Assembly Manual for the

Dick Smith Explorer

40 Channel UHF Transceiver

Cat.K-6300

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DICK SMITH KIT

Here's a chance to break into a whole new world of amateur radio, where the operators are more relaxed, the antenna hardware is more manageable, and the risk of TV/audio interference is considerably reduced.

There's a catch, of course: instead of buying a shiny new transceiver in a sealed box, and putting it straight to air, the starting point is a packaged kit, requiring some 10-15 hours of assembly time, depending on your skill with a soldering iron.

The reward is the money which remains in your own pocket and the satisfaction of owning a "rig" which you've put together yourself – a rare distinction, these days.

There was a time when most amateur gear was "home brewed" – often in the most primitive sense of the term. Amateurs started out with an odd assortment of components, collected from every imaginable source, and proceeded to string them together in every imaginable way, until they worked. The results ranged, physically, from an untidy collection of bits and pieces to somebody's pride and joy but it was a lot of fun – and instructive fun at that!

This photograph shows the completed kit (including the optional S-meter and repeater switch. Notice how the microphone plug is mounted on the right hand side of the unit – a feature many commercial units lack.

What's more, it provided the basis for many discussions on air, as amateurs compared notes about their constructional successes and failures.

Unfortunately – in some respects – the technology of equipment being used on the amateur bands has long since outstripped the resources of the experimenter and his proverbial junkbox. Only in exceptional circumstances, nowadays, could an amateur even contemplate designing and building the kind of equipment that is in everyday use on the bands. Even packaged, pre-designed kits are no longer very viable, commercially.

That is what makes this new kit for a 70 cm amateur band transceiver especially interesting. As much as anything, it owes its existence to the personal commitment of Garry Crapp VK2YBX, General Manager of R & D at Dick Smith Electronics, and to a fellow amateur Gill McPherson VK2ZGE. Their stated objective was to promote amateur activity on the UHF bands in Australia.

The "six-metre" and the "two-metre" VHF bands need no introduction, but, partly because of interference problems, VHF activity has tended to concentrate in the two-metre band where, unfortunately, the behaviour of some operators – to say the least – does not reflect much credit on amateur radio!

The next, logical option open to amateurs is the "70cm" UHF band between 420 and 450MHz, strategically placed so that it could conceivably be utilised by frequency triplers operating in conjunction with existing two-metre (144-148MHz) transmitters and transceivers. This technique is seldom used these days, however, the preference being for separate and distinct 70cm band transceivers.

While a certain amount of equipment has been adapted from surplus two-way systems and UHF CB transceivers, most amateurs currently operating on the band have simply saved up enough "hard-earned" cash to invest in a normal commercial transceiver, either a hand-held portable or a 12V system for in-car use. Quite a few such units are currently available from amateur equipment suppliers ranging from something over $300 for a personal portable to $700-odd for a car system.

As with the two-metre band, the "ultimate" transceiver is one capable of transmission and reception on crystal-locked frequencies right across the band with or without frequency offset for repeater operation and with all-mode facilities.

By nature, any such receiver is both complex and costly, and the more practical approach for most amateurs is to settle for FM operation only and an agreed system of channels identified by numbers and frequencies. These, along with associated regional repeaters, can then be accessed by more modest mobile FM transceivers and, in a more limited way, by small hand-held units.

Possibly the most familiar example of this approach is provided by the Philips FM-321 transceiver, which is a 70cm amateur band version of their well known FM-320 UHF CB unit. It provides coverage of 40 channels, 25kHz apart, between 438.025 and 439MHz, with offset for repeater working, in line with the recognised band plan.

The new DSE kit design conforms to the same plan and is therefore fully compatible with commercial units like the FM-321, and with regional repeaters. It lacks one or two of the operator frills, like channel sequencing and control from the handset, but it will do the same basic job.

We also took up the question of an antenna system for use with the built-up kit. There is a certain frustration in owning a transmitter but no antenna, and also a certain risk if the constructor is tempted to feed it into the proverbial piece of "wet string" – in-built protection circuitry notwithstanding.

A basic antenna construction kit involving a quarter-wave vertical radiator, guttergrip mounting base and feed, a PL-259 connector and three metres of good quality coaxial cable can be obtained from any Dick Smith store. The system can be set up for either 438MHz amateur use or 476MHz CB.

So you should end up with a fully compatible 40-channel 70cm mobile FM system, with an RF output of about 5W and a receiver sensitivity of around 0.3μV for 20dB of quieting.

Index

Dear Customer,

We are pleased that this company is the first Australian company to release a kit as sophisticated and as functional as the 'Explorer' UHF Transceiver kit. It is bound to bring great satisfaction to you in constructing it.

We would also like to give a word of warning. This kit is complex, and so we feel that it should not be undertaken by anyone who does not have considerable experience in constructing RF equipment. Most 'Hams' will have the skills necessary to complete this project without great difficulty, but for the inexperienced may we suggest you gain qualified assistance or else return the kit to us in its original packing for a full refund.

Thanking you,
Dick Smith and Staff

EXPLORER – SPECIFICATIONS

1. General

Frequency Range	From 438.025 (channel 1) to 439.000 MHz (channel 40)
Channel Spacing	25 kHz
Number of Channels	40 consecutive channels, numbered from 1 – 40
Frequency Stability	Better than ±1Cppm from 0-60°C.
Modulation	Frequency Modulation
Temperature Range	5-50°C.
Duty Cycle	2 minutes transmit, 2 minutes recieve
Supply Voltage	From 12.5 to 16.5 volts, –ve earth. Standard test voltage: 13.8V
Current Consumption	Receive (Standby): 140mA nominal (180mA with meter) Receive (Operating): 300mA nominal (340mA with meter) Transmit: 1.8A
Protection	a) 2A in-line fuse b) Fuse operated polarity protection using a shunt diode c) RF-Power Amplifier can withstand 5:1 VSWR including short or open circuit output conditions, for at least 2 minutes. d) Audio PA can withstand open circuit continuously and momentary short circuits.

2. Transmitter

Power Output	5 watts
Maximum Deviation	<5 kHz, limited up to 10 kHz available, with +20dB overdrive at 1 kHz
Distortion	<10% at 3 kHz deviation and at 1 kHz modulation frequency
FM-noise	>40dB w.r.t. 3 kHz deviation
Spurious Emissions	<60dB w.r.t. carrier
Harmonics	<1uW, or less than –60dB (typically –70dB)
Microphone Sensitivity	5mV RMS

3. Receiver

Sensitivity	0.4uV p.d. for 12dB SINAD, (typically 0.3uV into 50 ohms)
Selectivity (single signal method)	<6dB at ±7.5 kHz >60dB at ±25 kHz <55dB at ±50 kHz or more
Blocking	>50dB at ±200 kHz (single channel method)
Intermodulation (2 signals)	>60dB for f_0 + 100 kHz
Audio Output Power	>1.0 watts at 1% T.H.D. into 8 ohms
Audio Response	FM with 6dB/octave de-emphasis from approximately 1 kHz
Hum & Noise	>50dB below ±3 kHz deviation for 1 kHz signal

A WORD ON CONSTRUCTIONAL TECHNIQUES AT UHF

One of the most important considerations at UHF is the length of component leads. It is impossible to use construction techniques devised for HF and even VHF at UHF frequencies without jeopardising circuit operation. In all cases, lead lengths should be kept as short as possible, components should be pressed firmly as close to the PCB as lead spacing will allow before soldering and, unless unavoidable, components should not be mounted vertically. Where this vertical mounting is inevitable, the exposed component lead should be located at the 'cold' end of the circuit. Remember all exposed leads act as antennae, both radiating and receiving signals from other parts of the circuit. By placing the exposed lead at the 'earthy' or 'cold' end of a circuit, this radiation and/or pickup can be minimised.

Another part worth mentioning is soldering technique. Many constructors feel that semiconductors are very sensitive to heat and avoid heat damaging components at the expense of making good solder connections. In fact, most semiconductor manufacturers guarantee that a temperature of 300°C, applied 1/16" of an inch from the junction of a semiconductor for a period of ten seconds will not harm the device. Ten seconds is an enormous time to solder one connection; try timing yourself and you will see! The moral is - many more faults are caused by dry joints than heat damaged components. So don't be afraid to apply the necessary heat to make a good solder joint.

A GENERAL GUIDE TO KIT CONSTRUCTION

FOLLOW THE MANUAL

Read each step completely — before starting. Make sure you understand everything that's involved.

TAKE YOUR TIME

Allow yourself plenty of time to build the kit. Set aside an area where you can work undisturbed, and can leave the kit between sessions.

CHECK YOUR WORK

Refer frequently to the kit's instruction manual, check each step as it is completed.

SOLDERING

Poor soldering is the major cause of kits not working. This is simply because most people do not take the time to learn how to solder properly and practise it.

THE IRON

The soldering iron used should be suited to electronic work. A wattage of from 10 to 30 watts is ideal, with a tip size from 1.5 to 4mm across. A chisel shape is usually best.

The tip should be kept clean at all times. The best way is to keep a damp sponge or cloth handy and wipe the iron on it occasionally. If the tip is pitted it will have to be reshaped by filing (except iron plated tips which must not be filed).

THE SOLDER

The best solder for general electronics use is 60/40 multicore (60% tin/ 40% lead with inbuilt resin flux). SAV-BIT is a variation of this type with 2% copper added to improve tip life. 'Acid core' solders must not be used.

METHOD

The joint must be clean and free from tarnish, lacquers etc. for the solder to adhere properly. If necessary, use sandpaper or a fine file to clean the joint.

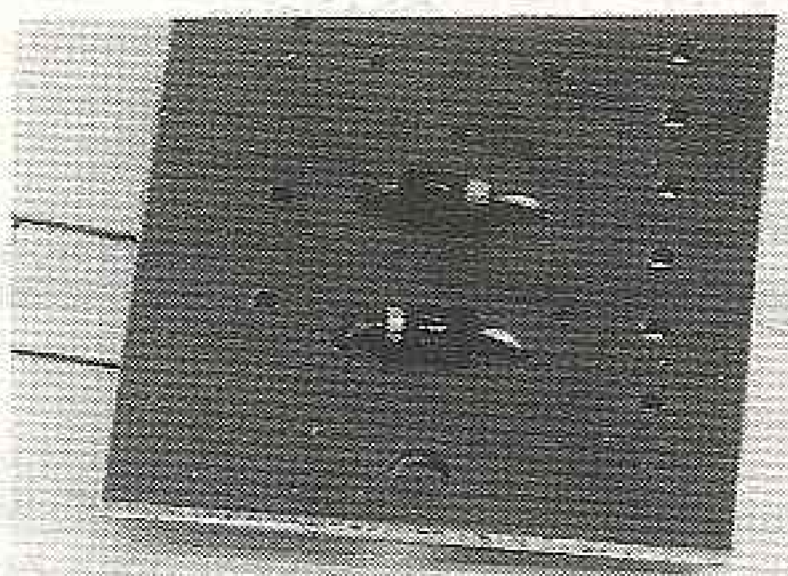
Make a good mechanical connection: bend leads of components mounted on printed circuit boards at 45° once inserted; and on wires connecting to switches, terminals etc. at 90°.

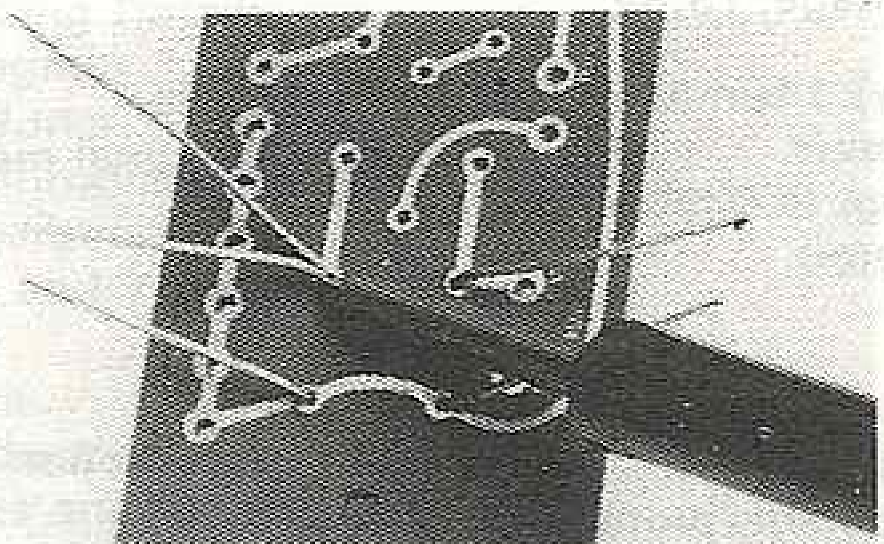
Hold the iron as you hold a pencil and apply it to the joint before the solder to pre-heat the joint (about one second for PC boards) then apply the solder to the joint and the iron. The solder will flow freely when the joint is hot enough. Remove the iron and and solder when the solder has flowed across the whole joint. If the solder forms a ball the joint needs more heat.

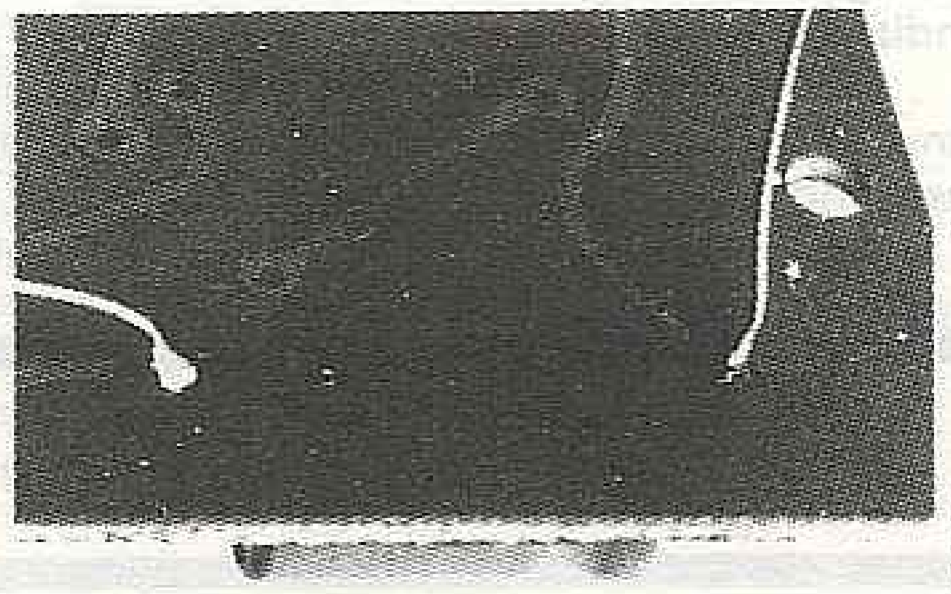
Don't move anything while the solder is cooling. If you do, re-heat and add a little more solder to ensure a clean joint.

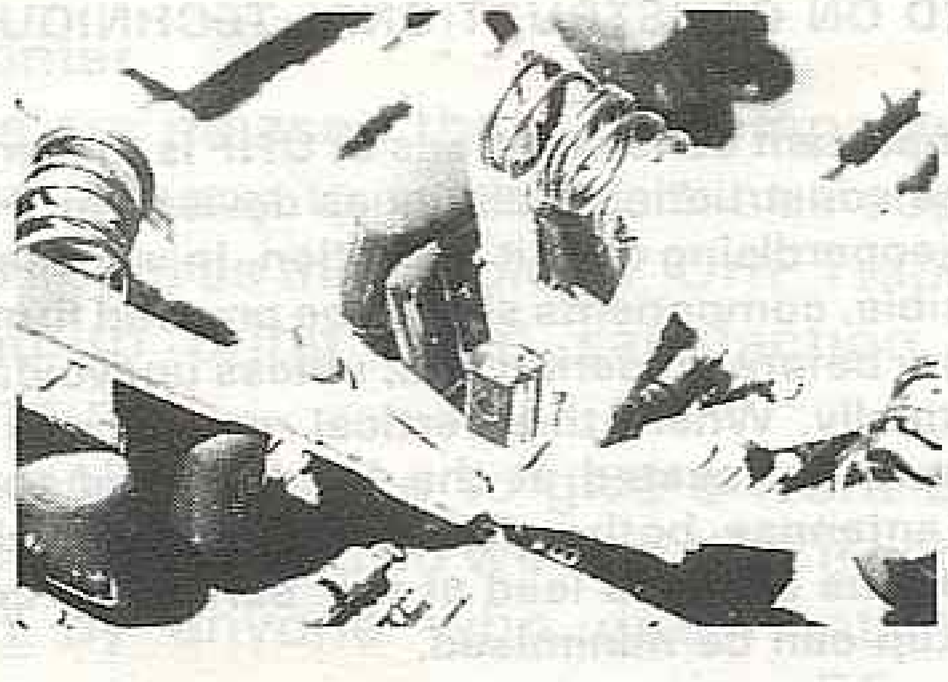
The connection should be shiny and the solder should flow smoothly into it. If it looks cracked or frosty, the joint is dry and must be re-done.

If you've never used an iron before, do some practise runs first. Get the feel of the solder flow, and when to apply and remove the solder and the iron.









When soldering semiconductors and other sensitive components it is a good idea to hold the lead with pliers or a heatsink clip to prevent damage by overheating. This isn't necessary once you can solder fast and reliably.

When it is cool, inspect each joint carefully; look for solder 'bridges' shorting across PC tracks, pinholes and cracks in the joints.

COMPONENT IDENTIFICATION

One of the biggest problems for the beginning constructor is identifying the components correctly. The main trap is in the maze of numbers put on components by manufacturers. There will normally be a drawing of the parts in the kit manual, but identifying numbers may not be easy to find on the components themselves. As an example, what's described as a '741' IC may be marked LM741CN, N5741T, 741TC, MC1741CP1 or SN52741N. Confusing, isn't it? Notice though, that there is a '741' somewhere in all the numbers. The other numbers and letters indicate the manufacturer, and various batch and variety codes of the particular manufacturer. All these may be ignored as any of these ICs would work equally well in a circuit.

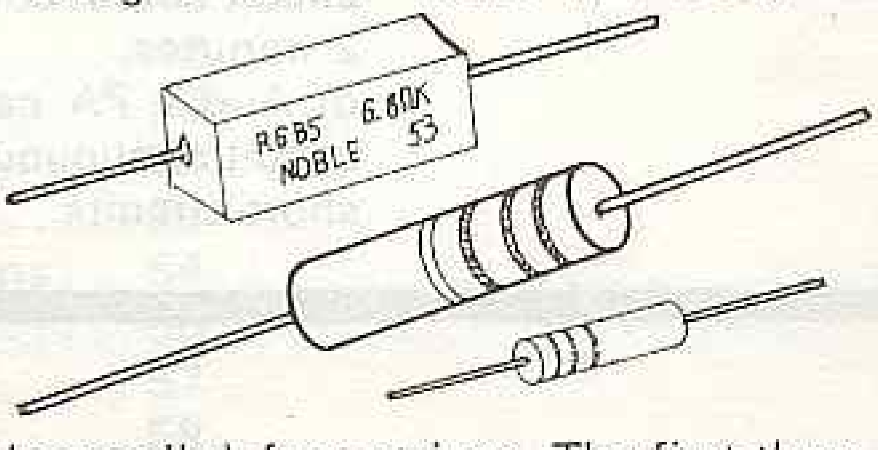
We will now go through the common components in our kits.

RESISTORS

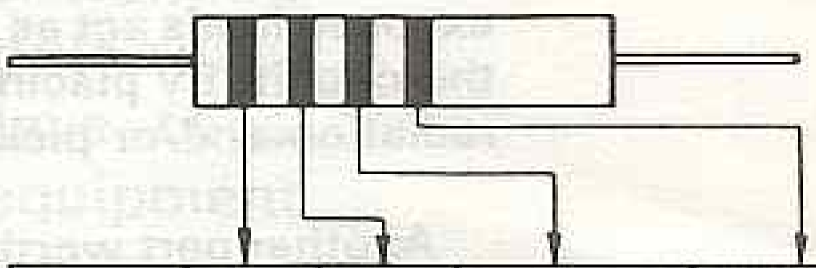
So called because they 'resist' the flow of current. They are normally in the form of small cylinders about 10mm long. Some high wattage types are rectangular.

Resistance is measured in ohms, abbreviated to Ω or R. Thousands are indicated by 'k', millions by 'M'. Thus a 12k resistor has a resistance of 12 000 ohms.

This value is marked on the resistors using a colour code. The body has



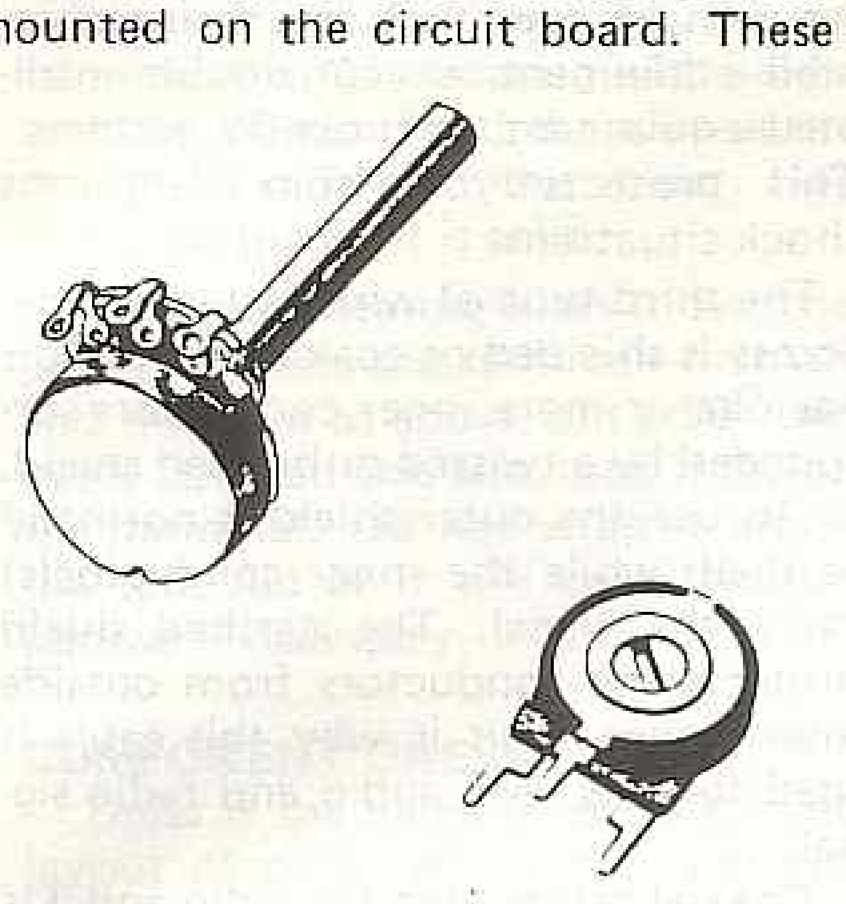
(normally) four stripes. The first three indicate the resistance, the last the tolerance - how much the resistor may vary from its quoted resistance. The last band need not concern us as it is normally gold (5%) in our kits, which is accurate for most uses. To read the colour code, start with the band closest to the end. The first two are the significant figures, and the third is the number of zeroes following. The chart below shows the value of the different colours.



COLOUR	TENS	UNITS	MULTIPLIER	TOLERANCE
BLACK	0	0	1	20% (M)
BROWN	1	1	10	1% (F)
RED	2	2	100	2% (G)
ORANGE	3	3	1000	—
YELLOW	4	4	10000	—
GREEN	5	5	100000	—
BLUE	6	6	1000000	—
VIOLET	7	7	—	—
GREY	8	8	—	—
WHITE	9	9	—	—
GOLD	—	—	0 1	5% (J)
SILVER	—	—	0 01	10% (K)

POTENTIOMETERS

Potentiometers are variable resistors. There are two main types in kits: normal potentiometers (often called pots) which are used as front panel controls for volume, speed or whatever; and 'trimpots' which are smaller devices mounted on the circuit board. These



are used for initial adjustment of frequencies, levels etc. and are not normally adjusted once set.

CAPACITORS

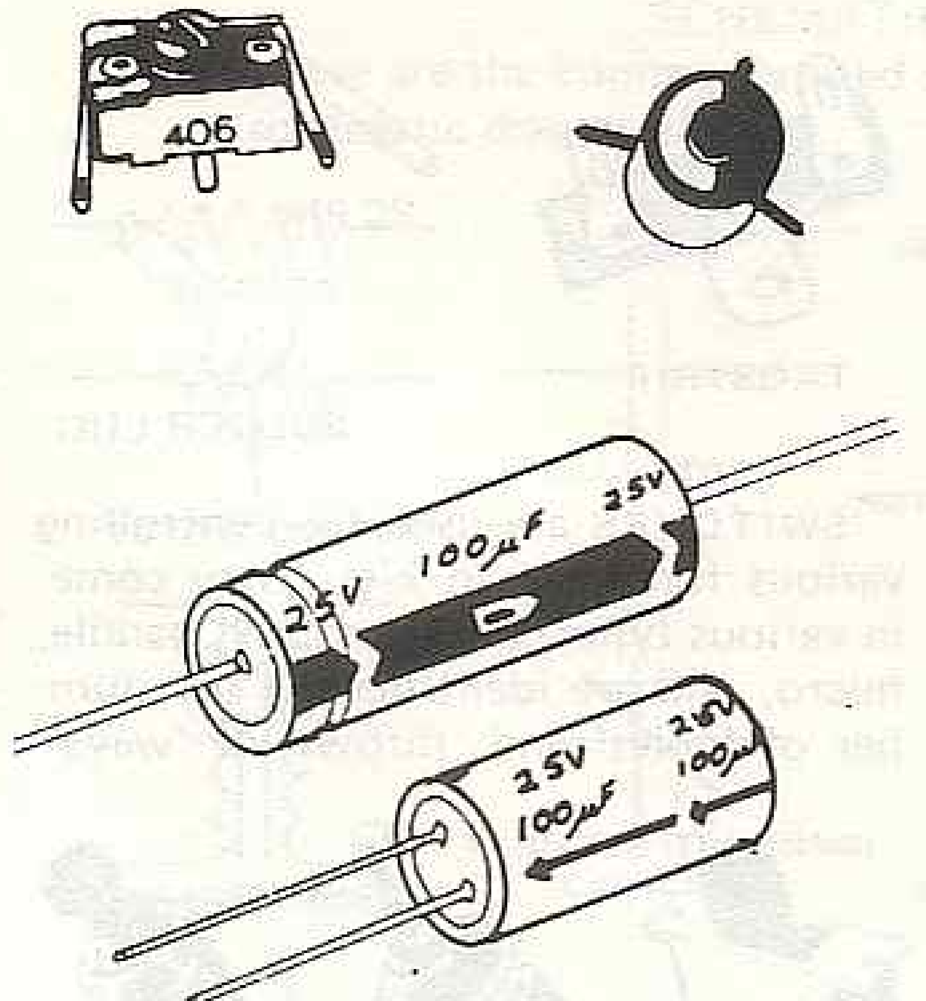
Capacitors store a charge. They come in an enormous range of sizes and types with the most confusing identification of all the components

The most common types are mylar (greencaps), ceramic, electrolytic and tantalum. Some kits also use polystyrene and polyester. Electrolytic and tantalum capacitors are 'polarised', that is, have a positive and negative end which must be installed in the correct direction for the circuit to work.

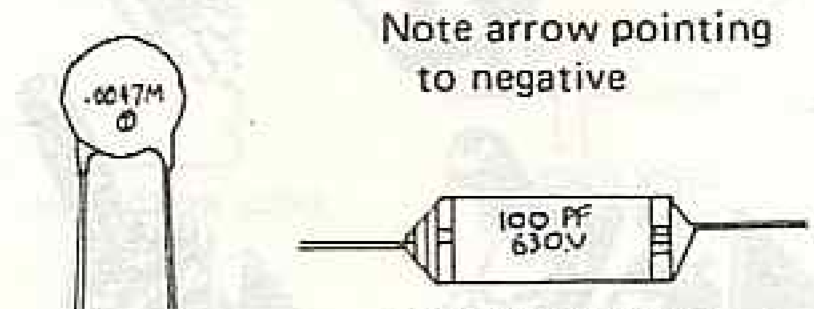
Capacitance is measured in Farads. This is too large a unit for most uses so various fractions are used: microFarad (uF)- a millionth of a Farad; nanoFarad (nF)- a thousandth of a microFarad; picoFarad (pF)- a thousandth of a nanoFarad. So 0.01uF= 10nF = 10 000pF.

Capacitors are marked in all these units - often without indicating which one! Electrolytics and some tantalum capacitors are marked in uF with the working voltage; ceramics in pF and mylar in pF or uF.

Many ceramic and mylar capacitors are marked using the IEC capacitor code, a system of three numbers and a letter giving the value and tolerance of a capacitor. The first two numbers are the significant figures, and the third the number of zeroes following (value in picoFarads). The letter indicates the tolerance - M = 20%; K = 10%: J = 5%. So a 123K is a 12 000pF or 12nF or 0.012uF 10% capacitor.

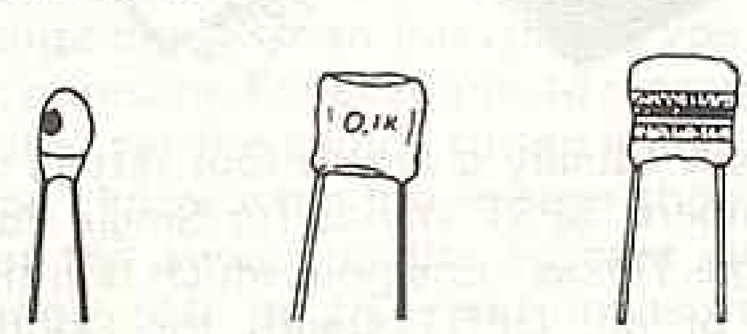


ELECTROLYTIC
Note arrow pointing to negative



POLYSTYRENE

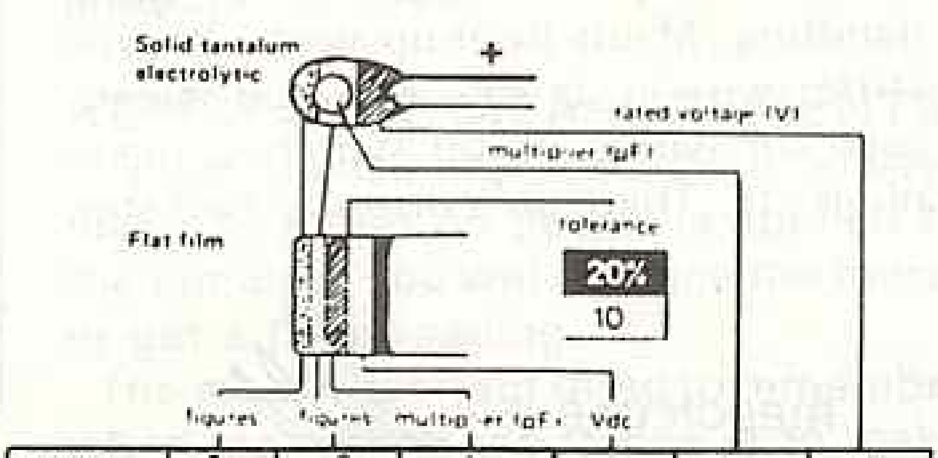
CERAMIC



TANTALUM MYLAR POLYESTER

Some of the larger value greencaps are marked in uF (usually 0.1uF and larger). Smaller ceramics are usually marked in pF. This is why many constructors find capacitors confusing!

One more method is used to identify capacitors. Some polyester and tantalum capacitors are marked with a colour code similar to resistors.



