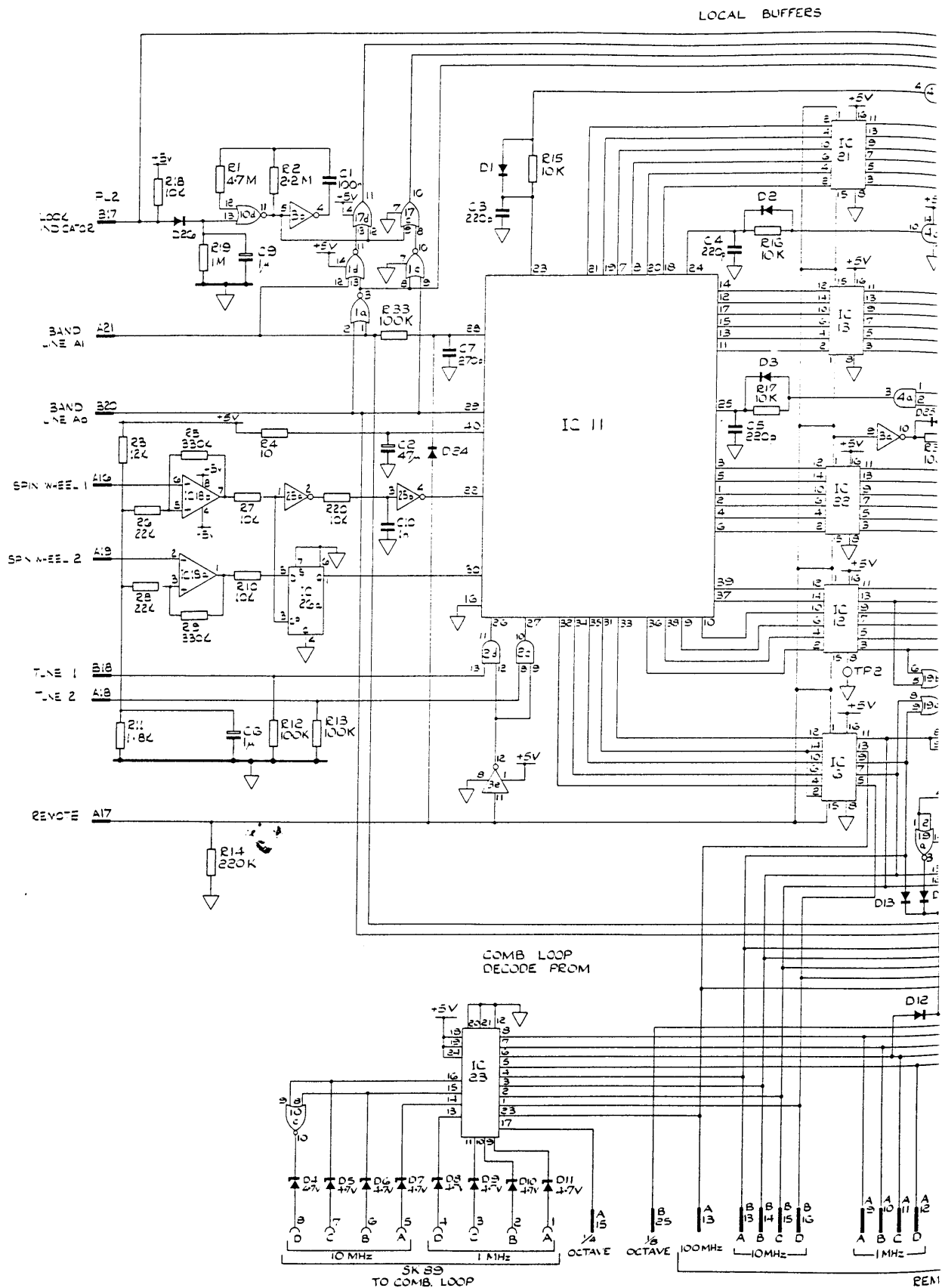
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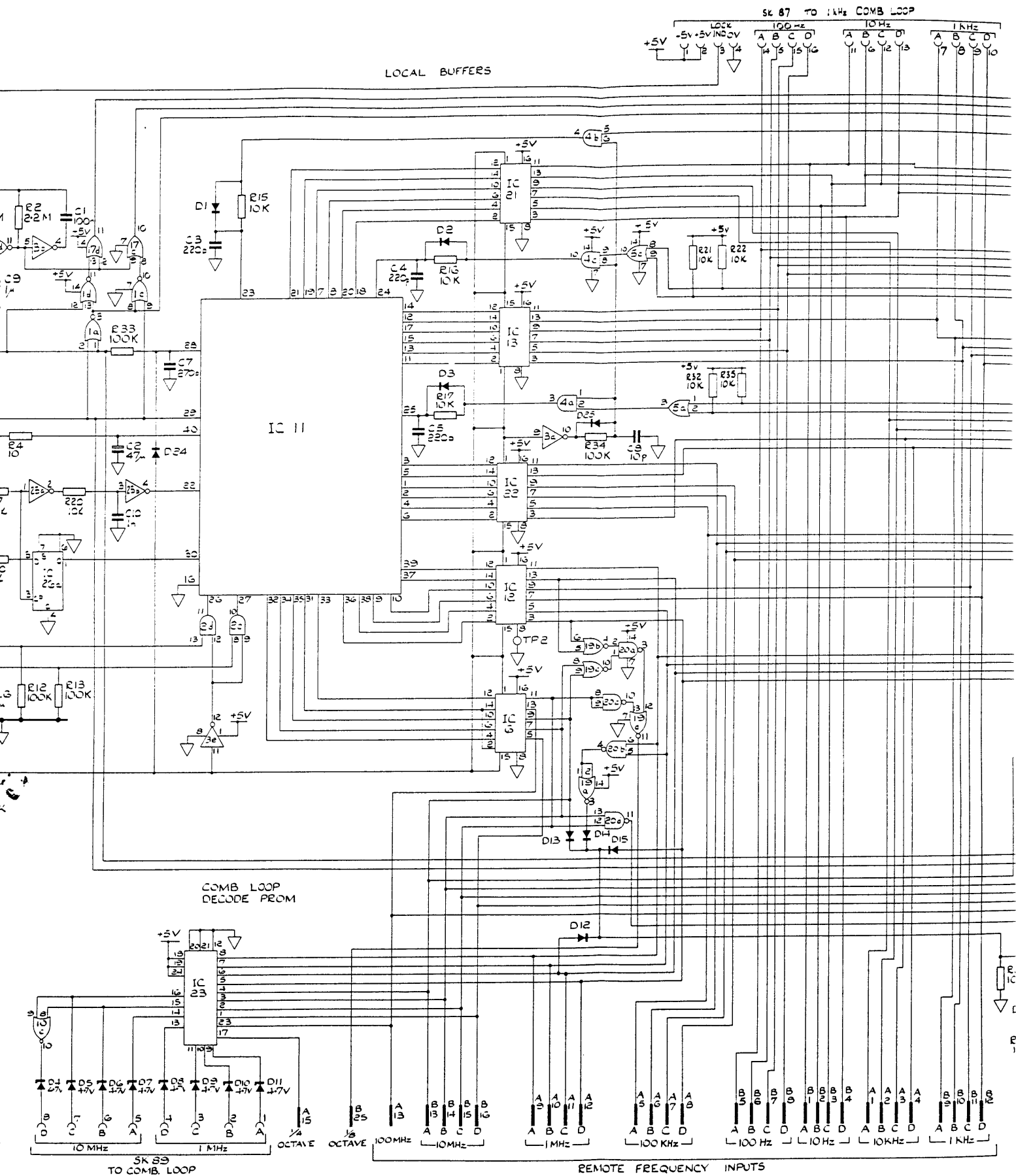


