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9478

FREQUENCY STANDARD DISTRIBUTION SYSTEM

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FREQUENCY STANDARD DISTRIBUTION SYSTEM 9478

AMENDMENTS

The following manuscript amendments should be made to the Issue 2 Maintenance Manual.

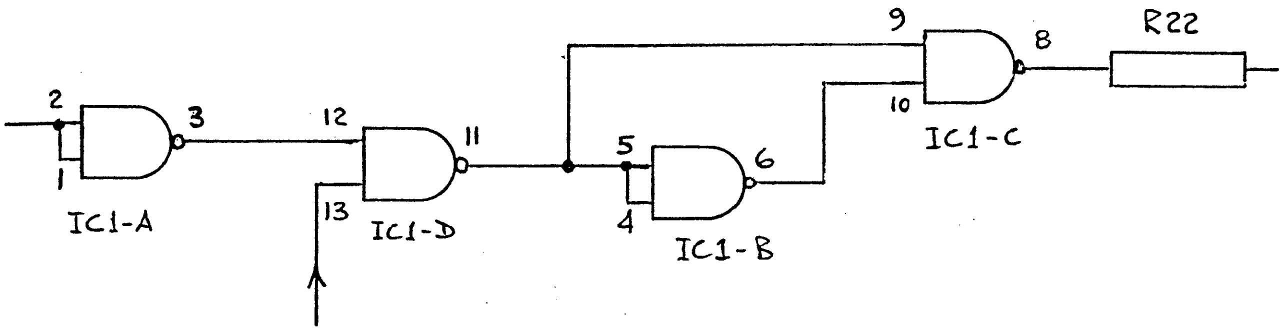
PARTS LIST 4

R74 Delete '150' and '21-2151'
Insert '120' and '21-2121'

FIG.2

R74 Delete '150' Insert '120'

IC1 Amend pin numbers to be as shown



Racal Dana instruments   February 1984

FREQUENCY STANDARD DISTRIBUTION SYSTEM 9478

The changes listed below have been made to some instruments having serial numbers above 1035.

Changes found to apply to the instrument with which this manual is to be used should be incorporated in the manual by manuscript amendment.

PARTS LIST 8

Resistors: Add new components

'Ra to Ri	100	Carbon Film	0.1	5	20-1514'

PARTS LIST 15

Inductors: Add new components

'Lx	15µ	Choke, sub-miniature	10	23-7015
Ly	33µ	Choke, sub-miniature	10	23-7017'

FIG. 2

Add Lx, 15µ, in parallel with L4.
Add Ly, 33µ, in parallel with L5.

FIG.3

Add Ra to Ri, 100Ω, in base lead of transistors Q26, Q28, Q30, Q32, Q34, Q36, Q38, Q40 and Q42.

AR5360
AR5414

9478
Issue 2
Change No.1

Racal Dana Instruments   June 1984

FREQUENCY STANDARD DISTRIBUTION SYSTEM 9478

The changes listed below have been made to some instruments having serial numbers above 1085

Changes found to apply to the instrument with which this manual is to be used should be incorporated in the manual by manuscript amendment.

PARTS LIST 8

Capacitors	C11 & C12	Delete	'100n	25	-20+80	21-1616'
		Insert	'1n	500	20	21-1532'

PARTS LIST 14

Transistors	Q8	Delete	'MPS-A12	22-6133'
		Insert	'2N2369	22-6017'

AR5692
9478
Issue 2
Change No.2

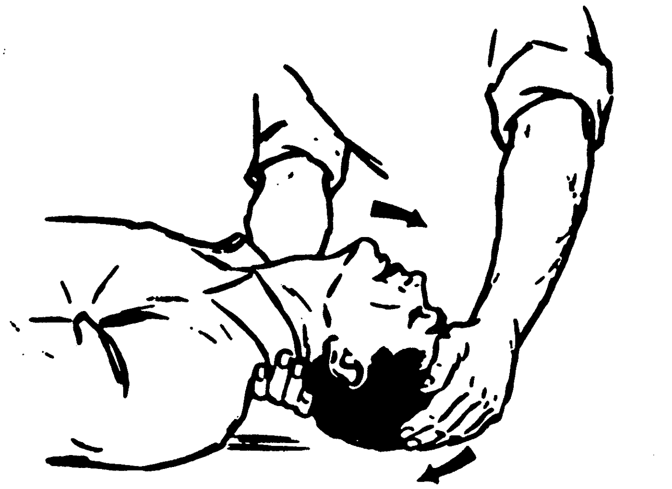
LETHAL WARNING

Voltages within this equipment are sufficiently high to endanger life.

Covers are NOT to be removed except by persons qualified and authorised to do so and these persons should always take extreme care once the covers have been removed.

Resuscitation instructions are given overleaf.

FIRST AID in case of Electric Shock



1. Lay victim on his back.
2. Clear victim's mouth and throat.
3. Tilt victim's head back as far as possible and raise his head.

4. Pinch victim's nostrils.
5. Take a deep breath.
6. Cover the victim's mouth with yours and blow, watching his chest rise.
   Note: Blow forcefully into adults, but gently into children.
7. Move your face away to allow victim to breathe out, watching his chest fall.
8. Repeat first five to ten breaths at a rapid rate; thereafter, take one breath every three to five seconds.
9. Keep victim's head back as far as possible all the time.

Have someone else send for a Doctor

Keep patient warm and loosen his clothing

DO NOT Give liquids until patient is conscious

'POZIDRIV' SCREWDRIVERS

Metric thread cross-head screws fitted to Racal equipment are of the 'Pozidrive' type. Phillips type and 'Pozidriv' type screwdrivers are not interchangeable, and the use of the wrong screwdriver will cause damage. POZIDRIV is a registered trademark of G.K.N. Screws and Fasteners Limited. The 'Poidriv' screwdrivers are manufactured by Stanley Tools Limited.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1 TECHNICAL SPECIFICATION

1.1 **SPECIFICATION**

1.1.1 The published specification for the Racal-Dana Frequency Standard Distribution System 9478 is given in Table 1.1

TABLE 1.1

Technical Specification

INTERNAL FREQUENCY STANDARD	
Options Available:	A choice of two crystal controlled oscillators from the Racal-Dana range is offered. The technical specifications are given under OPTIONAL FREQUENCY STANDARDS at the end of this section of the manual.

EXTERNAL FREQUENCY STANDARD	
Frequency:	1 MHz, 2 MHz, 2.5 MHz, 5 MHz or 10 MHz. The phase lock pull-in range is 10×10^{-6} of the nominal frequency.
Input Level:	100 mV to 5 V r.m.s.
Input Impedance:	50 Ω
Connector:	Connection is to a BNC socket on the rear panel. The system automatically selects the external standard when an input having sufficient amplitude is present.
Indicator:	A front panel indicator lights, and a TTL compatible logic '1' level is present at a rear panel connector, when the system is operating from the external standard.

TABLE 1.1 (Continued)

Technical Specification

OUTPUT PARAMETERS	
Number of Output Sockets:	Nine
Output Frequencies:	Frequencies of 1 MHz, 5 MHz and 10 MHz are available. The standard configuration is with channels 1, 2 and 3 giving 10 MHz, channels 4, 5 and 6 giving 5 MHz and channels 7, 8 and 9 giving 1 MHz. Any other combination of frequencies and outputs can be obtained by means of internal links.
Output Level:	1 V ± 0.1 V r.m.s. into 50 Ω
Output Impedance:	50 Ω
Connectors:	Rear panel mounted BNC sockets.
Indicators:	A separate front panel indicator is provided for each channel. This lights when a channel output is present. A single, TTL compatible, logic '1' level is present at a rear panel connector if any channel output fails.
Monitor Output:	A low level, 10 MHz output, giving 500 mV ± 100 mV r.m.s. into 50 Ω, is available at a front panel BNC socket.
Output Harmonics:	At least 30 dB below the output level.
Spurious:	At least 80 dB below the output level.
Sub-harmonics:	At least 70 dB below the output level.
Line Related Sidebands: (operating on internal frequency standard)	At least 70 dB below the output level
Output Socket Protection:	The channel output sockets will withstand continuous short circuit conditions. Each socket will withstand the continuous application of reverse power not exceeding 500 mW.

TABLE 1.1 (Continued)

Technical Specification

POWER SUPPLY	
Voltage:	A four-range supply voltage selector is provided to accept 100 V, 120 V, 220 V or 240 V AC ±10%.
Frequency:	45 Hz to 440 Hz.
Power Consumption:	Approximately 15 VA

MECHANICAL PARAMETERS	
Dimensions:	Height: 104 mm Width: 440 mm Depth: 403 mm
Weight:	Approximately 4 kg

ENVIRONMENTAL SPECIFICATION	
Operating Temperature Range:	0^oC to $+55^oC$
Storage Temperature Range:	-40^oC to $+70^oC$
Relative Humidity:	95% at $+40^oC$
Safety:	The equipment has been designed to meet the safety requirements of IEC publication 348.

ACCESSORIES SUPPLIED	
Power Lead:	Part Number 23-3227
Fuse for 100/120 V Operation:	Part Number 23-0052
Maintenance Manual	

TABLE 1.1 (Continued)

Technical Specification

OPTIONAL ACCESSORIES	
19 inch Rack Mounting Kit:	Part Number 11-1496
Mating connector for rear panel mounted connector:	Cinch R43 81043 with shell R43 81960 Part Numbers 23-3215 and 23-3216

OPTIONAL FREQUENCY STANDARDS	
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 ^oC averaged over the range -10^oC to $+45^oC$, but operable to $+55^oC$.
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 in 10^{10}/day averaged over a minimum of 10 days after 3 months continuous operation.

TABLE 1.1 (Continued)

Technical Specification

OPTIONAL FREQUENCY STANDARDS (Continued)	
Option 04B: Frequency Standard 9421 (Continued)	
Warm-up Time:	Better than ±1 part in 10^7 within 20 minutes.
Temperature Stability:	Better than ±6 parts in 10^{10} per ^{o}C averaged over the range $-10^{o}C$ to $+45^{o}C$, but operable to $+55^{o}C$.

SECTION 2 GENERAL DESCRIPTION

2.1 **INTRODUCTION**

2.1.1 The Racal-Dana Frequency Standard Distribution System 9478 provides a reliable and convenient means of generating and distributing up to nine standard frequency signals, all phase locked to a single frequency standard. Where more than nine independent outputs are required, two or more systems may be cascaded.

2.2 **FREQUENCY STANDARD**

2.2.1 The frequency standard used may be internally mounted. A choice of two crystal oscillators from the Racal-Dana range is offered. The specifications of these oscillators are given in Section 1.

2.2.2 Alternatively an external master oscillator or atomic frequency standard may be used. External frequency standards having outputs at 1 MHz, 2 MHz, 2.5 MHz, 5 MHz or 10 MHz are all suitable for use with the 9478.

2.2.3 Systems fitted with an internal frequency standard will automatically lock to the input from an external standard when such an input is present.

2.3 **SYSTEM OUTPUTS**

2.3.1 The nine BNC output sockets are mounted on the rear panel. Each is fed from an individual driver amplifier and provides a level of 1 V r.m.s. into 50 Ω. Internal coaxial links, which may easily be reset by the user, allow the frequency at any output to be set to 1 MHz, 5 MHz, or 10 MHz.

2.4 **STATUS INDICATORS**

2.4.1 Each output channel is provided with an individual LED indicator. These are mounted on the front panel, and light when an output is present. In addition a TTL compatible, logic '1' alarm signal is given at a rear panel mounted connector if any output fails.

2.4.2 Two further front panel LED indicators are provided. One lights when the system is in lock, and the other when an input from an external frequency standard is present. Both indicators are repeated, in the form of TTL compatible logic '1' levels, at a rear panel mounted connector.

2.5 **MAINTENANCE**

2.5.1 Customers are reminded of the repair and calibration service offered by Racal-Dana Instruments and their agents. In particular, this manual provides no technical information in respect of the Racal-Dana model 9442 and 9421 frequency standards. In the event of failure, these items should be repaired by Racal-Dana Instruments, or their agents, only.

SECTION 3 PREPARATION FOR USE

3.1 POWER SUPPLY

3.1.1 AC VOLTAGE RANGE SETTING

3.1.1.1 The supply voltage setting is varied by changing the position of a small printed circuit board located under the fuse on the rear panel. The setting in use can be seen through the clear plastic fuse cover.

3.1.1.2 If it is necessary to change the voltage range proceed as follows:

(a) Switch the 9478 off, and remove the line power socket.

(b) Slide the clear plastic fuse cover to the left, to expose the fuse.

(c) Pull the lug marked FUSE PULL out and to the left. This will remove one end of the fuse from its holder. Remove the fuse.

(d) Using a pair of snipe nosed pliers, pull out the voltage setting board from beneath the fuse holder.

(e) Reinsert the board so that the required voltage range can be read the correct way up when viewed from above looking at the rear of the instrument.

(f) Push the lug marked FUSE PULL back into position.

(g) Insert the correct fuse for the range selected into the fuse holder.

(h) Slide the clear plastic cover to the right until it is clear of the line power plug. Insert the line power socket.

3.1.2 LINE FUSE

3.1.2.1 Check that the line fuse rating is correct for the local AC supply voltage. The fuse is a ¼ in x 1¼ in glass cartridge, anti-surge type. The Racal-Dana part numbers for replacement fuses are:-

90 V to 132 V supply	500 mAT	23-0052
198 V to 264 V supply	250 mAT	23-0056

3.1.3 POWER LEAD

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

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

3.2 FITTING THE FIXED RACK MOUNTING KIT 11-1496

3.2.1 The kit contains a pair of mounting brackets and four screws. The method of fitting the kit is shown in Fig. 3.1. The fitting procedure is as follows:

(a) Switch off the instrument and the AC supply. Remove the line power socket.

(b) Stand the instrument upside down on a firm bench.

(c) Remove two screws from each of the plastic mouldings at the rear corners of the instrument. Remove the mouldings.

(d) Slide the bottom cover towards the rear of the instrument by about 1 inch, and lift the cover off.

(e) Remove the bench feet from the bottom cover by removing the retaining screw from each foot. Replace the bottom cover.

(f) Remove the side trim panels by sliding them to the rear of the instrument. Replace and secure the plastic mouldings removed in (c).

(g) Remove the two screws securing the handle at one side of the instrument. Do not remove the handle.

(h) Position a bracket from the kit at the side of the instrument, so that the two holes in a flange are positioned over the holes for the handle securing screws.

(j) Secure the handle and bracket, using two of the countersunk headed screws from the kit.

(k) Repeat (g) to (j) at the other side of the instrument.

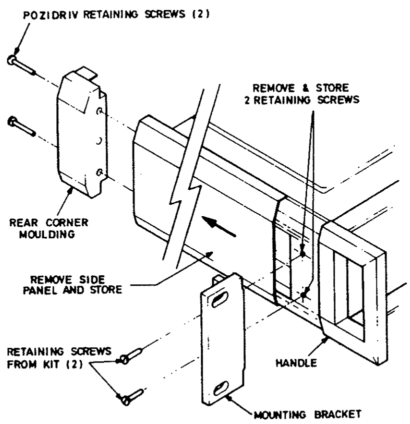


Fig. 3.1 Fitting the Fixed Rack Mounting Kit

3.3 SETTING THE OUTPUT CHANNEL FREQUENCIES

3.3.1 The 9478 is normally supplied with channels 1, 2 and 3 giving 10 MHz, channels 4, 5 and 6 giving 5 MHz and channels 7, 8 and 9 giving 1 MHz. To change this pattern proceed as follows:

(a) Remove the covers as instructed in paragraph 3.7

(b) On printed circuit board assembly 19-1105, locate the signal input for the driver amplifier of the channel to be changed, as shown in Table 3.1. Unsolder the remote end of the coaxial link connected to this input from the frequency distribution point.

(c) Resolder the coaxial link to the new frequency distribution point, as shown in Table 3.2. Up to three links may be connected to any one pin at a frequency distribution point.

(d) Replace the equipment covers.

NOTE: The frequency setting links must be formed with coaxial cable only.

TABLE 3.1

Driver Amplifier Inputs

Channel No.	Signal Input Pin	Ground Pin
1	21	22
2	23	24
3	25	26
4	27	28
5	29	30
6	31	32
7	33	34
8	35	36
9	37	38

TABLE 3.2

Frequency Distribution Points

Frequency	Signal Pins	Ground pins
10 MHz	3 5 7	4 6 8
5 MHz	9 11 13	10 12 14
1 MHz	15 17 19	16 18 20

3.4 **EXTERNAL STATUS INDICATOR CONNECTION**

3.4.1 If external status indicators are to be used the appropriate connections should be made to the rear panel mounted, 9-pin connector. The mating free plug for this connector is a Cinch R43 81043 with shell R43 81960, Racal-Dana Part Numbers 23-3215 and 23-3216, and is available as an accessory. The pin allocation and form of status indication given are shown in Table 3.3

TABLE 3.3

External Status Indication

Indication	Pin Number	State Represented by logic '1'
Loop Lock	1	Loop in lock
External Standard	3	Input from external standard detected.
Output Failure	5	At least one output has failed

3.5 CONNECTION OF EXTERNAL FREQUENCY STANDARD

If an external frequency standard is to be used it should be connected to the rear panel EXT STD socket. When operating, the 9478 will automatically lock to the input from an external standard when such an input is present. Should the external standard input fail the 9478 will automatically lock to the internal frequency standard, so the EXT STD indicator will be extinguished but the LOCK indicator will remain lit.

3.6 CASCADE CONNECTION

3.6.1 If two 9478's are to be connected in cascade a 10 MHz channel output or the 10 MHz MONITOR output of the master equipment should be connected to the EXT STD input of the slave.

