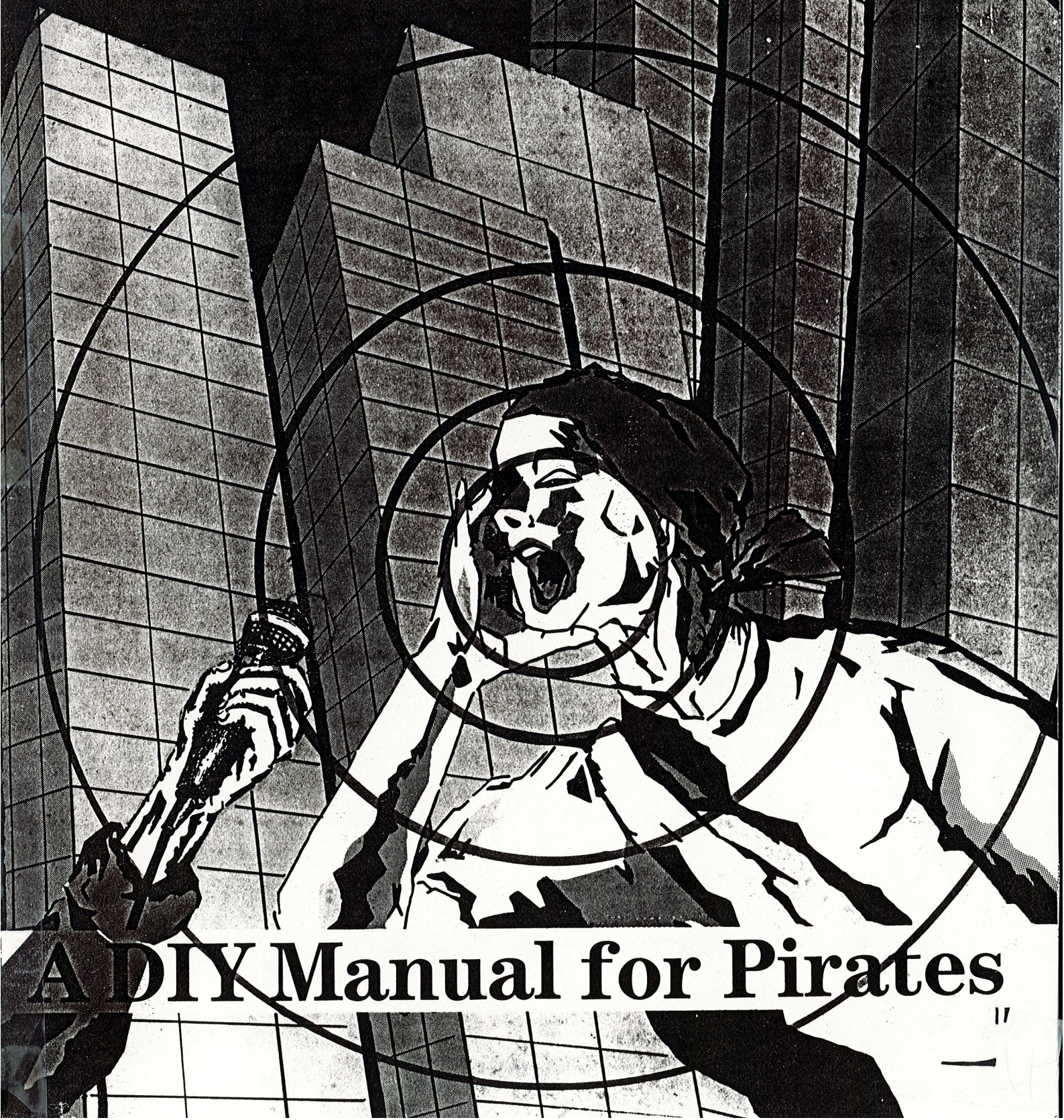


RADIO IS MY BOMB



A DIY Manual for Pirates

Hyvä Vapaa Radio -ystävä,

Tähän saakka on Suomessa ollut vaikea saada käsiinsä AM/FM -radio-lähettimien rakennus- ja kytkentäkaavioita. Hajanaisia kaavioita on ollut saatavilla, mutta mitään yhtenäistä esitystä ei ole ollut olemassa.

Tämän kirjasen syntyyn on johtanut useiden vuosien keräily ja materiaalin arkistointi, ja lukuisten ihmisten aseman perustamista ja lähettimien rakentamista koskevat kyselyt. Tämä kirjanen on koottu lukuisista eri lähteistä Suomessa, Hollannissa, Ruotsissa ja Englannissa. Sen vuoksi osa materiaalista voi olla hiukan vanhanaikaista, mutta silti käyttökelpoista. Osa tiedoista taas on varsinkin Englannin erityisoloja varten kirjoitettu, mutta informaatio on helposti jokaisen sovellettavissa Suomeen.

Kirjanen pyrkii antamaan perustiedot Vapaan Radioaseman perustamisesta, ULA- ja lyhytaaltolähetin tekniikan perusteista, antennien ja yleisradiolähettimien rakentamisesta. Mukana myös harvinaisia kaavioita mm. FM-stereokooderin rakentamiseksi. Erityiset kiitokset menevät seuraaville tahoille: Jerry Dayton, Hooligaan Press & Free Radio Magazine.

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The title 'Radio Is My Bomb' comes from a quote from Chantal Paternostre, a Belgian anarchist, when being interrogated on trumped up charges of arson and bombings for the CCC guerillas. Chantal worked for Radio Air Libre, the Brussels pirate prior to her arrest on Aug 15th 1985. After more than a year in prison, most of it in solitary for resisting the system, the Belgian authorities finally believed her statement and let her go.

Toivottavasti kirjasesta on hyötyä ja pitäkää hauskaa!
 Saatavissa osoitteesta FRC-F, PL 82, 40101 JKL hintaan 50 markkaa.

How To Be

A Radio Pirate

What You'll Need

- A group of committed people who get on with each other and have plenty of time and energy.
- A programme, presuming you have something worth saying or playing. You don't even need a studio to start off with. Just borrow someone's stereo and a microphone and start making practice recordings onto good quality cassette tapes.
- A Transmitter. Ideally over 10 watt power, but 5 watt is fine for local broadcasts, or when using an aerial with 'gain' (see Technical section). You can't buy one over the counter in Britain, but here are some alternatives:

- 1) Buy one from another pirate (beware of rip-offs).
- 11) Buy one over the counter abroad (see Contacts).
- In Italy for instance you can get a high quality 50W transmitter over the counter for £200. You can buy kits in Belgium, France, Netherlands, USA, etc. You then have to smuggle it home.
- 111) Build your own. A hobbyist can build a low power FM transmitter from the instructions in this book. You can add on amplifiers later if you need more power.

Try to interest radio

VHF : Pros and Cons

First lets deal with FM (Frequency Modulated) broadcasting, which is your probable choice. The advantages of FM are many. The transmitters are small, light and quite cheap. Reception tends to be either very clear or non existant. Its excellent for music and for recording off and can quite easily be adapted to transmit in stereo (impossible with AM). A major plus for the pirate is that its easy to hide and transport the gear, aerials are comparatively small and can be made collapsible. Its also possible to put it in a vehicle, even a bicycle, and go mobile, albeit with a smaller and changing reception area. The average 5 to 20 watt transmitter would be in a metal box not bigger than 12" by 6" by 3" in size, and weigh not more than 8 lbs with the rest of the gear (but not including the car battery if you're using one). The aerial is not only shorter but more efficient and of course more practical than the long and tricky procedure for MW aerials. Also low power FM transmitters ('rigs') can be tuned to slightly diff-

This section tells you exactly how to go about setting up your own radio pirate, with all the tips learned from bitter experience. First of all here's a list of the main things you will need. So you want to be a radio pirate?...Read On.

hams or dissident engineers. Its almost essential to have at least one person in your group with some technical know how.

1V) Get one built to your specifications. There are a few electronics engineers about who will build them for a reasonable price. Obviously we can't publish their names and addresses. If you write to the obvious addresses on the Contacts Page we may be able to give you a box number to contact.

D. Antenna (aerial). You can adapt a design yourself from an antenna book (eg. The 2 Metre Antenna Handbook: Babani or Tabs books, or an Amateur Radio handbook). Or use one of our ready made designs (see Tech. Section). Look out for aluminium tubing or struts (on skips) which make good building material.

E. Odds and ends. You'll need basic tools (also look out for soldering iron, multimeter, SWR meter), a cheap cassette deck, probably one or two good car batteries, a roll of co-ax cable for the aerial, a radio to listen in on, etc. Also start collecting and reading Amateur Radio Handbooks and all relevant writings..

KEEP YER PEEPEERS WIDE FOR ABUV STUFF!!

erent frequencies, on MW you're stuck on one, unless you get a new crystal.

The disadvantage is that VHF -FM is essentially a 'line of sight' communication...Which means that your reception area depends crucially on the height of your aerial above large blocking objects. This is no problem if you can get up on a hill, or a tower block but it does restrict the choice of broadcasting sites, making you easier to find and trap. With local broadcasting you have more choice of sites. In very hilly areas, unless you can get up on a mountain, you'd better choose MW, also if you want to broadcast to scattered communities over a wide area. Distance covered with an FM rig depends as much on height as on power. A 40 watt rig on a 15 story tower block should cover a 15 mile radius if there are no blocking hills. A 4 watt rig should go 5 miles from the same height, but if you build a directional aerial with 'gain' you can multiply that power many times. You don't really need a big expensive and hard to build trans-

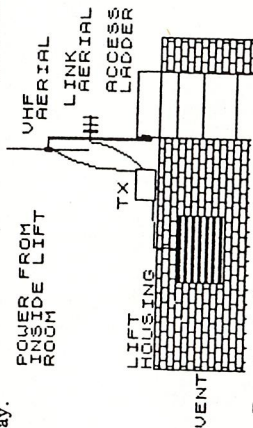
itter. Also don't assume a 100w rig is ten times as powerful as a 10w one it doesn't work like that.

To sum up, FM broadcasting is the ideal for the guerrilla or community pirate, cheap, mobile and adaptable. Another advantage is that there's loads

The Broadcasting Site (FM).

TOWER BLOCKS

In cities tower blocks have been an ideal answer for good coverage and wide reception, and are especially favoured by commercial pirates (who often use a 'Link Transmitter' from the studio to the tower block so as to 'go live'). A further advantage is that there are usually electric sockets in the lift or heating rooms on the roof, so you can just plug in, provided your gear is so adjusted, rather than lug car or lorry batteries about. This is 'Stealing Electricity' of course, if you're caught broadcasting the Electricity Board could bring this additional charge, though in practice we've never heard of it happening.. The advantage of sticking to car batteries is that you can conceal your rig anywhere on the roof, rather than having it right by the plug socket, though in a surprise raid your aerial cable will lead them straight to it any way.



To get onto the roof of a Tower Block you need a crowbar or better a key. The 'firemans keys' have to be standard for all blocks, so once you have one you can get onto most roofs easily. Try asking other pirates, or possibly a friendly caretaker or fireman. Or you can break the door, steal the mortice lock, get keys made up for it, then replace it, such keys may not fit all roofs.

When on the roof BE CAREFUL (sudden gusts of wind can blow you over at this height!) and always wear soft shoes and keep quiet. Lots of people have been busted simply because the tenants below heard them and called the police. Its useful to dress like a repair person, and claim if seen or challenged, to be a lift mechanic. The main problem with Tower Blocks is that, if raided, you can easily be trapped. (See How To Get Away With It.)

MEDIUM SIZED BUILDINGS

If you're a local station, or have a high power rig or an aerial with 'gain' (or if you're just testing) you don't need to be on a Tower Block. Any building higher than most others will do, and you can increase your height, for instance by mounting your aerial on top of a high, well secured scaffold pole (note: there must then be a wooden or plastic section between

of room on the FM broadcast band, its literally half empty, and there will be more when the police eventually move off it. On MW its pretty crowded, and at night you're likely to be blotted out by continental interference.

the pole and the actual aerial).

The advantage of lower buildings is that you can multiply both the available sites for broadcasting. You will have to switch sites as often as possible. Also you will have many more escape routes and 'bolt holes' than on a tower block. Unfortunately this may also mean you have to watch more potential approach routes by the police and DTI, and you'll need more lookouts if you're planning to save the gear when attacked.

BROADCASTING FROM HILLS (FM)

If your town or city has hills this is a good option, the higher the better. You can use a piece of derelict or common land, or at night you can use parks, cemeteries or even allotments. A better option is if there are hills outside the built up area, then use a field or wood away from houses. If you use the directional aerial you can cover the city just as well. This was done by Andromeda radio, to good effect, they used to cover most of Manchester from a high hill outside, using a mere 4 watt transmitter with directional 'gain' aerial. If you can get up into mountainous forests you're even better off and can adopt classical guerrilla tactics, often see the enemy coming miles away, and be very difficult to stop. (See example of Radio Dreyeckland, International Section, who were never caught.)

On a hill within the town or city use good lookouts, escape routes, CB's etc and have regular 'escape

VAL LORA
RADIO
LIBERTARIA
106.5 FM



in these circumstances. If possible make a 'live' studio in a tent, caravan or truck and get everyone involved. Try to get mentioned in pre-festival publicity, or do your own, so people will bring radios. This is pirate radio at its best.

DEMOS, especially long ones, like blockades for eg. of Nuclear Stations or War bases, can be equally worthwhile. (See Sheffield Peace Radio). In this context the pirate can be a perfect medium for discussion, information and warnings of police movements, as well as for entertainment and music.

BARRICADED SQUATS OR SQUATTED VENUES are another obvious and much underused site for the guerrilla pirate, especially during big meetings or gigs, which you can broadcast live from the roof. This has been done successfully for instance in Amsterdam and Berlin.

OCCUPIED FACTORIES or industrial areas during strikes and disputes provide an excellent and often missed opportunity for the more political pirate group, and can provide vital communication for mobilising, publicising and gaining support. There have been many such opportunities in Britain over recent years.

SIT-INS and protest occupations (eg. Greenpeace) are another good possibility, which we don't think has been tried. Especially occupations of high towers, buildings or pylons for publicity. But in this situation capture is pretty certain, therefore a small disposable transmitter would be ideal. A good strategy is for everyone to deny using it, and to use any following trial for more publicity, eg. on the lines that the army etc and police are already hogging most of the airwaves.

'NO GO AREAS' are a step up from occupied factories. We know for instance that nationalist pirates broadcast from Free Derry and parts of West Belfast when they were 'no go areas' to the state. Of course there are now no true 'no go areas' in Britain, but there are plenty of inner city estates where the police rarely venture, especially in the evenings in the riot season, for fear of 'concrete rain' or worse from the roofs. A high block in such an area could be an excellent site, especially if you can tip off the local youth to lend a hand. Whenever major rioting begins large areas are suddenly devoid of police, till they can group in numbers and re-take the area. This is another opportunity for 'on the ball' local pirates. By monitoring police radio, runners, and phoned in reports such 'uprising radio' could be a brilliant aid to the fighters on the streets (see Amsterdam in Int. Section) though you would need good security, disposable transmitter, quick getaway routes, disguised voices, etc.

LIBERATED ZONES ! (Let us know if you find one!) Practically every guerrilla or 'Nat. Liberation movement, be they right or left wing, has their own pirate radios, which are often a crucial influence in

such wars, broadcasting from freed zones or neighbouring countries. But you're not likely to come across this in Britain.

INTERNATIONAL WATERS is of course a favourite

How To Set Up Your Gear. (FM).

BEFORE YOU GO

Before setting out you had best brief everyone, especially newcomers, on what will or might happen. Talk about getting caught, for instance have good excuses made up for being at or near the site. If you are planning to give false names, for instance, you'll need an address where someone will confirm you live, otherwise you might have troubles getting bail if you were arrested. In this case keep your first names the same, to avoid being caught out. (See Legal Section).

Make out a standard 'check list' of all you need, and go through it before you set out. Its surprisingly easy to find yourself on top of a Tower Block, or climbing some tree, only to discover that your cassette deck lead is at home five miles away.

HERE IS A SAMPLE LIST OF THINGS YOU NEED
Transmitter (TX) / TX mains lead, or 2 clip on battery leads (large & well insulated) / TX lead to cassette deck if not attached / cheap cassette deck plus mains lead or 2 clip ons and 6 volt bike battery / charged up car battery 12 volt, if not on mains / Antenna (aerial) check you have the butterfly bolts if collapsible / the co-axial cable (with plug attached and clips or attached to aerial / fused plug board (if on mains) / programme tapes (rebound to starting position) / small FM radio receiver(s) to monitor broadcasts / CB's for lookouts, fairly essential, (£10 licence fee optional) / plastic 'gaffer tape' / soldering iron and solder in case of broken leads / torch / warm clothes / munchies / bus fare.

ON THE WAY

Ideally you need four people, at least two. Carry the gear as inconspicuously as possible, in holdalls or placky bags. The antenna is a problem. If its a big long one make it collapsible, using butterfly nuts in assembly. Or try to keep it somewhere close to the site. On arrival at the site, especially if you've used it before, send an emptyhanded scout ahead, to be sure the police and DTI aren't waiting for you and all is clear. Check also you're not followed.

SETTING UP

In the case of a tower block. You should have been there beforehand, and have either a key or a broken lock, to get straight onto the roof. Lock the door quietly behind you. If there's two doors onto the roof have access through both. Take your gear to the lift/ heating room and find a plug in wall socket

drills'. Best place for the aerial is a high, easily climbable tree. If its not too obvious leave it up there and have a spare ready. An added problem with hills is that you normally have to lug at least one car battery about, which is terrible if you have to climb fences, ditches, etc at night (wear gloves and old clothes against acid spills), something like a pram or shopping trolley can help. You can't leave the batteries on site as they need re-charging for your next broadcast. So mains electric is a big help if you can run a lead from somewhere. Outdoors all your gear must be in waterproof cases, or covered with a tent or tarp. Tents are good if you can pretend to be camping. Take care also of yourself and your group (you need at least two people, preferably four. Hot drinks, food, waterproofs, short shifts for lookouts, etc are good ideas. It gets boring after a few hours. CBs are excellent, but get ones with earphones if possible to avoid noise.

SOD THE HOUSEWORK!
I'M GONNA BE A RADIO PIRATE!!



If on a hill you can also use an ordinary house, flat, squat or derelict, and just set up your aerial as high as practicable on the roof (eg. sliding it up, atop a scaffold pole, through a skylight). Its better to get a place, by squatting or if you're rich, by renting, specially as a broadcast site, no one likes to live under constant threat of the police storming in. In practice you may have to use someone's house, then don't use it too often. If you must use your own place DON'T leave dope, stolen goods, false ID's or other naughties lying about. It is possible to run your antenna cable from your house to the aerial on another roof and whip the cable off quick if they come, but this would only work once, and you lose output power with every extra foot of co-ax cable going to your aerial. More of this in the 'How to get away with it' section. NEVER have your studio at the broadcast site. They'll confiscate the lot, under the new laws.

OTHER POSSIBLE BROADCASTING SITES

FESTIVALS, especially large free festivals are an excellent and common broadcast site. A small 4w rig will do fine. Set up on high ground in a tent or vehicle, and invite the festival goers to protect you from possible police attack, much more unlikely

site, but out of the question for the small 'do it yourself' pirate.

GOING MOBILE, from cars, vans or even bicycles is discussed with 'Guerrilla Radio' later in this Section.



avoid interference. Keep the din lead well away from the power leads. Interference between leads can often cause loss of power and/or "Sprogs" (unwanted signals on the wrong frequency). You can go so far as to block leads from each other with bricks.

Plug in the cassette deck and the TX to your plug board (or connect to batteries) and switch on. If you have that facility just switch on the 'exciter' stage of the TX first for testing, no need to alert Big Brother prematurely. Go to the other end of the roof with your radio receiver and tune in. Then adjust the modulation on your TX, in relation to other channels, to get the best sound. If that's OK but there is unusual knocking or crackling sounds try moving the cassette deck further from the TX, or raise it above ground if possible. Try further separating or screening the power lines from the din lead.

You may well find that you have sprogs (harmonics or spurious signals) all over the waveband. Check for this. If so check reception with your lookout

BROADCASTING.....HOW TO GET AWAY WITH IT

KNOW YOUR ENEMY

On a tower block, in London, the DTI squads can tell where you are, within 20 metres, less than 10 minutes after you switch on. So they can bust you any time. In the case of new pirates the procedure is to monitor you for a while (in case you're just messing about) before busting you. It could easily be a few months before your first attempted bust. If you play anything but straight music they will record and keep all your programmes for possible further use against you (though voice prints aren't used in court).

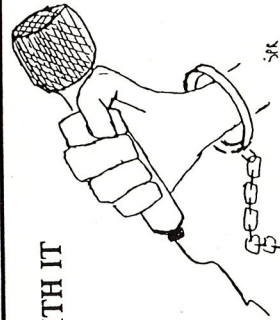
In other cities they are generally slower to get after you. In smaller towns they don't have permanent staff so will have to come specially, depending on your usual broadcast time, so switching your time is a big advantage.

The detection squads are now directed by the Home Office through the Department of Trade and Industry (DTI) and are officially responsible for stamping out "radio interference". They have recently been reorganised and upgraded with fancy new equipment. Their HQ is at Waterloo House by Waterloo Bridge and they have several other fixed triangulation stations in London, for instant tracking. We think their facilities are also connected to the GCHQ bases and M15. They use also mobile detection vans and lots of unmarked cars and have a depot in East London for vehicles and gear. We don't know where they keep their extensive horde of stolen transmitters prior to disposal. They also have their own radio frequencies, they used to be (and still may be) using around 86mhz, just off the commercial FM waveband.

The DTI squads are not supposed to arrest you, so they have to bring the local filth along on busts, which makes them a lot easier to spot and makes them less flexible as they often have to wait till the cops have the time free.

100 yards away, normally such sprogs disappear by that distance and you're OK. But if your signal is still spread all over further away switch off and clear off. Your TX is fucked up and needs difficult repair or tuning you can't do on site. If you find you're interfering with fire ambulance or pigs, stop, before they come after you. Most pirates are very careful not to do this.

When all checks out OK, insert your programme tape, switch off, and wait for the agreed time to begin. With practice you can easily set it all up and test it in 10 minutes, but its good to allow a half hour and be methodical and cool. Never, for instance, switch on your TX without the antenna attached, you'll blow it. The amp stage of your TX should get quite hot when drawing power, if not its not working. With bigger transmitters you may need also a small electric fan to cool the heatsinks on the power transistors. Once you're on air its good to go and phone friends for reception reports further afield.



For large rich commercial pirates the game is to have plenty of transmitters lined up, and not to try and save them if the police and DTI raid. They often use remote 'links' and can often switch on and off using timers or radio signals, so they don't have to go back and change tapes and no one need get caught in the act (but recently the DTI have cracked this by raiding the 'live studios' and nicking everyone and everything).

But for small community /political pirates with only one or two transmitters its essential to save the gear if at all possible. At the same time its now always cheaper to lose all the gear than to get caught and pay the fines. Nowadays even for the small pirate it may be more advisable to put energy into money raising and mass producing cheap transmitters than into trying to save the gear when they're hot on your trail (though you need to guard anyway against the curious and rip-offs by other pirates).

PRECAUTIONS

Don't talk or boast unnecessarily about your sites or studio. Work on a 'need to know' basis from the start. One method is to keep programme makers separate from your broadcasting team. Tapes can even be delivered to a 'dead letter drop' for instance. But if you can really trust each other its better if everyone takes a turn at broadcasting, otherwise the

broadcasters can both get pissed off and become a power elite ('I'm not transmitting this crap!').

Don't of course broadcast your location, real names or addresses. Don't give your phone number either, certainly in Britain, the days of phone-ins and instant access to pirates are numbered (see Legal Section). If you're really into phone-ins get a



THE RAID..SAVING THE GEAR

A) HIDING IT ON SITE

Some pirates have tried building the transmitter into walls, parapets, roof, chimney stacks etc. You can conceal it under water tanks, central heating or lift machinery. Better still have it hidden in a legal or squatted top floor flat (possibly 2nd to top would do) concealing your co-ax cable, either up the side of

the building, by boring a hole in the roof, or by running it up ventilation or 'sink' pipes. Another variation is to have your tape player in a flat, and a long concealed din lead to the TX on the roof. The possibilities are endless, and most have been tried. On one occasion Our Radio tried the 'dummy transmitter' trick, with its own dummy aerial, leading the hounds to one end of the roof, while they left by another door. Inside the transmitter box was a can of beer and a 'Booby Prize' note. In all these cases you still need to at least remove your co-ax cable before the baddies arrive, or of course it'll lead straight to your TX.

B) LOOKOUTS

You need two, preferably three, and take it in turns, and if possible also monitor police and DTI radio channels. You can use torches or signals from ground to roof. If on CBs turn them very low or use headphones, and use code words, they're very public. Watch out for cars or vans with too many aerials, electrical gear in the passenger seat, hanging around

trying not to look suspicious, police cars passing several times, etc. Keep an eye on nearby tower blocks or anywhere they may observe the roof with field glasses. A raid is usually obvious, two or three cars with uniformed police accompanying them (though piggies may be also in an unmarked car). They usually try and rush in a side or back entrance, so watch out.. its quite embarrassing to have all your friends nicked, and you still standing out front yawning! Usually they take the lift (sometimes using a 'firemans key' to bring it down fast) and often send a few young ones up the stairs.

C) CAT AND MOUSE

This involves moving and hiding the gear, in flats, stair cupboards, lift shafts, hanging out windows, disguised as something else, etc., etc....Normally they have no case if they can't find it, but under the new laws they might try to do you anyway if you're caught. If your lookout system works you have at least 2 minutes warning before they reach the top of

phone in a false name at a temporary address or squatted flat (NOT your studio). Tape the calls and check you're not followed there. For letters use a box number (BM boxes are best) and assume all mail is read, or use a forwarding address. When travelling to sites vary your means of transport.



the tower block. You can delay them by switching off the power in the lift room, but if doing this be quite certain you're not trapping anyone, which is difficult. You can call the lifts immediately, and if you get them first jam the doors open. You should practice for quick dismantling and packing of the gear in advance. Sometimes its easier to leave the antenna and build a new one.

A good simple 'Cat and Mouse' is to run down several flights of stairs with the gear, hide it in a good spot (the ideal is the flat of a 'neutral' friend) and turn into 'normal' citizens. If you get stopped have a good excuse for being there.

Cat and Mouse is a good system to start off with. But remember they have done it 1000s of times before. When they become determined to bust you you'll need more and more determined people and new broadcasting sites to stay ahead. After a certain point they're sure to catch you, as they learn more about you, your faces, your habits, your tricks, and as they put more and more men on the case. If you want to get away with it its time for a complete change of tactics.

D) DISAPPEARING

When the DTI are really on your tail one thing you can do is take a weeks rest, then come back with a different name, style and timing. Of course this fucks up totally your efforts to make a name for yourselves and gain a regular audience, but at least you're still on air, with maybe a few months grace before they start after you again. Also change your frequency and voices on tape if possible.

E) SWITCHING

In theory this is a good system, but you need a big team, your own transport, and two or three transmitters (on the exact same wavelength). The idea is this...as the police and DTI close in on one location, the signal switches to a second site. Either you're using links, or have copies of the programme tapes. The team at the first site evades the police and sets off for a 3rd site and sets up. If they go for the 2nd site you switch to the 3rd site and carry on, etc.

When combined with Cat and Mouse tactics this can make you difficult to stop. The problems are, if you're using tower blocks your choices are limited. If you set up say 5 miles away your reception area may be completely different, and you'll need plenty of dedicated people ready to wait night after night to play games with the police. And when they become determined they will still get you. We know of one South London pirate, who used switching with apparent success, then one night all 3 of their transmitters were seized within 15 minutes!

Switching would work better when combined and varied with other methods of getting away with it. Particularly if you're doing a local station, where you don't need so much height, and have lots more choice of broadcasting sites.

F) GUERRILLA RADIO

This is one of the main ideas this book is trying to promote (See Chapter One). Guerrilla or Hit and Run radio is the war of the flea. First of all you can reduce the risks of getting caught drastically by broadcasting not at fixed times or with a fixed name, or by doing it only for 1/4 hour periods. The problem of course is that your audience is also random and small. The guerrilla idea is to get together quite a few stations broadcasting on the same frequency with cheap mass produced transmitters, thus forming one big loose station which listeners would have a good chance of finding on air, while being very difficult for the DTI and police to stop.

BREAK-INS

Break-ins are a higher and riskier form of guerrilla radio, as used in this country by Radio Arthur and Radio Wapping. The idea is to grab your audience by broadcasting on top of a legal station. The sentences are much higher (see Legal Section) but there is little chance of getting caught if you keep your break-ins short, say for five minutes, on top of the news or advertising of a major station. You're taking advantage of a quality of FM broadcasting that the stronger signal tends to 'win', blotting out the weaker one completely. With a small transmitter you'll only 'win' for a short distance, but even a few hundred yards could cover a whole high density estate. For break-ins strength of signal is the main factor, a big powerful transmitter (100 - 200 Watts) would be ideal, and your TX needs to be built and tuned exactly to the required frequency so you can break in with your message on the most popular channel on prime time. For break-ins all precautions should be doubled, also be sure to clear right away from the area as soon as you've finished, and don't use the same time or broadcast site again. It's as simple as that.

Break-ins are also easily possible on TV, but only over the sound. Break-ins are more common in countries where pirates have been repressed, e.g. in W. Germany or the Eastern Block, and are ideal for announcing demonstrations etc.

There is another and better way of doing break-

ins on FM, which may have been used by Radio Arthur. This is to use the VVHF microwave transmitter, beaming your signal at the microwave dish receiving the signals of a legal station from their studio's. Your dish then picks up your signal, and providing you're close enough to be stronger than their signal, you get re-broadcast by their main transmitter, thus giving your break-in perfect coverage throughout their reception area.

However, we don't have technical plans to build such tricky VVHF transmitters, and it would be quite expensive. Though this type of break-in is possible at present. (To stop you fast, they'd have to switch off the entire station). They will probably make it more difficult by using access codes to receiver dishes, as is already done to avoid piracy of satellite dishes. (Note: Don't play around with microwaves, they can be dangerous). See also Radio Arthur, Radio Wapping.

GOING MOBILE

In theory this is an ideal way of getting away with it, but there are quite a few problems. If you're going in a vehicle you can use an ordinary car cassette player, but you are better off having a separate 12 Volt car battery to power the transmitter. One problem is with the aerial. If you use a bigger, more efficient one it will be very obvious, one possibility is to have it under a tarpaulin on a roof rack. A bigger problem is height, unless you can park or drive up and down on a high hill, your coverage will be badly blocked. And then of course your reception area will vary radically if you're driving any distance. Not much use for gaining or developing an audience. The main advantage is that you will be much more difficult to stop.

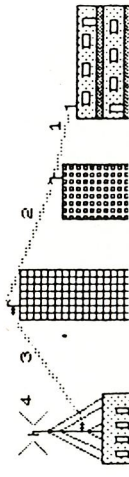
Going mobile is more practical as a publicity stunt, or possibly for local broadcasts. To a small extent, having a bigger TX will compensate for lack of height. Going mobile is good for broadcasting at random just for the hell of it.

Doing break-ins in this way would be great fun in the rush hour traffic.

LINKS, TIMERS, SQUARE WAVES.

These aren't for the shoe-string pirate, though you can build them cheap if you have the know-how. As we said earlier links often prevent you being busted personally, if you can afford to lose the gear, and allow you to do live programmes. All it involves is

- 1 INFRA RED LINK FROM STUDIO
- 2 MICROWAVE LINK
- 3 UHF LINK
- 4 UHF BROADCAST SIGNAL



using a receiver instead of a cassette deck, then beam- ing up your signal from your studio or wherever, using a small UHF transmitter (eg on 370 mhz) or

adapted cordless telephone, or an FM exciter on a different frequency (or even over an ordinary phone line, though sound quality suffers). You also have to make a small directional high gain antenna. If you're using a low power link and a narrow beam its high assumed it was safe to link from the studio. But recently studios using links have been raided in a few cases, with every bit of equipment, furniture, record collections etc etc seized under the 1984 laws (eg. a raid on Radio Horizon's studios in late 85 when over £20,000 worth of gear was 'stolen' legally. This may not however mean that the DTI's new gear can detect links. Its just as easy to find your location by gossip, phone taps or just by following you. Links can make you personally safe, if they can trace one you could



Next, you need to consider how you'll get the signal from the studio to the transmitter. The main priority is to ensure the studio is as difficult as possible to trace, so DJs won't get caught and fined large sums of money. To do this you need a series of hidden links.

The first link from the studio will be the most secure, maybe infra-red (like TV remote control units) or possibly an even safer method. This may then be followed by a microwave link to take the signal across town, where it's converted to UHF for the final trip to the transmitter site.

The DTI will need to work backwards from the transmitter site to detect the links. The UHF repeater is usually fairly easy to locate - which some small stations haven't yet realised. Microwave links are more difficult, but given time they can be found. Basically, the higher the frequency, the more difficult it is to find the

transmitter, but the DTI are now capable of finding just about any radio signal after importing new tracking gear from the USA last autumn.

Infra-red links have the advantage that they are undetectable unless you find the transmitter or receiver - the army uses them for secret communications in battle! Even if they've found a receiver it won't always be easy to find where the signal is coming from.

As you can see, it takes time to locate the pieces of equipment. And if the station is only operating one day a week, they may disappear before the DTI have finished got very close down the chain. With equipment hidden on buildings, finding the precise location may be even harder.

Pirates still have the leading edge over the DTI, but

they're catching up slowly on present methods. However, pirates are moving on all the time. In the future we may see lasers being used as links (not as far fetched as you think!) Lasers outside the visible range are completely undetectable and can travel large distances which makes it extremely difficult to find the transmitter.

So, how much does this all cost? Starting at the studio (see last month) you could expect to pay around £400 or so for a reasonably decent set of equipment. Link equipment would come to around £200 also, depending upon its complexity. A fast and antenna system could be typically around £300, depending upon the exact type, height and antenna gain. Then finally, you could expect to pay around £250 per transmitter. TOTAL COST: around £1,500. Sure beats the 1/2 million for IM!