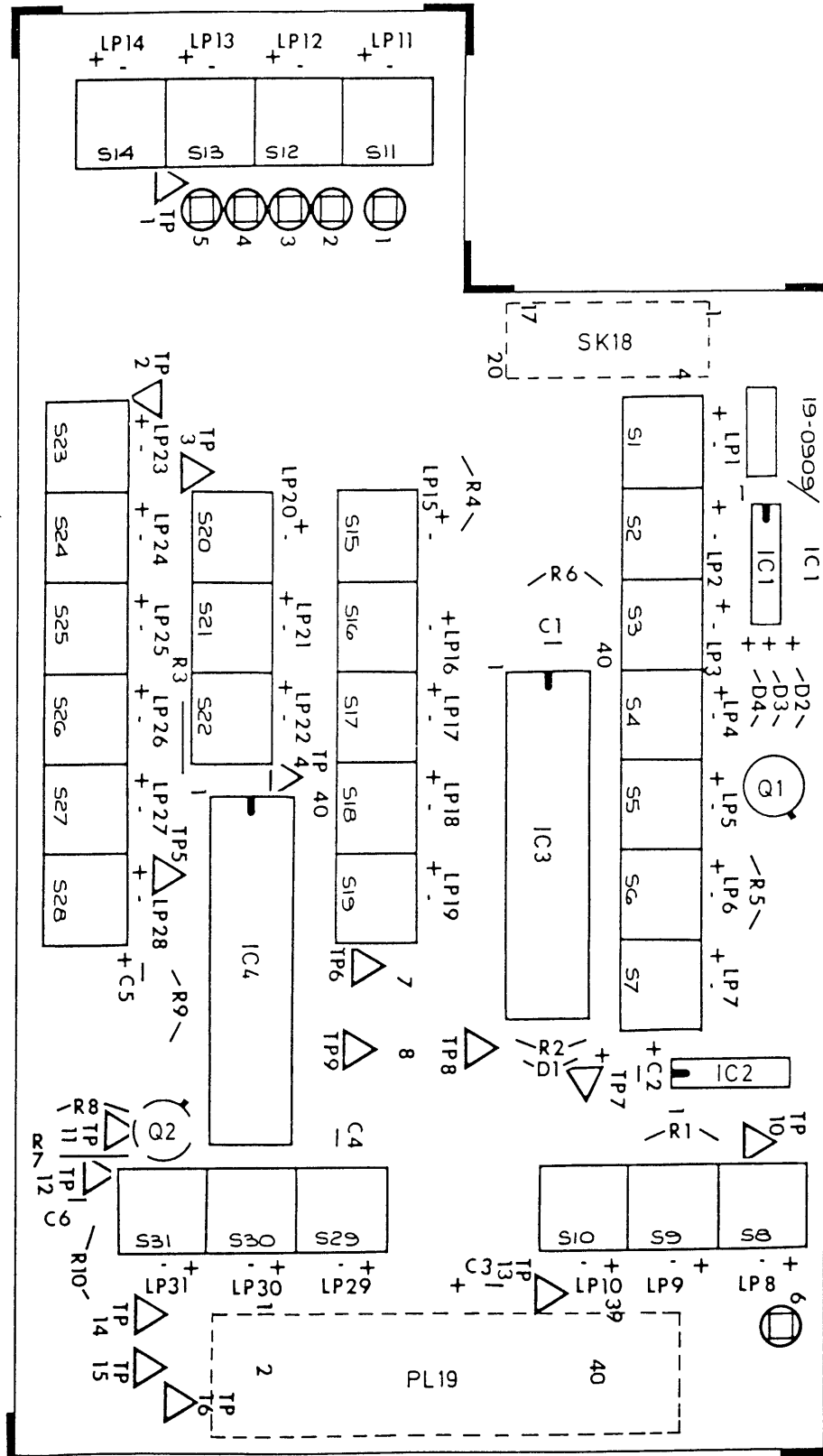


Circuit Diagram: FM and Audio
Oscillator Assembly 19-0896



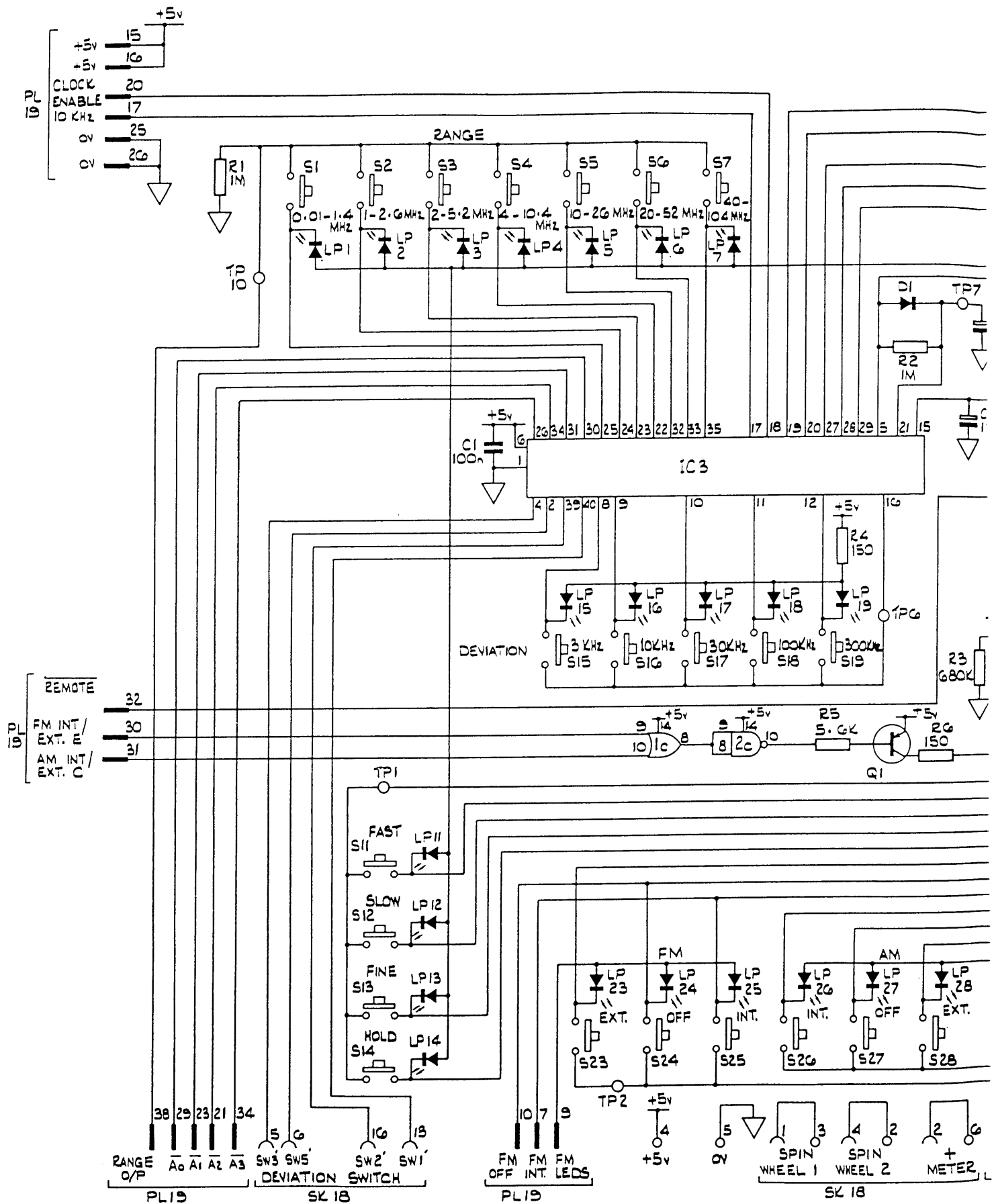


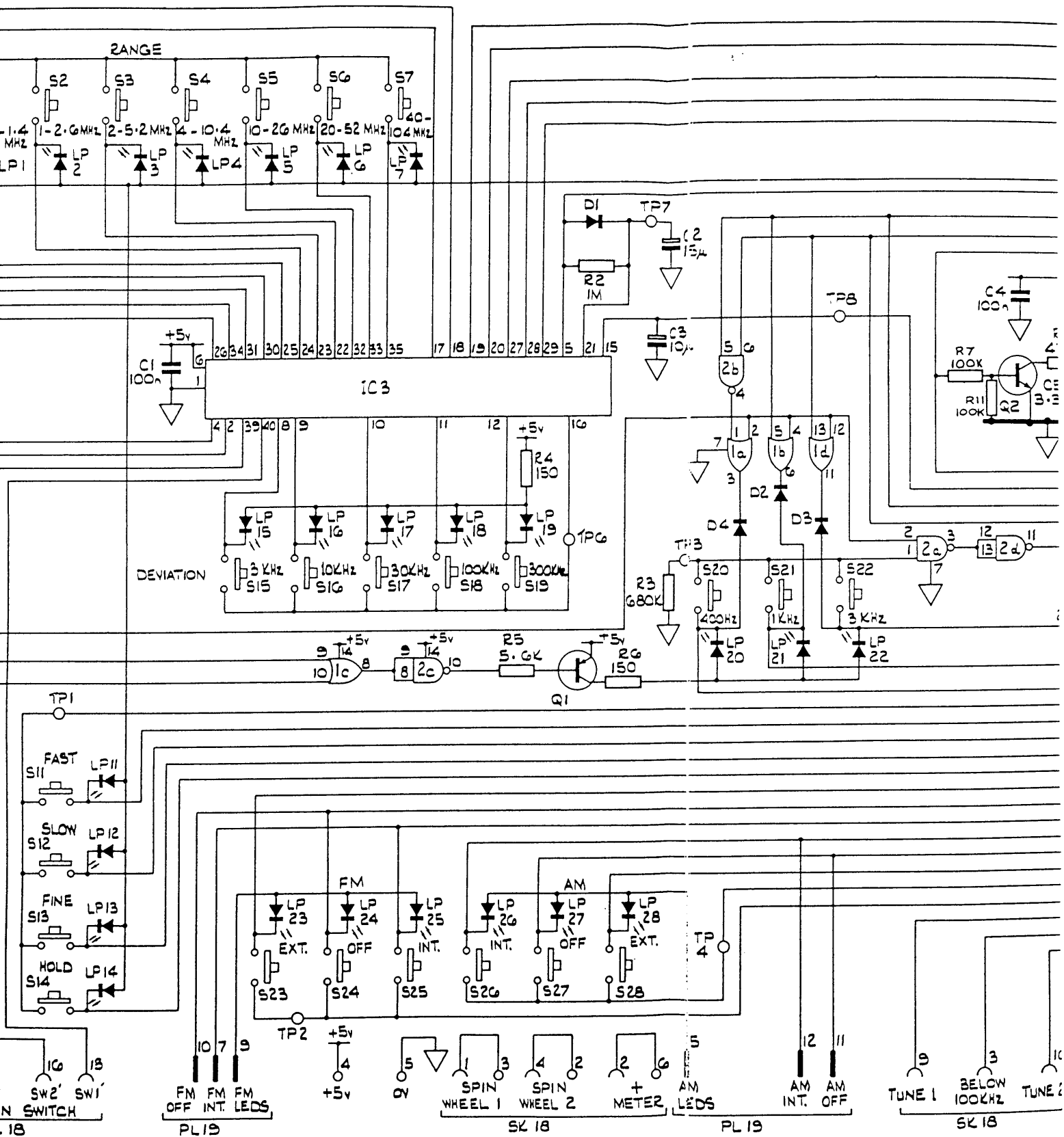


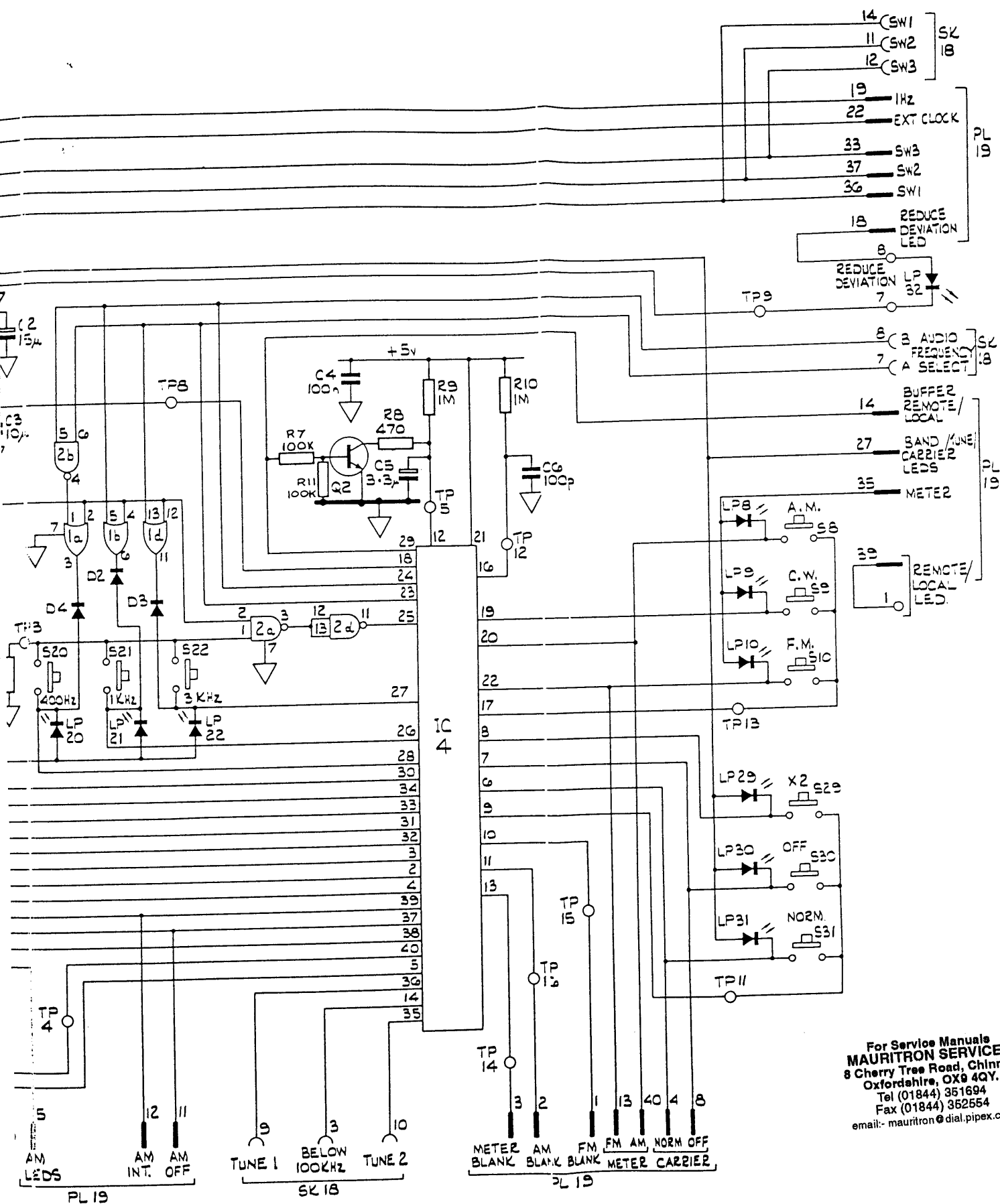


Component Layout:
Front Panel Switch Assembly 19-0909

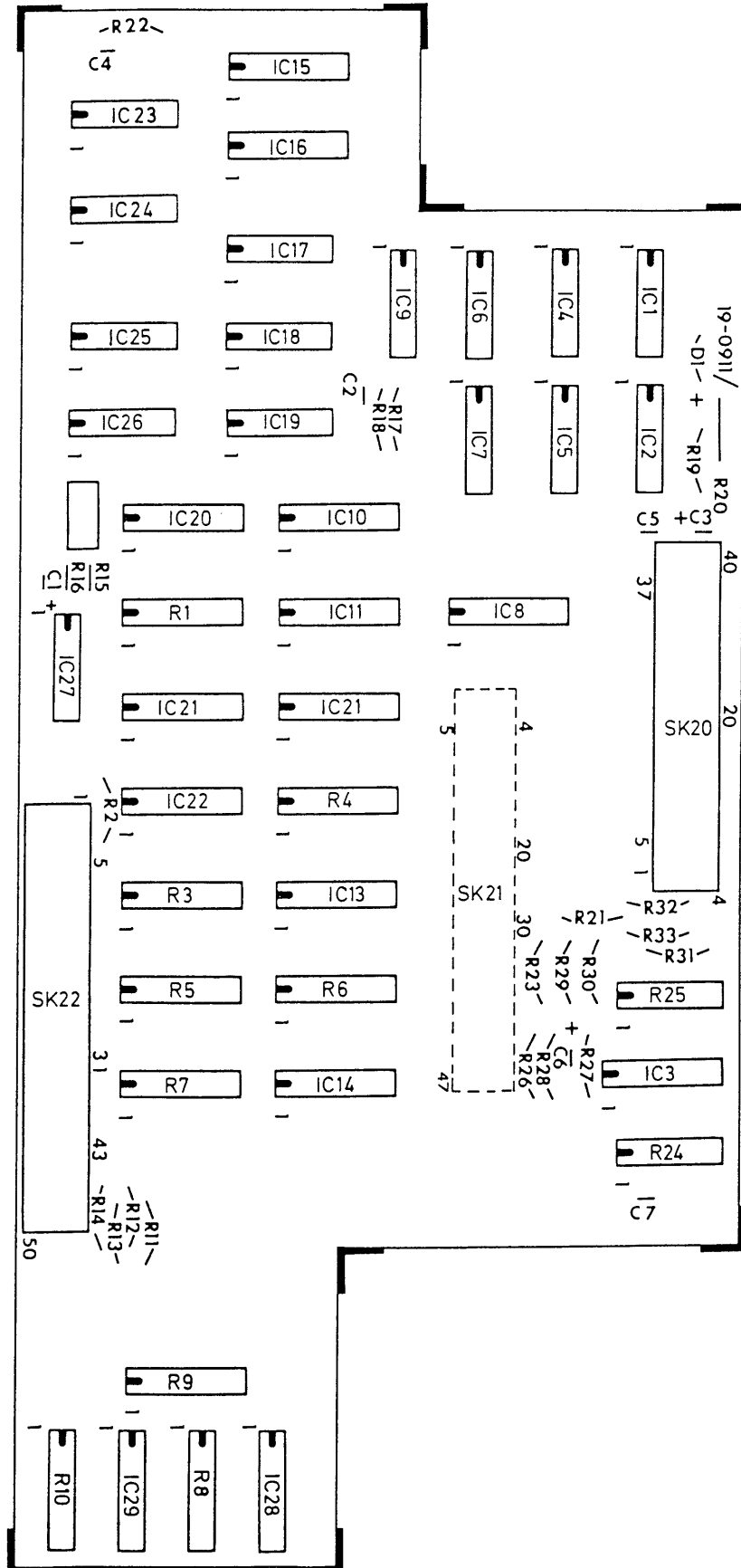
Fig.32