3.7 REMOVAL AND REPLACEMENT OF COVERS

WARNING: DANGEROUS AC VOLTAGE LEVELS ARE EXPOSED WHEN THE COVERS ARE REMOVED WITH THE AC SUPPLY CONNECTED.

3.7.1

(1) Switch off the instrument and the AC supply. Remove the line power socket.

(2) Stand the instrument on its front handles, and remove the two screws from each of the plastic mouldings at the rear corners of the instrument. Remove the mouldings.

(3) The covers can now be removed by sliding them towards the rear of the instrument. Note that the removal of the plastic mouldings also releases the side trim panels, which should either be removed or secured by replacement of the mouldings.

(4) The covers are replaced in the reverse manner. Note that the straight, unfolded edge of the cover fits to the front of the instrument, and locates in a groove in the rear face of the front panel. The rear edge of the cover is folded under, and locates in a groove in the rear panel.

SECTION 4 OPERATING INSTRUCTIONS

4.1 **INTRODUCTION**

4.1.1 The 9478 must be prepared for use as instructed in Section 3 before connecting it to the AC supply. If using the equipment for the first time, or at a new location, pay particular attention to the setting of the AC voltage range selector.

4.2 **DESCRIPTION OF CONTROLS, INDICATORS AND CONNECTORS**

4.2.1 Each group of controls, indicators or connectors described is numbered to correspond with the indicators on Fig. 4.1 (front panel) or Fig. 4.2 (rear panel).

4.2.2 FRONT PANEL ITEMS

(1) LINE Switch and Indicator: This controls the AC supply to the 9478. The indicator lights when the equipment is switched on.

(2) 10 MHz MONITOR Output: A TTL compatible output at the frequency of the phase locked loop.

(3) CHANNEL Indicators: Separate indicators are provided for each output channel. An indicator lights when the specified output level is available at the corresponding CHANNEL output socket.

(4) EXT STD Indicator: This indicator lights when the equipment detects a signal applied at the EXT STD input socket.

(5) LOCK Indicator: This indicator lights when the equipment is locked to the frequency standard in use.

4.2.3 REAR PANEL ITEMS

(6) Oscillator Adjustment: This aperture provides access to the internal frequency standard calibration controls. Only one control is provided on the model 9442 frequency standard.

(7) EXT STD Input: A BNC socket, to which an external frequency standard may be connected. Details of the permitted frequencies and signal level are given in Section 1.

(8)	CHANNEL Outputs:	Each BNC socket provides an output which is locked to the frequency standard. The specification of the output signal is given in Section 1. The method of changing the output frequency is given in Section 3.
(9)	9-way Connector:	Three TTL compatible indications of the equipment operating status are provided at this connector. Details are given in Section 3.
(10)	LINE Connector:	This connector contains the line input plug, the AC line fuse and the AC supply voltage selector. Instructions for setting the voltage selector are given in Section 3.

4.3 SWITCHING ON

4.3.1

(1) Connect the power plug of the power supply lead to the rear panel power supply socket. Connect the power supply lead to the local AC supply, and switch the supply on.

(2) Switch the 9478 on by means of the LINE switch. Check that the LED indicator lights.

(3) If an external frequency standard is being used, switch the standard on and check that the EXT STD indicator lights.

(4) Check that the LOCK indicator lights.

(5) Check that all the CHANNEL indicators light.

NOTE: The extinguishing of any CHANNEL indicator represents a fault condition. While this may not affect the remaining channel outputs the equipment should not be operated unless fully serviceable.

4.4 SWITCHING OFF

4.4.1 The 9478 should be switched off by means of the LINE switch. There is no provision for operating in the standby mode, with power applied to the internal frequency standard only.

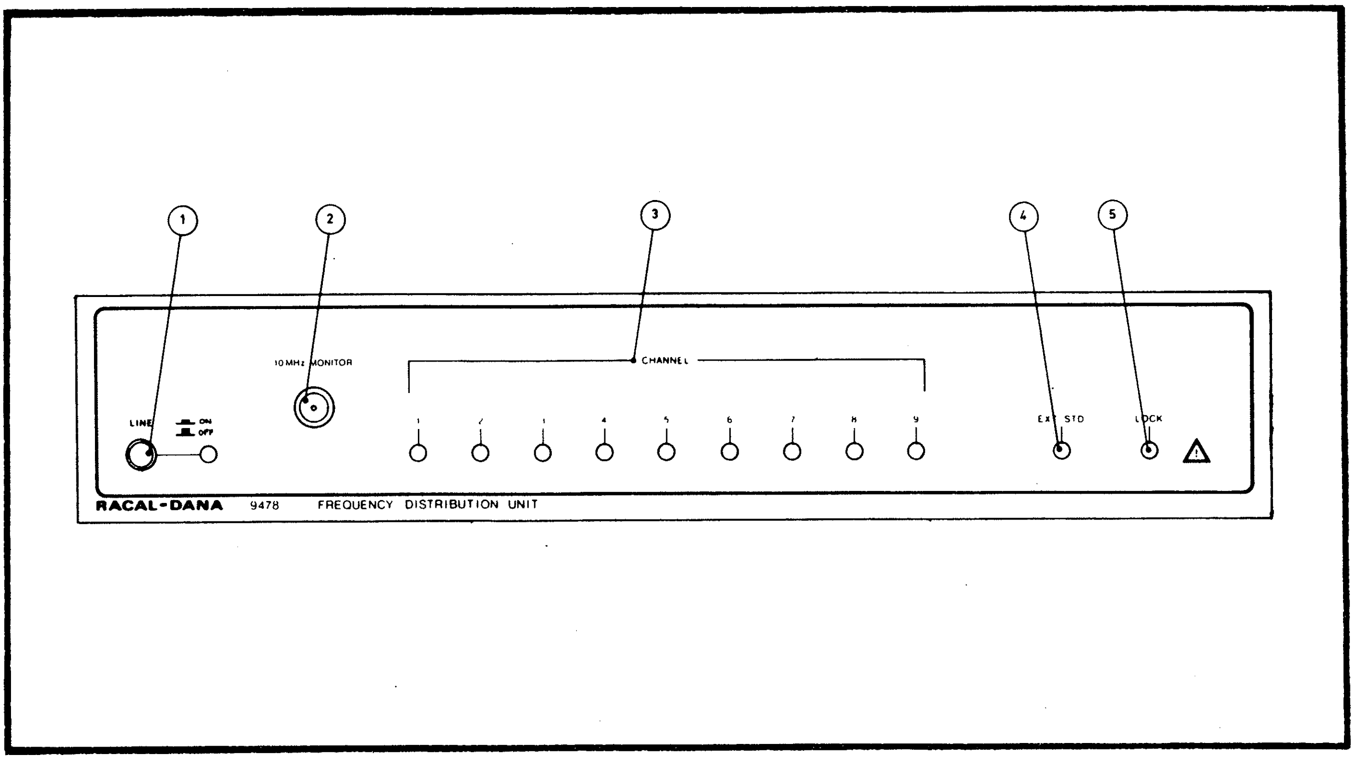


Fig. 4.1 Front Panel

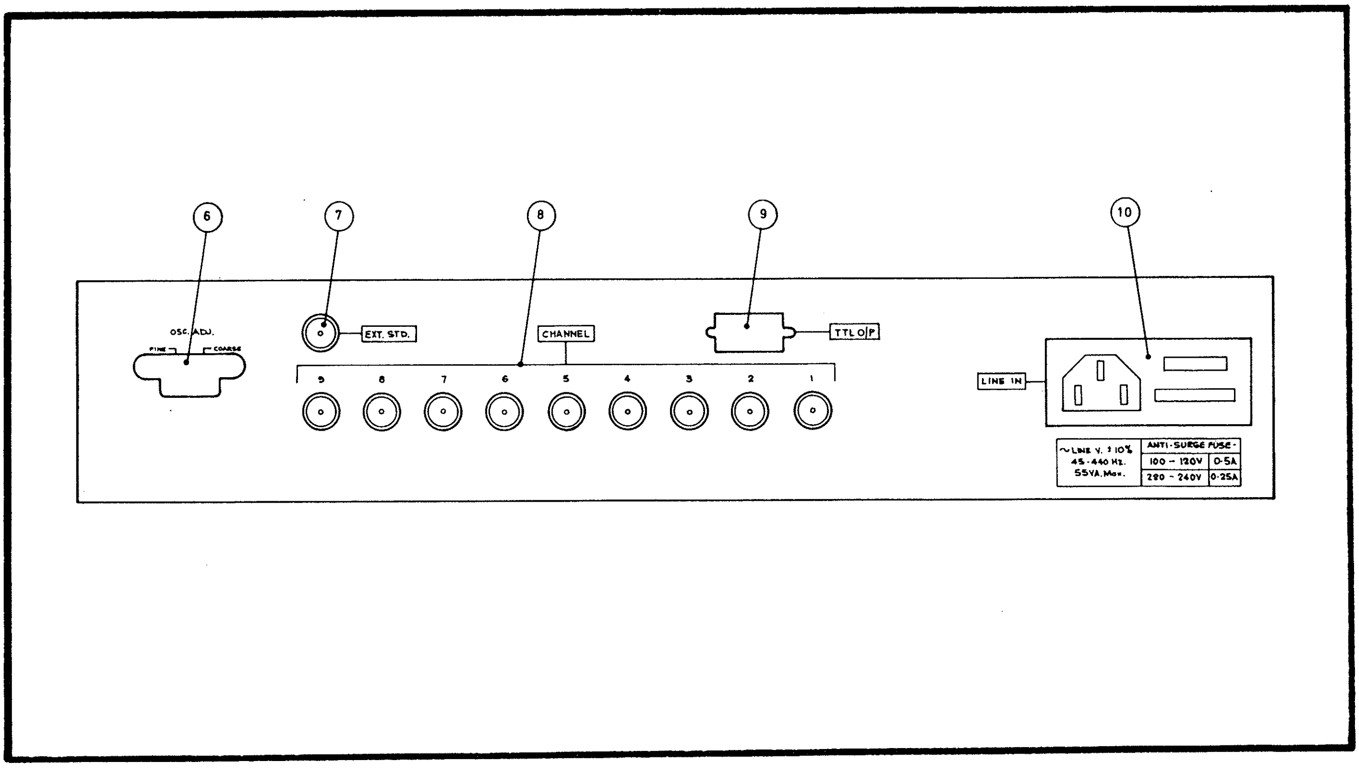


Fig. 4.2 Rear Panel

SECTION 5 PRINCIPLES OF OPERATION

5.1 **INTRODUCTION**

5.1.1 This section is written in two parts. Paragraph 5.2 covers the operating principles in general terms, with reference to the block diagram, Fig. 5.1. Paragraph 5.3 describes the operation of the circuits in greater detail, with reference to the circuit diagrams Fig. 2 and Fig. 3 in Section 7 of this manual. It is essential that the principles of operation are understood before the detailed circuit description is read.

5.1.2 In the circuit descriptions the integrated circuits are referred to by the circuit reference given on the appropriate circuit diagram. Note that a separate series of numbers, starting at IC1, is 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 circuit reference, with suffix letter if appropriate, is followed by an oblique stroke and the required pin number.

5.2 **PRINCIPLE OF OPERATION**

5.2.1 A block diagram, showing the operating principle of the 9478 is given in Fig. 5.1.

5.2.2 The system contains a phase-locked loop, operating at 10 MHz, which locks to the output of the frequency standard in use. The loop uses a sampling phase detector, which allows the system to lock directly to frequency standards operating at sub-multiples of 10 MHz.

5.2.3 If an input from an external frequency standard is detected the output of the internal frequency standard is inhibited. This provides automatic change-over to operation from the external standard.

5.2.4 Three outputs at 10 MHz are taken from the loop. Two of these are divided, to give frequencies of 5 MHz and 1 MHz. The 10 MHz, 5 MHz and 1 MHz signals are filtered, to give low distortion and high spectral purity, and then fed via emitter followers to the frequency distribution points.

5.2.5 Each output has its individual driver amplifier. An amplifier input may be obtained from any of the frequency distribution points by means of a soldered coaxial link. Each driver amplifier has its own output level detector and LED indicator.

5.3 **TECHNICAL DESCRIPTION**

5.3.1 EXTERNAL STANDARD INPUT CIRCUIT

The signal from an external frequency standard connected to the rear panel EXT STD socket is fed, via a coaxial cable, to pin 57 and C1. The signal

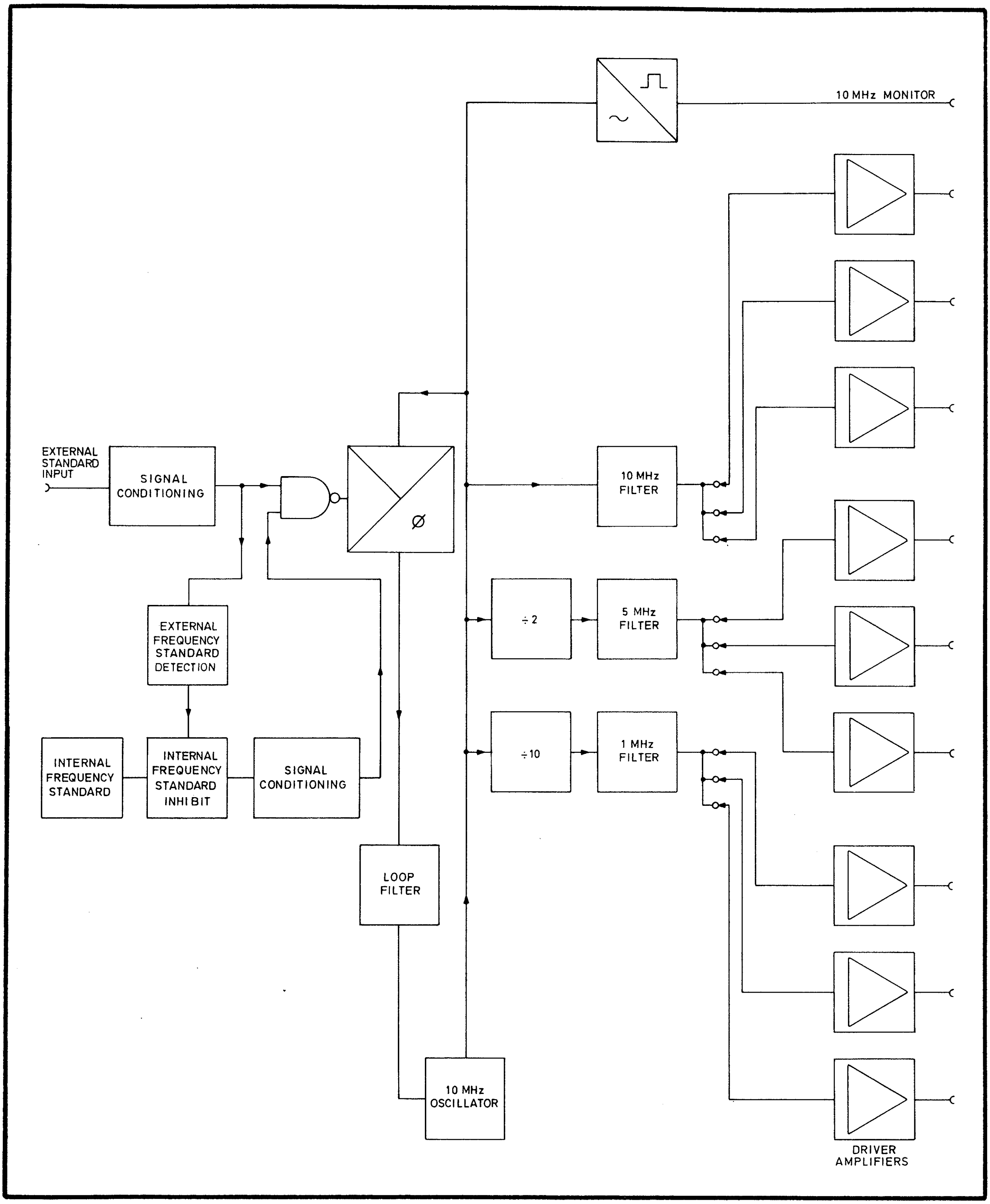


Fig. 5.1 Block Diagram

is amplified in the two stage amplifier containing Q1 and Q2, which has a gain of approximately 15. The input is protected against the application of excessive signal levels by D1 and D2.

5.3.1.2 The amplifier output drives IC2-A, giving a pulse waveform at IC1-D/13. When no signal is applied to the EXT STD input the inputs to IC1-A are held at logic '0' by Q2 and IC1-D/13 is held at logic '1'.

5.3.2 EXTERNAL STANDARD DETECTOR

5.3.2.1 The output of IC1-A is applied, via IC2-C, to the voltage doubling detector formed by C12, D4, D5 and C13. When an input from an external standard is present the detector output switches Q7 on, lighting the EXT STD indicator, D47, and providing a TTL logic '1' indication at the rear panel connector via IC11-B.

5.3.3 INTERNAL STANDARD INPUT CIRCUIT

5.3.3.1 The output of the internal frequency standard is fed, via a coaxial cable to pin 1 and C7. Provided Q3 is in the non-conducting state the signal is amplified in the two stage amplifier containing Q4 and Q5. When an input from an external frequency standard is detected and Q7 is switched on, Q43 is switched off. The base of Q3 is pulled up by R179, and Q3 clamps the base of Q4 close to 0 V. The signal from the internal frequency standard is then inhibited.

5.3.3.2 The output from Q5 drives IC2-A. Provided the internal standard signal is not inhibited this gives a pulse waveform at IC1-D/11. When the signal is inhibited the inputs to IC2-A are pulled to logic '0' by Q5, and IC1-D/11 is held at logic '1'.