TX

LONDON'S ALTERNATIVE RADIO MAGAZINE

CONFRONTATION

A good trick if you can get away with it. The DTI and police (they normally only bring a few) are wide open to attack (the mouse becomes the cat!) when coming to get you. The problem is that in future you'll have to change your station name, frequency, even your radio voice and they'll always be on your trail. The good thing is that if pirates start attacking them they have to bring many more police with them, and can only do it when spare police are available. Also they are always looking over their shoulders, and have to be more careful with their surveillance work.

One easy way to hit back, on tower blocks, is to trap them in the lifts. The lookout signals up when they're in and you throw the main power switches in the lift room. (Careful you don't trap residents as well). Then you take your gear down the stairs, beating up any of them you meet on the

way, and make off. Their cars are also vulnerable, usually they're parked unguarded around the corner. If you're going to attack them directly make sure you're well masked and tool up and have enough skill and numbers to get past them. Go straight for the police officers and disable them before they can make their 'officer in distress' call (take or smash their radios, or have someone jamming their frequencies).

Other direct ways of hitting back are, attacking the DTI at their bases, attacking their vehicles at their depot, obtaining home addresses/phone numbers of chief officers and harassing them, etc.etc..

Remember, they have the entire state apparatus backing them up, any form of direct attack should therefore be anonymous and never spoken of or boasted about later.

or before hahahahahahah!

When the lookout signals a raid or anything very suspicious (e.g. a cop car cruising too close too often) immediately switch off, dismantle the

Building Your Pirate Station.

We're not talking here about commercial pirates, where its just a matter of having good financial backing, popular D.J.'s and hit records, plenty of ads, jingles and news replayed from legal stations.

We're talking about the 'do it yourself' community or political pirate, starting from square one, and doing something worthwhile and original. The truth is that most commercial pirates, in their effort to offend nobody and build towards a possible licence, practice heavy self censorship and are often as boring, banal, repetitive, capitalist, sexist elitist and even as anti-democratic as the legal ones, though there are a few exceptions.. Such pirates are obsessed with keeping their technology secret and attacking the 'competition at every opportunity.

Smaller, non-commercial pirates are in a different situation, and can only survive and develop by co-operation, with the eventual aim of breaking the state and commercial monopoly of 'Her Majesty's' airwaves.

YOURSELF.

First thing you need is an interest in sound, and something worth saying or playing. Get a hold of a mike and a cassette deck and play around with it. Record yourself, record any and everything. Listen and record off the radio, off TV, off people's stereos, in the street. Play back your results, see where you went wrong, and try again. Note down your results and ideas and discuss them with others. Read and find out everything you can about sound and recording and think about why you want to be a radio pirate. Join the Free The Airwaves campaign and read their 'Radio Crimes' bulletins

THE GROUP

You need to find more people with similar ideas, and not just 'hangers on'. You need to get to know each other well, find out who you can trust, and ditch those you can't! Members should be prepared to share in the tasks, risks and finances equally, according to their abilities (in practice this rarely happens). Hold regular meetings, just keeping in touch can be a problem in big cities. Go for the maximum openness, so everyone knows what's going on. Beware of the power freaks, ego trippers, party builders etc., who are sure to turn up sooner or later.

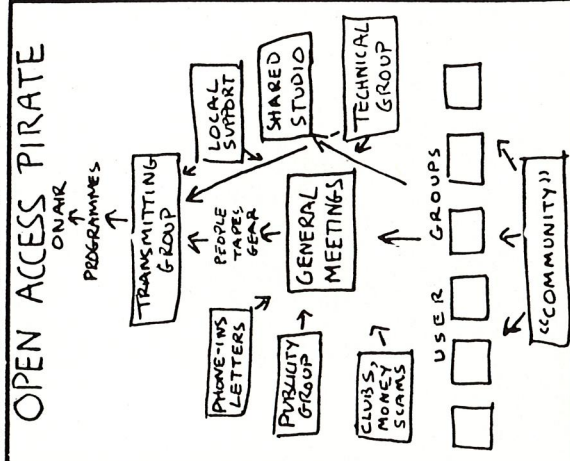
A good point to start is with fund raising, organising gigs, jumble sales, meetings, sponsored events or whatever, which can cement your group, attract more people, and advertise your station. How you do it depends a lot on the type of project you're doing. If for example you're planning a minority language station (and there's millions in

gear and move it (switch off the TX first, then the tape deck, DON'T rip out the aerial when the TX is still switched on!).

Britain who have no radio in their first language) you'll want to advertise widely through ethnic organisations. If you're a 'revolutionary' group planning to claim responsibility for armed actions you want want to advertise at all. Minority music stations are the most common. But we'd advise you to widen and deepen your group, or join with others, if you're going to build and maintain the commitment (and cash) to keep a station going. Many music stations get backing from clubs, and are the platform for the disgustingly egotistical and inane DJ's who work in those clubs. Such solid backing is a good idea however. If you're running a station you'll be hard pushed to fund raise as well. If you see your station as part of a wider movement (eg. anti-war, women's, gay, anarchist, animal rights, etc) you should try to get regular backing from that movement. Another good trick is to siphon off small amounts of cash regularly from council, charity or student union funded bodies which your members are involved in. What you need is income, not a lot, even £20 a week would do if regular. If some of your members have good jobs they might be able to do it, otherwise you could be tied in with a money making co-op or small business. One example of this is the squatters pirates in Amsterdam, who can get a small regular income from a fund raised by a small tax on drink in squatted pubs and cafes.

OPEN ACCESS

Once your group is going well, and you've started to make tapes and get the gear and cash



at? Or better, creating your pirate with? Or are you really working on your own career? Or trying to create 'community' in your own head?.....

Local pirate radio is a more clear idea. There are many advantages to broadcasting locally, eg. more broadcast sites, harder to get caught, room for more pirates on the broadcast band, cheaper easier to build transmitters, closer contact and participation of listeners etc. In a big city its a good idea for your station to base yourselves in one area, whether you're broadcasting locally or citywide. You need a local base, and local backing, financial if possible. If your station is appealing to one small section of listeners it may not however make sense to do a local station, because the potential listeners are fewer a local station should aim at a fairly wide section of the population. An open access station would work well on a local basis as coordination would be easier, and all kinds of interest and minority groups could be persuaded to make programmes. On a local basis publicity and support are much easier to get, as is the possibility of mobilising people to defend you when attacked, eg. a popular station in the middle of a large housing estate. Local broadcasting in inner city areas can nevertheless involve hundreds of thousands of potential listeners. Most of the smaller existing pirates are, in effect, local stations, because of the limitations of height and the power of their transmitters, though very few allow any access or see themselves as a local voice and resource.



HOW TO MAKE A STUDIO

Back to square one, you've fooled around with tapes and microphones, but soon you're going to want your own studio. If you have no cash don't let that stop you! Most of the gear can be borrowed to start off with. For beginners purposes a studio is a small room, a couple of turntables and cassette decks, a microphone, headphones, a small disco mixer, a plug board, leads, some records and a table to put it all on. You'll also need some blank cassette tapes, and sound effects records if you can, (borrow from a record library).

together, you should think seriously about teaming up with other groups who you broadly agree with (or don't disagree). For example at the moment (late 1986) there are dozens of such groups who have failed to get Community Radio licences and are dying to get their stuff on air, though afraid to 'go pirate' in the present hostile climate.

The idea of 'Open Access' is to share a frequency, studios and even transmitting gear to start with, with different groups. The advantages are obvious...more money coming in from more sources, less equipment needed to begin with, a pooling of technical abilities, more political clout, more participation, bigger audiences etc. A good way to approach this idea is by having public meetings, contact Free The Airwaves Campaign, etc.

The problems come with coordination, political rivalry, possible infiltration and the sharing of tasks. For an Open Access grouping you need regular democratic meetings of all involved (at least monthly) and insist on full attendance. You need a few good people who are into organising it and making it work. Another problem is with broadcasting. You should aim for everyone having their own gear and broadcast team as soon as you can, so you will be more difficult to stop by the police and DTI. So you should insist on every group producing tapes providing at least two trusted people regularly both to the broadcast team and to work on the technical and backup side of it (building, repairing, purchasing etc.).

Open Access stations depend on cooperation, if you have that then all the other advantages come into play, but you are fighting all the time against our training, in this society, to be competitive and individualist. The ideas of Open Access radio have been pioneered in this country by stations like Sheffield Peace Radio, Our Radio and Cambridge Community Radio and its worth studying their experience quite closely, as well as the example of such stations and Federations of pirates in other countries. (See elsewhere in this book). Its often fatal to allow one person, however benevolent they may seem, to become a leader or spokesperson for an Open Access grouping. The straight media also love this to happen.

LOCAL / "COMMUNITY" PIRATE RADIO

The word 'community' has lost any real meaning, through misuse and over-use (eg 'Community Policing'). The old style communities are a thing of the past (if they ever really existed) except on the Soap Operas, as the system breaks us all down into individual consumers. So if you're talking about 'Community Radio' you should be quite clear what you mean by it, and what the State means by proposing (and then cancelling) such an idea. What class, ethnic, interest, political or gender sections of the people are you aiming your pirate

and on the final tape recorder, allow the needle to go just into the red for music recording, but only half way up for speech recording. For group interviews an omni-directional mike can be handy, and pay special attention to sound recording levels and background noise. Don't use a telephone in the studio. Though the phone is the lifeline of democratic radio, in the present climate it means you'll be busted and/or have everything in the room recorded by the police. You really do need two turntables, and at least two cassette decks. All these tips, and more you'll pick up as you go along, but its good to work out a standard 'how to use the studio' lesson for newcomers. Pay attention to safety, eg have the plugboard (fused) well out of the way, and don't allow coffee or beer near the gear. Read a book on basic sound studios.

One last tip, lock it up well, especially if its not in your own home, and barricade and cover any windows. There's one sure thing about accumulating sound gear... sooner or later someone'll nick it!

THE PROGRAMME.....

This entirely up to yourself. No need to follow any conventions. Some people say you have to 'master' conventional programming before you can do something different. Other say if you do that you'll never do anything different.

Again there are some hard learned tips for pirates. Its good to talk with all concerned before starting, make a list of all the possible material gathered (music, interviews, sound effects, news items, jokes, or whatever) and try to put it into some kind of order. A signature tune or jingle isn't such a bad idea, as people recognise the programme by it, often after they've forgotten the name. Repeat the name of your programme often, but not too often, along with your frequency and broadcast time. Put your important items first (eg a demo next day, your appeal, etc) as its always possible you may be busted before the programme ends. If you're expecting a bust put all your best material first and keep the programme short. Use first names (false ones) and try to have a friendly, relaxed atmosphere and give everyone present a go on the microphone and control desk.



While throwing out conventions don't forget that we're all conditioned to quick variety and short attention spans. Long single person interviews are not on, no matter how interesting, but need breaking up. Also remember people are continually tuning in (and

out) and if doing long pieces you need to 'flash back' the story so far. You need variety and interaction. without sticking in jingles every 30 seconds. Try and make it interesting/enjoyable/entertaining both for you and the audience, otherwise why bother?

Style and themes are your department. Its easy on radio to get arrogantly carried away with an idea of your own ego, or with 'in' jokes or political hobby horse, watch out for this. Practice with using the gear, good preparation and research make everything go much more smoothly. Background music and fading music in and out can be very effective if done well. A large studio, tea breaks etc., help a lot. The more time you put in the better the result (usually) you can spend a whole night making a good one hour current affairs programme, for instance.

More than that its hard to say, so much depends on the people, the subject, the projected audience, the time of broadcast etc. You should actively go out and seek feedback and opinions from people you know have listened. Probably you won't be able to do phone ins and mail is slow and erratic (dont worry if you dont get a big postbag, few stations or programmes really do). Its easy to become cut off and feel like you're talking into a vacuum, or get a completely wrong idea of what kind of people are listening.

Making programmes is really not that hard, however bad and inexperienced you are, you can quite easily improve on some of the 'aural shit' being pumped out by legal stations over the airwaves, 24 hours per day!

PUBLICITY

Publicity is very important, especially when you're starting off your new station. Of course your main publicity is to keep coming back on air, no matter what. But if you're hoping for a minority audience to tune in specially you need to advertise a lot where those people are likely to see or read it. Be warned, there's no real tradition in this country for large scale support for pirates, and people often tend to consume the media ie forget instantly they switch off. It could take you a long time to build up the regular, participating audience, and the solid support you need to attract new blood, break even financially etc.

If you're a local station your publicity is obviously a lot easier, and you can poster, graffiti or even leaflet your entire reception area. If you're a wider station make sure you're always mentioned in the 'whats on' papers and get articles or interviews into any paper likely to support you. Send out regular press releases to the local and national press, and try to cultivate contacts among the slimy reptiles (journalists). Almost any publicity is good, as those people likely to listen in to you will also likely read behind the bias of the Tory press. Oddly, one place you should certainly seek publicity is on radio, try for instance getting onto phone ins. On radio you are already talking to people who listen to it! TV, if you can find any way or stunt to get onto it,

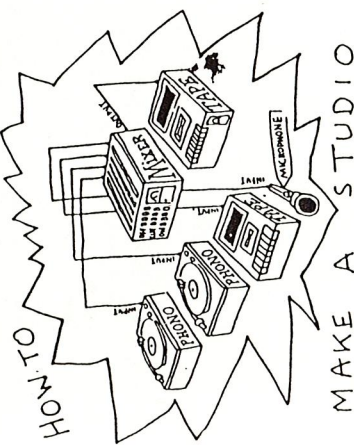
is the most powerful publicity and you should certainly court the bastards running the local TV news, this kind of appearance really does stick in peoples minds and start them talking. Strangely enough the media are not overly hostile to pirates, providing you're just an oddity, not a direct threat. Many media workers hate the shit they're forced to produce and admire the 'romantic' pirates. You should play on this for all its worth, and always try and get your frequency and broadcast times across. They will sometimes put you on, as an interesting item. Remember that pirate radio is a 'victimless' crime!

If you're a mainly music station you should publicise where people listen to that type of music, if you have your own club, of course, you're laughing. Join Free The Airwaves and get publicity in their paper. Write articles for radio papers, and do benefit gigs, public meetings, media stunts, whatever you can manage. Choose a catchy, hard hitting name for your station. If you're doing political stuff they're going to go for you anyway, so you might as well get value for effort!

Remember, if you want to be a participatory station, you'll have to go out and seek feedback. Get out on the street and do interviews wherever you can. Take along your cassette recorder to every type of event, the more different voices and views the better.

BUILDING UP YOUR PIRATE STATION

Its hard to give advice about longer term development, but there's a few things worth saying. First of all its important to pace yourselves. Its easy to start off with a lot of enthusiasm, then get busted off the air, or just burnt out with too much work or too few people. However good or different you are you will be very lucky to build up a regular audience or mass support overnight. Though your potential no. of listeners may be huge you can expect response to be slow. Breaking down passive consumption of the media is not easy. Having your own clubs, events, regular demos etc helps, as do dramatic publicity stunts. You need to work out what you're aiming at. We say support, participation and a large number of listeners is a good aim. But you may just be broadcasting as a way of pressuring for a licence (which is a bit of a sellout and a pipedream). Ideally you should plan ahead and gradually increase your broadcasting times, while developing all aspects of your station, rather than going all out and then collapsing at the first 'bust'. The best advice then is to operate well within your capabilities, and to join up with any other pirates who are not commercial and not racist, sexist or fascist. Your longer term aim, as a pirate, should be to reach a situation where you have so much support (money, volunteers, transmitters, listener support etc.) that the state just cannot wipe you out at will. The best hope for pirates is to swamp the forces of repression by sheer numbers, as happened, at different times, in Belgium, the Netherlands, France, Italy, and now, it seems, in Spain. This does not imply chaos, but cooperation.



After that its just practice and patience, knowing and collecting your material, and getting more or better sound gear as you go along.

Having said that there's plenty of tips we can give you. A permanent room is handy. Sound proof it if you can, cardboard, layers of carpet, egg boxes or styrofoam are all good. Try to plan it out before you start so as to have everything within reach of the operator(s), while having enough room for the interviews and group work (See Diagram example). If you build your own control desk you can drill holes and arrange for all the leads to disappear and join up underneath, much less hassle. If you're buying cassette decks try to get something also suitable for outdoor work. Try it out before buying, eg don't get one which leaves a loud click on the recording whenever you lift the 'pause' button. Quality and editing are better if you record your final product from the mixer onto a reel to reel tape recorder, though that means re-recording onto cassettes for broadcasting, and a good cassette deck can give near as good results and is cheaper. If buying a microphone its worth getting a good directional one suitable for studio and outdoor interviews, and make sure the 'impedance' suits your mixer. A 'cheap' £50 disco mixer will do the job (you can even mix through some stereo units). If you have the cash go for the flashy new £150 range with built-in graphic equaliser with which you can do wonders. Another tip, keep mike leads, din leads and power leads well separate from each other and make sure everything is well earthed (from the chassis if necessary). If you also have 'hum' problems with cassette decks try plugging in the power lead the other way round! (ie where it goes into the deck). Use cheap turntables, not automatics, and buy ones which use cheap cartridges, as you'll have to replace them often anyway. Use good quality cassette tapes however (TDK's are just about okay). C120s are best for length of programme, but get the best or they'll tear or jam. On the turntables put in your own on-off 'cue' switches, for ease of operation. When you've 'cued' a record to where you want to start, turn it a full turn back, by hand, to avoid 'slow start' up noise. Try and have an LED meter on the mixer

federations and sharing of the available airwaves and times. This swamping the airwaves is NOT going to be caused by the commercial pirates, however, hiding and mystifying the technology and even sabotaging each other. However if we do manage to start a non-commercial movement of pirates capable of doing this then commercial pirates will jump onto the airwaves, with more power, and try to force us off. This would be a major problem. (See International

Medium Wave

Advantages and Problems.

At the moment FM broadcasting, with all its advantages, is the favourite for pirates. But its well worth pointing out that at least 25% of radio receivers in Britain can't even receive FM, so you can't pick up most pirates on older radios. Another thing, in some hilly areas FM broadcasts have a very bad coverage area. And a third advantage, you can cover a very much bigger area on MW, at least potentially. MW can be the best choice for you, especially if you're in a country area, or in hills or mountains, or only want to broadcast by day and aren't too worried about sound quality. MW transmitters are also fairly cheap and easy to build, and because you use a crystal there's no problem with tuning or with 'sprogs' (harmonics). Though the antenna is a huge length its just a roll of wire, and doesn't necessarily have to be up high, which gives you a quite different, if still limited, range of possible broadcasting sites. MW works by bouncing radio waves back off the stratosphere, not by line of sight like FM.

Of course there's lots of other disadvantages, one is sound quality, and stereo is out of the question, and there's not much free space on the wave band, chiefly because of a host of European stations, which become stronger at night, blotting out your relatively weak signal (this is due to atmospheric changes we are told). The TX is also bigger and heavier (about 12"x8"x6") and you'll probably need to use car batteries.

One thing I forgot, if you want to reach any of the 50,000 prisoners in Brit jails, you must use MW, FM is still banned in prison, for some typically petty reason.

It is also agreed that you're generally less likely to get busted. In the present repressive climate that's well worth considering.

HOW TO BROADCAST ON MW (540 - 1600 KHz).

YOUR TRANSMITTER.

Enough general talk. So you want to broadcast on MW. So here's how to do it. First, your transmitter. Medium Wave transmitters aren't so hard to build, any good amateur radio buff could do it, and there's people around who will build them (reckon to spend £100 to £150). The technology is tried and tested and our design (see Tech Section) is as good as any. The TX is valve operated and you use a crystal (which you have to order on the chosen wave length) which

Section, especially Italy.)

It is a mistake and an excuse to blame the Tories and the new draconian laws for the lack of alternative pirates in Britain. The main thing stopping us is the lack of any strong combative movement (whether it be workers, women, anarchist, or whatever) in which to build a big wave of new pirates, though there are literally millions of sympathetic people about.

keeps you on frequency without the problems of FM. So you have to decide from the start which frequency you're going for and stick to it, or buy a new crystal. When choosing your frequency remember that it must be divisible by 9. MW frequencies are separated by 9 KHz by international treaty. If your signal doesn't conform you'll probably have your signal ruined by a horrible whistle, and certainly have the DTI and police down on you faster. If you have problems getting a MW transmitter you may be able to buy a kit (See Contacts) or adapt an amateur radio transmitter.



ADAPTING A MW TRANSMITTER

I'm not exactly an expert on this and the following info comes from the US. Apparently you can easily buy second hand radio ham transmitters and adapt them. The best to go for is the Viking Valiant (200watt) or the Viking Ranger (75watt), both made by Johnson & Co. These ham radios are well built, have excellent audio, and moreover have built in VFO's (variable frequency oscillators) which make them simple to modify to work on the top end of the AM band. All you need to do to the RF (radio frequency) circuits is to add capacitance to the 160 meter tuned circuits. And all you must do to the audio circuits is to bypass the first pre-amp (assuming you're using a line level instead of a mike level). One other thing, you must bypass the speech frequency filter, which is located between the 2nd pre-amp and the driver.

When buying such a 2nd hand ham transmitter a) get one with 160 meter capability. b) Don't pay more than £100 for one. c) make sure it has plate modulation (look inside and check there are two transformers well separated from each other), and e) don't get a 'kit built' one with dodgy wiring and if possible check the valves before buying, they're costly.

SETTING UP YOUR AERIAL (Medium Wave).

Security precautions and preparation are the same as for FM. But there the similarity ends. For a start your total aerial length is 1/4 your wavelength, so if your wavelength was 200 meters, for instance, your aerial would be 50 meters long! You use ordinary thin single strand wire. Buy a roll, keep it on the roll and measure it out, metre by metre. Ideally the aerial would point straight up, but that's just not feasible, unless you hang it out from the side of a tower block or a steeple, or suspend it from a balloon (only the balloon blows away). The normal method is the 'dogleg' which works just fine (See Diagram). The ideal site is a field, or deserted common land, far away from houses, with two tall trees (only 2 if possible, poplars are best) about 30 to 40 metres apart. Now string the 'dogleg' between the trees and down to your TX without touching branches or leaves. Sounds impossible? If you have a trained monkey that's just fine. Otherwise try our method. Practice and patience is necessary.

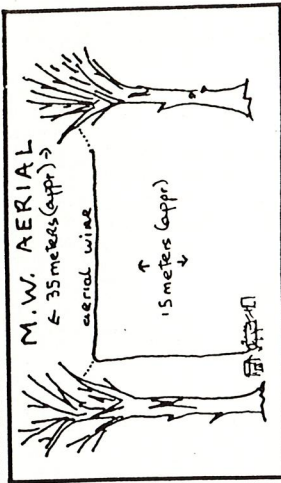
Bring along with you a catapult, a long reel of 70 lb strength fishing line, and plenty of lead fishing weights (not too heavy for the catapult). Also some small plastic rings (cut out lids of plastic containers work fine).

SAMPLE CHECKLIST. Things to bring along when broadcasting on Medium Wave outdoors.

Transmitter. TX battery leads. Cassette Deck. and battery leads. Din lead from Cassette to TX. 12 volt and 6 volt batteries (charged). Earth leads and stakes. Aerial wire. 70lb fishing line and weights. Catapult. Plastic rings. Disguise gear (eg kite, fishing rods). Screwdriver & pliers. Soldering iron & solder with 12v transformer (if possible). Programme cassettes. CB's or torches or whistles. Plastic sheet or large umbrellas (for gear in rain). Fieldglasses. Food and drink. Radio receivers. Waterproofs (warm). Possibly a tent.

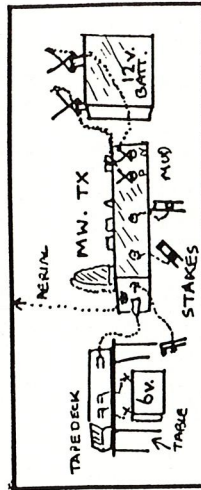
The one end of the fishing line to a lead weight, leaving the line coiled neatly and loosely on a piece of bare ground. Then fire the lead weight from the catapult right over the centre of a tree! Go and search for it (don't try this at night). Tie on your plastic ring in place of the weight and pass about 30 metre of your aerial wire through the ring. Now get your mate to pull in the other end of the fishing line, if it doesn't get tangled pull it till the ring is about 5 metres from the tree top. Tie the fishing line securely (to the tree), cut it, and head for the second tree. Repeat the performance, firing right over the tree from the far side. Pull the aerial end through, and this time tie it to the ring. Pull up as before to about 5m from the top and tie the line. Now back to the roll of aerial wire (extended with fishing line as necc.) and start pulling it in till its suspended without touching the trees! Its hard to get it just right so the aerial reaches your X and is tight, adjust fishing line lengths and/or position of TX. Better choose two

trees too far apart than too close. When you finally get it all set its hardly worth taking it down again or it'll snap in the wind. Disguise it if possible. A further problem can be with kids and passers by, disguise your actions, bringing along fishing rods or a kite is a good ploy. One of the best broadcast sites is a clearing in a large wood. On Medium Wave remember, you can go right outside the city and still cover it and lots more besides.



SETTING UP THE GEAR (Medium Wave).

See the Diagram. The transmitter should be on wet ground. If its dry, wet it. Mud is good stuff. The aerial wire should be taut all the way. Bushes are an advantage, for concealment, but don't let any touch the aerial. You power supply is a 12 volt car battery. Bring two, well charged up, if you're broadcasting for more than a few hours. Medium wave uses lots of power. If your TX is on mains (240vAC) you'll have to get it adapted using a 'rotary inverter', its not difficult. A lorry battery is the real thing, but what a drag to carry! If there's a chance to go on mains, by running a line from somewhere, you should go for it. Otherwise wear old clothes and gloves against acid spills. When choosing your site balance the need for



remoteness with the problems of moving the gear.

The Transmitter must be very well earthed, the earth is an essential part of the aerial system. Use a ring of metal stakes (eg tent stakes) and file off any rust or dirt for good connections. Attach the stakes securely to the chassis of your TX, with thick metal straps or wires held by butterfly nuts or strong clean battery clips.

So far so good. The cassette player, on the contrary, should be off the ground, on a box or whatever. As usual keep the din lead, battery leads, and aerial wire as far apart from each other as possible. The cassette player is normally powered by a 6 volt motor bike battery, with suitable leads. Torch batteries are dear and have a pathetic lifespan.

SWITCHING ON

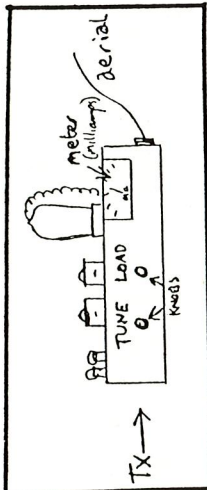
Connect up your batteries, load up your cassette player with a 'trial tape' and you're ready to go. (See Diagram B):

- 1) Turn tuning adjuster to the right till the meter gives the lowest reading.
- 2) Turn 'load' adjuster till meter rises about 50 milliamps.

- 3) Tune again till it drops about 25 Ma.
- 4) Load up again as above.
- 5) Carry on procedure till you get a load of about 150Ma on a 20 watt transmitter, or 100Ma on a 10 watt rig. Your last tuning adjustment should produce virtually no dip on the meter needle.

6) Adjust modulation in relation to other channels to get your best sound. Use a radio receiver held at least 50 yards away for testing.

- 7) If there is crackling, knocking or bad sound, repeat from the beginning. Check that your stakes are in well to damp ground, that all lines are well separated, that aerial isn't touching trees, hold receiver further away, etc.



If you've done all the above you should be broadcasting loud and clear. If your signal is still wretched, chances are your crystal is burnt out, or something is blown. Then go home.

If all is well, switch off and await the time your programme is due to start. Don't detach aerial wire with the TX still turned on.

BUSTS...IF ALL GOES WRONG

You're nicked. (See Legal Section). What you say to them depends on the circumstances. If they haven't got you, deny it point blank, give them your cover story and a verifiable address, and stick to your story no matter what. The problem with this is if they have nicked others and they give different stories, a different name for you etc. Best discuss all this beforehand. If caught on the hop, best say you don't know any of the others. You're caught in the act or with the gear. Give them a verifiable name and address and refuse to discuss the matter further. No matter what. People have managed to get off in the past, even with the gear in their hands, but under the new laws this is unlikely.

Although they can arrest and charge you, illegal broadcasting is still normally treated as a "summons offence". Which means they question you, let you go

PACKING UP

When you're finished switch off immediately. Then disconnect everything and pack into holdalls or large plastic bag. Be especially careful carrying the TX with its delicate valves. You should have several sites, and switch as often as you can. Don't re-use a site after an attempted bust. If you have a good dry safe stash and are coming back best leave your transmitter, cassette deck and leads there, and just take the batteries back for recharging. Such a stash should be in cover, be quite sure a hidden watcher or bod with binoculars couldn't spot you stashing the gear. Its likely that the DTI will send in men to sneak up and watch you, prior to planning a bust, so be careful, even when not on air, don't relax till safely home.

WHEN ON AIR. PRECAUTIONS. (Medium Wave).

Read the FM chapter 'How To Get Away With It'. A lot of those precautions also apply.

At a MW site your chances should be much better, you need one person just to stay near the TX, in case of kids, passers-by etc., and to grab or hide it fast when they get the danger signal. On many sites you can work out lookout points to give plenty of warning. However you might as well abandon the batteries, and certainly the aerial, if you have to run far. If you have transport or good escape routes you can try a clean getaway, but a safer method is to hide the gear well (not too close to the aerial if its left up) and beat it. We favour bunkers, holes pre-dug and lined with waterproofs, under rocks, with heavy lids covered with earth and bushes. In theory they could find these with dogs or metal detectors, but we've never heard of them succeeding or even trying. (You could always bury bits of metal all over the place). The possibilities are unlimited, if you're on the ball there's no reason they should get the gear...and without that they have a lousy case against you.

(eventually), then summons you by letter to appear in court. This opens possibilities of getting away with it - you may be able to bullshit them with a false name etc. (though they can now hold you on suspicion of doing this for three days). They will normally 'ask to accompany you to the station', or if they've raided your flat may interrogate you there and then. If you refuse to go to the station they will arrest you (for obstruction, insulting words, suspicion of stealing electric etc. etc.) and take you there, where you can be interviewed by police and DTI. The 'pretext charge' is often dropped later. When interviewed in the station it's better really to refuse to say anything, especially if there are several of you, coverstories usually fall apart under long and detailed questioning. However silence usually means they will hold you longer. If they get you to the station they are pretty certain to photograph

and fingerprint you. You can't refuse under the new Police Bill.

When nicked your best bet is to remain calm. Demand to ring your solicitor. Don't panic, it's not the end of the world. Smile at the bastards. Have a good kip in the cell - you've done your best. **FIGHTING YOUR CASE.** (See Legal Section).

It's usually months before your summons arrives, if they decide they have a case. Get legal aid if at all possible, and a good solicitor who knows the by now, pretty complex legal situation. Plead NOT GUILTY, but beware if you have money, they may award costs against you if you lose. Get your Bust Fund together, with gigs jumble, radio appeals, donations all round etc. It's good to campaign about your bust on the air if your station is still going. Most commercial (read 'conservative') pirates don't do this, carrying their bid for respectability so far as to ignore their own best weapon. Make sure the address you gave when arrested is 'clean' they could possibly raid you to look for further evidence. If you're a political station watch out for suspicious break-ins where nothing is stolen, the Branch often do this.

Get your story straight, get any witnesses to write out their statements together, make copies and give them to your solicitor. Don't trust your solicitor too far, they sometimes say 'plead guilty' just to save themselves trouble, if he/she starts getting cold feet get yourself a new one (they don't like this at all but it can be done). Get your solicitor to ask for copies of the prosecutions witness statements in advance of the case and make sure you see them. In court dress neatly and be polite to the bastard (magistrate) and the fifth. Have a good 'hard luck'

story for your solicitor to tell, its always good to say you're just getting married/starting a new job, etc but don't say you have money or the fines will be bumped up higher. If you're going to 'bend the truth' a little don't tell your solicitor you're doing it, and be sure friends watching in court don't start laughing! The DTI and police will lie anyway more likely than not, get your witnesses to focus on these lies and your solicitor to cross question them closely, especially any police witnesses who are more stupid and inexperienced in this kind of case. Demonstrations outside the court are good for publicity and can intimidate the magistrate if big enough, but don't always help your case (eg. if you're pleading 'dumb bystander' how come all these people are so concerned about you?). If you want press, send out 'Press Releases' at least a week in advance, so the hacks can put it in their diaries, and phone round with reminders the day before.

Your fine should be paid by the Bust Fund if at all possible. If not extra costs should be divided up among everyone in the station (always plead poverty and ask for time to pay).

When you've been busted once you shouldn't, ideally, work on the broadcasting end again, though you could still do lookout, backup, monitoring etc., as second offenders normally get the maximum fine.

If you win the case, as quite often happens, have a good party!

If you win there is also some possibility, in theory of claiming the gear back, though this is much less likely under the new laws. Ask your solicitor about it, and if there's a chance get someone else, with some kind of receipt, to apply for it, saying they'd bought it before the bust.

Radio Support Group

To join Radio Support Group and get updates and development aid write to:

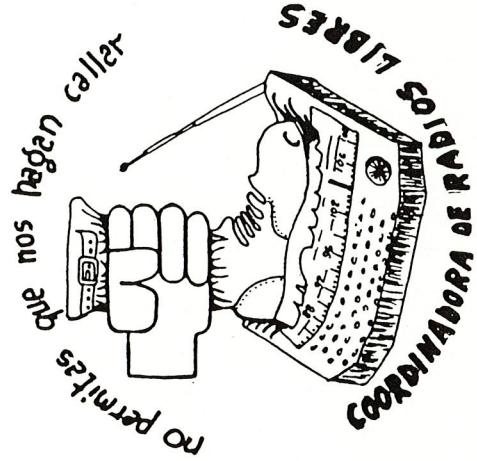
Radio Support Group, c/o Drowned Rat Communications,
Box 010, 27 Stokes Croft,
Bristol, Avon BS1 3PY

Free The Airwaves

BCM Box 1502, London WC1N 3XX

Radio Crimes is the name of the FTA bulletin, and will carry full technical updates on these designs, and much more. To join FTA and receive the bulletin send £2 (for organisations £10) to the address above.