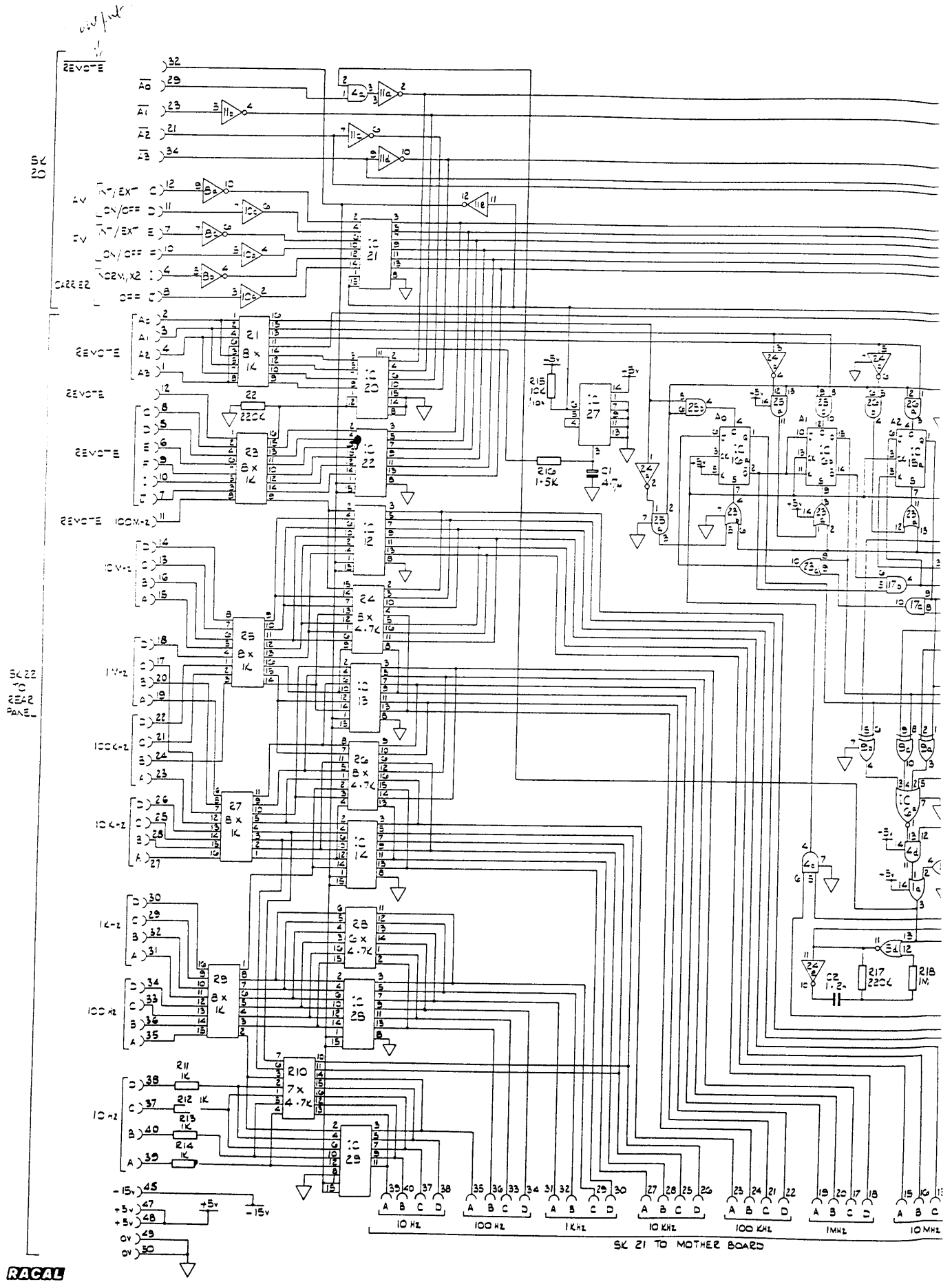


Circuit Diagram : Front Panel
Switches Assembly 19-0909

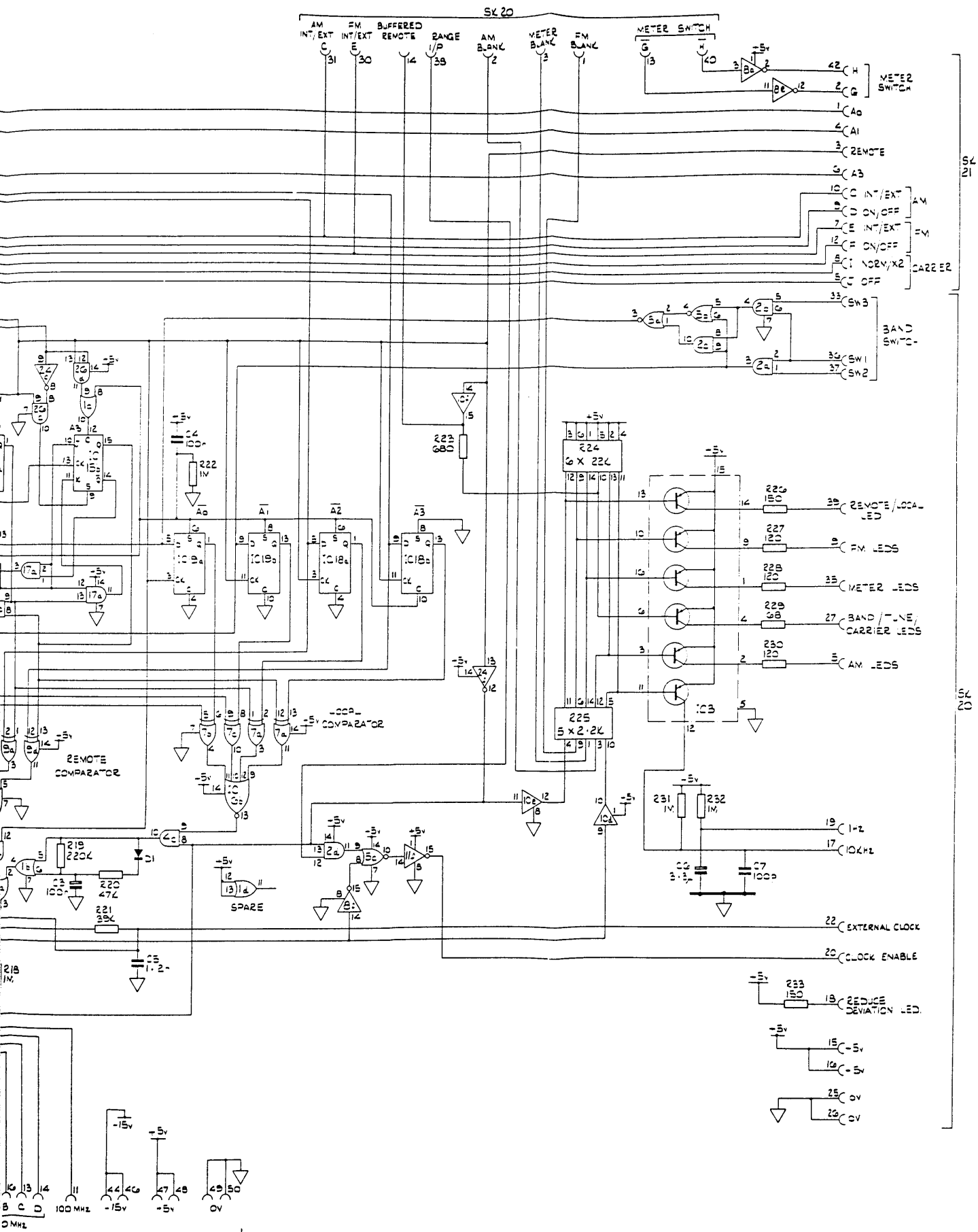


Component Layout:
Front Panel Logic Assembly 19-0911

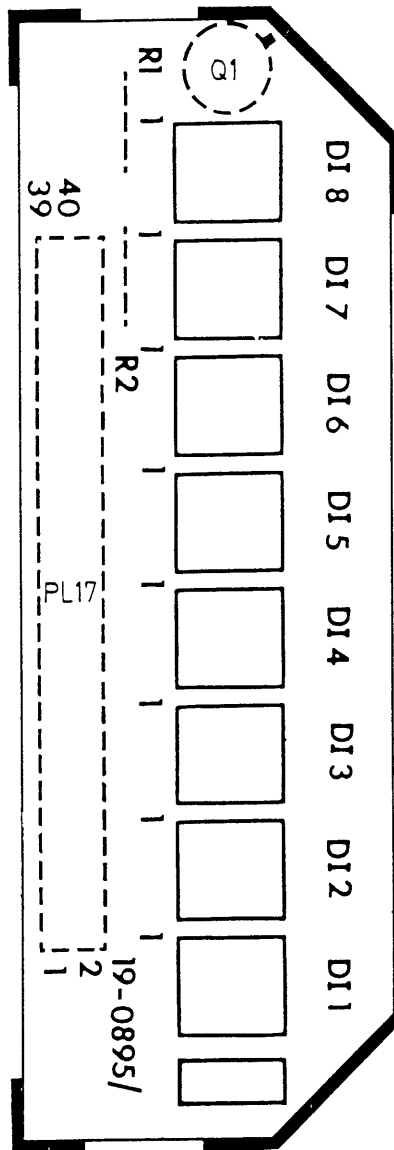
Fig.34



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Circuit Diagram:
Front Panel Logic Assembly 19-0911 Fig.35