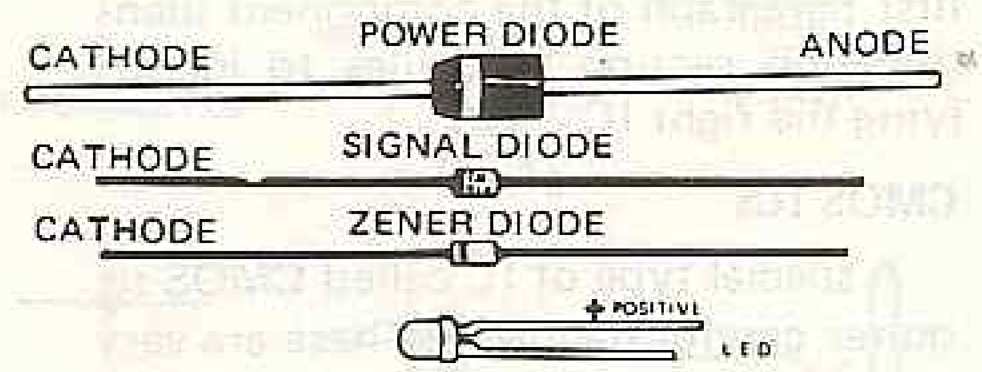
	figures	figures	multiplier (pF)	Vdc		
BLACK	0	0	1		1	10
BROWN	1	1	1.	1..		1.6
RED	2	2	100	250		4
ORANGE	3	3	1k			40
YELLOW	4	4	10k	400		6.3
GREEN	5	5	100k			16
BLUE	6	6		630		
VIOLET	7	7			10^{-3}	
GREY	8	8	0.01		10^{-2}	25
WHITE	9	9	0.1		10^{-1}	2.5

CAPACITOR COLOUR CODE

DIODES

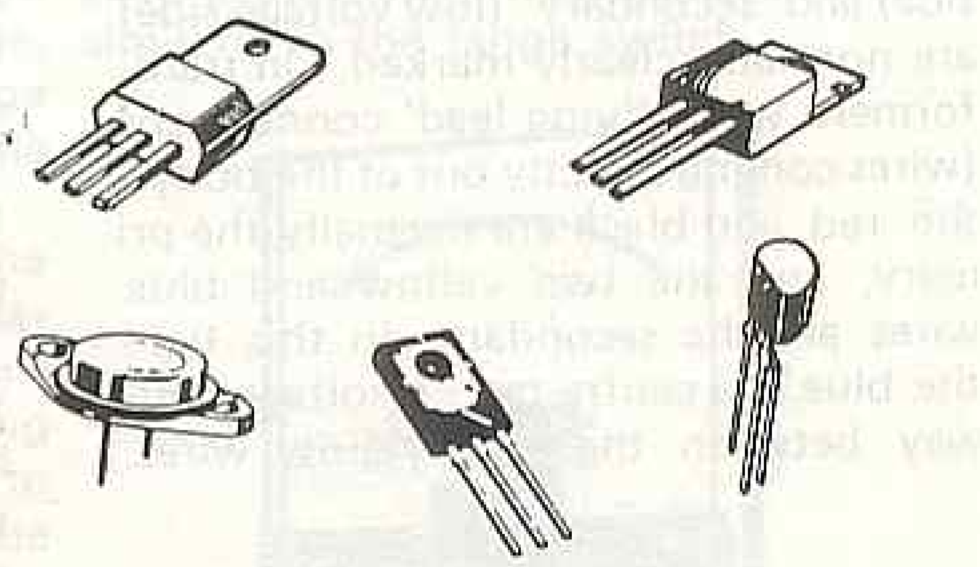
Diodes are used to convert AC current to DC (rectify), or to detect signals. Most are in the form of a black or clear cylinder 3 - 10mm long. Diodes are also polarised, with a cathode end (k), and an anode (a) end. The cathode is marked with a black or silver stripe, or in some small signal diodes, a white end. Always check that they are installed the right way round.

Light emitting diodes (LEDs) are a special type of diode which lights up red, green or yellow when voltage is applied. These are also polarised, and must be fed the correct voltage, with an appropriate resistor to limit the current.



TRANSISTORS

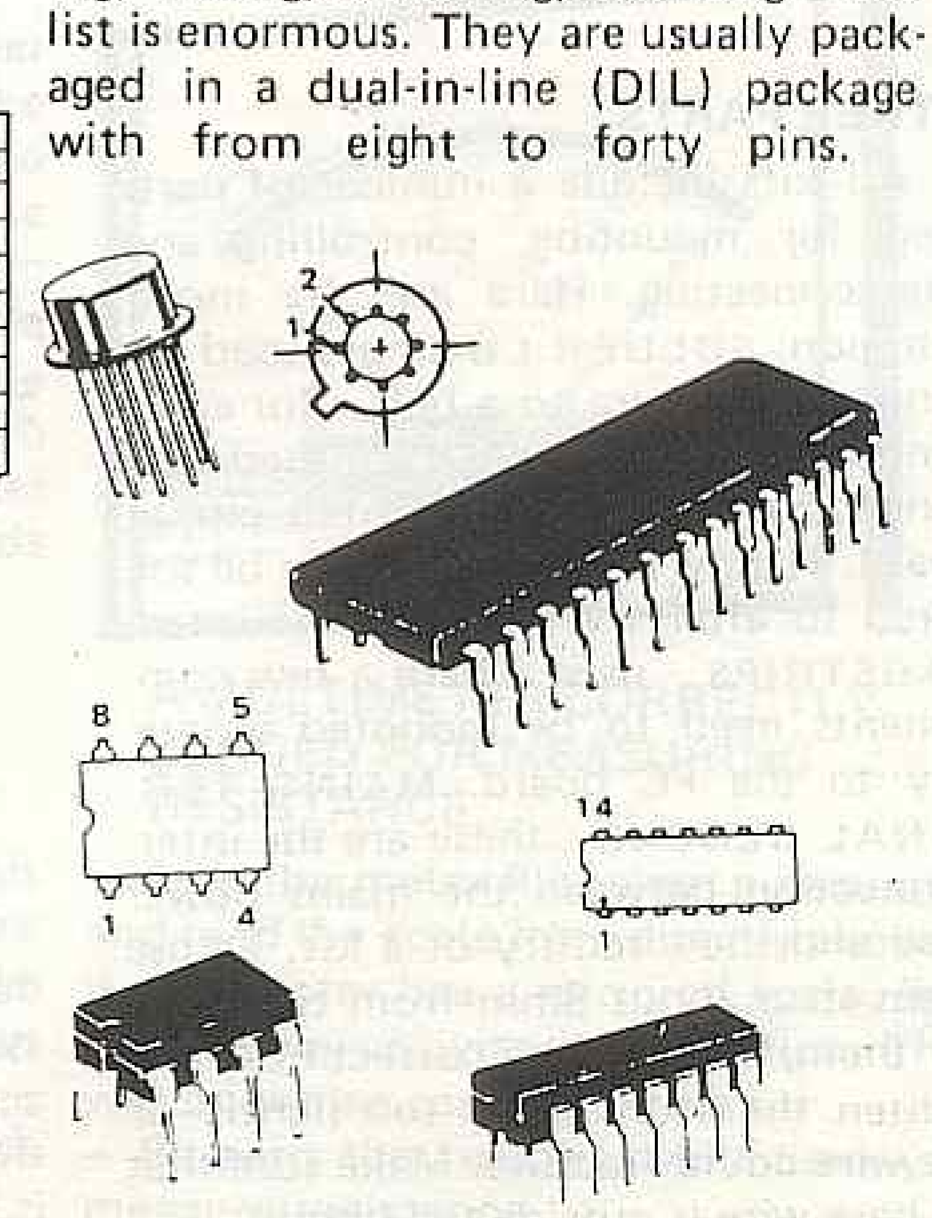
Transistors are the heart of most solid state equipment. They are used to amplify and switch signals. Transistors generally have three leads called emitter (e), base (b) and collector (c) and come in a wide variety of different cases. Always check that the leads are installed in the correct positions - two transistors may look the same, they may even work the same, but their leads could be differently oriented. The number of a transistor is normally printed on the case. Any other numbers or letters are manufacturers' codes and may be ignored. Typical transistors are illustrated alongside.



ALWAYS FOLLOW THE PIN CONNECTIONS ON THE CIRCUIT DIAGRAMS CAREFULLY

INTEGRATED CIRCUITS (IC)

Integrated circuits are just what their name indicates: a complete circuit in a single package. They perform a wide variety of functions - amplifying, timing, switching, counting - the list is enormous. They are usually packaged in a dual-in-line (DIL) package with from eight to forty pins.



ICs must be installed in the correct direction. One end will be marked with a notch or hole which must be installed as indicated in the circuit layout.

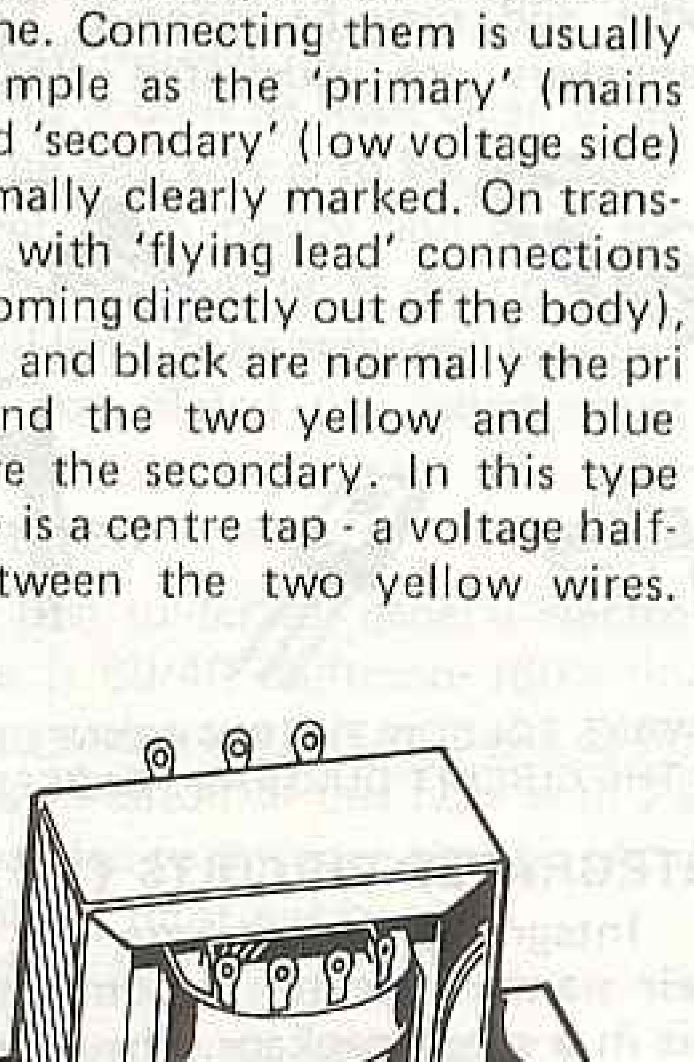
Identifying the right IC can sometimes be difficult due to the maze of numbers printed on them. See the first paragraph of the component identification section for clues to identifying the right IC.

CMOS ICs

A special type of IC called CMOS requires careful handling. These are very sensitive to static electricity and come packed on special conductive foam for protection. Always install these ICs last, soldering the power and earth pins first. Make sure your soldering iron is properly earthed, and avoid touching the pins with your fingers. Follow the instructions in the kit carefully and if you have any doubts about soldering, buy sockets for the ICs.

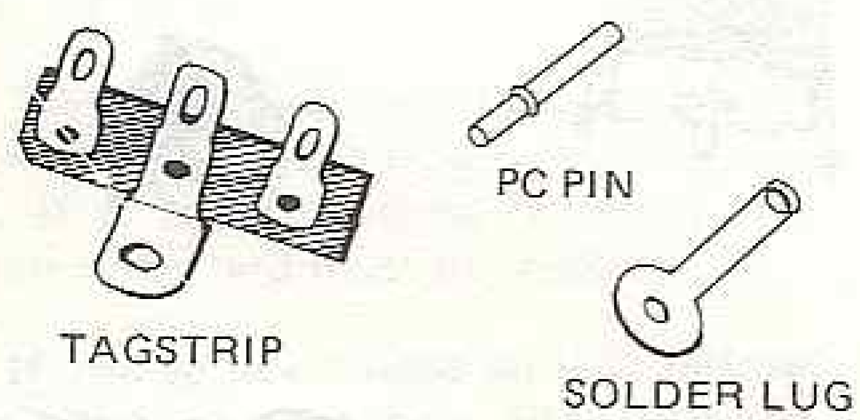
TRANSFORMERS

Transformers are used mainly for reducing the 240V mains to a voltage suitable for powering the circuitry of a kit. All mains operated kits will include one. Connecting them is usually fairly simple as the 'primary' (mains side) and 'secondary' (low voltage side) are normally clearly marked. On transformers with 'flying lead' connections (wires coming directly out of the body), the red and black are normally the primary, and the two yellow and blue wires are the secondary. In this type the blue is a centre tap - a voltage halfway between the two yellow wires.

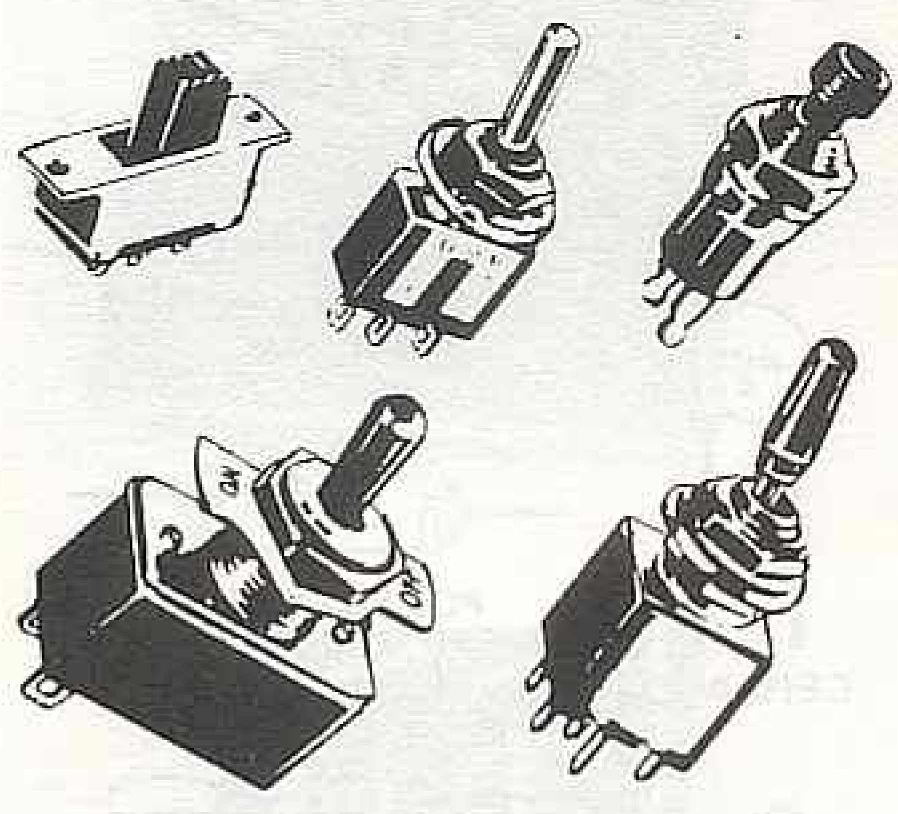


OTHER PARTS

All kits include a number of parts used for mounting, controlling and interconnecting. Here are the most common: SOLDER LUGS are used for connecting a wire to a bolt - for earth connections etc. PC PINS - used for connecting wires to a printed circuit board. Handy because they can be soldered to after the board is mounted. TAGSTRIPS - used where a few components need to be mounted separately to the PC board. MAINS TERMINAL BLOCKS - these are the interconnection between the mains power cord and the circuitry of a kit. To use them strip about 8mm from the wires tin them, insert in the correct hole and tighten the screw - not too tightly or the wire could fracture. Make sure that no bare wire is outside the block.



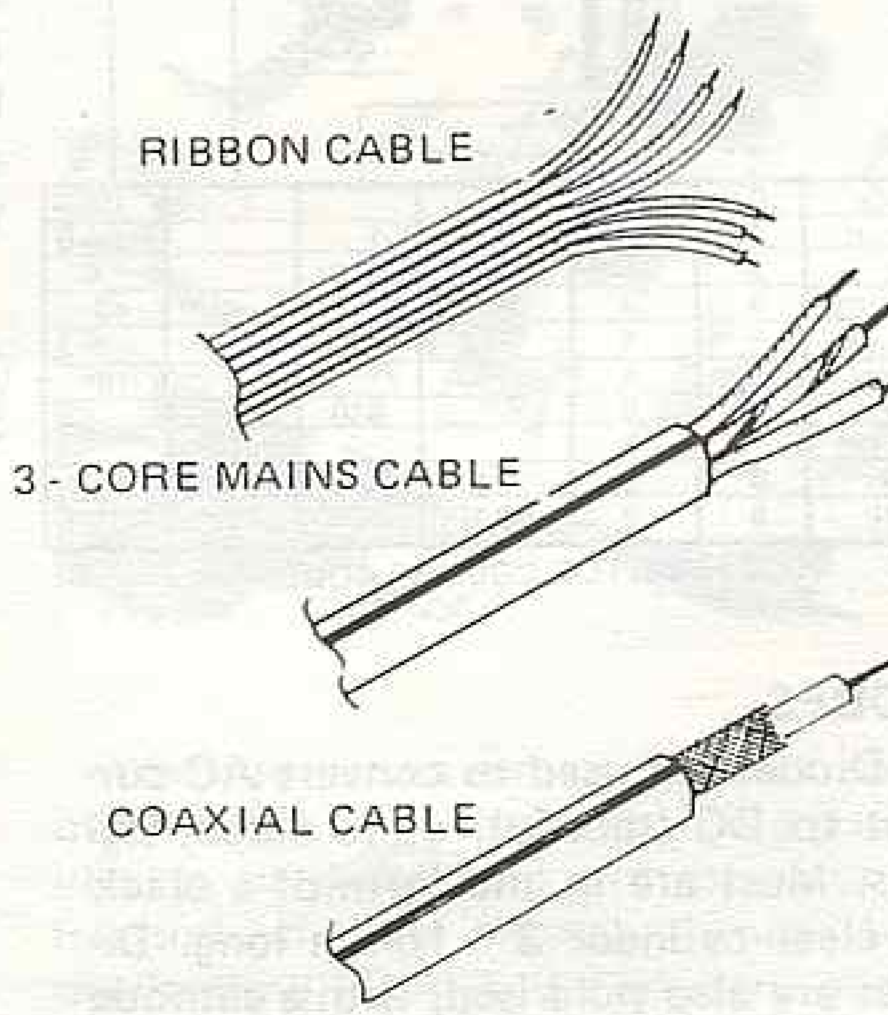
SWITCHES are used for controlling various functions in kits. They come in various types - toggle, rotary, paddle, micro, and are identified by the number of 'poles' and 'throws' or 'ways'.



This is usually given as four letters or numbers. SPST stands for Single Pole Single Throw - one pole which is either off or on; DPDT stands for Double Pole Double Throw - two separate poles which have two 'on' positions. The drawings at the right will clarify these descriptions.

WIRE AND CABLE

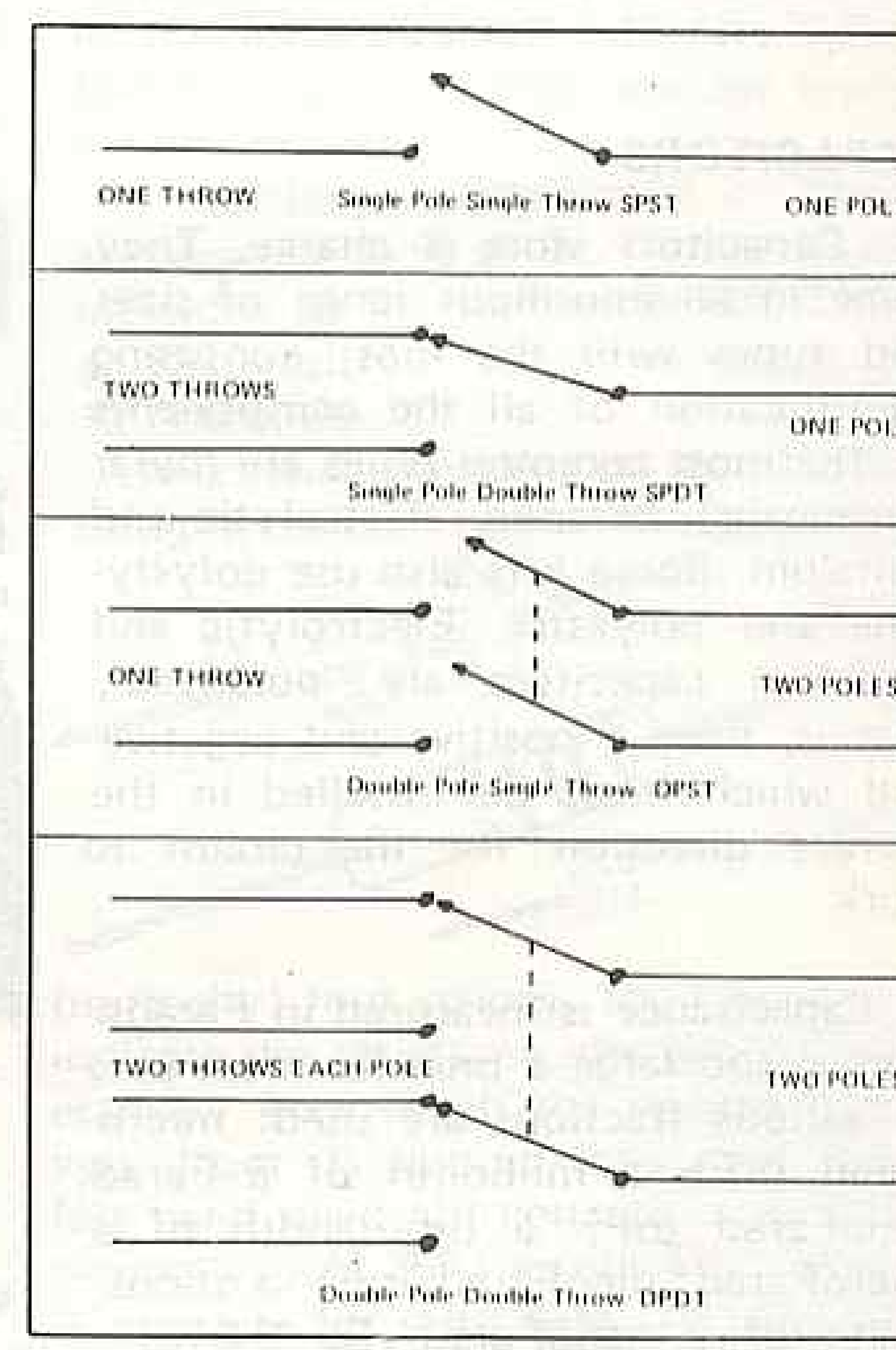
You will come across three main types of cable in our kits. Standard hookup wire - light, flexible wire in a wide range of colours for low voltage connections. This may be in the form of a flat 'ribbon' of twelve separate conductors joined together for easier handling. Mains hookup wire - heavier stiffer wire in black, red and green used for wiring power switches, mains plugs etc. There are currently two standards for mains colour codes. The old system uses red, black and green for active, neutral and earth wires respectively. The new international standard is brown, blue and yellow/green striped



At the moment both are used about equally, with the new standard eventually being the only one. Remember the equivalents: red and brown are for the active line, black and blue for the neutral and green and green/yellow are for the safety earth connection. Always make sure that any mains operated equipment, except double insulated equipment, is properly earthed. This protects you from dangerous shock situations.

The third type of wire you will come across is shielded or coaxial cable. This has one or more inner conductors surrounded by a twisted or braided shield. In use the outer shield is normally earthed, while the inner conductor(s) carry the signal. The earthed shield protects the conductors from outside interference. This is why this cable is used for low level audio and radio signals.

Coaxial cables used for radio and TV have an impedance - measured in ohms. Always use coax of the specified impedance; usually 75 ohm for TV and FM, and 50 ohm for CB and amateur radio use.



CONSTRUCTION TECHNIQUES

The drawings show how components are mounted on the PC board.

1. Bend component leads to fit the holes.
2. Insert leads in the correct holes and push down hard against the board. If the component is polarised, check that it is installed the right way round.
3. Turn the board over and bend the leads to 45^{o}.
4. Hold the bit of your soldering iron against the component lead and the copper.
5. After pre-heating for about one second apply the solder to the joint and the iron.
6. When the solder has flowed across the pad remove the iron and solder.

7. When cool cut the leads off flush with the solder.

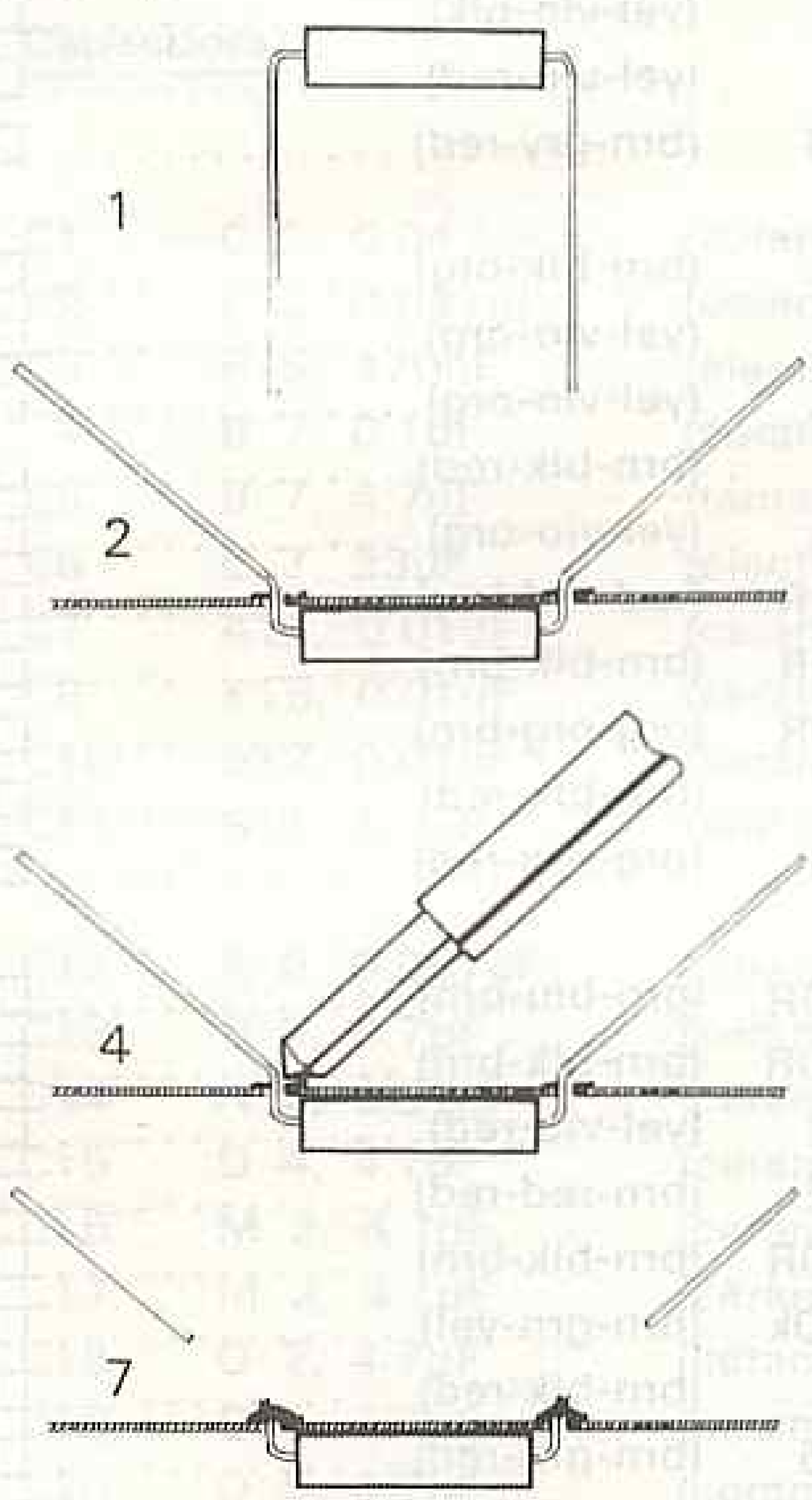
The printed circuit boards are connected to the other components using hookup wire. Usually PC pins will be used to simplify connection. To connect to these first strip 5mm of insulation from the wire, tin the end (tinning is simply coating with solder) and the PC pin. Hold the wire against the pin and re-melt the solder. Hold still until the joint is solid.

When connecting wires to switches, potentiometers and terminals first strip and tin them as above; put a 90° bend in the stripped end and hook it through the terminal. Do not wrap it around the terminal or it will be difficult to remove if necessary.

COMPONENT DRESS

Dress is the name given to the neat layout of parts. Whilst it is not essential, neat consistent layout and construction makes any fault-finding much simpler, as well as producing a more professional and reliable finished product.

Bend leads to fit their PCB holes accurately, using long-nose pliers. This means easier installation and less strain on the point where the lead enters the component. All components except transistors should sit right on the board. Line up all resistors so that their colour codes can be easily read. Position capacitors so that their values can be read (except polarised types, which must go in the direction indicated).



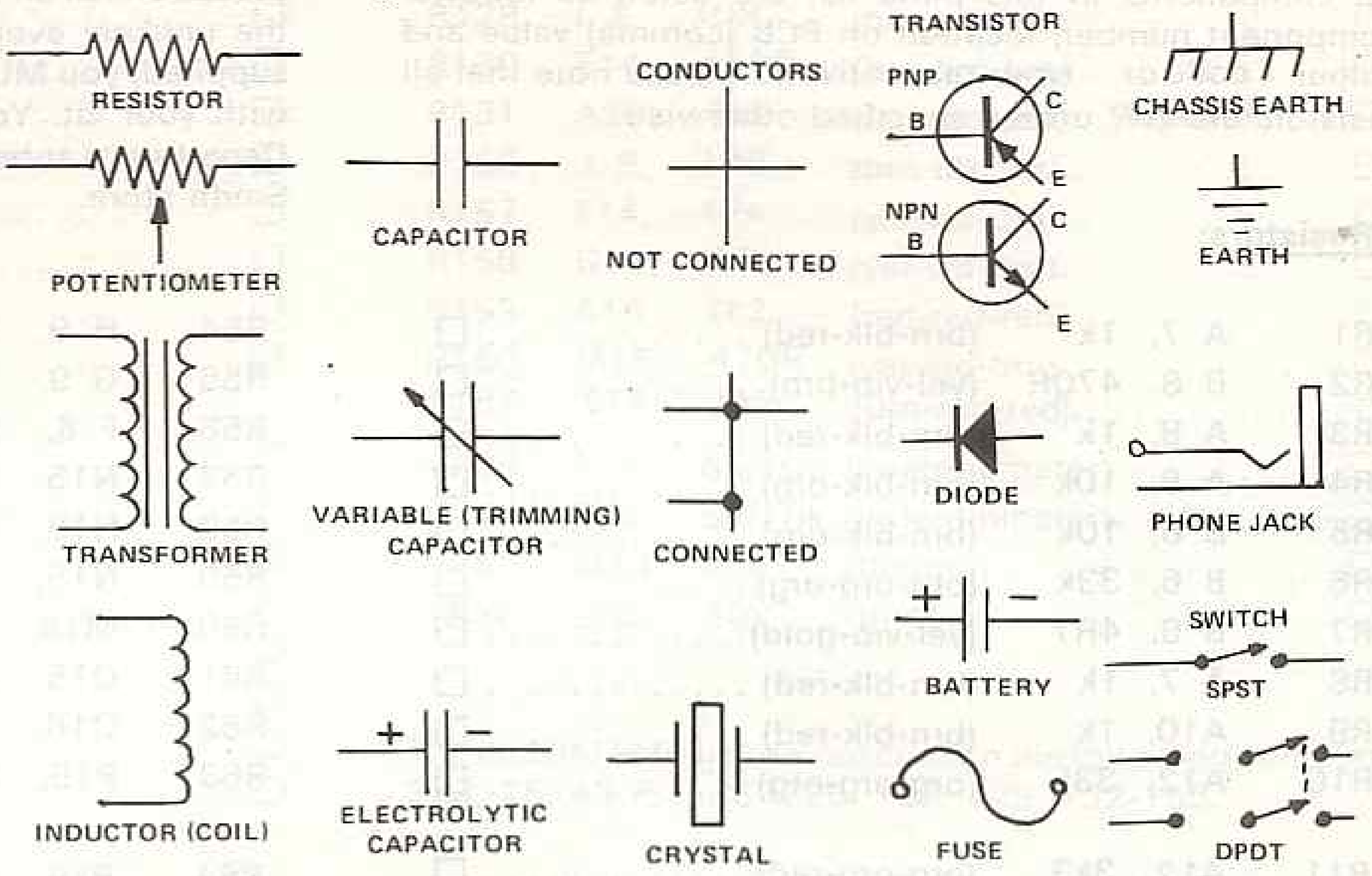
USING A MULTIMETER

A multimeter is indispensable for testing and troubleshooting circuits. These notes will help you to use it effectively.