5.3.4 INTERNAL STANDARD DETECTOR

5.3.4.1 The output of IC2-A is fed, via IC2-B to the voltage doubling detector formed by C11, D6, D7 and C14. When the internal frequency standard is operating and its output is not inhibited by Q3, a positive potential is developed across C14. This potential forms one input to the LOCK indicator circuit.

5.3.5 PHASE DETECTOR DRIVE CIRCUIT

5.3.5.1 The pulse waveform from IC1-D/12, which has the same frequency as the frequency standard in use, is applied to the pulse generating circuit formed by IC1-B and IC1-C. The operation of this circuit is illustrated in Fig. 5.2.

5.3.5.2 The negative going pulses at IC1-C/9 are used to switch Q6, which drives the transmission line type transformer, T1. The transformer acts as a phase splitter, so that, for the duration of each pulse from IC1-C/9, the phase detector sampling bridge is held forward biased, with the D8/D9 and D10/D11 junctions symmetrical about 0 V.

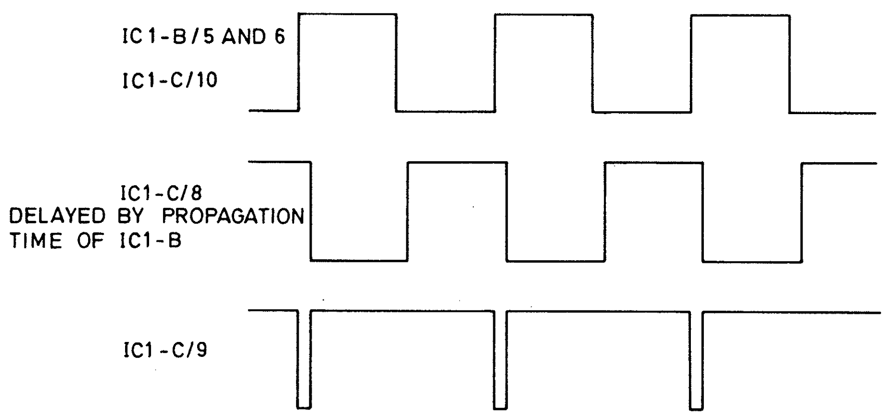


Fig. 5.2 Pulse Generator Waveforms

5.3.6 LOOP OSCILLATOR

5.3.6.1 The active element of the loop oscillator is Q11. The oscillator frequency is 10 MHz, and is controlled by the crystal XL1 and the varactor diode D13. The oscillator output is buffered in the cascode connected amplifier containing Q13 and Q44 and passed via a low-pass filter to the D9/D11 junction of the phase detector sampling bridge.

5.3.7 PHASE DETECTOR OPERATION

5.3.7.1 When the sampling bridge is forward biased by the pulses from T1, the D8/D10 junction adopts the same potential as the D9/D11 junction. At other times the junctions are isolated from each other by the high impedance of the non-conducting diodes. The bridge output is therefore a series of samples of the loop oscillator waveform, taken at the frequency of the frequency standard in use.

5.3.7.2 The phase detector output depends upon the relative frequency of the loop oscillator and the frequency standard, and upon the phase of the loop oscillator waveform at the instant of sampling. If the standard frequency is 10 MHz every cycle of the loop oscillator output is sampled, but if it is a sub-multiple of 10 MHz only every second, fourth, fifth or tenth cycle will be sampled. In all cases, however, provided the standard frequency is an exact sub-multiple of 10 MHz, the samples will be of constant amplitude. If the standard frequency is not an exact sub-multiple of 10 MHz the output pulses will be amplitude modulated.

5.3.7.3 The amplitude of each phase detector output pulse depends upon the instantaneous value of the loop oscillator waveform at the instant of sampling. When the loop is locked, sampling occurs when the loop oscillator waveform is passing through zero volts, so that the pulse detector output is zero and no correcting signal is applied to the loop oscillator. If sampling occurs at any other point in the waveform the amplitude and polarity of the phase detector output pulses are an indication of the magnitude and sense of the phase error.

5.3.8 THE LOOP FILTER

5.3.8.1 The output of the phase detector is applied to the active filter circuit containing IC3-B. The pulses are filtered, and the output voltage applied to the varactor diode, D13. This gives a change in loop oscillator frequency such that the phase error is reduced.

5.3.8.2 The voltage at IC3-B/5 can be set by means of R33. This provides a means of adjusting the sampling point in the loop-locked condition.

5.3.9 LOCK INDICATOR CIRCUIT

5.3.9.1 For the LOCK indicator to light it is necessary for the loop to be in the phase-locked condition and for a satisfactory input from a frequency standard to be present.

5.3.9.2 When the system is operating correctly, Q10 is held in the non-conducting state. Q8 will be held in the conducting state, either by the output of the internal frequency standard detector (if the internal standard output is enabled), or by the potential at Q43 collector, applied via D50 and R20 (if an input from an external standard is detected). With Q8 conducting the LOCK indicator, D48, lights, and a TTL logic '1' level indication is given at the rear panel connector by IC11-C. The LOCK indicator will not be extinguished by failure of the external frequency standard if an internal standard is fitted, since, if this occurs, the output of the external standard detector will fall, Q43 will be switched on and the output of the internal frequency standard will be enabled by Q3. Failure of the external standard will, however, be indicated by the extinguishing of the EXT STD indicator.

5.3.9.3 If the loop loses phase lock, amplitude modulated pulses occur at the phase detector output. The envelope of the pulse amplitudes is detected by the lock detector, IC3-A, and when the envelope is positive Q9 is switched on, charging C21. This puts Q10 to the conducting state and clamps the base of Q8 close to 0 V, so extinguishing the LOCK indicator and putting the output of IC11-C to logic '0'.

5.3.10 LOOP OUTPUTS

5.3.10.1 A 10 MHz output is taken from the loop, via the emitter follower Q14 and amplifier Q15, and is passed via IC4-C and the driver amplifier containing Q16 and Q17 to the 10 MHz filter. The filter output is connected via the emitter follower, Q22, to the 10 MHz distribution point. An additional, low-level output is taken from IC4-C/8 via IC11-D to the 10 MHz MONITOR socket on the front panel.

5.3.10.2 The 10 MHz output from Q15 is also fed, via IC4-B and IC4-D to the dividers IC5-B and IC6. These give outputs at 5 MHz and 1 MHz, which are amplified and filtered before connection to the appropriate distribution points.

5.3.11 <u>OUTPUT DRIVER AMPLIFIERS</u>

5.3.11.1 The nine output driver amplifiers are identical, each consisting of a wide-band cascode connected amplifier with a transformer coupled output. The overall gain of each amplifier from its input to the rear panel socket is approximately 7, when loaded with 50 Ω.

5.3.11.2 The signal at the transformer primary of each stage is applied to a voltage doubling detector, which provides a positive voltage when the channel is operating. This voltage is compared with a reference voltage of approximately 1.6 V, derived from the +5 V supply by R197 and R198, in a comparator. When there is an adequate channel output the comparator output is held low, and the front panel LED indicator for that channel lights. If a channel output fails the comparator output goes high, the channel indicator is extinguished, and comparator IC8-A is triggered via the wired-OR diode gate. This results in IC8-A/2 going low, providing a TTL logic '1' failure indication at the rear panel connector, via IC11-A.

5.3.12 <u>POWER SUPPLIES</u>

5.3.12.1 The AC supply is connected to the 9478 via the supply lead provided, which connects to the rear panel mounted power input plug. The plug is part of a power input assembly, which incorporates the line fuse and the means of setting the operating voltage range. A double-pole LINE switch is mounted on the front panel.

5.3.12.2 The output of the power input assembly feeds the primary windings of the power transformer. This transformer has two secondary windings, from which independent +5 V and -15 V regulated supplies are derived. Both supply circuits are conventional, and employ integrated circuit voltage stabilisers. The LINE indicator is supplied from the unregulated +5 V supply.

SECTION 6 MAINTENANCE

6.1 **INTRODUCTION**

6.1.1 This section contains information on the setting up and performance testing of the instrument. The tests should be carried out in the order given.

6.2 **CALIBRATION PROCEDURE**

WARNING: THIS PROCEDURE REQUIRES THE INSTRUMENT TO BE OPERATED WITH THE COVERS REMOVED. LETHAL VOLTAGE LEVELS ARE EXPOSED UNDER THESE CONDITIONS.

6.2.1 TEST EQUIPMENT REQUIRED

6.2.1.1 The test equipment required is listed in Table 6.1. A particular model of instrument is recommended in some cases, but other instruments having the required parameters may be used.

6.2.2 POWER SUPPLY TESTS

6.2.2.1 Test equipment required:

Description	Table 6.1 Item No.
Multimeter	1

6.2.2.2

(a) Switch off the AC supply and disconnect the power supply lead from the rear panel power input plug.

(b) Put the LINE switch to ON.

(c) Set the supply voltage selector to each of the positions shown in Table 6.2 in turn. Measure the resistance between the line and neutral pins on the power input plug, and ensure that the values shown in the table are obtained. Ensure that the value obtained for the 120 V setting is greater than that obtained for the 100 V setting, and that the value obtained for the 240 V setting is greater than that for the 220 V setting.

(d) Set the voltage selector to suit the local AC supply. Check that the correct fuse for this setting is fitted.

(e) Set the LINE switch to OFF.

TABLE 6.1

Test Equipment Required

Item	Equipment Type Suggested Model	Required Parameters
1	Multimeter AVO Model 8	0 V to 25 V DC.
2	Oscilloscope	Y bandwidth 80 MHz. External trigger facility.
3	Signal Generator Racal-Dana 9084	RF output from 1 MHz to 10 MHz. Output level from -40 dBm to +13 dBm in 50 Ω.
4	Frequency Counter Racal-Dana 9910	To measure 1 MHz, 5 MHz and 10 MHz at a level of 1 V.
5	RF Millivoltmeter Racal-Dana 9301A	To measure to 1.25 V at 1 MHz, 5 MHz and 10 MHz. Input impedance 50 Ω.
6	Spectrum Analyser Hewlett Packard 141T with RF Section 8553B IF Section 8552B	Bandwidth 3 kHz to 100 kHz. To measure relative power levels in the range from +13 dBm to -60 dBm over a frequency range from DC to 60 MHz.
7	Tuneable-Notch Filter	At least 30 dB notch at 1 MHz, 5 MHz and 10 MHz.
8	50 Ω load	BNC, with feedthrough for montior.
9	Frequency Standard	For calibration of internal frequency standard.
10	Frequency Difference Meter Tracor Type 527A	

TABLE 6.2

Power Input Resistance

Voltage Selector Setting	Resistance
100 V	7 Ω - 11 Ω
120 V	8 Ω - 12 Ω
220 V	24 Ω - 40 Ω
240 V	28 Ω - 42 Ω

6.2.2.3 Using the power supply lead, connect the 9478 to the AC supply. Switch on the AC supply.

6.2.2.4 Switch on the 9478. Using the multimeter, check that the voltage at TP1 on assembly 19-1105 is between 4.75 V and 5.25 V, while that at TP2 is between -14.4 V and -15.6 V, both relative to 0 V.

6.2.2.5 Switch off the 9478 and the AC supply. Disconnect the test equipment.

6.2.3 LOOP LOCK SETTING

6.2.3.1 Test equipment required:

Description	Table 6.1 Item No.
Oscilloscope	2
Signal Generator	3

6.2.3.2 Connect the oscilloscope to monitor pin 1 of IC3 on assemby 19-1015, using DC coupling. Connect the signal generator output to the EXT STD input of the 9478. Set the signal generator output to a frequency of 1 MHz at a level of -40 dBm. Switch on the AC supply and the 9478. Check that the LINE indicator and the nine OUTPUT indicators light.

6.2.3.3 (a) If the 9478 is not fitted with an internal frequency standard, increase the signal generator output to a level of +13 dBm. Check that the EXT STD indicator lights.

(b) Turn R33 on assembly 19-1105 fully anti-clockwise. Check that the LOCK indicator is not lit.

(c) Adjust the oscilloscope until the mean level of the oscillatory displayed waveform is at the centre graticule.

(d) Turn R33 fully clockwise check that the LOCK indicator is not lit. Note the mean level of the oscillatory displayed waveform.

(e) Adjust R33 until the displayed waveform is half the level noted in (d). Check that the LOCK indicator lights.

(f) If the 9478 is fitted with an internal frequency standard, increase the signal generator output level to +13 dBm. Check that the EXT STD indicator lights.

(g) Reduce the signal generator output level until the EXT STD indicator is extinguished. Check that the signal generator output is not greater than -27 dBm.

(h) Disconnect the test equipment.

6.2.4 OUTPUT LEVEL AND FREQUENCY TEST

6.2.4.1 Test equipment required:

Description	Table 6.1 Item No.
Signal Generator	3
Frequency Counter	4
RF Millivoltmeter	5

6.2.4.1 Connect the millivoltmeter and frequency counter to monitor the CHANNEL 1 output. Connect the signal generator output to the EXT STD input of the 9478. If the model of signal generator and frequency counter used permit, operate both instruments from the same frequency standard.

6.2.4.2 (a) Set the signal generator output to 1 MHz at a level of -40 dBm.

(b) Increase the signal generator output to -7 dBm. Check that the EXT STD indicator and the LOCK indicator light.

(c) Check that the output level indicated on the millivoltmeter is between 0.9 V and 1.1 V, and that the frequency is 1 MHz, 5 MHz or 10 MHz, as determined by the internal wiring of the 9478.

NOTE: If the signal generator and frequency counter are operated from the same frequency standard, the counter should indicate the channel frequencies ± 1 digit. If not, it may be necessary to measure both the signal generator frequency and the channel frequency, using the counter, to establish that the ratio of these frequencies is correct.

(d) Repeat (c) for the remaining eight channel outputs.

(e) Repeat (a) to (d) for signal generator frequencies of 5 MHz and 10 MHz.

(f) Disconnect the test equipment.

6.2.5 SPECTRAL PURITY TESTS

6.2.5.1 Test equipment required:

Description	Table 6.1 Item No.
Signal Generator	3
Spectrum Analyser	6
Tuneable Notch Filter.	7

NOTE: The signal generator is only required for instruments not fitted with an internal frequency standard.

6.2.5.2 Connect the signal generator output, if required, to the EXT STD input. Connect the spectrum analyser input to the CHANNEL 1 output via the tuneable notch filter.

6.2.5.3 Set the output of the signal generator, if used, to a frequency of 1 MHz at a level of +13 dBm. Check that the EXT STD indicator of the 9478 lights.

6.2.5.4 (a) Check that the 9478 LOCK indicator is lit.

(b) Set the spectrum analyser to the conditions given in Table 6.3 relating to the output frequency of channel 1.

(c) With the notch filter tuned away from the display centre frequency, adjust the spectrum analyser sensitivity so that the signal peak is at the reference graticule.

(d) Tune the notch filter to the display centre frequency to obtain a reduction of the displayed signal of at least 30 dB. Reduce the spectrum analyser input attenuator to 0 dB.

(e) Adjust the centre frequency of the spectrum analyser to move the 9478 output frequency to the right hand edge of the display. This displays the frequency range from DC to the output frequency.

(f) Ensure that all spurious signals displayed are at least 70 dB below the 9478 output level.

(g) Repeat (b) to (f) for channels 2 to 9.

TABLE 6.3

Spectrum Analyser Settings (Spurious Test)

	9478 Output Frequency		
	1 MHz	5 MHz	10 MHz
Bandwidth	3 kHz	30 kHz	30 kHz
Total Scan Width	1 MHz	5 MHz	10 MHz
Scan Centre Frequency	1 MHz	5 MHz	10 MHz
Reference Graticule	20 dBm	20 dBm	20 dBm
Input Attenuator	30 dB	30 dB	30 dB

6.2.5.5 (a) Connect the spectrum analyser input to the CHANNEL 1 output of the 9478 via the tuneable notch filter.

(b) Set the spectrum analyser to the conditions given in Table 6.4 relating to the output frequency of channel 1.

(c) With the notch filter tuned away from the display centre frequency, adjust the spectrum analyser sensitivity so that the signal peak is at the reference graticule.

(d) Tune the notch filter to the display centre frequency, to obtain a reduction in the displayed signal of at least 30 dB. Reduce the spectrum analyser input attenuation to 0 dB.

(e) Adjust the spectrum analyser centre frequency to move the 9478 output frequency to the left hand edge of the display.

(f) Ensure that all harmonic signals displayed are at least 30 dB below the 9478 output level.

(g) Repeat (b) to (f) for channels 2 to 9.

(h) Disconnect the test equipment.

TABLE 6.4

Spectrum Analyser Settings (Harmonic Test)

	9478 Output Frequency		
	1 MHz	5 MHz	10 MHz
Bandwidth	10 kHz	30 kHz	100 kHz
Total Scan Width	5 MHz	20 MHz	50 MHz
Scan Centre Frequency	1 MHz	5 MHz	10 MHz
Reference Graticule	-10 dBm	-10 dBm	-10 dBm
Input Attenuator	30 dB	30 dB	30 dB

6.2.6 HUM SIDEBAND TEST

6.2.6.1 Test equipment required:

Description	Table 6.1 Item No.
Signal Generator	3
Spectrum Analyser	6

NOTE: The signal generator is only required for instruments not fitted with an internal frequency standard.

6.2.6.2 Connect the signal generator output, if required, to the EXT STD input. Connect the spectrum analyser to the CHANNEL 1 output.

6.2.6.3 Set the output of the signal generator, if used, to a frequency of 1 MHz at a level of +13 dBm. Check that the EXT STD indicator lights.

6.2.6.4 Set the spectrum analyser to the conditions shown in Table 6.5. Adjust the sensitivity to set the peak of the displayed signal at the reference graticule. Measure the hum sidebands at 100 Hz from the centre frequency, and ensure that they are at least 70 dB below the output level. Note that hum sidebands will be introduced by the signal generator, if this is used as an external frequency standard.