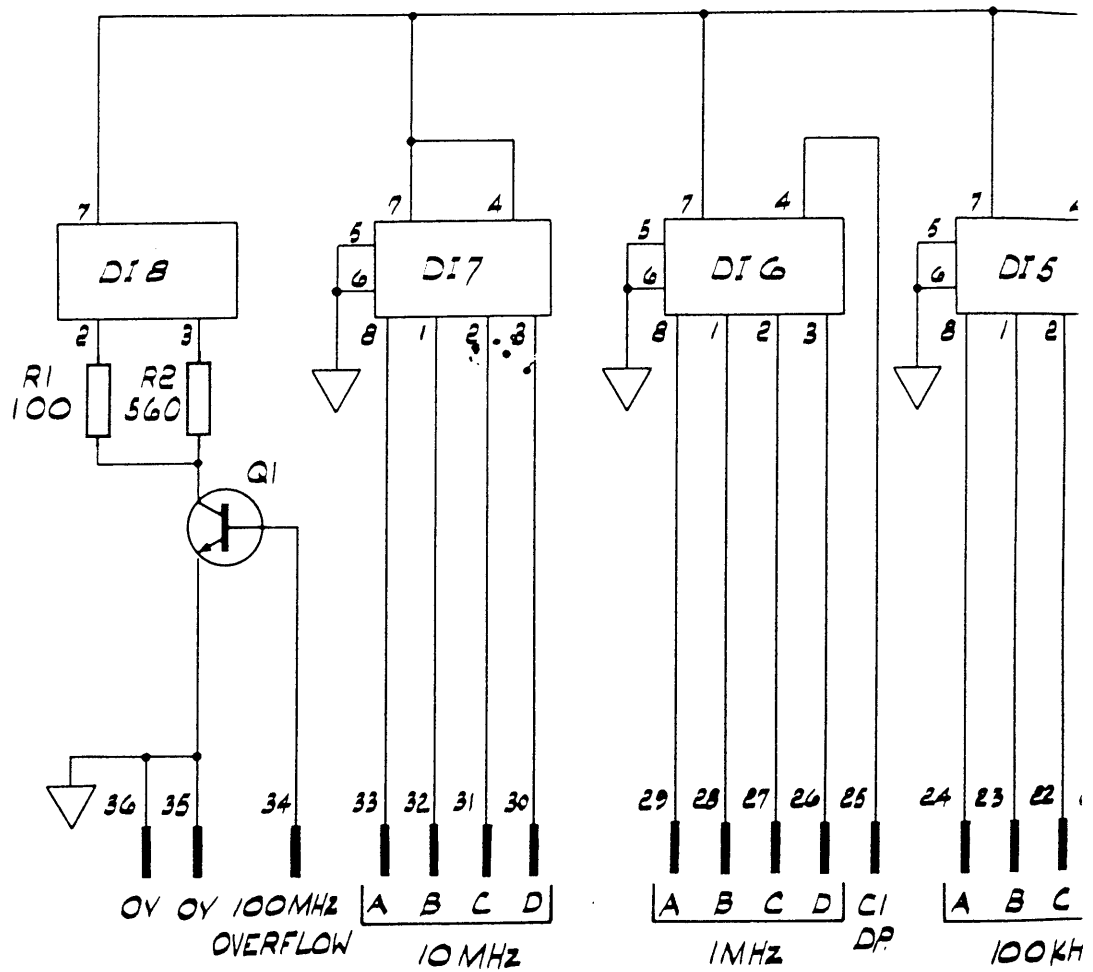


Component Layout:
Display Assembly 19-0895

Fig. 36

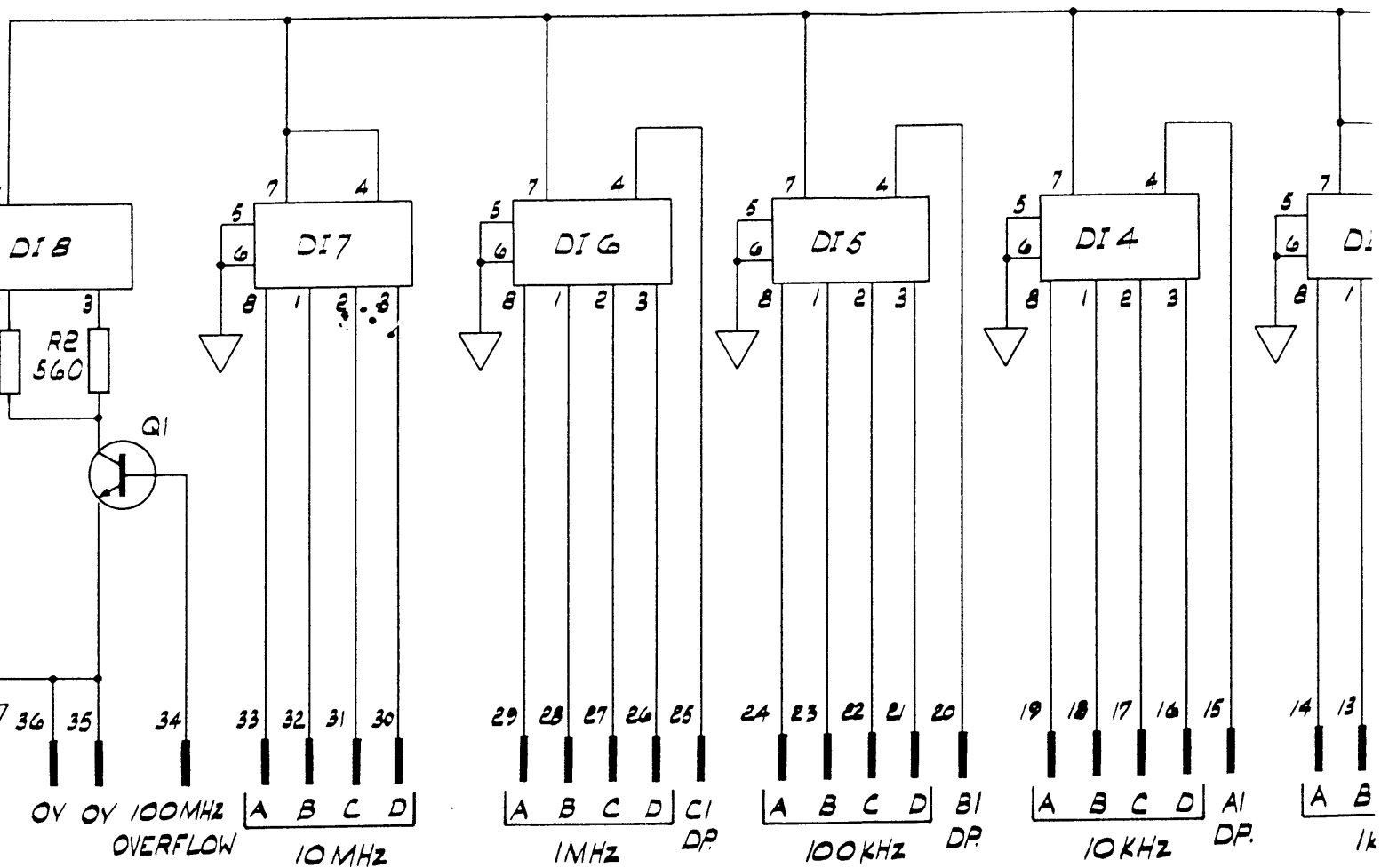
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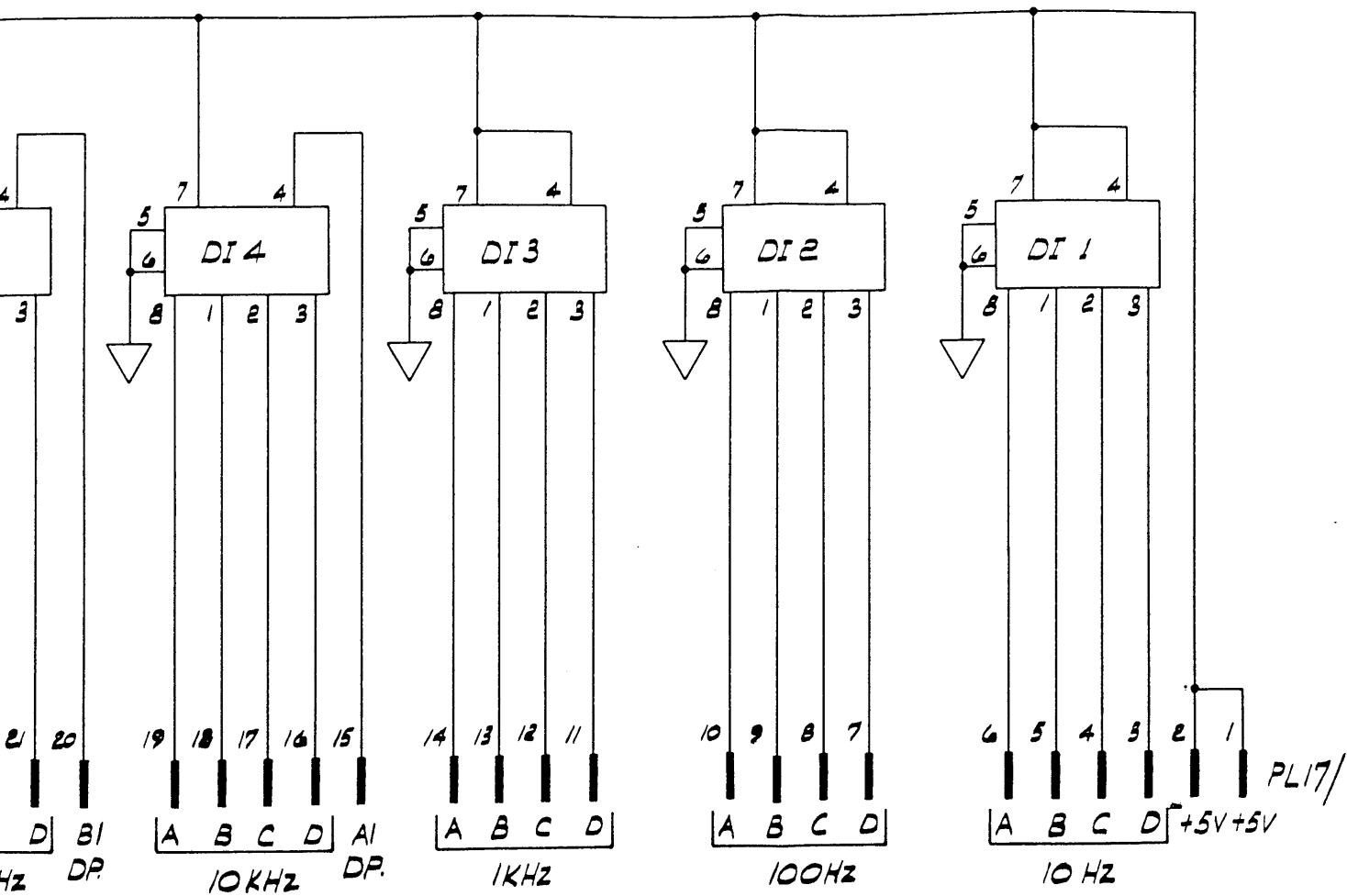
TH1007
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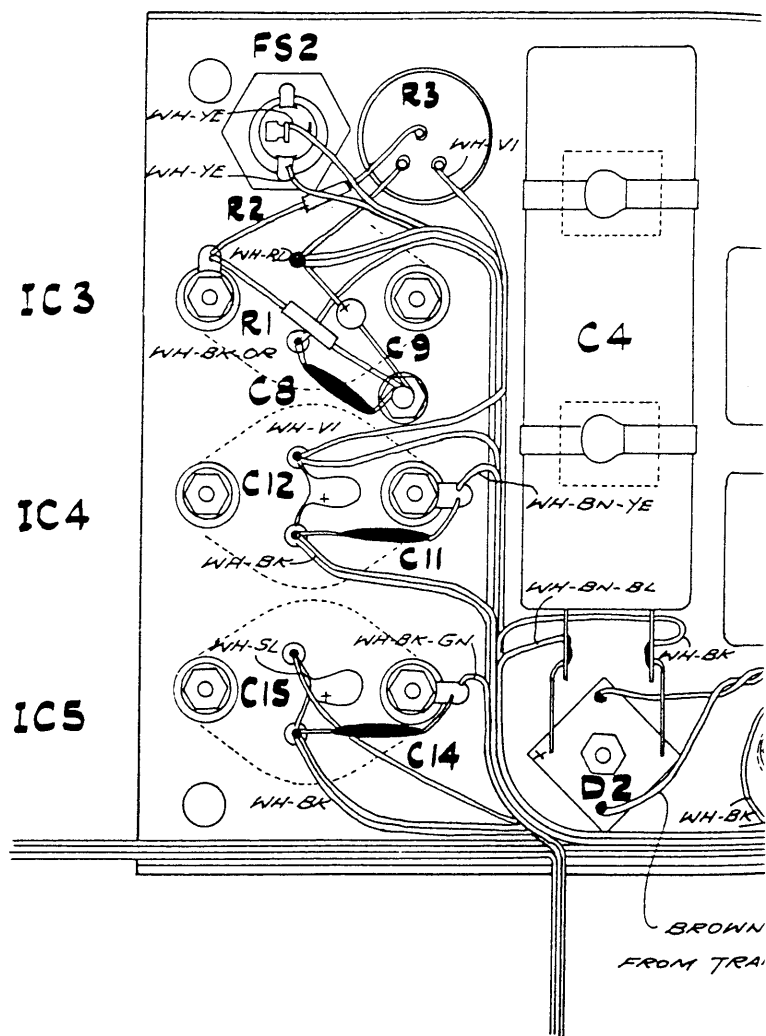
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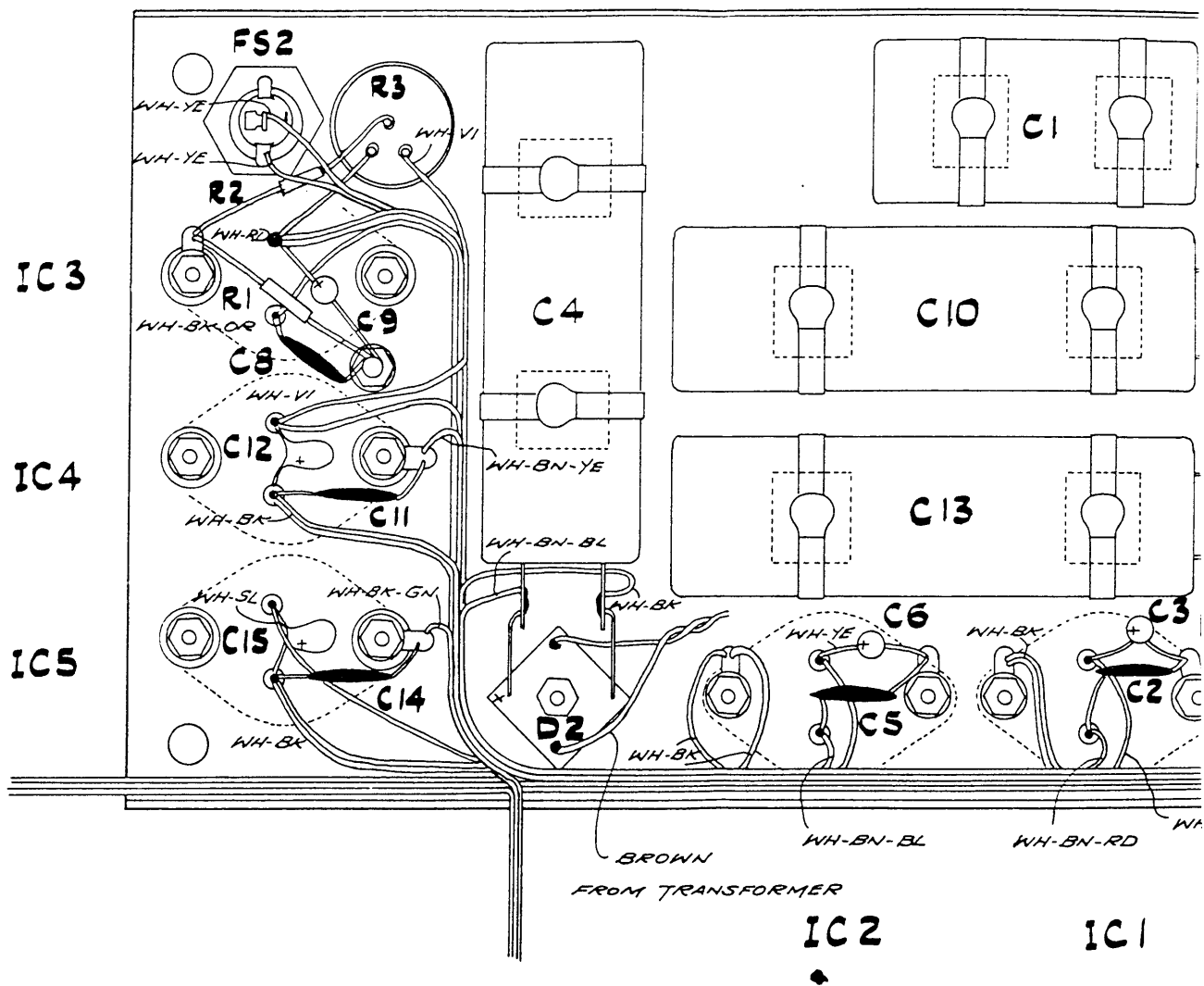


Circuit Diagram:
Display Assembly 19-0895 Fig. 37



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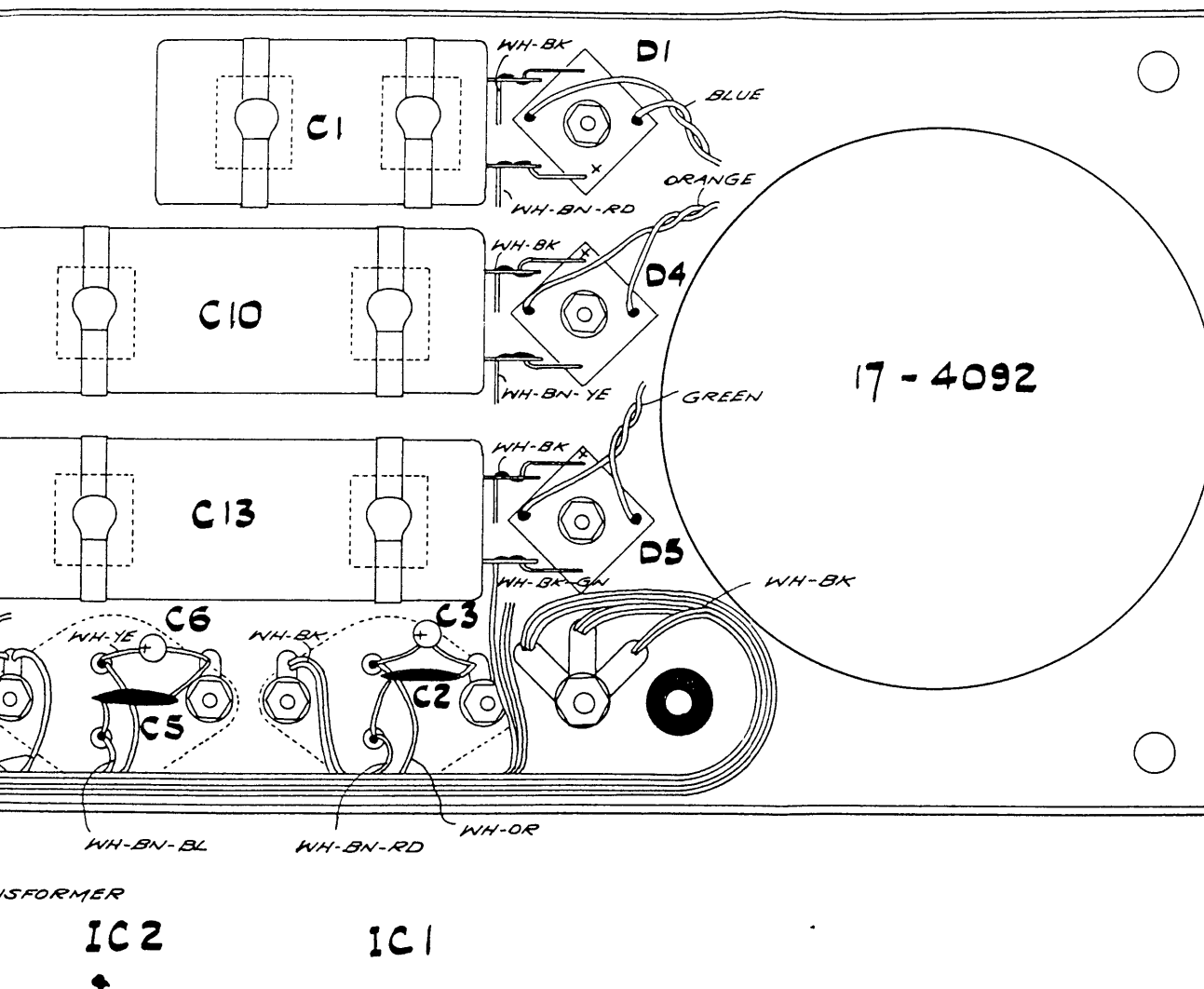
TH1007	
1	2