A typical multimeter measures volt (AC & DC), resistance and DC current.

SCHEMATIC DIAGRAMS

These are the commonly used symbols for components on schematic diagrams.



To measure voltages, set the multimeter's range switch to the next voltage range higher than the voltage you want to measure. For example, to measure six volts, set the switch to ten volts. If you don't know what the voltage should be, set the switch to the highest voltage range (AC or DC) and measure the voltage. If it barely moves the needle, move the switch to the next range down. Do this until the needle falls around the middle of the scale.

Always make sure that you have set the meter to AC or DC as needed. Transformers and mains wiring are AC, transistor circuits are DC. When measuring DC, the red lead must be connected to the positive side, and the black to the negative. If the needle swings to the left, you have them the wrong way around.

RESISTANCE MEASUREMENTS

When measuring resistance always make sure that no power is applied to the circuit or you will damage the meter or get a false reading.

The most important thing to remember when measuring resistance is to make sure the meter is properly 'zeroed'. To zero the meter, set it in the appropriate range ('ohms x 1') and hold the two probe tips together. Now adjust the knob labelled 'ohms adjust' until the meter needle is sitting over the zero mark on the right hand side of the meter scale. Notice that the ohms scale reads from right to left.

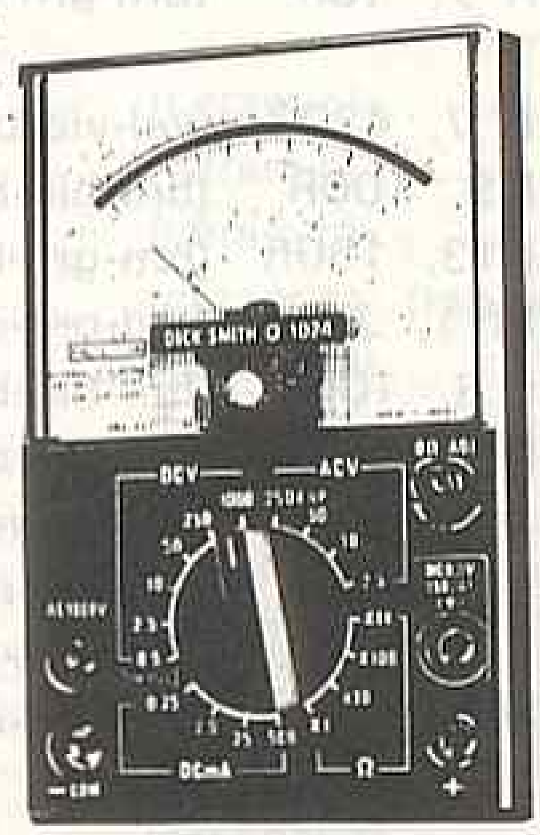
CURRENT MEASUREMENTS

To measure current, the point you wish to measure will have to be separated, as the meter will only measure current in series with the circuit. Adjust the range switch as for voltage measurements – start with the highest range and work down.

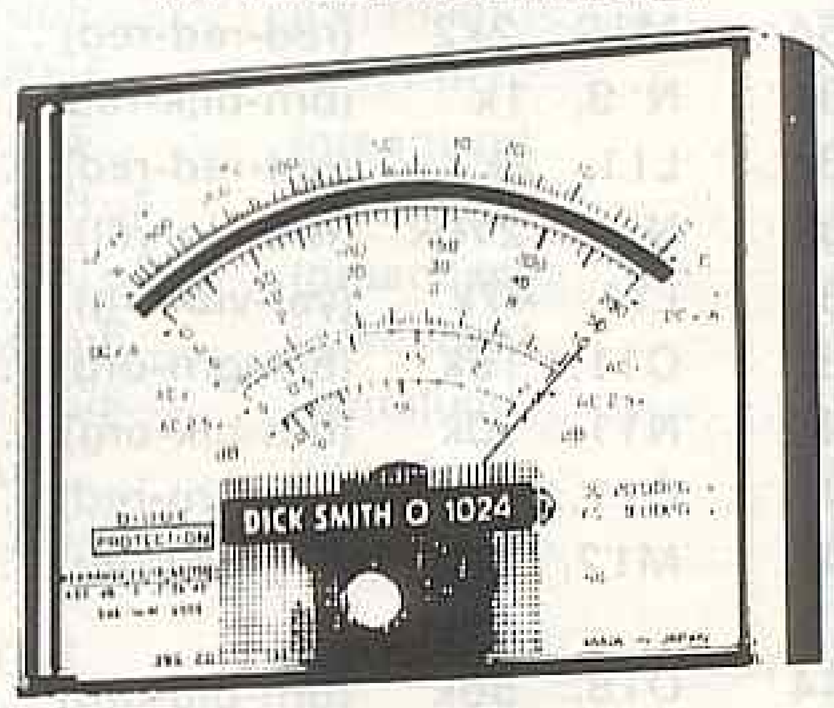
GENERAL RULES

– Check the position of the range switch before every measurement. Multimeters will NOT take much abuse (such as connecting to the mains on the ohms range!)

– Make sure that you're reading the right scale of the meter. These will be identified similarly to the range switch.



A TYPICAL MULTIMETER



A MULTIMETER CORRECTLY ZEROED FOR MEASURING RESISTANCE.

– Keep the meter flat when measuring, and read the scale from directly above – if your meter has a mirrored scale, line the needle up with its reflection. This will minimise reading errors.

– Re-zero the needle every time you measure resistance.

Parts List & Component Locations (on PCB)

(Please refer to page 17 for introductory information.)

All components in this parts list are listed as follows: component number, location on PCB (comma) value and colour code or type, respectively. Please note that all resistors are ¼W unless specified otherwise.

Please check all the parts in the kit against this parts list. In the unlikely event of a part being missing or incorrectly supplied, you MUST use the Quality Control Card included with your kit. You can send the card directly to the Kit Department at head office or drop it in at your nearest Dick Smith store.

Resistors:

R1	A 7,	1k	(brn-blk-red)	□
R2	B 8,	470R	(yel-vio-brn)	□
R3	A 9,	1k	(brn-blk-red)	□
R4	A 8,	10k	(brn-blk-org)	□
R5	B 8,	10k	(brn-blk-org)	□
R6	B 6,	33k	(org-org-org)	□
R7	B 6,	4R7	(yel-vio-gold)	□
R8	A 7,	1k	(brn-blk-red)	□
R9	A10,	1k	(brn-blk-red)	□
R10	A12,	33k	(org-org-org)	□
R11	A12,	3k3	(org-org-red)	□
R12	O 5,	820R	(gry-red-brn)	□
R13	N 1,	4k7	(yel-vio-red)	□
R14	M 6,	56k	(grn-blu-org)	□
R15	L 7,	470R	(yel-vio-brn)	□
R16	L 6,	22R	(red-red-blk)	□
R17	K 9,	100R	(brn-blk-brn)	□
R18	G 6,	10R	(brn-blk-blk)	□
R19	I 7,	1k5	(brn-grn-red)	□
R20	H 7,	15k	(brn-grn-org)	□
R21	H 7,	470R	(yel-vio-brn)	□
R22	I 9,	100R	(brn-blk-brn)	□
R24	N13,	150R	(brn-grn-brn)½W	□
R25	M11,	22k	(red-red-org)	□
R27	L 8,	10R	(brn-blk-blk)	□
R28	N 8,	82k	(gry-red-org)	□
R29	O10,	4k7	(yel-vio-red)	□
R30	K17,	6k8	(blu-gry-red)	□
R31	L 9,	100k	(brn-blk-yel)	□
R32	M10,	1k5	(brn-grn-red)	□
R33	K12,	220k	(red-red-yel)	□
R34	M12,	2k2	(red-red-red)	□
R35	N 9,	1k	(brn-bl;k-red)	□
R36	L11,	2k2	(red-red-red)	□
R37	N10,	270k	(red-vio-yel)	□
R38	L11,	47k	(yel-vio-org)	□
R39	O11,	15k	(brn-grn-org)	□
R40	N11,	10k	(brn-blk-org)	□
R41	O11,	1k5	(brn-grn-red)	□
R42	M12,	33k	(org-org-org)	□
R44	O18,	56k	(grn-blu-org)	□
R45	P19,	220k	(red-red-yel)	□
R46	O18,	47k	(yel-vio-org)	□
R47	N20,	220R	(red-red-brn)	□
R48	O19,	5k6	(grn-blu-red)	□
R49	N19,	18R	(brn-gry-blk)	□
R50	M19,	2R2	(red-red-gold)	□
R51	N19,	2R2	(red-red-gold)	□
R52	M20,	220R	(red-red-brn)	□
R53	F10,	1k5	(brn-grn-red)	□
R54	H 9,	100R	(brn-blk-brn)	□
R55	G 9,	15k	(brn-grn-org)	□
R56	F 8,	330R	(org-org-brn)	□
R57	N15,	82k	(gry-red-org)	□
R58	N16,	100k	(brn-blk-yel)	□
R59	N15,	5k6	(grn-blu-red)	□
R60	M15,	560R	(grn-blu-brn)	□
R61	O15,	22k	(red-red-org)	□
R62	O16,	15k	(brn-grn-org)	□
R63	P15,	39k	(org-wht-org)	□
R64	P16,	100k	(brn-blk-yel)	□
R65	O15,	56k	(grn-blu-org)	□
R66	O14,	56k	(grn-blu-org)	□
R68	K14,	15k	(brn-grn-org)	□
R69	J13,	1k	(brn-blk-red)	□
R70	J13,	47k	(yel-vio-org)	□
R71	I12,	4k7	(yel-vio-red)	□
R72	I11,	47R	(yel-vio-blk)	□
R73	I12,	4k7	(yel-vio-red)	□
R74	H11,	1k8	(brn-gry-red)	□
R75	H11,	10k	(brn-blk-org)	□
R76	J15,	47k	(yel-vio-org)	□
R77	G11,	47k	(yel-vio-org)	□
R78	F12,	1k	(brn-blk-red)	□
R79	G12,	47k	(yel-vio-org)	□
R80	F11,	220R	(red-red-brn)	□
R81	F12,	100R	(brn-blk-brn)	□
R82	F13,	330R	(org-org-brn)	□
R83	F14,	1k	(brn-blk-red)	□
R84	L17,	3k3	(org-org-red)	□
R85	L16,	560R	(grn-blu-brn)	□
R87	E12,	100R	(brn-blk-brn)	□
R88	E12,	4k7	(yel-vio-red)	□
R89	E12,	1k2	(brn-red-red)	□
R90	F11,	100R	(brn-blk-brn)	□
R91	D15,	150k	(brn-grn-yel)	□
R92	E15,	1k	(brn-blk-red)	□
R93	H15,	1k5	(brn-grn-red)	□
R94	D10,	10R	(brn-blk-blk)	□
R95	D12,	1k5	(brn-grn-red)	□
R96	D12,	2k2	(red-red-red)	□
R97	G15,	220k	(red-red-yel)	□
R98	C12,	15R	(brn-grn-blk)	□
R99	C10,	2k2	(red-red-red) ⅛W	□
R100	C 9,	270R	(red-vio-brn) ⅛W	□
R101	E10,	10R	(brn-blk-blk) ⅛W	□
R102	F13,	220R	(red-red-brn)	□
R103	E 5,	270R	(red-vio-brn)	□
R104	C 4,	220R	(red-red-brn)	□
R105	E 4,	3k3	(org-org-red)	□

R106	H 5,	120R	(brn-red-brn)	☐
R107	J 5,	120R	(brn-red-brn)	☐
R108	L 2,	10R	(brn-blk-blk)	☐
R109	A17,	2k2	(red-red-red)	☐
R110	A19,	2k2	(red-red-red)	☐
R111	B16,	470R	(yel-vio-brn)part of L27	☐
R112	C16,	6k8	(blu-gry-red)	☐
R113	C17,	4k7	(yel-vio-red)	☐
R114	C14,	2k2	(red-red-red)	☐
R115	C15,	22R	(red-red-blk)	☐
R116	D16,	1k2	(brn-red-red)	☐
R117	I20,	15k	(brn-grn-org)	☐
R118	I18,	15k	(brn-grn-org)	☐
R119	J19,	1k5	(brn-grn-red)	☐
R120	I18,	100R	(brn-blk-brn)	☐
R121	H14,	470R	(yel-vio-brn)	☐
R122	G14,	180R	(brn-gry-brn)	☐
R123	H15,	100R	(brn-blk-brn)	☐
R124	F15,	3k3	(org-org-red)	☐
R125	D14,	150R	(brn-grn-brn)	☐
R128	2,	10R	(brn-blk-blk)	☐
R130	E14,	150R	(brn-grn-brn)	☐
R131	A20,	2k2	(red-red-red) . . (repeater)	☐
R156	J 9,	10R	(brn-blk-blk)	☐
R157	F14,	47k	(yel-vio-org)	☐
R158	G14,	47k	(yel-vio-org)	☐
R159	A16,	2k2	(red-red-red)	☐
R160	M15,	470R	(yel-vio-brn)	☐
R161	E17,	1k2	(brn-red-red)	☐
VR26	N/A,	5k/10k	(potentiometer)	☐
VR43	N/A,	5k/10k	(potentiometer)	☐
VR67	M14,	10k	(trimpot)	☐
VR86	L16,	10k	(trimpot)	☐

The resistor listing does not contain the following numbers: R23, 26, 43, 67, 86, 126, 127, 129, 132-155.

Capacitors:

C1	C 3,	0.047uF	(ceramic)	☐
C2	C 2,	0.047uF	(ceramic)	☐
C3	B 5,	470uF	(electro)	☐
C4	B 7,	0.1uF	(ceramic)	☐
C5	B 7,	4.7uF	(tantalum)	☐
C6	C 7,	33uF	(electro)	☐
C7	A11,	0.01uF	(ceramic)	☐
C9	K15,	0.01uF	(ceramic)	☐
C10	B12,	0.01uF	(ceramic)	☐
C11	B11,	4.7uF	(tantalum)	☐
C12	A 6,	0.001uF	(ceramic)	☐
C13	O 3,	4.7pF	(ceramic)	☐
C14	N 5,	0.01uF	(ceramic)	☐
C15	O 4,	4.7pF	(ceramic)	☐
C16	M 3,	4.7pF	(ceramic)	☐
C17	M 2,	4.7pF	(ceramic)	☐
C18	O 2,	4.7pF	(ceramic)	☐
C19	O 4,	4.7pF	(ceramic)	☐
C20	O 5,	4.7pF	(ceramic)	☐
C21	O 6,	4.7pF	(ceramic)	☐
C22	P 8,	0.01uF	(ceramic)	☐
C23	O 6,	47pF	(ceramic)	☐
C24	O 1,	47pF	(ceramic)	☐
C26	M 7,	0.001uF	(ceramic)	☐
C27	M 6,	47pF	(ceramic)	☐
C28	K 7,	47pF	(ceramic)	☐
C29	L 8,	0.01uF	(ceramic)	☐
C30	G14,	0.01uF	(ceramic)	☐
C31	J 9,	0.01uF	(ceramic)	☐
C32	I 7,	0.001uF	(ceramic)	☐
C33	H 6,	1.5pF	(ceramic)	☐
C34	G 7,	0.01uF	(ceramic)	☐
C35	I 9,	0.01uF	(ceramic)	☐
C36	J 8,	2.2pF	(ceramic) . (repeater)	☐
C37	N 9,	10uF	(tantalum)	☐
C38	M12,	0.1uF	(greencap)	☐
C39	M 9,	56pF	(ceramic)	☐
C40	L 9,	82pF	(ceramic)	☐
C41	L11,	0.01uF	(ceramic)	☐
C42	L10,	0.047uF	(greencap)	☐
C43	L11,	0.047uF	(greencap)	☐
C44	M11,	10pF	(ceramic)	☐
C45	K18,	470uF	(electro)	☐
C46	O10,	0.1uF	(greencap)	☐
C47	O10,	0.001uF	(greencap)	☐
C48	O10,	0.001uF	(greencap)	☐
C49	O11,	0.01uF	(greencap)	☐
C50	N17,	0.22uF	(tantalum)	☐
C51	N12,	1uF	(tantalum)	☐
C52	P19,	0.22uF	(tantalum)	☐
C53	O20,	10uF	(tantalum)	☐
C54	O18,	0.1uF	(greencap)	☐
C55	N19,	0.01uF	(greencap)	☐
C56	M19,	220uF	(electro)	☐
C57	F10,	4.7pF	(ceramic)	☐
C59	F 9,	2200pF	(ceramic)	☐
C60	G 9,	2200pF	(ceramic)	☐
C62	G 9,	3.3pF	(ceramic)	☐
C64	F10,	22pF	(ceramic)	☐
C65	P15,	10uF	(tantalum)	☐

C66	N17, 0.001uF	(ceramic)	....	☐
C67	O17, 0.001uF	(ceramic)	....	☐
C68	O16, 22uF	(tantalum)	....	☐
C69	O16, 0.01uF	(ceramic)	....	☐
C70	N14, 2200pF	(ceramic)	....	☐
C71	M15, 270pF	(ceramic) small	......	☐
C72	J13, 2200pF	(ceramic)	....	☐
C73	J13, 0.001uF	(ceramic)	....	☐
C74	H10, 0.01uF	(ceramic)	....	☐
C75	I13, 0.01uF	(ceramic)	....	☐
C76	I11, 4700pF	(ceramic)	....	☐
C77	J12, 5.6pF	(ceramic) NPO	....	☐
C78	I12, 5.6pF	(ceramic) NPO	....	☐
C79	J12, 5.6pF	(ceramic) NPO	....	☐
C80	I11, 4.7pF	(ceramic) NPO	....	☐
C81	I11, 3.3pF	(ceramic) NPO	....	☐
C82	H12, 0.01uF	(ceramic)	....	☐
C83	H11, 68pF	(ceramic)	....	☐
C84	G10, 47uF	(electro)	....	☐
C85	J15, 1uF	(tantalum)	....	☐
C86	H11, 0.01uF	(ceramic)	....	☐
C87	F11, 0.01uF	(ceramic)	....	☐
C88	G12, 10pF	(ceramic)	....	☐
C89	F12, 0.01uF	(ceramic)	....	☐
C90	F14, 1pF	(ceramic)	....	☐
C91	F12, 10pF	(ceramic)	....	☐
C92	E14, 0.01uF	(ceramic)	....	☐
C93	E15, 3.3pF	(ceramic)	....	☐
C94	D13, 0.01uF	(ceramic)	....	☐
C95	D12, 0.01uF	(ceramic)	....	☐
C96	F11, 0.01uF	(ceramic)	....	☐
C97	F11, 4.7pF	(ceramic)	....	☐
C98	D11, 68pF	(ceramic)	....	☐
C99	C12, 18pF	(ceramic)	....	☐
C100	C12, 0.01uF	(ceramic)	....	☐
C101	D10, 18pF	(ceramic)	....	☐
C102	C10, 0.01uF	(ceramic)	....	☐
C103	B10, 4.7uF	(tantalum)	....	☐
C104	D10, 39pF	(ceramic)	....	☐
C105	C 9, 100pF	(ceramic) small	......	☐
C106	C 8, 0.01uF	(ceramic)	....	☐
C107	D 8, 15pF	(ceramic) small	......	☐
C108	D 6, 5.6pF	(ceramic) NPO	....	☐
C109	E 6, 20pF	(trimmer)	....	☐
C110	C 5, 0.01uF	(ceramic)	....	☐
C111	E 4, 0.001uF	(ceramic)	....	☐
C112	E 3, 0.001uF	(ceramic)	....	☐
C113	H 2, 0.01uF	(ceramic)	....	☐
C114	E 2, 10uF	(tantalum)	....	☐
C115	F 2, 100pF	(ceramic)	....	☐
C116	I 2, 0.001uF	(ceramic)	....	☐
C117	F 4, 33pF	(ceramic) small	......	☐
C118	G 3, 20pF	(trimmer)	....	☐
C119	J 2, 0.1uF	(greencap)	....	☐
C120	I 3, 22pF	(ceramic) small	......	☐
C121	J 1, 0.1uF	(ceramic)	....	☐
C122	L 3, 0.1uF	(greencap)	....	☐
C123	K 3, 0.001uF	(ceramic)	....	☐
C124	K 4, 22pF	(ceramic) small	......	☐
C125	J 3, 20pF	(trimmer)	....	☐
C126	M 4, 20pF	(trimmer)	....	☐
C127	M 5, 20pF	(trimmer)	....	☐
C128	E15, 180pF	(ceramic)	....	☐
C129	E15, 0.047uF	(ceramic)	....	☐
C132	H14, 180pF	(ceramic)	....	☐
C133	G15, 0.01uF	(ceramic)	....	☐
C134	C17, 20pF	(trimmer)	....	☐
C135	C18, 15pF	(ceramic) NPO	....	☐
C136	C18, 20pF	(trimmer)	....	☐
C137	C19, 15pF	(ceramic) NPO	....	☐
C138	A17, 0.01uF	(ceramic)	....	☐
C139	C16, 4700pF	(ceramic)	....	☐
C140	B15, 0.01uF	(ceramic)	....	☐
C141	C16, 27pF	(ceramic)	....	☐
C142	D16, 47pF	(ceramic)	....	☐
C143	C15, 12pF	(ceramic)	....	☐
C144	H19, 33pF	(ceramic)	....	☐
C145	J19, 560pF	(ceramic)	....	☐
C146	J19, 150pF	(ceramic)	....	☐
C147	I19, 0.01uF	(ceramic)	....	☐
C148	G16, .001uF	(ceramic)	....	☐
C149	I14, 1uF	(tantalum)	....	☐
C150	F14, 10uF	(tantalum)	....	☐
C151	I17, 1uF	(tantalum)	....	☐
C152	D13, 47uF	(electro)	....	☐
C153	I17, 22uF	(tantalum)	....	☐
C154	H17, 10uF	(tantalum)	....	☐
C155	G17, 0.047uF	(ceramic)	....	☐
C156	J 9, 0.01uF	(ceramic)	....	☐
C157	L10, 0.1uF	(ceramic)	....	☐
C158	M 8, 0.1uF	(greencap)	....	☐
C159	N 9, 0.1uF	(ceramic)	....	☐
C160	E13, 0.01uF	(ceramic)	....	☐
C161	M17, 0.1uF	(ceramic)	....	☐
C162	E13, 2200pF	(ceramic)	....	☐
C163	D 5, 5.6pF	(ceramic) NPO	....	☐
C164	D 5, 5.6pF	(ceramic) NPO	....	☐
C165	D 5, 5.6pF	(ceramic) NPO	....	☐
C166	A16, 0.01uF	(ceramic)	....	☐
C167	C19, 20pF	(trimmer)	..(repeater).	☐
C168	A20, 0.01uF	(ceramic)	..(repeater).	☐
C169	C20, 15pF NPO	(ceramic)	..(repeater).	☐

The capacitor listing does not contain the following numbers:
C25, 58, 61, 63, 130, 131
C8

Integrated Circuits

IC1	F16, PLL02A	....	☐
IC2	M10, MC3357	....	☐

Diodes

D1	B 4,	1N4002	(diode)	☐
D2	A 9,	5V6 (400mW)	(zener)	☐
D3	A 9,	1N914/4148	(diode)	☐
D4	B12,	1N914/4148	(diode)	☐
D5	B 7,	1N914/4148	(diode)	☐
D6	N 4,	BA244	(diode)	☐
D7	O 4,	BA244	(diode)	☐
D9	M12,	5V6(400mW)	(zener)	☐
D10	O 9,	1N914/4148	(diode)	☐
D11	N20,	1N914/4148	(diode)	☐
D12	O16,	1N914/4148	(diode)	☐
D13	P16,	1N914/4148	(diode)	☐
D14	J12,	BB122	(varicap diode)	☐
D15	H12,	BB122	(varicap diode)	☐
D16	K16,	1N914/4148	(diode)	☐
D17	J16,	1N914/4148	(diode)	☐
D17A	C 9,	1N914/4148	(diode)	☐
D18	D 6,	1N914/4148	(diode)	☐
D19	E 4,	5V6 (400mW)	(zener)	☐
D20	B17,	BA244	(diode)	☐
D21	B18,	BA244	(diode)	☐
D22	H17,	5V6 (400mW)	(zener)	☐
D23	B19,	BA244	(diode) . (repeater)	☐

Transistors

Q1	A 8,	BD140	☐
Q2	B 8,	BC107/547	☐
*Q3	B 6,	BC327/328/640/2N3905	☐
Q4	A10,	BC337/639	☐
Q5	B12,	BC157/557	☐
Q6	M 6,	BFR91	☐
Q7	H 7,	BFR90/91	☐
Q8	K11,	BC547	☐
Q9	O19,	BC548	☐
Q10	N18,	BC558	☐
Q11	N18,	BC337/639	☐
*Q12	N20,	BC327/328/640/2N3905	☐
Q13	F 9,	2SC1674	☐
Q14	N16,	BC548	☐
Q15	N15,	BC548	☐
Q16	N14,	BC558	☐
Q17	I11,	2SK125	☐
Q18	G11,	MFE 131 or 3SK40	☐
Q19	F14,	MFE 131 or 3SK40	☐
Q20	E11,	2SC1674	☐
Q21	E15,	2SC1674	☐
Q22	C11,	2SC2053	☐
Q23	G14,	BC548	☐
Q24	D 9,	2N3948	☐
Q25	E 5,	MRF629	☐
Q26	I 4,	MRF629	☐
Q27	K 5,	MRF660	☐
Q28	C16,	2SC1674	☐
Q29	I19,	BC547	☐
Q30	H16,	BC547	☐

Inductors

L1	B 2,	DC choke	☐
L2	N 4,	11T ECW 25 B&S on ⅛" former	☐
L3	O 3,	2T 20B&S on ⅛" former	☐
L4	N 3,	2T 20 B&S ⅛ diam. airwound	☐
L5	N 2,	2T 20 B&S ⅛ diam. airwound	☐
L6	N 2,	2T 20 B&S ⅛ diam. airwound	☐
L7	O 4,	2T 20 B&S ⅛ diam. airwound	☐
L8	P 7,	1T 25 B&S on ferrite bead	☐
L9	O 6,	2T 20 B&S ⅛ diam. airwound	☐
L10	L12	455kHz coil (white or yellow slug)	☐
L11	G 9,	4T 25 B&S on ⅛" former	☐
L12	J11,	red coil VCO	☐
L13	G12,	150MHz coil 10GP0045	☐
L14	E11,	150MHz coil 10GP0045	☐
L15	E14,	4T 25 B&S on ⅛" former	☐
L16	G15,	10uH coil	☐
L17	C11,	red coil 150MHz AMP	☐
L18	C 8,	2T 25 B&S ⅛" diam.stretched	☐
L19	D 6,	hairpin 20 B&S 3/16 diam	☐
L20	D 5,	hairpin 20 B&S 3/16 diam	☐
L21	D 4,	hairpin 20 B&S 3/16 diam	☐
L21A	E 5,	hairpin 20 B&S 3/16 diam	☐
L22	G 4,	hairpin 20 B&S 3/16 diam	☐
L23	G 5,	8T 25 B&S ⅛ diam (RFC)	☐
L24	J 5,	8T 25 B&S ⅛ diam (RFC)	☐
**L25	K 4,	(under PCB)	☐
L26	L 4,	1T 20 B&S 3/16 diam airwound	☐
L27	B16,	24T 33 B&S wound on R111	☐
L28	D15,	150MHz coil 10GP0045	☐
L29	C 8,	1T 25 B&S on ferrite bead (RFC)	☐
L30	G 2,	1T 25 B&S on ferrite bead (RFC)	☐
L31	I 3,	20 B&S wire link	☐
L32	F 3,	1T 25 B&S on ferrite bead (RFC)	☐
L34	H 8,	10.7MHz coil 10mA015S	☐

Please note that you have been supplied copper wire to wind some of these inductors yourself. You should, therefore only tick (✓) these when you have actually wound them. **You'll find winding details on page 13.**

* Check that the BC328 transistor supplied is the correct type. If a 2N3905 (the electrical equivalent) has been supplied, the collector and emitter leads must be reversed.

** Please note L25 at location K4. This coil is actually the base lead of Q27 so please do not shorten this lead.

Helical resonators

H1	N 6,	1506 helical resonator	☐
H2	J 7,	1506 helical resonator	☐
H3	G 7,	1506 helical resonator	☐
H4	D 7,	1506 helical resonator	☐

RF chokes

RFC2	B 9,	link 25 B&S thru ferrite bead	☐
RFC3	F 4,	20 B&S wire link	☐
RFC4	I 2,	1T 25 B&S on ferrite bead (RFC)	☐
RFC5	L 3,	6-hole ferrite choke	☐
RFC6	K 2,	20 B&S wire link	☐

Filters

FL1	J 8,	10.7MHz filter	☐
FL1a	K 8,	10.7MHz filter. (repeater)	☐
FL2	K11,	455kHz filter	☐

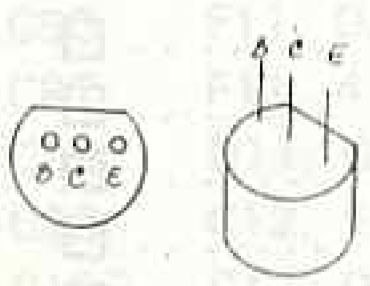
Crystals

X1	B17,	xtal 47.86110MHz	☐
X2	B18,	xtal 46.67222MHz	☐
X3	I19,	xtal 8.5333MHz	☐
X4	L 9,	xtal 10.245MHz	☐
X5	B19,	xtal 47.3055MHz .(repeater)	☐

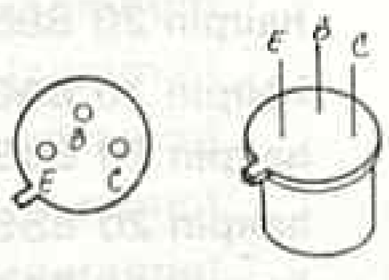
Miscellaneous Parts List

transformer wax	☐
a length of 12 core cable	☐
PCB pins (around 40)	☐
In line fuse holder	☐
solder	☐
microphone	☐
case and screws	☐
speaker	☐
front panel	☐
back panel	☐
mounting bracket	☐
thumbscrews	☐
nuts	☐
microphone plug	☐
microphone socket	☐
channel switch	☐
dial plate	☐
knobs for front panel	☐
heatsinks	☐
antenna	☐

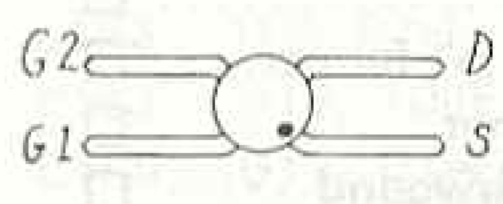
TRANSISTOR PIN OUTS



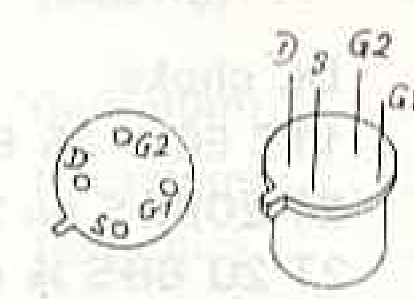
2SC2053



2N3948

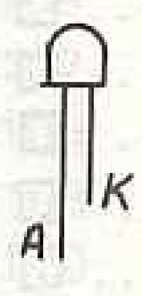


MEM631

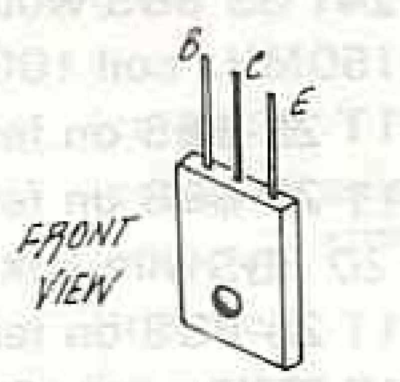


3SK40

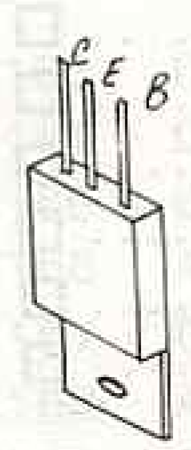
You may be supplied with either of these two transistors. They are both compatible and they both can be used in the circuit board.