6.2.6.5 Disconnect the test equipment.

TABLE 6.5

Spectrum Analyser Settings

Control	Setting
Bandwidth	10 Hz
Total Scan Width	500 Hz
Scan Centre Frequency	Frequency of CHANNEL 1 output
Reference Graticule	10 dBm
Video Filter	10 Hz
Input Attenuator	30 dB

6.2.7 INDICATOR AND MONITOR OUTPUT TEST

6.2.7.1 Test equipment required:

Description	Table 6.1 Item No.
Oscilloscope	2
Signal Generator	3
50 Ω load	8

6.2.7.2 Connect the output of the signal generator to the EXT STD input. Load the 10 MHz MONITOR output with the 50 Ω load, and connect the oscilloscope to monitor the signal across the load.

6.2.6.3 Set the output of the signal generator to a frequency of 1 MHz at a level of +13 dBm. Check that the EXT STD indicator and the LOCK indicator light.

6.2.7.4 (a) Check that the signal displayed on the oscilloscope has a frequency of 10 MHz and a peak-to-peak amplitude of between 400 mV and 700 mV.

(b) Transfer the oscilloscope to monitor the voltage level at pin 5 of the rear panel 9-pin connector. Ensure that the level is $<$0.8 V.

(c) Short circuit each channel output in turn. Check that the related CHANNEL indicator is extinguished, and that the voltage level monitored goes to >2.5 V as this is done. Check that the level returns to <0.8 V when the short circuit is removed.

(d) Transfer the oscilloscope to monitor the voltage level at pin 1 of the 9-pin connector. Ensure that a level of >2.5 V is present.

(e) Set the frequency of the signal generator to 1.1 MHz. Check that the monitored voltage falls to <0.8 V and the LOCK indicator is extinguished.

(f) Return the signal generator frequency to 1 MHz. Check that the LOCK indicator lights, and that the monitored voltage level returns to >2.5 V.

(g) Transfer the oscilloscope to monitor pin 3 of the 9-pin connector. Check that the voltage level is >2.5 V.

(h) Disconnect the signal generator from the EXT STD input. Check that the monitored voltage falls to < 0.8 V and the EXT STD indicator is extinguished.

(j) Disconnect the test equipment.

6.2.8 INTERNAL FREQUENCY STANDARD ADJUSTMENT

6.2.8.1 Test equipment required:

Description	Table 6.1 Item No.
Frequency Standard	9
Frequency Difference Meter	10

6.2.8.2 The calibration of high stability oscillators, such as the Racal-Dana models 9442 and 9421, requires the use of special test equipment such as that specified above. Such equipment must be operated strictly in accordance with the operating instructions provided by the manufacturer. For this reason no calibration procedure is given in this manual.

6.2.8.3. The specification of the internal frequency standard to be calibrated, as given in Section 1 of this manual, must be borne in mind when selecting the frequency standard which is to form part of the test equipment.

SECTION 7

PARTS LIST AND CIRCUIT DIAGRAMS

PARTS LIST

FRONT AND REAR PANEL ASSEMBLIES

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
FRONT PANEL ASSEMBLY 11-1559					
		Cable assembly and Power Switch			10-2849
		Knob for Power Switch			23-9098
		BNC bulkhead receptacle (10 MHz Monitor)			23-3005
REAR PANEL ASSEMBLY 11-1560					
		Power transformer			17-4097
		BNC bulkhead receptacle (CHANNEL outputs)			23-3198
		BNC bulkhead receptacle (EXT STD input)			23-3198
		Connector, 9-way			23-3214
		Base for 23-3214			23-3217
		AC power plug, filter and fuse holder			23-3294
		Fuse link 250 mAT (198 V to 264 V)			23-0056
		Fuse link 500 mAT (90 to 132 V)			23-0052

PARTS LIST

FREQUENCY DISTRIBUTION BOARD 19-1105

Fig.2 and Fig.3

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Resistors	Ω		W		
R1	56	Carbon Film	½	5	20-3560
R2	1k	Carbon Film	½	5	20-3102
R3	47	Carbon Film	¼	5	20-2470
R4	10k	Carbon Film	¼	5	20-2103
R5	2.2k	Carbon Film	¼	5	20-2222
R6	10k	Carbon Film	¼	5	20-2103
R7	8.2k	Carbon Film	¼	5	20-2822
R8	1.5k	Carbon Film	¼	5	20-2152
R9	1k	Carbon Film	¼	5	20-2102
R10	10k	Carbon Film	¼	5	20-2103
R11	47	Carbon Film	¼	5	20-2470
R12	5.6k	Carbon Film	¼	5	20-2562
R13	2.2k	Carbon Film	¼	5	20-2222
R14	10k	Carbon Film	¼	5	20-2103
R15	10k	Carbon Film	¼	5	20-2103
R16	680	Carbon Film	¼	5	20-2681
R17	820	Carbon Film	¼	5	20-2821
R18	470	Carbon Film	¼	5	20-2471
R19	3.3k	Carbon Film	¼	5	20-2332
R20	3.9k	Carbon Film	¼	5	20-2392
R21	3.9k	Carbon Film	¼	5	20-2392
R22	100	Carbon Film	¼	5	20-2101
R23	330	Carbon Film	¼	5	20-2331
R24	330	Carbon Film	¼	5	20-2331
R25	270	Carbon Film	¼	5	20-2271
R26	100	Carbon Film	¼	5	20-2101
R27	100	Carbon Film	¼	5	20-2101
R28	220k	Carbon Film	¼	5	20-2224
R29	47k	Carbon Film	¼	5	20-2473
R30	270k	Carbon Film	¼	5	20-2274
R31	47k	Carbon Film	¼	5	20-2473
R32	15k	Carbon Film	¼	5	20-2153
R33	20k	Variable			20-7090
R34	68k	Carbon Film	¼	5	20-2683
R35	220	Carbon Film	¼	5	20-2221

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Resistors	Ω		W		
R36	10k	Carbon Film	¼	5	20-2103
R37	10M	Carbon Film	¼	5	20-2106
R38	150k	Carbon Film	¼	5	20-2154
R39	15k	Carbon Film	¼	5	20-2153
R40	6.8k	Carbon Film	¼	5	20-2682
R41	47k	Carbon Film	¼	5	20-2473
R42	100k	Carbon Film	¼	5	20-2104
R43	1k	Carbon Film	¼	5	20-2102
R44	10k	Carbon Film	¼	5	20-2103
R45	1k	Carbon Film	¼	5	20-2102
R46	100	Carbon Film	¼	5	20-2101
R47	47k	Carbon Film	¼	5	20-2473
R48	47k	Carbon Film	¼	5	20-2473
R49	5.6k	Carbon Film	¼	5	20-2562
R50	2.2k	Carbon Film	¼	5	20-2222
R51	2.2k	Carbon Film	¼	5	20-2222
R52	39	Carbon Film	¼	5	20-2390
R53	240	Carbon Film	¼	5	20-2241
R54	100	Carbon Film	¼	5	20-2101
R55	100	Carbon Film	¼	5	20-2101
R56	2.7k	Carbon Film	¼	5	20-2272
R57	1k	Carbon Film	¼	5	20-2102
R58	10k	Carbon Film	¼	5	20-2103
R59	1k	Carbon Film	¼	5	20-2102
R60	100	Carbon Film	¼	5	20-2101
R61	10	Carbon Film	¼	5	20-2100
R62	5.6k	Carbon Film	¼	5	20-2562
R63	5.6k	Carbon Film	¼	5	20-2562
R64	3.3k	Carbon Film	¼	5	20-2332
R65	47	Carbon Film	¼	5	20-2470
R66	47	Carbon Film	¼	5	20-2470
R67	82	Carbon Film	¼	5	20-2820
R68	10	Carbon Film	¼	5	20-2100
R69	5.6k	Carbon Film	¼	5	20-2562
R70	5.6k	Carbon Film	¼	5	20-2562
R71	3.3k	Carbon Film	¼	5	20-2332
R72	47	Carbon Film	¼	5	20-2470
R73	47	Carbon Film	¼	5	20-2470
R74	120	Carbon Film	¼	5	20-2121
R75	10	Carbon Film	¼	5	20-2100

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Resistors Ω			W		
R76	5.6k	Carbon Film	¼	5	20-2562
R77	5.6k	Carbon Film	¼	5	20-2562
R78	3.3k	Carbon Film	¼	5	20-2332
R79	47	Carbon Film	¼	5	20-2470
R80	47	Carbon Film	¼	5	20-2470
R81	150	Carbon Film	¼	5	20-2151
R82	100	Carbon Film	¼	5	20-2101
R83	100	Carbon Film	¼	5	20-2101
R84	100	Carbon Film	¼	5	20-2101
R85	1.2k	Carbon Film	¼	5	20-2122
R86	47	Carbon Film	¼	5	20-2470
R87	2.7k	Carbon Film	¼	5	20-2272
R88	100	Carbon Film	¼	5	20-2101
R89	1.2k	Carbon Film	¼	5	20-2122
R90	47	Carbon Film	¼	5	20-2470
R91	2.7k	Carbon Film	¼	5	20-2272
R92	100	Carbon Film	¼	5	20-2101
R93	1.2k	Carbon Film	¼	5	20-2122
R94	47	Carbon Film	¼	5	20-2470
R95	2.7k	Carbon Film	¼	5	20-2272
R96	100	Carbon Film	¼	5	20-2101
R97	3.3k	Carbon Film	¼	5	20-2332
R98	470	Carbon Film	¼	5	20-2471
R99	1k	Carbon Film	¼	5	20-2102
R100	10	Carbon Film	¼	5	20-2100
R101	1k	Carbon Film	¼	5	20-2102
R102	33	Carbon Film	¼	5	20-2330
R103	39	Carbon Film	¼	5	20-2390
R104	3.3k	Carbon Film	¼	5	20-2332
R105	13 x 220	DIL Array			20-5553
R106	3.3k	Carbon Film	¼	5	20-2332
R107	470	Carbon Film	¼	5	20-2471
R108	1k	Carbon Film	¼	5	20-2102
R109	10	Carbon Film	¼	5	20-2100
R110	1k	Carbon Film	¼	5	20-2102
R111	33	Carbon Film	¼	5	20-2330
R112	39	Carbon Film	¼	5	20-2390
R113	3.3k	Carbon Film	¼	5	20-2332
R114		Not Used			
R115	3.3k	Carbon Film	¼	5	20-2332

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Resistors Ω			W		
R116	470	Carbon Film	¼	5	20-2471
R117	1k	Carbon Film	¼	5	20-2102
R118	10	Carbon Film	¼	5	20-2100
R119	1k	Carbon Film	¼	5	20-2102
R120	33	Carbon Film	¼	5	20-2330
R121	39	Carbon Film	¼	5	20-2390
R122	3.3k	Carbon Film	¼	5	20-2332
R123		Not Used			
R124	3.3k	Carbon Film	¼	5	20-2332
R125	470	Carbon Film	¼	5	20-2471
R126	1k	Carbon Film	¼	5	20-2102
R127	10	Carbon Film	¼	5	20-2100
R128	1k	Carbon Film	¼	5	20-2102
R129	33	Carbon Film	¼	5	20-2330
R130	39	Carbon Film	¼	5	20-2390
R131	3.3k	Carbon Film	¼	5	20-2332
R132		Not Used			
R133	3.3k	Carbon Film	¼	5	20-2332
R134	470	Carbon Film	¼	5	20-2471
R135	1k	Carbon Film	¼	5	20-2102
R136	10	Carbon Film	¼	5	20-2100
R137	1k	Carbon Film	¼	5	20-2102
R138	33	Carbon Film	¼	5	20-2330
R139	39	Carbon Film	¼	5	20-2390
R140	3.3k	Carbon Film	¼	5	20-2332
R141		Not Used			
R142	3.3k	Carbon Film	¼	5	20-2332
R143	470	Carbon Film	¼	5	20-2471
R144	1k	Carbon Film	¼	5	20-2102
R145	10	Carbon Film	¼	5	20-2100
R146	1k	Carbon Film	¼	5	20-2102
R147	33	Carbon Film	¼	5	20-2330
R148	39	Carbon Film	¼	5	20-2390
R149	3.3k	Carbon Film	¼	5	20-2330
R150		Not Used			
R151	3.3k	Carbon Film	¼	5	20-2332
R152	470	Carbon Film	¼	5	20-2471
R153	1k	Carbon Film	¼	5	20-2102
R154	10	Carbon Film	¼	5	20-2100
R155	1k	Carbon Film	¼	5	20-2102

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Resistors Ω			W		
R156	33	Carbon Film	¼	5	20-2330
R157	39	Carbon Film	¼	5	20-2390
R158	3.3k	Carbon Film	¼	5	20-2332
R159		Not Used			
R160	3.3k	Carbon Film	¼	5	20-2332
R161	470	Carbon Film	¼	5	20-2471
R162	1k	Carbon Film	¼	5	20-2102
R163	10	Carbon Film	¼	5	20-2100
R164	1k	Carbon Film	¼	5	20-2102
R165	33	Carbon Film	¼	5	20-2330
R166	39	Carbon Film	¼	5	20-2390
R167	3.3k	Carbon Film	¼	5	20-2332
R168		Not Used			
R169	3.3k	Carbon Film	¼	5	20-2332
R170	470	Carbon Film	¼	5	20-2471
R171	1k	Carbon Film	¼	5	20-2102
R172	10	Carbon Film	¼	5	20-2100
R173	1k	Carbon Film	¼	5	20-2102
R174	33	Carbon Film	¼	5	20-2330
R175	39	Carbon Film	¼	5	20-2390
R176	3.3k	Carbon Film	¼	5	20-2332
R177	470	Carbon Film	¼	5	20-2471
R178	22k	Carbon Film	¼	5	20-2223
R179	1.2k	Carbon Film	¼	5	20-2122
R180	47k	Carbon Film	¼	5	20-2473
R181	47	Carbon Film	¼	5	20-2470
R182	180	Carbon Film	¼	5	20-2181
R183		Not Used			
R184	10k	Carbon Film	¼	5	20-2103
R185	1k	Carbon Film	¼	5	20-2102
R186		Not Used			
R187	1k	Carbon Film	¼	5	20-2102
R188	22k	Carbon Film	¼	5	20-2223
R189	22k	Carbon Film	¼	5	20-2223
R190	22k	Carbon Film	¼	5	20-2223
R191	22k	Carbon Film	¼	5	20-2223
R192	22k	Carbon Film	¼	5	20-2223
R193	22k	Carbon Film	¼	5	20-2223
R194	22k	Carbon Film	¼	5	20-2223
R195	22k	Carbon Film	¼	5	20-2223

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Resistors Ω			W		
R196	22k	Carbon Film	¼	5	20-2223
R197	4.7k	Carbon Film	¼	5	20-2472
R198	1.5k	Carbon Film	¼	5	20-2152
R199	15k	Carbon Film	¼	5	20-2153
Capacitors F			V		
C1	10n	Ceramic	25	-20+80	21-1545
C2	10n	Ceramic	25	-20+80	21-1545
C3	6.8µ	Electrolytic	25		21-0691
C4	820p	Ceramic	500	10	21-1531
C5	100n	Ceramic	12	-20+80	21-1616
C6	100n	Ceramic	12	-20+80	21-1616
C7	10n	Ceramic	25	-20+80	21-1545
C8	100n	Ceramic	12	-20+80	21-1616
C9	6.8µ	Electrolytic	25		21-0691
C10	820p	Ceramic	500	10	21-1531
C11	100n	Ceramic	25	-20+80	21-1616
C12	100n	Ceramic	25	-20+80	21-1616
C13	100n	Ceramic	25	-20+80	21-1616
C14	100n	Ceramic	25	-20+80	21-1616
C15	100n	Ceramic	25	-20+80	21-1616
C16	100n	Ceramic Monobloc	50	20	21-1708
C17	6.8µ	Electrolytic	25		21-0691
C18	6.8µ	Electrolytic	25		21-0691
C19	1µ	Polycarbonate	100	20	21-5507
C20	33µ	Electrolytic	25		21-0693
C21	33µ	Electrolytic	25		21-0693
C22	2.2n	Ceramic	500	20	21-1536
C23	220p	Ceramic	500	10	21-1524
C24	150p	Ceramic	500	10	21-1522
C25	6.8µ	Electrolytic	25		21-0691
C26	10n	Ceramic	25	-20+80	21-1545
C27	10n	Ceramic	25	-20+80	21-1545
C28	10n	Ceramic	25	-20+80	21-1545
C29	150p	Ceramic	500	10	21-1522
C30	150p	Ceramic	500	10	21-1522
C31	10n	Ceramic	25	-20+80	21-1545
C32	100n	Ceramic	25	-20+80	21-1616
C33	6.8µ	Electrolytic	25		21-0691
C34	6.8µ	Electrolytic	25		21-0691
C35	6.8µ	Electrolytic	25		21-0691