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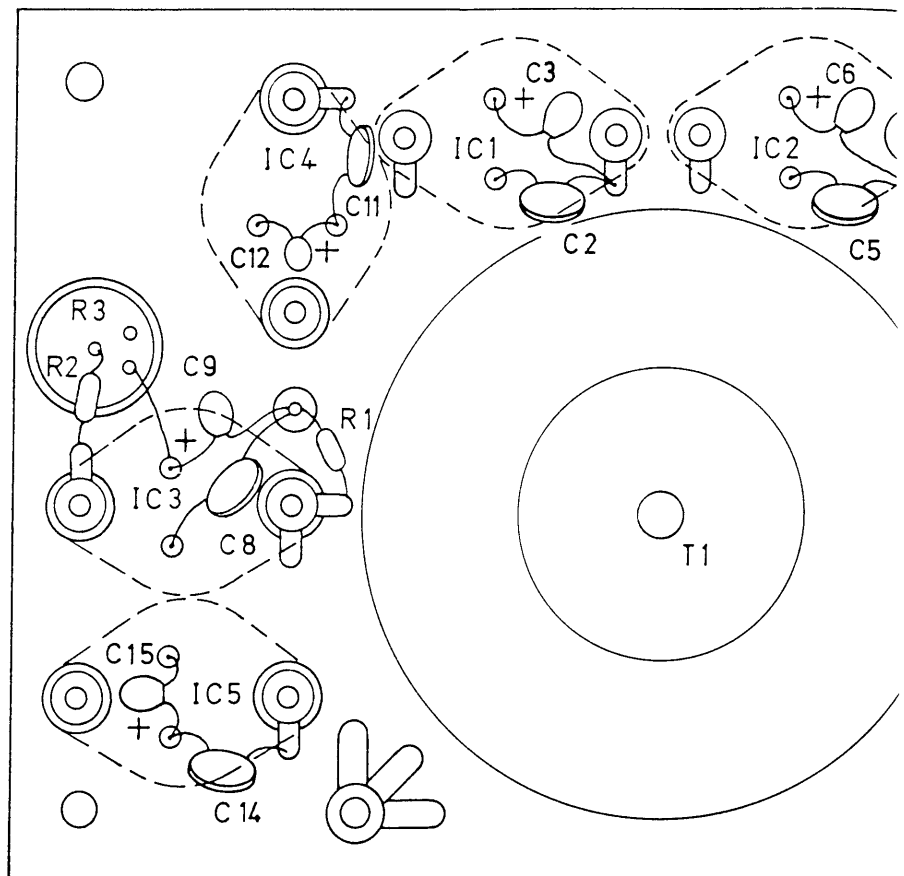
TH1007

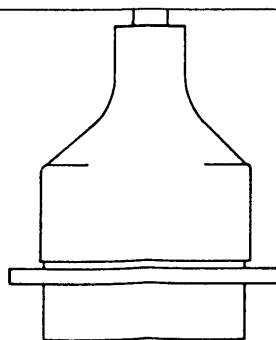
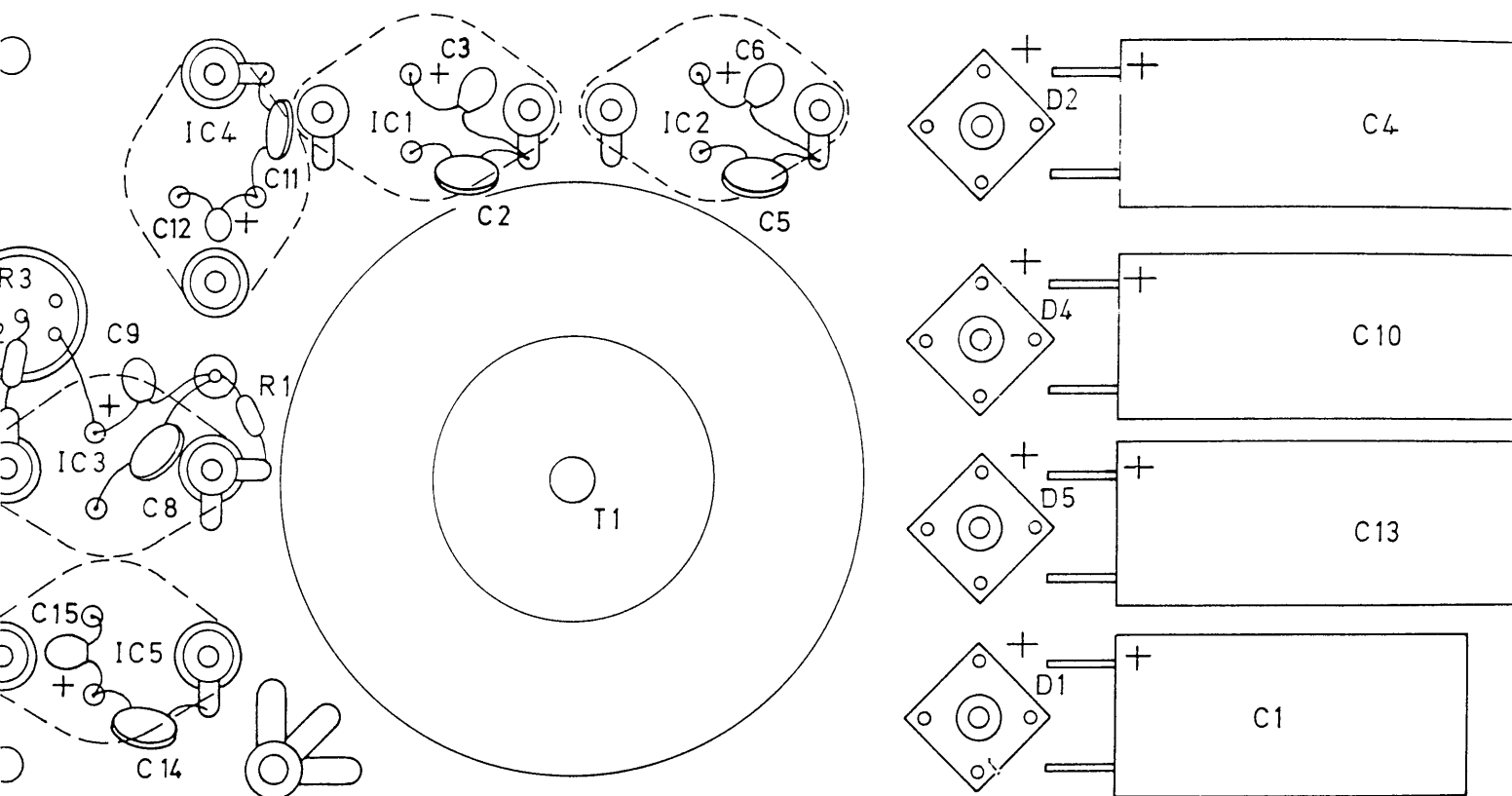
1 2



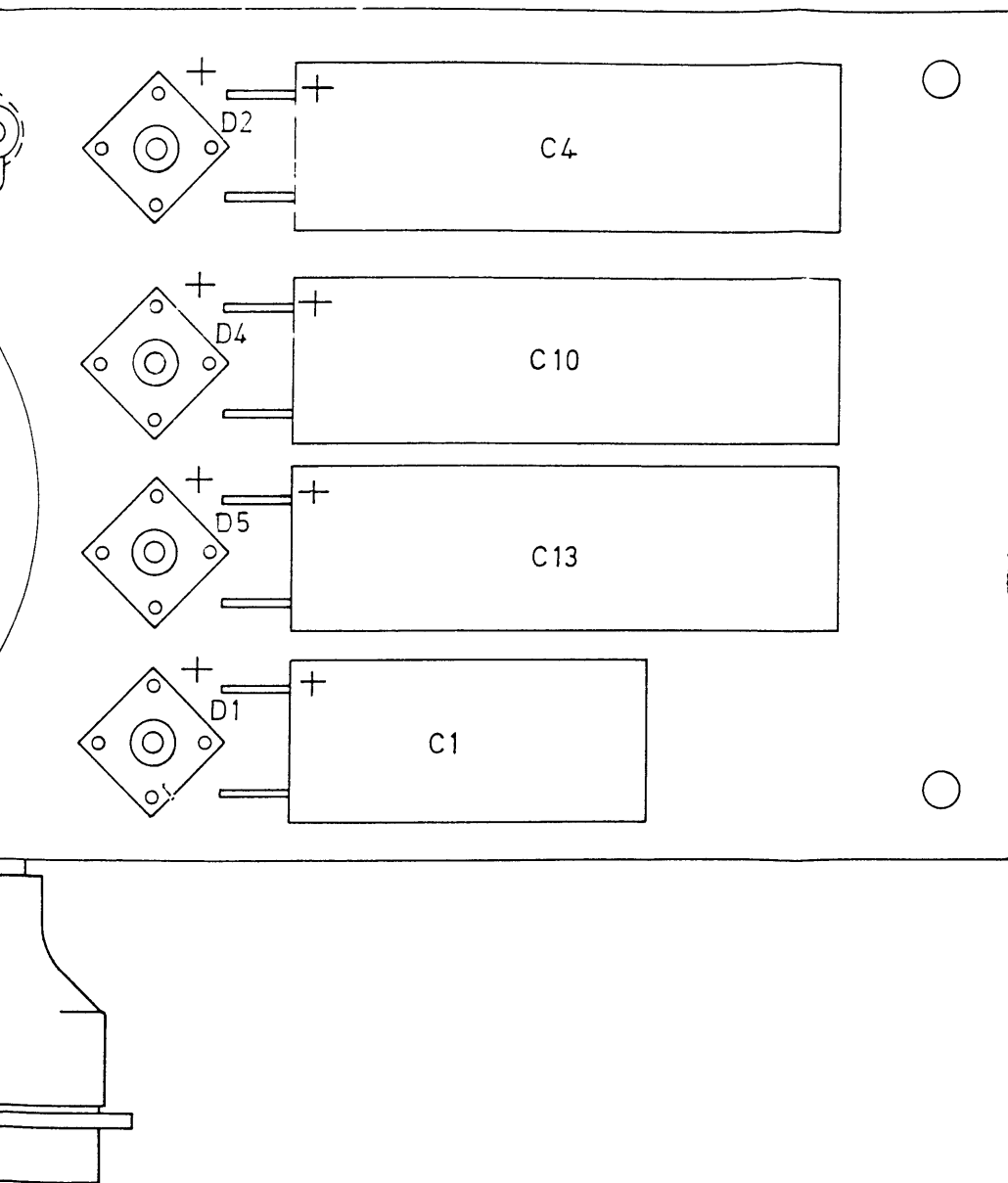
Component Layout:
Power Supply Plate 13-1663