JOIN NOW



Radio Electronics (FM)

A General Introduction

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 Buffers.
 Amplifiers: Bandwidth/ Gain and Max output power/
 Input and output impedance/ VSWR /
 The Dummy Load/
 Harmonics: Wavemeters.
 Bandpass Filter / Connectors./ Feeders.
 Aerials: Polarisation / Siting.

FOREWARD

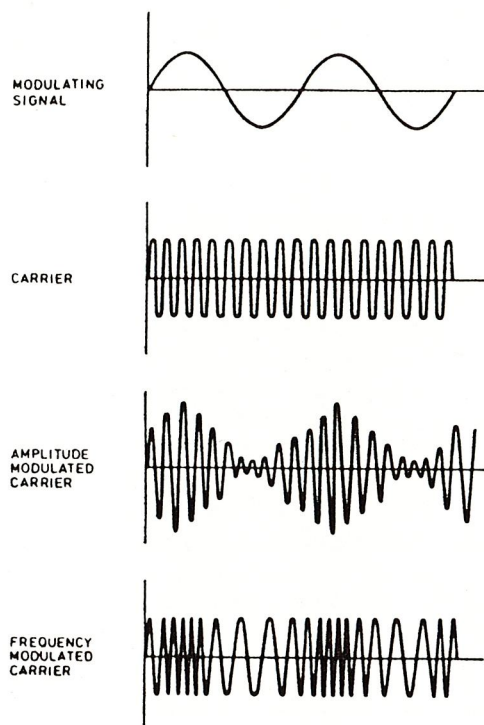
The following is by no means an introduction to electronics, there are many such books that cover the subject, but intends to explore some of the ideas and concept involved in radio broadcasting that are relevant to the pirate radio operator on VHF FM. In particular we will go a step by step tour of a typical VHF FM transmitter system starting with the output from the tape recorder or mixer, and finishing with a brief discussion of aerials. At each stage we will discuss the pros and cons of various alternatives and additional background info, eg. the use of test equipment will be introduced

Radio Frequency signals have AMPLITUDE and FREQUENCY. The frequency is how fast the signal is oscillating from one extreme to the other and back again. Frequency is measured in cycles per second (cp/s), which these days are known as HERTZ (Hz), 1000Hz = 1kHz, 1,000,000Hz = 1MHz The amplitude is to what extent the signal is oscillating. LEVEL or STRENGTH can be thought of as meaning the same as amplitude. Amplitude can be measured in Volts (v). There is more than one way of measuring amplitude.

INTRODUCTION

What we are trying to is get information from one place to lots of others. I'm using information here in a wider sense, meaning speech, music etc., rather than phone numbers of local hairdressers or whatever. Now I'm going to assume we're going to use radio broadcasting to achieve this, which immediately rules out things like standing on top of tall buildings and shouting really loud. We'll also assume we've got this info in the form of an audio frequency signal, ie. what comes out of a tape recorder or an audio mixer. You can't transmit audio frequency signals very easily so what we can do is impart the info in the audio frequency signal onto a higher frequency carrier signal. Two ways of doing this are AMPLITUDE MODULATION and FREQUENCY MODULATION (AM and FM).

In AM the amplitude of the carrier is determined at every instant by the amplitude of the audio signal, the carrier frequency remains constant. In FM the frequency of the carrier is determined at every instant by the amplitude of the audio signal, and the carrier amplitude remains constant.



Frequencies between 30 MHz and 300 MHz are known as Very High Frequencies or VHF. This corresponds to wavelengths between 10m and 1m. To convert between wavelength and frequency use the formula

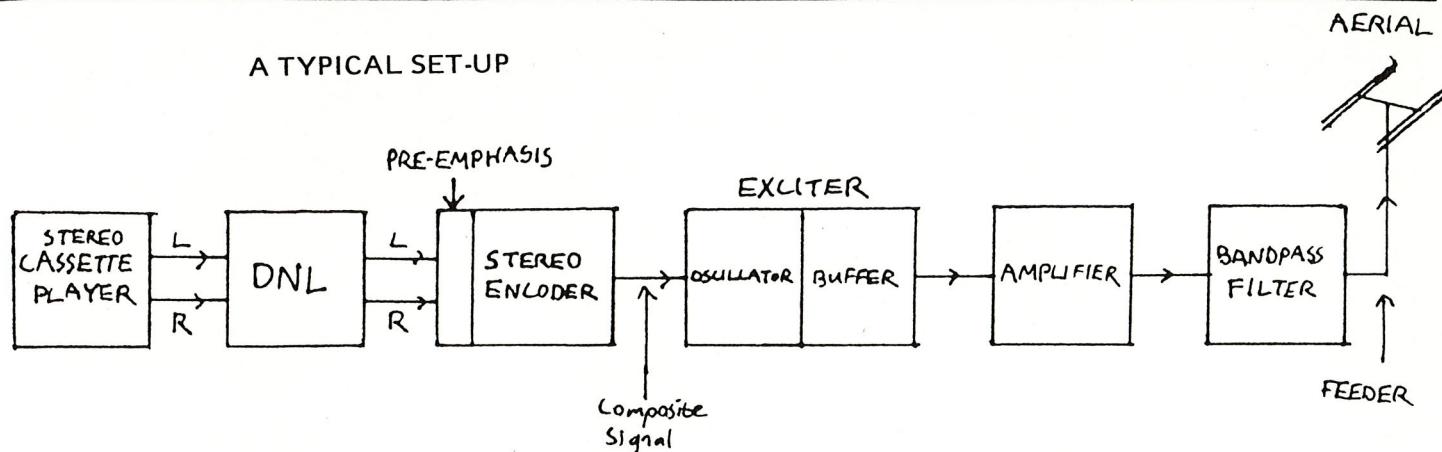
$$\text{wavelength (in metres)} = \frac{300}{\text{frequency (in MHz)}}$$

FM

There are two sorts of FM, known as Narrow Band FM (NBFM) and Wideband FM. They differ by the maximum allowable frequency shift of the carrier when the transmitter is fully modulated. This frequency shift is known as the DEVIATION. Legal CB radios use NBFM with a maximum deviation of 3 kHz. Wideband FM is used by the BBC and IBA for radio broadcasting and for studio to transmitter links. The standard maximum deviation for FM radio broadcasting in this country is 75kHz. There is no simple way to set the deviation of a transmitter without a Deviation Meter which is an expensive piece of test gear. Probably the best way to do this is to vary the level of the audio signal going into the transmitter (TX) and listen on a receiver, until your signal sounds about the same loudness as the other (legal) broadcast stations. If you use too high a deviation you'll use a bigger than necessary chunk of the radio spectrum and be more likely to cause interference to others, which will make you even more unpopular with the DTI.

The police use NBFM as well, which is why if you listen to them on an ordinary FM receiver, which is wideband, you can hear more than one channel at a time.

A TYPICAL SET-UP



CHOOSING A FREQUENCY

If Your first action could be to reach for you receiver and tune through looking for a blank space, think again, for a kick-off the UK FM broadcast band is 88 to 97.6 MHz and 102.1 to 108 MHz. 97.6 to 102.1 MHz is used by the police, so is best left alone. What stations you can receive is determined by where you are, as well as by the nature and positioning of your aerial. If you look to our old friend the Maplin catalogue we find on P24 of the current issue a list of the frequencies and locations of all FM broadcast stations. What it doesn't say, of course, is the frequency of existing pirates. TX Magazine gives a good rundown of these (see CONTACTS). Armed with this info you should make a list of all frequencies in use in, say, a 30 mile radius. If you write to the BBC or IBA's Engineering Info Offices they'll send you service maps of where their TX's are meant to be able to be heard. Then its just a question of finding a big enough gap between stations, with the proviso that your station shouldn't be nearer than 200kHz (0.2 MHz) to the frequency of any existing station. This is no problem as the band is half empty. Also don't choose a frequency which is 10.7 MHz away from any other station as for complex reasons (which involve the use of 10.7 MHz as intermediate frequency in FM receivers) reception will be hard for people listening to you and/or the other station.

Now lets take a little stroll through the whole system.

TAPE OR LIVE

What are we going to feed into our TX? The obvious two possibilities are

- A tape or cassette player.
- Live, either directly from the mixer or via some kind of link from studio to TX site (highly recommended).

TAPE. This is the safest approach in that you can put a tape on and then retire to a safe distance. Links are now being traced and studios busted, and some of the biggest pirates (eg LWR) are going back to taped broadcasts. If the DTI trace your transmission and turn up all they can do is confiscate your tape plater, TX and aerial, ie no arrests (unless they catch you changing the tape!). Its also the most inflexible alternative as tapes will have to be prepared in advance. Time checks, if you're into that, will be difficult and live phone ins are right out.

Give a little thought to your choice of tape recorder, as it will probably be the weakest link in terms of sound quality. In an old clapped out one the heads will be worn flat. Maybe you can use a 'Walkman' type of player, which are small, can be battery powered and have ok quality and are cheap. An amateur radio rally I was at recently were selling off very slightly damaged ones for £2 each. To reduce 'noise' or 'tape hiss'

on such recorders, if you're doing programmes with quiet passages, you can use a circuit known as a Dynamic Noise Limiter (DNL), which is placed on the output and cuts off the 'noise' just in quiet pauses. DNLs are sometimes used in the soundtracks of old films. You can find a DNL circuit in part of the 'Audio Embellisher' project in the Jan 84 issue of 'Elector' magazine.

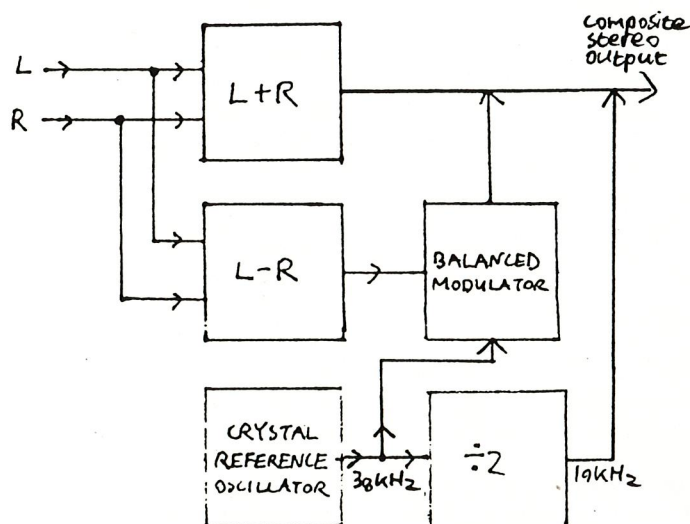
If you want to go upmarket you could use a proper 1/4" reel to reel tape recorder, though few pirates do. The latest and greatest is to use 'Stack machines' which will change the tapes for you. Whatever you use get one that can be battery powered as you may not always have access to mains power.

MONO OR STEREO

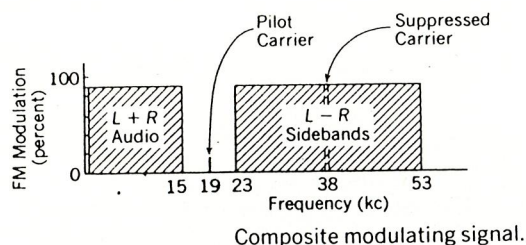
The advantages of mono are that the TX is kept as simple and cheap as possible, and you don't need as much power as on stereo to get the same result. The disadvantages are you don't sound as professional, quite small pirates are now using Stereo Encoders, and maybe people might dial past when the red stereo light on their receivers doesn't flash. With stereo the listener can get quality the same as legal stations. Weigh against this the extra cost, extra circuitry and more output power needed for the same signal.

What you need is a Stereo Encoder, which combines the left and right stereo signals into a single composite stereo signal which is then fed into your TX.

BLOCK DIAGRAM OF STEREO ENCODER



For those interested a brief technical description follows. The left (L) and Right (R) signals are fed into a summing and differential amp to get a L+R and L-R signal respectively. The L-R signal is mixed in a balanced modulator with a 38kHz sub carrier to produce an amplitude modulated double sideband and suppressed carrier signal. The 38kHz signal is derived from the same source as the 19kHz pilot tone. The composite output is formed by mixing the L+R signal, the sidebands containing the info of the L-R signal, and a bit of 19kHz pilot tone. The pilot tone switches on the Stereo Decoder in peoples' receivers.



Back in the receiver, once the Stereo Decoder has extracted the L+R and L-R signal the original left and right signals are easily got by

$$(L+R) + (L-R) = 2L$$

$$(L+R) - (L-R) = 2R$$

The reason L+R and L-R signals are encoded rather than L and R is so that a mono receiver can just demodulate the L+R bit and ignore the rest of the signal. If L and R were encoded a mono receiver would only be able to hear the left channel. The 19kHz pilot tone is usually got from a crystal oscillator, to be quite accurate and stable. A crystal resonating on 4.8640 MHz is convenient as 4864 divided by 256 is 19 kHz. This can easily be done by digital logic chips. But its highly unlikely you'll be able to buy a 4.8640 crystal off the shelf, so you'll have to have one made to order.

We had hoped to include a design for a Stereo Encoder in this book, but we haven't got it yet. See CONTACTS for where you can buy the design or a ready made system.

It doesn't matter if you didn't understand all of the above but one thing is important. The standard FM broadcast audio bandwidth extends only to 15kHz and Stereo Encoders are designed to assume this figure. If you put signals into them with frequencies above that the L+R signal and the lower side band of the L-R signal could spread into each other and you will get a right bloody mess. With a tape recorder you can't really get over 15kHz, but if you're live its quite possible. In that case you need a LOW PASS FILTER on each input to a stereo encoder. Maplin have a high quality design on page 243 of their current catalogue (summer 86). The pot could be replaced with a 500k resistor to wire the circuit permanently for max roll off. If you're using a link between studio and TX and you want stereo you'll have to know the bandwidth of the link. If its 53kHz (= 38+15) or more you can use it after the encoder. Otherwise you'll need two links and have to encode at the TX end.

PRE- EMPHASIS

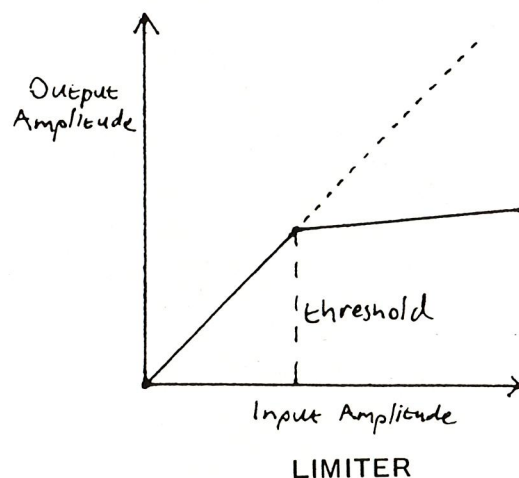
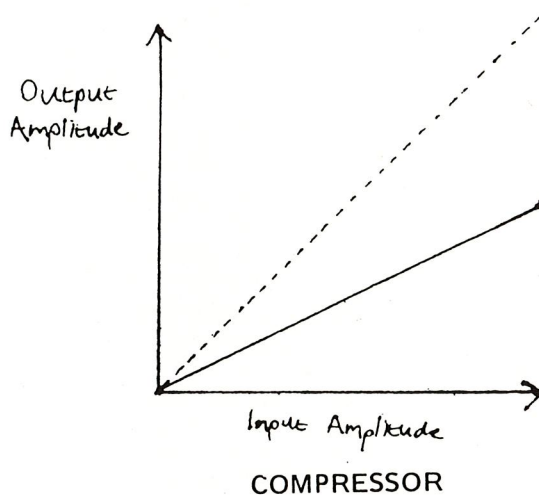
In a typical audio signal the high frequency sounds have less energy than the low ones and so produce less deviation of the carrier. This in turn makes them susceptible to 'noise' when received. To avoid this high frequencies are boosted before being transmitted by PRE-EMPHASIS. In the receiver the frequencies are cut by the same amount by DE-EMPHASIS. So the overall frequency response of TX to receiver stays flat, but the level of background noise is reduced a lot.

Pre and De-emphasis networks are characterised by their TIME CONSTANT. In the USA the standard is 75 μ S, but in

UK its 50 μ S so anything designed or bought from there needs slight modification. In a mono TX the pre-emphasis network can be built into the front end of the exciter. For a stereo TX such a network must NOT be in the exciter or it'll play hell with the composite stereo signal from the encoder. Instead you need 2 networks, one for each channel, on the inputs of the stereo encoder, They're actually often built into the studio encoder.

COMPRESSORS AND LIMITERS

Compressors and Limiters operate on the same principles, but their effects and the reasons for using them are completely different.



A compressor compresses, it reduces the DYNAMIC RANGE of its input signal. This means as the input amplitude varies over a certain range, the output amplitude varies over only a fraction of that range. The graph shows a 2:1 compression characteristic. In this case with every change in the input amplitude the output changes only half as much. The dotted line shows a 1:1 non compressed characteristic.

But a Limiter passes its signal unaffected till the input amplitude reaches its THRESHOLD. At this point the limiter prevents the output increasing much by compressing its input much more strongly than in compressors eg 10:1.

Some American music stations and some pirates compress their programmes to make it seem 'louder' and more 'upfront' than other stations, This occurs cos the compressor keeps the average level of the signal high, even in quiet parts of the prog. The flip side of this is listeners can soon get 'listener fatigue' as constant compression can become boring and irritating to the ear, as if the music were rammed into it!

Compression has other uses, you might compress your programme as you transfer it to tape to stop quieter bits fading into background tape hiss when played. The process of recording and replaying does this to some extent anyway. Don't compress the output of a tape recorder as it'll make tape noise worse. Guitar effect units, labelled compressors, are unlikely to be much use. Compressors intended for use in home studio recording are worth experimenting with. A stereo compressor with a 2:1 characteristic can be simply constructed around a NE570 or NE571 IC.

Limiters are used to stop a signal's amplitude going over a certain level. Eg when cutting a master disc in record manufacture, large PA systems at gigs to stop loudspeakers blowing every time someone burps in a mike and, surprise surprise, in broadcasting. In FM particularly, as the signal level increases so also does the bandwidth of the transmitted signal, risking interfering with other stations. With tape input to your TX the output is inherently limited by the recording process, no limiter needed. With live input to the TX its different. Though you might set the levels right to start, along comes a loud record or voice and you could be interfering with the next station. Use a limiter.

Any limiter based on 2 back to back diodes is little more than a guitar fuzz box and will sound like one. A suitable high quality limiter was described in the May 83 issue of 'Electronics Today' International Magazine.

THE OSCILLATOR

At the heart of everything is the OSCILLATOR that generates the VHF signal. The Frequency of this is modulated by applying an audio signal to it. The most common way of doing this is by using one or two VARICAP diodes. When a varicap diode is operated with a reverse bias the capacitance of the diode varies with that bias. The diode(s) is/are connected to a frequency determining part of the oscillator. The audio signal is connected across the diode to achieve frequency modulation. Also by varying the DC reverse bias the oscillator can be fine tuned. The higher the voltage, the lower the capacitance, the higher the frequency.

The VHF signal can either be generated directly, or the oscillator can oscillate on a lower frequency eg a third or half that desired and then followed by a TRIPLER or DOUBLER stage. There are three main types of oscillator:

- a) Variable Frequency Oscillator (VFO).
- b) Crystal Oscillator.
- c) Phase locked Loop Oscillator (PLL).

VFO's

These are simple oscillators which can be built round a single transistor. This can be:

- Bipolar Junction Transistor (BJT). 
Field Effect Transistor (FET). 

The problem with oscillators based on BJT's is that the frequency is too dependent on the temperature of the transistor. ie a few degrees temperature change will result in a significant change in transmitting frequency. For this reason oscillators based on BJT's are UNSUITABLE for serious use as a TX. FET's don't suffer from this problem so badly, so they can be used, but you should still bear it in mind.

The FET will heat itself up slightly, and other bits of the TX, like the power amps, will be fair old chucking heat out, and are usually built into the same case as the oscillator. The frequency will drift most when the TX is 1st switched on as all the components will be at the same temperature as the air outside the TX's case, this is known as the AMBIENT TEMP-

ERATURE. After the TX is turned on the heat from the amps will warm the air in the case directly or indirectly. As the FET warms the frequency will drift a bit. When heat loss equals heat gain you get THERMAL EQUILIBRIUM and it won't drift more. Keep your TX out of drafts to avoid messing this up. If you have a frequency counter plug in to a dummy load and see how long it takes for the frequency displayed to settle down, maybe about 15 minutes. If you have time you can arrive at the TX site early and run your TX for the warm up time with no input into a dummy load. This avoids listeners who tune in immediately having to retune as your frequency drifts.

CRYSTAL OSCILLATORS

This is also a simple oscillator but incorporates a crystal into the frequency determining network. There are various types of crystal (fundamental, 3rd overtone, 5th overtone etc) and various ways of using them (series mode, parallel mode) but their basic properties are the same. They're resonant on one frequency which is determined by the crystal's characteristics when made. This is their problem, whereas VFO's are not very stable crystal oscillators are too bloody stable and its a job to get enough deviation. You'll probably lose the higher frequencies of your programme and stereo is right out. Also chances are you'll have to get a crystal made to order for your desired frequency so if you want to change it you'll need a new one. There are places which make crystals to order.

PHASE LOCKED LOOP (PLL) OSCILLATORS

The way its done properly is with the Phase Locked Loop oscillator. This combines the ease of tuning and wide deviation of a VFO with the frequency stability of a crystal oscillator. It works thus: A crystal oscillator is used to provide a reference frequency. This is digitally divided by logic chips to a relatively low frequency, say 25kHz. A VFO provides the output, which is also digitally divided to give another relatively low frequency. These two low frequencies are presented to a PHASE COMPARATOR which basically decides which frequency is higher by comparing the phases of the two signals. The phase comparator generates an ERROR VOLTAGE which is connected back to the input of the VFO through a LOW PASS FILTER (LPF). This is the loop bit.

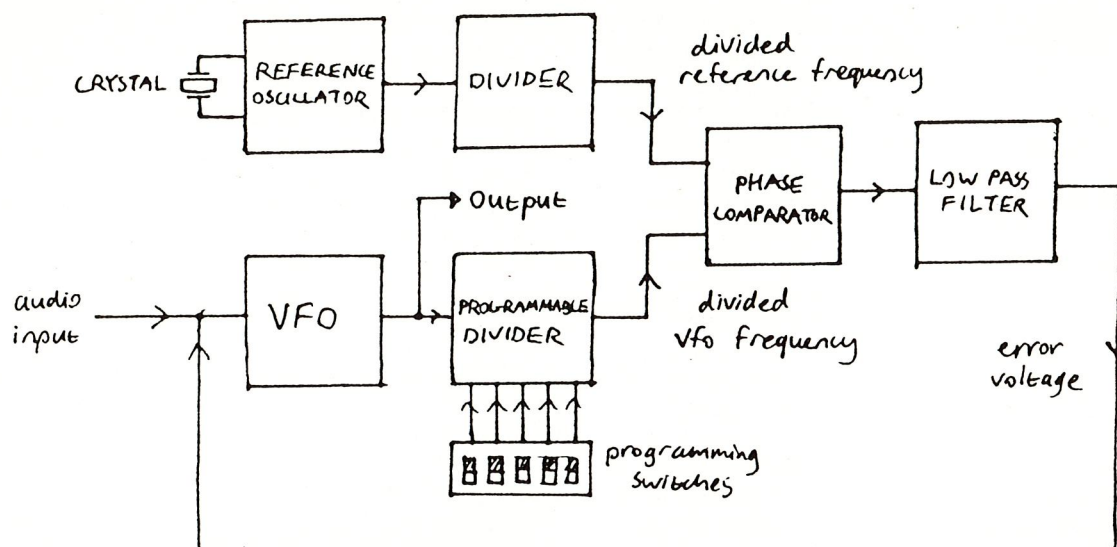
If the VFO is running too fast the phase comparator decreases the error voltage so as to slow it down till the phases at its input are the same. If its running too slow the error voltage is increased to speed it till the phases are the same. All this happens instantaneously of course so the output frequency remains constant.

In this way the temperature stability of the VFO isn't important and it can be built round a BJT, as its output frequency is phase locked to the crystal oscillator, and the frequency of this is very good. Clever eh?

Two more things to explain. How do you change the output frequency? By making the VFO's divider programmable. Say its set to divide by the number N. The phase comparator is a simple minded sort of soul, concerned only with equalising the phases at its inputs, it doesn't know what's really coming out of the VFO, which is N times the divided reference signal. Because this signal is so low compared to the VFO frequency N can be made to have hundreds of different values, giving hundreds of different output frequencies from the VFO. So changing the frequencies is just a matter of clicking some little switches. (Beats me...typist).

Hang on a sec, the VFO is being frequency modulated by the audio input, so its frequency at any given instant depends on the voltage of the audio output. We don't want THIS

PHASE LOCKED LOOP OSCILLATOR BLOCK DIAGRAM



variation of the VFO's frequency to be ironed out by the PLL system so we 'iron out' the error voltage from the phase comparator, so it just contains the underlying trend rather than what's happening at any split second. This is the purpose of the low pass filter.

This system can be simplified by leaving out the dividers. If this is done you end up with an output frequency determined solely by the crystal. You've still got the wide deviation capability of course, which distinguishes this system from one based on a simple crystal oscillator. This sort of fixed frequency oscillator is used for things like wireless mikes and could be used for studio to TX links. Programmable PLL oscillators are used in all manner of professional communications equipment, including broadcast TX's.

We don't include a PLL oscillator design in this book. It's a bit complex to start with and the IC's are expensive. See CONTACTS for where to get the design or ready made.

BUFFERS

Any oscillator, regardless of its type, is followed by a buffer. This is usually one or two transistors operating in what is known as class A mode. Its function is to protect the oscillator from what is going on further along the circuit, especially from changes in its 'load' as the following stage is tuned. The combination of oscillator and buffer together is called the EXCITER and is a small but fully fledged TX. Small in respect to its output power. Typical values are in the region of 100 - 500 mW (1000mW = 1W).

AMPLIFIERS

To increase the power output of our fledgling TX we need to add an amplifier. Obviously we are talking about Radio Frequency (RF) amps, not audio amps. RF amps have certain important characteristics: a) Bandwidth b) Gain and maximum power output c) Input and output impedance.

BANDWIDTH This is the range of frequencies the amp will amplify properly. The Bandwidth is ultimately limited by the characteristics of the active devices in the amp (ie the transistors or valves) but more specifically by its type, LINEAR or a TUNED amplifier.

A linear amp will amplify quite a large range of frequencies and they have a good bandwidth, commonly 1.8 - 30 MHz which covers all of the amateur shortwave broadcast bands.. no good for a VHF pirate, but could be useful for a MW pirate. They operate in class A or B mode and have the advantage that they don't need adjusting when the frequency is changed. Their disadvantage are they're more complex and

dearer than tuned amps and are much harder to design, requiring extensive knowledge of the transistors round which the amp is constructed. Linear amps for VHF are uncommon.

Tuned amps only amplify a narrow band of frequencies, they have a small bandwidth, centred on one frequency which is determined by the TUNED CIRCUITS in the input and output networks of the amp. Tuned circuit have a RESONANT frequency. This can be adjusted by variable capacitors known as trimmers, to the desired frequency. The amp will produce max output when the tuned circuits resonant frequency is the same as the input frequency from the exciter. Tuned amps often operate in the class C mode, which is more efficient than A or B. This means more of the power being drawn from the battery or whatever turns into watts up the aerial rather than heat in the amp. They are relatively simple circuits, and are easier to design. The bandwidth is a trade-off with gain, the wider the bandwidth the less the gain. The disadvantages of a tuned amp is, of course, you have to tune it to the frequency you're using and if you change the frequency you'll you'll have to retune to maintain the gain of the amp.

GAIN AND MAXIMUM OUTPUT POWER

The POWER GAIN (as opposed to a voltage or current gain which is different) of an amp is defined as a ratio:
$$\text{power gain} = \frac{\text{output power}}{\text{input power}}$$

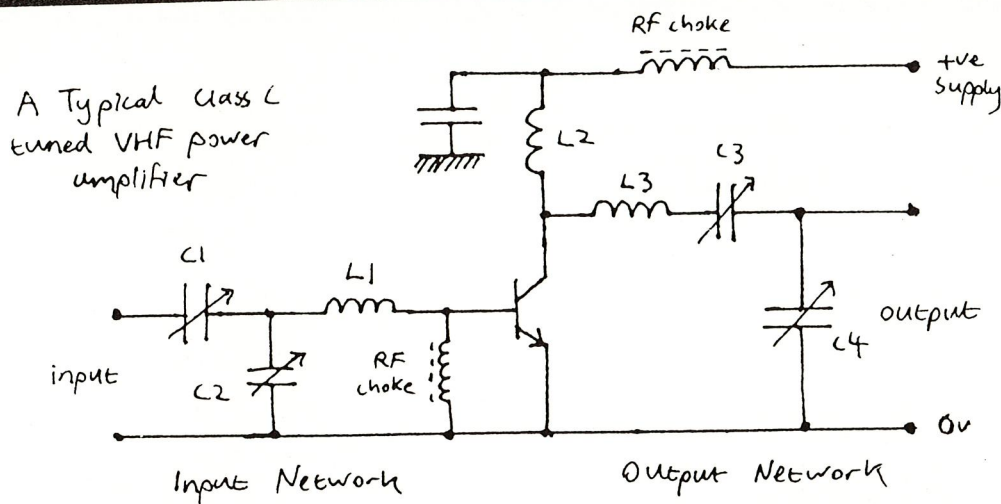
and is a measure of the amp's ability to make its input 'bigger'. Power gains are often expressed in DECIBELS (dB) which are defined:
$$\text{power gain (dB)} = 10 \log_{10} \frac{\text{output power}}{\text{input power}}$$

Amps also have a max output power. When this is reached increasing the input power won't result in more output power and may damage the amp.

In the case of single stage (ie one transistor) class C tuned amps the gain and max output power of the amp is basically the gain and max output power of the transistor. Knowing these we can calculate the power necessary to produce the max output power. EG let's consider the popular MRF237 transistor. According to the makers data sheet this has a max output power of 4w and a gain of 12dB. First we've to convert the gain in dB to ordinary gain:

$$\text{gain} = 10^{\frac{\text{gain (dB)}}{10}}$$

$$\text{for example gain} = 10^{\frac{12}{10}} = 10^{1.2} \approx 15.85$$



$$\text{Input power} = \frac{\text{Output power}}{\text{gain}} = \frac{4}{15.85} = 0.25\text{w} = 250\text{mW}$$

So for 4w output power we need 250mW input power. Most excitors can manage this, hence the popularity of the MRF237 in the 1st amp after the exciter. The joker in the pack is that all these figures are for a frequency of 175mHz, that on which the transistor was designed. You can't predict what happens at 100mHz and have to experiment.

The MRF238 has 30w output power and a gain of 9dB, so it needs 3.8w input power. This can be had from the MRF237. That's how the makers (Motorola Corpse.) planned it.

INPUT AND OUTPUT IMPEDENCE

Impedence is the alternating current (AC) version of resistance. The standard impedance outputs of excitors and outputs and inputs of amps is 50Ω . The impedance of the input and the output networks of an amp is altered by the tuned circuits which you recall also tune the circuit in a tuned amp. The INPUT IMPEDENCE is important as it effects the LOAD the amp has on the stage before it. Max power is transferred between stages when the impedance of the output and input are equal. If the impedences aren't equal a MISMATCH is said to occur and in this case some energy is reflected back from the input of a stage into the output of the preceding one, where it's wasted as heat.

THE VSWR METER

Some of you may know that we can use a VSWR meter (also known as Voltage standing wave ratio meter, SWR meter or a Reflectometer) to detect mismatch between TX and the aerial, but the VSWR meter is just as much at home doing this between amp stages. VSWR is the ratio of the forward (or incident) and reflected power. Except for dear ones they work the same. The switch is set to Forward or the SET button is pressed. The knob is then adjusted to make the meter read full scale. The switch is then set to Reverse or the button is pre-released. It now indicates the VSWR. A VSWR of 1:1 is perfect (no reflected power) and so unlikely. One of 00:1 shows all the power is reflected back into the amp, you'll get this with a VSWR connected to the amp output with nothing on the VSWR output (unless it's got a built in dummy load). You'll also get it if there's a short circuit in the VSWR meter. In either case switch off IMMEDIATELY or you'll blow your power transistor.

The point of all this is to get the max power output from the amp into the aerial, instead of a hot TX and a bad signal.

To tune such an amp you need a LOAD connected to the output (or it'll blow up). We could use an aerial but this introduces an extra unknown quantity..the characteristics of the aerial. As well as the fact that we'd be broadcasting. What we need is a DUMMY LOAD.

THE DUMMY LOAD

This is basically a resistor, made so it presents a load to the amp's output independent of frequency (unlike the aerial). The 3 things about a dummy load we're interested in are:

- It should be suitable for the frequency we're interested in, about 100mHz.
- It should be rated to take the power we're trying to make.
- It should have a resistance of 50Ω . To match the output network of the amp.

When buying ask for one for the 2 meter band, amateur radio, centred on 145mHz. Most test gear for this band (dummy loads, VSWR meters, power meters, wavemeters, RF volt meters, frequency counters etc) will work on the frequencies we're interested in.

The amp should first be tuned with reduced input power and supply voltage. Adjust the input network trimmers C1 & C2 for the best input match (lowest reading on a VSWR meter connected to the input side) and adjust the output trimmers for max output power. Be sure the extra power is in the frequency you want and not in the HARMONICS. Check with a wave meter (more of this coming up). Another VSWR meter can be used for a relative indication of the output power, or the RF PROBE, described on page will give an absolute indication. The pairs of trimmers are very interdependent, adjust one and you'll have to adjust the other, and so on.

This done, if all OK, increase the input power by increasing the voltage supply to the previous stage, and the voltage supply slightly and repeat the tuning. Do all this a few times till you reach the required levels. Listen in on a nearby (but not too near) receiver. The signal should be in just one place on the dial with no funny noises or modulations going on. Check with a wave-meter. Altering the trimmers and varying the input power and supply voltage should result in smooth variations of the supply current and output power with no steps or jumps. The exception is, as the input power is reduced at some point the amp will switch off, a characteristics of Class C amps.