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Capacitors F			V		
C36	2.7p	Ceramic	500	½p	21-1501
C37	2.7p	Ceramic	500	½p	21-1501
C38	6.8μ	Electrolytic	25		21-0691
C39	2.7p	Ceramic	500	½p	21-1501
C40	2.7p	Ceramic	500	½p	21-1501
C41	6.8μ	Electrolytic	25		21-0691
C42	2.7p	Ceramic	500	½p	21-1501
C43	2.7p	Ceramic	500	½p	21-1501
C44	270p	Silvered Mica	125	5	21-2630
C45	39p	Ceramic	63	2	21-1687
C46	270p	Silvered Mica	125	5	21-2630
C47	470p	Silvered Mica	350	2	21-2587
C48	82p	Ceramic	63	2	21-1691
C49	470p	Silvered Mica	350	2	21-2587
C50	2.7n	Silvered Mica	350	2	21-2647
C51	470p	Silvered Mica	350	2	21-2587
C52	2.7n	Silvered Mica	350	2	21-2647
C53	100μ	Ceramic	12	-20+80	21-1616
C54	100n	Ceramic	12	-20+80	21-1616
C55	100n	Ceramic	12	-20+80	21-1616
C56	100n	Ceramic	12	-20+80	21-1616
C57	100n	Ceramic Monobloc	50	20	21-1708
C58	33μ	Electrolytic	16		21-0682
C59	100n	Ceramic	12	-20+80	21-1616
C60		Not Used			
C61	100n	Ceramic	12	-20+80	21-1616
C62	100n	Ceramic	12	-20+80	21-1616
C63	100n	Ceramic Monobloc	50	20	21-1708
C64	33μ	Electrolytic	16		21-0682
C65	100n	Ceramic	12	-20+80	21-1616
C66		Not Used			
C67	100n	Ceramic	12	-20+80	21-1616
C68	100n	Ceramic	12	-20+80	21-1616
C69	100n	Ceramic Monobloc	50	20	21-1708
C70	33μ	Electrolytic	16		21-0682
C71	100n	Ceramic	12	-20+80	21-1616
C72		Not Used			
C73	100n	Ceramic	12	-20+80	21-1616
C74	100n	Ceramic	12	-20+80	21-1616
C75	100n	Ceramic Monobloc	50	20	21-1708

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Capacitors F			V		
C76	33µ	Electrolytic	16		21-0682
C77	100n	Ceramic	12	-20+80	21-1616
C78		Not Used			
C79	100n	Ceramic	12	-20+80	21-1616
C80	100n	Ceramic	12	-20+80	21-1616
C81	100n	Ceramic Monobloc	50	20	21-1708
C82	33µ	Electrolytic	16		21-0682
C83	100n	Ceramic	12	-20+80	21-1616
C84		Not Used			
C85	100n	Ceramic	12	-20+80	21-1616
C86	100n	Ceramic	12	-20+80	21-1616
C87	100n	Ceramic Monobloc	50	20	21-1708
C88	33µ	Electrolytic	16		21-0682
C89	100n	Ceramic	12	-20+80	21-1616
C90		Not Used			
C91	100n	Ceramic	12	-20+80	21-1616
C92	100n	Ceramic	12	-20+80	21-1616
C93	100n	Ceramic Monobloc	50	20	21-1708
C94	33µ	Electrolytic	16		21-0682
C95	100n	Ceramic	12	-20+80	21-1616
C96		Not Used			
C97	100n	Ceramic	12	-20+80	21-1616
C98	100n	Ceramic	12	-20+80	21-1616
C99	100n	Ceramic Monobloc	50	20	21-1708
C100	33µ	Electrolytic	16		21-0682
C101	100n	Ceramic	12	-20+80	21-1616
C102		Not Used			
C103	100n	Ceramic	12	-20+80	21-1616
C104	100n	Ceramic	12	-20+80	21-1616
C105	100n	Ceramic Monobloc	50	20	21-1708
C106	33µ	Electrolytic	16		21-0682
C107	100n	Ceramic	12	-20+80	21-1616
C108		Not Used			
C109	100n	Ceramic	12	-20+80	21-1616
C110	100n	Ceramic	12	-20+80	21-1616
C111	1.8n	Ceramic	500	20	21-1535
C112	6800µ	Electrolytic	16	-10+30	21-0668
C113	2200µ	Electrolytic	25	-10+30	21-0665
C114	6.8µ	Electrolytic	25		21-0691
C115	6.8µ	Electrolytic	25		21-0691

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
C116	100n	Ceramic	12	-20+80	21-1616
C117	100n	Ceramic	25	-20+80	21-1551
C118	10n	Ceramic	25	-20+80	21-1545
C119	10n	Ceramic	25	-20+80	21-1545
C120	10n	Ceramic	25	-20+80	21-1545
C121	100n	Ceramic Monobloc	50	20	21-1708
C122	10n	Ceramic	25	-20+80	21-1545
C123	33µ	Electrolytic	16		21-0682
C124	33µ	Electrolytic	16		21-0682
C125	33µ	Electrolytic	16		21-0682
C126	33µ	Electrolytic	16		21-0682
C127	33µ	Electrolytic	16		21-0682
C128	33µ	Electrolytic	16		21-0682
C129	33µ	Electrolytic	16		21-0682
C130	33µ	Electrolytic	16		21-0682
C131	33µ	Electrolytic	16		21-0682
C132	100n	Ceramic Monobloc	50	20	21-1708
C133	100n	Ceramic Monobloc	50	20	21-1708
C134	100n	Ceramic Monobloc	50	20	21-1708
C135	100n	Ceramic Monobloc	50	20	21-1708
C136	100n	Ceramic Monobloc	50	20	21-1708
C137	100n	Ceramic Monobloc	50	20	21-1708
C138	100n	Ceramic Monobloc	50	20	21-1708
C139	100n	Ceramic Monobloc	50	20	21-1708
C140	100n	Ceramic Monobloc	50	20	21-1708
C141	6.8µ	Electrolytic	25		21-0691
C142	6.8µ	Electrolytic	25		21-0691
C143	6.8µ	Electrolytic	25		21-0691
C144	100n	Ceramic	25	-20+80	21-1551
C145	6.8µ	Electrolytic	25		21-0691
C146	100n	Ceramic	25	-20+80	21-1551
C147	220µ	Electrolytic	25	20	21-0686
C148	6.8µ	Electrolytic	25		21-0691
C149	220µ	Electrolytic	25	20	21-0686
C150	220µ	Electrolytic	25	20	21-0686
C151	220µ	Electrolytic	25	20	21-0686
C152	220µ	Electrolytic	25	20	21-0686
C153	100µ	Electrolytic	25	20	21-0790
C154	33µ	Electrolytic	16		21-0682

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Diodes					
D1		Silicon (IN4149)			22-1029
D2		Silicon (IN4149)			22-1029
D3		Silicon (IN4149)			22-1029
D4		Silicon (IN4149)			22-1029
D5		Silicon (IN4149)			22-1029
D6		Silicon (IN4149)			22-1029
D7		Silicon (IN4149)			22-1029
D8		Silicon (IN4149)			22-1029
D9		Silicon (IN4149)			22-1029
D10		Silicon (IN4149)			22-1029
D11		Silicon (IN4149)			22-1029
D12		Silicon (IN4149)			22-1029
D13		Varactor (MV1642)			22-1042
D14		Silicon (IN4149)			22-1029
D15		Silicon (IN4149)			22-1029
D16		Silicon (IN4149)			22-1029
D17		Silicon (IN4149)			22-1029
D18		Silicon (IN4149)			22-1029
D19		Silicon (IN4149)			22-1029
D20		Silicon (IN4149)			22-1029
D21		Silicon (IN4149)			22-1029
D22		Silicon (IN4149)			22-1029
D23		Silicon (IN4149)			22-1029
D24		Silicon (IN4149)			22-1029
D25		Silicon (IN4149)			22-1029
D26		Silicon (IN4149)			22-1029
D27		Silicon (IN4149)			22-1029
D28		Silicon (IN4149)			22-1029
D29		Silicon (IN4149)			22-1029
D30		Silicon (IN4149)			22-1029
D31		Silicon (IN4149)			22-1029
D32		Silicon (IN4149)			22-1029
D33		Bridge Rectifier (VS.248)			22-1650
D34		Not Used			
D35		Rectifier (IN4009)			22-1602
D36		Not Used			
D37		Rectifier (IN4009)			22-1602
D38		LED (ESBR 5531)			26-5022
D39		LED (ESBR 5531)			26-5022
D40		LED (ESBR 5531)			26-5022

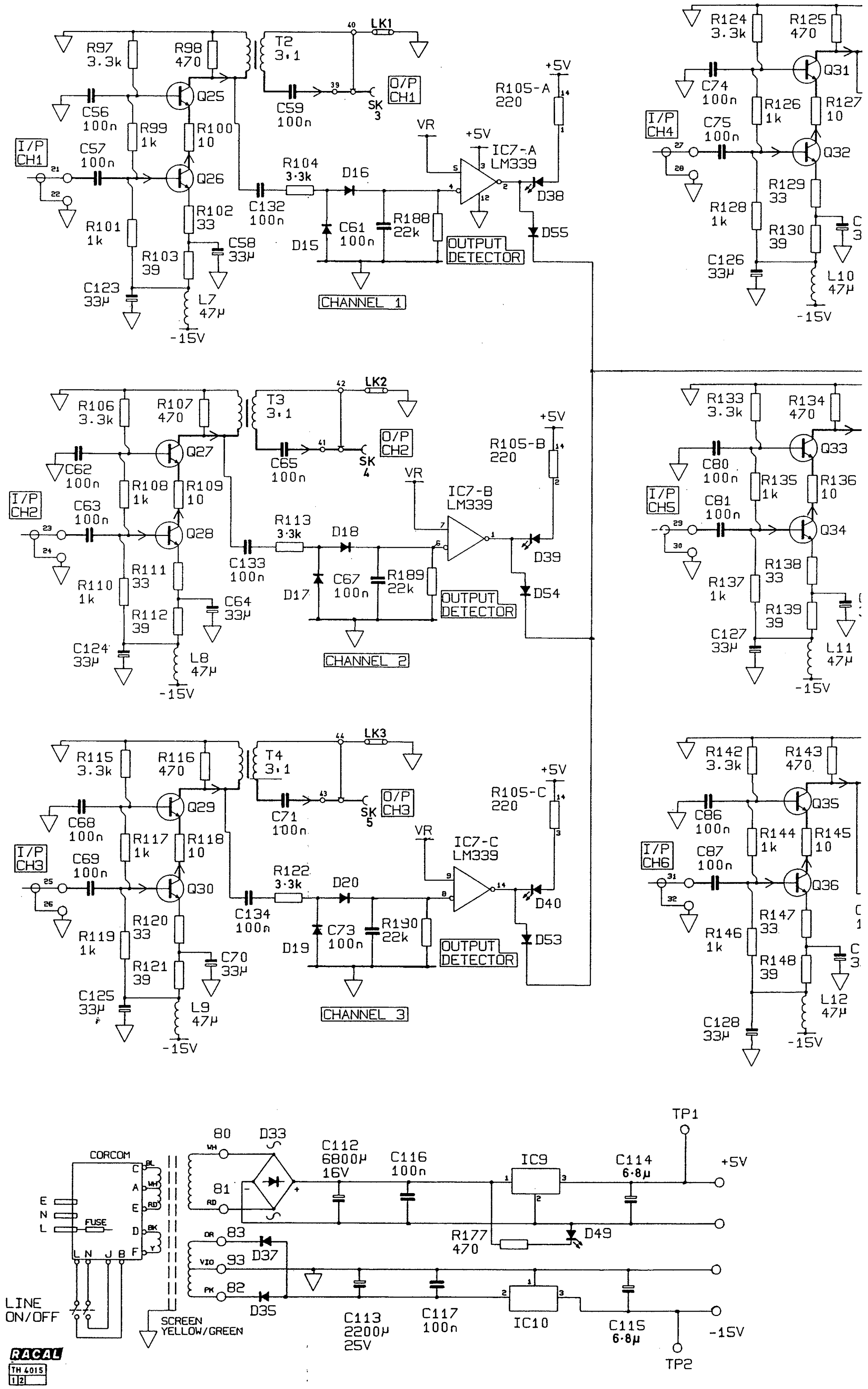
Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Diodes					
D41		LED (ESBR 5531)			26-5022
D42		LED (ESBR 5531)			26-5022
D43		LED (ESBR 5531)			26-5022
D44		LED (ESBR 5531)			26-5022
D45		LED (ESBR 5531)			26-5022
D46		LED (ESBR 5531)			26-5022
D47		LED (ESBR 5531)			26-5022
D48		LED (ESBR 5531)			26-5022
D49		LED (ESBR 5531)			26-5022
D50		Silicon (IN4149)			22-1029
D51		Silicon (IN4149)			22-1029
D52		Silicon (IN4149)			22-1029
D53		Silicon (IN4149)			22-1029
D54		Silicon (IN4149)			22-1029
D55		Silicon (IN4149)			22-1029
D56		Silicon (IN4149)			22-1029
D57		Silicon (IN4149)			22-1029
D58		Silicon (IN4149)			22-1029
D59		Silicon (IN4149)			22-1029
Integrated Circuits					
IC1		74LS132			22-4582
IC2		74LS00			22-4531
IC3		TL 082			22-4240
IC4		74LS00			22-4531
IC5		74LS74			22-4534
IC6		74LS90			22-4536
IC7		LM339			22-4249
IC8		LM339			22-4249
IC9		7805			22-4222
IC10		7915			22-4209
IC11		74S00			22-4505
IC12		LM339			22-4249
Transistors					
Q1		2N2369			22-6017
Q2		2N2369			22-6017
Q3		2N2369			22-6017
Q4		2N2369			22-6017
Q5		2N2369			22-6017

Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number

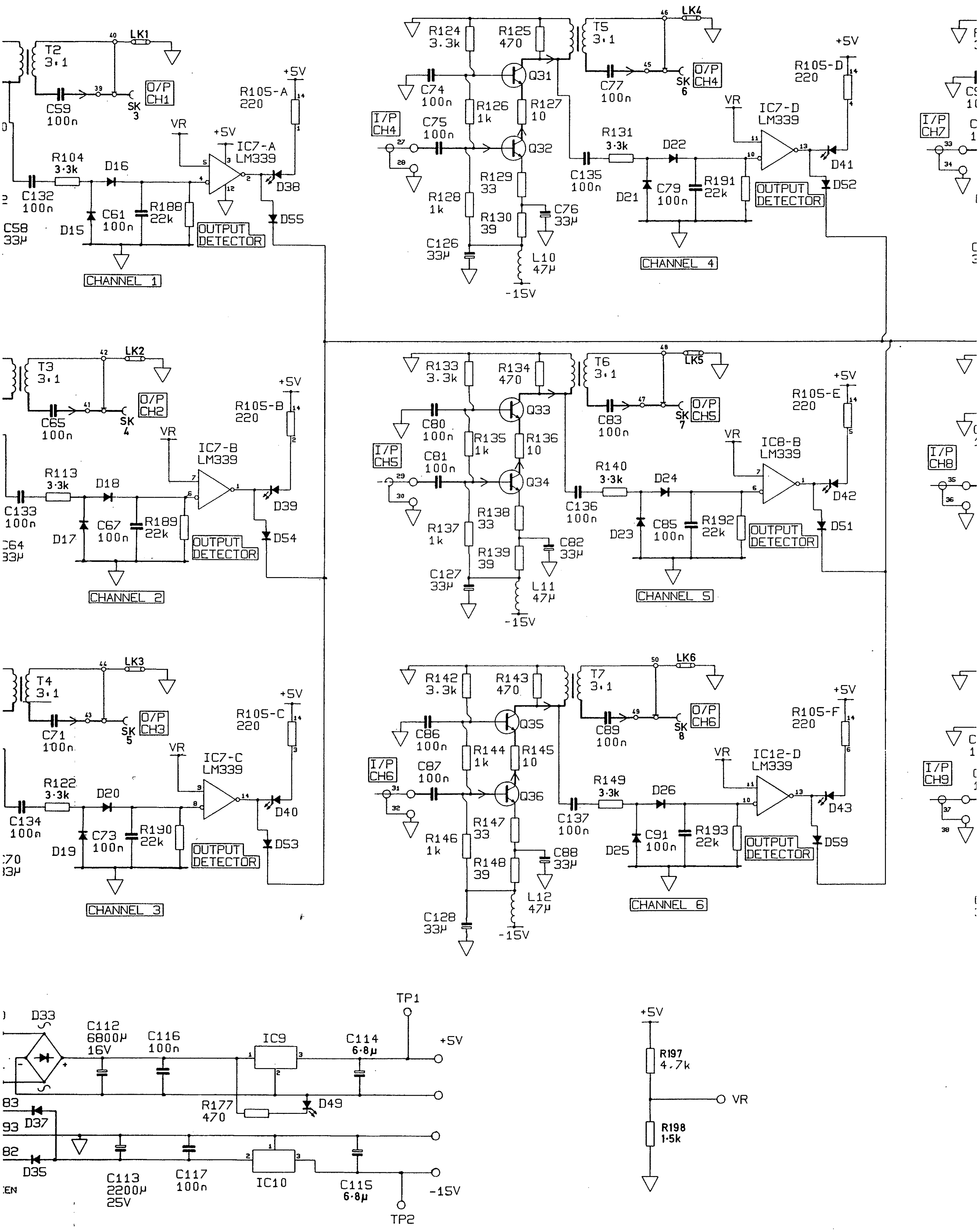
Transistors

Q6		BFX48			22-6110
Q7		2N2369			22-6017
Q8		MPS-A12			22-6133
Q9		BFX48			22-6110
Q10		2N2369			22-6017
Q11		2N2369			22-6017
Q12		BFX48			22-6110
Q13		2N2369			22-6017
Q14		2N2369			22-6017
Q15		2N2369			22-6017
Q16		MPS3640			22-6018
Q17		2N2369			22-6017
Q18		MPS3640			22-6018
Q19		2N2369			22-6017
Q20		MPS3640			22-6018
Q21		2N2369			22-6017
Q22		2N2369			22-6017
Q23		2N2369			22-6017
Q24		2N2369			22-6017
Q25		ZTX313			22-6079
Q26		ZTX313			22-6079
Q27		ZTX313			22-6079
Q28		ZTX313			22-6079
Q29		ZTX313			22-6079
Q30		ZTX313			22-6079
Q31		ZTX313			22-6079
Q32		ZTX313			22-6079
Q33		ZTX313			22-6079
Q34		ZTX313			22-6079
Q35		ZTX313			22-6079
Q36		ZTX313			22-6079
Q37		ZTX313			22-6079
Q38		ZTX313			22-6079
Q39		ZTX313			22-6079
Q40		ZTX313			22-6079
Q41		ZTX313			22-6079
Q42		ZTX313			22-6079
Q43		2N2369			22-6017
Q44		2N2369			22-6017