Fig.38



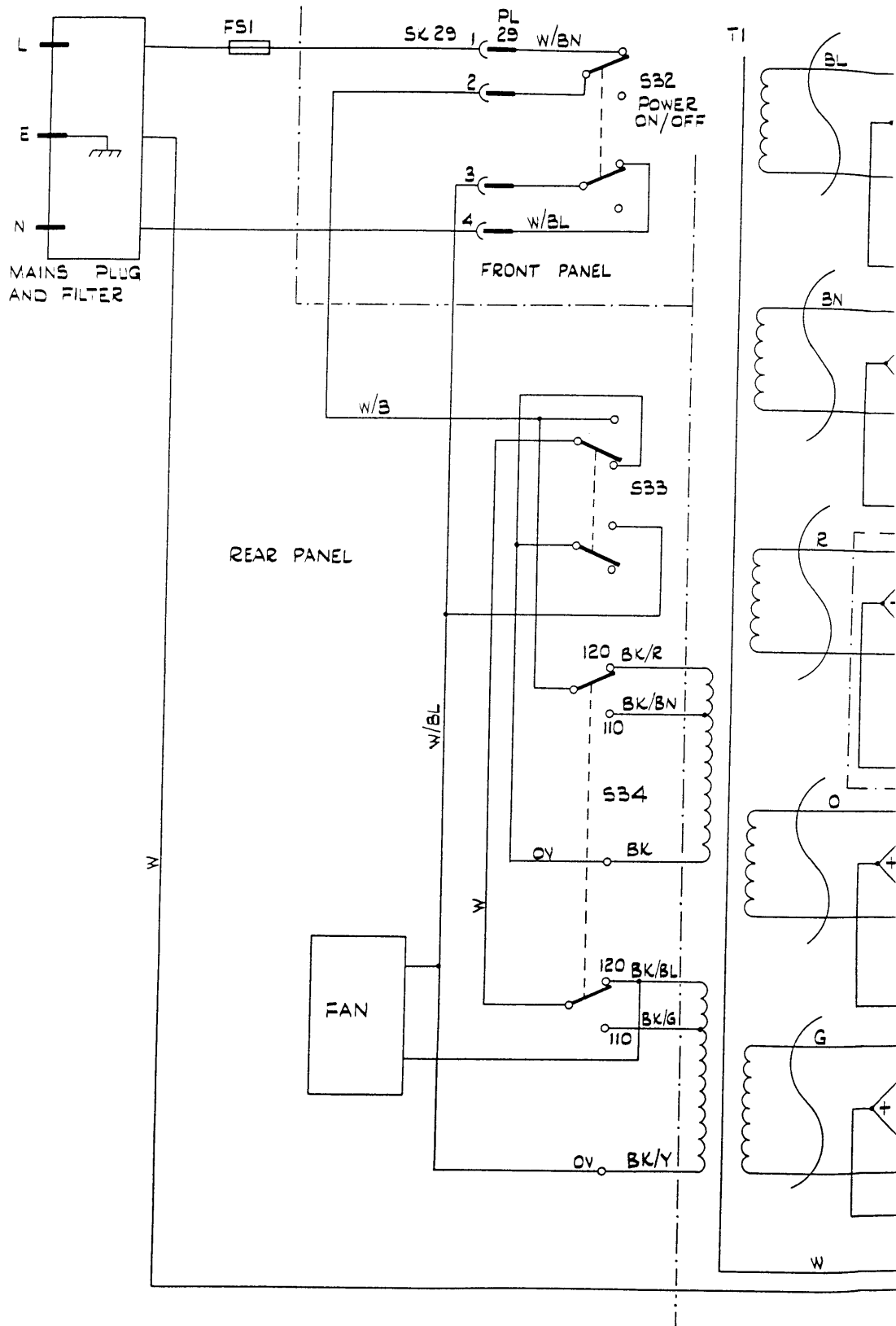


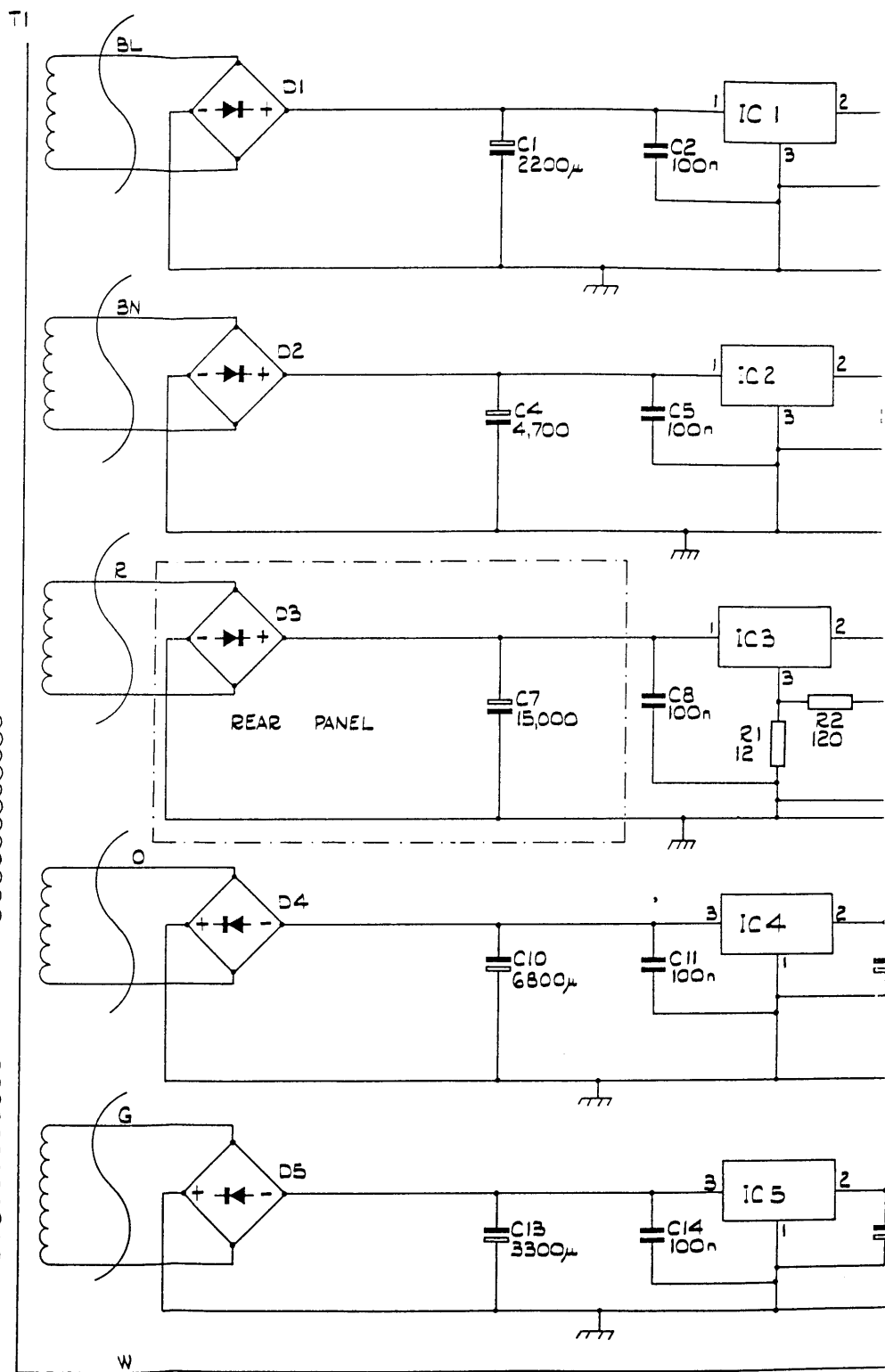
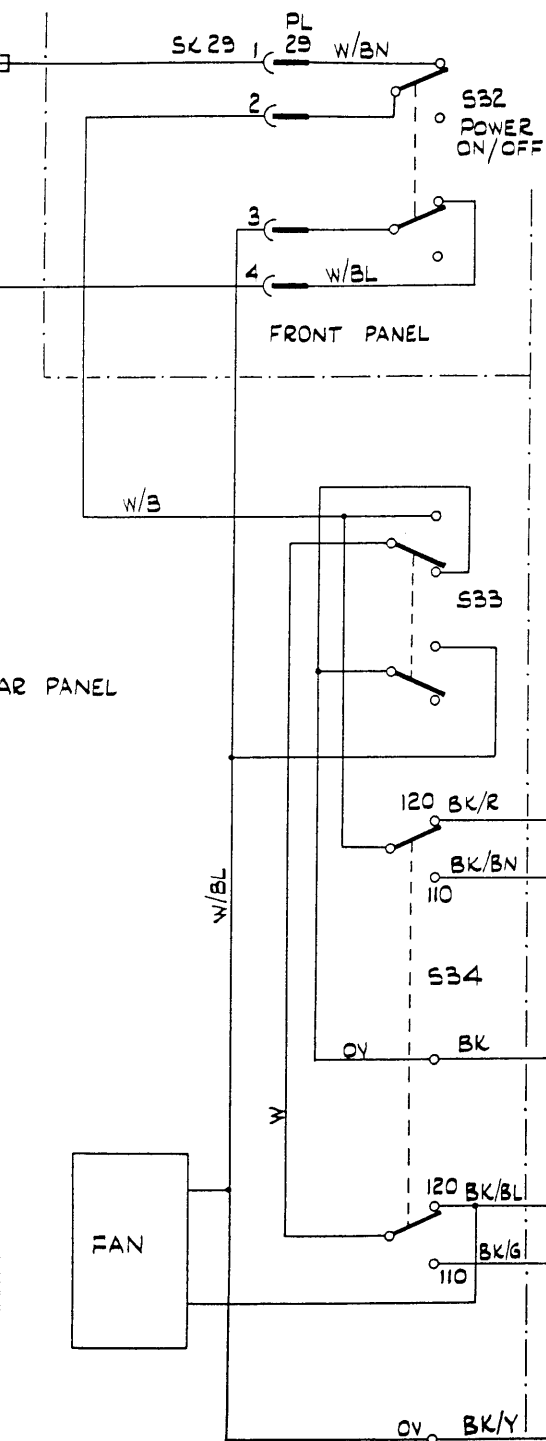
Compo
Power



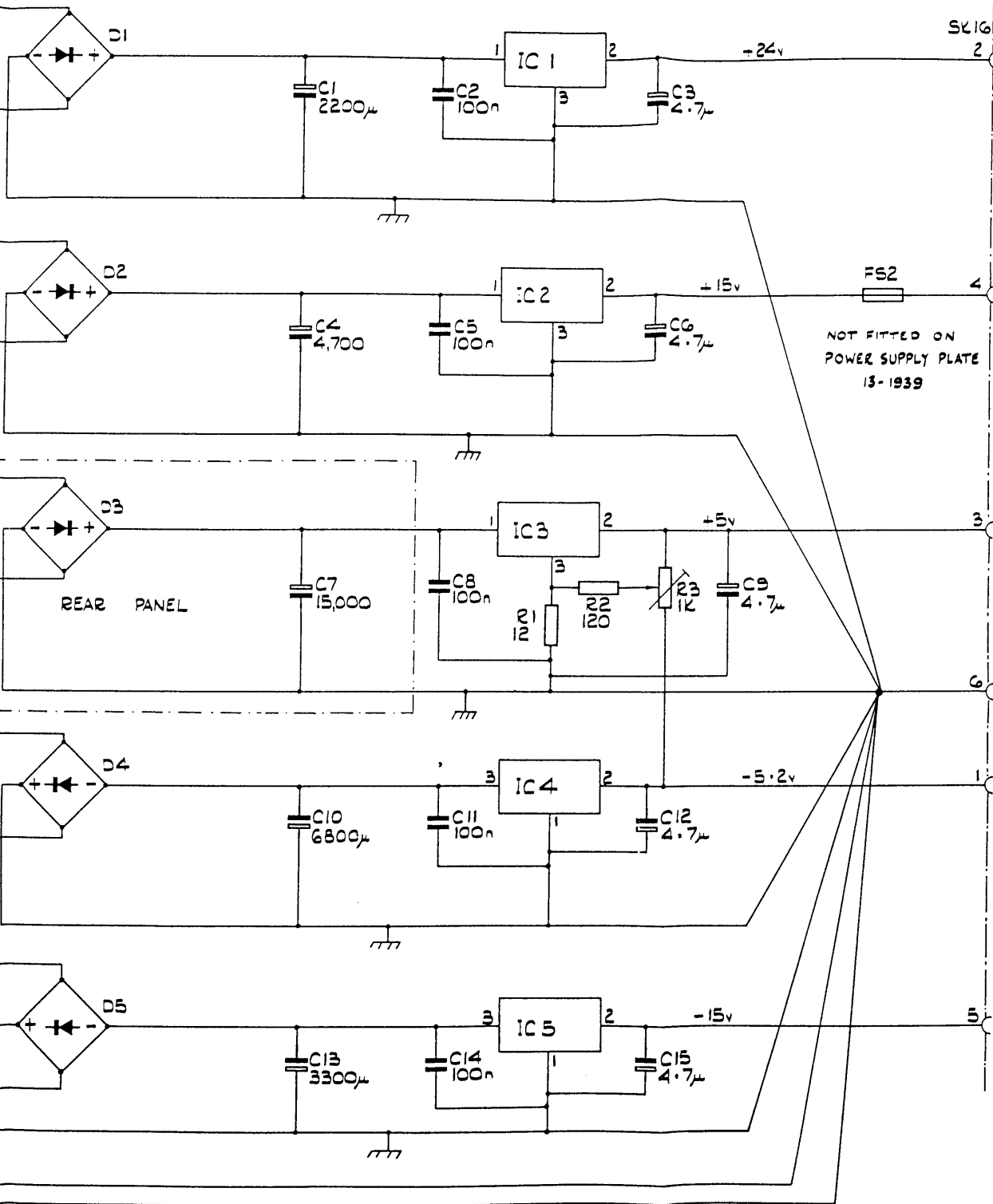
Component Layout:
Power Supply Plate 13-1939