To vary the supply voltage you need a Variable Stabilised Power Supply Unit. If you can't get hold of one you could

build one. They're not expensive and are well handy, and give you some experience, if needed, of electronic construction.

HARMONICS

Harmonics are multiples of the transmitting frequency. For a frequency of 100mHz, the 1st harmonic, known as the FUNDAMENTAL is 100mHz, The second is 200mHz, the 3rd is 300mHz etc. They're produced as side effects in various parts of the circuit and will interfere with other users of these frequencies if let escape from the TX. Known as RADIO FREQUENCY INTERFERENCE (RFI). Tuned class C amps don't amplify harmonics, as they're out of the range of the amp's abilities. But the use of Class C means that harmonics are generated by the amp along with the desired frequency. The strongest ones (apart from the fundamental) from such amps are usually the 3rd, then the 5th etc. The amplitude of harmonics is minimised if the output networks are tuned properly, but they're still there. Oscillators and Buffers can also make harmonics if not set up right.

WAVEMETERS

To detect harmonics we need an ABSORPTION WAVE-METER usually called just a wavemeter. Or we can use a GRID DIP OSCILLATOR (GDO) or a gate dip oscillator, both of which are known as DIP METERS. Most dipmeters have a switch which turns them into wavemeters. A wavemeter has a tuning knob, calibrated in frequency, a meter showing signal strength, and some kind of short aerial. You hold the aerial near a coil in the bit of the circuit you're interested in, and tune the wavemeter. It shows how much signal is present on the frequencies shown on the scale. So you can see what frequencies are being generated in that part of the circuit. Ideally you'll just find the fundamental, unless the circuit is a frequency tripler or something.

If you buy a wavemeter be sure it covers the right range, from below 100mHz to get the fundamental to above 300mHz to get the 3rd harmonic.

Even with all tuned right you're still going to have some harmonics generated by the last stage. A sensible pirate won't let these reach the aerial, e.g. if you're using a frequency of 102.35mHz the third harmonic is 307.05mHz which happens to be that used by USAF Upper Heyford's Control Tower. You might think this funny but you won't stay on the air for long. To stop harmonics reaching the aerial we need a BAND-PASS FILTER.

Each amp bumps up the power some more, cos the transistor in each one can only supply so much gain. So if you're the proud owner of a 5 watt and you're offered a 1000w amp it's useless as you'd need probably 100w input to drive it so you'd need amps in between.

To tune a series of amps on your TX you must break in, physically if needed, to tune each one at a time. Do this by unsoldering components and soldering in short bits of co-ax with plugs to connect to dummy load and VSWR meter.

BANDPASS FILTER

This filter only allows through a narrow band of frequencies, ie it has a narrow bandwidth, a good one would be less than 1MHz. It needs standard 50 ohm input and output impedance and be able to take the power you're using and be tuned to the frequency you want let through. Other frequencies are reduced drastically, by an amount known as INSERTION LOSS.

It reduces also the desired frequency slightly, by an amount known as INSERTION LOSS. To keep this loss low bandpass filters for high output powers are usually pretty chunky numbers.

Pirate gear doesn't have this filter built into the final stages so if you need one you have to add it on. It needs a well

screened case to stop harmonics leaking out. In fact your whole TX should be well screened for the same reason. Say for eg you used a shoebox and had your oscillator on a third of a frequency of 92.25mHz..you could be interfering with pagers of a local hospital as they use 31.75mHz. Proper screening and a bandpass filter will eliminate such possibilities.

CONNECTORS

As you may have guessed you can't use any connectors on VHF as they have to match the amp and feeder. Use BNC or the UHF series (PL259 plug and SO239 socket). UHF is best for higher powers as you can get a wider cable into the plug. N type is also good but dearer.

FEEDERS

So you've got your nice clean harmonic free signal coming out of your bandpass filter..we're on the home run. All that's left is to get the signal up the aerial feeder to the aerial and we're away. BUT the aerial cable needs to MATCH the TX's output stage at one end and the aerial at the other. This cable like the TX's output, the connectors and the aerial has an impedance and to match this should be 50Ω. It also needs LOW LOSS or your watts will escape as heat. Not the same as a bad VSWR where you lose energy in the TX, a good VSWR does not mean the cable's okay. Decent cables for short runs are UR76 and RG56U. For longer runs or higher powers use UR67. (UR67 and UR76 are available from Cirkit).

AERIALS

At last, the aerial! You can run a pirate knowing little of TX's, but if you know nothing of aerials you'll have few listeners. So you must read a book on it. I recommend 'The Two Metre Antenna Handbook' by FC Judd G2BCX. It's a paperback by Newnes technical books at £5.95. You may get it in the library. Lots in it isn't useful but he goes into things like propagation, matching, VSWR in better detail. All the dimensions he gives are for the 2m amateur band, centred on 145mHz. To convert to other frequencies all dimensions (including diameter of aerial element, etc) should be divided by your frequency in mHz and then multiplied by 145. eg 978mm for 2m becomes $978 \times 145 = 1377\text{mm}$ for 103mHz.

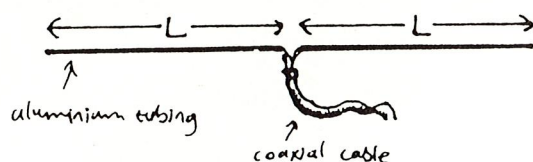
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POLARISATION

One thing to decide is what polarisation to use. The main ones are HORIZONTAL and VERTICAL. To simplify you can say a horizontally placed aerial produces horizontally polarised radio waves and a vertically placed one vertically polarised radio waves. To receive a horizontally polarised signal you need a horizontally polarised aerial, and for a vertical one a vertically polarised aerial. Most receivers on FM have horizontally polarised aerials, but all car aerials are vertically polarised. So what polarisation you go for depends on the audience you expect. Eg on Sunday afternoon you'd expect people at home so use horizontal, while in rush hour you might favour vertical. You can build an aerial which splits the power between both, as used in legal stations, known as MIXED polarisation. But the effect of radio waves bouncing off buildings etc tends to twist the polarisation of your signal from horizontal to vertical and vice versa, so your signal could still be picked up by the wrong aerial.

Your transmitting site will affect your choice of aerial (see also Ch 2, How To Get Away With It). In the middle of the area you want to cover you'll need an OMNIDIRECTIONAL aerial which transmits equally all ways, while outside your coverage area you can beam the signal in, with a DIRECTIONAL aerial.

The simplest possible aerial for VHF is known as the HALF WAVE DIPOLE and looks like this:

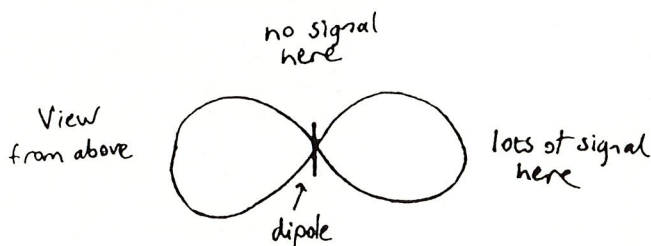


The elements can be bits of thin aluminium or copper tube. The lengths of each dipole, L , you get from your frequency

$$\text{by: } L = \frac{71}{f \text{ (in MHz)}} \text{ metres}$$

The impedance is about 72Ω which is close enough to 50Ω to be fed from 50Ω cable without too much power loss.

A half wave dipole used vertically is omnidirectional, but when used horizontally it has a fig of eight coverage like this:



which isn't v. useful. Also a dipole needs a balanced feed. You need a BALUN (BALance to UNbalance) transformer. These can be easily made out of bits of co-ax cable. If you don't do this power will be radiated from the feeder. An aerial with an impedance greatly different from 50Ω needs an IMPEDANCE TRANSFORMER. Also made out of bits of co-ax, see aerial book for details.

Before going on air get a low VSWR by adjusting the position of the aerial and any adjustable pieces. Aim for 2:1 or less. Use low power into the aerial when tuning it up and adjusting, if using 100's of watts and a bit came off in your hand the VSWR could be so bad as to blow the final transistor. For the same reason check the continuity of the aerial with an ohmmeter before plugging in, to be sure it's what it's meant to be, either a short circuit or an open one, depending on the type. A dipole should be an open circuit.

SITING

Siting is very important. Height is the main factor, even more than watts! Since VHF radio waves go almost in straight lines, 100w in your front room will only reach your neighbours, while 5w up high and unblocked will go 5 miles or more. The waves do bend a bit so you'll cover more than you can see but it's hard to say how much. GO for it!

To join the Radio Support Group and get up dates and development aid write to RSG. c/o Box 010, 37 Stokes Croft, Bristol. Avon BS13PY. It costs £5 to join. Make cheques payable to D.R. Communications.

Appendix A. THE FREQUENCY COUNTER

If you can get hold of one setting up an exciter is so much easier, you can see what frequency you're on and if it's drifting. You don't need a physical connection to the circuit to use it as this can upset things. Either connect a single bit of wire to the input or use a BNC lead ending in a pair of crocodile clips clipped together to form a little loop. Frequency Counters are normally sensitive enough to get a reading when the wire or loop is placed near a coil. You might get lots of other readings as you move it about. Look for a stable one near the frequency you expect (use receiver or a wavemeter if you're not sure). It's a bit of an art but you'll soon get the hang. For our purposes a frequency must have:

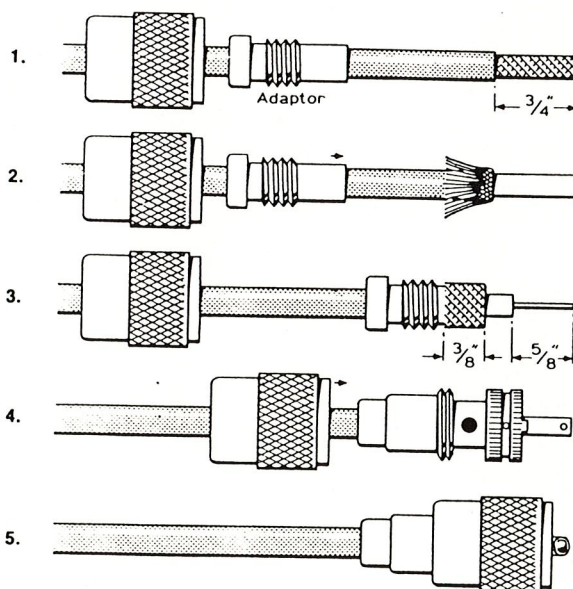
- The bandwidth, up to at least 150MHz.
- The Resolution i.e. number of digits on display. Four isn't good enough, six is OK, 8 is preferable.

The Thandor PFM200A is around £75 plus vat from Cirkit.

APPENDIX B UHF PLUG ASSEMBLY

UHF type (clamped screen)

- Cut end of cable even. Remove vinyl jacket $\frac{3}{4}$ in. Slide coupling ring and adaptor on cable.
- Fan braid slightly and fold back as shown.
- Position adaptor to dimension shown. Press braid down over body of adaptor and trim to $\frac{3}{8}$ in. Bare $\frac{1}{2}$ in of conductor. Tin exposed centre conductor.
- Screw plug sub-assembly on adaptor. Solder braid to shell through solder holes. Use enough heat to create bond of braid to shell. Solder conductor to contact.
- For final assembly, screw coupling ring on plug sub-assembly.

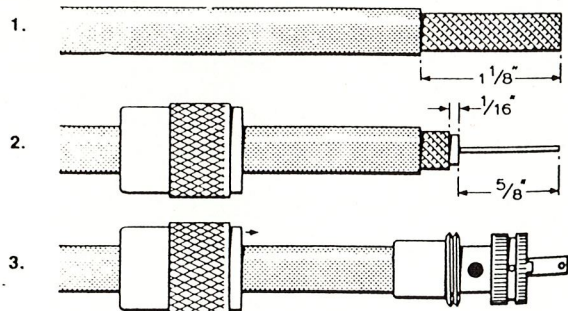


UHF type (clamped screen)

UHF type (soldered screen)

- Cut end of cable even. Remove vinyl jacket $\frac{1}{2}$ in.
- Bare $\frac{1}{2}$ in of centre conductor. Trim braided shield. Slide coupling ring on cable. Tin exposed centre conductor and braid.
- Screw the plug sub-assembly on cable. Solder assembly to braid through solder holes. Use enough heat to create bond to braid to shell. Solder centre conductor to contact.
- For final assembly, screw coupling ring on plug sub-assembly.

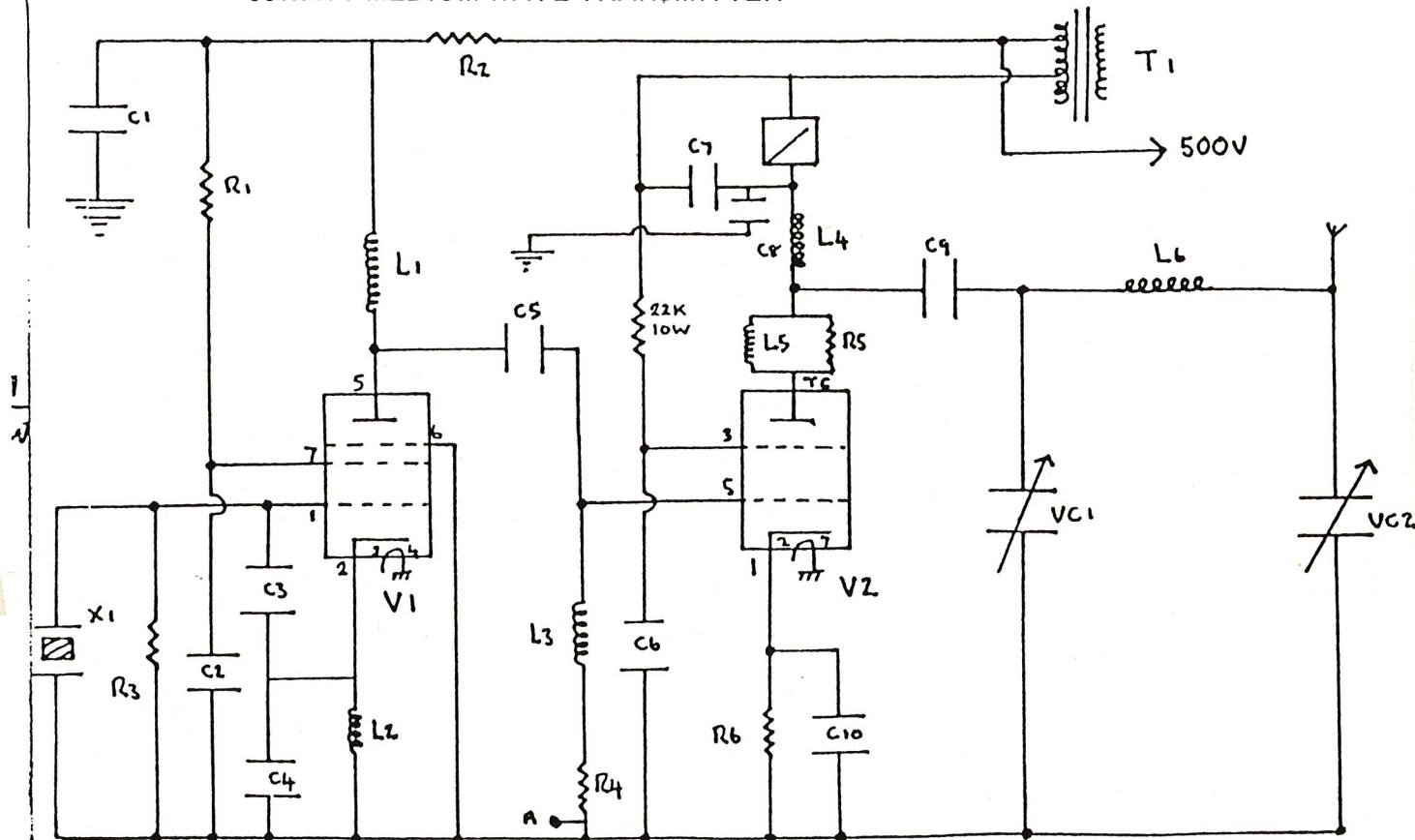
UHF type (soldered screen)



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How to Draw and Make your own PCB by R.A.Penfold
 Babani Books. £1.95 from Maplin.
 Two Meter Antenna Handbook by F.L.Judd G2BCX
 Newnes Technical Books £5.95.
 VHF UHF Manual edited by G.R.Jessop G6JB RSGB
 This book is a mish mash of i-fo aimed at Radio Amateurs.
 Some is relevant, most isnt. The chapter on aerials is worth
 a look. About a tenner.

60WATT MEDIUM WAVE TRANSMITTER



60 Watt medium wave transmitter

CAPACITORS

C 1 0.005 mfd 500v
 C 2 0.005 mfd 500v
 C 3 30 pf 50v
 C 4 200 pf 50v
 C 5 100 pf 500v
 C 6 0.005 mfd 500v
 C 7 0.01 mfd 1Kv
 C 8 0.005 mfd 1Kv
 C 9 0.005 mfd 1Kv MICA
 C 10 0.005 mfd 50v
 VC 1 500 pf (wide spa
 VC 2 1000 pf

VALVES

V 1 EF 91 or 6AM6
 V 2 6146 or QV06-20

RESISTORS - all 1/2 watt unless stated

R 1 4.7K 2W
 R 2 27K 3W
 R 3 22K
 R 4 22K
 R 5 33
 R 6 220 3W
 R 7 (between C7 & C6) 47K 3W

COILS

L 1 2.5 mH RF Choke
 L 2 2.5 mH RF Choke
 L 3 2.5 mH RF Choke
 L 4 2.5 mH RF Choke 200 mA
 L 5 6 turns 22 swg en. cu. wire round resistor
 L 6 70 turns 22 swg en. cu. wire round 1 1/4" former.
 Tapped at 5 40 turns
 and then every 5 turns.

MISCELLANEOUS

M 1 150 mA meter
 X 1 medium wave crystal (1MHz - 1.5 MHz)
 T 1 modulation transformer (Woden UM 1 or similar)
 A Metering point. Disconnect R4 from earth. 6146 grid current should
 be set to 3.4 mA by changing the value of EF 91 screen grid resistor
 if necessary.)

ERROR There should be a link between the cathode of V1 and the junction of
 C 3 & C 4.

Ohessa olevat lähetinkaaviot näyttävät ehkä jo sellaisenaan melko monimutkaisilta, etenkin jos elelektroniikkatuntemus ei ole kovin suuri. Seuraavaksi pyritään antamaan ohjeita lähettimen kuin lähettimen rakentamiseksi.

Yksinkertaisimmalta saattaa tuntua joku pieni yksinkertainen transistorioskilllaattori, mitä se ei kuitenkaan välttämättä ole. Rakentaminen on helppoa - mutta kaikki kytkennät eivät edes suostu värähtelemään yms. ja tuloksena voi olla palanut kivi. Putki-lähettimet ovat aloittelijoille vaikeampia mm. korkeiden jännitteiden vuoksi. Kokemattomampi rakentaja pääsee kyllä putkilähettimellä parempiin tuloksiin kuin vastaavalla transistorilähettimellä. Ensimmäinen putkitx voi olla vaikkapa 2 x EL 84:llä toteutettu tx. Jännite voi olla 250-350 VDC, joka on sopiva siinä mielessä, että esim. sopivan muuntajan puuttuessa voi tehdä "harakiri"-kytkennän ja tasasuunnata verkkovirran, jolloin tulos on 300-310 VDC, mutta tapa ei ole suositeltava ilman erotusmuuntajaa ja tx:n ruhkoon tulevan jännitteen vuoksi! Suodatuksessa on yleensä käytettävä 100-500 μ F välillä olevia 350 V konkkia, joita on mm. televisioissa.

KURISTIMET voi käämiä myös 1,5 cm $\varnothing$ muoviputkelle, 5x25k ja langan paksuus esim. 0,4-0,5mm, jolloin virrankestoisuus on suurempi. 15W tx:n pääteputken anodille olisi hyvä laittaa tämä "powerimpi" malli. Jos runkona käytetään 2W vastusta ei arvon tarvitse olla 1M vaan muutama K ohmikin riittää. Näitä vastuksia on myös TV:ssä.

EL 84 (pääteputki) hilalla oleva vastus olisi oltava massavastus, 1/2 W vastus riittää hyvin. Saman putken suojahilavastus voi olla mikä tahansa 3-5W tehovastus(5,4k) tai pari pienempää sarjassa.

PIISUODIN: Lähettimen tankkipiirin tehtävä on sovittaa läh. anodilta tuleva signaali 50-75 ohmiin. Yksinkertaisimmin anodin ja maan välisen resistanssin lasku käy jakamalla anodijännite anodivirralla. Samoin kuten teho on $P=I \times U$. Tämä on tietenkin vain putken ottoteho, josta puolet on modulaattorin teho, ja ulostuloteho on 75% ottotehosta(C-luokassa). Itse piisuodin on helppo tehdä monialueiseksi tekemällä päätekelaan väliulosottoja. Kelan voi käämiä mm. 4cm $\varnothing$ PVC putkelle miel. 2mm langasta. Kelan etäisyys rungosta olisi oltava vähintään 3cm, meilummin enemmän. Kourmituskonkkana, anodin ja piisuodattimen välillä, olisi käytettävä keraamista konkkaa. "Tune"-säätökonkka voi olla vaikka 500pf, kunhan siitä saadaan säädettyä tarvittava kapasitanssi, esim 70pf. "Tune"-konkasta (ei s. säätökonkka) riippuu lähettimen viritys, load eli jälkimmäinen konkka, ei vaikuta kovinkaan paljoa riippuen antennista. Suuremmilla anodijännitteillä (500-3000V) tulee pulmaksi mm. "tune"-säätökonkka, sillä sen pitäisi kestää ko. jännite lyömättä läpi! Nämä ovat nk. harvavälisiä säätökonkkia ja maksavat 100-200mk/kpl.

MODULAATIO tuodaan modulaatiomuuntajaan, joka löytyy putkivastaanottimesta. AM modulaatiossa muutetaan kantoaallon amplitudia. Paras tulos saavutetaan kun modulaatiomuun. muuntosuhde on oikea. Käytännössä tämä onkin jo hankalampaa suuren toisioimbedansin vuoksi. Helpon tapa olisi laskea muuntosuhde modulaattorin ulostulojännitteen avulla. Kun modulaatio näissä tapauksissa olisi 100% vaihtelee PA- putken anodilla oleva jännite välillä 0-2U. Siksi osat on mitoitettava kestäämään kaksinkertaisen jännitteen.

Häiriönpoisto: Häikuhurinat yms. poistetaan kahdella 5nF konkalla kytkemällä niiden kautta molemmat navat maahan. Kytkemällä modulaattorin miinusnapa 0,5uF:n konkalla maahan päästään yleensä pahimmasta häiriöstä, mutta joskus on tarpeen kytkeä verkkohurinan estämiseksi powerin diodien rinnalle 1nF konkat(1kv).

HUOM. TEKSTIN KOMMENTIT VIITTAAVAT SIVUN
50 SW-LÄHETTIMEEN. 20

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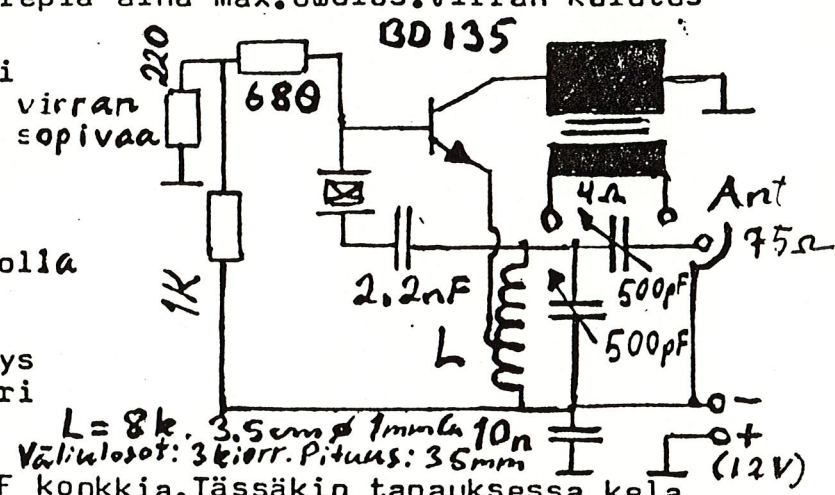
Joillakin putkityypeillä on tapana "ruveta värähtelemään" tietyillä taajuuksilla, joka on estettävissä putken neutralisoinnilla, joka onkin jo eri jutta.

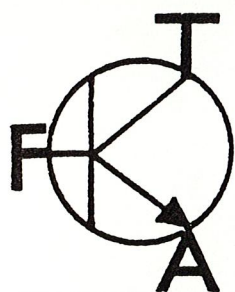
Putkien kantakytkennät poikkeavat hyvinkin suuresti. Suuremmat lähetinputket vaativat jo erikoisemman kannankin. Novalannoissa on hehkut useasti kytketty pisteisiin 4 ja 5. Pentodeissa (mm. EL 84) jarruhila kytketään tavallisesti maahan. Nk. Maattohilakytkenässä (käytetään linukoissa) kytketään kaikki hilat maihin olipa kyseessä vaikkapa triodo. Katodi kytketään kuristemen kautta maahan ja ohjausteho tuodaan myös katodille. Yleensä ko. kuristemen kanssa sarjassa käytetään suurteho zenerdiodia vakavoimassa ko. esijännitteen halutuksi. Linukan täytyy toimia joko A, AB tai B luokassa AM:llä ja SSB:llä. CW:llä ja FM:llä riittää jo C-luokan vahvistin, jolloin hyötysuhdekin on parempi. Maattohilakytkenässä on yleisesti kysymyksessä B-luokka. suuri tehoisissa modulaattoreissa saavutetaan suuri hyötysuhde kytkemällä kaksi putkea nk. push-pull kytkentään, verrattuna esim. vastaavan A-luokkaiseen asteeseen.

ANTENNI: Hyvä antenni on dipoli. Mitoitus: puoli kertaa aallonpituus kertaa 0,95. Syöttö antennin keskipisteeseen 50-75ohm kaapelilla kun käytetään dipolia lähetintä ei maadoiteta. Viritykseen voi käyttää SWR-mittaria, joka näyttää seisovan aallon suhteen. Kun SWR on 1:1 on kaikki parhaalla mahdollisella tavalla OK, asiaa voi vielä tarkistaa lisäämällä 1:4 allonpituiseen pätkän koaksiaalia kaapeliin. Arvoilla 1:3 ei ole vielä mitään merkittävää hätää. SWR-mittaria voi käyttää TX:n viritykseen "eteen" asennossa. Virityksen voi suorittaa myös TX:n anodi virtamittaria hyväksi käyttäen (PA) TX on vireessä kun anodivirta on pienimmillään. saman voi tehdä myös voltti mittarilla: kun jännite modulaatiomuuntajan jälkeen on suurimmassa arvossaan on TX vireessä.

TRANSISTORILÄHETTIMET ovat käytännöllisempiä mm. mobile valmiuden ansiosta. Ne ovat myös arkoja liian suurille SWR:lle. Seuraava 3W:n mobile TX on tarkoitettu 7MHz amatööritoimintaan (ks. Kootut kytkennät kirja). Se aluksi lähde välttämättä värähtelemään esim. 48, mutta kääntelemällä konkkia se alkaa toimia. Jos jännite on kytketty ja laite ei värähtele tuhoituu kivi ihmeen helposti, varsinkin jos jäähdytys ole hyvä. Joku kaupallinen jäähdytysprofiilimalli olisi erittäin hyvä, esim 10x10cm. Tällöin voidaan repiä aina max. 8W ulos. Virran kulutus on 0,5A ja hyötysuhde n. 50%

Modulaatio muuntajaksi ei sovi enää putkarin muuntaja suuren virran kulutuksen vuoksi, vaan mikäli sopivaa ei löydy, sen voi käämiä itse. Runko 15-25W (AFe = esim. 5cm²) 4ohm käämi voi olla esim 16m 0,3mm CU:ta. Toision käämi voi olla 0,5mm CU:ta niin paljon kuin pakkaan mahtuu tai lankaa on tms. Tämänkin lähettimen viritys sujuu kytkemällä jännitemittari transistorin kollektorilta ja virittämällä jännite maksimiarvoon säätämällä 500pF konkkia. Tässäkin tapauksessa kela on syytä pitää erillään muista metalli esineistä, tämä on huomioitava kotelo tehtäessä. Nk. silmukka antennilla on päästy hyviin tuloksiin tämän TX:n kanssa. Tämä nk. triangeli antenni antaa 2dB suuremman vahvistuksen dipoliin nähden ja lähtökulma pienemmillä korkeuksilla on loivenpi. Itse ulostuloteho ei ole viimeisen päälle tärkeä, vaan yleensä antenni ja sen sovittaminen määrää kuuluvuuden. Lisätietoja lähetintekniikasta saa yleensä suomalaisilta piraateilta esim. Meteor, Meteor... osoitteet kaikille: P.O. BOX: 41 NL-7700AA Dedemsvaart, HOLLAND. KIRJALLISUUTTA: ARRL, Radioamateurs hand book esim 1980.





FREE THE AIRWAVES TRANSMITTER PLANS

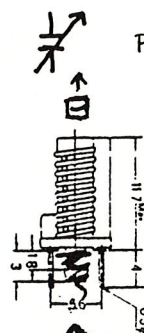
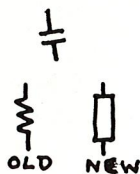
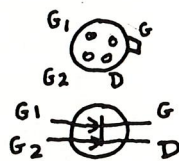
1/2 WATT DRIVER STAGE (DIAGRAM 1)

4WATT VHF M Transmitter, parts and instructions

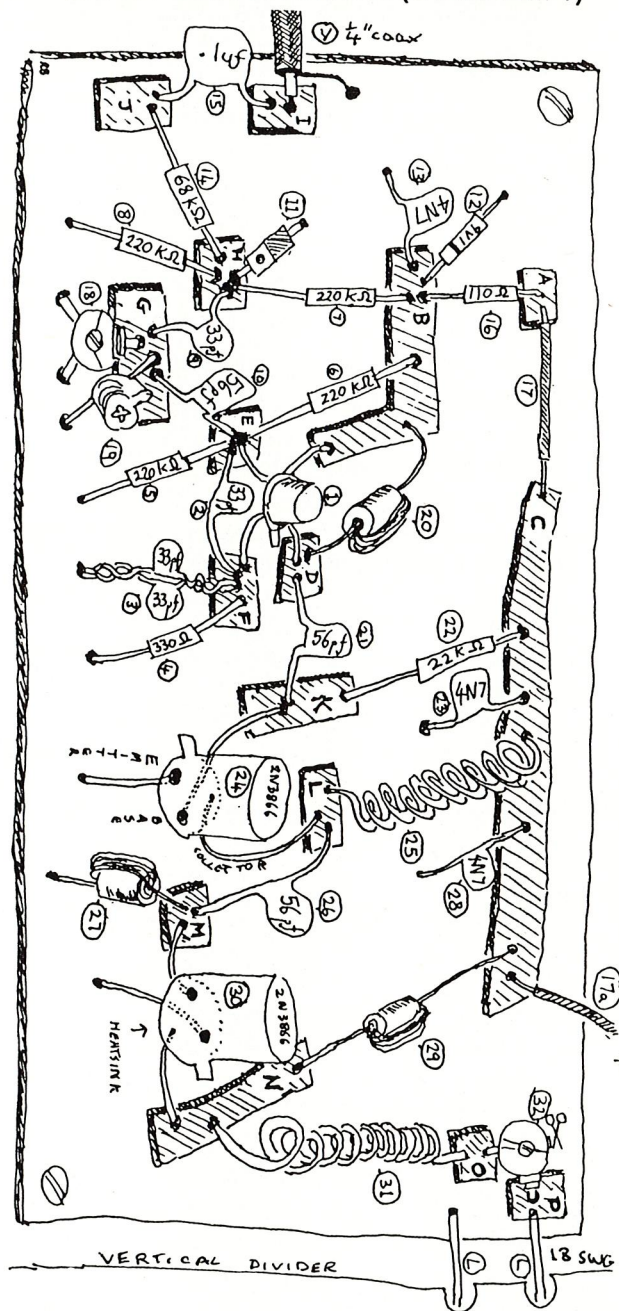
* Get some *double-sided copper clad PCB*, enough to make boards in Diag. II and IV, and a piece $1\frac{1}{2}'' \times 3''$. Cut PCB with *stanley knife* — score, bend, snap. Cut islands with *junior hacksaw*. Clean with *emery cloth*. Drill holes $1/8''$ bit. Mark islands with felt tip A to X (see Diags. II and IV). Mark board. Glue islands with *Lochite superglue* — one drop will do. Clean islands of any glue. Apply liberal amount of *solder* to islands with a decent *iron*, 25watt Weller is a good buy, small style.

DIAGRAM I. ASSEMBLY ORDER

1. **3SK51 or 40673 dual-gate mosfet transistor**
Cut two legs off to about $2/10''$, opposite sticking-out bit. Apply solder. Try not to handle transistor, but use legs to position. Stick these legs to islands B and E. Cut other legs, press down and solder to islands D and F.
2. **33pf capacitor**
Same principle, cut one leg, apply solder, use other leg to position.
3. Wind **2 x 33pf capacitors** legs together. Solder to islands F and the negative rail, which is the board.
4. **330 Ω resistor, 1/4 watt (orange/orange/brown)**
Keep close to 3, island F to board.
- 5/6/7/8. **4 x 220K Ω 1/4 watt (red/red/yellow)**
9. **33pf**
10. **56pf**
11. **BB105B or BB205B varicap diode**
Spot nearest island.
12. **9V1 zenner diode**
Line nearest island.
13. **4N7 capacitor (or 4700pf, or .0047uf)**
14. **68K Ω (blue/grey/orange)**
15. **.1UF capacitor (or 100N, or 100,000 pf)**
16. **110 Ω (brown/brown/brown)**
17. **Single piece of insulated 3-amp wire. 17a. Same**
18. **2-22 pf foil trimmer/variable capacitor (plastic)**
Odd leg is positive and goes to island G
19. **MC108 Toko VHF mounted coil inductor 5.5 turns, 0.64 μ .H**
This is the most tricky component in the circuit, due to difficulty in raising ferrite core. Sharpen a piece of plastic with Stanley Knife to act as trimmer. Be patient. Order a number of different coils near this one, so that you can experiment, as it is this component and the variable capacitor above that combine to create the frequency for transmission.