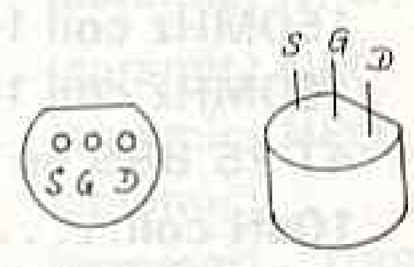
LED



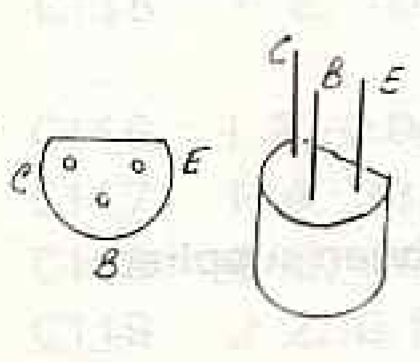
BD140



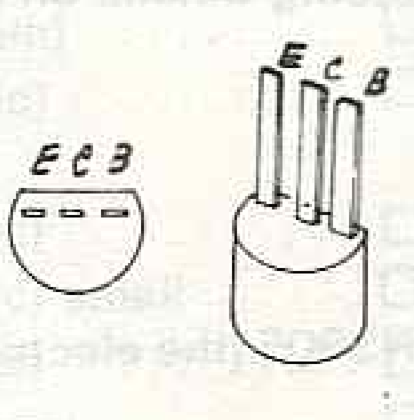
MRF660



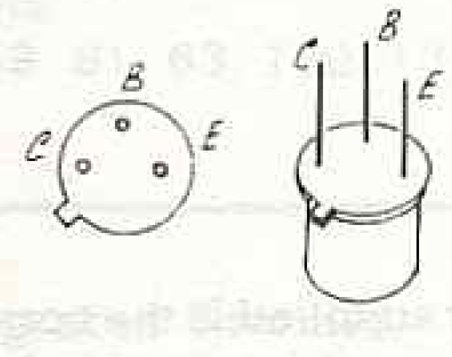
2SK125



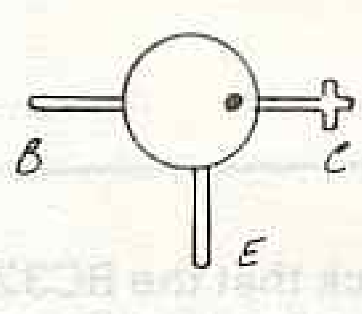
BC547/557/327



2SC1674



MRF629



BFR90/91

You will find that we have specified four different gauges and to make things easier for you, we now explain the differences.

Firstly, there are two distinctly different wires: a plain tinned wire and another copper-coloured type. The copper wire is actually enamelled with an insulating layer which needs to be scraped off before soldering.

Now to the gauges:

33 B&S is the thin enamelled wire (0.1799mm).

25 B&S is the thicker enamelled wire (0.4548)

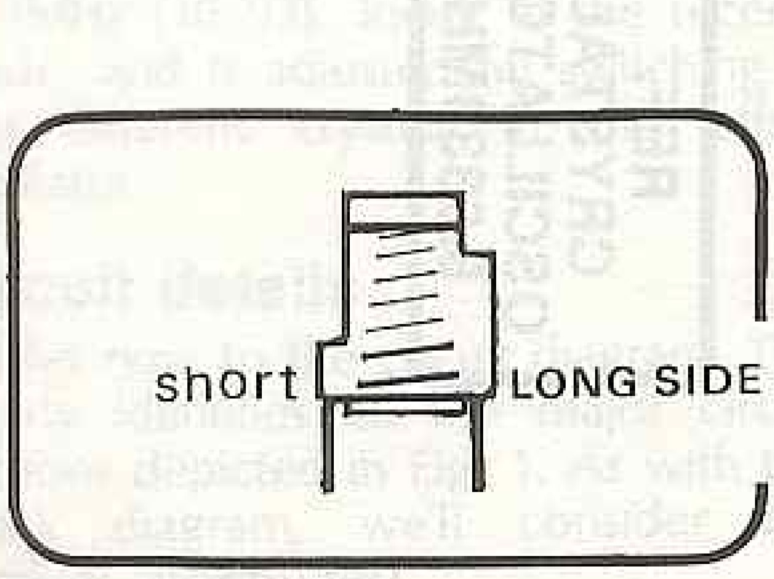
20 B&S is the thicker tinned copper wire (0.9119mm)

As explained elsewhere in this manual, it is good practice to wind the coils before checking them off against the parts list. The details for winding these coils are shown on the right.

The coils are specified in a number of ways, including 3mm airwound. What this actually means is the coil is wound on a 3mm drill bit or similar, then the drill is removed. The coil stands in free air rather than on a former.

If you look at L17 and L12 (red coils), you will notice that they are polarized with one long lug and one short lug. The diagram below will make it clearer.

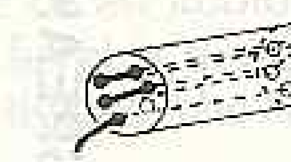
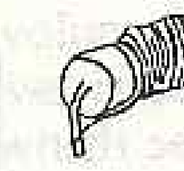
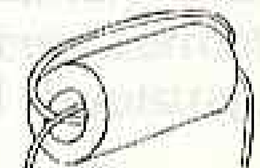
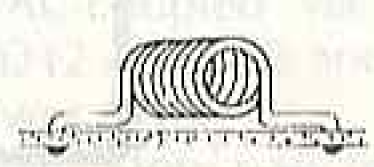
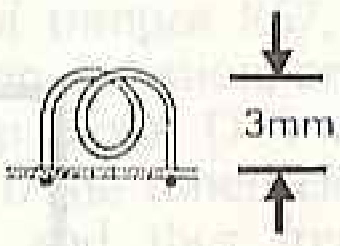
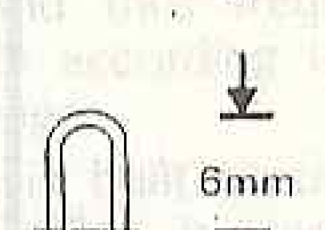
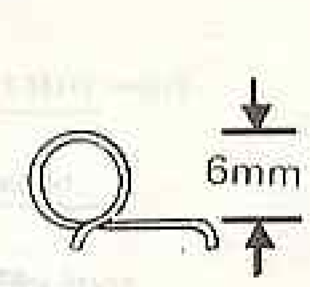
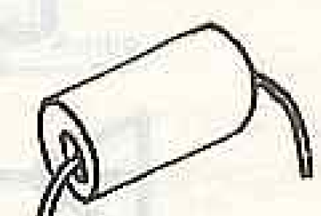
On L12, sitting in the VCO section, the long lug faces the rear of the unit, while L17, at location C11, the long lug faces the left-hand edge of the PCB.



L12/L17

Note: Winding details for L18 apply to the wire portion of L18 only. L18 is actually a tapped coil half of which is PCB foil.

COIL WINDING DETAILS

RFC5	6-hole ferrite choke using 25 B&S		
L27	33 B&S En/Cu	24T wound on R111	
L2	25 B&S En/Cu on 3mm former close wound	11T	
RFC 4 L8, 29, 30, 32	25 B&S En/Cu on ferrite bead	1T	
L11, 15	25 B&S En/Cu airwound 3mm close wound	4T	
L18	25 B&S En/Cu 3mm diam. stretched	2T	
L23, 24	25 B&S En/Cu airwound 3mm former close wound	8T	
L3, 4, 5, 6, 7, 9	20 B&S airwound 3mm former stretched tinned/Cu	2T	
L19, 20, 21, 22, 26	20 B&S	Hairpin	
L21A	20 B&S	1T	
L31 RFC 3 RFC 6	20 B&S	Link	
RFC 2	25 B&S (link through ferrite bead)		

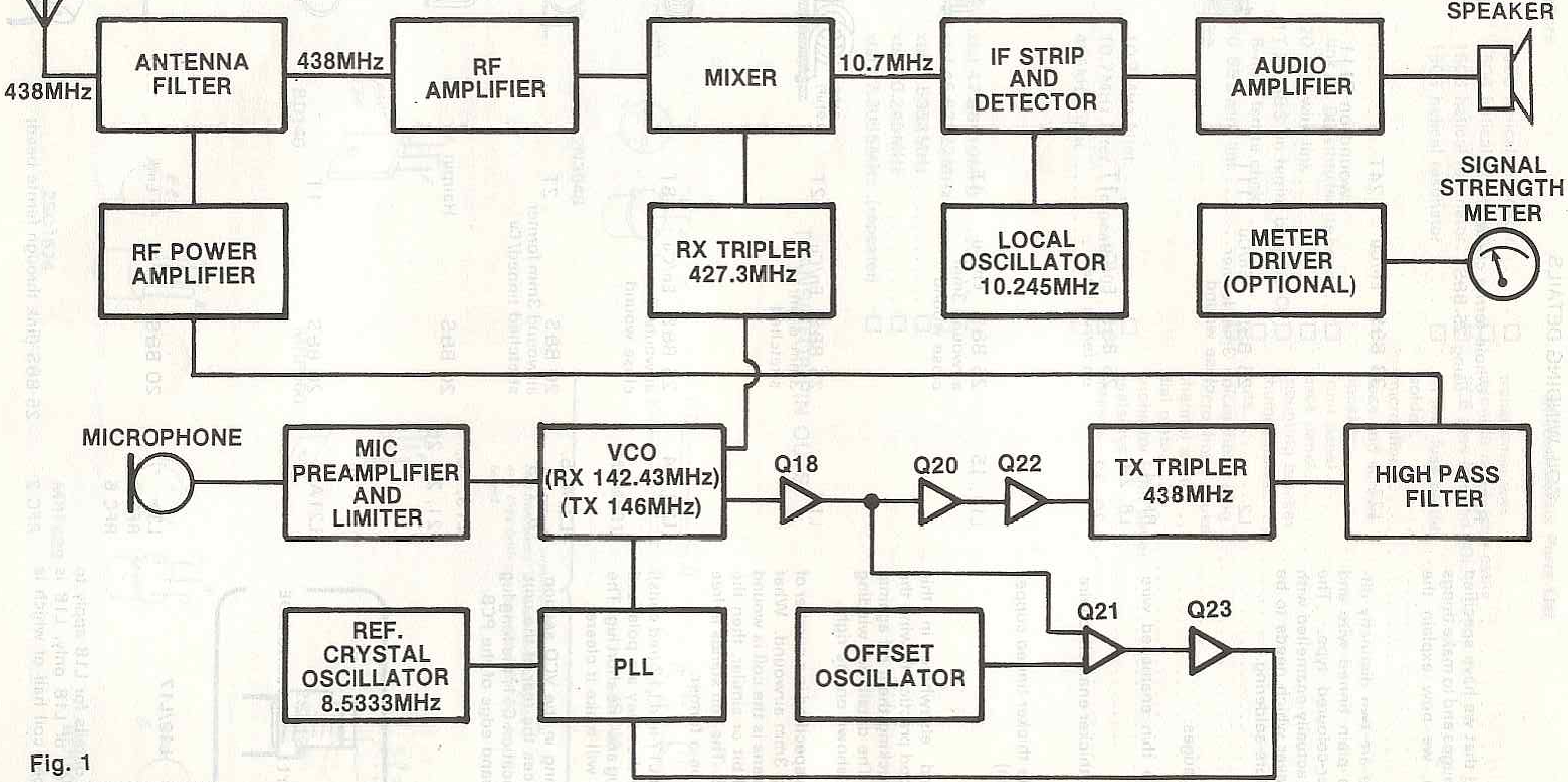


Fig. 1
BLOCK DIAGRAM

How it works

By now, some constructors will have taken a peek at the circuit diagram and blanched. But don't be intimidated. Let's go through the circuit logically, block by block, and see how it works.

Fig. 1 shows the basic building blocks of the new transceiver. The first thing to note is that both the receiver and transmitter sections employ a frequency synthesiser which comprises a phase lock loop (PLL) and frequency dividers to provide 40 crystal-locked channels. An 8.5333MHz crystal oscillator provides the reference frequency for the PLL which, together with the offset oscillator, sets the centre frequency of the voltage controlled oscillator (VCO).

Note that the 438MHz and related VCO and Rx (receive) tripler frequencies marked on Fig. 1 are nominal values only. The 438MHz frequency has been chosen merely to serve as an example.

The receiver employs a double conversion superhet circuit with limiting IF amplifiers and a quadrature detector for the FM mode. As shown, the incoming 438MHz signal is first passed through a filter network. It is then amplified and mixed with the tripled VCO frequency to produce a 10.7MHz IF.

This 10.7MHz IF is now fed to the IF strip which in conjunction with a 10.245MHz local oscillator circuit provides second conversion to 455kHz. The signal then passes to the limiters and quadrature detector circuit and finally to the audio amplifier.

In the transmit mode, the offset oscillator and PLL set the VCO centre frequency to 146MHz. The output of the VCO is then amplified and tripled to 438MHz before passing to a high pass filter and the RF power amplifier stage. Finally, the signal is fed to the antenna filter circuit and thence to the antenna.

Note that the VCO runs at two different frequencies: 142.43MHz in the receive mode, and 146MHz in the transmit mode. The reason for this is that, in the receive mode, it is necessary for the Rx tripler to provide 10.7MHz offset frequency. Thus, the VCO runs 3.57MHz (10.7/3) lower in the receive mode, and is adjusted by switching in two different crystals in the offset oscillator.

Circuit details

Refer now to the circuit diagram. This clearly identifies all the major circuit sections depicted in Fig. 1. As with the block diagram, we'll consider the receiver circuitry first.

Input signals from the antenna are firstof all fed to a multi-stage low-pass filter and RF switching network. In the receive mode, both D6 and D7 do not conduct, thus allowing the input signal to pass via capacitor C23 to helical filter H1 and thence to the base of common emitter amplifier Q6. H1 is a helical resonator, chosen for its high selectivity, while Q6 acts as an RF amplifier. The amplified output is taken from the collector circuit of Q6 and AC-coupled to helical resonator H2.

Transistor Q7 functions as the mixer. The incoming RF and Rx tripler signals (from Q13) are both fed to the base of Q7 while L34 and its associated capacitors tune the collector to the 10.7MHz difference frequency (ie, the 10.7MHz IF). This 10.7MHz IF is then filtered by crystal filter FL1 (and optional filter FL1a where fitted) and fed to pin 16 of IC2.

IC2 is a Motorola MC3357 device which is specifically designed for use in the IF stages of FM dual conversion transceivers. Quite a lot happens inside that innocuous-looking 16-pin DIL package, the chip containing no less than an oscillator, mixer, limiting amplifier, quadrature detector, active filter, squelch, scan control and a mute switch. Fig. 2, taken from the Motorola Linear IC handbook, shows the block diagram.

The MC3357 FM IC chip has three functions:

- it provides second conversion to 455kHz using a 10.245MHz local oscillator;
- it provides internal limiting and quadrature detection; and
- it provides the squelch function.

In greater detail, crystal X4 sets the local oscillator frequency to 10.245MHz. This frequency is mixed with the incoming 10.7MHz signal to produce a 455kHz IF which is then filtered using external ceramic filter FL2. Transistor Q8 amplifies the filter output and feeds the signal to the limiting amplifier input at pin 5.

Although not shown in Fig. 2, the limiter is actually a five-stage differential amplifier. Its job is to ensure that the input signal is driven well into clipping, thus removing any AM component that may be present in the signal waveform. The limiter output drives the quadrature FM detector associated with the coil and capacitor at pins seven and eight.

The detected audio is extracted from pin nine of IC2 and fed via low pass filter R40 and C49 (de-emphasis) to volume control VR43. At the same time, a sample of the signal noise is coupled via C48 to an internal amplifier in IC2, the output of which is filtered by C47 and R37. In the absence of an audio signal, the increased noise level is detected by diode D10 and activates the internal squelch circuit.

As shown in Fig. 2, the squelch circuit controls an internal switch which shunts the signal across the volume control to earth. The squelch level is adjusted by potentiometer VR26 which sets the DC bias of the internal squelch amplifiers via pin 12. R28 and C37 determine the squelch delay.

Transistors Q9-Q12 form a fairly conventional audio amplifier. Q9 and Q10 both function as class A amplifier stages, with Q9 direct coupled to Q10. Q10 drives Q11 and Q12 which together form a fully complementary class B output stage with quiescent current set by D11 and R49 and bootstrapping supplied by R52.

Resistors R48 and R47 set the gain of the audio amplifier to 25 (ie, 5600/220=25) while capacitor C55 rolls off the audio response above 3kHz. Note that the bias for Q9 is derived via R44 and R45 from the +10V supply rail which is switched in when in the receive mode. In the transmit mode, the supply rail is switched out and the input to R44 is taken low to mute the amplifier.

Transmitter circuit

The transmitter action begins at the microphone input. Q14 and Q15 form a two-stage common emitter amplifier which provides substantial gain for the microphone input. The amplified input signal is then AC-coupled via C68 to limiting diodes D12 and D13 and thence to emitter follower Q16.

Q16 functions as a low pass filter with unity gain. The output signal is extracted from the wiper of trimpot R67, which sets the modulation deviation, and then applied to varicap diode D14 via R68 and C72. D14 is in the tuned circuit of VCO stage Q17 and thus frequency modulates the VCO according to the incoming signal voltage.

The VCO circuit is built around N-channel FET Q17. This is wired in

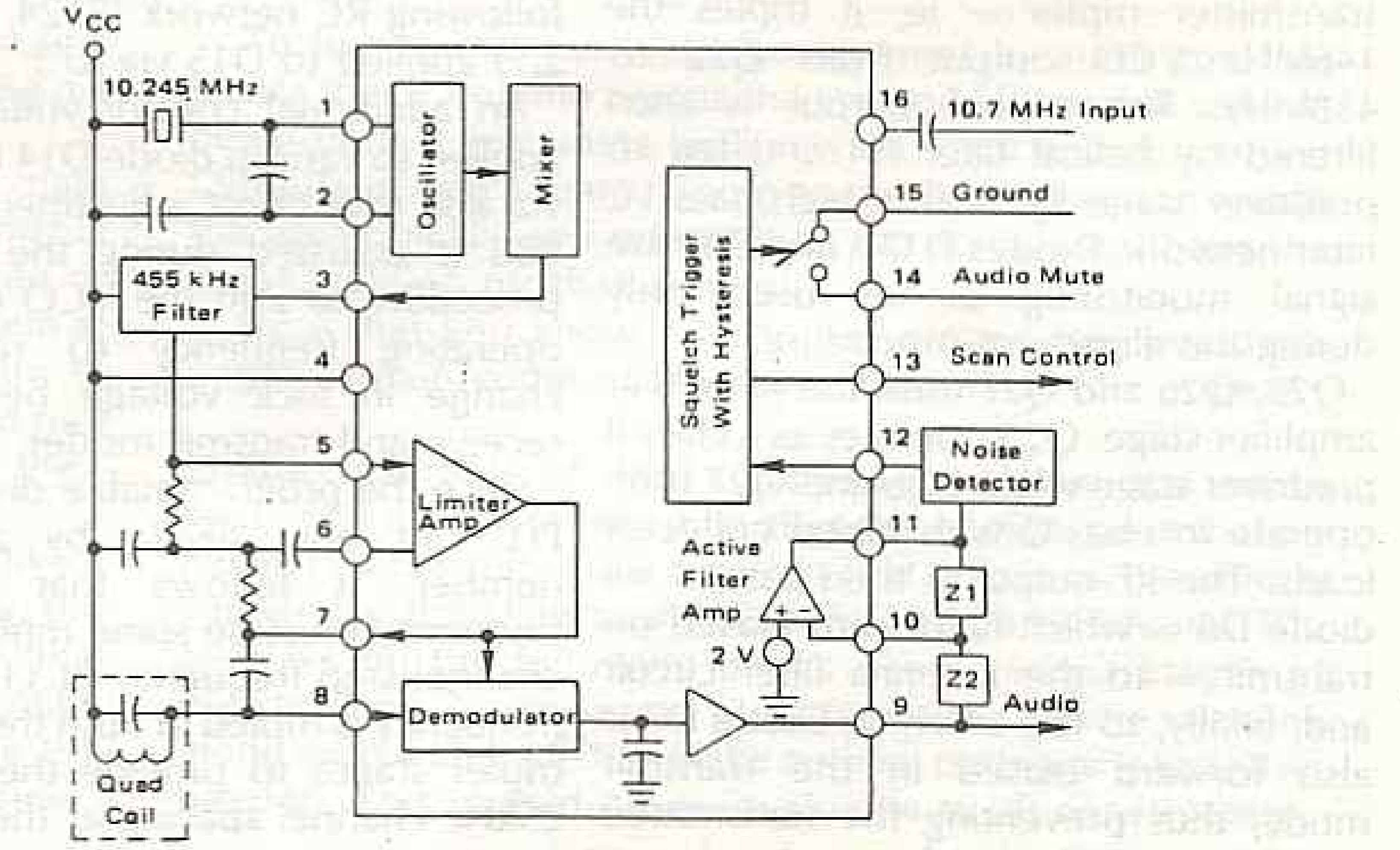


Fig.2

grounded gate configuration and oscillates at a nominal 146MHz as set by frequency determining components L12 and C78. Varicap diode D15, in series with C78, tunes the oscillator to the exact frequency required, and is controlled by the output of the PLL.

The output of the VCO is now fed to a rather complex network consisting of transistors Q18-Q23, together with various tuned circuits. Q18 is a dual gate Mosfet transistor which buffers the VCO signal and passes it to tuned circuit L13. From there, the signal is split into two paths (see Fig. 1). One signal path goes to common emitter amplifier Q20 and thence to the Rx tripler (Q13), while the other path is buffered by dual gate Mosfet transistor Q19.

Q13, the Rx tripler does exactly as its name implies – it triples the incoming VCO frequency to 427.3MHz. Because it is overdriven by the VCO, Q13 has an output signal which is rich in odd harmonics. The load circuit of Q13 – consisting of L11, C60 and the following helical filter (H3) – is tuned to accept the third harmonic (ie, 427.3MHz) and reject the fundamental (142.43MHz in the receive mode).

The signal output from the Rx tripler is coupled to the base of Q7 and mixed with the 438MHz received frequency to produce a 10.7MHz IF, as discussed earlier.

In addition to driving the Rx tripler, Q20 also drives common emitter amplifier Q22 via transformer L14. A rather clever, although fairly standard, circuit arrangement is used here to ensure that the transmitter does not produce out-of-band frequencies during channel switching. This arrangement involves deriving the base bias voltages for Q20 and Q22 from the PLL lock detector circuit.

It works like this. Pin 6 of IC1 (PLL02) controls transistor Q30 and is high only when the PLL is in lock. Q30 thus turns on to provide DC bias to Q20 and Q22 only when the PLL is locked to the correct frequency. When the PLL is out of lock – as when switching channels – Q20 and Q22 are turned off to inhibit the transmitter output.

Transistor Q24 functions as the transmitter tripler – ie, it triples the 146MHz VCO output from Q22 to 438MHz. The tripled output is then filtered by helical filter H4 and fed to predriver stage Q25 via a high pass LC filter network. Diodes D17A and D18 are signal monitoring diodes used only during the alignment procedure.

Q25, Q26 and Q27 form the RF power amplifier stage. Q25 operates as a class-B predriver stage while Q26 and Q27 both operate in class-C with tuned collector loads. The RF output is then passed via diode D6 – which is forward biased on transmit – to the antenna filter circuit and, finally, to the antenna. Diode D7 is also forward biased in the transmit mode, thus preventing the transmitted signal from passing to the receiver input.

Frequency synthesis

The VCO is controlled by a frequency synthesis circuit consisting of crystal oscillators Q28, Q29 and the PLL (IC1). Q29 and crystal X3 form a standard Colpitts oscillator circuit which provides the 8.533MHz reference frequency for the PLL. This frequency is fed to pin 3 of the PLL (IC1) and divided by 1024 to derive an 8.333kHz reference (or "channel step") frequency which is applied to the internal phase detector.

Although it looks much more complicated, the offset oscillator (Q28) functions in almost exactly the same manner as Q29. Like Q29, it is wired as a Colpitts oscillator, the main difference being that it uses diodes to switch in three different crystals for the receive, transmit and repeater modes. When the transceiver is in the receive mode, for example, diode D21 is forward biased and the receive crystal (X2) is in circuit.

The transmit and repeater crystals (X1 and X5) are switched into circuit in similar fashion for the transmit mode, with switch S2 selecting between simplex and repeater operation.

The output of the offset oscillator is tripled by tuned circuit L28 and coupled to the emitter of mixer stage Q21. There the signal is mixed with the incoming VCO frequency from buffer stage Q19 and the output filtered by L16 and its associated capacitors to give the difference frequency. This signal is then amplified by Q23 and AC-coupled to pin 2 of the PLL via a .01μF capacitor.

The difference frequency on pin 2 is divided by an internal programmable divider, the division ratio of which is set by the channel selector. What happens now is that the PLL compares the divided frequency with the 8.333kHz reference frequency by means of an internal phase comparator, and produces an error voltage to control the VCO. This error voltage pulls the VCO frequency until the divided difference frequency equals 8.333kHz, whereupon a lock condition exists.

Control of the VCO is effected by means of varicap diode D15 as discussed earlier. The control voltage is derived from pin 5 of IC1 and takes the form of a pulsed DC output which is filtered by the following RC network (R124, C151, etc) and applied to D15 via R73.

An additional control voltage is also applied to varicap diode D14 in the VCO via R86 (the offset adjustment trimpot). R86 is adjusted during the alignment procedure to shift the VCO close to its operating frequency to reduce the change in lock voltage between the receive and transmit modes.

Since the programmable divider in the PLL can only divide by an integer number, it follows that the VCO frequency must be some multiple of the channel step frequency (8.333kHz). This frequency is tripled in both the Rx and Tx tripler stages to provide the necessary 25kHz channel spacing at the operating frequency.

It is also quite easy to understand how the 10.7MHz IF and 5MHz repeater offsets are obtained. The main points to remember are that the offset oscillator output is tripled and that the VCO output is tripled in both the receiver and transmitter stages. Thus, for simplex operation, the offset oscillator output will differ by 3.57MHz between the transmit and receive modes – ie, (47.86110-46.67222) x 3=3.57MHz. If this frequency is tripled again, as in the Rx tripler stage, we get the required 10.7MHz IF.

Similarly, the 5MHz offset required for repeater operation is derived by tripling the frequency difference between crystals X1 and X5 and then tripling the result in the Tx tripler stage – ie, (47.86110-47.3005) x 9=5MHz.

Power supply

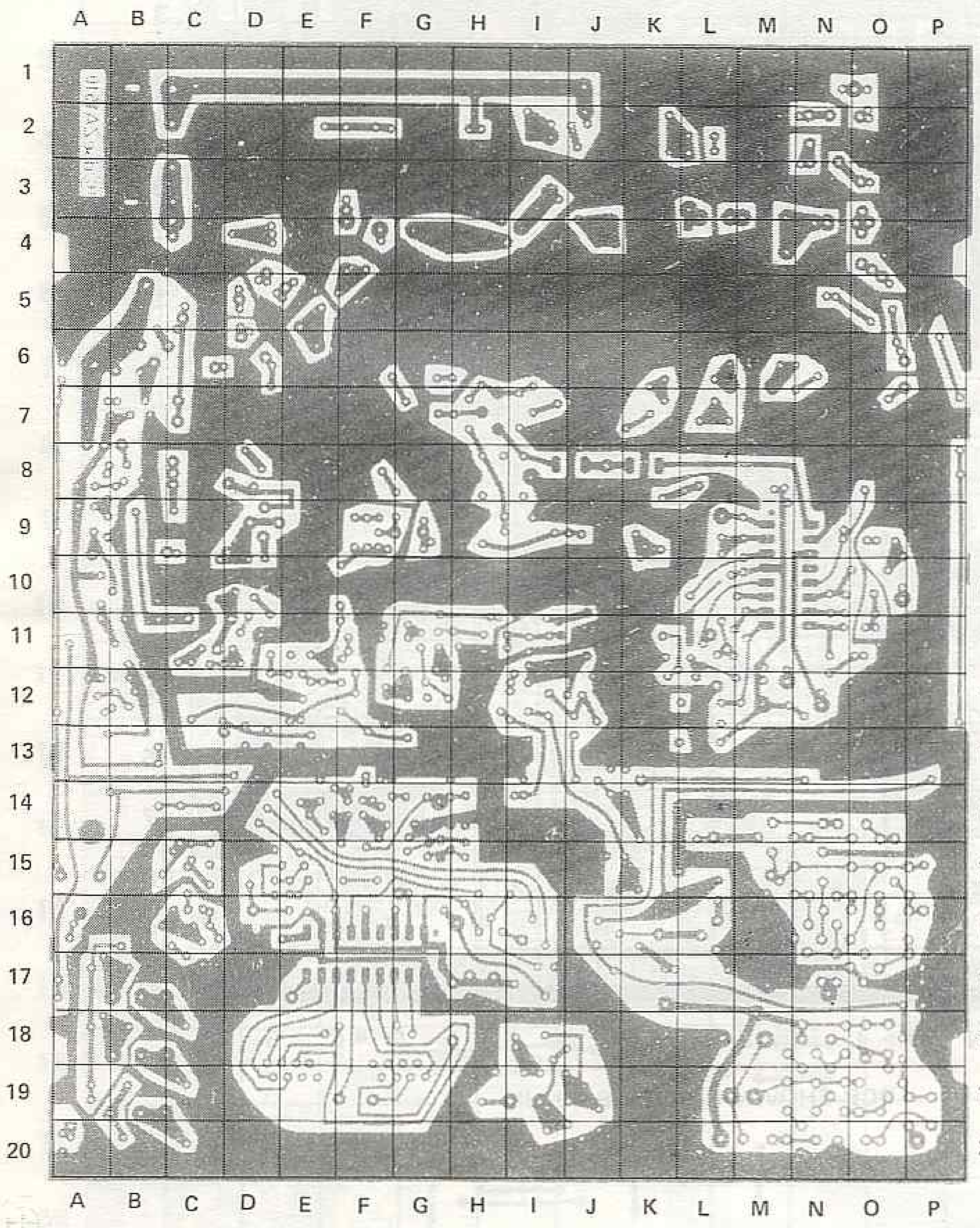
A +10V regulated supply derived from Q1, Q2 and D2 supplies power directly to the VCO, offset oscillator, reference oscillator and PLL circuit. Q1 serves as a conventional series regulator while D2 sets the reference voltage at the emitter of error amplifier Q2. The voltage on Q2's base, as set by voltage divider R4 and R5, is compared with the reference voltage on Q2 which then varies the drive to Q1.

The +10V regulated rail is also switched to various other sections of the circuit by transistors Q4 and Q5, depending upon whether or not the transceiver is in the receive or transmit mode. When the transceiver is in the receive mode (ie, the PTT – press to talk – switch is open), Q4 turns on via D3 and supplies power to the receiver circuitry. At the same time, diode D21 in the offset oscillator is forward biased so that the oscillator functions with the receive crystal (X2) in circuit.

When the transceiver is in the transmit mode (ie, PTT switch closed), Q4 turns off and Q5 turns on to power the microphone preamplifier and to switch in crystal X1 (via D20) in the offset oscillator. A separate 12V supply is also switched by Q3 on transmit to supply power to the Tx tripler and RF predriver stages (Q24 and Q25).

The final two stages of the RF power amplifier – Q26 and Q27 – are run from the 13.8V supply side of switch S1. This is a perfectly satisfactory arrangement since Q26 and Q27 are normally biased off and only draw current when the PTT switch is depressed on transmit. At the same time, it also minimises resistance in the supply line to the RF power amplifier, thereby ensuring maximum output.

The receiver audio amplifier runs direct from the switched side of the 13.8V supply rail. Note, however, that the base bias to Q9 is switched by Q4, so that the amplifier only operates when the transceiver is in the receive mode.



WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

GENERAL INTRODUCTORY INFORMATION

As the diagram above shows, the overlays used in this manual are set out the same as any street directory. (Be it a Melway's, UBD or Gregory's.)