Fig 38a



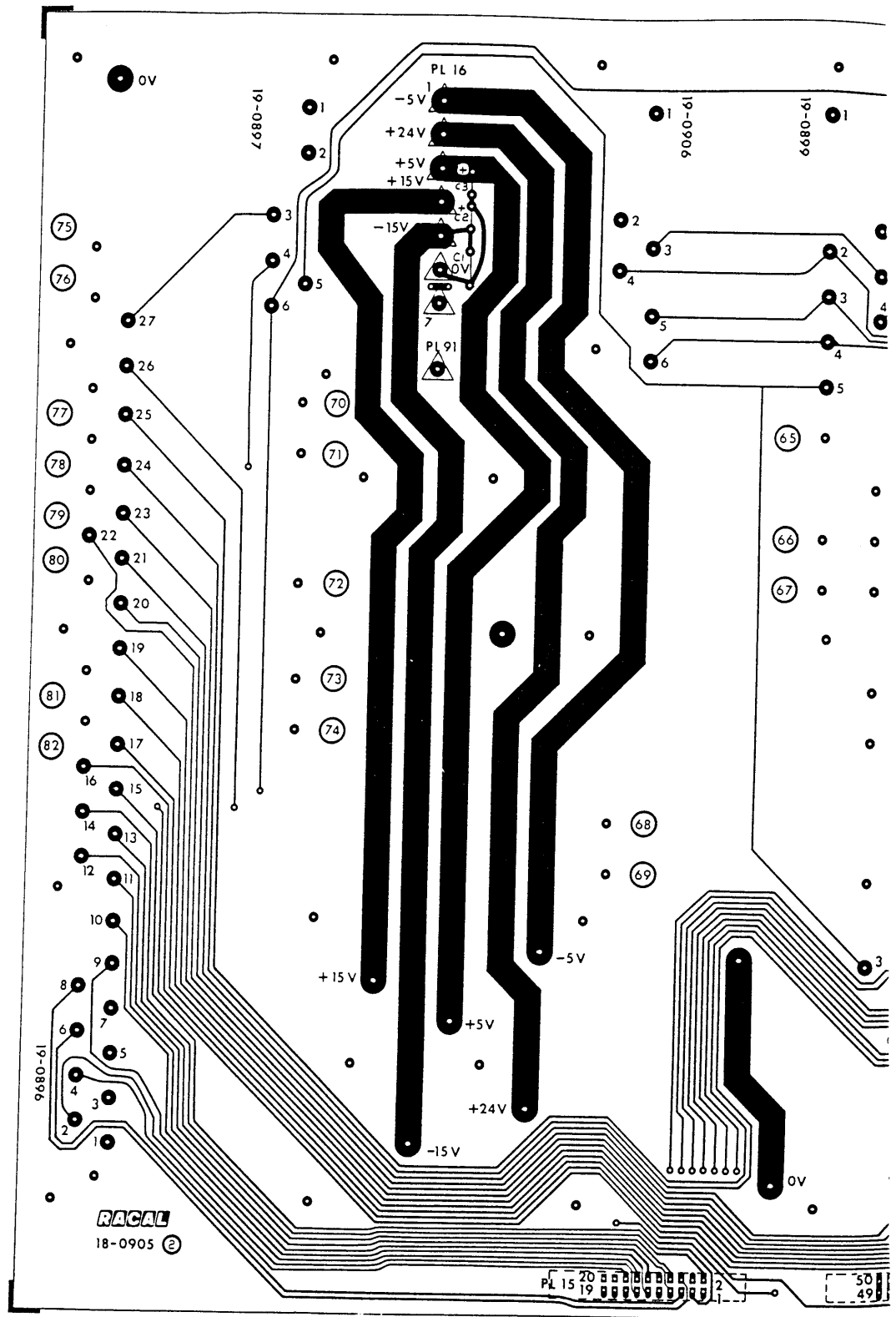


Circuit
Power

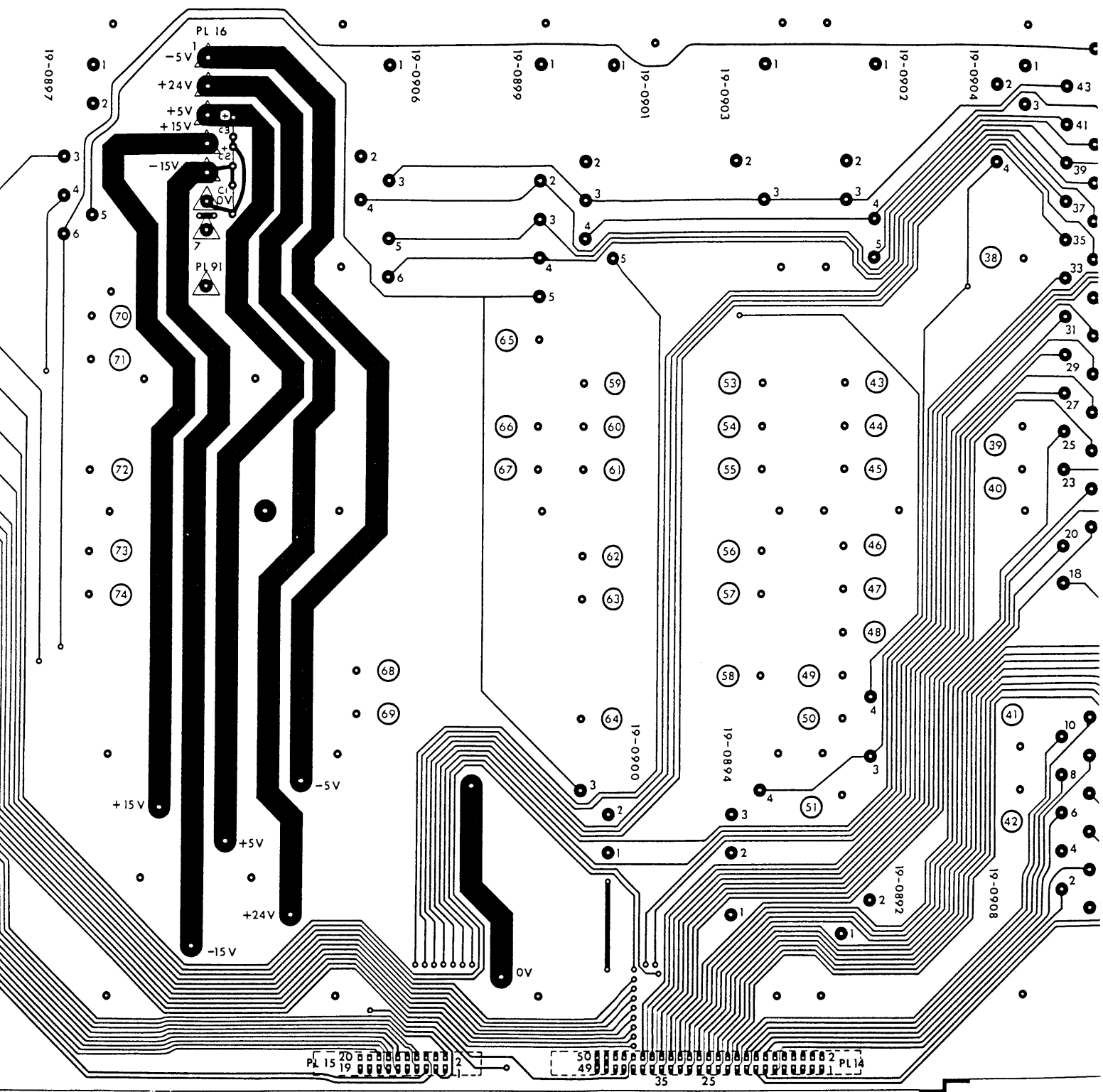


Circuit Diagram:
Power Supply

Fig.39

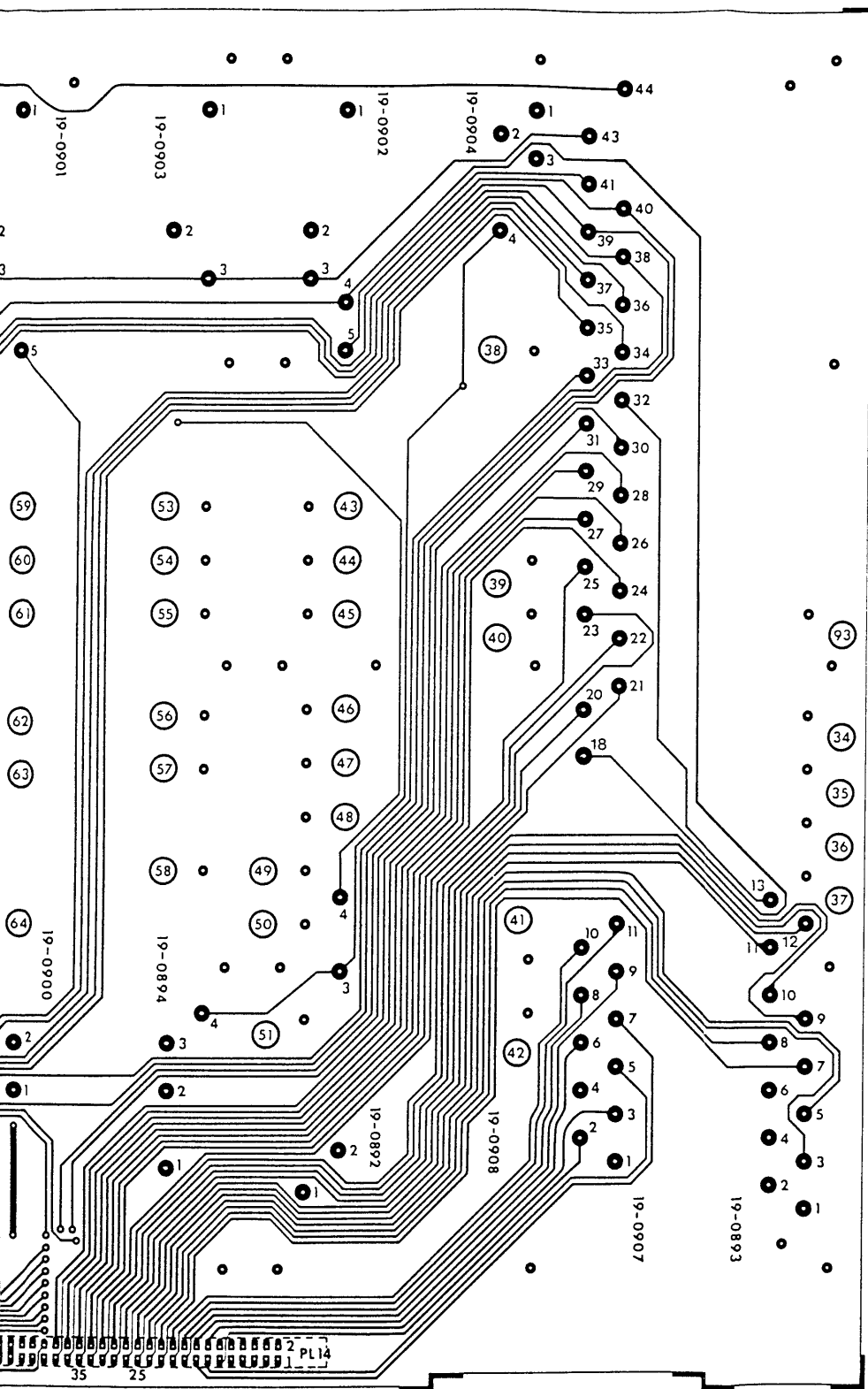


VIEW FROM TRACKSIDE



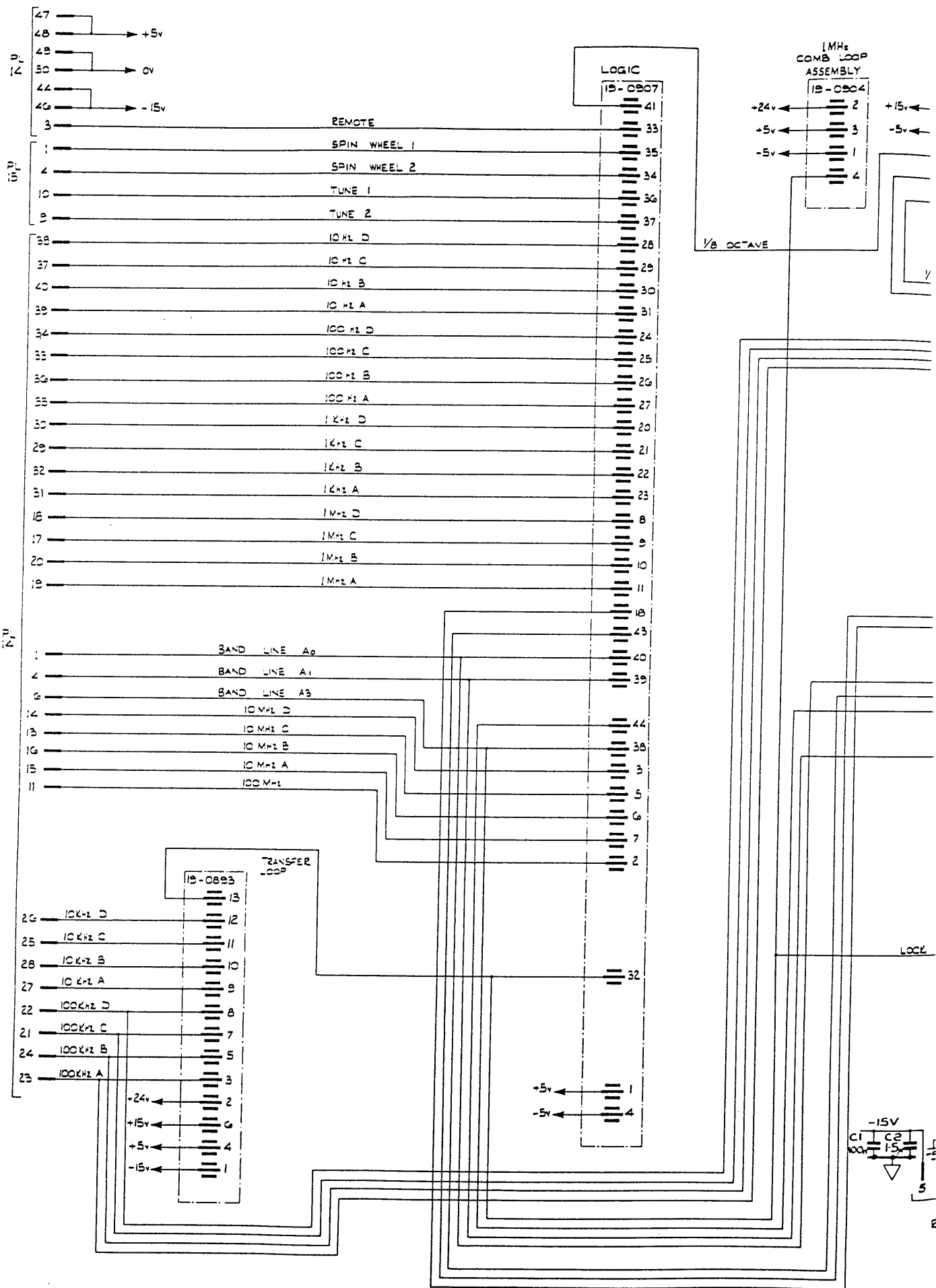
VIEW FROM TRACKSIDE

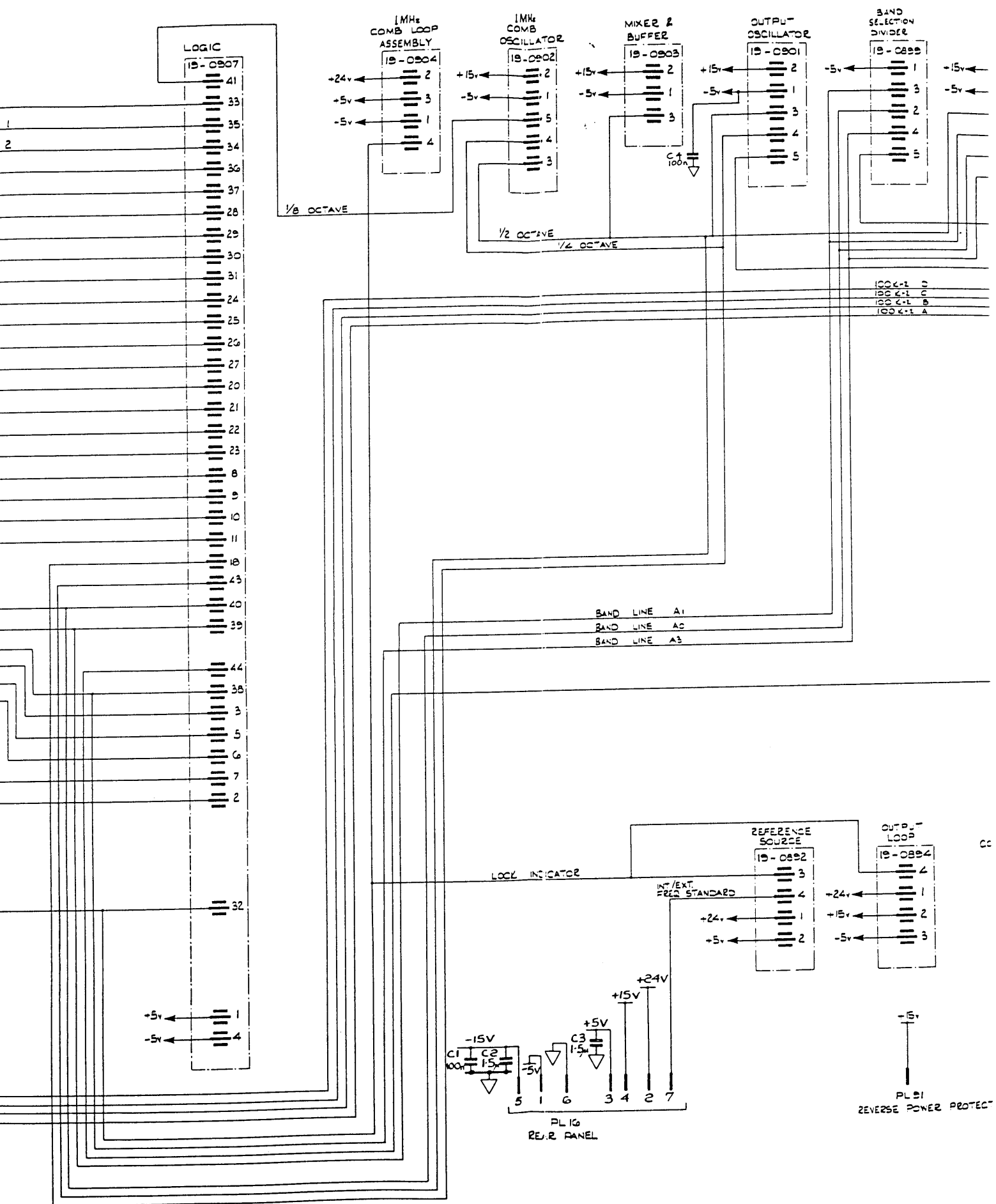
Track Layout:
Motherboard Assembly 19

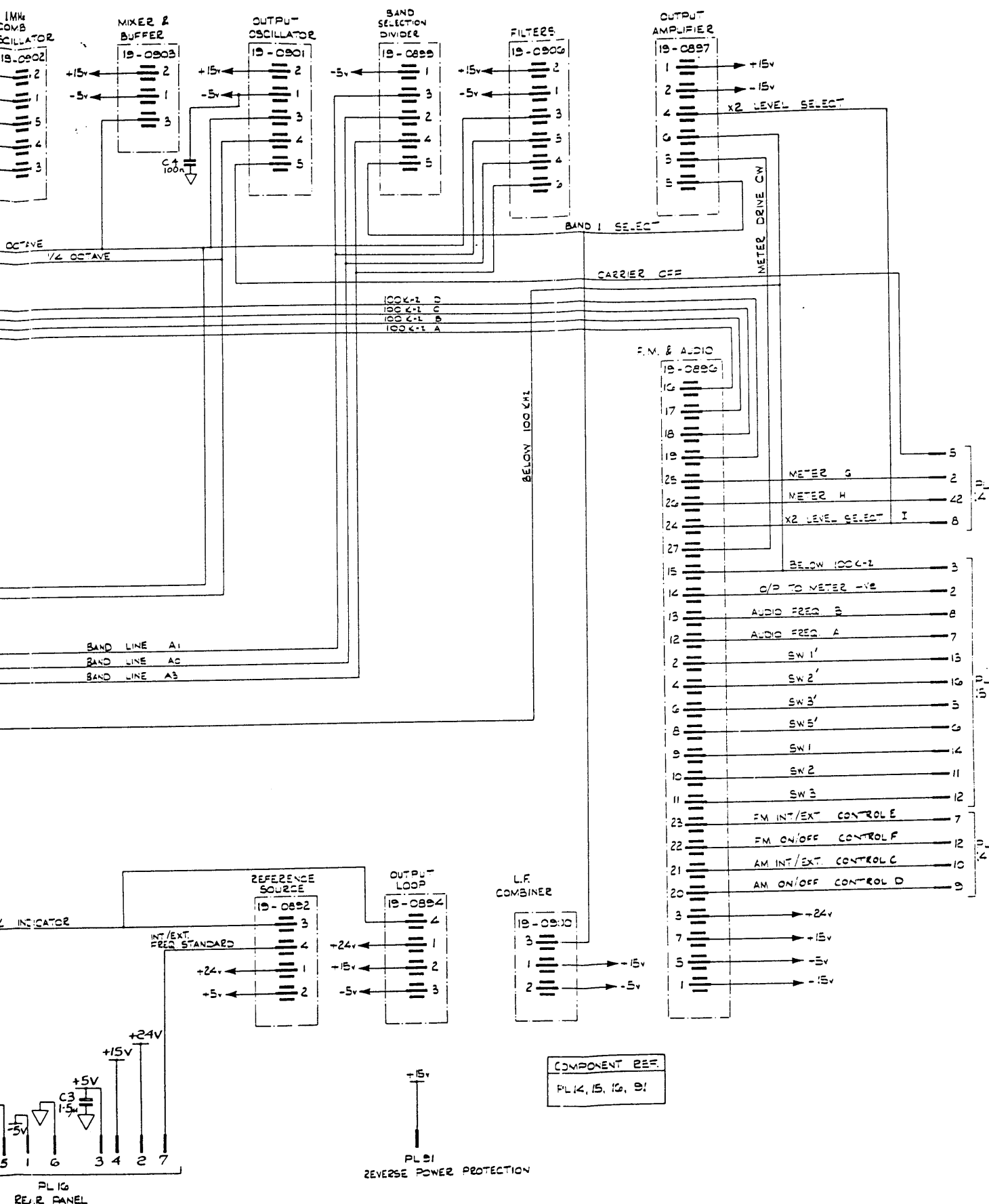


Track Layout :
Motherboard Assembly 19-0905