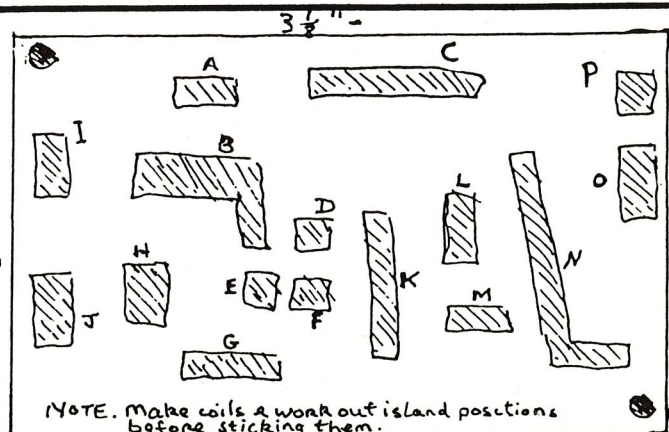
NOTE:
KEEP
ALL
LEADS
SHORT
AS
POSS.



MC 108 TOKO: Another way of getting into the ferrite core is to heat up a needle in a flame, pierce underneath, and then push up.

20. RF choke, fixed inductor

This isn't ready-made, but you have to build it yourself. Get a dozen FX 1115 ferrite beads and some 28-gauge, enamelled SWG copper-wire. Wind wire through middle 6 times. Remove enamel from the ends, best way to do this is to burn off then use emery cloth.



Actual Size 2-1/8" x 3-1/8" with islands for 1/2 WATT DRIVER STAGE (Fig 2).

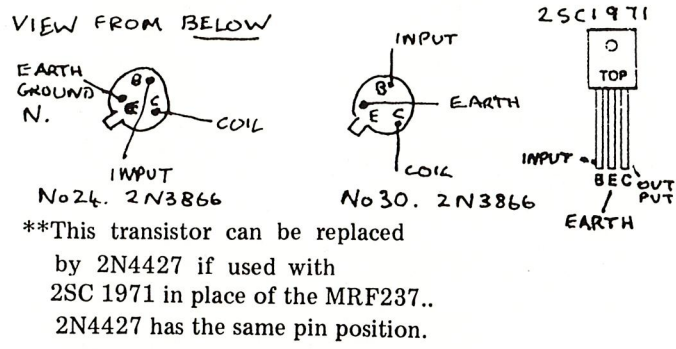
21. 56pf
22. 22KΩ
23. 4N7
24. 2N3866 transistor
Before bending legs into right position relative to islands, we must *heatsink* transistor. Small heatsink will do. Plus we need *silicon grease* in a syringe. Put grease around sides of transistor can, prise open heatsink with screwdriver, slide tranny in, take out screwdriver. Bend legs and cut. Solder. Make sure with crossover that no legs touch.

30. 2N3866 The larger the heatsink, the better. See No. 24.
31. SWG18 guage enamel copperwire 10 turns this time.
32. 2-22 pf variable
Positive leg to P. Cut off leg facing leg on 0.

** The first board can now be tested once we have added piece of UF67 Coax, or any heavy-duty 7mm CB Coax. (See diag. V). We must fix Coax to a UFH male plug (see diag. VII). Plus e need stereo 1/4" jackplug socket plus 250KΩ log pot and some insulated 3-amp wire.
To properly test and develop we need:

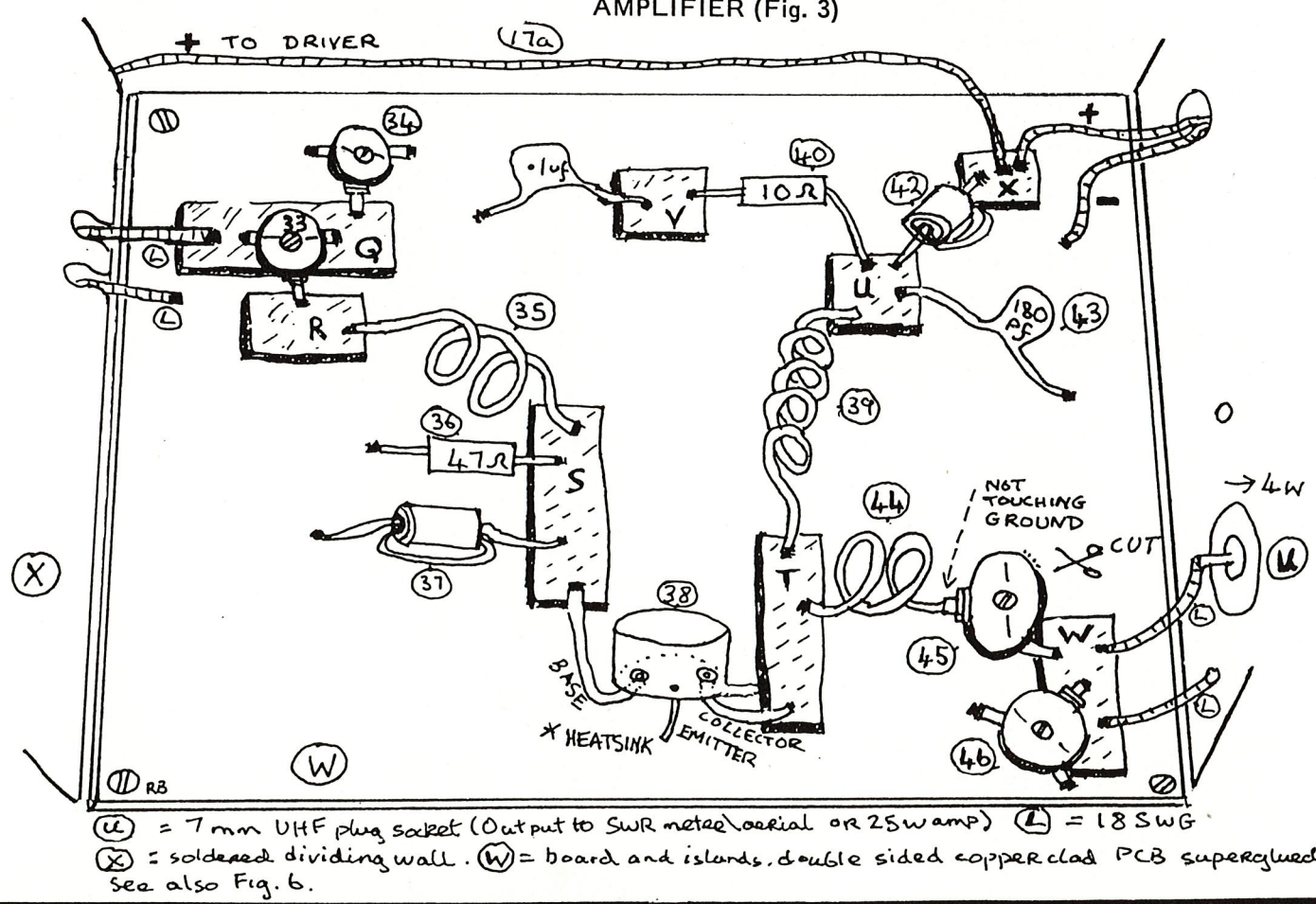
- a) a power supply – a CB 13.8v 3-amp unit, or a 12v car/motorbike battery.
- b) a power/SWR meter—capable of up to 150mHz, plus dummy load=25W
- c) A frequency counter. This is the most expensive item. A Thandor PFM200A is the best value
We could do without a frequency counter, but if anything is slightly out, ie off the VHF band, than a radio receiver is no good to find a fault.
- d) A cassette-player with a 5-pin Din plug.
- e) A radio receiver

Fit to power supply, fit to power meter. Turn on frequency counter. Set counter to 0.2 gate, put probe into left-hand socket (probe can be just a piece of single core insulated wire). Turn on power. Adjust parts no. 18 and no. 19. See the reading change. Choose a free frequency. To adjust power, turn part no. 32 (to adjust variable capacitors, use a plastic trimmer).
If all's going well, plug in cassette (5-pin Din plug to 1/4" jack Tandys). Put in your favourite tape, turn on radio, and if everything's okay you should hear your tape on the radio. If something is wrong, check and double-check. If you can't work it out, send board back to us via Free The Airwaves and we will see what's wrong. If everything's okay then you can go to the next stage.

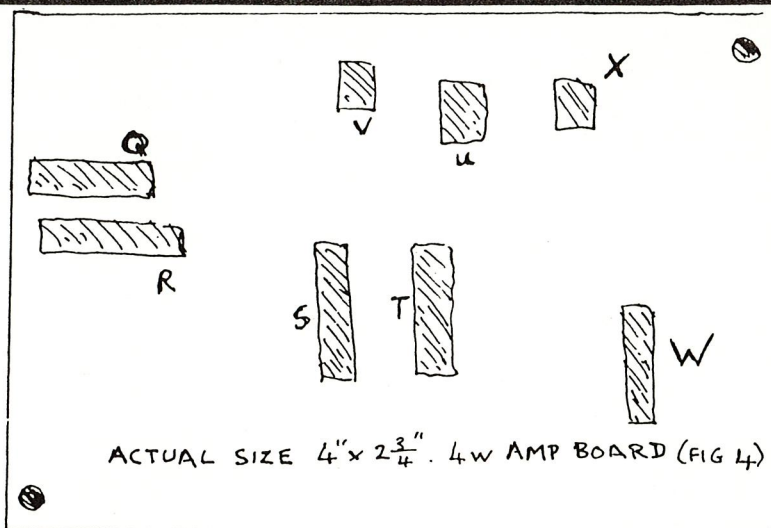
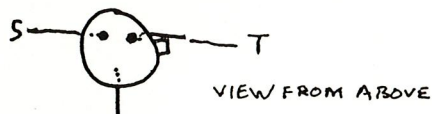


25. 18-gauge enamelled SWG copperwire
Wind wire 9 times around pencil, shape legs, scrape off enamel and solder.
26. 56pf.
27. RF Choke. Fixed inductor.
Same as no. 20.
28. 4N7
29. RF choke, as above

SCHEMATIC DIAGRAM FOR 4WATT AMPLIFIER (Fig. 3)



33. 3-90 pf variable capacitor (foil trimmer).
34. As above
35. 2 and a half turns of 18 gauge tin coated SWG using a 1/4" drill as former.
36. 47Ω resistor.
37. RF choke, same components but only 3 turns.
38. MRF237 transistor Large heatsink.



40. 10Ω resistor.
41. .1uf.
42. RF choke - 3 turns.
43. N18 (or 180pf)
44. 2 turns 18 TC SWG Solder directly to positive leg of part no. 45, which is a 3-90pf trimmer. Cut off leg facing away from island W.
45. 3-90pf trimmer
46. 3-90pf trimmer

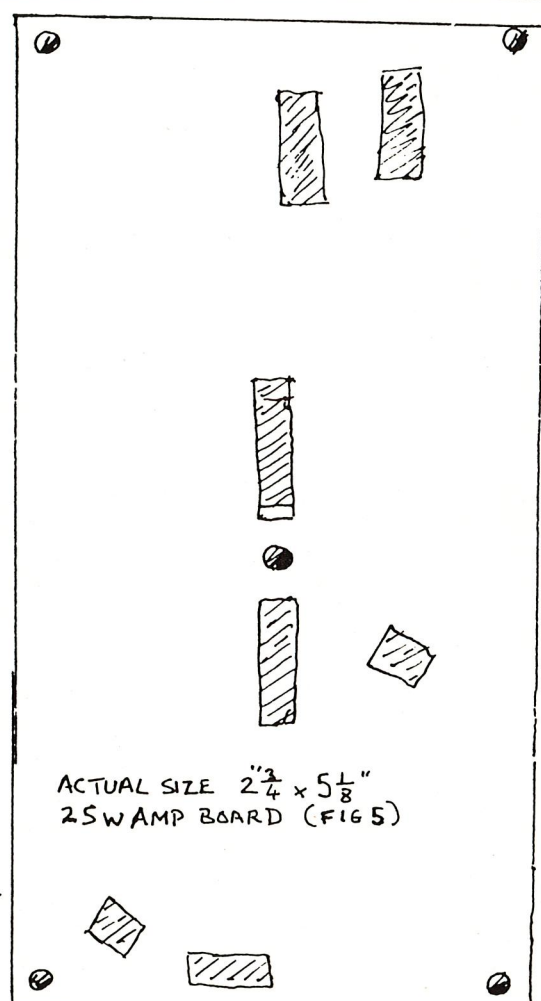
We are now ready to fit into a box (see diag. VI). Get 8" x 3" x 1 1/2" aluminium box. Drill holes. To put in divider, solder along dotted line in diag. 111 and solder along side of divider. Don't solder together yet. Solder TCSWG18 wire between earth and islands P and Q. With the second wire make sure there is no contact with earth. Now solder divider, also making sure no contact with P and Q connection. Last points to solder, using same wire: from island W to centre of UHF female plug, and from earth to outer. Solder 4N7 capacitor from the stereo plug to earth. see dia. 6 and 8 for positions).

If alls well on testing, using same procedure as with first board - you should get nearly 5 watts with the 13.8v supply. To trim up power, go through each variable capacitor starting from island P until you get the maximum reading from each capacitor.

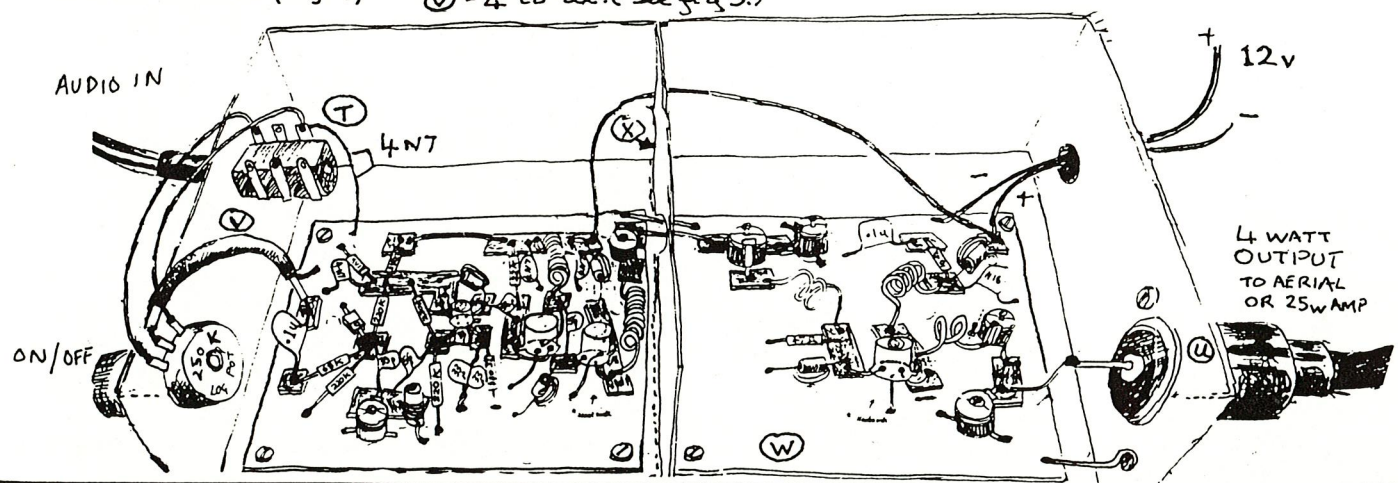
Now you must make an aerial. Get 10 metres of UR67 Coax. 4 metres of 1/2" aluminium tubing (either go to a specialist metal supplier, or get an old H or X 407 VHF TV aerial). Cut to the frequency required (see diag. V11 for calculation). Plus we need some 1/2" electrical conduit and about 3 feet of 2" by 1" wood.

To tune aerial to its maximum efficiency, we want a setting nearest to 1 on the SWR scale. Experiment first with dummy load. Remember, maximum watts and a rubbish SWR reading won't help you get a better signal.

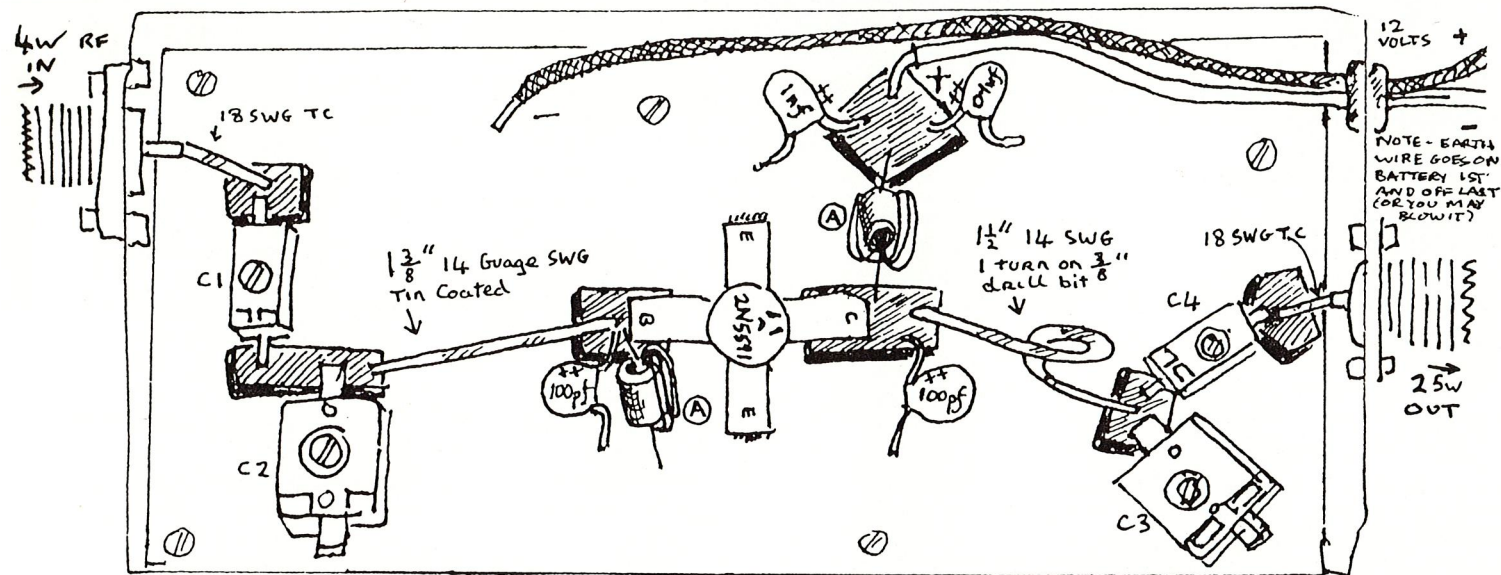
To test press SWR button, press SET button, slide scale till the meter reads SET, then press TEST button- if its properly tuned, the needle will drop to 1. Now try with aerial- don't worry about power reading- with a setting of 2.5 SWR, this will get you over a mile with a 12v battery. Try aerial in different positions and locations. The best results will only come with experience and experimentation.



BOX & WIRING (Fig. 6)
 (T) = 1/4" jack plug socket.
 (V) = 1/2" co-ax. (see fig 3.)



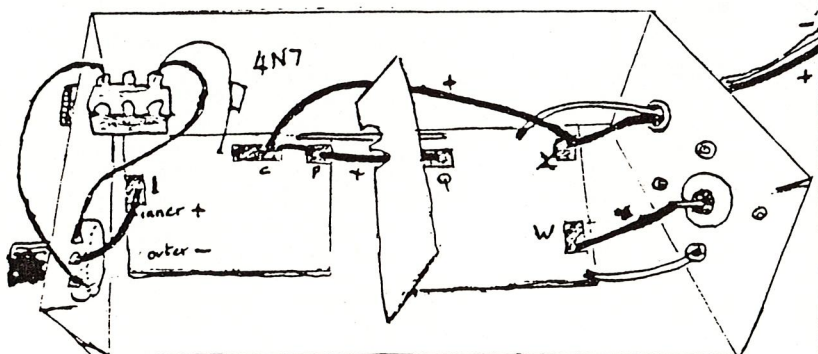
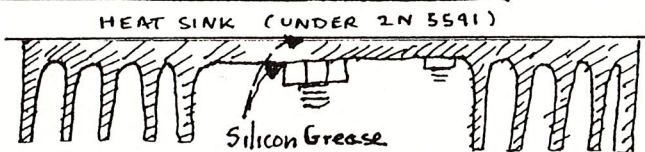
SCHEMATIC DIAG. 2N5591 25 WATT AMP. (Fig. 7)



C1 5-80 pF C2 ARCO 464 25-280 pF
C4 5-80 pF C3 " " "
A FERRITE BEAD - 3 TURNS SWG 28 RF CHOKE

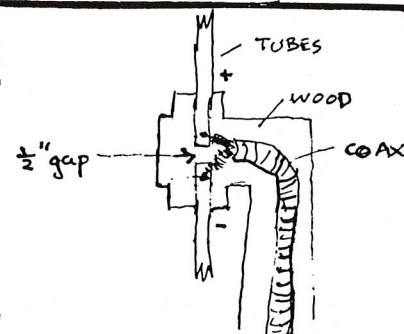
NOTES.

- 1.) AS WE GO TO PRESS WE FIND THAT THE ARCO CAPACITORS (C3 AND C2) ARE NO LONGER EASILY AVAILABLE. WE CAN GET ROUND THIS BUT DON'T HAVE TIME TO TEST THE NEW DESIGN. ANYONE WITH A SOURCE OR STOCK OF ABOVE PLEASE CONTACT 'FREE THE AIRWAVES'.
- 2.) LAST ONE WE BUILT WE USED SILVER INSTEAD OF TIN COATED WIRE WITH BETTER RESULTS.
- 3.) 25W IS THE MAX OUTPUT. SHOULD BE OK WITH 80W AMP (P.61).



WIRING (Fig. 8)

Aerial design
Keep inner wire as short as you can and as covered as you can
Face dipole with inner wire upward.



(Fig. 9)

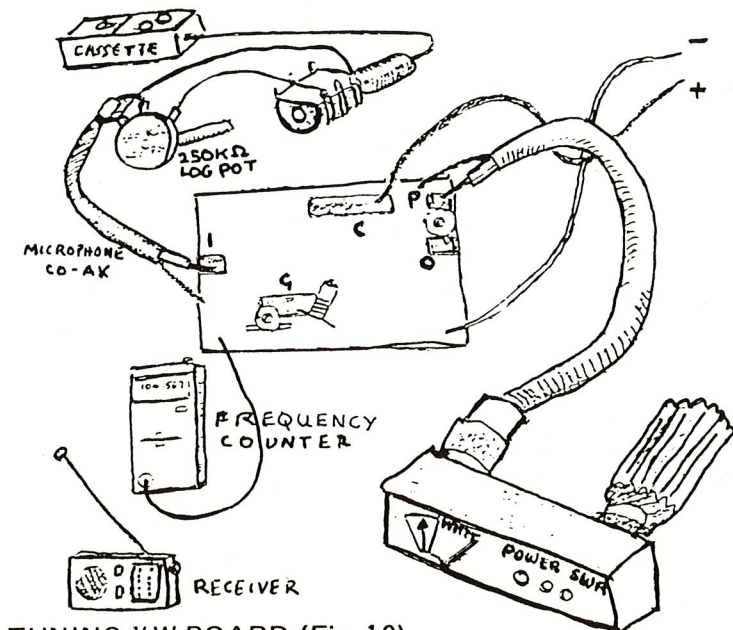
LENGTH OF TUBING = $\frac{300}{4} \div 4$

Anyone who has any better ideas, why not let us know so we can make them available. Or, if you have any queries, or want to get parts, or even ready built, please write.

Free The Airwaves

Approximately 480 one - mile - radius local VHF/M commune - ization stations are possible in London. In the most dense areas we are talking about 50,000 people, eg. the Elephant and Castle district. For less dense areas, where, say, only 12,000 people live in a 5 - mile radius, we are trying to develop a 10 watt transmitter. Again, if anyone knows any useful information, don't sit on it, give it to Free The Airwaves.

THE LATEST 'RADIO CRIMES' IS OUT NOW'. FOR NEXT 3 COPIES SEND MINIMUM DONATION. £2 (For organisations £10) for next 3 ISSUES to :
FREE THE AIRWAVES, BCM BOX 1502, LON. WC1N3XX.



TUNING 1/2W BOARD (Fig. 10)

5 Watt Transmitter.

Complete Building Instructions.

GENERAL DESCRIPTION

The following describes a small VHF FM transmitter with an output power of 5 watts, adequate to cover a 3 or 4 mile radius reception area from a suitable high transmitting site. The microphone or cassette recorder can be connected directly to this transmitter. To test and tune it you will need a multimeter, a dipmeter and preferably a RF power meter.

With just a modicum of effort this 'peoples transmitter' achieves acceptable frequency stability, low feedback from output to input, and a stable power output. In-built pre-emphasis means that the audio quality is good.

5 Watt Transmitter : CIRCUIT DESCRIPTION

T1 is configured as a microphone pre-amp with enough sensitivity for low impedance microphones. T2 and T3 are configured to provide standard pre-emphasis. D4 provides protection against the supply being connected the wrong way round. The field effect transistor (FET) T4, (BF245) is configured as an oscillator (and is a very good feature for stopping the frequency from wandering). Two varicap diodes D3 and D3' (BB105) or a double varicap diode (BB204) allow the frequency of the oscillator to be modulated. T5 is configured as a buffer. T6 and T7 are cascaded to form a high performance amplifier, with high stability. The transformer L2 ; L3 enhances the performance of this amplifier. C25 and R9 protect T7 from overload. T8 is the power amplifier.

If the transmitter is tuned up at a frequency of about 98 Mhz (see later) the desired frequency can be set with C16 without the power output falling below 4 watts, i.e. it should not be necessary to re-tune.

When drilling the printed circuit board (PCB) use 3mm diameter for mounting holes, 1mm diameter for trimmers and coils, and 0.8mm diameter for the rest. Mark the mounting holes on the bottom of the case.

Radio Support Group

We reprint here complete details of a more sophisticated 5W TX which has been translated and developed by our Radio Support Group in Bristol. The approximate cost of parts (excluding PCB board and case) is a mere £16, once you've got old of the tools and testing gear.

To join Radio Support Group and get updates and development aid write to:

Radio Support Group, c/o Drowned Rat

Communications.

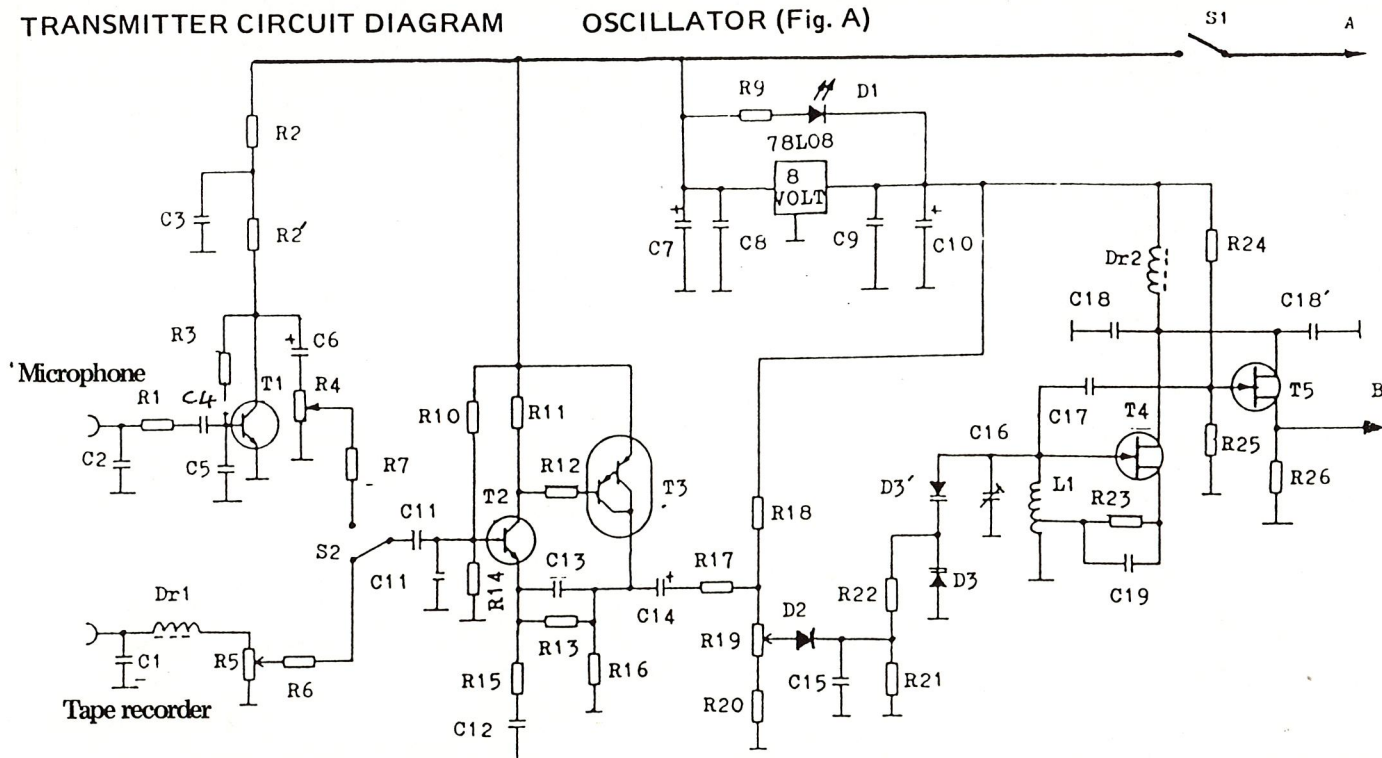
Box 010,
27 Stokes Croft,
Bristol,
Avon BS1 3PY.

Begin by constructing the low frequency section, and the oscillator and the buffer, i.e. all the parts in Figure A of the circuit diagram. First mount the resistors, then the diodes. The symbol for a diode in the circuit diagram is an arrow with a bar in front of it. The bar corresponding to the broad ring of the diode and the varicap, and the middle lead on the BB204.

Next mount the capacitors and trimmers. Be careful when bending the leads of the ceramic capacitors near the body of the capacitor, as it can crack. Ensure the electrolytic and tantalum capacitors are mounted the right way round. Finally mount the semiconductors and the coil L1. The coil should touch the PCB with all its turns (windings) and should be inserted with no tension on the turns. After testing stick it to the PCB with UHU (glue). This will improve frequency stability and help prevent microphony. The coils are best wound on drill bits of the correct diameter. R23 and C19 are soldered 1½ turns from the cold end of the coil (that's the end connected to earth). Use solder sparingly to avoid damaging the coil. Mount the semiconductors the right way round. The pinouts are shown from below.

TRANSMITTER CIRCUIT DIAGRAM

OSCILLATOR (Fig. A)



This is the underside of the board viewed from below (Components on other side).

Ⓐ lines up with Ⓐ on Fig F. Make your PCB board from this.



Ⓐ

OSCILLATOR PCB DESIGN
Actual Size
Fig. B

Now check whether the right component is in the right place. Inspect the track side of the board for short circuits and breaks. Check for short circuits across the power supply connections with an ohm-meter. Apply 12 volts via an am-meter, preferably from a stabilised power supply with current limiting. Otherwise put a 1 amp fast-blow fuse in the positive supply lead. If it blows there is either a short circuit, or D4 is the wrong way round, or the power supply is the wrong way round. Check D4 each time the fuse blows. There should be a current of 20 to 25 milli-amperes (mA) (without the LED connected). Tune a receiver to the desired frequency and adjust R19 and C16 until the receiver goes quiet. This means the oscillator is OK. With C16 in its middle position the oscillator frequency will probably be between 100 and 104 mhz.

Now connect an audio signal to an input. Switch S2 has to have been connected to do this, adjust the two pre-set resistors, R24 for the microphone input and R5 for the tape recorder input, so that the signal can be heard in the receiver as loud as possible without distortion. It can be a bit louder than all the other broadcasting transmitters. If you can hear your signal on several frequencies as you tune the receiver, use the transmitter without an aerial or take it into another room. If you can still hear it in several places then something is wrong.

If you have a dip-meter (or absorption wavemeter) it's much easier to check whether the oscillator only oscillates on one frequency. If it does oscillate on more than one frequency, re-solder R23/C19 onto the coil L1 a turn from the cold end. The best point of contact is when the oscillator only oscillates properly on any one frequency in the FM band. In 90% of all cases the point of contact is 1½ turns. Exceptionally high gain FET's are responsible for the exceptions.

If the oscillator doesn't work at all, and the voltage supply is correct, either D3, D3', T4, or T5 are the wrong way round, or there is a short circuit. Bear in mind that the oscillator is THE MOST CRITICAL PART of the whole circuit.

Mountains of solder and dry joints (to be avoided anyway) are most harmful here. All parts, especially L1, have to be completely stable and must not move on impact. The bodies of T4 and T5 should be no more than 2 to 3mm above the PCB.