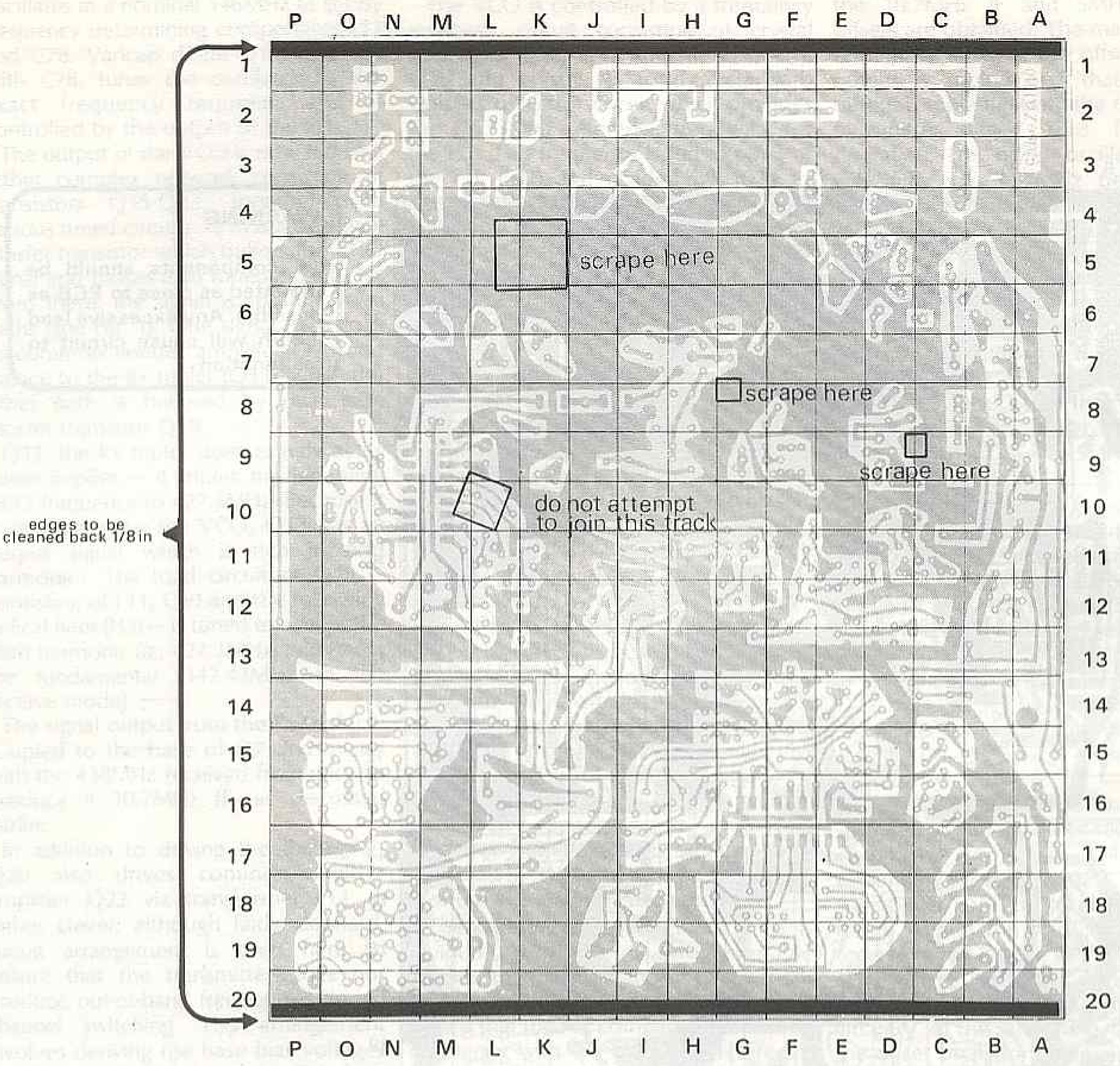
This has been done for a number of reasons, the main one being it will make it easier for the constructor to find his way around the circuit board. Because of the number of components used in this project it would be no problem at all to insert a component into the wrong hole only to discover it at a much later date. (Much confusion and bad language was generated during the building of the prototypes for this very reason.)

As you can see, the grid we are using is very much like a street directory, with the alphabetic co-ordinates along the horizontal and the numeric co-ordinates along the vertical axis. All references to a location are in the form alpha,num. If you care to look back at the parts list you will see the component number, followed by the location and value. eg. C96 F11, 0.01mfd ceramic.

To locate this particular component location you first locate the 'F' column across the top and follow that column down until it intersects with row 11. You now know that C96 sits in that square. Going to the board you can locate the area quickly and referring to the screen you have the exact location for that part.

Now that you know how to get around this board we might explain some of the other aspects of this project.

The insertion of the components follow the same sequence as any other kit, in that the components that sit closest to the board are inserted first. We insert resistors, capacitors, transistors, and then the integrated circuits. The overlays on the following pages show various stages of construction, broken up to provide easy to handle sections along with a checklist to make sure all parts are inserted as needed. This should prove invaluable to all constructors.



PCB SHOWN COPPER-SIDE UP

PCB PREPARATION

There are a few jobs that need to be done to the copper side of the PCB. Follow the instructions and diagrams and you should encounter no problems. (Please note that this PCB preparation only applies to blue solder mask PCBs).

1) The solder mask needs to be cleaned from the front and rear edges of the board to a width of ⅛". This is best done by laying a sellotape or masking tape strip across the board leaving ⅛" exposed. Wipe the exposed edge with a clean piece of steel wool pad.

2) Remove solder mask from underneath Q27 (located at K5), with a blade or sharp knife.

3) Remove solder mask from the earthy end of C34 (located at G7).

4) Remove solder mask from the earthy end of C105 (located at C 9).

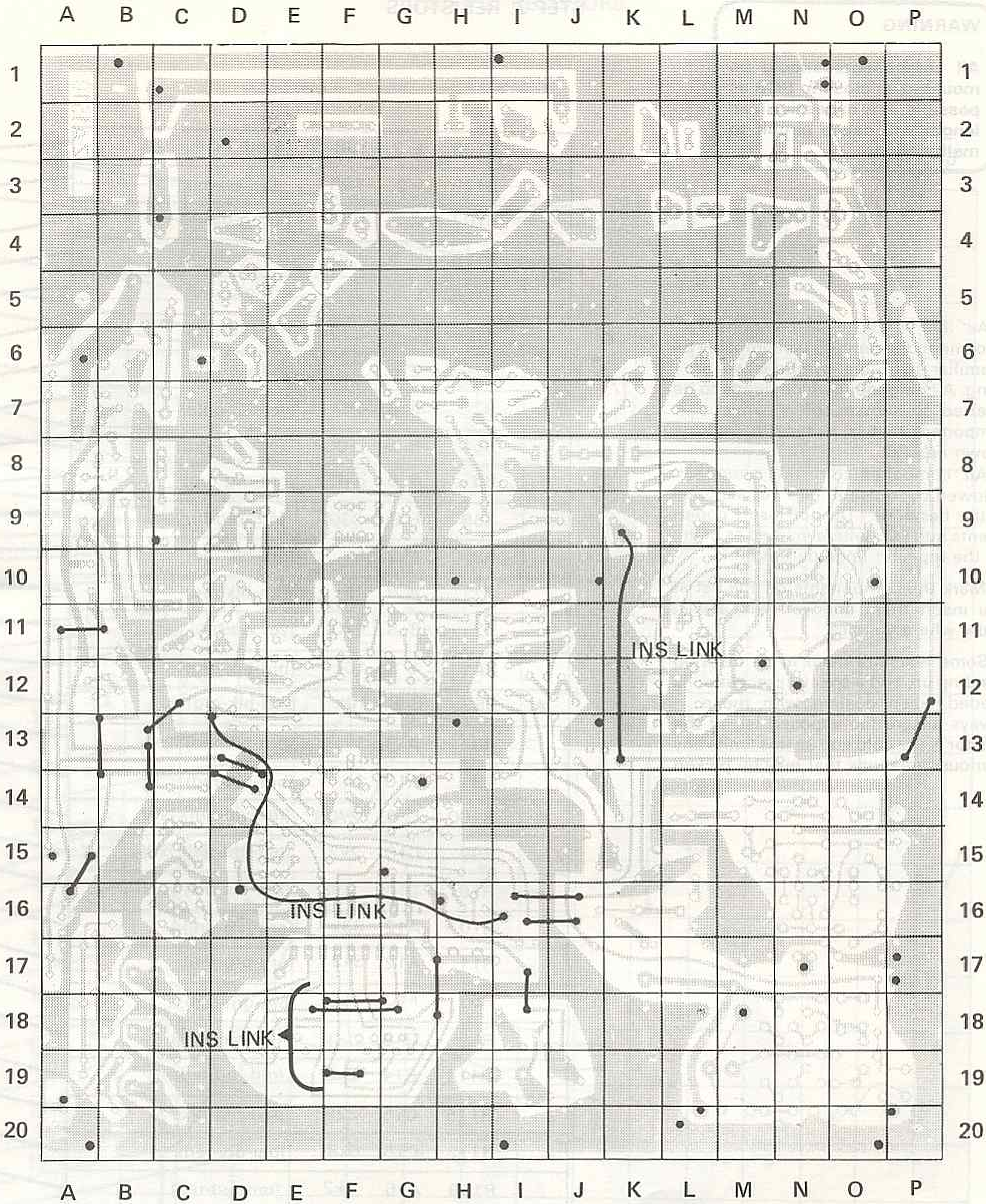
You should also note the area identified on the grid as L10. You will see a track that heads toward pin 4 of IC2 and then stops short. Do not attempt to join this track with the nearby pad as this track acts as a shield between the two parallel tracks either side.

Note: To preserve the clean copper foil at the point of manufacture, your PCB has been coated with a protective flux. Do not remove this coating. It assists in the production of good solder joints.

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

STEP 1. PCB PINS AND WIRE LINKS



This is the first stage of construction and, as you can see, involves only the PCB pins and the wire links.

Please make note of the following:

1) The four PCB pins at locations H10, H13, J10 and J13, are inserted from the copper-side of the board. This ensures that the collars of the pins do not splay the sides of the VCO shield when it comes time to insert it.

2) The three links located at F18, and F19 (which sit beneath the channel switch) should be made from insulated wire as are the two longest links at locations K9, K13 and D13, I16 (all marked INS LINK on the board). All other links are 23 B&S (.5734mm) tinned copper wire.

3) The link at locations A15 and A16 should be used until such time when the basic kit is upgraded.

4) The two pins located at H3 and F4 must be inserted from the copper side of the PCB. These pins must be soldered to the metal case of Q25 and Q26 on the component side of the PCB. Cut off excess pin length under the PCB after soldering. These pins form the low impedance return for Q25 and Q26.

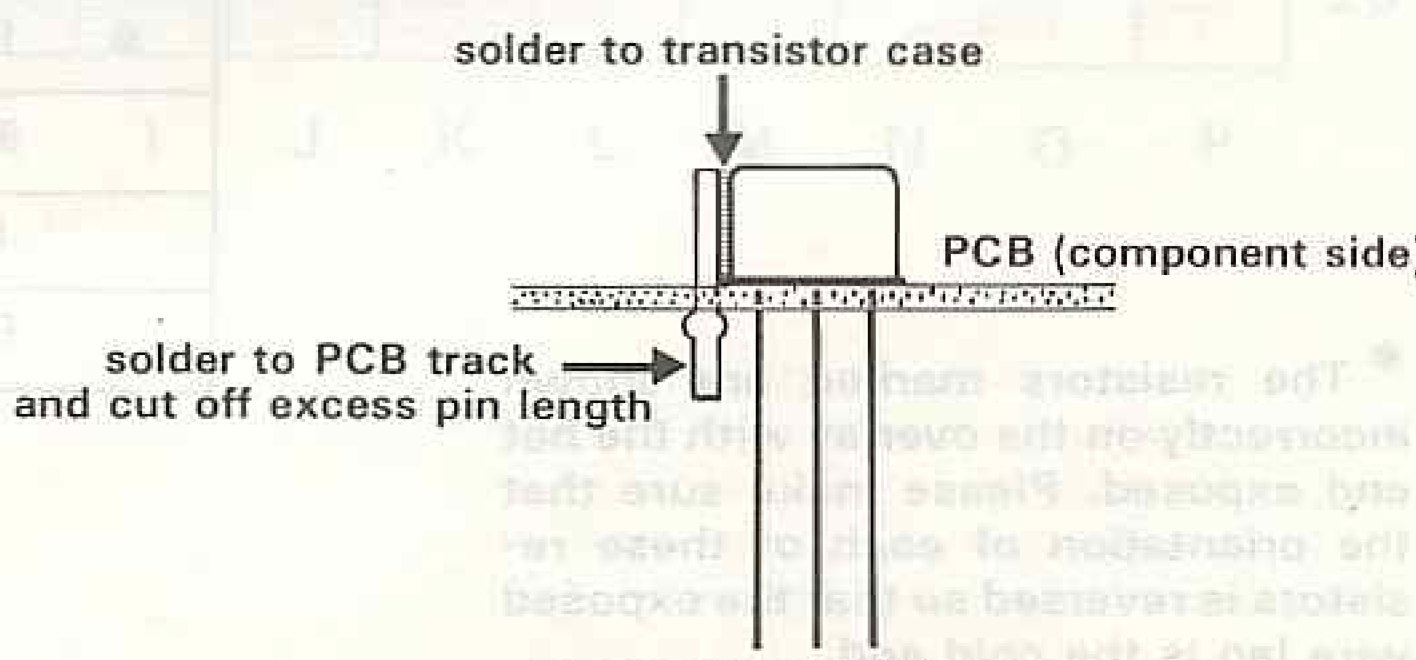


DIAGRAM SHOWING PIN

> **WARNING**
>
> All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

STEP 2. RESISTORS

As this is the first component placement diagram you will probably be unfamiliar with the symbols we are using. A component which needs to be inserted is shown *OPEN* while a component that is already inserted is shown *FILLED*.

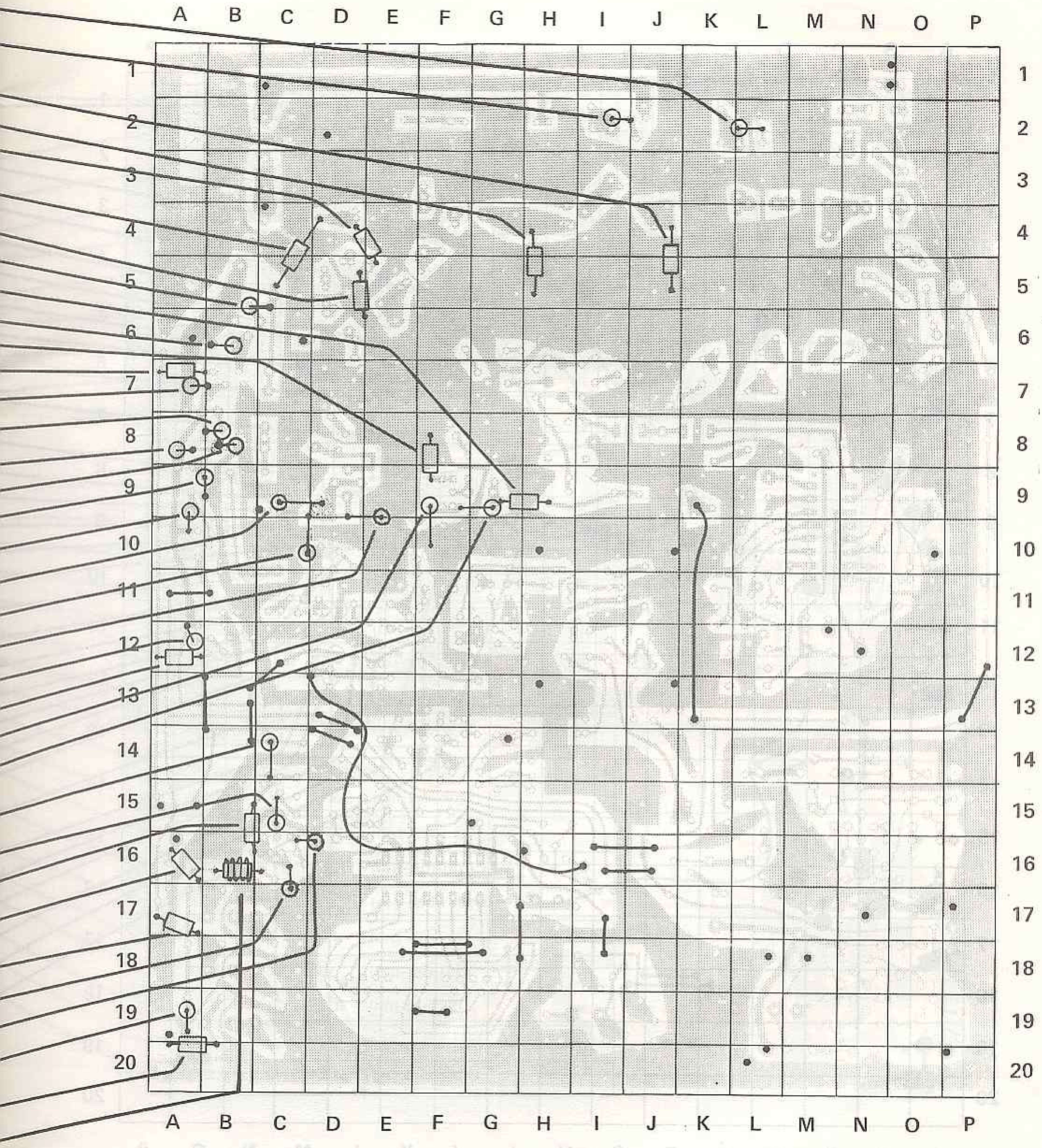
All components in the parts list, followed by 'repeater' are not supplied in the basic kit. Do not insert components into PCB where marked as being for the repeater upgrade option.

Mark the components off the list as you insert them and you will always know where you are.

Some resistors need to be inserted standing up, and a special precaution is needed when dealing with these. Always ensure the exposed leg of the resistor is the cold end as this limits any spurious radiations that may be picked up.

	R108	L 2,	10R	(brn-blk-blk)
	R128	I 2,	10R	(brn-blk-blk)
	R107	J 5,	120R	(brn-red-brn)
	R106	H 5,	120R	(brn-red-brn)
	R105	E 4,	3k3	(org-org-red)
	R104	C 4,	220R	(red-red-brn)
	R103	E 5,	270R	(red-vio-brn)
	R7	B 6,	4R7	(yel-vio-gold)
	R54	H 9,	100R	(brn-blk-brn)
	R6	B 6,	33k	(org-org-org)
	R56	F 8,	330R	(org-org-brn)
	R8	A 7,	1k	(brn-blk-red)
	R1	A 7,	1k	(brn-blk-red)
	R2	B 8,	470R	(yel-vio-brn)
	R4	A 8,	10k	(brn-blk-org)
*	R5	B 8,	10k	(brn-blk-org)
	R3	A 9,	1k	(brn-blk-red)
	R9	A10,	1k	(brn-blk-red)
*	R100	C 9,	270R	(red-vio-brn) ⅛W
	R99	C10,	2k2	(red-red-red) ⅛W
*	R101	E10,	10R	(brn-blk-blk) ⅛W
	R10	A12,	33k	(org-org-org)
	R11	A12,	3k3	(org-org-red)
	R53	F10,	1k5	(brn-grn-red)
	R55	G 9,	15k	(brn-grn-org)
	R114	C14,	2k2	(red-red-red)
	R115	C15,	22R	(red-red-blk)
	R112	C16,	6k8	(blu-gry-red)
	R159	A16,	2k2	(red-red-red)
	R109	A17,	2k2	(red-red-red)
*	R113	C17,	4k7	(yel-vio-red)
*	R116	D16,	1k2	(brn-red-red)
	R110	A19,	2k2	(red-red-red)
	R131	A20,	2k2	(red-red-red) (repeater)
	R111	B16,	470R	(yel-vio-brn)part of L27

* The resistors marked are shown incorrectly on the overlay with the hot end exposed. Please make sure that the orientation of each of these resistors is reversed so that the exposed wire leg is the cold end.


A B C D E F G H I J K L M N O P
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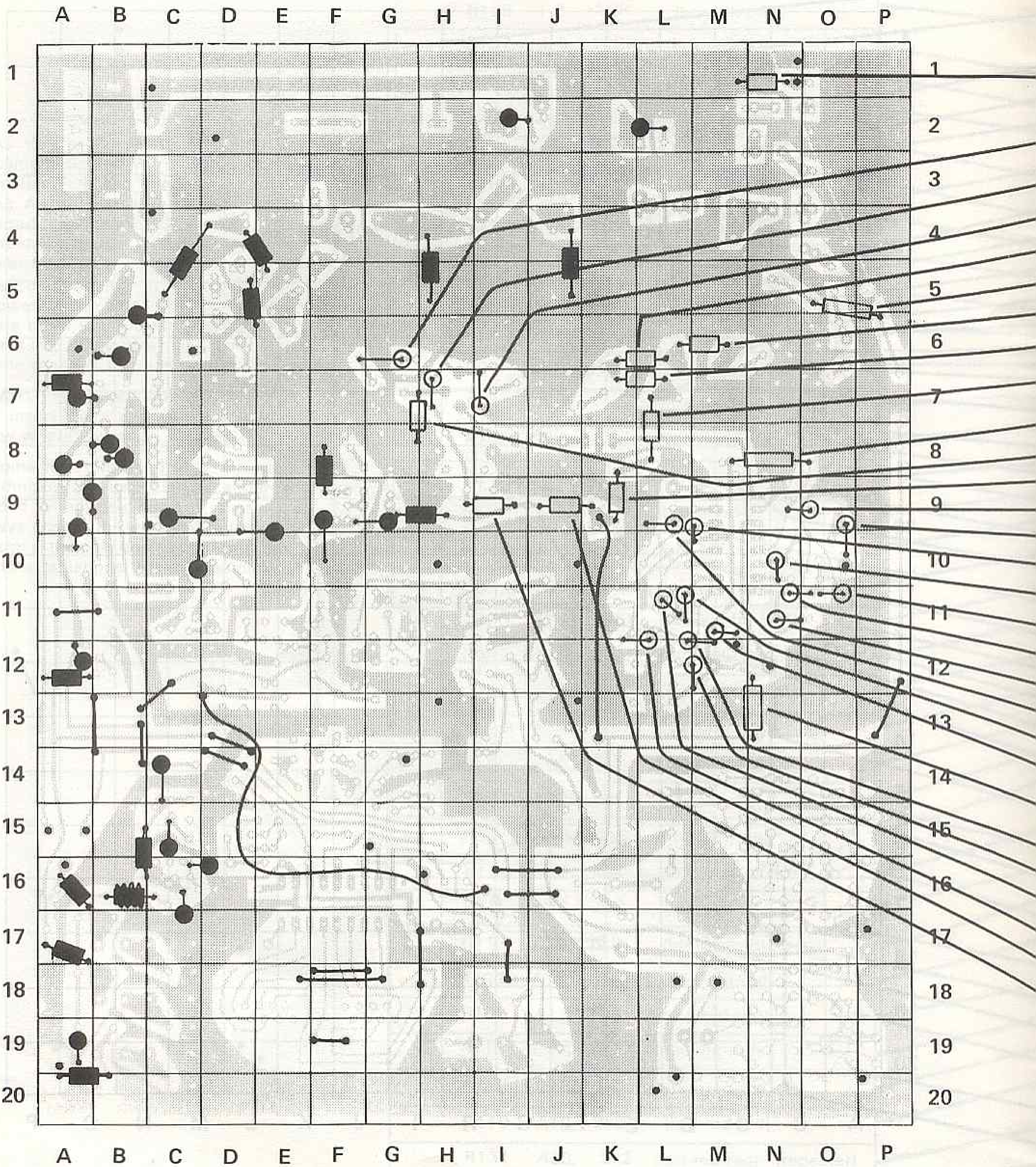
STEP 3. RESISTORS



R13	N 1,	4k7	(yel-vio-red).	
R18	G 6,	10R	(brn-blk-blk)	
R20	H 7,	15k	(brn-grn-org)	
R19	I 7,	1k5	(brn-grn-red)	
R16	L 6,	22R	(red-red-blk)	
R12	O 5,	820R	(gry-red-brn)	
R14	M 6,	56k	(grn-blu-org)	
R15	L 7,	470R	(yel-vio-brn)	
R27	L 8,	10R	(brn-blk-blk)	
R28	N 8,	82k	(gry-red-org)	
R21	H 7,	470R	(yel-vio-brn)	
R17	K 9,	100R	(brn-blk-brn)	
R35	N 9,	1k	(brn-blk-red)	
R29	O10,	4k7	(yel-vio-red).	
R32	M10,	1k5	(brn-grn-red)	
R37	N10,	270k	(red-vio-yel).	
R41	O11,	1k5	(brn-grn-red)	*
R39	O11,	15k	(brn-grn-org)	
R40	N11,	10k	(brn-blk-org)	
R31	L 9,	100k	(brn-blk-yel)	
R38	L11,	47k	(yel-vio-org).	
R25	M11,	22k	(red-red-org)	
R24	N13,	150R	(brn-grn-brn) ½W	
R34	M12,	2k2	(red-red-red)	
R42	M12,	33k	(org-org-org)	
R36	L11,	2k2	(red-red-red)	
R33	K12,	220k	(red-red-yel)	*
R156	J 9,	10R	(brn-blk-blk)	
R22	I 9,	100R	(brn-blk-brn)	

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

* The resistors marked are shown incorrectly on the overlay with the hot end exposed. Please make sure that the orientation of each of these resistors is reversed so that the exposed wire leg is the cold end.

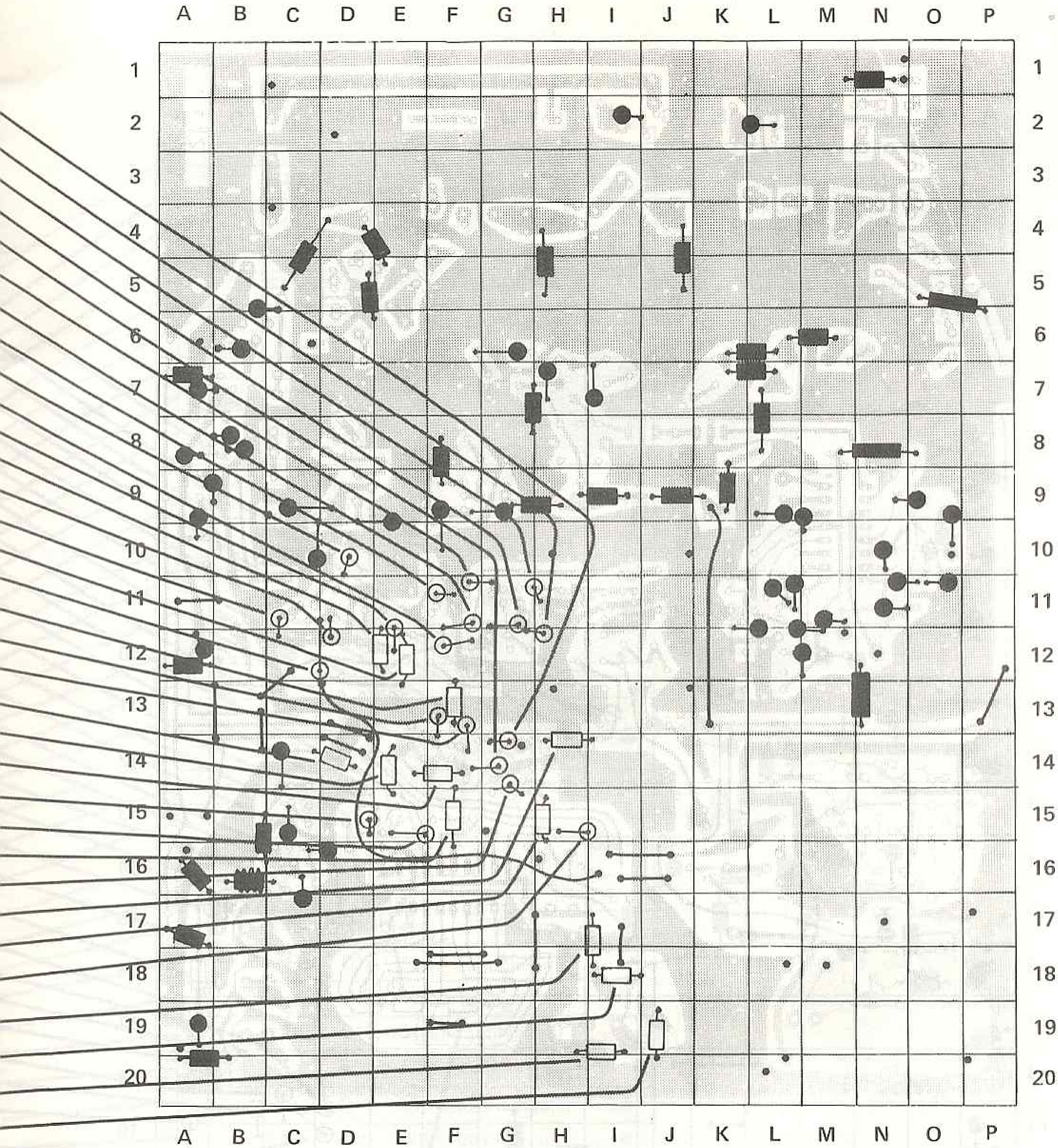
STEP 4. MORE RESISTORS

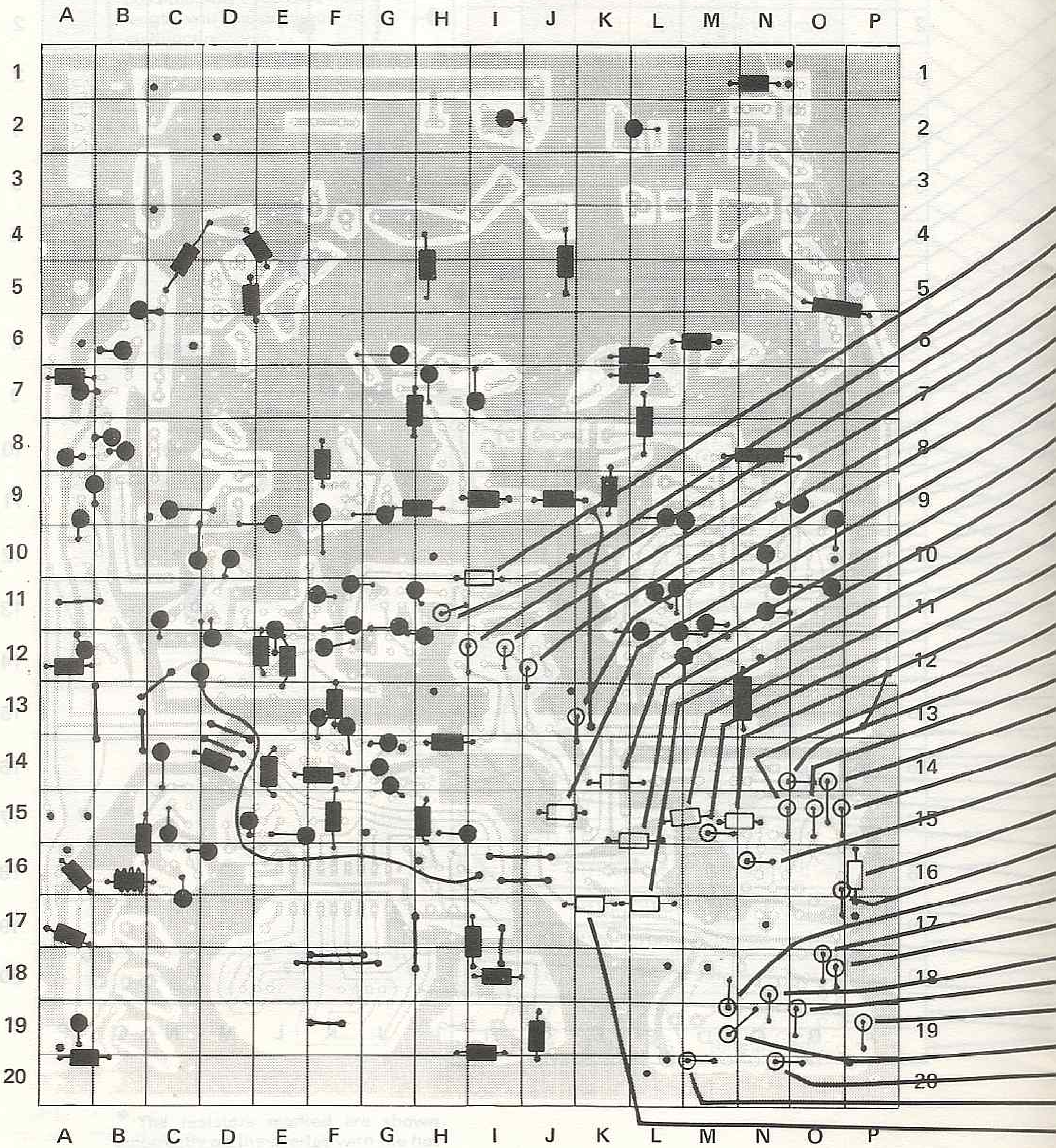
WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

	R122	G14,	180R	(brn-gry-brn)
*	R79	G12,	47k	(yel-vio-org)
	R75	H11,	10k	(brn-blk-org)
	R77	G11,	47k	(yel-vio-org)
*	R158	G14,	47k	(yel-vio-org)
*	R80	F11,	220R	(red-red-brn)
	R78	F12,	1k	(brn-blk-red)
	R90	F11,	100R	(brn-blk-brn)
	R94	D10,	10R	(brn-blk-blk)
	R81	F12,	100R	(brn-blk-brn)
	R89	E12,	1k2	(brn-red-red)
	R87	E12,	100R	(brn-blk-brn)
*	R95	D12,	1k5	(brn-grn-red)
	R98	C12,	15R	(brn-grn-blk)
	R88	E12,	4k7	(yel-vio-red).
	R96	D12,	2k2	(red-red-red)
	R82	F13,	330R	(org-org-brn)
*	R102	F13,	220R	(red-red-brn)
*	R83	F14,	1k	(brn-blk-red)
	R125	D14,	150R	(brn-grn-brn)
	R130	E14,	150R	(brn-grn-brn)
	R157	F14,	47k	(yel-vio-org).
	R91	D15,	150k	(brn-grn-yel)
	R92	E15,	1k	(brn-blk-red)
	R124	F15,	3k3	(org-org-red)
	R97	G15,	220k	(red-red-yel)
	R121	H14,	470R	(yel-vio-brn).
	R93	H15,	1k5	(brn-grn-red)
	R123	H15,	100R	(brn-blk-brn)
	R120	I18,	100R	(brn-blk-brn)
	R118	I18,	15k	(brn-grn-org)
	R117	I20,	15k	(brn-grn-org)
	R119	J19,	1k5	(brn-grn-red)

* The resistors marked are shown incorrectly on the overlay with the hot end exposed. Please make sure that the orientation of each of these resistors is reversed so that the exposed wire leg is the cold end.