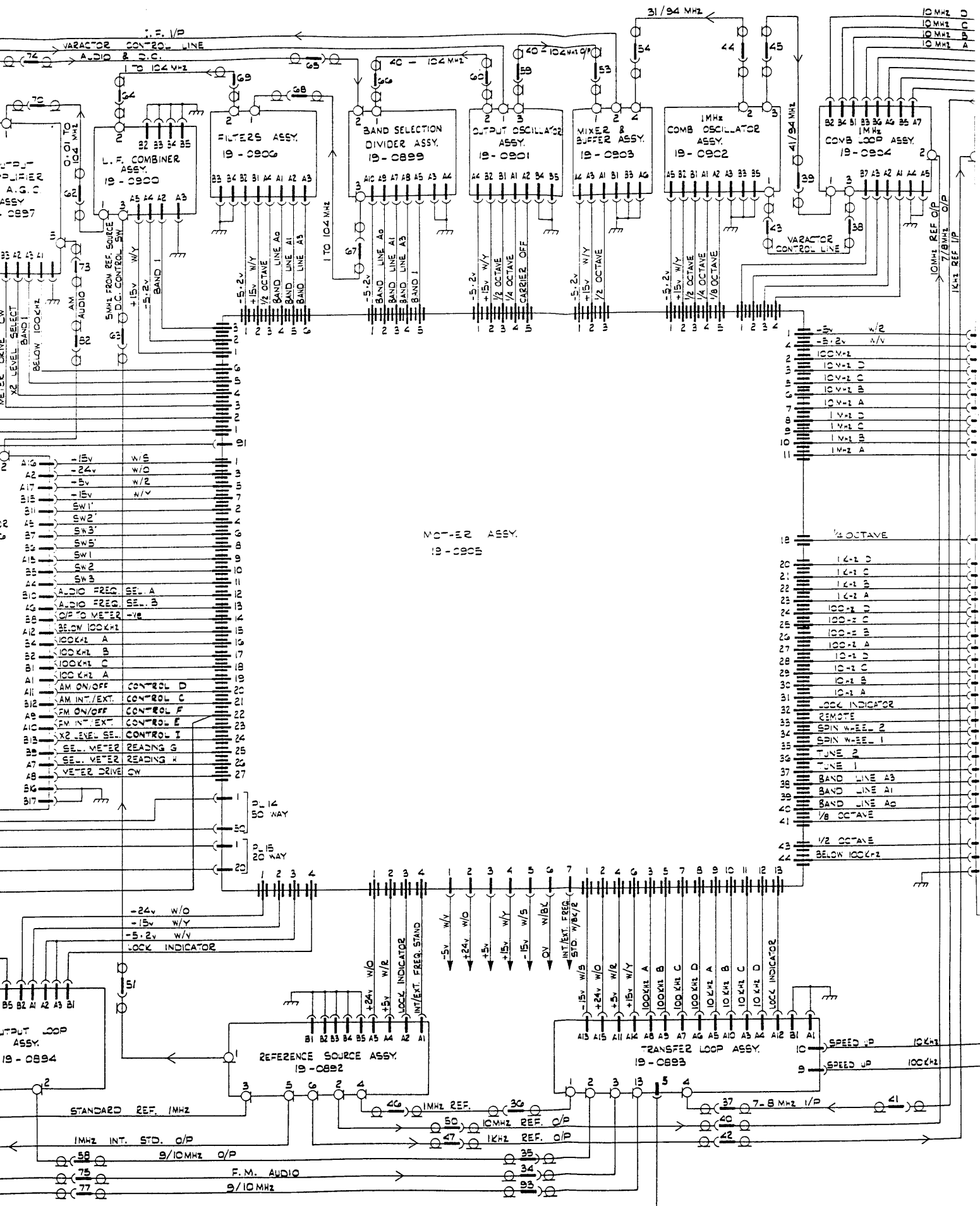
Fig.40

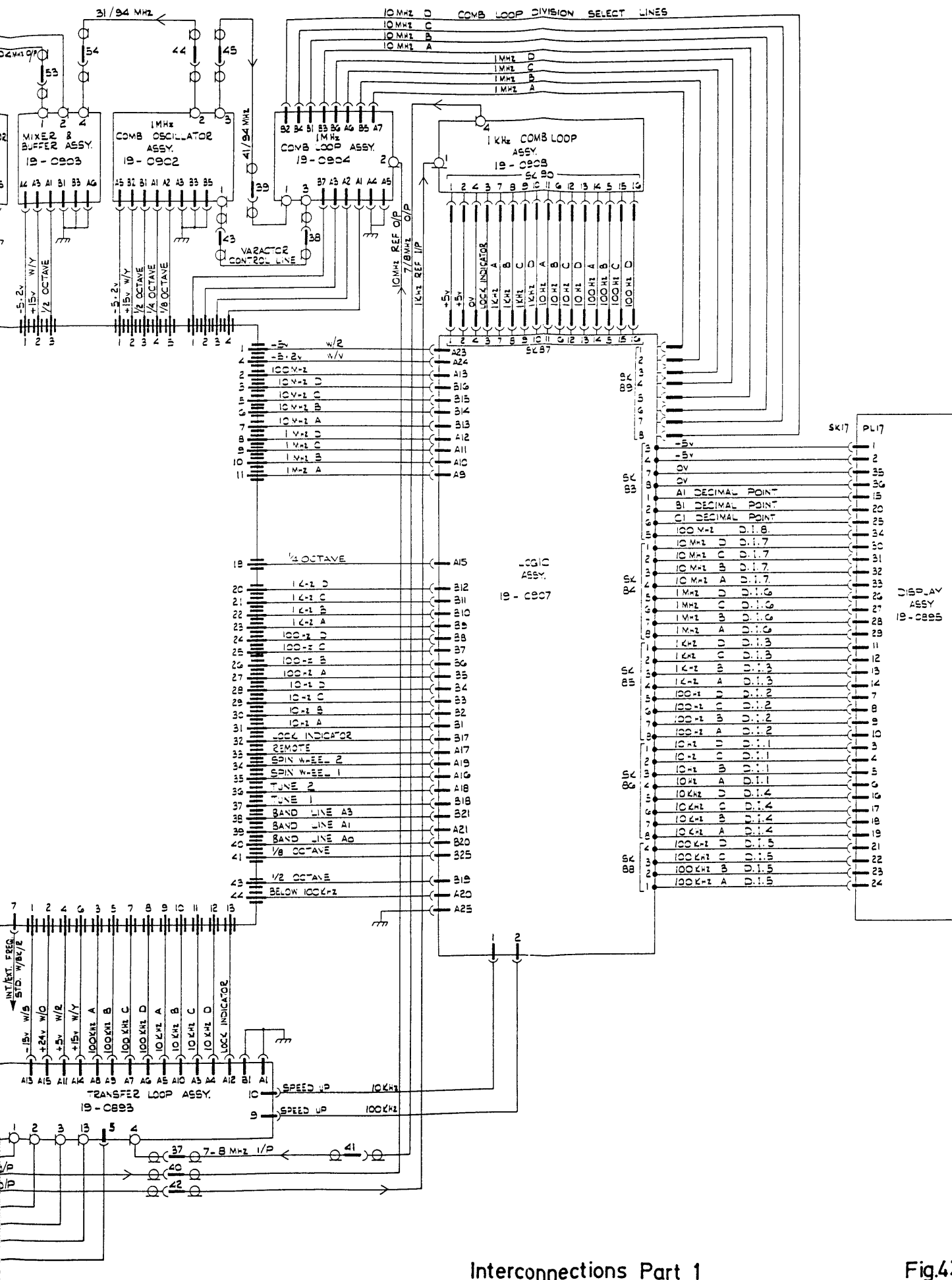






Circuit Diagram:
Motherboard Assembly 19-0905

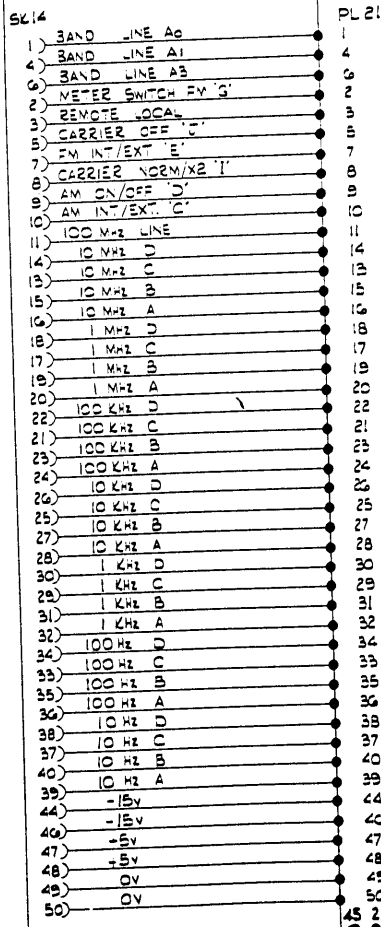
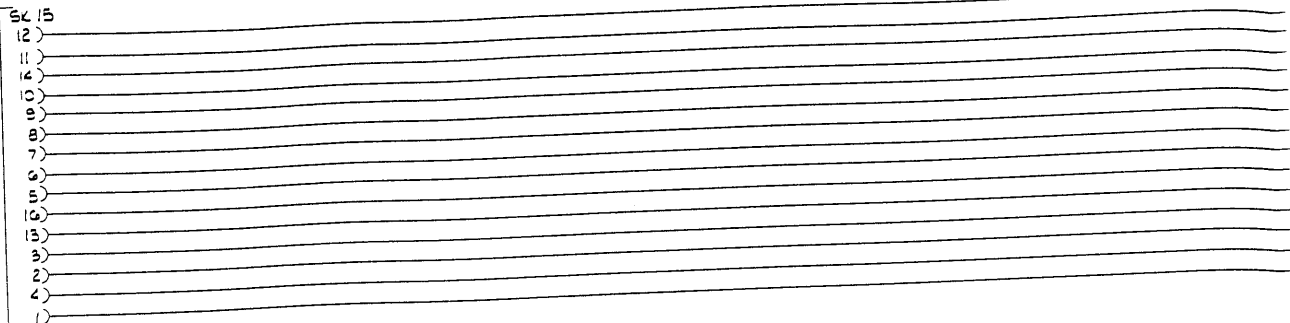




Interconnections Part 1

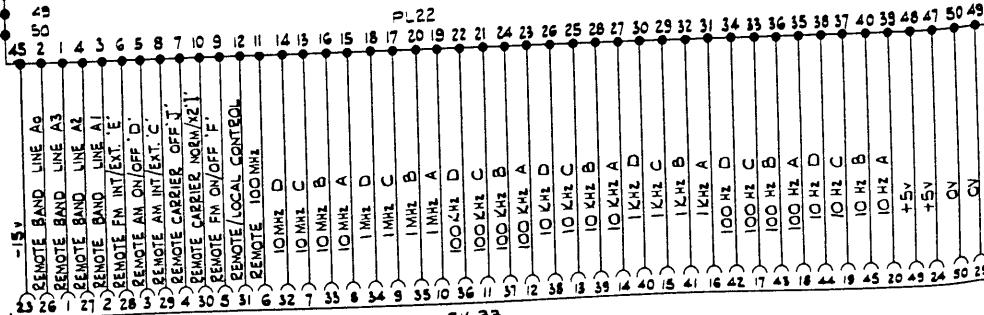
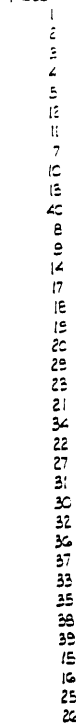
Fig.42

10
NOT
BOARD
19-0905



19-0911
FRONT PANEL
LOGIC

PL20



SK 33
REMOTE CONTROL BUS