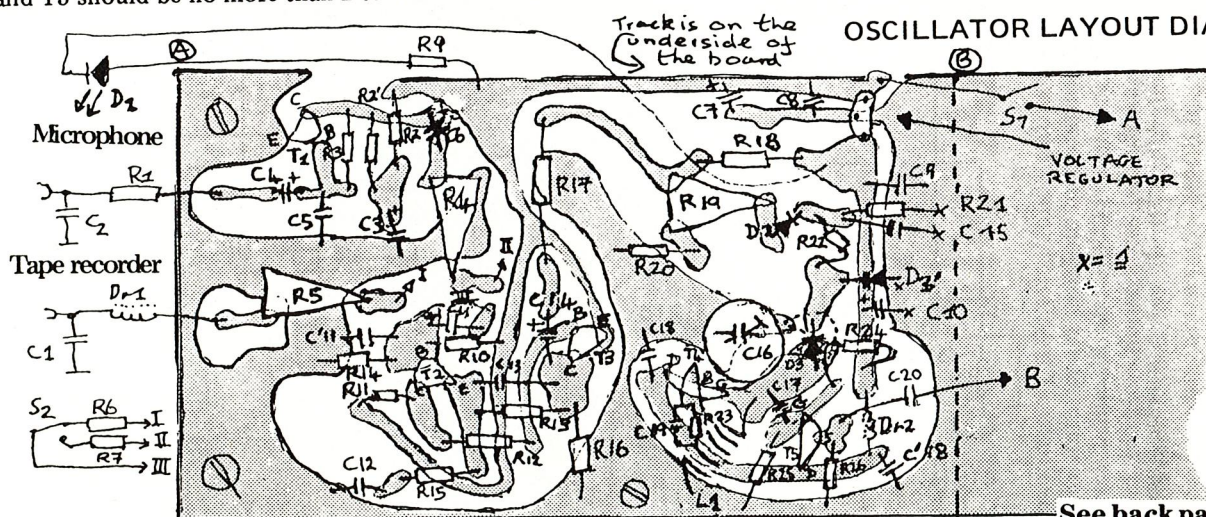
Rotating R19 anticlockwise increases the transmitter frequency as does unmeshing C16. The frequency should be adjustable between 80 - 150 Mhz. (If you want a higher frequency see later '2M Modification').

The final adjustment of the oscillator and tuning the amplifiers can only be done after finally building the transmitter into its case and putting the top on. If you want to alter the frequency often rotate R19 fully anticlockwise and set the highest wanted frequency with C16. The frequency can now be altered using R19. You could possibly replace C16 with a ceramic capacitor (colour black or red!). If you want to use a frequency under 80 Mhz add one turn to L1. If you use a BB204 for D3 you can tune across the whole FM band with R19. The circuit is designed so that the modulation index remains constant as you change the frequency.

Now the VHF amplification stages (Figure D of the circuit diagram). Begin by mounting the resistors and capacitors. The ferrite bead Dr6 is threaded onto one of the R27's leads. All connections which go to earth (X in the circuit diagram) solder only on top. Construct the transformer L2:L3 (see Fig K). Use 0.2 diameter enamelled copper wire for L3. Wind round a ferrite bead 3 times and tighten carefully. Don't cut the wire too close to the bead. Tin the ends. If you can solder through the enamel, no problem. Otherwise hold the ends of the wire in a lighter flame and carefully scrape off the remainder of the enamel with fine sandpaper. Then tin with solder. Put bits of sellotape on the ends so as not to confuse them with L2. Same thing now with L2, only its 6 windings this time, three right and three left of L3, spread equally over the bead. Now mount L2:L3, keeping the wire ends short, and fix it in place with glue.

Next mount the trimmers. All the legs that are going to be soldered on top of the PCB should be tinned with solder beforehand, as should their respective contact points on the PCB. Bend these legs outward at right angles so that the trimmer will lie flat against the PCB. Use a little soldering iron (15-20w) and be very careful, the material the trimmers are made of can't take much heat at all. It must NOT be touched with the tip of the iron. Check after soldering that you can turn the trimmers easily.

OSCILLATOR LAYOUT DIAGRAM (Fig. C)

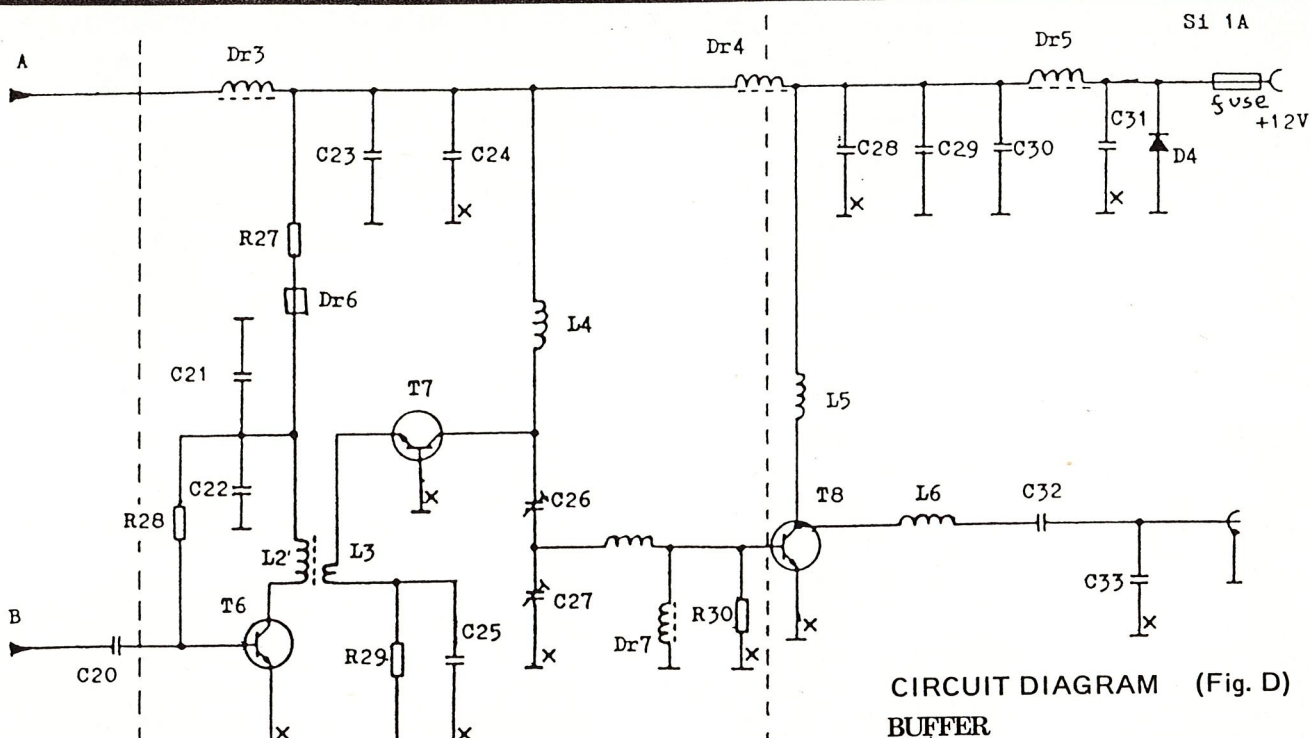


X = soldered on both sides

This is the left hand side of top side (component side) of the board viewed from above. Ⓐ Ⓑ Ⓒ line up with Figs A, E and F. A bit of a mind twister!

See back page for blow-up of design.

on layouts... X = Soldered Top and Underside



Next mount the transistors. First T6 and T7. The transistors should be mounted close to the PCB (2-3mm). This is especially important for the emitter of T7 (base to earth). Ensure that nothing metallic touches T7's case as this is connected internally to its collector. Now mount the MRF237. Slightly countersink the base and collector holes on the underside of the board with a 3mm drill. This is to prevent a short circuit between the transistor's base and collector leads with the earth plane. Mount the transistor underneath the board onto the earthplane, having first put some heatsink compound on the bottom of the transistor (ie between the transistor and the board). Push the transistor against the PCB and solder base and collector on top. You can either cut off the emitter lead beforehand (this is connected internally to the case) or put it through its hole, and bend it so it can be soldered to the screen to the left of T8 (to be put on later). Using a high powered soldering iron (at least 50w) solder the case of the transistor to the earth plane. This has to be done as fast as possible. Rather hot and fast than slow and cold!

Now wind and mount the remaining coils. It doesn't matter in which sense you wind them (clock or anticlock-wise) except that they should stand at right angles to each other (at each stage) and be as far as possible from the sides of the case. This is especially important for L4 and L6. L6 should be approx. 5mm above the PCB.

The printed circuit board should be attached to the bottom of the case in such a way that the MRF237 is gently pressed against the bottom of the case. This is done with bolts

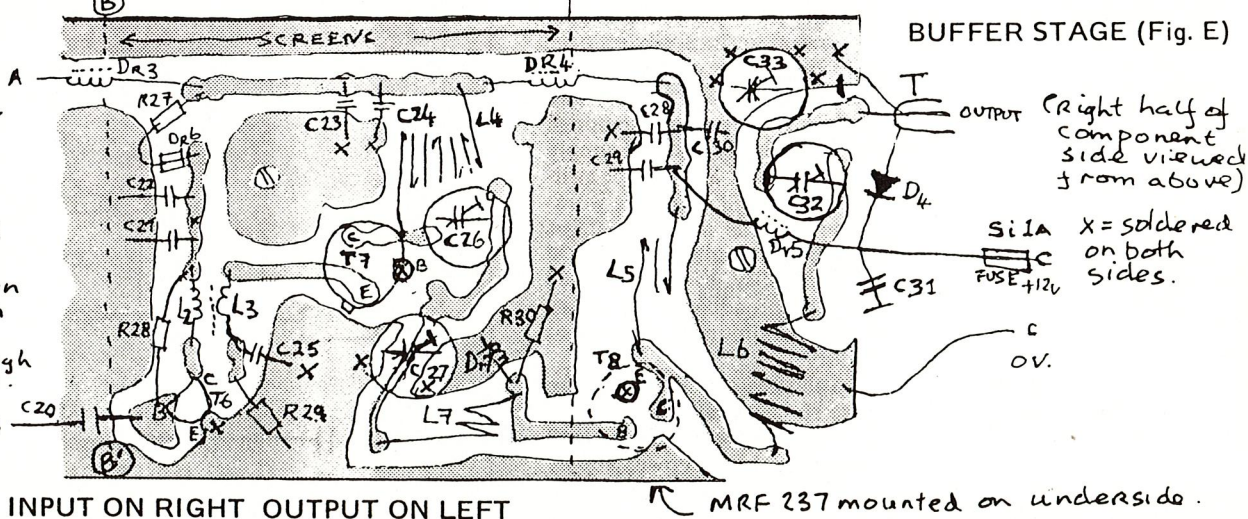
washers, spacers and nuts. Don't forget to put some heatsink compound between the transistor and the case.

The screens to the left of T6 and T8 are made from bits of single or double sided PCB. They should be measured to fit neatly with the sides and top of the case. Where a PCB track goes from one chamber to the next the screen will have to filed at the bottom to prevent shorting. Watch the trimmers when soldering!

The circuit is complete now, only Dr3, Dr4, Dr5 are missing. Connect 12v to the input of the 8v regulator and to the top of R27. There should be a current of 30-50 mA. The collector of T6 should be at 10-11v. If it is 0v, L2 is an open circuit. If the voltage is too low, R28 has to be increased, and if too high (rarely) decrease R28. Now mount Dr3. Put trimmer C27 into middle position. Turn C26 so it is 1/4 meshed. Connect the 12v supply again, the current should be 80-120 mA. Write down the current and then adjust C26 and C27. The current consumption will change and T7 will get hotter than T6 (but should still be cool enough to touch). If the current consumption is still 50 mA as before there is a mistake somewhere. There should be a 12v on the case of T7. If there are no short circuits and no tantalum capacitors connected the wrong way round (Do check each stage meticulously before connecting the supply) the only possibility is a broken trimmer. If you have a dip meter or absorption wavemeter hold it near L4 and tune through...ie check there is no spurious output on other frequencies. Switch off again.

Finally mount Dr4 and Dr5 and clip a heatsink onto the

In the Fig C half of board the track is on underside. But on the Buffer half the track is on top and below is solid copper. All components on this side. In Fig C they connect through drilled holes. Geddit? (B) and (B') line up with Fig. C.



MRF 237. Solder a piece of co-ax cable to the output. Connect the cable by soldering a suitable plug onto the end to a dummy load via a Voltage Standing Wave Radio meter (VSWR meter) with power indication. Alternatively use the circuit in Fig.2 as the dummy load and a VSWR meter without power indication.

NEVER use the transmitter without a load! Short circuits can destroy the MRF237!

Check with an ohm meter that your dummy load has a resistance of 50 ohm. Now adjust your power supply to a maximum current of 800mA (if you can, that is). Adjust the trimmers C26...¼ C27...½ C32...¼ C33...¼ (ie. C26 ¼ meshed, C27 ½ meshed etc.)



FIG. F PCB DESIGN FOR BUFFER STAGE OF OSCILLATOR. (the actual pattern you get on top side of board is mirror of this! Viewed from below. (Figs B & F on same board!) ACTUAL SIZE

After switching on watch simultaneously power output and input current. Tune for max output power. Use a brass or aluminium tuning tool with an insulated handle. Tune C26, then C27 (doesn't have much effect) then C32, lastly C33. For the 1st 2 trimmers increasing power output results in an increase in input current. Not so with the final stage, if you mistune that current consumption can get too high.

Some power supplies go mad with high frequencies..try and get one which is high frequency stabilised. Very careful people start tuning with low power supply voltages, but the stage supplied by the voltage regulator needs 12v to make sure the V regulator is working properly. You should repeat the tuning several times to get the feel of it. Maximum output power is 6 watts with a 12v supply and a MRF237, which corresponds to an input current of 750 mA to the whole circuit, of which 640mA goes to the MRF237. Under these conditions the transistor dissipates 8w (as heat) which it can handle if it has good heatsinking. If you have a trial run outside the case, the earth plane will just about keep the transistor cool. The MRF237 can cope with 700mA for some time, but bear in mind that the voltage of a lead/acid battery can be up to 13.5 volts..ie its better to lower the output power by 0.5w, which isn't noticeable, than to risk low reliability by the transistor running too hot and blowing.

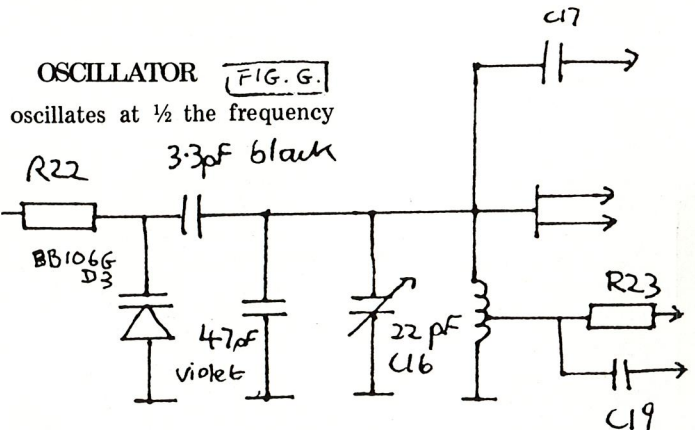
Using the formula $I = w/v$ (w over v), you can calculate the maximum allowable input current for a particular supply voltage V, and $W = 8$ watts. The power can be easily reduced by adjusting C27. You should only do this after everything is built into the case as the sides of the case affect the coils and lower the circuit's amplification. In any case there is enough spare gain in the circuit to tune it uncritically and still supply the MRF237 with enough input drive. With a dipmeter switched to absorption wavemeter mode check all stages are working on only the oscillator frequency. If the amplifier stages have sufficient gain the tuning should be completely uncritical and the oscillator should have good stability, even when used outside the case. This is in spite of the broadband circuit design. If C26 is completely enmeshed at maximum output power then pull the turns of L4 apart slightly.

Now mounting the board onto the case. Drill holes above the trimmers in the top of the case so the final tuning of the trimmers and R19 can be done with the top in place. Drill holes also for the switches, sockets and LED. Power supply and output sockets should be on one of the shorter sides. In the high frequency part of the board put thin copper foil

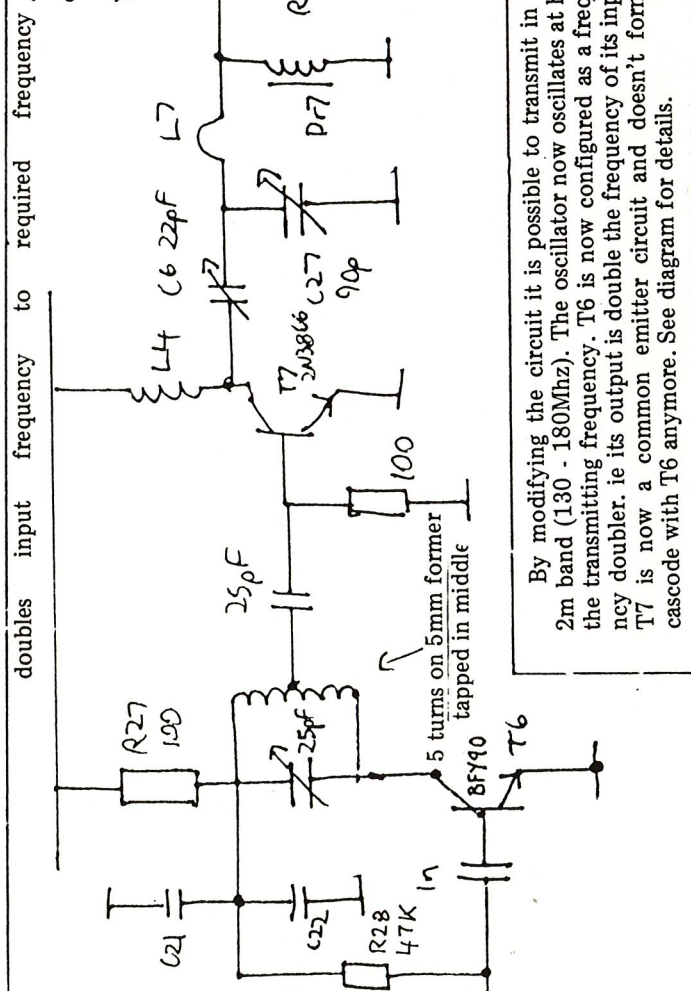
round the edge of the PCB, as far as the earth plane extends to, and round the edges of the screening walls. Solder on both sides of the PCB and the screening walls. Now using spacers, etc, mount the PCB. Don't forget heatsink compound for the MRF237. Mount the sockets and switch with all the components which are to be mounted on them (see diagram). Connect the output socket to C33 with the shortest possible length of wire. The earth connection can be soldered to a tag, which is bolted to one of the socket's mounting holes.

Now the final tuning. This is the same as the trial run. You should not use a dummy load with a SWR worse than 1 : 1.4. In practice the output power can be estimated from the power consumption of the transmitter, if you assume the efficiency is 60-70% approx.

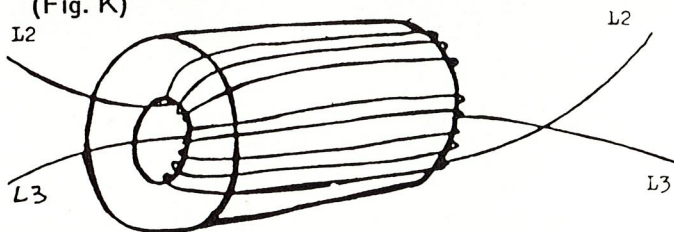
2m MODIFICATION.



DOUBLER (Fig. H),



Transformer L2:L3 wound on FX1115 ferrite bead.
(Fig. K)



COMPONENT LIST FOR 5 WATT TRANSMITTER.

R1 220
R2 470
R2' 4.7k
R3 1m
R4 100k min. trimmer, horizontal
R5 100k " " "
R6 47k
R7 47k
R8 not required
R9 220
R10 470k
R11 47k
R12 1k
R13 4.7k
R14 470k
R15 100
R16 2.2k
R17 2.2k
R18 2.7k
R19 100k min. trimmer, horizontal
R20 47k
R21 100k
R22 100k
R23 220
R24 150k
R25 100k
R26 180
R27 100
R28 27k
R29 2.2
R30 52 or 47

C1 Inf ceramic
C2 Inf ceramic
C3 47µf 16v elect. PCB mounting
C4 10µf 16v elect.
C5 1 nf ceramic
C6 10µf 16v elect.
C7 15µf 16v elect.
C8 1nf ceramic
C9 1 nf ceramic
C10 16µf 16v tantalum
C11 47 pf ceramic
C12 10 nf polystyrene foil
C13 680pf polystyrene foil
C14 16µf 16v tantalum
C15 680pf ceramic

C16 2-22pf min. foil trimmer 7.5mm,

green. (eg. Cirkit 06-22001)

C17 6.8pf ceramic
C18 plus C18', C19, and C20 1 nf ceram.
C21 100 nf ceramic
C22 Inf ceramic
C23 100nf ceramic
C24, C25 Inf ceramic
C26 2-27pf min. foil trimmer 7.5mm, red
(eg. Cirkit 06-36001)
C27 5.5-80pf min. foil trimmer 10mm, red
(eg. Cirkit 06-80001)

C28 Inf ceramic
C29 100nf ceramic
C30 16nf 16v tantalum
C31 Inf ceramic
C32, C33 As C27

D1 LED

D2 1N4148

D3, D3' either BB105G (two) or one BB204G

D4 1N4001

T1 BC549, BC239, BC109 (pref C type)



T2 as for T1

T3 BC516

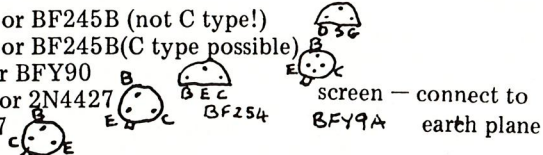
T4 BF256B or BF245B (not C type!)

T5 BF256B or BF245B (C type possible)

T6 BF254 or BFY90

T7 2N3866 or 2N4427

T8 MRF 237



screen — connect to earth plane

DR1 Wide band choke mounted directly on tape recorder socket

DR2 3 turns of 0.2mm (34SWG) enamelled copper wire on FX 1115 ferrite bead

DR3 wide band choke

DR4 wide band choke

DR5 wide band choke

DR6 FX1115 ferrite bead on lead of R27

DR7 wide band choke

L1 4½ turns of 1mm (18SWG) silver coated copper wire on 6mm former, tapped at 1½ turns from cold end

L2 6 turns of 0.3mm (34SWG) on FX1115 ferrite bead

L3 2 turns of (same as above)

L4 7 turns of 1mm (18SWG) silver coated copper wire on 8mm former

L5 3 turns of 1mm (18SWG) silver coated copper wire on a 6mm former

L6 6 turns 1mm (18SWG) silver coated copper wire on a 6mm former

L7 as L5

78L08 8v voltage regulator

S1, S2 switches

Printed Circuit Board (PCB)

S0239 UHF socket with earthing tag

copper foil

braided wire

power supply connectors

input connectors

1A fast blow fuse and holder



viewed from below

FOOTNOTES

Here is some info for people who aren't too knowledgeable about high frequency circuitry, and who probably have had even less experience on a practical level.

1. COMPONENTS SHOULD HAVE SHORT LEADS.

Every additional unnecessary length of wire in VHF circuits increases the chances of undesirable oscillations (properly called parasitic oscillations). To guard against this solder components as close to the Pcb as you can, to get an unambiguous output on just ONE frequency!

2. WE WON'T GET ANYWHERE WITHOUT EARTH.

The case must be earthed. ie be at zero volts potential relative to the negative side of the supply. Use a tag bolted to

the output sockets' mounting holes. Solder a thick bit of braided wire between the tag and the neg. supply input socket. This will earth the case, but the circuit board still needs earthing. There might be an earth contact from the MRF237 to the heatsink to the case but its better to provide an additional safe earth connection. Another piece of thick braided wire will work. Solder one end to the earth plane and connect the other to the case near the power supply connections.

If you use metal connectors for the microphone and tape recorder input sockets they will be earthed through the case. If you use plastic ones you'll have to solder a wire between the earth tag on the connector and the earth plane on the board. Better still regardless of choice of connector is to use a piece of screened audio co-ax.

3. EARTHLY DELIGHTS.

Its important to use a double sided PCB for the High Frequency stages, so that any part of the circuit can be easily earthed.

4. HEAT HAS TO GET OUT.

If, for eg, the threaded bolt of a high power transistor has broken off, its no use trying to solder it back on. A soldered joint doesn't transfer heat at all well, so either the transis-

tor overheats and is destroyed, or the heat melts the joint and then it overheats and is destroyed.

Similarly any heatsink has to be all one piece of metal. Even a setup like "threaded bolt- heatsink compound- heatsink -case-heatsink compound- another heatsink" does not transfer enough heat to the outside air. (But here we're talking about mega power situations you wont face with your 5 watter).

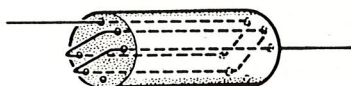
5. CAN YOU PUT ANY ONE IN ANY POSITION?

No. We'll have to wait till after the revolution for that. If you want to use different transistors than those mentioned you'll have to check the pin outs to see which is base, collector, etc. There are nearly as many pin outs as there are transistors. Check in a catalogue or data book that replacements are compatible.

6. MATCHMAKING

If you want to use a telescopic aerial check the matching before each use. You'll get much better results with a proper aerial. You might get a better match without using the full extension. How far you can pull such an aerial out depends (among other things) on the transmitting frequency..Matching can only properly be done with a VSWR meter, thats why its a basic piece of test gear.. See later under AERIALS.

Detail Of A Wideband Choke. **FIG. I**



TO MAKE A WIDE BAND CHOKE:

Get a FX1898 ferrite bead or Cirkit stock no. 55-25111. Wind $2\frac{1}{2}$ turns of 24 SWG tinned or enamelled copper wire through 5 of the 6 holes as shown on the diagram.

WHERE TO GET THE PARTS:

Cricklewood Electronics, for instance, stock everything except the ferrite beads and the wire. Their MRF237 is rather expensive (£7.05).

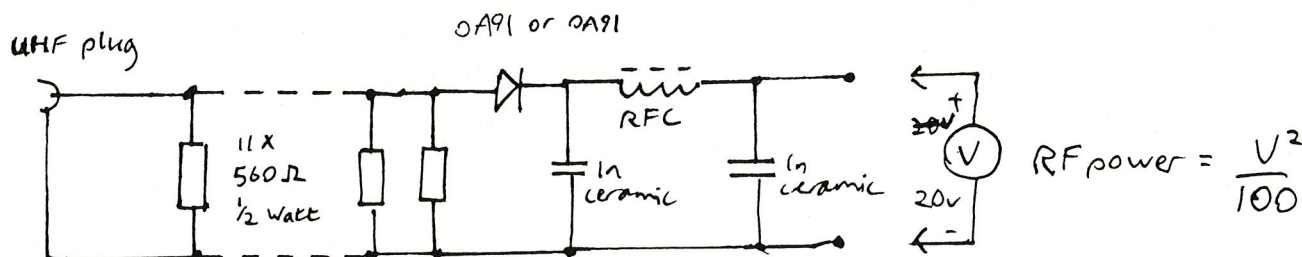
Maplin has most of the bits except some semiconductors, FX1898 and the silver coated wire.

Cirkit stocks most of the bits including the FX1115 ferrite beads (comes in packs of 10), the other ferrite bead, and the silver coated copper wire. They don't stock all the semiconductors but their MRF237 is cheaper (£4.46).

Cricklewood Electronics Ltd. 40 Cricklewood Broadway, Lon NW23ET. Tel. 01-450-0995 or 01-452-0161. Free catalogue on request.

Maplin and Cirkit catalogues from your local W.H.Smut.

(5WATT TRANSMITTER) DUMMY LOAD WITH POWER MEASURING CIRCUIT (Fig. J)



RFC is five turns (34SWG) on FX1115 ferrite bead.

If you buy a dummy load (loads less hassle, a 30w one will set you back £9) you can build the rest of the circuit (ie the diode, capacitors and choke) into the body of a UHF plug.

Get a UHF T-piece connector and you can connect the transmitter output into the dummy load and power measuring circuit at the same time

MAKING YOUR PCB BOARD

You can make your PCB board photographically by using the blacked in Fig. B & F.

A paperback book which describes the whole and several alternative processes in intimate detail is 'How to Design and Make Your Own PCB's' by R.A. Penfold. Published in the Babani Series of electronic books. It's available from the Maplin Catalogue, Page 48, (costs £1.95), and there's a good chance your local library will have it.

COST

5 WATT TRANSMITTER. . . approx. £16, excluding PCB and case.

15 to 80 WATT AMPLIFIER. . . approx. £70, excluding PCB and case and heatsink.

80 Watt Amplifier

General Description.

The following describes a 80w VHF FM amplifier. Input and output impedances are 50 ohm. Output power is 80w with a 12.5v supply and 15w input power. Its possible to increase the input power to 25w but this does not increase output power significantly. You shouldn't use more than 25w of input power without using an input attenuator.

The power supply has to be much more serious affair than for a 25w design. The power amp can draw up to 14A DC. Adding this to the current drawn by a 25 watt transmitter and we're talking 16A. You'll have to work with a car battery or similar lead/acid battery rated at least 20Ah. If you have a RF stabilised mains power supply with a 20A output capability you could apply 13.5 volts to the amplifier and achieve an output power of 110w. We suggest you only try this if you have proper heatsinking and guaranteed low SWR. (The manufacturers data sheet says dont exceed 100w output power (on the transistor). The bandwidth of this amp is 5Mhz for a 20% decrease. You can only use this bandwidth if you use a low pass filter on the output, otherwise the simple built in bandstop filter L6/C10 (tuned to the 2nd harmonic) will restrict the usable bandwidth to 2 Mhz.

Our prototype used a relay to provide reverse polarity protection. Three LED's indicate ready, reverse polarity, and high temperature. On reaching 90degrees C the amplifier is disconnected from the supply. The transmitter feeding this amplifier should also be connected via this relay, as the power transistor doesn't take kindly to having input power applied to it when it doesn't have a supply voltage.

The amplifier power supply should be connected using crocodile clips or big plugs...something like a DIN plug could not handle the current. The supply cables should be of 3-5 square mm cross section and no longer than 100cm.

CIRCUIT

The heart of the circuit is the RF power transistor MRF 245. This is a controlled Q transistor with internal base and collector matching. This transistor is designed for the 145-175 Mhz VHF band and exhibits broad band characteristics within this range. The circuit is tuned as the development of a linear amplifier, and would require extensive knowledge of the transistor and extensive calculations. The transistor's characteris-

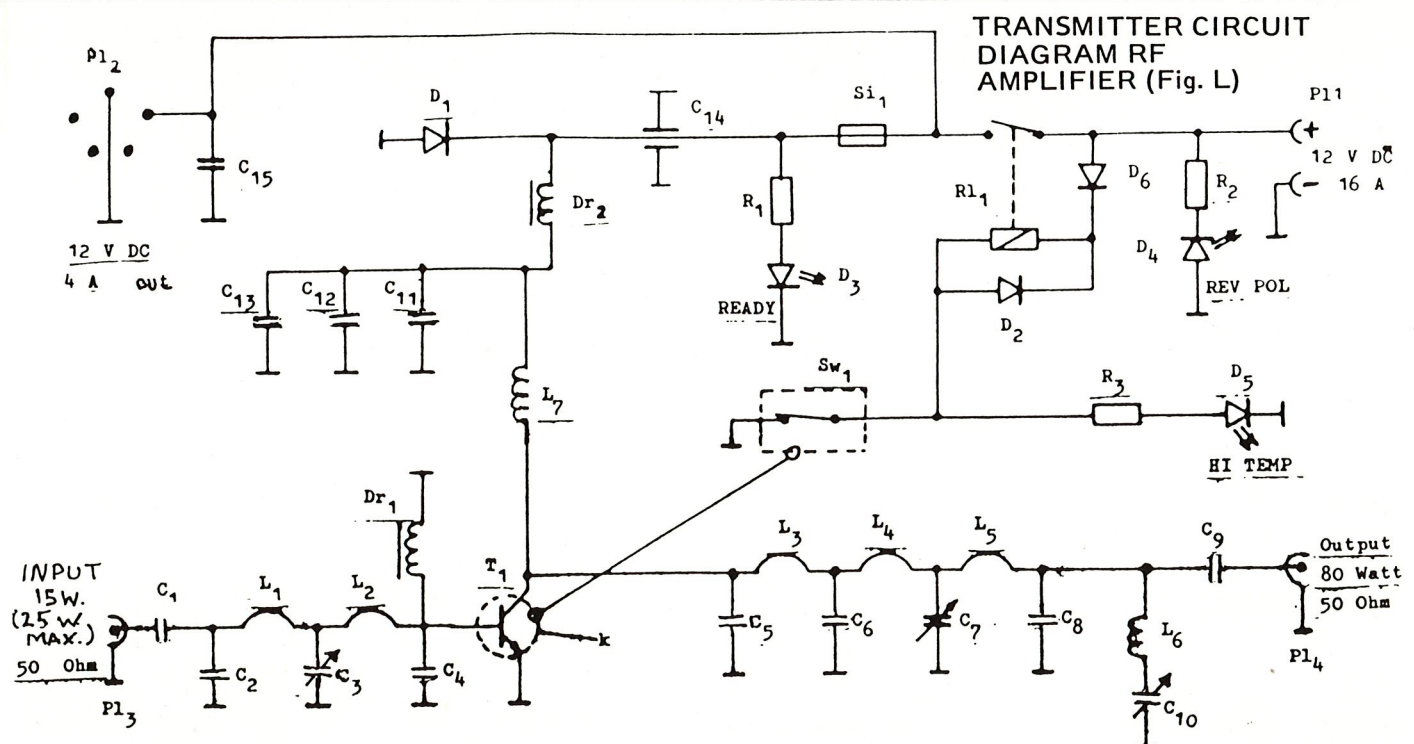
This Amp should be quite suitable to attach onto the 25W (max.)—design on p. 25. We haven't built one ourselves yet.

tics in the frequency band we are interested in are not published by the maker and we you'd need loads of expensive test gear to find them for yourself. Therefore this circuit was developed mainly by experiment. If you had all the test gear you could probably achieve a better bandwidth and greater harmonic suppression.

At the base and collector of the MRF245 are the relatively high value capacitors C4 and C5. These are part of the low pass impedance matching networks for input and output. Enormous currents flow through these capacitors so they have to be specially chosen eg Unelco mica capacitors or Erie high Q chip capacitors with low pass C3G dielectric. Because of the small size of the chip capacitors they've a tendency to overheat. Avoid this by using a combination in parallel to add up to the correct value, which is 440-550 nf. The only variable component of the input network is the trimmer C3. This allows the input network to be tuned across a wide range of frequencies. The input network has a narrower bandwidth than the output network.