A B C D E F G H I J K L M N O P
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20


A B C D E F G H I J K L M N O P
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STEP 5. MORE RESISTORS

R72	I11,	47R	(yel-vio-blk).	
R74	H11,	1k8	(brn-gry-red)	*
R73	I12,	4k7	(yel-vio-red).	
R71	I12,	4k7	(yel-vio-red).	
R70	J13,	47k	(yel-vio-org).	
R69	J13,	1k	(brn-blk-red)	*
R76	J15,	47k	(yel-vio-org).	
R68	K14,	15k	(brn-grn-org)	
R85	L16,	560R	(grn-blu-brn)	
R84	L17,	3k3	(org-org-red)	
R160	M15,	470R	(yel-vio-brn)	
R60	M15,	560R	(grn-blu-brn)	*
R57	N15,	82k	(gry-red-org)	
R59	N15,	5k6	(grn-blu-red)	
R66	O14,	56k	(grn-blu-org)	
R61	O15,	22k	(red-red-org)	
R65	O15,	56k	(grn-blu-org)	
R63	P15,	39k	(org-wht-org)	
R58	N16,	100k	(brn-blk-yel).	
R64	P16,	100k	(brn-blk-yel)	
R62	O16,	15k	(brn-grn-org)	
R50	M19,	2R2	(red-red-gold)	
R46	O18,	47k	(yel-vio-org)	
R44	O18,	56k	(grn-blu-org)	
R49	N19,	18R	(brn-gry-blk)	
R48	O19,	5k6	(grn-blu-red)	
R45	P19,	220k	(red-red-yel)	
R51	N19,	2R2	(red-red-gold)	
R47	N20,	220R	(red-red-brn)	*
R52	M20,	220R	(red-red-brn)	
R30	K17,	6k8	(blu-gry-red)	

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

* The resistors marked are shown incorrectly on the overlay with the hot end exposed. Please make sure that the orientation of each of these resistors is reversed so that the exposed wire leg is the cold end.

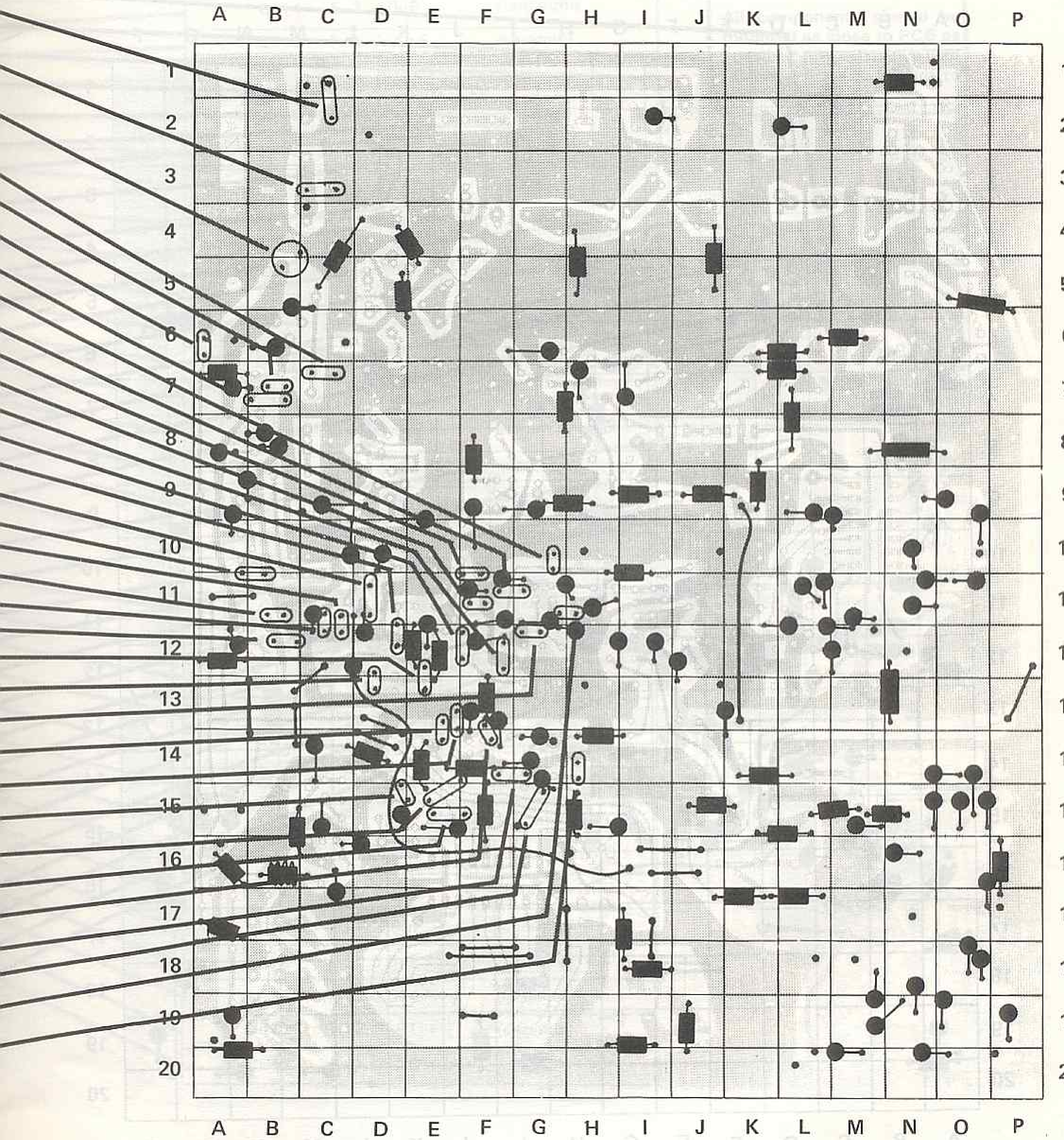
All lead lengths are to be kept as short as possible with a maximum length of 3mm.

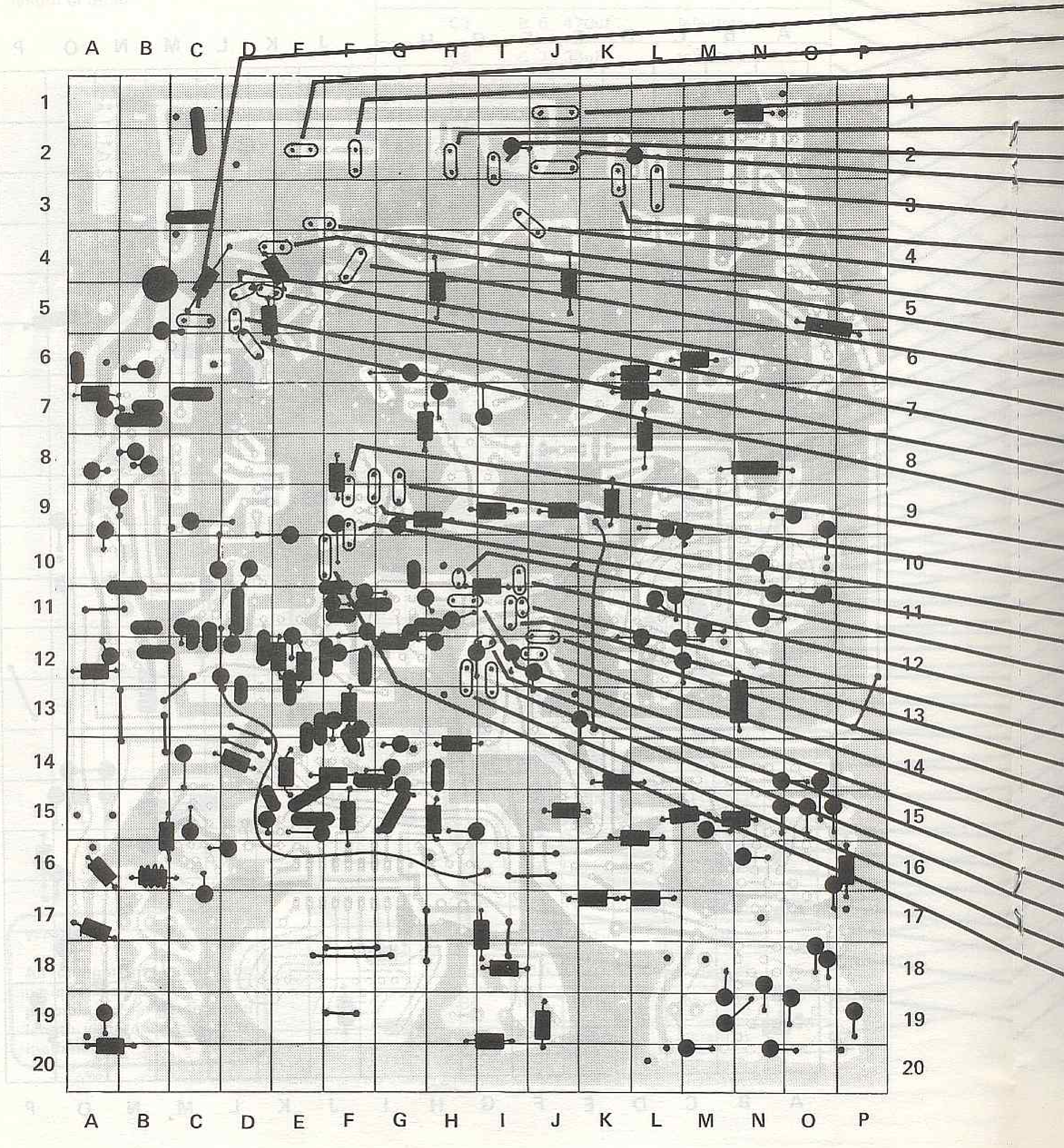
C2	C 2,	0.047uF	(ceramic)
C1	C 3,	0.047uF	(ceramic)
C3	B 5,	470uF	(electro)
C6	C 7,	33uF	(electro)
C5	B 7,	4.7uF	(tantalum)
C12	A 6,	0.001uF	(ceramic)
C4	B 7,	0.1uF	(ceramic)
C84	G10,	47uF	(electro)
C87	F11,	0.01uF	(ceramic)
C97	F11,	4.7pF	(ceramic)
C96	F11,	0.01uF	(ceramic)
C89	F12,	0.01uF	(ceramic)
C91	F12,	10pF	(ceramic)
C95	D12,	0.01uF	(ceramic)
C98	D11,	68pF	(ceramic)
C7	A11,	0.01uF	(ceramic)
C99	C12,	18pF	(ceramic)
C11	B11,	4.7uF	(tantalum)
C100	C12,	0.01uF	(ceramic)
C10	B12,	0.01uF	(ceramic)
C160	E13,	0.01uF	(ceramic)
C94	D13,	0.01uF	(ceramic)
C88	G12,	10pF	(ceramic)
C92	E14,	0.01uF	(ceramic)
C162	E13,	2200pF	(ceramic)
C128	E15,	180pF	(ceramic)
C93	E15,	3.3pF	(ceramic)
C129	E15,	0.047uF	(ceramic)
C90	F14,	1pF	(ceramic)
C30	G14,	0.01uF	(ceramic)
C133	G15,	0.01uF	(ceramic)
C86	H11,	0.01uF	(ceramic)
C132	H14,	180pF	(ceramic)

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

STEP 6. CAPACITORS




A
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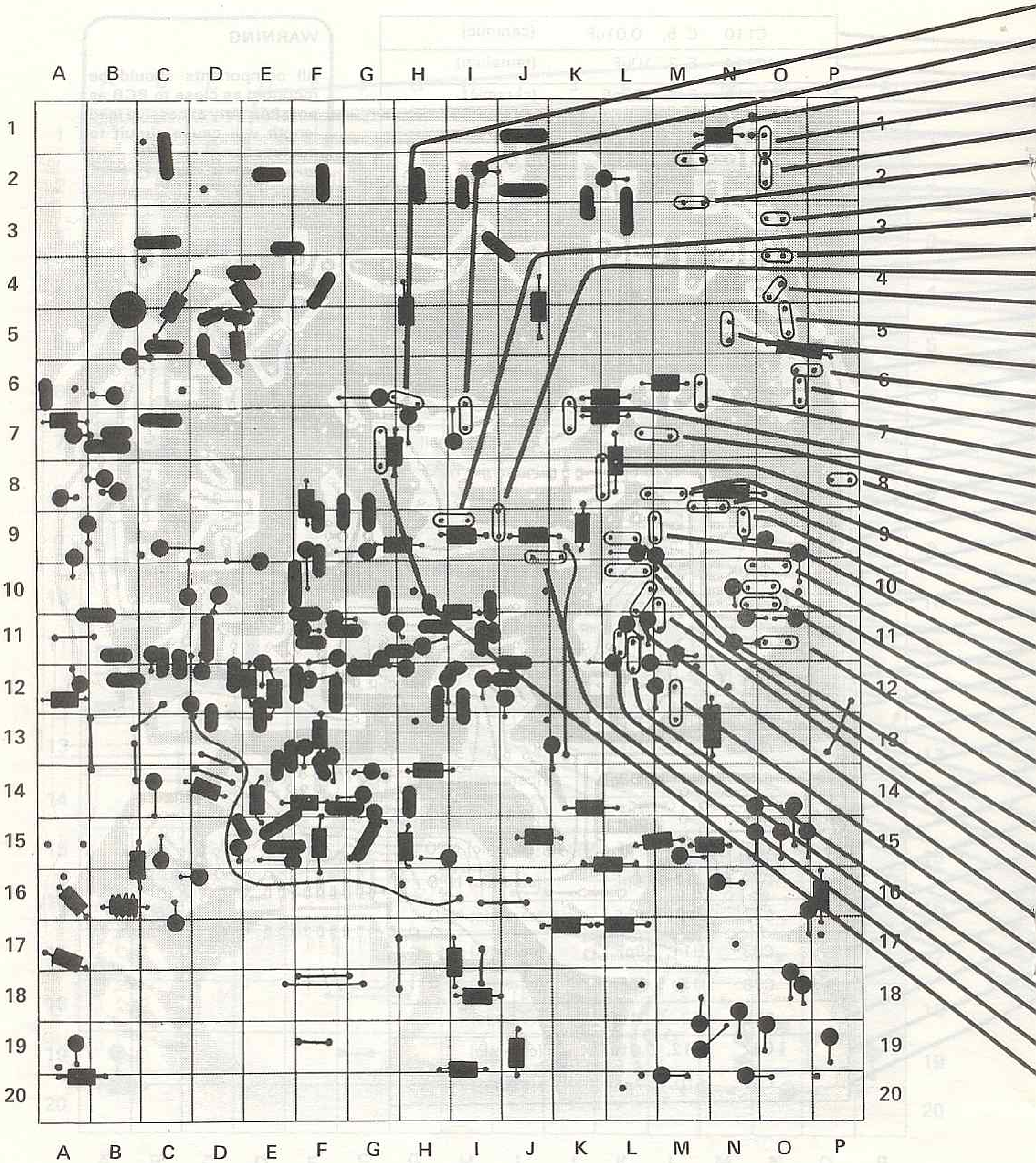
C110	C 5,	0.01uF	(ceramic)
C114	E 2,	10uF	(tantalum)
C115	F 2,	100pF	(ceramic)
C121	J 1,	0.1uF	(ceramic)
C113	H 2,	0.01uF	(ceramic)
C116	I 2,	0.001uF	(ceramic)
C119	J 2,	0.1uF	(greencap)
C122	L 3,	0.1uF	(greencap)
C123	K 3,	0.001uF	(ceramic)
C120	I 3,	22pF	(ceramic) small
C112	E 3,	0.001uF	(ceramic)
C111	E 4,	0.001uF	(ceramic)
C117	F 4,	33pF	(ceramic) small
C164	D 5,	5.6pF	(ceramic) NPO
C165	D 5,	5.6pF	(ceramic) NPO
C163	D 5,	5.6pF	(ceramic) NPO
C108	D 6,	5.6pF	(ceramic) NPO
C59	F 9,	2200pF	(ceramic)
C60	G 9,	2200pF	(ceramic)
C62	G 9,	3.3pF	(ceramic)
C64	F10,	22pF	(ceramic)
C74	H10,	0.01uF	(ceramic)
C76	I11,	4700pF	(ceramic)
C81	I11,	3.3pF	(ceramic) NPO
C80	I11,	4.7pF	(ceramic) NPO
C79	J12,	5.6pF	(ceramic) NPO
C77	J12,	5.6pF	(ceramic) NPO
C83	H11,	68pF	(ceramic)
C78	I12,	5.6pF	(ceramic) NPO
C75	I13,	0.01uF	(ceramic)
C82	H12,	0.01uF	(ceramic)
C57	F10,	4.7pF	(ceramic)

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

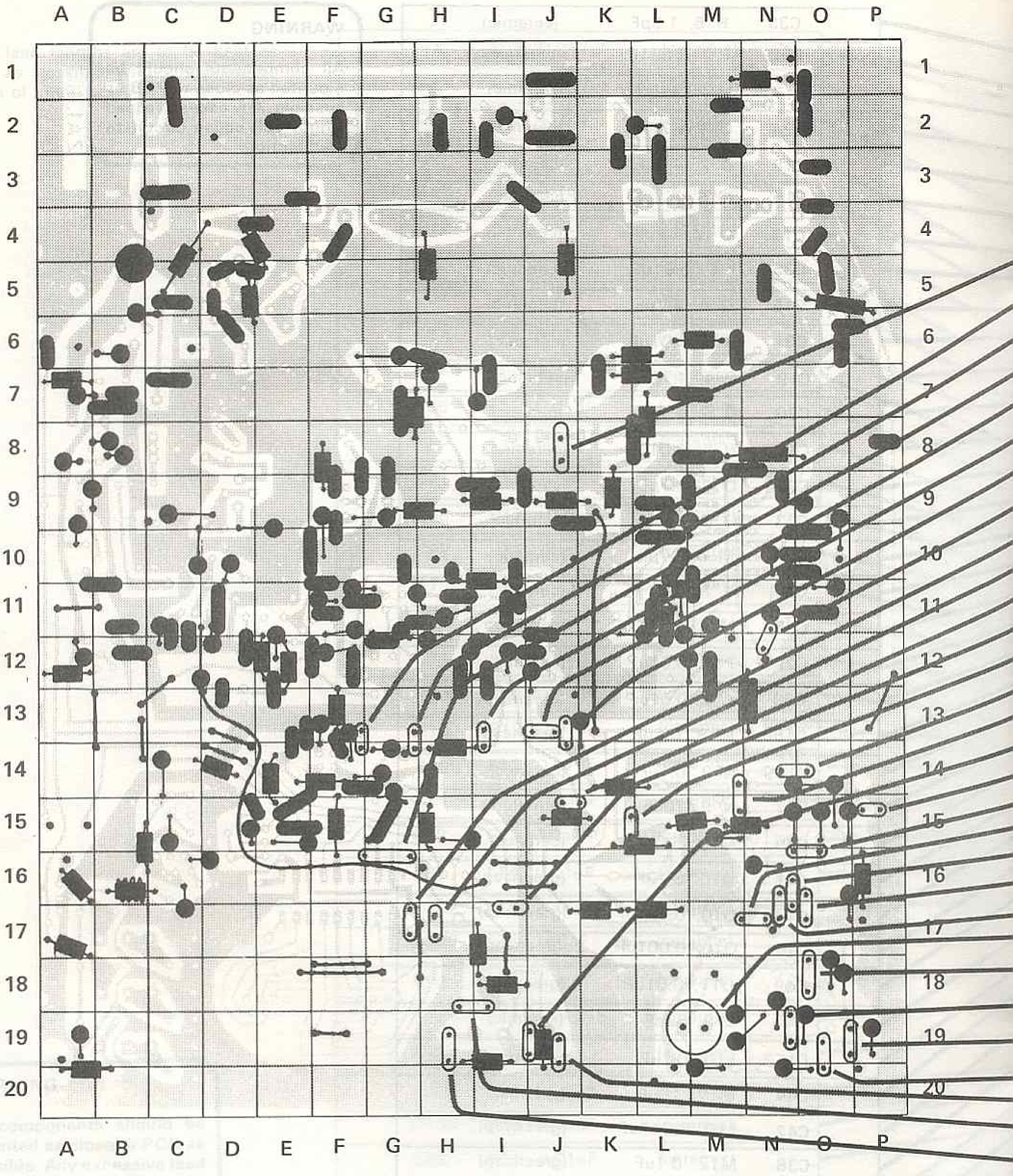
STEP 8. MORE CAPACITORS



C33	H 6, 1.5pF	(ceramic)
C32	I 7, 0.001uF	(ceramic) .
C17	M 2, 4.7pF	(ceramic)
C24	O 1, 47pF	(ceramic)
C18	O 2, 4.7pF	(ceramic)
C16	M 3, 4.7pF	(ceramic) .
C13	O 3, 4.7pF	(ceramic) .
C35	I 9, 0.01uF	(ceramic)
C15	O 4, 4.7pF	(ceramic)
C31	J 9, 0.01uF	(ceramic) .
C19	O 4, 4.7pF	(ceramic)
C20	O 5, 4.7pF	(ceramic)
C14	N 5, 0.01uF	(ceramic)
C21	O 6, 4.7pF	(ceramic)
C23	O 6, 47pF	(ceramic)
C27	M 6, 47pF	(ceramic)
C28	K 7, 47pF	(ceramic)
C26	M 7, 0.001uF	(ceramic)
C22	P 8, 0.01uF	(ceramic)
C29	L 8, 0.01uF	(ceramic)
C158	M 8, 0.1uF	(greencap) .
C159	N 9, 0.1uF	(ceramic)
C37	N 9, 10uF	(tantalum)
C39	M 9, 56pF	(ceramic)
C46	O10, 0.1uF	(greencap)
C47	O10, 0.001uF	(greencap)
C48	O10, 0.001uF	(greencap)
C49	O11, 0.01uF	(greencap)
C40	L 9, 82pF	(ceramic)
C157	L10, 0.1uF	(ceramic)
C44	M11, 10pF	(ceramic)
C42	L10, 0.047uF	(greencap)
C38	M12, 0.1uF	(greencap)
C43	L11, 0.047uF	(greencap)
C41	L11, 0.01uF	(ceramic)
C156	J 9, 0.01uF	(ceramic)
C34	G 7, 0.01uF	(ceramic)

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.


A B C D E F G H I J K L M N O P
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

STEP 9. MORE CAPACITORS

C36	J8,	2.2pF	(ceramic)	(repeater)
C150	F14,	10uF	(tantalum)	
C151	I17,	1 uF	(tantalum)	
C148	G16,	1000pF	(ceramic)	
C149	I14,	1uF	(tantalum)	
C72	J13,	2200pF	(ceramic)	
C73	J13,	0.001uF	(ceramic)	
C51	N12,	1uF	(tantalum)	
C155	G17,	0.047uF	(ceramic)	
C154	H17,	10uF	(tantalum)	
C85	J15,	1uF	(tantalum)	
C153	I17,	22uF	(tantalum)	
C9	K15,	0.01uF	(ceramic)	
C70	N14,	.0022uF	(ceramic)	
C71	M15,	270pF	(ceramic)	
C145	J19,	560pF	(ceramic)	
C65	P15,	10uF	(tantalum)	
C68	O16,	22uF	(tantalum)	
C66	N17,	0.001uF	(ceramic)	
C69	O16,	0.01uF	(ceramic)	
C67	O17,	0.001uF	(ceramic)	
C50	N17,	0.22uF	(tantalum)	
C56	M19,	220uF	(electro)	
C54	O18,	0.1uF	(greencap)	
C55	N19,	0.01uF	(greencap)	
C52	P19,	0.22uF	(tantalum)	
C53	O20,	10uF	(tantalum)	
C146	J19,	150pF	(ceramic)	
C147	I19,	0.01uF	(ceramic)	
C144	H19,	33pF	(ceramic)	

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

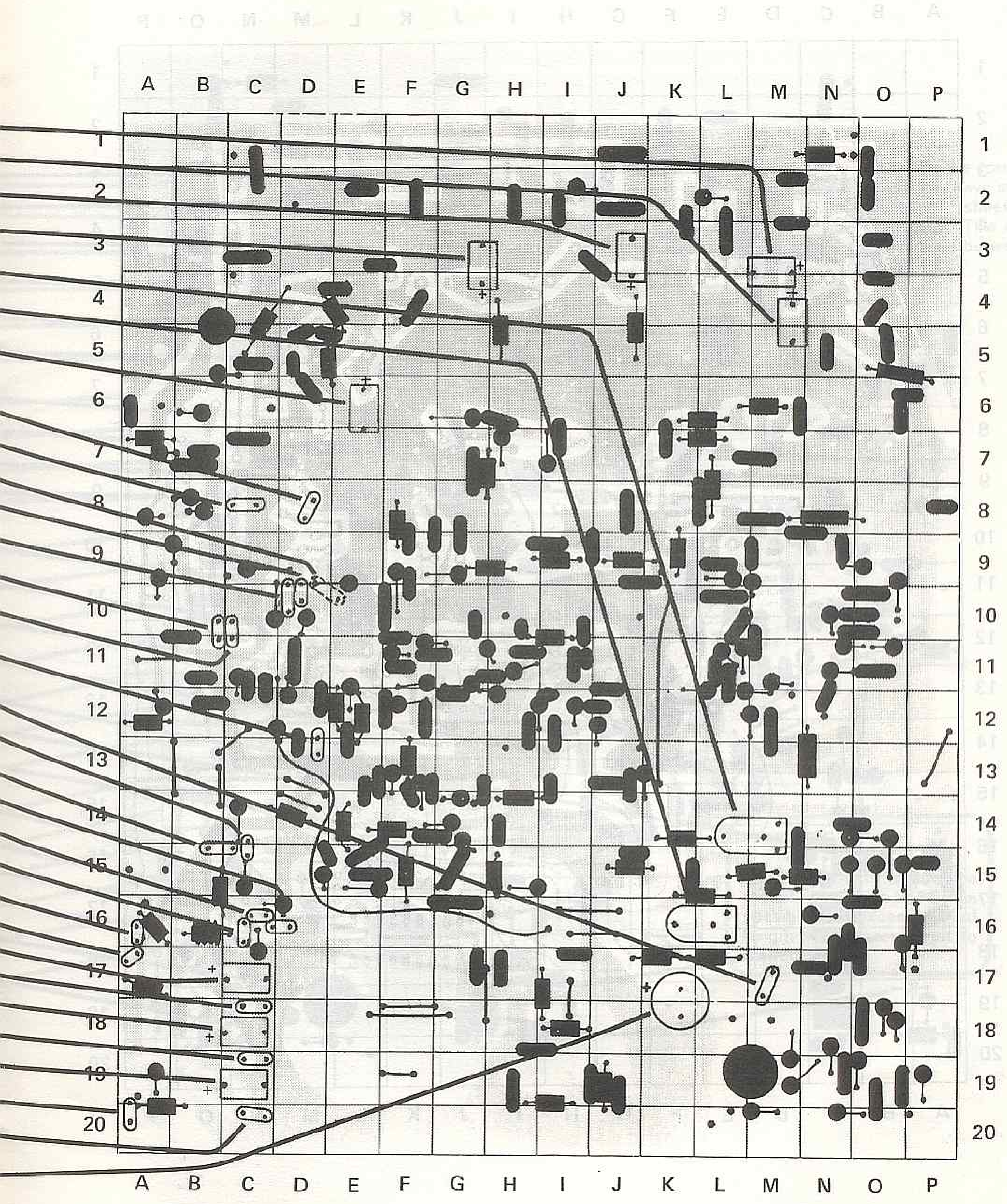
STEP 10. MORE CAPACITORS

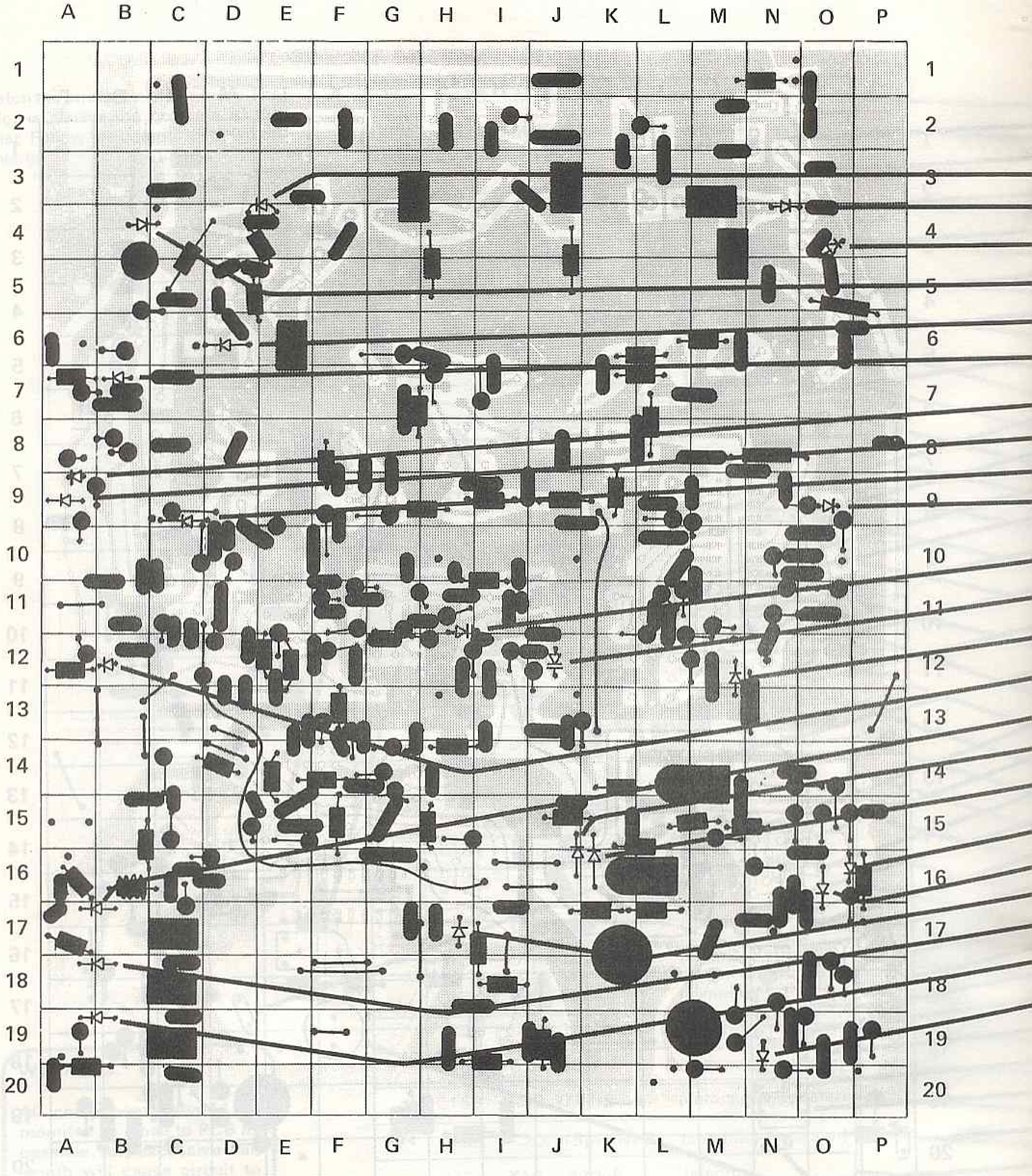
Watch the orietation of trimmers. The red dot is always the hot side of the trimmer. Follow the polarities shown on the overlay

C126	M 4,	20pF	(trimmer) .
C127	M 5,	20pF	(trimmer) .
C125	J 3,	20pF	(trimmer) .
C118	G 3,	20pF	(trimmer)
VR67	M14,	10k	(trimpot)
VR86	L16,	10k	(trimpot)
C109	E 6,	20pF	(trimmer)
C107	D 8,	15pF	(ceramic) small .
C106	C 8,	0.01uF	(ceramic)
C105	C 9,	100pF	(ceramic) small
C104	D10,	39pF	(ceramic)
C101	D10,	18pF	(ceramic)
C103	B10,	4.7uF	(tantalum)
C102	C10,	0.01uF	(ceramic)
C152	D13,	47uF	(electro)
C161	M17,	0.1uF	(ceramic)
C143	C15,	12pF	(ceramic)
C140	B15,	0.01uF	(ceramic)
C142	D16,	47pF	(ceramic) NPO
C141	C16,	27pF	(ceramic) NPO
C139	C16,	4700pF	(ceramic)
C166	A16,	0.01uF	(ceramic)
C138	A17,	0.01uF	(ceramic)
C134	C17,	20pF	(trimmer)
C135	C18,	15pF	(ceramic) NPO
C136	C18,	20pF	(trimmer)
C137	C19,	15pF	(ceramic) NPO
C167	C19,	20pF	(trimmer) (repeater)
C168	A20,	0.01uF	(ceramic) (repeater)
C169	C20,	15pF NPO	(ceramic) (repeater)
C45	K18,	470uF	(electro)

WARNING.