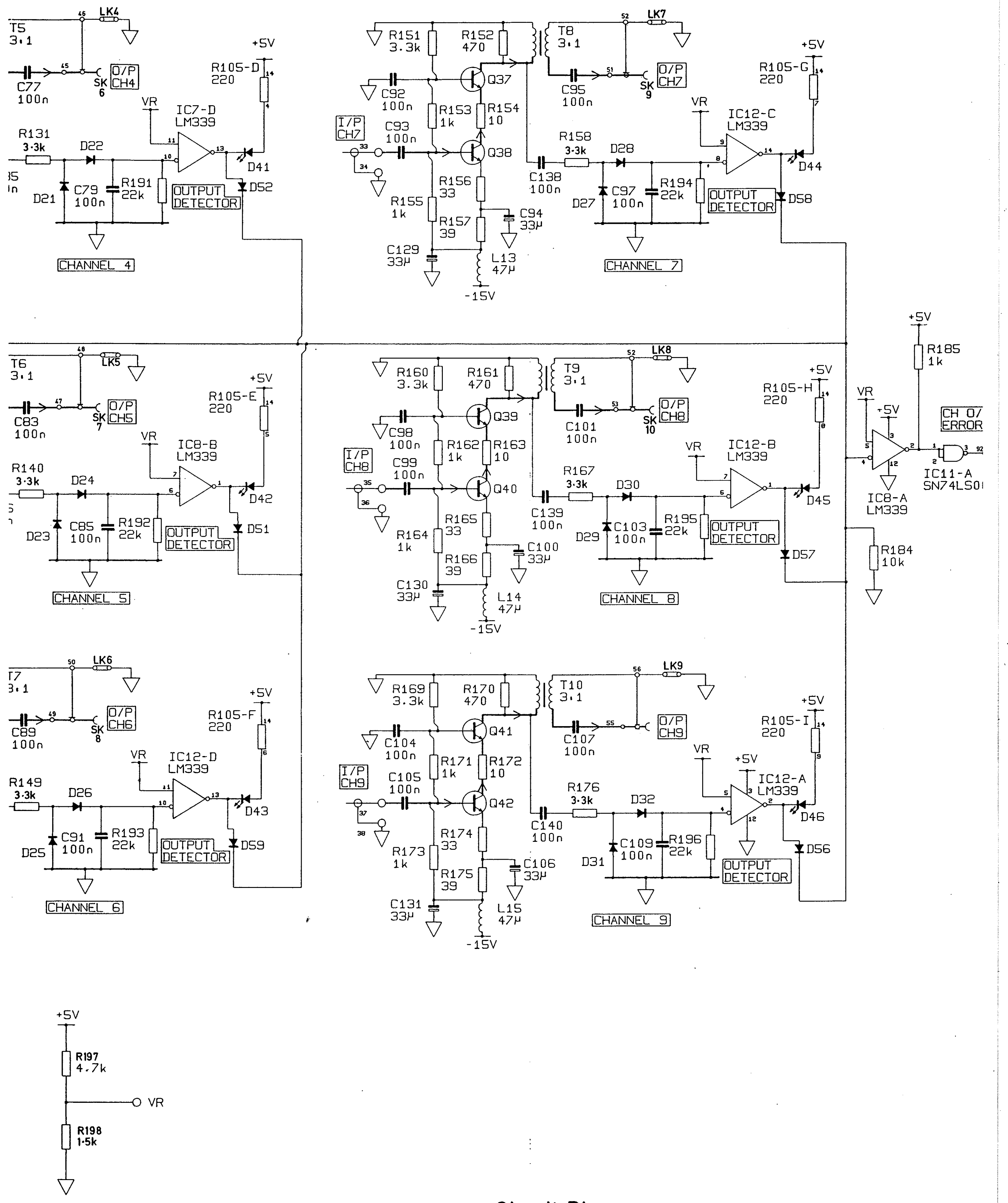
Cct Ref.	Value	Description	Rat.	Tol %	Racal-Dana Part Number
Inductors H					
L1	2.2µ	Choke, sub-miniature		10	23-7010
L2	3.3µ	Choke, sub-miniature		10	23-7011
L3	3.3µ	Choke, sub-miniature		10	23-7011
L4	1.5µ	Choke, sub-miniature		10	23-7009
L5	3.3µ	Choke, sub-miniature		10	23-7011
L6	15µ	Choke, sub-miniature		10	23-7015
L7	47µ	Choke, sub-miniature		10	23-7018
L8	47µ	Choke, sub-miniature		10	23-7018
L9	47µ	Choke, sub-miniature		10	23-7018
L10	47µ	Choke, sub-miniature		10	23-7018
L11	47µ	Choke, sub-miniature		10	23-7018
L12	47µ	Choke, sub-miniature		10	23-7018
L13	47µ	Choke, sub-miniature		10	23-7018
L14	47µ	Choke, sub-miniature		10	23-7018
L15	47µ	Choke, sub-miniature		10	23-7018
L16	47µ	Choke, sub-miniature		10	23-7018
L17	47µ	Choke, sub-miniature		10	23-7018
L18	47µ	Choke, sub-miniature		10	23-7018
Transformers					
T1		Transformer to Racal-Dana specification			17-3226
T2		Transformer to Racal-Dana specification			17-3227
T3		Transformer to Racal-Dana specification			17-3227
T4		Transformer to Racal-Dana specification			17-3227
T5		Transformer to Racal-Dana specification			17-3227
T6		Transformer to Racal-Dana specification			17-3227
T7		Transformer to Racal-Dana specification			17-3227
T8		Transformer to Racal-Dana specification			17-3227
T9		Transformer to Racal-Dana specification			17-3227
T10		Transformer to Racal-Dana specification			17-3227
Miscellaneous					
XL1	10 MHz	Crystal			17-2114



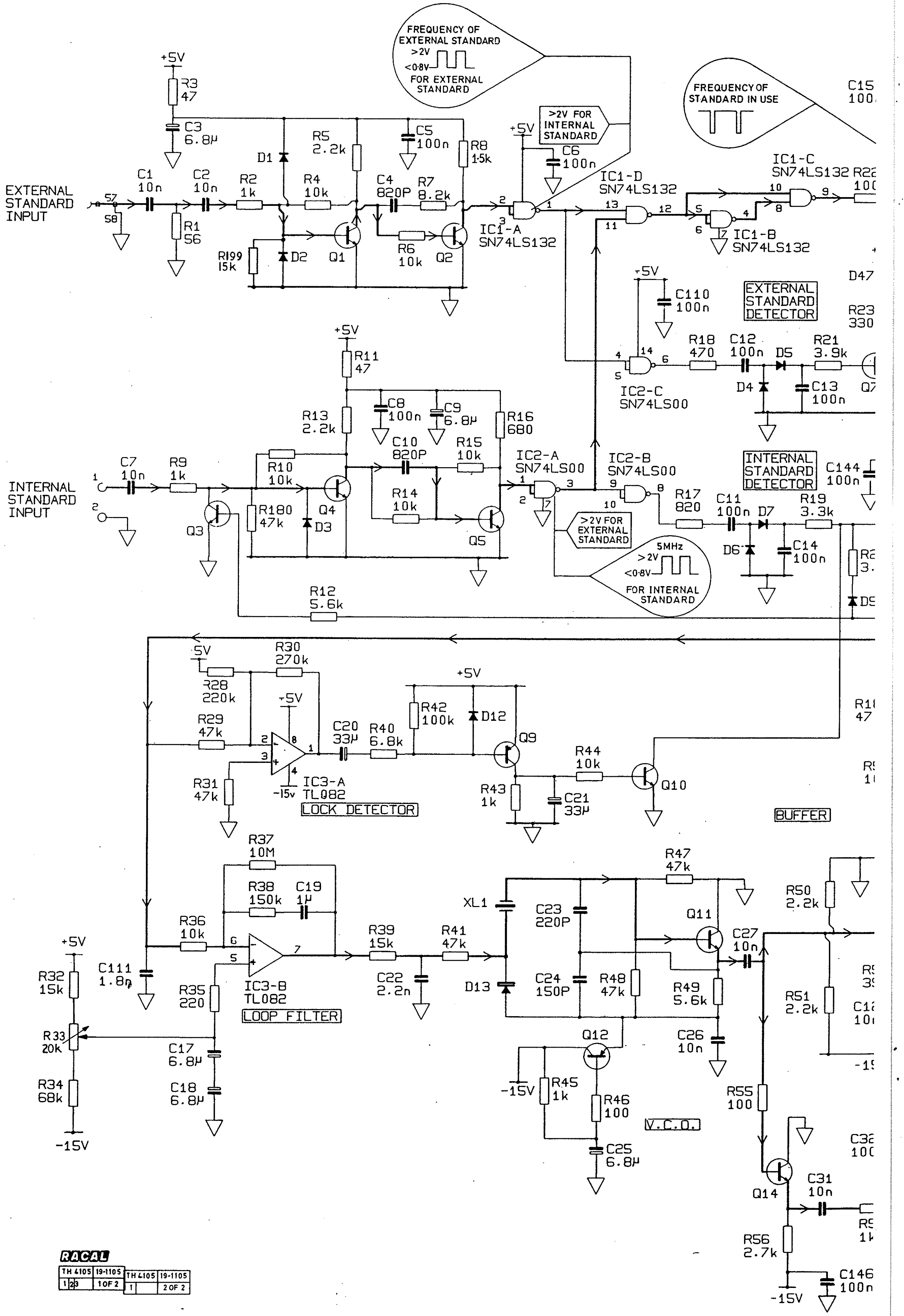
R97 3.3k
R98 470
T2 3:1
LK1
O/P CH1
SK 3
C56 100n
Q25
C59 100n
R99 1k
R100 10
I/P CH1
C57 100n
Q26
R101 1k
R102 33
C58 33µ
R103 39
C123 33µ
L7 47µ
-15V
R104 3·3k
C132 100n
D16
D15
C61 100n
R188 22k
R105-A 220
+5V
VR
IC7-A LM339
D38
D55
OUTPUT DETECTOR
CHANNEL 1
R106 3.3k
R107 470
T3 3:1
LK2
O/P CH2
SK 4
C62 100n
Q27
C65 100n
R108 1k
R109 10
I/P CH2
C63 100n
Q28
R110 1k
R111 33
C64 33µ
R112 39
C124 33µ
L8 47µ
R113 3·3k
C133 100n
D18
D17
C67 100n
R189 22k
R105-B 220
IC7-B LM339
D39
D54
CHANNEL 2
R115 3.3k
R116 470
T4 3:1
LK3
O/P CH3
SK 5
C68 100n
Q29
C71 100n
R117 1k
R118 10
I/P CH3
C69 100n
Q30
R119 1k
R120 33
C70 33µ
R121 39
C125 33µ
L9 47µ
R122 3·3k
C134 100n
D20
D19
C73 100n
R190 22k
R105-C 220
IC7-C LM339
D40
D53
CHANNEL 3
R124 3.3k
R125 470
C74 100n
Q31
R126 1k
R127 10
I/P CH4
C75 100n
Q32
R128 1k
R129 33
R130 39
C126 33µ
L10 47µ
R133 3.3k
R134 470
C80 100n
Q33
R135 1k
R136 10
I/P CH5
C81 100n
Q34
R137 1k
R138 33
R139 39
C127 33µ
L11 47µ
R142 3.3k
R143 470
C86 100n
Q35
R144 1k
R145 10
I/P CH6
C87 100n
Q36
R146 1k
R147 33
R148 39
C128 33µ
L12 47µ
CORCOM
FUSE
E N L
LINE ON/OFF
SCREEN YELLOW/GREEN
80
81
D33
C112 6800µ 16V
C116 100n
IC9
C114 6·8µ
TP1
+5V
R177 470
D49
83
D37
93
82
D35
C113 2200µ 25V
C117 100n
IC10
C115 6·8µ
TP2
-15V
RACAL
TH 4015