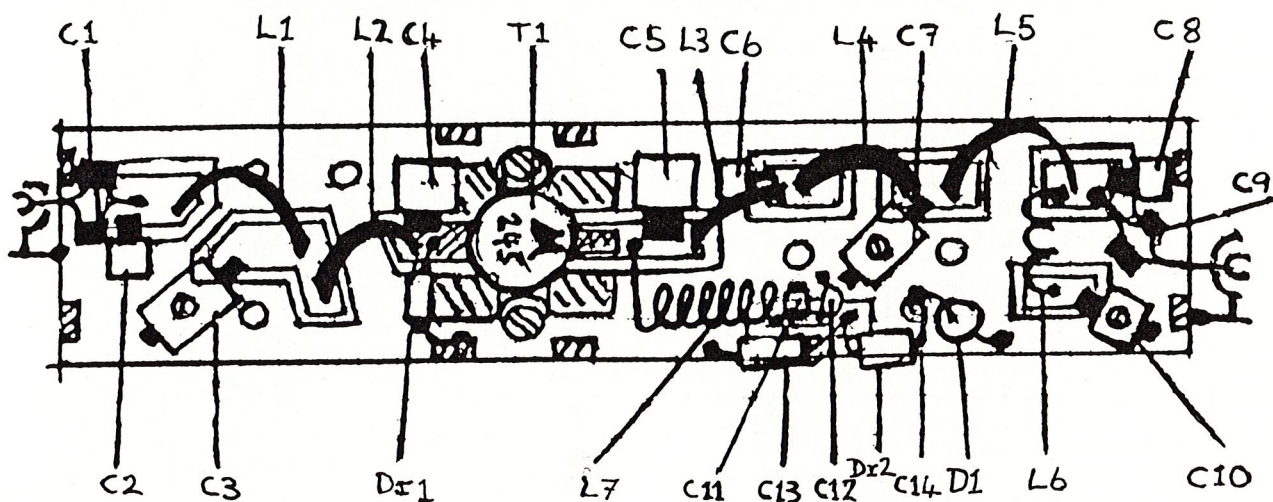
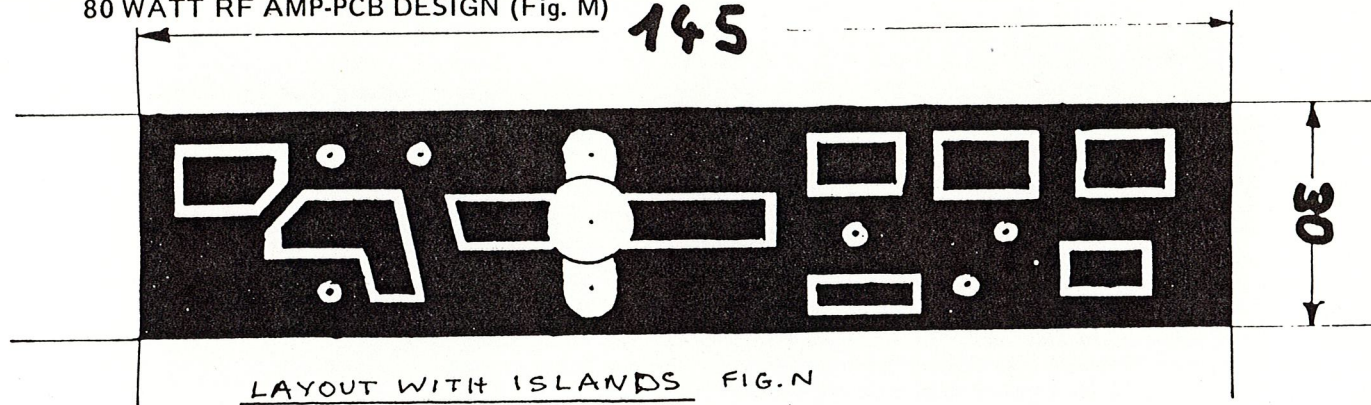
The transistor MRF245 operates in class C mode, and so has no base bias, Dr1 ensures this condition is met. The power supply voltage is applied to the collector via L7. The output impedance transformation back to 50 ohm is performed by three pi networks with low pass characteristics. This network is tuned with C7. L6 and C7 form a bandstop filter which is tuned to the 2nd harmonic. It works by providing a low impedance path to earth for frequencies in that region, thereby reducing the power output of the 2nd harmonic. If you can't get a dipped mica capacitor for C9 use two or three readily available ones in parallel. The purpose of this capacitor is to isolate the DC supply from the aerial output, it doesn't do any matching. Using ceramic capacitors in parallel is necessary cos it keeps the parasitic inductance small. Similarly for C1 use a dipped mica or 2 or 3 ceramic capacitors in parallel.

The power supply decoupling is very important. The capacitors C11, C12 and C13 have different orders of magnitude as they're only efficient at preventing parasitic oscillations in a particular frequency range. Together they'll do it over a wide range. The supply is further decoupled by choke Dr2 and feedthrough capacitor C14. The amp is protected from reverse power supply polarity by a relay. The relay's contacts only close, allowing the supply voltage to the



80 WATT RF AMP-PCB DESIGN (Fig. M)

145



amplifier, if the supply is connected the right way round. If the relay fails by, eg, the contacts welding together, which can happen with 16A, D1 will short the supply voltage and the fuse will blow. Reverse polarity on plug PL1 is indicated by the green LED D4. 'Ready' is indicated by red LED D3. The amplifier is protected by a thermal switch. If the heatsink exceeds 90 degrees c the supply to the relay coil is interrupted which disconnects the power to the amp. This is shown by yellow LED D5. The amp is reconnected when the heatsink cools below 70 C. Plug PL2 supplies the exciter (12v max 5 A) which should also be protected from overheating or reverse polarity.

CONSTRUCTION

Use double sided glass fibre PCB. The suggested layout is only one of many possibilities. If you change the layout do NOT alter the size or shape of the islands on the PCB to which any of the inductors L1 to L5 or the transistor are soldered. This is to ensure the inductors have the same bending radius and therefore inductance as they have on our prototype. The suggested circuit plan was designed to use miniature mica compression trimmers. Anything else will probably be too big to fit on our design. If you enlarge the PCB by 10mm on both sides you'll have more room for alternative set-ups.

You should have all parts on hand and then redesign the PCB layout accordingly, bearing in mind what you're going to do about heatsinking and putting the whole thing in a case. You might need to drill another hole in the PCB to accommodate the feedthrough capacitor, bearing in mind that its fragile and shouldn't be subjected to any mechanical stresses.

We recommend you introduce a second PCB, completely screened from the High Frequency PCB, on which is mounted the reverse polarity protection relay, the LED's and the DC output socket PL2.

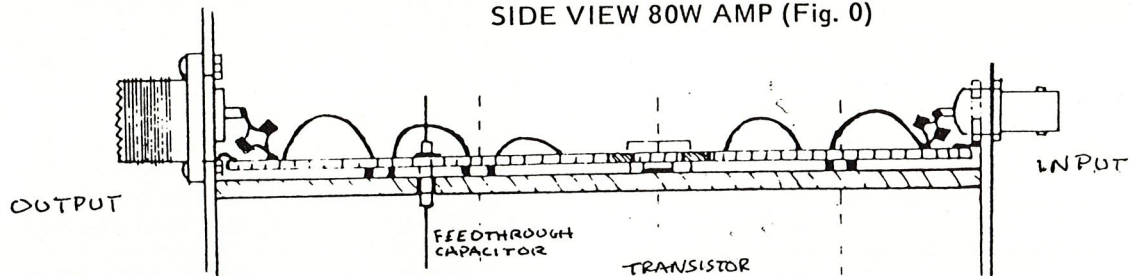
The high frequency input and output sockets should be mounted on the case directly over the PCB so they're perpendicular to the PCB. Or the sockets can be over the ends of the PCB, parallel to the board, in which case the length of the PCB dictates the length of the case and heatsink in this dimension.

The sockets must have a durable and flawless connection to the earth plane on the PCB. The best thing is to connect a thick wire from the PCB earth plane to the case next to the sockets. Either solder directly to the case material, or preferably use tags bolted through the sockets, mounting holes. Most BNC sockets have their own tags which you can use.

Drill the holes in the PCB. Apart from the holes for the transistor the PCB should be bolted to the heatsink at least twice on the base and collector side of the PCB. Use 6BA/M3 or larger bolts. Solder brass or copper strips along the long edges of the PCB to connect the top and bottom earth planes together, do the same by soldering strips through the hole where the emitter flanges of the transistor are to be soldered. This is so the emitter will be connected to both the top and bottom earth planes next to the body of the transistor. If your PCB is much wider than our design we recommend you introduce such 'through contacts' two times each near the emitter. There should also be a through contact near the feedthrough capacitor. To do this drill a small hole in the PCB, insert a thick wire, and solder on both sides. The earth plane should have a good connection both to the high frequency sockets and the negative supply connection.

After these plumbing jobs mount the transistor from above. Solder the whole length of the emitter flanges. These are the ones on the outside. The collector is the smaller of the two inner flanges. Then mount capacitors C4 and C5. Cut L1 to L5 out of copper or brass sheet and mount these as shown on the diagram together with C1 to C9. When soldering the capacitors make the joint as large as possible to keep stray inductance low and achieve better heat conduction. The loose ends of C1 and C9 will be soldered directly to the central contacts of the BNC or UHF sockets later on. When soldering the trimmers ensure to solder the contact which is connected to the rotating part to earth, otherwise you'll have big problems trying to tune the circuit with metallic instruments. Before you solder in L7 you should mount C11, C12 and C13 then Dr2 and Dr1. Leaving Dr1 out would be disastrous (positive base voltage = high collector current = new transistor). The feedthrough capacitor C14 can be fitted now, or left till later, depending on which construction you've chosen.

SIDE VIEW 80W AMP (Fig. 0)



After finishing work on the PCB it can be bolted to the heatsink. Put a thin coat of heatsink compound on the bottom of the mounting flange of the transistor. Bolt this flange to the heatsink with 6BA or M3 bolts. The PCB is then bolted to the heatsink in 4 places, using shakeproof washers above and below the PCB at such a height so as not to flex the PCB or put

any stress on the transistors leadouts. If this is done right the PCB will end up about 2mm above the heatsink. Obviously you'll have drilled holes in the heatsink corresponding to those in the PCB and the transistor mounting flanges. The use of shakeproof washers ensures good contact on both sides and stops loosening by vibration. Provisionally attach a fuse and the input and output sockets and you can start tuning.

TUNING

Tuning the amplifier is relatively simple, but you have to have the right test gear. You'll need a 100w power meter and a correspondingly rated 50 ohm dummy load. Most shortwave dummy loads can be used up to 100Mhz, eg. the well known oil cooled tin models. At 80w they can be used without the oil for several minutes. If you use a dummy load in conjunction with a feed through power metre (or calibrated SWR meter) this must be able to cope with 100w at 100Mhz as well. The best solution is to get a complete dummy load power meter. For brief standing wave and relative power measurements you can use the normal little SWR meter, but its recommended that you reduce their sensitivity by adding a resistor of about 10 K ohms in series with each gang of the twin potentiometer. This prevents the meter indicating FSD with the sensitivity set just above zero. Also the matching of the potentiometer gangs is not guaranteed at the extremes of its travel, which could result in a wrong SWR reading. If you use the SWR meter for more than brief periods, at a power over 40w, the diodes will get warm and your readings will be inaccurate. So switch on transmitter and amp just to take a reading and then switch off.

To tune the 2nd harmonic filter you'll need a dipmeter or an absorption wavemeter (or a spectrum analyser if you've a

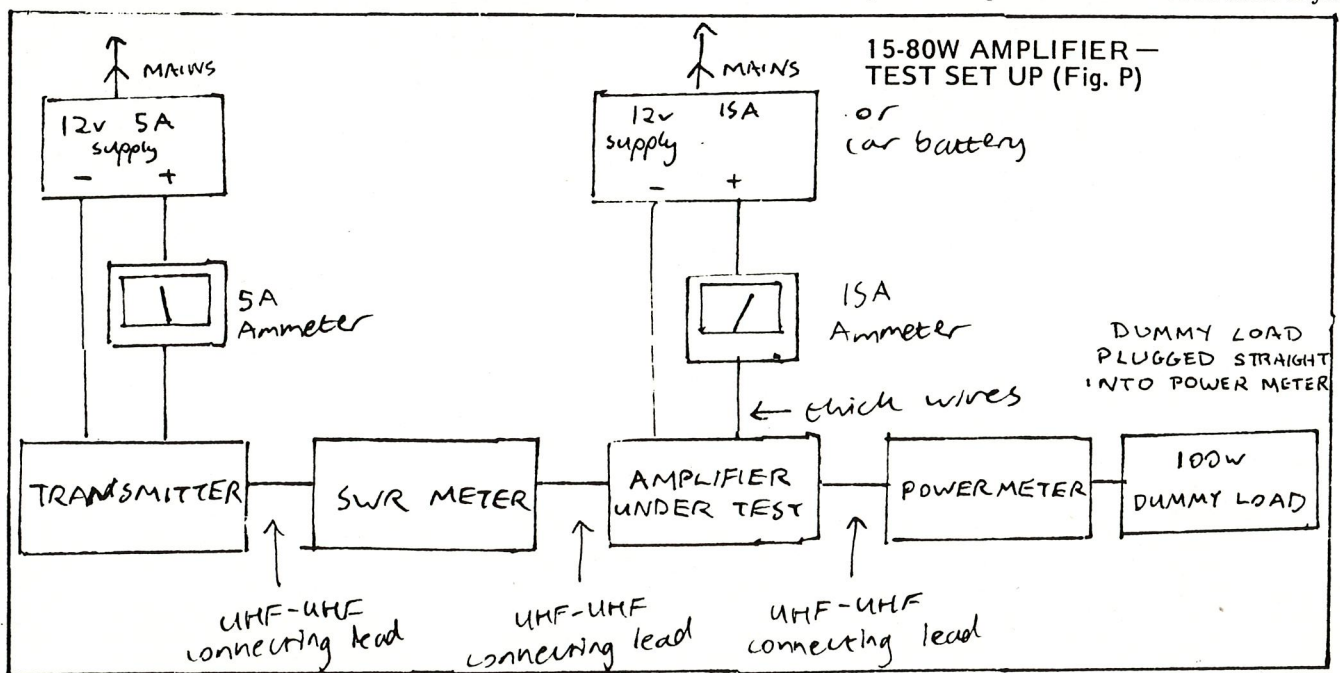
few grand to spare). You'll need two ammeters, a 5A for the TX (transmitter) power supply and a 15A for the amp power supply, assuming they're not part of any mains supply units you may be using. Useful, but not necessary, are two volt meters, one of each supply.

To sum up, to tune the amp you need: A transmitter, ideally 15-20w output power, tuned to the desired frequency. A 12v 5A mains power supply to run the TX. A 5A amp A lead to connect the Tx to a SWR meter. A lead to connect the SWR meter to the amp. being tested. A 12v 15A mains power supply or 12v car battery. A 15A ammeter. A lead to connect the amplifier into the power meter. A power meter. . . A lead to connect the power meter into the dummy load. The dummy load. The dip meter (see diagram)

Tuning is as follows. Switch on the amplifier. It should draw practically no current. Now switch on the 15w TX which obviously has to work properly. Read the 5A ammeter and the SWR meter. The SWR value will probably be bad and the amp still drawing hardly any current.. and the power meter showing a low reading. Carefully adjust C3. Suddenly the current shown on the 15A ammeter will rise sharply, and the power meter will follow more or less. Adjust C3 so the current is about 7A, Now adjust C7 for maximum power output, for this C10 should be completely unmeshed (min. capacitance) .Adjust C3 and C7 alternately to trim the amplifier for max power output. Depending on the supply voltage and the thickness of the supply leads you should be able to get 80-110 watts. The little SWR meter between the TX and the amp. should show a good SWR reading (less than 1 : 2) The amplifier current consumption should be between 10 and 14A. The transmitter's consumption should be about the same as if it was driving a dummy load (check it if you can't remember).

If you run into problems and things aren't clean switch it all off. Think. This stuff is power electronics..ie it can get real hot and start smouldering.

After this rough tuning tune the amp's harmonic filter. Set up the dipmeter so it covers 100-250Mhz. It has to be near the dummy load in a position that isn't screened. If you



can't find such a position you could for example unscrew the top off the dummy load, but beware, you're now transmitting!

Approaching with the dipmeter you'll detect a definite indication at the desired frequency, even at some distance. Now set the dipmeter to double the frequency and approach the dummy load again. Tune the dipmeter..you shouldn't get any other readings but the one on double the transmitting frequency. If you get a reading that increases steadily as you tune up the scale of the dipmeter this is an aperiodical coupling to the dummy load.. the readings are meaningless.

If you get close enough to the dummy load to get aperiodic coupling but still no indication of the first harmonic, the amp should be OK as far as that harmonic is concerned, but there is usually a fairly strong indication at double the frequency after rough tuning.

Keep the dipmeter in position tuned to the 2nd harmonic and using an insulated screwdriver with a short blade adjust C10. Suddenly the indication on the dipmeter will disappear completely, but the output power will fall as well. Adjust C7 to improve the power output again, and then adjust C10 to obliterate the 2nd harmonic again. This will give you optimum tuning for a bandwidth of about 1Mhz.

If you want a wider bandwidth you'll have to tune up differently. When performing the rough tuning (C10 completely unmeshed as before) turn C7 further than to achieve max power so that the power output and current consumption decrease again. (output power will be 65-80w). Now tune the TX to the lowest frequency of the desired frequency range and minimise the 2nd harmonic using a dipmeter and C10 as described above. Check the power output across your desired frequency range.

The wider the bandwidth you want the more output power you'll have to sacrifice. Tuning for a bandwidth of more than 4Mhz involves a lot of high precision work. C3 could be used to keep the output power constant across a wide bandwidth but this can result in the in SWR readings of 1:3 between the TX and the amp at the extremes of the band. In this situation the TX has to be cooled well.

PARTS

The biggest problem in building a VHF amp for this output power is getting the necessary parts. Often CB and amateur radio specialist shops won't have all of them. Most are to be had by mail order from various sources.

The MRF 245 and MRF247 are also stocked by Raedek Electronics at £33 each. Phone for current prices (See CONTACTS below). The fixed capacitors C2, C4, C5, C6 and C8 are special due to their high quality and extremely low inductance leads. Use either dipped mica or high quality ceramic chip capacitors with C3J dielectric. The dipped mica capacitors are made by UNELCO. Also check out the SEMCO range of capacitors in the Cirkit catalogue. There are two different sizes, the principle of construction is the same. Several layers of metal foil are insulated from each other by layers of very thin mica. Every second layer of foil is led to the outside to the tag of the capacitor, the other foil layers connect to the metal clip holding the system together. This side should be soldered to earth and the tag soldered to the PCB islands. The ceramic chip capacitors (ERIE high Q ones with C3G dielectric) are symmetrical. At each end of the almost square chip (about 4X4mm) is a solderable metal strip. Which one of these is earth doesn't matter. Cirkit stock a small range of chip ceramics. They call them Leadless Ceramic.

If you can't get the right value you should think of using smaller values in parallel. Unelco capacitors can be soldered on top of each other if you haven't space. This shouldn't cost too much if you don't build too many amps. For C4 and C5 definitely use the larger dipped mica. If you can only get ceramic chip use two in parallel cos of their tendency to heat up. For the trimmers C3 and C7 you can't use anything but mica compression trimmers. These work by compressing metal foils insulated from each other with mica. By tightening the bolt you compress and increase the capacitance. For C10 you should use a miniature air spaced trimmer cos of its low capacity.

To make the strip inductors get some copper or brass

sheet metal of about 0.1mm thickness. This can be had hopefully from craft shops. The silver coated copper wire is available from Cirkit. You could use insulated copper wire for L7.

The heatsink largely determines the looks and construction of the amp. There are special heatsinks the above described PCB can be sunk into. If you can't find one best use a standard heatsink of enough cooling capacity, ie. thermal resistance less than 0.5 degrees C/W. The shape of the heatsink will determine the problems when designing the heatsink protection, feedthrough capacitor, case, etc.

For better bandwidth use MRF247 instead of MRF 245.

Naturally you wouldn't even consider using an amp of this power into some crummy piece of TV co-ax cable, Get some Uniradio 67 from Cirkit.

PARTS LIST FOR THE 80 WATT AMPLIFIER

- T1 MRF245 or MRF247 (Raedek)
- D1 IN5402
- D2, D6 IN4002
- D3 Red LED
- D4 Green LED
- D5 Yellow LED
- SC1 16A fuse and fuse holder
- PL1 Din socket 5 pin 240 degree, or what you fancy
- PL2 two 4mm sockets, one red, one black
- PL3 BNC socket or UHF S0239 socket with earth tag
- PL4 S0239 UHF socket with earth tag
- SW1 90 degree C thermal switch (not thermal fuse)
- R1, R2, R3, 1k. ohm
- RL1 Relay 12v 150ohm, 16A contacts
- C1 500pf dipped mica capacitor or two nf ceramic in parallel
- C2 10 or 15pf Unelco or Semco or Erie high Q C3G dielectric
- C3 10 to 80pf or 15 to 115pf or 30 to 120pf mica compression trimmer
- C4 500pf (440 to 510) Unelco or Semco or two Erie 220pf in parallel
- C5 as C4
- C6 100pf Unelco, Semco or Erie
- C7 as C3
- C8 22pf Unelco or Semco or two 10pf Erie in parallel
- C9 as C1
- C10 5 to 15pf Air trimmer
- C11 3.3nf ceramic, preferably chip ceramic
- C12 100nf ceramic
- C13 10µf 35v tantalum
- C14 4.7nf feedthrough capacitor, bolttable
- C15 3.3nf ceramic
- L1 3 X 35 X 0.1mm brass or copper strip
- L2 3 X 25 X 0.1mm " " "
- L3 3 X 15 X 0.1mm " " "
- L4 3 X 25 X 0.1mm " " "
- L5 3 X 35 X 0.1mm " " "
- L6 3½ turns 1mm (18SWG) silver coated copper wire on 6mm former
- L7 6 turns 2mm (14SWG) silver coated copper wire on 7mm former
- Dr1, Dr2 wideband ferrite choke (see parts list of 5w transmitter for details of these)

Copper or brass sheet

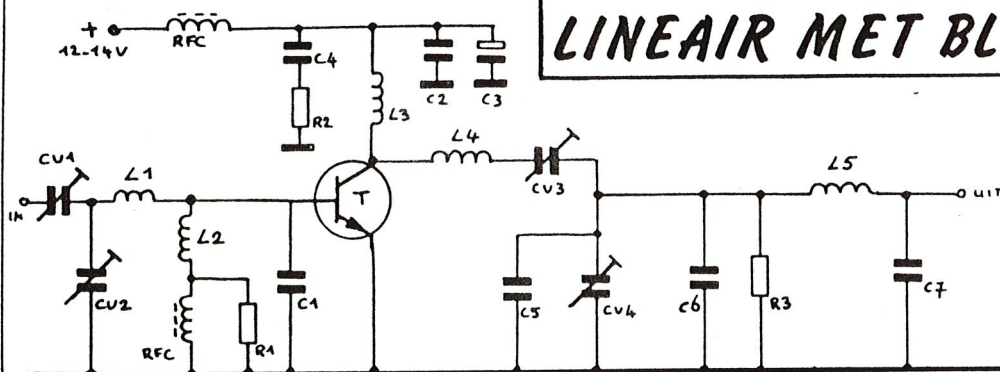
Heatsink, thermal resistance less than 0.5 degrees C / W

CIRKIT, Park Lane, Broxbourne, Herts, EN10 7NQ. Tel. (0992) 444111.

RAEDEK Electronics, 102 Priory Road, Scribers Lane, Hall Green, Birmingham B28 0TB. Tel. 021 474 6000

Also useful are Cirkit and Maplin catalogues, from your local W.H.Smith.

LINEAIR MET BLY 87/88/89



	87	88	89
CV1-2	Folietrimmer 65 pF	Folietrimmer 65 pF	Folietrimmer 65 pF
CV3-4	" " 65 pF	" " 65 pF	Ker. trimmer 65 pF
C1	47 pF ker. cond.	47 pF ker. cond.	2x 47 pF ker. cond.
C2	220 pF " "	220 pF " "	220 pF " "
C3	47 uF/35V	47 uF/35V	47 uF/35V
C4	100 nF ker. cond.	100 nF ker. cond.	100 nF ker. cond.
C5	22 pF " "	22 pF " "	22 pF " "
C6	10 pF " "	10 pF " "	10 pF " "
C7	27 pF " "	27 pF " "	27 pF " "
L1	1 wdg. Ø 6 mm.	1 wdg. Ø 6 mm.	1 wdg. Ø 6 mm.
L2	7 wdg. Ø 3 mm.	7 wdg. Ø 3 mm.	7 wdg. Ø 3 mm.
L3	3 wdg. Ø 6 mm.	3 wdg. Ø 6 mm.	4 wdg. Ø 6 mm.
L4	5 wdg. Ø 6 mm.	3 wdg. Ø 6 mm.	2 wdg. Ø 6 mm.
L5	4 wdg. Ø 6 mm.	4 wdg. Ø 6 mm.	4 wdg. Ø 6 mm.
R1-2	10 Ohm 1/2 W	10 Ohm 1/2W	10 Ohm 1/2W
R3	1k5 1W koolweerstand	1k5 1W kool	1k5 1w kool

RFC = 6-gats ferrietkraal (varkenssnuutje) VK 200.20

L2 draaddoorsnede 0,5 mm. alle andere spoelen draadd. 1 mm.

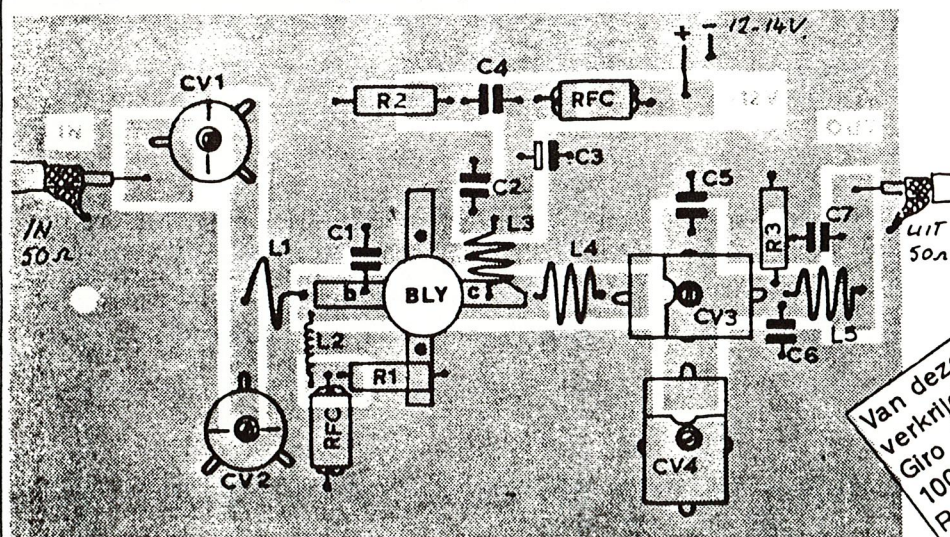
BLY 87A 1W input- 10W output 13,8 volt 2 Amp.

BLY 88A 4W input- 18W output 13,8 volt 4 Amp.

BLY 89A 10W input- 40W output 13,8 volt 6 Amp.

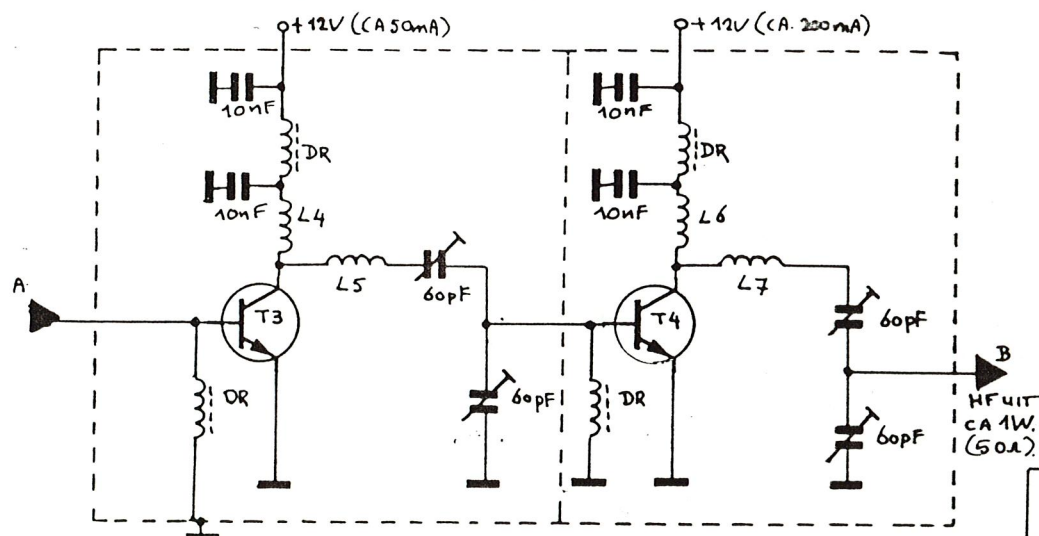
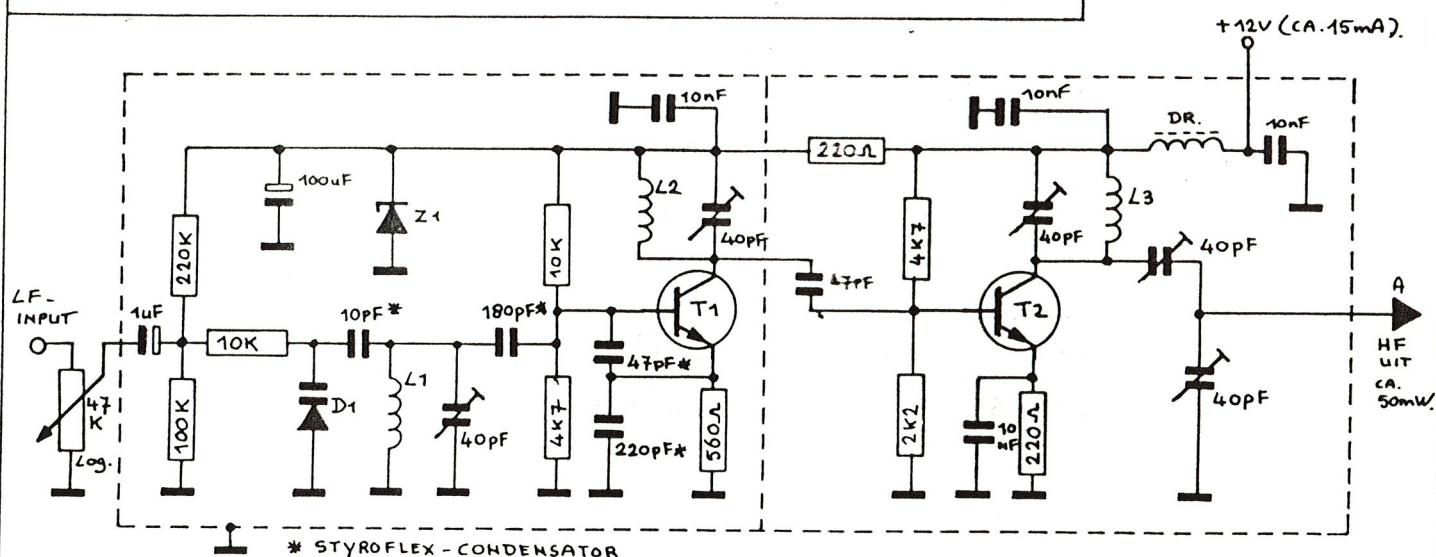
De print op een koelprofiel monteren en bij voorkeur in een metalen kast inbouwen. Koelprofiel voor BLY 87: 6°/W, BLY 88: 3°/W en BLY 89: 1,5°/W. Lineair eerst aansluiten op SWR-meter en dummyload of antenne en dan input en voeding aansluiten.

Afregelen door de trimmers te verdraaien op max. vermogen op de SWR-meter. Deze schakeling is vrij van zelfosc. en beveiligd tegen kortstondige misaanpassingen d.m.v. de 1k5 weerstand op de uigang. Deze weerstand zorgt ervoor dat bij een misaanpassing de stroom door de transistor iets terugloopt in tegenstelling tot het oplopen van de stroom bij het ontbreken van deze weerstand. Door het teruglopen van de stroom, kan de transistor een misaanpassing langer doorstaan alvorens defect te raken.



Van deze schakeling is een voorgedrukte print verkrijgbaar door overmaking van Fl. 15,00 op Giro 909515 t.n.v. A. Debels, Postbus 10252, 1001 EG Amsterdam. Verzending onder Rembours kost Fl. 8,50 extra.

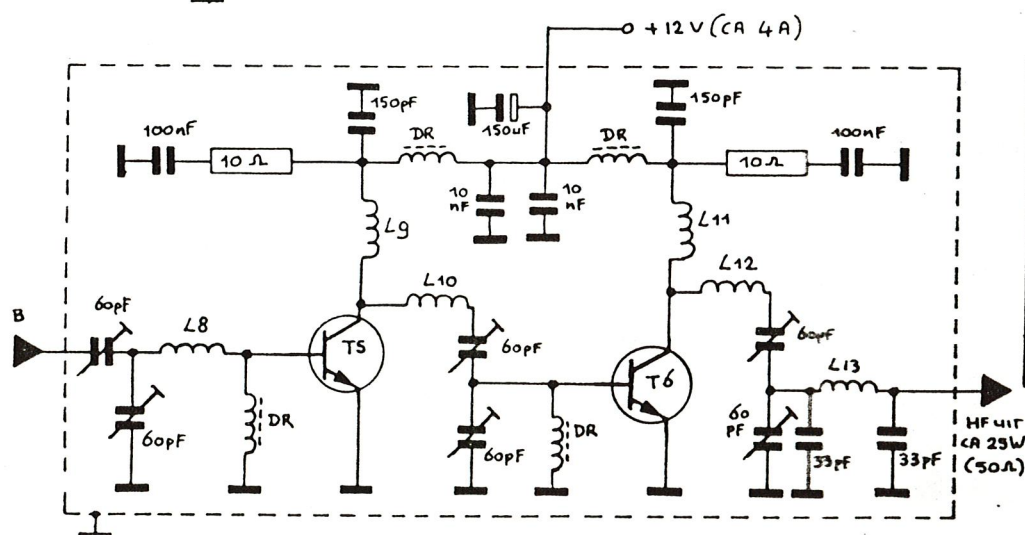
25 WATT FM -SENDER TIL RADIOFONIBÅNDET



DR: Ferrit-
drossel:



 (Ferrit)
-form)
vikles med 0.5 mm $\varnothing$
uisoleret monte-
ringstråd på form.