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.


A B C D E F G H I J K L M N O P
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20


A B C D E F G H I J K L M N O P
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

STEP 11. SEMI-CONDUCTORS

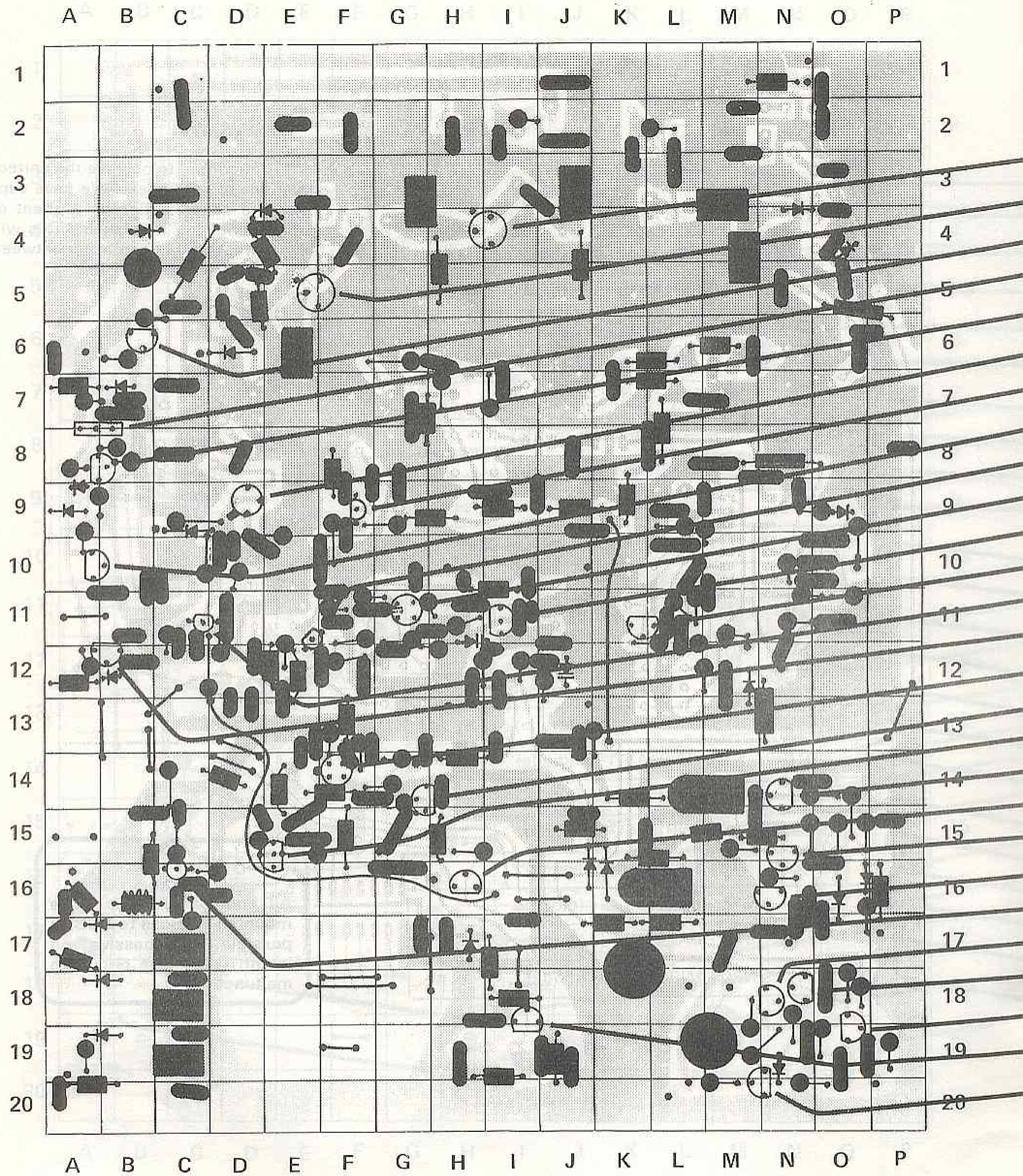
D19	E 4,	5V6 (400mW)	(zener)	
D6	N 4,	BA244	(diode)	
D7	O 4,	BA244	(diode)	
D1	B 4,	1N4002	(diode)	
D18	D 6,	1N914/4148	(diode)	
D5	B 7,	1N914 /4148	(diode)	
D2	A 9,	5V6 (400mW)	(zener)	
D3	A 9,	1N914/4148	(diode)	
D17A	C 9,	1N914/4148	(diode)	
D10	O 9,	1N914/4148	(diode)	
D15	H12,	BB122	(varicap diode)	*
D14	J12,	BB122	(varicap diode)	*
D9	M12,	5V6 (400mW)	(zener)	
D4	B12,	1N914/4148	(diode)	
D20	B17,	BA244	(diode)	
D17	J16,	1N914/4148	(diode)	
D16	K16,	1N914/4148	(diode)	
D13	P16,	1N914/4148	(diode)	
D12	O16,	1N914/4148	(diode)	
D22	H17,	5V6 (400mW)	(zener)	
D21	B18,	BA244	(diode)	
D23	B19,	BA244	(diode)	(repeater)
D11	N20,	1N914/4148	(diode)	

It is important to observe the correct polarities of all diodes. We have supplied the zener diodes on a sheet of paper identifying it as such. This will save a great deal of confusion between the zeners and the 1N914s.

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

* mount horizontally


A B C D E F G H I J K L M N O P
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

STEP 12. SEMI-CONDUCTORS

Q26	I 4,	MRF629	*
Q25	E 5,	MRF629	*
Q3	B 6,	BC327/328/640	
Q1	A 8,	BD140	
Q2	B 8,	BC107/547	
Q24	D 9,	2N3948	**
Q13	F 9,	2SC1674	
Q4	A10,	BC337/639	
Q20	E11,	2SC1674	
Q18	G11,	MPF131	
Q17	I11,	2SK125	
Q8	K11,	BC547	
Q22	C11,	2SC2053	
Q5	B12,	BC157/557	
Q19	F14,	MPF131	
Q23	G14,	BC548	
Q21	E15,	2SC1674	
Q16	N14,	BC558	
Q30	H16,	BC547	
Q15	N15,	BC548	
Q14	N16,	BC548	
Q28	C16,	2SC1674	
Q11	N18,	BC337/639	
Q10	N18,	BC558	
Q9	O19,	BC548	
Q29	I19,	BC547	
Q12	N20,	BC327/328/640	

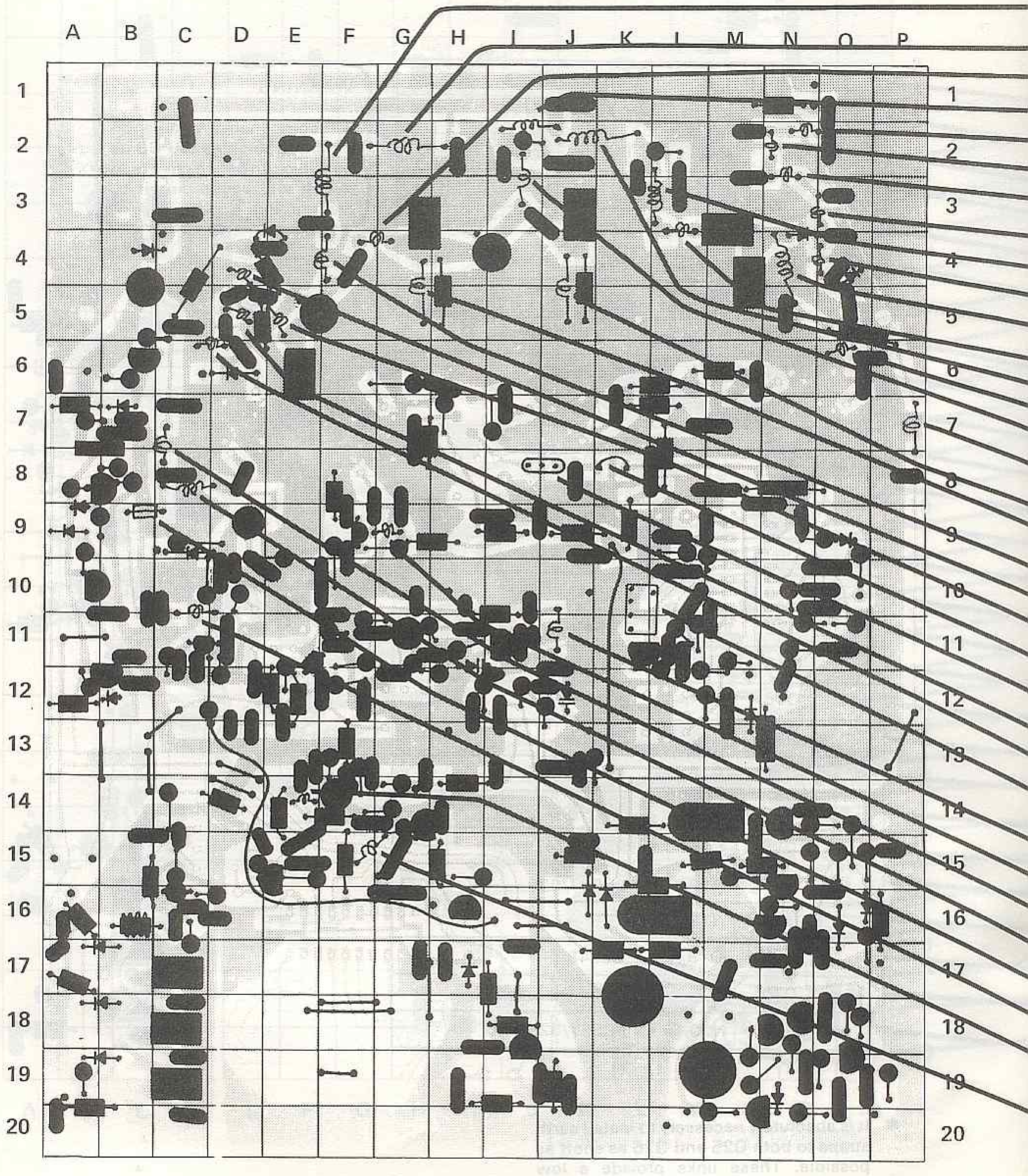
WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

* It is absolutely necessary to install earth straps to both Q25 and Q26 as short as possible. These links provide a low impedance earth.

** Q24 - although this transistor has three legs, there are four holes drilled in the PCB to allow the use of alternate types of transistor. The polarity marked is for the 2N3948 transistor.

STEP 13. RF CHOKES AND INDUCTORS



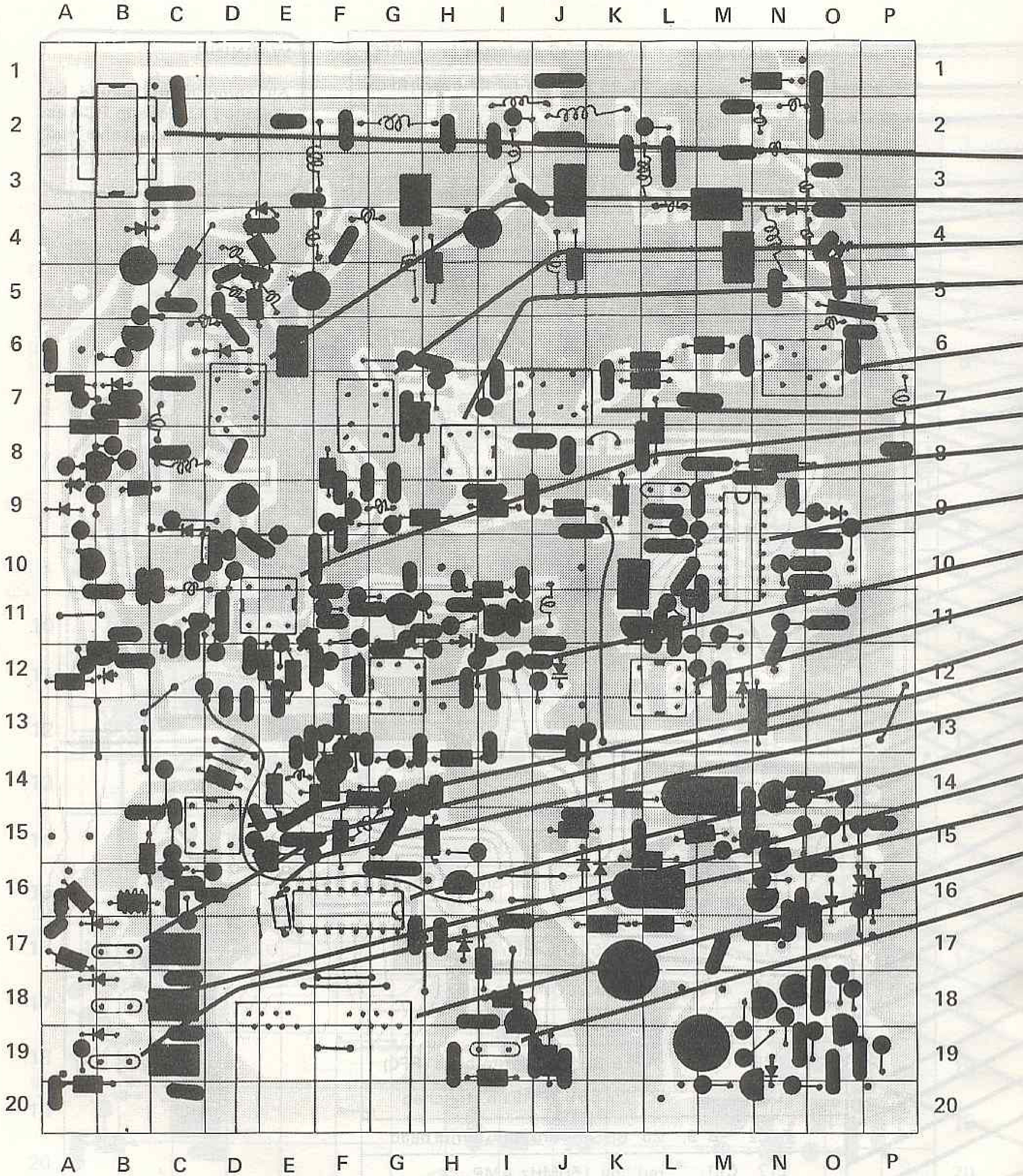
STEP 13. RF CHOKES AND INDUCTORS

L32	F 3,	1T 25 B&S on ferrite bead (RFC)
L30	G 2,	1T 25 B&S on ferrite bead (RFC)
L22	G 4,	20 B&S hairpin on 3/16" former
RFC4	I 2,	1T 25 B&S on ferrite bead
L6	N 2,	2T 20 B&S on ⅛" former
L5	N 2,	2T 20 B&S on ⅛" former
L4	N 3,	2T 20 B&S on ⅛" former
L3	O 3,	2T 20 B&S on ⅛" former
RFC6	K 2,	20 B&S wire link
L7	O 4,	2T 20 B&S on ⅛" former
L2	N 4,	11T 25 B&S on ⅛" former.
L26	L 4,	20 B&S hairpin on 3/16" former
RFC5	L 3,	25 B&S on 6-hole ferrite choke *
L9	O 6,	2T 20 B&S on ⅛" former
L31	I 3,	20 B&S wire link
L8	P 7,	1T 25 B&S on ferrite bead
L24	J 5,	8T 25 B&S on ⅛" former
L23	G 5,	8T 25 B&S on ⅛" former
RFC3	F 4,	20 B&S wire link
L21	D 4,	20 B&S hairpin on 3/16" former
L21A	E 5,	1 T 20 B&S on 3/16" former.
Link	23 B&S	(tinned copper)
FL1	J 8,	10.7MHz filter
L20	D 5,	20 B&S hairpin on 3/16" former
L19	D 6,	20 B&S hairpin on 3/16" former
FL2	K11,	455kHz filter
L12	J11,	red coil VCO 150 MHZ
L11	G 9,	4T 25 B&S on ⅛" former
L29	C 8,	1T 25 B&S on ferrite bead (RFC)
L18	C 8,	2T 25 B&S ⅛" diam. stretched
RFC2	B 9,	25 B&S link thru ferrite bead
L17	C11,	red coil 150MHz AMP
L15	E14,	4T 25 B&S on ⅛" former.
L16	G15,	10uH coil

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

* 2½ turns through 6-hole ferrite bead


A B C D E F G H I J K L M N O P
1
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15
16
17
18
19
20

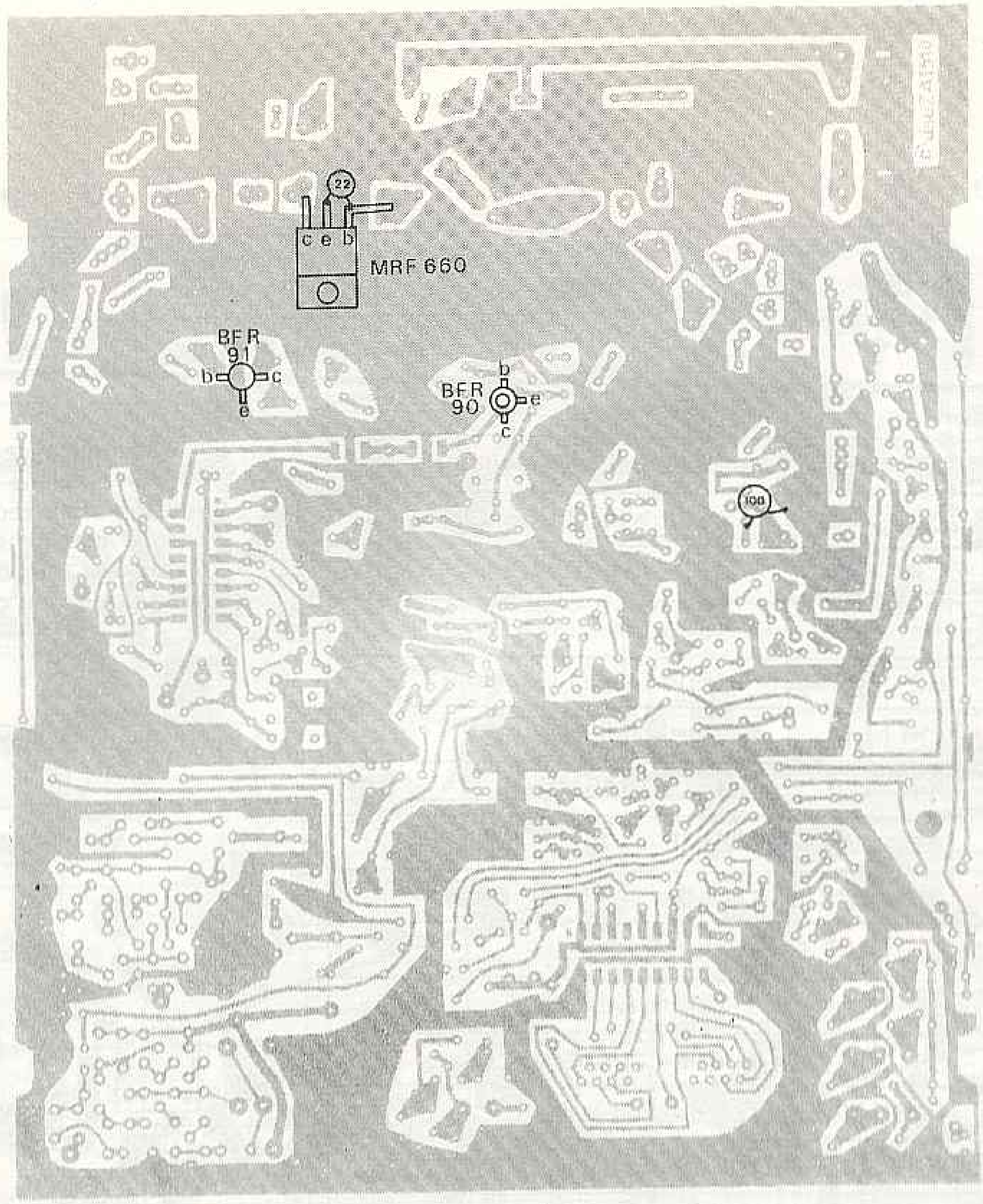
L1	B 2,	DC choke
H4	D 7,	1506 helical resonator
H3	G 7,	1506 helical resonator
L34	H 8,	10.7MHz coil 10mA015 S
H1	N 6,	1506 helical resonator
H2	J 7,	1506 helical resonator
L14	E11,	150MHz coil 004
X4	L 9,	xtal 10.245MHz
IC2	M10,	MC3357P
L13	G12,	150MHz coil 004
L10	L12	455kHz coil
L28	D15,	150MHz coil 004
X1	B17,	xtal 47.86110MHz
R161	E17,	1k2 (brn-red-red)
IC1	F16,	PLL02A
X2	B18,	xtal 46.67222MHz
RPT X5	B19,	xtal 47.3055MHz (repeater)
SW		Channel switch
X3	I19,	xtal 8.5333MHz

The helical resonators are tested at 438MHz at the point of manufacture and therefore require little adjustment. Ensure that when mounting helical resonators the connecting leads do not bend under the can.

WARNING

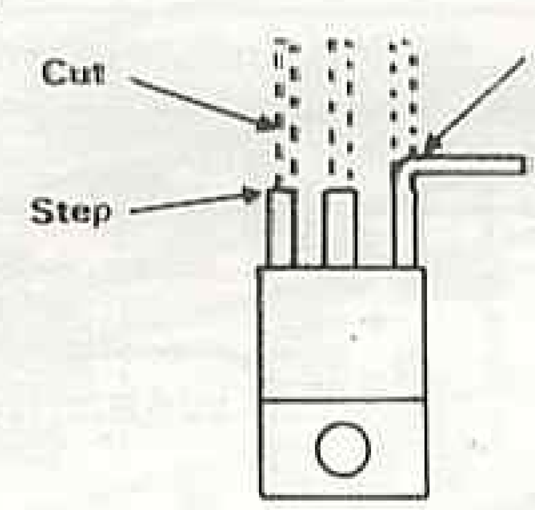
All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

UNDER BOARD COMPONENTS



PCB shown copper side up.

Figure 1



MRF660 LEAD CUTTING DETAILS

VIEW FROM LABELLED SIDE OF TRANSISTOR

WARNING

All components should be mounted as close to PCB as possible. Any excessive lead length will cause circuit to malfunction.

HOW TO MOUNT UNDER BOARD COMPONENTS

a) BFR 91, (Q6), is mounted flush on the PCB with the type number facing outwards (away from copper).

b) BFR 90/91, (Q7), is mounted flush to the PCB with the type number facing inwards (towards copper).

c) C124 (22pF) must be wired between the base of Q27, (MRF660 output transistor), and earth with the shortest possible lead arrangement. This is done by soldering the capacitor directly at the transistor body. This way the leads will be just 1.5mm long (see Figure 1).

d) C105 (100pF) mounted underneath the tripler, lead lengths should not exceed 3mm either side of the capacitors body.

e) The output transistor, Q27, must be mounted so that the hole through the transistor body lines up with the hole in the PCB. Ensure that the solder mask of the PCB has been scraped clean below the main body of the transistor and that heatsink compound is used when mounting. Additional heatsinking other than the brass stud and finned heatsink on the top side of the PCB will lessen the power sag on the transmitter. We recomend a piece of 16 g aluminium mounted under the head of the screw holding the transistor to the PCB and top heatsink.

NB. Ensure that if this additional heatsink is used that it does not touch any of the solder pads or component leads in the area surrounding the transistor mounting hole.

SEMICONDUCTOR VOLTAGES

All voltages for 13.8V input

Device	Operation	Base	Collector	Emitter	Condition
Q 1		13.0	10.0	13.8	
Q 2		5.0	12.8	4.3	
Q 3	Tx	13.7	12.8	13.8	
Q 4		9.8	10.0	9.0	
Q 5	Tx	9.9	10.0	10.0	
Q 6		0.76	7.5	0.0	
Q 7		1.0	8.9	0.34	
Q 8		0.67	2.0	0.0	
Q 9		7.0	13.0	6.6	
Q10		13.0	6.5	13.8	
Q11		6.5	13.8	5.9	
Q12		5.3	0.0	5.8	
Q13		0.75+	8.8	0.6	+Normal RF Reading
Q14	Tx	0.58	1.4	0.0	
Q15	Tx	1.5	3.0	0.74	
Q16	Tx	4.8	0.0	5.4	
Q17		(S)2.99	(G)0.0	(D)8.5	
Q18		(S)0.9	(G1)0.0	(D)9.5	(G2)4.8
Q19		(S)0.6	(G1)0.0	(D)5.4	(G2)2.7
Q20		0.9+	9.0	0.8	+Normal RF Reading
Q21		0.75	4.3	0.0	
Q22	Tx	1.7	11.9	1.0	
Q23		0.68	2.3	0.0	
Q24	Tx	1.1+	11.9	1.3	+Normal RF Reading
Q25	Tx	0.3	13.8	0.0	
Q26		—	13.8	—	
Q27		—	13.8	—	
Q28		2.4	6.0	1.6	
Q29		2.8	5.7	2.4	
Q30		5.8	5.9	5.2	

TX = push transmit (PTT) button when measuring this voltage.

IC VOLTAGES

IC1 (PLL02A)
Pin 1 - 5.88
Pin 2 - 2.86
Pin 3 - 2.8
Pin 4 - 5.8
Pin 5 - 2.8
Pin 6 - 5.8
Pin 7 - 5.8
Pin 8 - 0.0
Pins 9 to 15 - Program
Pin 16 - 0.0

IC2 (MC3357)
Pin 1 - 5.7
Pin 2 - 5.0
Pin 3 - 5.5
Pin 4 - 5.7
Pin 5 - 1.0
Pin 6 - 1.0
Pin 7 - 1.0
Pin 8 - 5.7
Pin 9 - 2.7
Pin 10 - 2.0
Pin 11 - 2.0
Pin 12 - 1.3
Pin 13 - 0.0
Pin 14 - 0.0
Pin 15 - 0.0
Pin 16 - 2.0

SAFETY

Never put up an antenna over or under power lines since contact with these would carry high voltage straight into your shack....destroying you and your equipment simultaneously.

Never use the earth pin on the 240 volt socket for your antennas or experiments - this could be extremely dangerous. When an earth is required always use the water tap or a metal pole hammered deep into the ground.

FRONT AND BACK PANEL WIRING DETAILS

Ensure that the LED and channel switch are fitted before fitting the front panel.

The front and rear panels are easily mounted by placing the main PCB in the bottom of the transceiver case and securing with the screws provided. Insert the front and rear panels into the slots at either end of the case. Bend the three PCB pins located at the extreme edges of the main PCB so they touch the front and rear panels. Solder these pins to the panels.

Now remove the screws securing the main PCB to the case and remove the entire assembly. Turn the assembly over and reinsert into the case slots. The next job is to flow solder along the mating edges of the front and back panels, and the main board.

WARNING!! If you intend to upgrade the unit for Repeater operation, only solder at a few points between the front panel and board as a new front panel is supplied with the upgrade kit.

VCO SHIELD

The VCO must be both shielded and mechanically protected to ensure stability. The shield is constructed from the strip of thin, double - sided, printed circuit board.

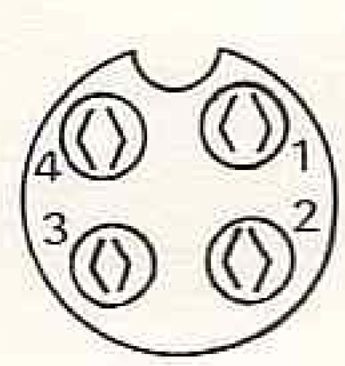
As previously noted, the four PC pins are inserted from the copper side of the board to form anchor points for the VCO shield. The reason the pins are inserted from under the board is to prevent the collar on the pins from splaying out the VCO shield sections.

The shield itself is soldered to these pins. Cut the blank PCB, (scissors will do the job), into strips long enough to allow them to be soldered to the pins, forming a rectangular box with the pins in each corner.

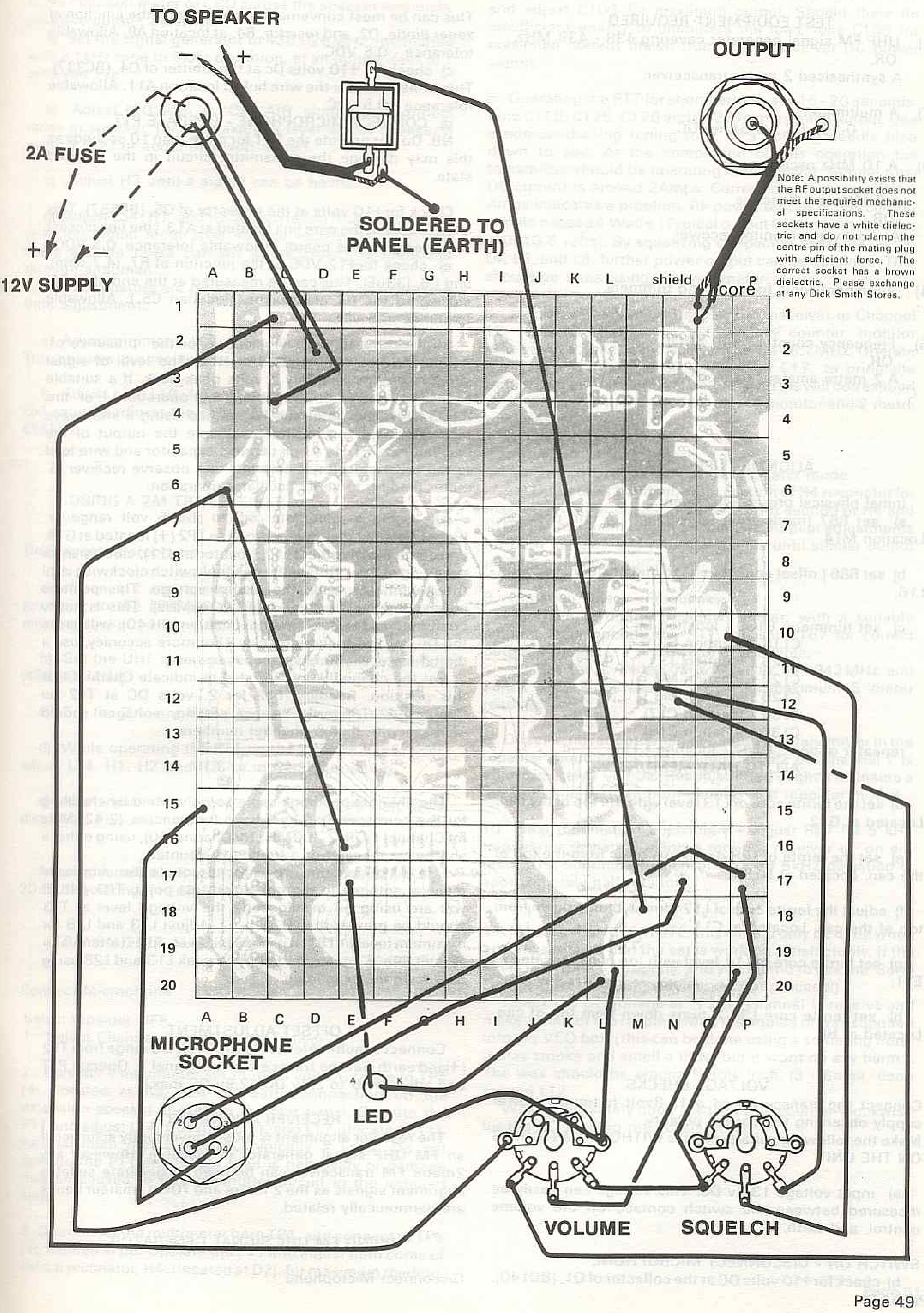
When the alignment and setting up procedure is completed, (NOT BEFORE!!), the VCO box is to be filled with the wax supplied for mechanical stability. This is normally found enough to ensure correct operation and prevent microphonics.