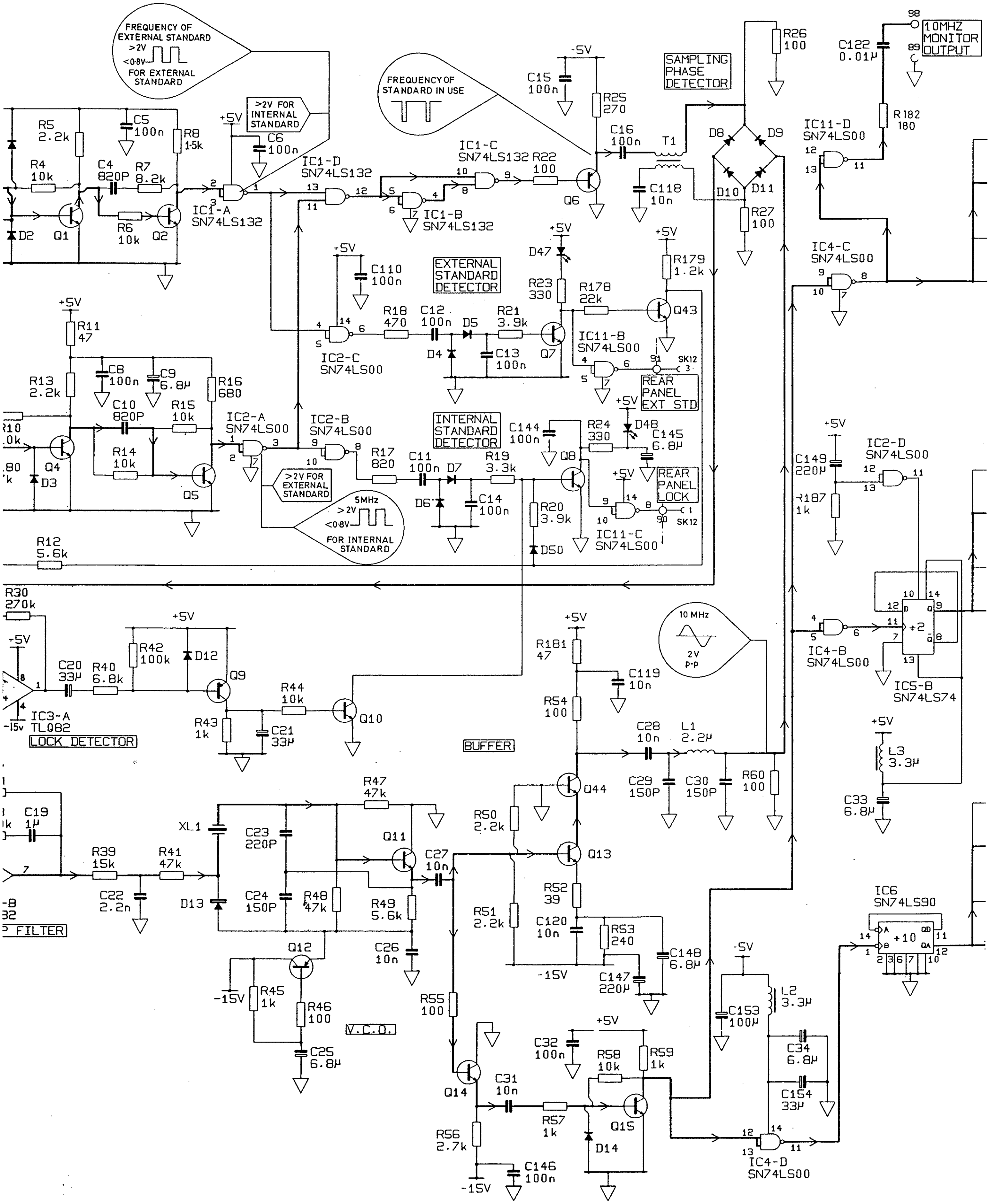


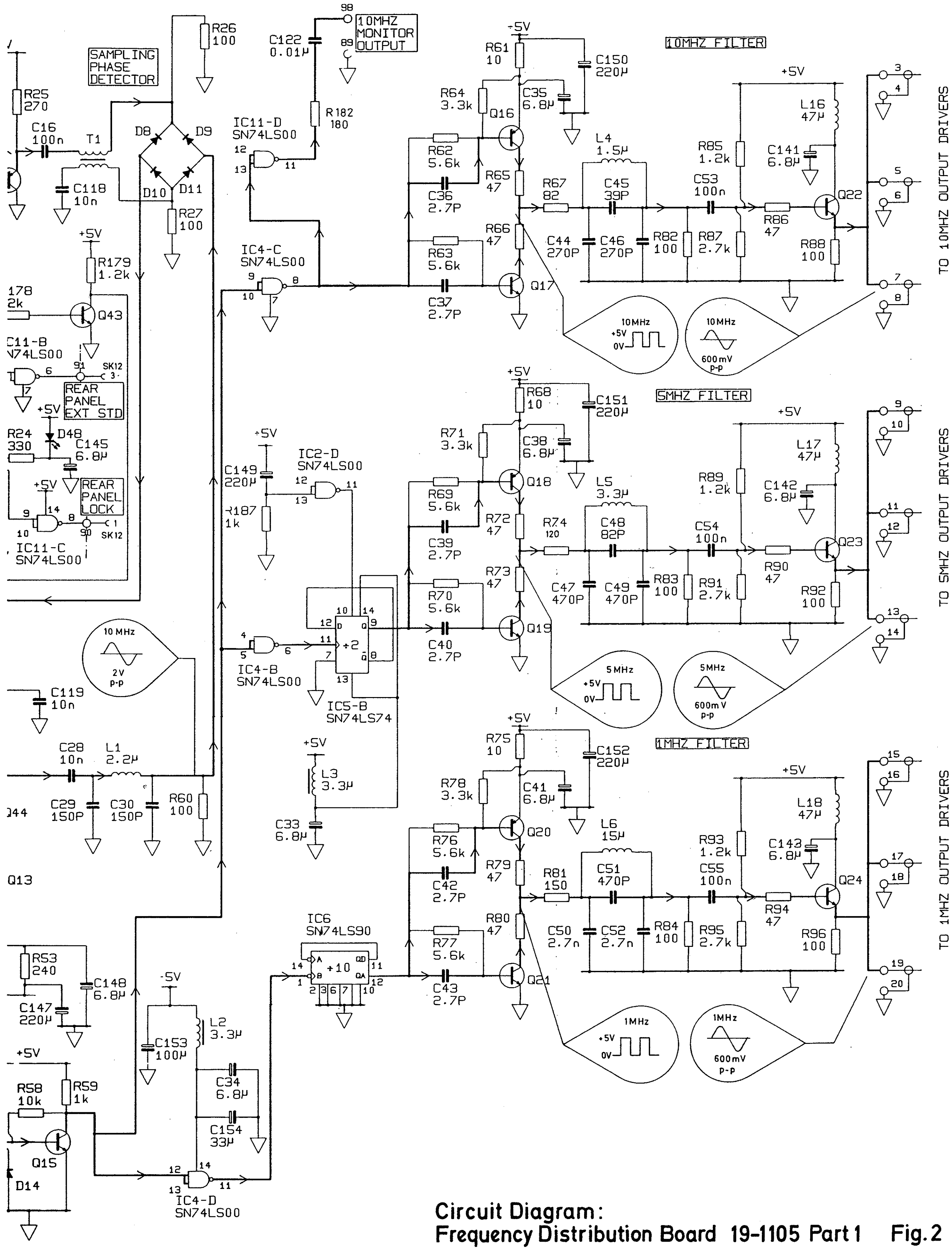
T2 3:1
LK1
C59 100n
O/P CH1
SK 3
R105-A 220
+5V
VR
IC7-A LM339
R104 3·3k
D16
C132 100n
D15
C61 100n
R188 22k
D38
D55
C58 33µ
OUTPUT DETECTOR
CHANNEL 1
T3 3:1
LK2
C65 100n
O/P CH2
SK 4
R105-B 220
IC7-B LM339
R113 3·3k
D18
C133 100n
D17
C67 100n
R189 22k
D39
D54
C64 33µ
CHANNEL 2
T4 3:1
LK3
C71 100n
O/P CH3
SK 5
R105-C 220
IC7-C LM339
R122 3·3k
D20
C134 100n
D19
C73 100n
R190 22k
D40
D53
C70 33µ
CHANNEL 3
R124 3.3k
R125 470
T5 3:1
LK4
C74 100n
Q31
C77 100n
O/P CH4
SK 6
I/P CH4
C75 100n
R126 1k
R127 10
Q32
R129 33
R128 1k
R130 39
C76 33µ
C126 33µ
L10 47µ
-15V
R131 3·3k
D22
C135 100n
D21
C79 100n
R191 22k
IC7-D LM339
R105-D 220
D41
D52
CHANNEL 4
R133 3.3k
R134 470
T6 3:1
LK5
C80 100n
Q33
C83 100n
O/P CH5
SK 7
I/P CH5
C81 100n
R135 1k
R136 10
Q34
R138 33
R137 1k
R139 39
C82 33µ
C127 33µ
L11 47µ
R140 3·3k
D24
C136 100n
D23
C85 100n
R192 22k
IC8-B LM339
R105-E 220
D42
D51
CHANNEL 5
R142 3.3k
R143 470
T7 3:1
LK6
C86 100n
Q35
C89 100n
O/P CH6
SK 8
I/P CH6
C87 100n
R144 1k
R145 10
Q36
R147 33
R146 1k
R148 39
C88 33µ
C128 33µ
L12 47µ
R149 3·3k
D26
C137 100n
D25
C91 100n
R193 22k
IC12-D LM339
R105-F 220
D43
D59
CHANNEL 6
I/P CH7
I/P CH8
I/P CH9
D33
C112 6800µ 16V
C116 100n
IC9
C114 6·8µ
TP1
R177 470
D49
D37
D35
C113 2200µ 25V
C117 100n
IC10
C115 6·8µ
TP2
R197 4.7k
R198 1·5k



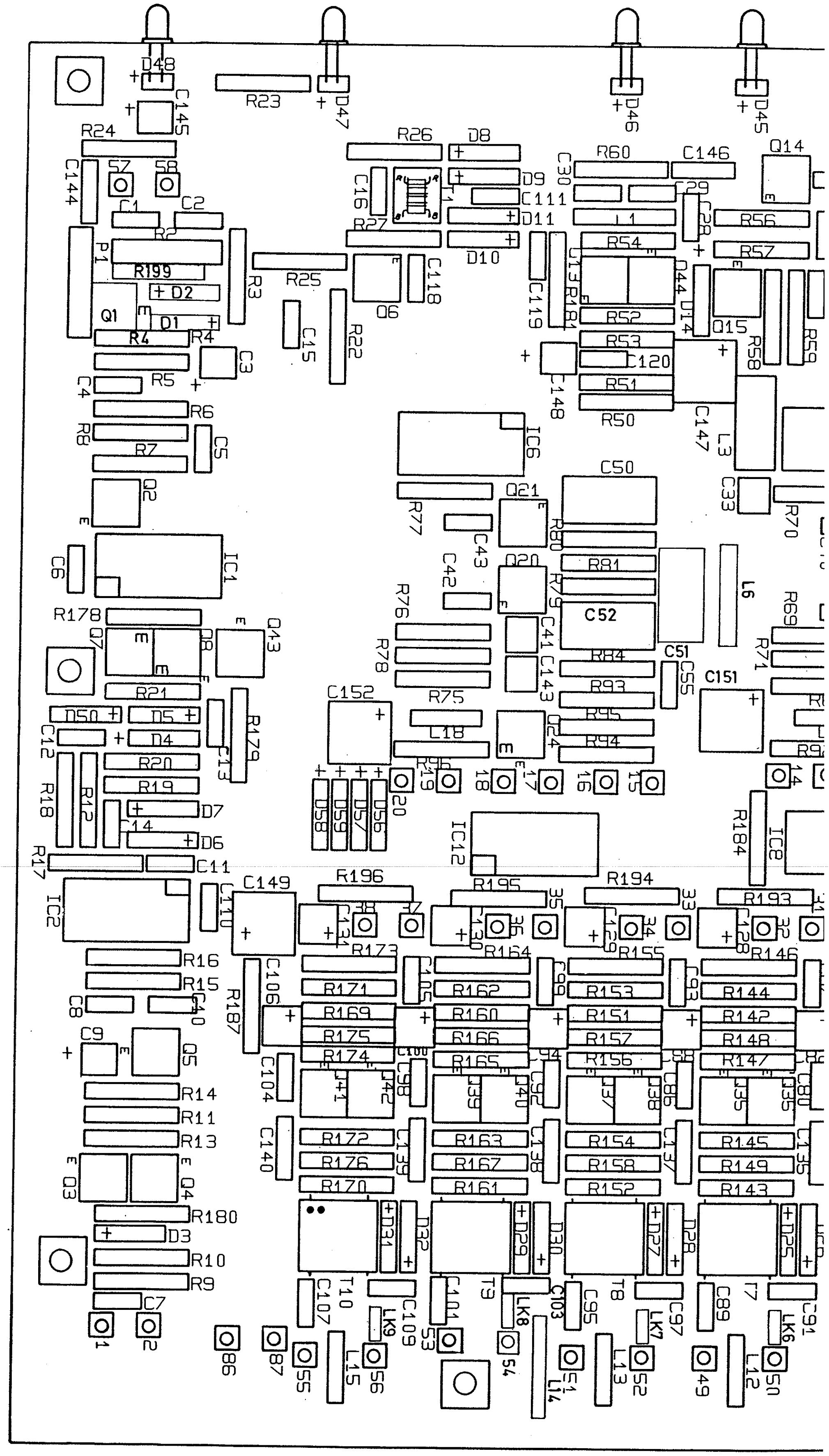
Circuit Diagram:
Frequency Distribution Board 19-1105 Part 2 Fig.


EXTERNAL STANDARD INPUT
INTERNAL STANDARD INPUT
FREQUENCY OF EXTERNAL STANDARD
>2V
<0·8V
FOR EXTERNAL STANDARD
>2V FOR INTERNAL STANDARD
FREQUENCY OF STANDARD IN USE
>2V FOR EXTERNAL STANDARD
5MHz
FOR INTERNAL STANDARD
IC1-A SN74LS132
IC1-B SN74LS132
IC1-C SN74LS132
IC1-D SN74LS132
IC2-A SN74LS00
IC2-B SN74LS00
IC2-C SN74LS00
IC3-A TL082
IC3-B TL082
EXTERNAL STANDARD DETECTOR
INTERNAL STANDARD DETECTOR
LOCK DETECTOR
LOOP FILTER
BUFFER
V.C.O.
+5V
-15V
R1 56
R2 1k
R3 47
R4 10k
R5 2.2k
R6 10k
R7 8.2k
R8 1·5k
R9 1k
R10 10k
R11 47
R12 5.6k
R13 2.2k
R14 10k
R15 10k
R16 680
R17 820
R18 470
R19 3.3k
R21 3.9k
R23 330
R28 220k
R29 47k
R30 270k
R31 47k
R32 15k
R33 20k
R34 68k
R35 220
R36 10k
R37 10M
R38 150k
R39 15k
R40 6.8k
R41 47k
R42 100k
R43 1k
R44 10k
R45 1k
R46 100
R47 47k
R48 47k
R49 5.6k
R50 2.2k
R51 2.2k
R55 100
R56 2.7k
R180 47k
R199 15k
C1 10n
C2 10n
C3 6.8µ
C4 820P
C5 100n
C6 100n
C7 10n
C8 100n
C9 6.8µ
C10 820P
C11 100n
C12 100n
C13 100n
C14 100n
C17 6.8µ
C18 6.8µ
C19 1µ
C20 33µ
C21 33µ
C22 2.2n
C23 220P
C24 150P
C25 6.8µ
C26 10n
C27 10n
C31 10n
C110 100n
C111 1.8n
C144 100n
C146 100n
D1
D2
D3
D4
D5
D6
D7
D12
D13
D47
Q1
Q2
Q3
Q4
Q5
Q9
Q10
Q11
Q12
Q14
XL1
S7
S8
RACAL
TH 4105
19-1105
1OF 2
2OF 2

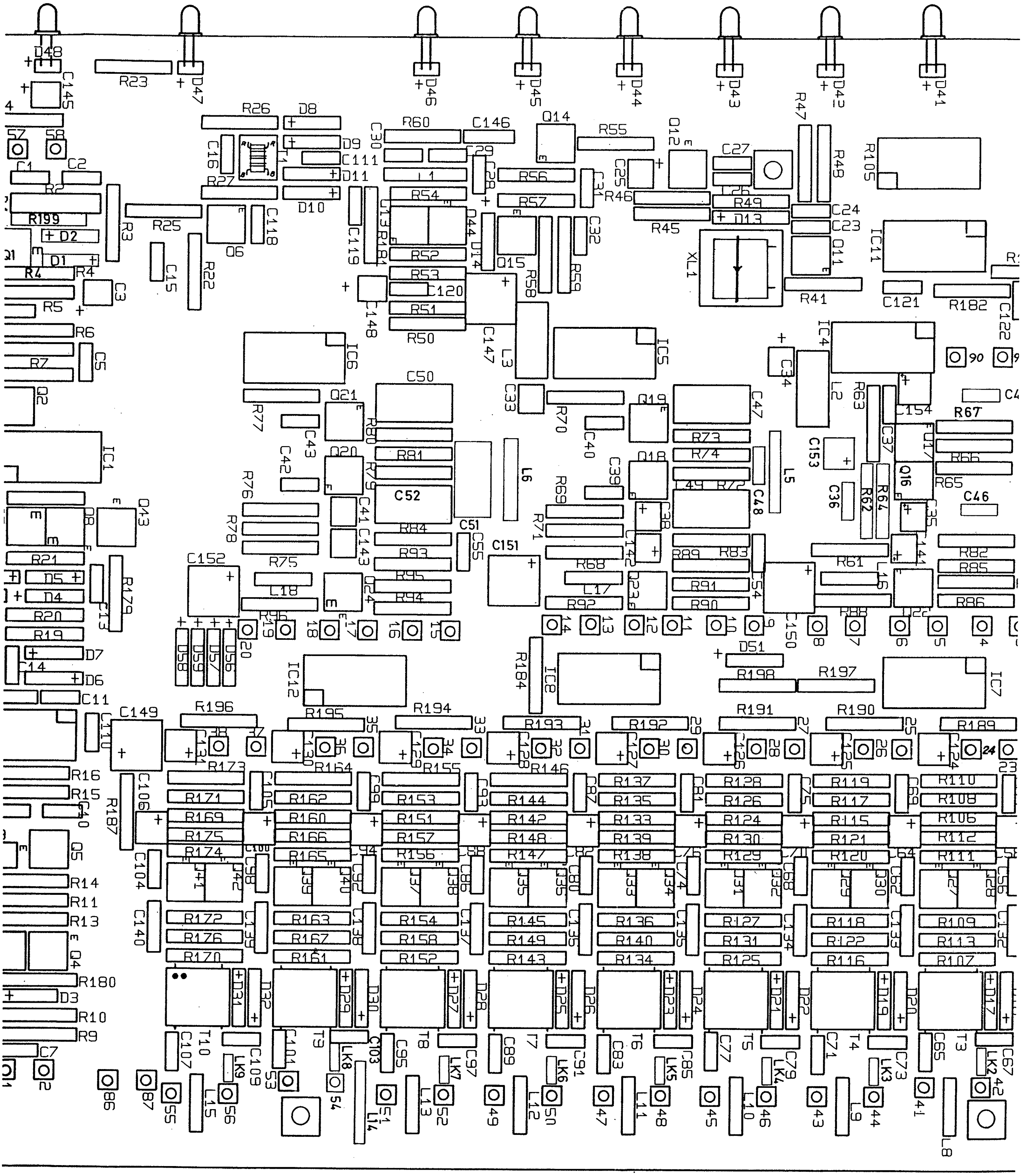

FREQUENCY OF EXTERNAL STANDARD
>2V
<0·8V
FOR EXTERNAL STANDARD
>2V FOR INTERNAL STANDARD
FREQUENCY OF STANDARD IN USE
SAMPLING PHASE DETECTOR
10MHZ MONITOR OUTPUT
EXTERNAL STANDARD DETECTOR
INTERNAL STANDARD DETECTOR
REAR PANEL EXT STD
REAR PANEL LOCK
SK12
>2V FOR EXTERNAL STANDARD
5MHz
FOR INTERNAL STANDARD
10 MHz
2V p-p
LOCK DETECTOR
BUFFER
V.C.O.
FILTER
IC1-A SN74LS132
IC1-B SN74LS132
IC1-C SN74LS132
IC1-D SN74LS132
IC2-A SN74LS00
IC2-B SN74LS00
IC2-C SN74LS00
IC2-D SN74LS00
IC3-A TL082
IC4-B SN74LS00
IC4-C SN74LS00
IC4-D SN74LS00
IC5-B SN74LS74
IC6 SN74LS90
IC11-B SN74LS00
IC11-C SN74LS00
IC11-D SN74LS00
R4 10k
R5 2.2k
R6 10k
R7 8.2k
R8 1·5k
R11 47
R12 5.6k
R13 2.2k
R14 10k
R15 10k
R16 680
R17 820
R18 470
R19 3.3k
R20 3.9k
R21 3.9k
R22 100
R23 330
R24 330
R25 270
R26 100
R27 100
R30 270k
R39 15k
R40 6.8k
R41 47k
R42 100k
R43 1k
R44 10k
R45 1k
R46 100
R47 47k
R48 47k
R49 5.6k
R50 2.2k
R51 2.2k
R52 39
R53 240
R54 100
R55 100
R56 2.7k
R57 1k
R58 10k
R59 1k
R60 100
R178 22k
R179 1.2k
R181 47
R182 180
R187 1k
C4 820P
C5 100n
C6 100n
C8 100n
C9 6.8µ
C10 820P
C11 100n
C12 100n
C13 100n
C14 100n
C15 100n
C16 100n
C19 1µ
C20 33µ
C21 33µ
C22 2.2n
C23 220P
C24 150P
C25 6.8µ
C26 10n
C27 10n
C28 10n
C29 150P
C30 150P
C31 10n
C32 100n
C33 6.8µ
C34 6.8µ
C110 100n
C118 10n
C119 10n
C120 10n
C122 0.01µ
C144 100n
C145 6.8µ
C146 100n
C147 220µ
C148 6.8µ
C149 220µ
C153 100µ
C154 33µ
L1 2.2µ
L2 3.3µ
L3 3.3µ
T1
XL1
D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D47 D48 D50
Q1 Q2 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q43 Q44
+5V
-5V
-15V
+10
÷2