In some cases where high ambient noise forces the use of high volume from the internal speaker, microphonics may still occur despite the shield and wax. In this case, the use of the PC pins allows a second shield to be fitted under the VCO. (Another way of avoiding this problem is, of course, to use an external speaker in noisy environments).

MICROPHONE WIRING DETAILS
(Front View of Microphone Plug)



1-------yellow
2-------black and braid (earth)
3-------not used
4-------red


TO SPEAKER
– +
OUTPUT
2A FUSE
SOLDERED TO PANEL (EARTH)
+ –
12V SUPPLY
Note: A possibility exists that the RF output socket does not meet the required mechanical specifications. These sockets have a white dielectric and do not clamp the centre pin of the mating plug with sufficient force. The correct socket has a brown dielectric. Please exchange at any Dick Smith Stores.
A B C D E F G H I J K L shield core P
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2
3
4
5
6
7
8
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10
11
12
13
14
15
16
17
18
19
20
A B C D E F G H I J K L M N O P
MICROPHONE SOCKET
LED
A K
VOLUME
SQUELCH

TEST AND ALIGNMENT PROCEDURES

TEST EQUIPMENT REQUIRED

1) UHF FM signal generator covering 438 - 439 MHz.
OR,
A synthesised 2 metre transceiver.

2) A multimeter
0-15v DC... 0-5Amp DC

3) A 10 MHz oscilloscope
OR,
A 5 MHz oscilloscope
OR,
A short wave monitor receiver.

4) Alignment tools for coils and trimmers.

5) Frequency counter (500 MHz)
OR,
A 2 metre amateur transceiver.

ALIGNMENT PROCEDURE

Initial physical preset adjustment.

a) set R67 (modulation adjustment) to mid position. Location M14.

b) set R86 (offset adjustment) to mid position. Location L16.

c) set trimmers C109 (location E6)
C118 (location G3)
C125 (location J3)
C127 (location M4)
C126 (location M3)
C134 (location C17)
C136 (location C18)
repeater option C167 (location C19)
ALL TO HALF MESH.

d) set the ferrite core of L13 level with the top of the can. Located at G12.

e) set the ferrite of L28 down two turns from the top of the can. Located at D15.

f) adjust the ferrite core of L17 former 2 turns down from top of the can. Located at C11.

g) set ferrite core of L14 level with top of can located at E11.

h) set ferrite core L34 2 turns down from top of can. Located at H8.

VOLTAGE CHECKS

Connect the transceiver to a 13.8volt (nominal) power supply observing the correct polarity.
Make the following voltage checks WITHOUT SWITCHING ON THE UNIT.

a) input voltage 13.8v DC. This voltage can easily be measured between the switch contact, on the volume control, and earth.

SWITCH ON - DISCONNECT MICROPHONE

b) check for+10 volts DC at the collector of Q1, (BD140). This can be most conveniently measured at the junction of zener diode, D2, and resistor, R4, at location A8. Allowable tolerance - 0.5 VDC.

c) check for +10 volts Dc at the emitter of Q4, (BC337). This is measured at the wire link at location A11. Allowable tolerance - 0.5 vDC.

d) CONNECT MICROPHONE - OPERATE PTT

NB. Do not operate the PTT for more than 10 seconds as this may damage the transmitter circuit in the untuned state.

Check for+10 volts at the collector of Q5, (BC557). This is measured at the wire link located at A13, (the link closest to the edge of the board). Allowable tolerance 0.5 VDC.

e) check for+12 VDC at the junction of R7, (4.7 ohm), and C6, (33uF). This can be measured at the end of R104, closest to the C3 electrolytic.(location C5). Allowable tolerance 0.5 vDC.

f) Using a 10 MHz cro, check for the presence of 8.5333MHz at TP1, located at H16. The level of signal should be approximately 2 volts peak-peak. If a suitable oscilloscope is not available, the operation of the 8.5333MHz oscillator can be verified using a shortwave receiver tuned to 8.533MHz. Couple the output of the oscillator at TP1 via a 1pF ceramic capacitor and wire lead to the receiver antenna terminal and observe receiver 'S' meter reading to verify oscillator operation.

g) Using a multimeter set to the 5 volt range or higher, connect multimeter probe to TP2 (+) located at G14, and earth. Slowly adjust L12, (located at J11), clockwise for a reading of 2.5v. Rotate the channel switch clockwise until the multimeter reads the lowest voltage. This position corresponds to Channel 1 (438.025MHz). This is easily confirmed as the next channel position (CH 40), will cause the DC voltage to jump quickly. (For more accuracy, use a digital meter if you have access to one.)

Set the channel knob and dial to indicate Channel 1 at this position. Readjust L12 for 2.7volts DC at TP2 on Channel 1. To verify correct setting, voltages should increase with higher channel numbers.

CH 1 ....2.7V
CH 40......... 3.1V

The channel positions can also be verified by checking for the corresponding mix-down frequencies, (2.425MHz for Channel 1 OR, 2.750MHz for Channel 40), using either a shortwave receiver or a frequency counter.

Use a 1pF ceramic capacitor to couple the shortwave receiver antenna to the mix-down test point, TP3. (NB. If you are using an oscilloscope, the voltage level at TP3 should be greater than 0.5v p-p.). Adjust L13 and L28 for maximum level at TP3. If using a receiver, adjust attentuator for suitable 'S' meter reading then peak L13 and L28 using half-scale meter reading.

OFFSET ADJUSTMENT

Connect a multimeter set to the 5volt DC range from TP2 (+)and earth. Set the transceiver to Channel 1. Operate PTT and adjust R86 to 2.7v DC. (2.9v DC max.).

RECEIVER ALIGNMENT

The receiver alignment is most conveniently achieved if an FM UHF signal generator is available. However any 2metre FM transceiver can be used to generate suitable alignment signals as the 2 metre and 70cm amateur bands are harmonically related.

USING FM UHF SIGNAL GENERATOR

Disconnect Microphone

With the receiver squelch control set fully anti-clockwise and the volume set to a suitable level, and the signal generator connected to the antenna socket, connect an audio milli-volt meter or CRO across the speaker terminals, (observe correct polarity).

a) Set the signal generator to 438.025MHz, modulated with a 1kHz tone to 3kHz deviation, at an output level of 1 milli-volt PD.

b) Adjust L10 with an 'OFF AIR' signal for maximum noise in speaker, (or for maximum level across speaker if using a CRO or audio milli-volt meter).

c) Adjust H3 until a signal can be heard.

d) Adjust L34, H1, and H2 for maximum recovered audio, reducing signal input level so that recovered audio has some audible noise content as sensitivity is improved through alignment.

NB. Resonators are preset at the factory and need very little adjustment.

e) Adjust trimmer, C136, for maximum recovered audio. This ensures the reciever is 'on frequency'.

f) Adjust coil, L10, for minimum audio distortion. This coil actually adjusts the centre frequency of the IF strip to 455kHz.

USING A 2M TRANSCEIVER

Disconnect Microphone

a) Place a 2 metre synthesised transceiver in close proximity to the UHF transceiver and terminate the the antenna socket with a suitable antenna or dummy load.

b) Set the UHF transceiver to the Channel 12 position (438.300MHz).

c) Set the 2 metre VHF transceiver to 146.1MHz.

d) While operating the PTT on the 2 metre transceiver, adjust L34, H1, H2 and H3 for maximum quieting.

e) Also adjust L10, located at L12, for minimum audio distortion. This is best done by using an 'OFF AIR' signal.

RESULTS

A typical receiver will easily achieve 0.5uV sensitivity for 20dB of quieting, (12dB SINAD).

TRANSMITTER ALIGNMENT

Connect Microphone

Select repeater OFF.

1. Select Channel 1 on UHF transceiver.

2. Connect a multimeter set to the 5 volt DC range to TP4 (+), located at B9, and the earth connection on the extension speaker socket on the rear panel. Operate the PTT and adjust L14, (located E11), and L17, (located C11), for maximum meter reading, typically 2 volts. Do not operate the PTT any longer than is necessary or damage may be caused to the transmitter circuit in the untuned state.

3. Disconnect the multimeter from TP4, and connect to TP5 (+), located at C6. Operate the PTT and adjust both cores of helical resonator, H4, (located at D7), for maximum reading.

4. Connect a dummy load to the antenna socket of the transceiver. The Dick Smith D7024 light globe load is suitable as an indicator for this purpose. Operate the PTT and adjust C109 for maximum output. Should there be insufficient energy to illuminate the load, tune C109 for maximum current drawn from the transceiver DC power supply.

5. Operating the PTT for short periods, say 15 - 20 seconds, tune C118, C125, C126 and C127 for maximum output. Use a non-conducting tuning tool, or a knitting needle filed down to suit. At the completion of this operation the transmitter should be operating at full power. Normal total DC current is around 2Amps. Current drain in excess of 2 Amps indicates a problem. RF power output at this current should exceed 4 Watts. (Typical output 5 Watts at 1.8 Amps with 13.8 volts). By squeezing or spacing the turns on L3, L4, L5, and L6, further power output can be obtained. This should be done using a power meter.

6. Frequency alignment - set UHF transceiver to Channel 12, (438.300MHz) using a frequency counter, monitor receiver or a 2 metre transceiver set to 146.1MHz. Operate the PTT and adjust C134, located at C17, to bring the transmitter onto the correct frequency. This will correspond to maximum 'S' meter reading on the monitor and 2 metre transceiver.

7. Repeater Offset - Power.

a) Switch UHF transceiver to repeater mode.

b) Operate PTT and tune rear section of H4 resonator for maximum output power, then tune front section of H4 and C109 for maximum output on simplex. Repeat adjustments for both simplex and repeater modes until similar output powers are acheived.

8. Repeater Offset - Frequency.

a) Using a digital frequency meter, with a suitable sniffing loop, operate the PTT and set C167 for correct output frequency. If a DFM is not available,

Set the 2 metre transceiver to 144.342MHz and adjust C167 while operating PTT, for maximum 'S' meter reading.

9. Offset verification - when operating the transmitter in the repeater mode check that voltage at TP2 on Channel 1 is approximately 1 volt DC. Readjust VR86 slightly to ensure a 'locked condition' on both simplex and repeater modes.

10. Final modulation adjustment - adjust R67 for 5 kHz transmitter deviation using a monitor receiver or 'on air' tests. The nominal position of R67 for 5kHz deviation is approximately half rotation.

11. Waxing the VCO. (NOTE: this should only be done when you are satisfied that the set is working satisfactorily. If the set is not working properly, and you intend to use the 'Sorry Dick It Doesn't Work' service, do not proceed!).

Check the DC voltage at TP2 on channel 1, receive and make a note of the reading. Melt the square of wax supplied into the VCO box, (this can be done using a soldering iron - it may smoke and smell a little, but it wont do any harm.). The wax should be around ⅛ to¼ inch, (3 - 6mm), deep around L12.

When completely cool, readjust L12 counter-clockwise for the DC reading previously noted.

EXPLORER UHF TRANSCEIVER KIT

Trouble Shooting Guide

As an addendum to the construction manual, we have written this short trouble shooting guide to assist you with difficulties you might come across. It covers most of the common problems we have found while building our own prototypes.

DESC	TEST POINT	GRID REF.	APPROX. METER READING	REQ. RES
Offset Osc. 150 MHz output	-	D 16	4 uA	-
Mix Down Level	3	G 15	20 uA	-
10.245 MHz Osc. Pin 1, IC 2	-	M 9	8 uA	-
Ref. Osc. 8.5333 MHz	1	H 16	28 uA	68k
Output of H3, RX Tripler	-	G 6	5 uA	-
VCO Output, Transformer end of C91	-	F 12	fsd	68k

Table of Test Probe Measurements

Readings may vary by up to 50%, a zero reading at any test point should be investigated further.

Surprisingly you will find that the problems that cause the most concern are relatively easy to avoid and fix. Look for solder bridges between adjacent circuit board tracks. Check for the correct placement and orientation of components, especially check for an incorrect component such as a 4.7pF capacitor instead of the 47pf capacitor it should have been. Check, and double check the orientation of transistors,diodes and electrolytic capacitors.

If all the above seems in order, proceed as follows.

On page 47 of the construction manual you will find a table of semi-conductor and IC voltages. With the power on check the audio stage first.

For this stage to work correctly, two supply voltages are needed : nominal 13.8 volts DC at the collector of Q11 and 10 volt (RX) measured at RX link, grid reference, J16.

With an audio signal applied to the top of the volume control, suitably adjusted, the audio signal should be heard in the speaker.

Next, check the operation of the squelch control. Setting the control fully counter clock-wise you should be hearing noise in the speaker. Double check the wiring of the squelch control.

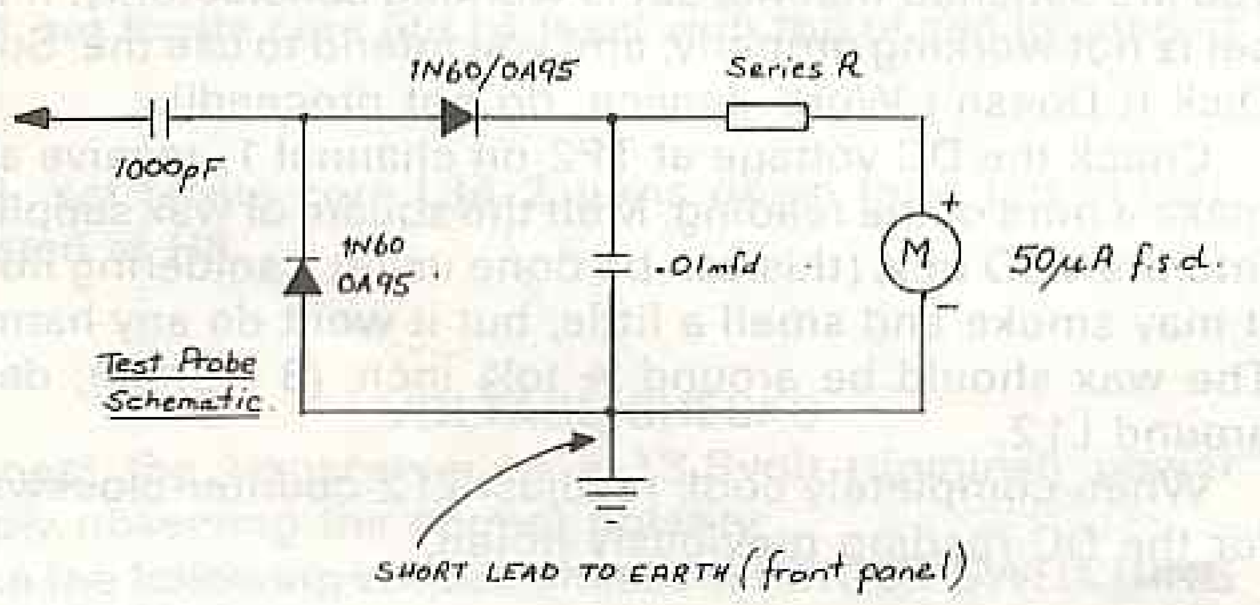
Touch the optional crystal filter PCB link, grid reference, K8, and you should hear some music. If a test signal of 10.7 MHz is available, even from the I.F. of another receiver, connect this to the link mentioned to check the operation of the I.F. (IC 2).

Next step - the Phase Lock Loop

As this circuit functions in a closed loop, all sections must be operating for a lock condition to exist.

(a) Reference Oscillator at 8.5333 MHz must be working and present at TP 1 at approximately 2 volts peak to peak.

(b) Offset Oscillator must be working and a test point is proved at grid reference, D16. A test probe connected to a sensitive meter can determine if all is well in this section. (Only a small reading will be obtained, approximately 10% f.s.d.). The circuit below shows a test probe capable of being used in this check.



(c) VCO. When the VCO is out of lock, TP 2 will normally be high, typically greater than 5 volts DC. Remember, high voltage - less capacitance across the oscillator and the higher the frequency of the oscillator.

To check operation of the VCO, measure the frequency at the output of L13, (transformer end of C91). This should be approximately 150 MHz, now short TP 2 to earth (negative supply), and the VCO frequency should drop by about 5 MHz.

If all the above is correct a sine wave of of approximately 0.5 to 1.0 volts peak to peak should be present at TP 3 with a frequency of around 2.5 MHz. This should vary when slowly adjusting L12.

With all the above correct, and if no lock condition exists, suspect IC 1 as faulty.

The VCO and PLL are the most complicated sections of this circuit and any fault in these sections will cause an 'out of lock', and no transceiver operation.

If you still have trouble with this section of the transceiver, a fellow amateur who has had experience with this type of circuit should be able to offer assistance. Comparison with a working unit is very helpful if you have access to such a unit.

Remember, a DC voltage check can be very helpful when trouble - shooting.

PROBLEMS ENCOUNTERED IN SOME PROTOTYPE KITS

A series resistor of 2.2k may be required in the centre arm of Volume Control if audio squeal is noticed when volume is fully counter clockwise, (lowest volume).

A larger heatsink on RF output transistor will reduce power sags.

In some transceivers, I.F. instability around FL 1 has been noticed. Earthing FL 1 case to L34 will help cure this fault, if not, remove L 34 from PCB with solder braid, cut off middle pin on the primary side of the transformer and reinsert at 180 degrees. The pin is cut off so as to allow L 34 to fit the opposite way around. This will cure the fault.

FINISHING OFF

Once you are satisfied the transceiver is properly working and aligned, (including VCO shielded and filled with wax), it should be assembled into the case.

The speaker drops into the well provided in the bottom half of the case and is held in place with a glue, such as Silastic or Araldite, around its edges. DO NOT over-glue as you may end up with the cone or voice coil impregnated with glue and wonder why the speaker doesn't work really well!

Follow the wiring diagram on page 49 for all other off-board components. Try to keep the wiring as short as possible while keeping it neat.

When fixing the front panel, note the comments about 'tacking' if you intend to upgrade your transceiver for repeater use. A new front panel is supplied with the Upgrade Kit so you must be able to remove the old panel from the main board.

The channel indicator plate must be glued onto the channel selector knob before the knob is placed on the switch shaft. First make sure the set is on channel 1 and the indicated position of the plate is channel 1 when the knob is in position. The plate is glued onto the knob with super glue or similar.

THE REPEATER OPTION KIT

The Dick Smith Explorer UHF Transceiver is designed for simplex operation. If operation through any of the amateur repeaters is required the repeater upgrade kit should be fitted.

This kit gives a minus 5MHz offset when the repeater switch is on - that is, the transmit frequency is 5MHz below the receive frequency. This allows standard 70cm repeater access.

A further refinement offered by this kit is the provision of an 'S' meter together with the required driving circuitry. This is on a seperate PCB which is fixed to the main transceiver PCB by means of PC pins.

The upgrade kit also includes a deluxe front panel cut ready for the 'S' meter and repeater switch. This panel replaces the existing basic front panel.

The upgrade kit is available from any Dick Smith Electronics store for just $24.50. (Cat. K-6302)

We would like to hear from you.....

We are very proud of this Australian designed kit - the first of its kind for home construction. Many thousands of hours have gone into its development to give you the best possible kit at the lowest possible price.

However, we're not so naive as to believe it is absolutely perfect. Some amateurs, (particularly the UHF wizz's), building this kit will have ideas on how it could be improved, or perhaps how component substitution could lower the cost even more.

If you have any ideas on this kit, we would like to hear from you. Please write to:

Dick Smith Electronics
UHF Transceiver Project
PO Box 321,
North Ryde, NSW 2113

INSTALLATION OF A MOBILE TRANSCEIVER

Most amateur operators will have operated mobile; however, if this is the first time you have contemplated 'going mobile' with a transceiver, the following may be helpful.

Safety.

Because operation of the transceiver must in no way interfere with safe operation the vehicle itself, consideration must be given to the proper location of the transceiver.

Select a position which will not interfere with any of the controls, (gear stick, pedals, etc), or which will allow such things as as the microphone cable to wrap around objects, (such as the steering wheel!).

Properly dress all cables so that they too cannot interfere, and make sure any exposed connections are well insulated. There are few things more disconcerting than driving along with smoke bellowing from under the dashboard, (apart from roaring flame maybe?).

Vision too must not be impaired - either directly or indirectly. If you have to take your eyes off the road for more than a split second to see the set, it is in a poor location. However, it must not obstruct vision or distract you either.

Mechanical Considerations.

Make sure your transceiver is firmly mounted with the bracket supplied. A motor vehicle is a harsh environment for a piece of precision RF equipment - the tighter you can mount it the better.

Sound Quality.

The speaker has been mounted on the bottom of the transceiver to compensate for the usual under dash mounting problems associated with conventional mobile units. This, of course, means the unit should not be mounted too close to the floor, especially carpeted floors, as sound quality could be impaired. If the volume has to be wound up too far to compensate, microphonic problems with the VCO may result.

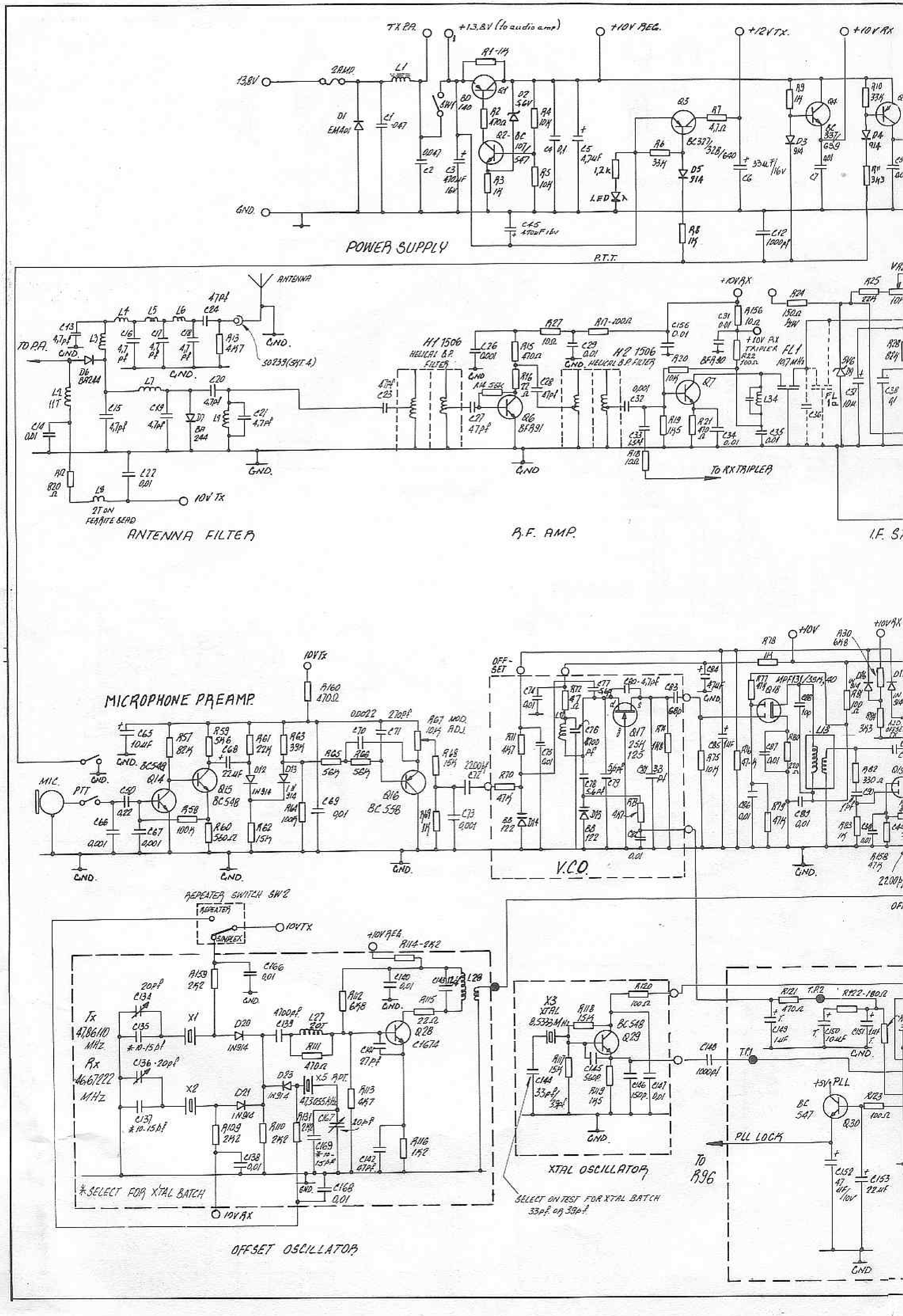
Using the Dick Smith Explorer as a Base Station

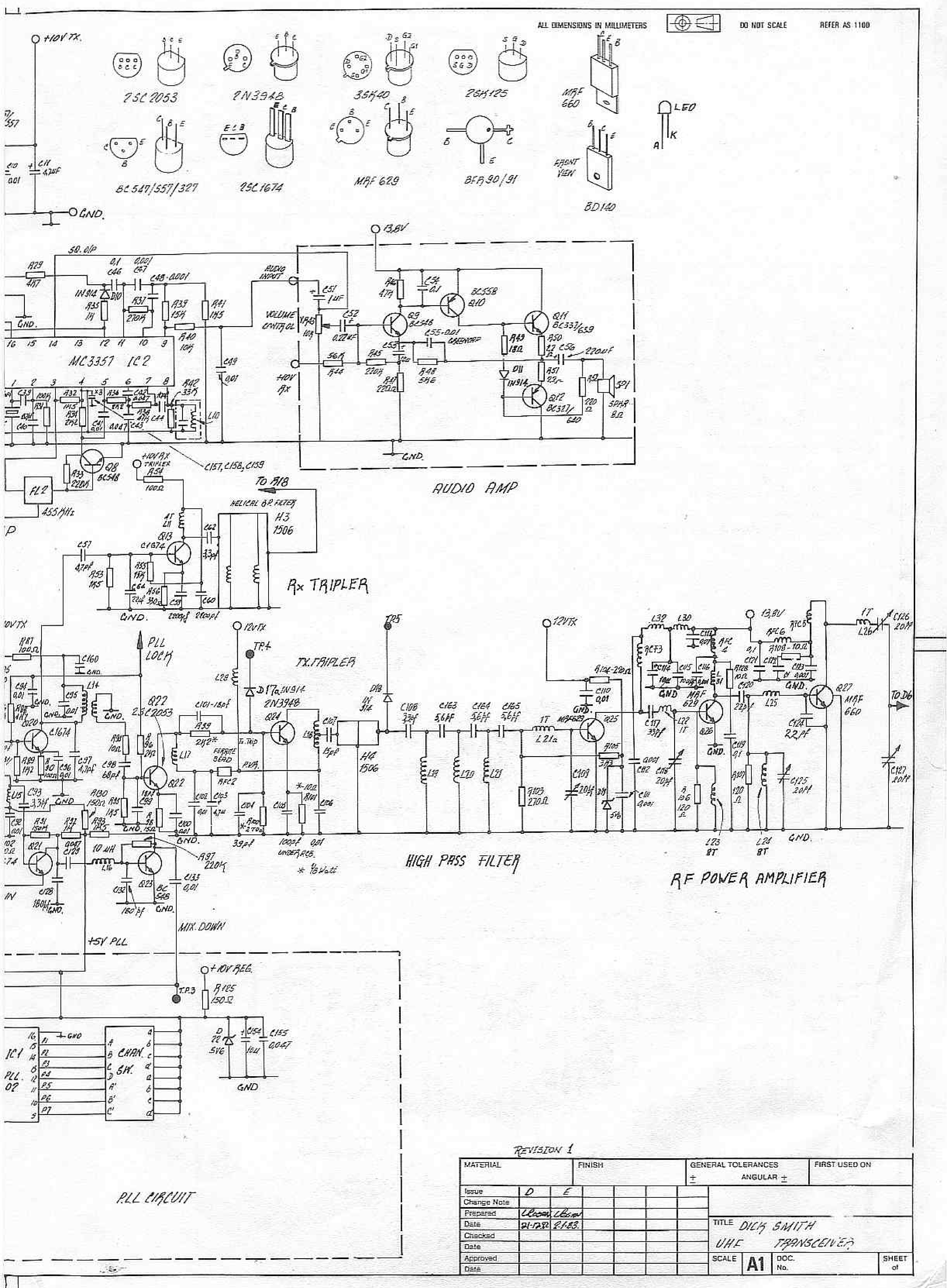
The Explorer makes an ideal 70 cm base station, especially when teamed with an efficient antenna system. The following points should be noted:

(1) An adequate power supply must be used. As the transmitter draws almost 2 Amps, this is the minimum power supply requirement. Obviously, a higher capacity supply would be better - our VK Powermate Kit is ideal for this transceiver with a 5 Amp continuous rating. (Cat. K-3449)

(2) Be careful which co-ax cable you use. Most co-ax sold in Australia is not suitable for long runs at UHF. Very short runs (eg. a few metres or so) would be okay, but if you want to run across a yard and up a tower, you really should give consideration to using special low loss UHF co-ax, (RG213 is recommended). Its not cheap, but you won't lose all your signal either!

(3) The better the gain of the antenna you use, the better the results will be. Several designs exist for do-it-yourself 70 cm antennas - try references such as the ARRL Antenna Book, ARRL Handbook, etc.


POWER SUPPLY
13,8V
GND.
+13,8V (to audio amp)
+10V REG.
+12V TX.
+10V RX
P.T.T.
ANTENNA
TO P.A.
10V TX
ANTENNA FILTER
H1 1506 HELICAL B.P. FILTER
H2 1506 HELICAL B.P. FILTER
TO RX TRIPLER
R.F. AMP.
MICROPHONE PREAMP.
MIC.
PTT
MOD. ADJ.
OFF-SET
V.C.O.
REPEATER SWITCH SW2
REPEATER
SIMPLEX
10VTX
Tx 47,86110 MHz
Rx 46,67222 MHz
*SELECT FOR XTAL BATCH
10V RX
OFFSET OSCILLATOR
X3 XTAL
XTAL OSCILLATOR
SELECT ON TEST FOR XTAL BATCH 33pF OR 39pF
PLL LOCK
TO R96
GND



ALL DIMENSIONS IN MILLIMETERS
DO NOT SCALE
REFER AS 1100
2SC2053
2N3948
3SK40
2SK125
MRF 660
LED
BC 547/557/327
2SC1674
MRF 629
BFR 90/91
BD140
FRONT VIEW
+10V TX.
GND.
+13.8V
MC3357 IC2
AUDIO INPUT
VOLUME CONTROL
AUDIO AMP
455KHz
TO R18
HELICAL B.P. FILTER
H3 1506
Rx TRIPLER
PLL LOCK
TX.TRIPLER
H4 1506
HIGH PASS FILTER
RF POWER AMPLIFIER
TO D6
MIX. DOWN
+5V PLL
+10V REG.
CHAN. SW.
GND
P.LL CIRCUIT
REVISION 1
MATERIAL
FINISH
GENERAL TOLERANCES
ANGULAR ±
FIRST USED ON
Issue D E
Change Note
Prepared
Date 21-12-82 21-1-83.
Checked
Date
Approved
Date
TITLE DICK SMITH UHF TRANSCEIVER
SCALE A1
DOC. No.
SHEET of