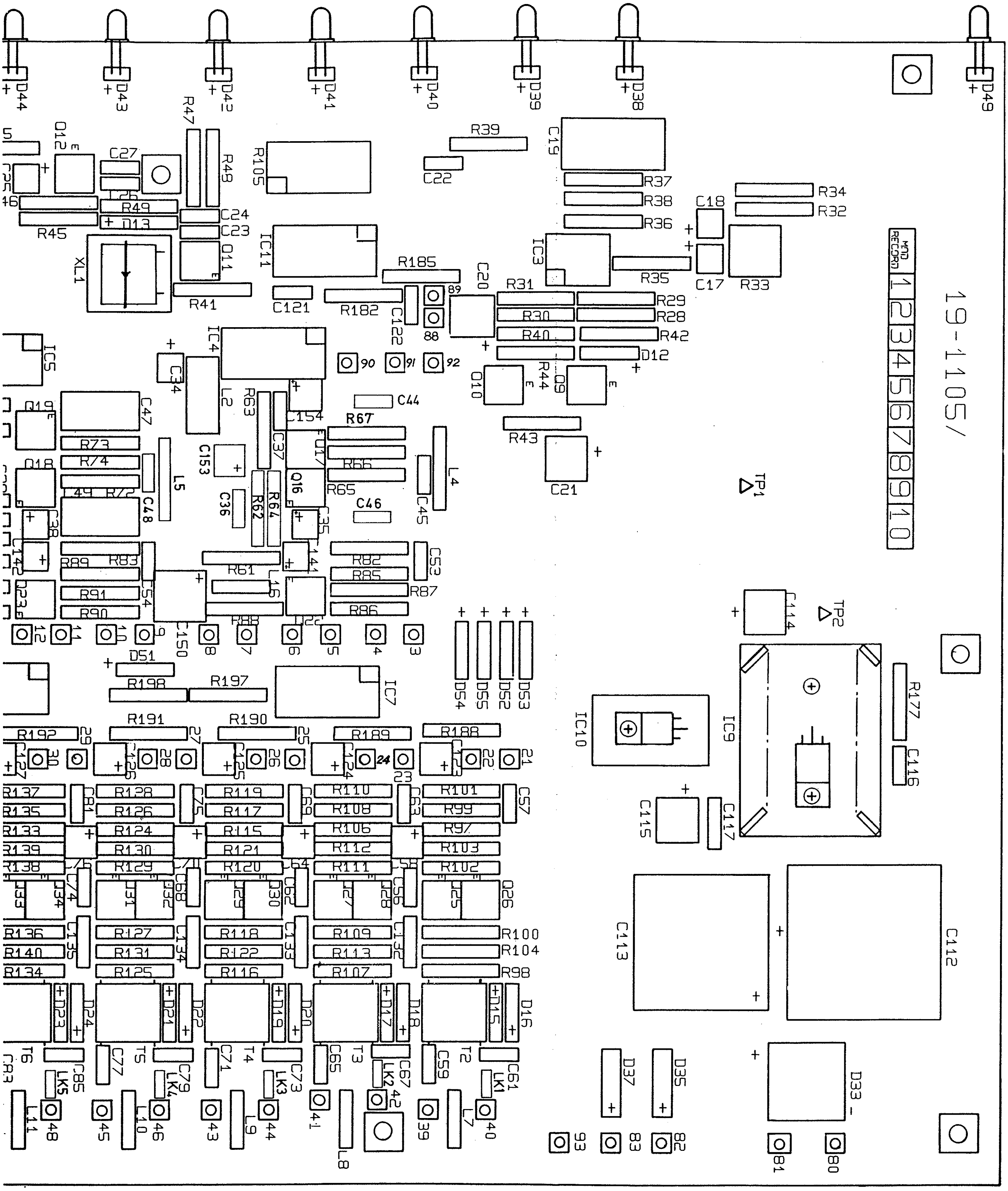
Circuit Diagram: Frequency Distribution Board 19-1105 Part 1 Fig. 2



TH 4015	19-1105
1 2	

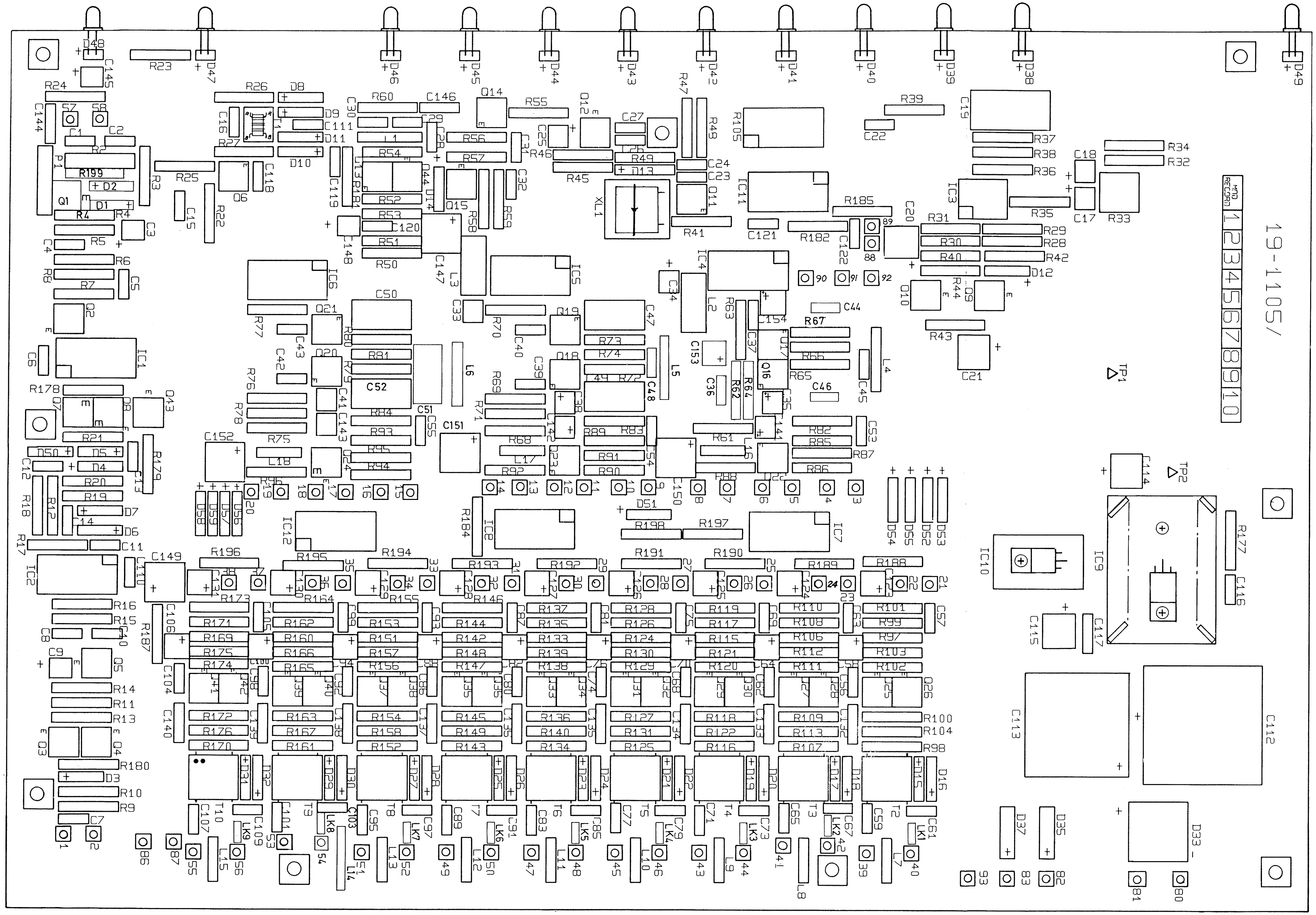


D48
D47
D46
D45
D44
D43
D42
D41
C145
R23
R26
D8
D9
D10
D11
C111
C16
R27
R25
R199
D2
D1
R4
R3
R5
R6
R7
C1
C2
C3
C5
C15
C118
Q6
R22
R60
C146
Q14
R55
Q12
C27
R47
R48
R105
C30
C29
C28
R56
C31
C25
R46
C26
R49
C24
R54
R57
C23
C119
R181
Q44
D14
Q15
R58
R59
C32
R45
D13
Q11
XL1
IC11
R52
R53
C120
R51
R50
C148
C147
L3
R41
C121
R182
C122
IC6
IC5
IC4
C34
L2
C50
C33
R70
Q19
C47
R63
C154
R67
Q2
IC1
R77
Q21
C43
R80
C40
R73
R74
C153
C37
C39
Q18
R72
L5
Q16
R66
R65
C42
Q20
R81
R79
L6
R69
C48
C36
R62
R64
C46
R76
C52
C41
C38
C35
Q13
R78
R84
C51
C143
C55
R71
R93
C151
C142
R89
R83
R82
R21
R68
R61
R85
C152
R75
R95
C141
D5
D4
R179
C13
L18
Q24
R94
L17
Q23
R91
C54
L16
R20
R96
R92
R90
C150
R88
Q22
R86
R19
D7
D58
D59
D57
D56
C14
D6
IC12
R184
IC8
D51
R198
R197
IC7
C11
C149
R196
R195
R194
R193
R192
R191
R190
R189
C110
C131
C130
C129
C128
C127
C126
C125
C124
R173
R164
R155
R146
R16
R15
C106
R137
R128
R119
R110
R171
R162
R153
R144
R135
R126
R117
R108
R187
R169
R160
R151
R142
R133
R124
R115
R106
R175
R166
R157
R148
R139
R130
R121
R112
Q5
R174
R165
R156
R147
R138
R129
R120
R111
C104
R14
R11
R13
C140
R172
R163
R154
R145
R136
R127
R118
R109
C139
C138
C137
C136
C135
C134
C133
C132
R176
R167
R158
R149
R140
R131
R122
R113
Q4
R170
R161
R152
R143
R134
R125
R116
R107
R180
D31
D32
D29
D30
D27
D28
D25
D26
D23
D24
D21
D22
D19
D20
D17
D3
R10
R9
T10
T9
T8
T7
T6
T5
T4
T3
C107
C109
C101
C103
C95
C97
C89
C91
C83
C85
C77
C79
C71
C73
C65
C67
C7
LK9
LK8
LK7
LK6
LK5
LK4
LK3
LK2
L15
L14
L13
L12
L11
L10
L9
L8



Component Layout:

Frequency Distribution Board 19-1105 Fi



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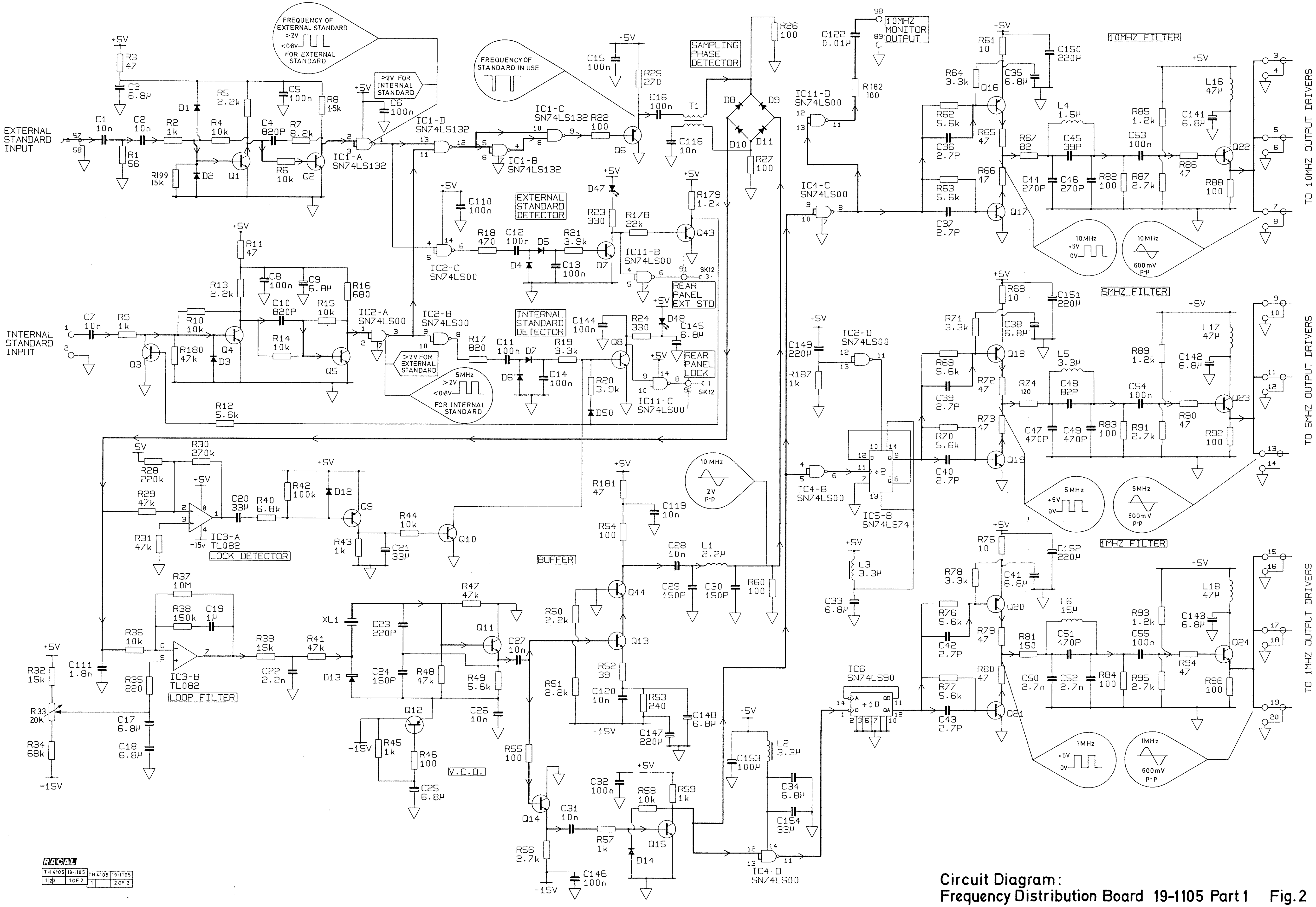
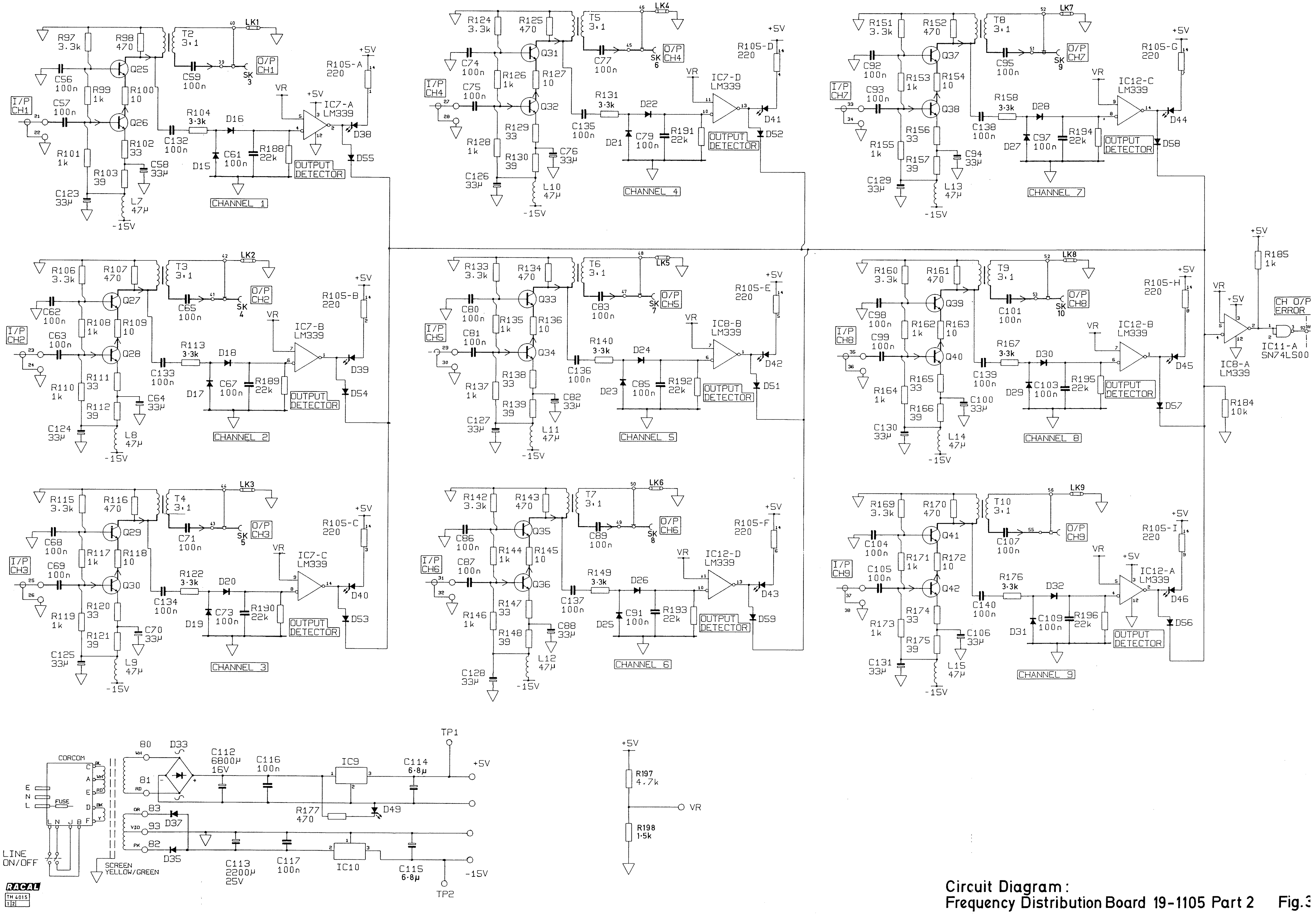
TH 4015	19-1105
1 2	

Component Layout:
Frequency Distribution Board 19-1105 Fiq



Circuit Diagram:
Frequency Distribution Board 19-1105 Part 1 Fig. 2



Circuit Diagram: Frequency Distribution Board 19-1105 Part 2 Fig.3