- T1 = BF199
T2 = BF199
T3 = 2N2219A
T4 = 2N3553
T5 = BLY87A of 2N6081
T6 = BLY87A of 2N6083
Z1 = 6,8V zenerdiode
D1 = BB105 Varicapdiode
DR = 6-gats ferrietkraal
volgewiseeld met
0,5 mm. montage draad
L1 tm L7 = 4 windingen Ø 7mm.
Draad 1mm.
L8 tm L13 = 4 wind. Ø 8mm.
Draad 1mm.
T5 en T6 monteren op een
koelprofiel van max. 2° C/W

Bovenstaand schema (met origineel opschrift) komt van een lezer uit Denemarken en is geplaatst voor die mensen, die ons gevraagd hebben eens iets te plaatsen om "zwevend" te kunnen bouwen. De stippellijntjes zijn de schotjes waartussen alles gemonteerd dient te worden. Ervaring is hiervoor zeker vereist. Alle draadeinden dienen zo kort mogelijk gehouden te worden. Op moeilijke knooppunten kan een hulpweerstand van 10M naar massa geplaatst worden.

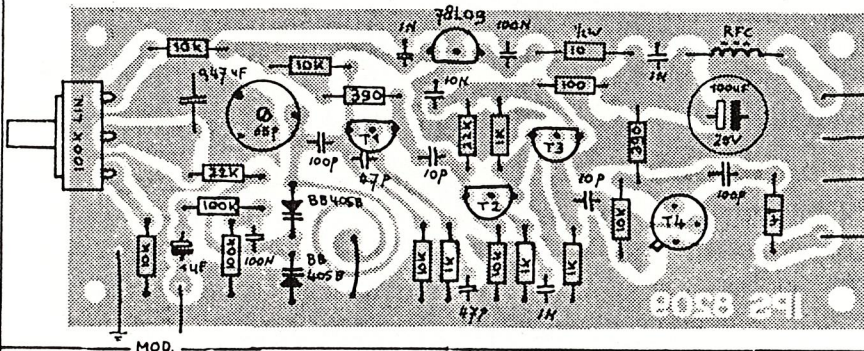
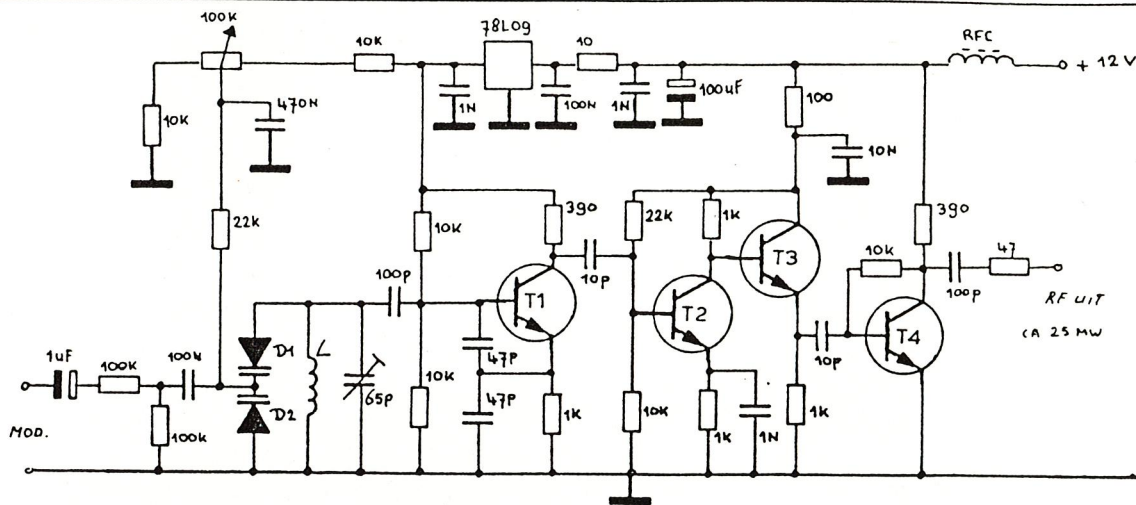
Succes.

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D-5600 Wuppertal 22
West Germany

5 Watt FM-Zender 88-108 MHz.

Nu al een nieuw ontwerp, en wel om de volgende redenen: A, De vele vragen om een regelbare oscillator i.p.v. de in het Februari nummer geplaatste vaste osc. en B, een nieuwe stuurzender om aan de vraag naar een eenvoudiger af te regelen ontwerp te voldoen. De vorige stuurzender gaf bij de minder ervaren bouwers nogal wat problemen met het afregelen.

SCHEMA



- D1, D2 - BB405B
- T1, T2, T3 - BF 199
- T4 - 2N3866
- RFC - 6-gats varkenssnuitje

COMPONENTENOPSTELLING

DE OSCILLATOR

De osc. schakeling bestaat uit een VFO met T1 en 2 varicapdiodes, die zowel voor de frequentie-regeling d.m.v. een regelspanning als de modulatie zorgen. Het regelbereik is afhankelijk van de gebruikte vari-caps. Bij de hier gebruikte BB405B is het regelbereik ca. 4 MHz. Andere varicaps kunnen zonder meer toegepast worden en hebben alleen invloed op het regelbereik, dat dan groter of kleiner wordt. Er is gekozen voor 2 varicaps om de modulatie een beter lineair verloop te geven. De spoel is op de print geëtst om de stabiliteit te verhogen; eveneens hiervoor is de 78L09 spanningsstabilisator, die de spanning op T1 op 9 volt houdt. Na de osc. een buffertrapje met T2 en T3 gevolgd door een breedbandversterker rond T4, die het uitgangssignaal gelijk maakt aan dat van de eerder geplaatste kristalosc. en eventueel later te plaatsen osc. schakelingen (b.v. PLL) zodat alles onderling uitwisselbaar wordt. De potmeter is op de print ondergebracht, maar kan uiteraard elders los geplaatst worden. De output is ca. 25 mW en de weerstand van 47E aan de uitgang dient ter bescherming van de laatste transistor tegen evt. kortsluiting van de uitgang. De osc. moet apart worden ingebouwd in een metalen kastje waarbij de voeding d.m.v. een doorvoercondensator naar de print moet worden gebracht.

De printen zijn te bestellen bij:

Alfred Debels, Postbus 10252, 1001 EG Amsterdam.

Giro: 909515

Tel. 020-320807

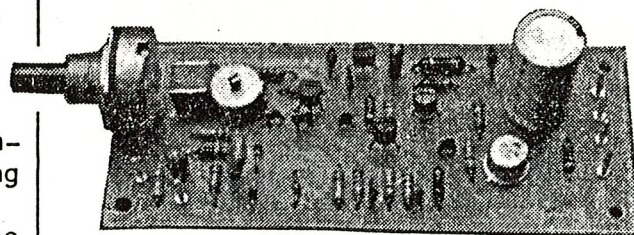
De osc. print kost Fl. 16,00 en de dubbelzijdige stuurzenderprint kosi Fl. 25,00

Deze prijzen zijn inkl. BTW en verzendkosten. Bij verzending onder rembours wordt Fl. 8,50 extra in rekening gebracht.

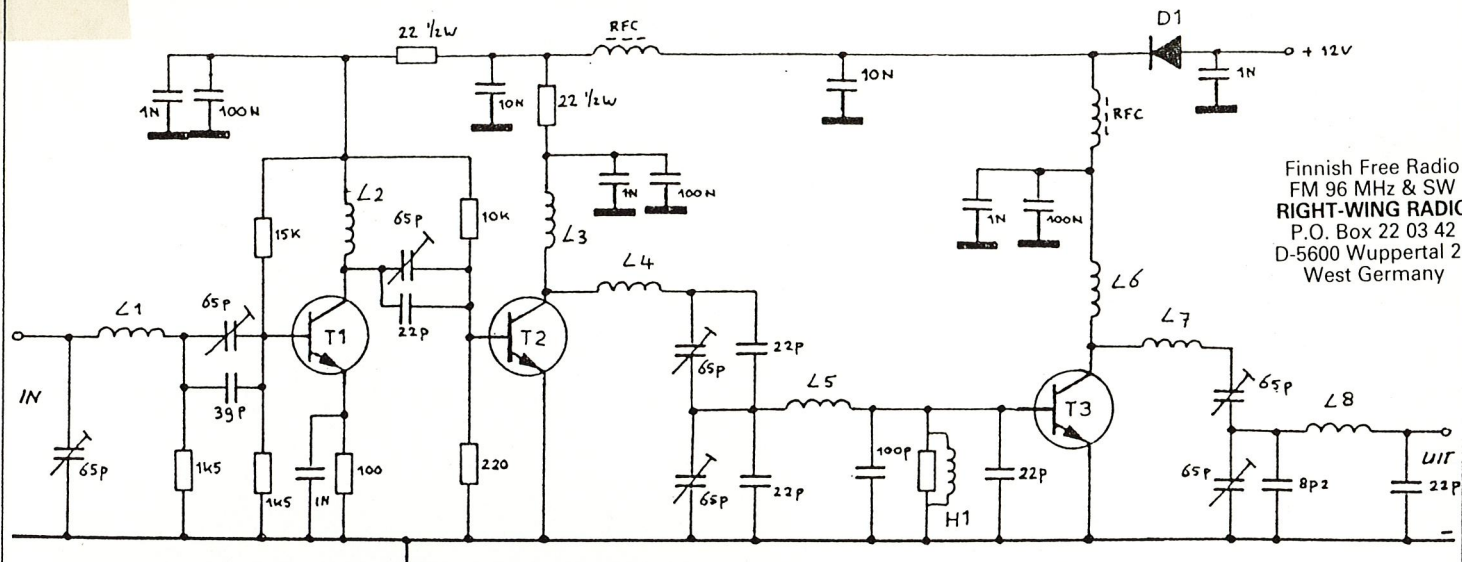
Bouwpakketten en gebouwde printen van deze twee schakelingen zijn verkrijgbaar bij:

Asian Electronics, Papaverhoek 22, Amsterdam

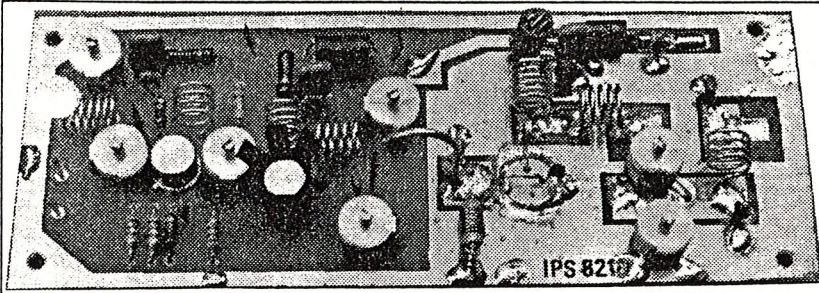
ZIE ADVERTENTIE ELDERS IN DIT BLAD VOOR PRIJZEN.



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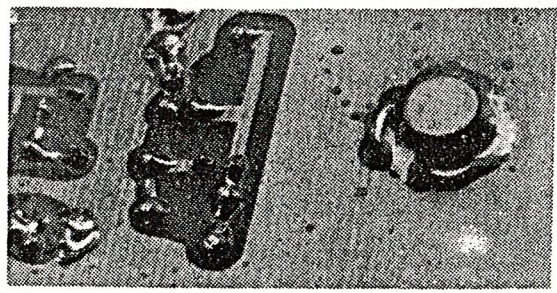


DE STUURZENDER.

Dit ontwerp is totaal gewijzigd. Er is gekozen voor minder transistors, echter wel types met een hogere versterking op frequenties rond 100 MHz. De ingangsgevoeligheid is ca. 10 mW, maar door op de ingang een weerstand van 1K5 te plaatsen is deze beschermd tot ca. 100 mw.

De gebruikte transistoren zijn wel iets duurder in aanschaf dan de gebruikelijke BF199 of 2N918, maar door het kleinere aantal en de kleinere print wordt het totaalbedrag voor deze schakeling toch aanzienlijk lager. Om het afstemmen van de stuurzender op harmonischen te voorkomen zijn over de trimmers parallelcondensators geplaatst en om parasitair oscilleren tegen te gaan zijn alle ontkoppelcond. dubbel uitgevoerd (100N + 1N).

De print is weer dubbelzijdig uitgevoerd om veel massa te verkrijgen die tevens dient om de laatste transistor voldoende te koelen. De SD1127 moet ondersteboven in de print worden gemonteerd en zowel aan de boven- als aan de onderzijde worden gesoldeerd.

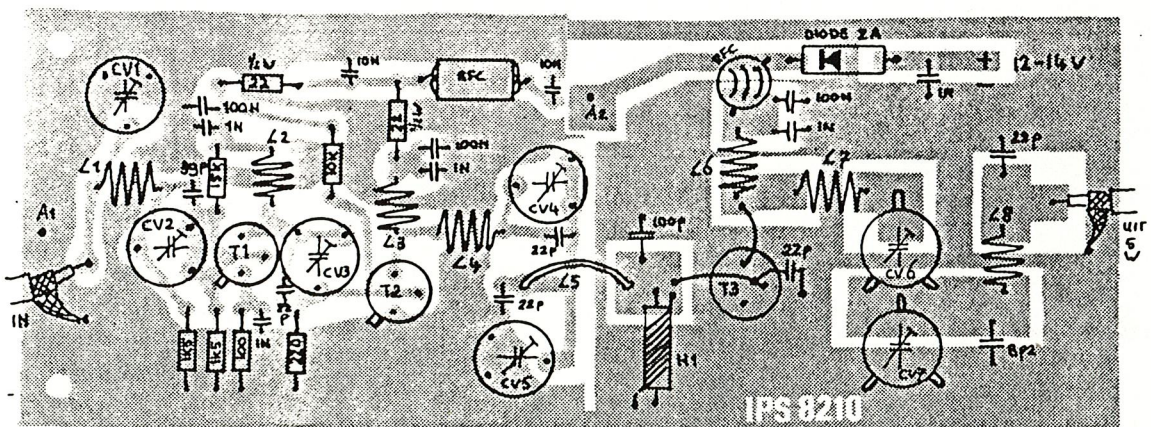


Door een andere basisinstelling van de SD1127 kunnen nu de trimmers bijna geheel rondgedraaid worden zonder dat dit de bekende rotzooi veroorzaakt; wat het afregelen wel zeer eenvoudig maakt. Op de punten A1 (massa) en A2 (plus) moet de onder- en de bovenzijde van de print worden doorgesoldeerd met een stukje draad.

AFREGELLEN

Als alles gebouwd en aangesloten is, de osc. op de gewenste freq. zetten en de trimmers van de stuurzender in de volgende stand:

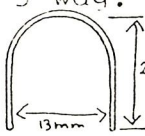
- CV1 - geheel open
- CV2 - geheel dicht
- CV3 - 1/2 open
- CV4 - dicht
- CV5 - 1/2
- CV6 - 1/2
- CV7 - 1/2

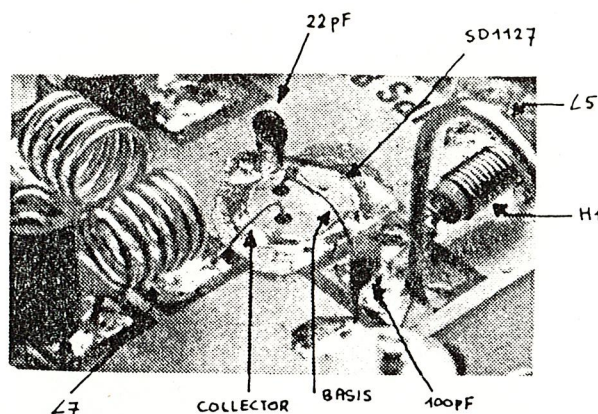


CV1,3,6 en 7 dan in deze volgorde afregelen op max. vermogen, daarna CV1,3,5,6 en 7 nogmaals. Tot slot CV6 en 7 nog wat bijregelen.

T2 moet gekoeld worden met een kleine koelster, en wel zo, dat deze de spoelen niet raakt. De stuurzen-der moet zó worden ingebouwd, dat de SD 1127 de (metalen) behuizing raakt. Let daarbij wel op dat de draadeinden kort genoeg afgeknipt zijn, want deze mogen de kast niet raken.

FRCE '88

- D1 - diode 2A
T1,T2 - 2N4427
T3 - SD 1127/MRF 237
H1 - 15 wdq. geëmailleerd koper-
draad 0,5 mm. gewikkeld op
22 Ohm 1 Watt koolweerstand.
L1 - 7 wdq. Ø 6mm. draad 0,8 mm.
L2 - 4 wdq. Ø 6mm. " "
L3 - 4 wdq. " " "
L4 - 5 wdq. " " "
L5 -  25mm DRAAD 1mm
L6 - 6 wdq. Ø 6mm. draad 0,8 mm.
L7 - 5 wdq. " " "
L8 - 4 wdq. " " "



LET OP. Er zijn op het ogenblik transistoren 2N4427 in de handel van het merk TIC, die niet werken op freq. rond 100 MHz. Let op het merk bij de aanschaf.

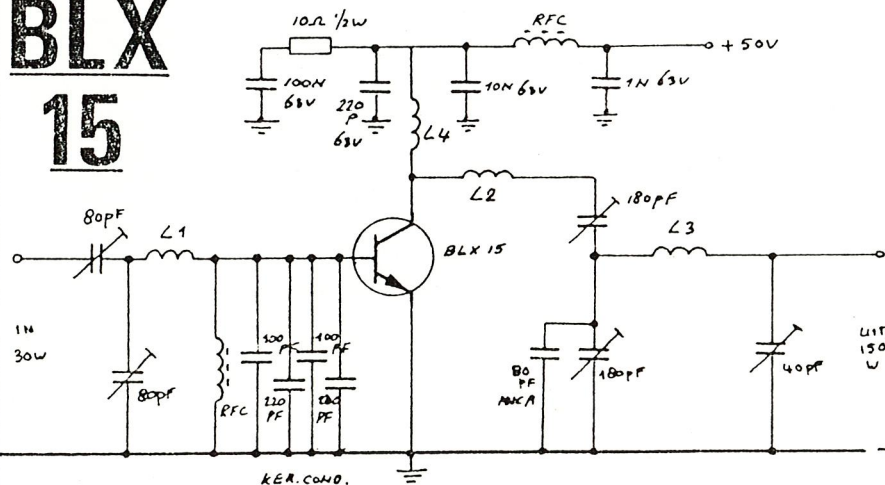


Betreft schema juli/augustusnummer FRM van de MRF 245/SD 1441 op pagina 39:

H1 moet gewonden worden met 0,5 mm. geëmailleerd koperdraad en niet met 0,3 mm.

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**BLX
15**



L1: 2WDG. Ø 9mm. L4: 3WDG Ø 8mm L2: 2WDG Ø 10mm
SPOELDRAAD L1 TH. L4 1,5 mm. L3: 4WDG Ø 6mm

150W./50 V.

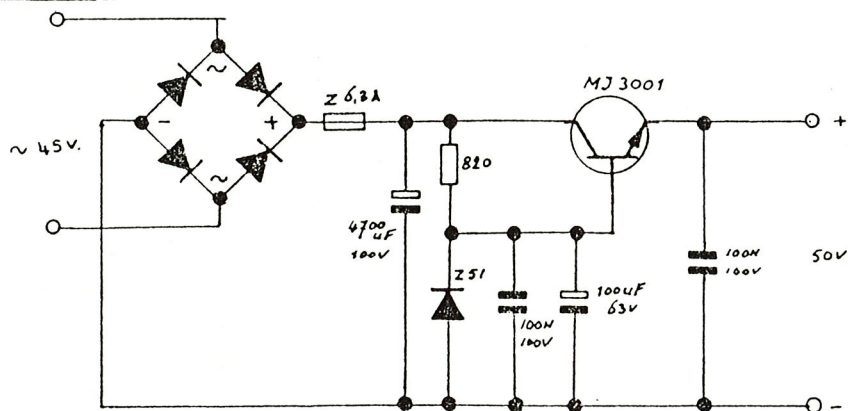
Door Aselcom wordt een bouwpakket geleverd voor de BLX 15. Deze transistor levert op 100 Mhz. een vermogen van ruim 150 Watt bij een input van ca. 30 Watt.

Daar de voedingsspanning nogal hoog ligt -50 Volt- is tevens een printje verkrijgbaar voor een eenvoudige voeding, met thermische beveiliging.

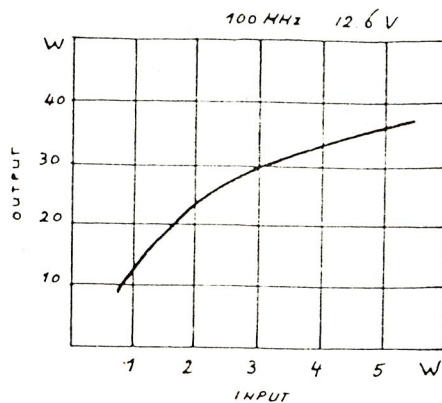
De schakeling rond de BLX-15 is de klassieke opbouw, welke meestal probleemloos werkt; de voeding is erg eenvoudig en niet kortsluitvast, dus enige voorzichtigheid is geboden, maar het geheel werkt zonder moeilijkheden.

Uiteraard bij deze vermogens weer noodzakelijk een zeer forse koeling voor zowel zendtor als voedings-transistor; een fikse trafo en veel frisse lucht.

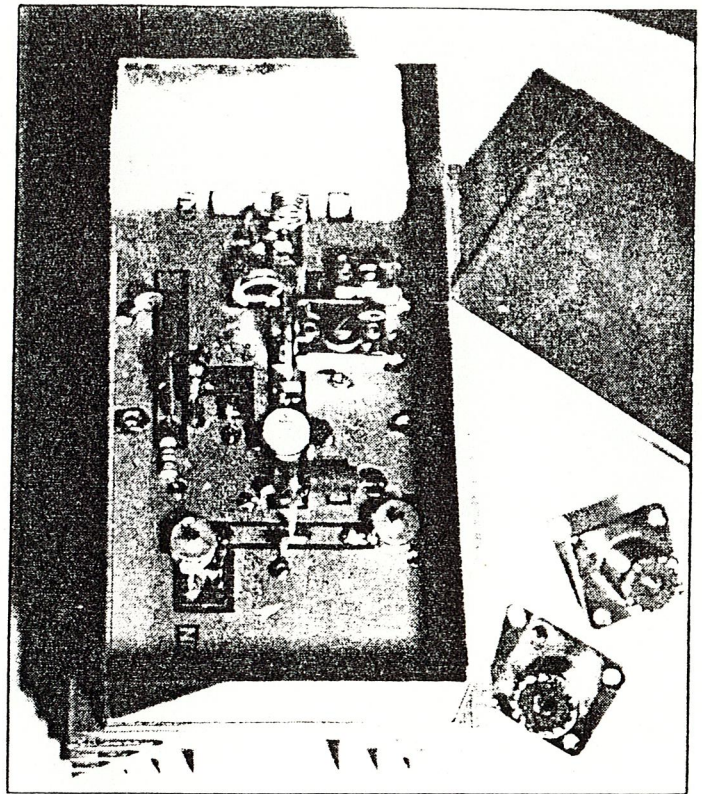
Asian Electronics levert voor dit lineair de printen en alle benodigde onderdelen in bouwpakketvorm. Tevens zijn leverbaar de (ringkern) trafo, koelmateriaal en eventueel de blower enz. (Zie adv. elders in dit blad).



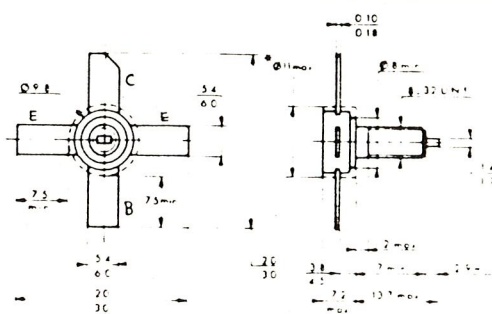
BOUW PROFESSIONELE F.M. (3m) ZENDER. DEEL 3
Eindversterker 35 Watt.



Karakteristiek transistor

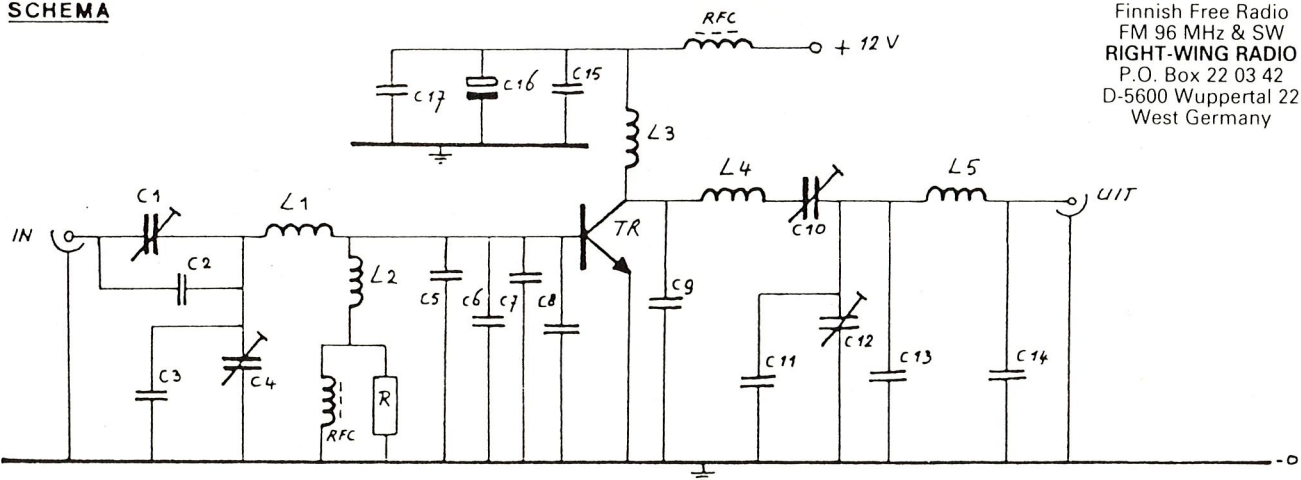


12-13,6 V. 5 amp.



SD 1272

SCHEMA



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Tot slot van deze serie van 3 artikelen de eindtrap van de FM-zender. Vanwege de vele reacties van 2-meter amateurs op deze rubriek plaatsen we bij dit lineair ook de gegevens voor gebruik in de 2-meterband.

Deze eindversterker moet -net als de oscillator- afgeschermd worden d.m.v. een eigen kastje binnen de behuizing van de complete zender. Indien los gebruikt, dienen in de afscherming 2 coax-chassisdelen te worden gemonteerd voor de aansluitingen van input en antenne.

Belangrijk bij het inbouwen:

1. De transistor moet direkt kontakt maken met een koelprofiel van min. 1,5 °W. liefst met koelpasta. Dus bij inbouw in een kast direkt kontakt met koelprofiel door een gat in de kast.

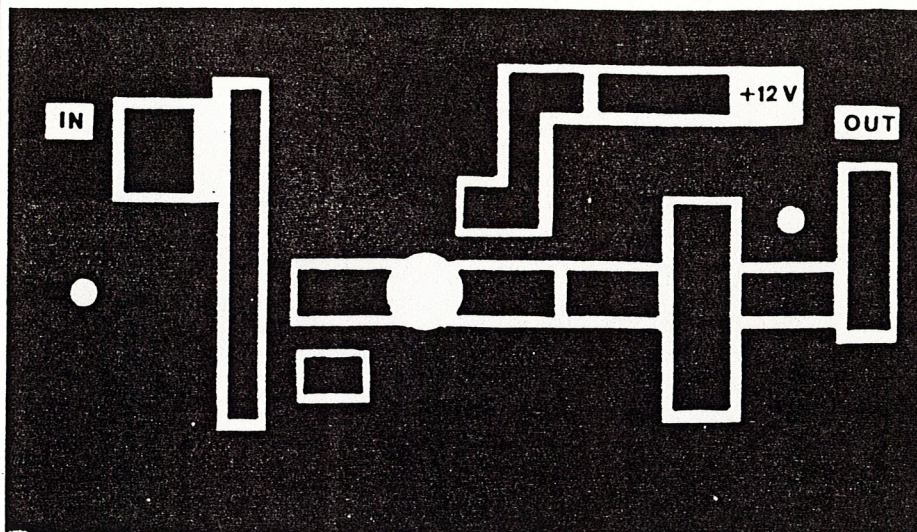
En niet de transistor tegen de kast monteren en het koelprofiel aan de andere kant van het aluminium alleen op de stud monteren; dit ter voorkoming van oververhitting en defekt raken van de transistor.

2. C10 en C12 moeten keramische trimmers zijn, bijv. ARCO 404 of 462 en geén folietrimmers. Bij dit vermogen kunnen ook de goedkopere merkloze ker. trimmers worden gebruikt.

3. De draadeinden van de componenten moeten ook hier weer zo kort mogelijk: **C5, C6, C7 en C8** zo dicht mogelijk tegen de transistor monteren.

4. Let op juiste montage. C10 (zie foto en componentenopstelling) niet omdraaien i.v.m. middenaansluiting.

Verder spreken de illustraties voor zichzelf, zodat verder commentaar overbodig is. Succes met het bouwen.



KOMPONENTEN 88-108 MHz.

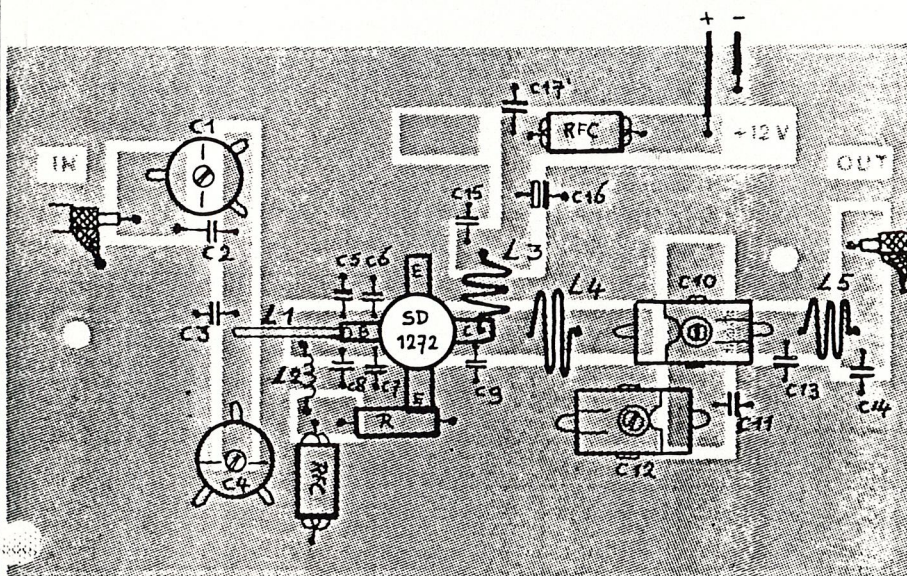
C1 - C4	4-40 pF folietrimmer
C2	1010 pF ker.cond.
C3	47 pF " "
C5 - C6	100 pF " "
C7 - C8	100 pF " "
C9	10 pF " "
C10- C12	4-60 pF Arco 404
C11	47 pF ker.cond.
C13- C14	22 pF " "
C15	470 pF " "
C16	47 uF 25 V.
C17	1 NF ker.cond.

R	10 Ohm 1/2 W.
---	---------------

L1	L = 14 mm. H = 20 mm.
L2	7 wdg. L= 3mm. (strak gewonden)
L3	5 wdg. D= 6mm.
L4	4 wdg. D= 8mm.
L5	4 wdg. D= 7mm.

RFC	"varkenssnuetje VK 200.20
-----	------------------------------

Tr.	SD 1272
-----	---------



144-148 MHz.

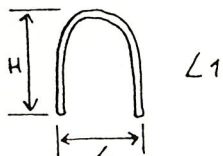
C1 - C4	4-40 pF folietrimmer	L1	L = 14 mm. H = 15 mm.
C3	18 pF ker.cond.	L2	7 wdg. D= 3mm. (strak gewonden)
C5 - C6	100 pF " "	L3	4 wdg. D= 5mm.
C7 - C8	47 pF " "	L4	3 wdg. D= 8mm.
C10- C12	4-60 pF Arco 404	L5	4 wdg. D= 6mm.
C11	15 pF ker.cond.	RFC	"varkenssnuetje VK 200.20
C13- C14	15 pF " "	Tr.	SD 1272
C15	470 pF " "		
C16	47 uF 25 V.		
C17	1 NF ker.cond.		
R	10 Ohm 1/2 W.		

Finnish Free Radio
FM 96 MHz & SW
RIGHT-WING RADIO
P.O. Box 22 03 42
D-5600 Wuppertal 22
West Germany

I.P.S.-foon.

Elke zondag van 12.00 tot 23.00 uur staat het volgende telefoonnummer open voor aanvullende informatie, opmerkingen en reacties naar aanleiding van deze artikelenreeks. Ook evt. suggesties voor later te plaatsen schema's zijn welkom.

020-32.08.07

Spoelen:

L3, L4 en L5:

draaddikte 1 mm.

spatie 1 mm.

L2:

draaddikte 0,5 mm.

geen spatie.

Gezocht: Schema's van kristalgestuurde oscillators:

Geschikt voor FM-modulatie 3 meter (75 kc) omroep. Alleen goede schema's s.v.p.

Wanneer de kwaliteit door ons voldoende wordt bevonden, kan na overleg een redelijke vergoeding plaatsvinden, waarna wij zorgen voor publikatie, printen, printlay-out e.d. in het Free Radio Magazine.

Inzendingen met afzender en eventueel telefoonnummer naar:

INTERNATIONAL PRINT SERVICE,

POSTBUS 10252,

1001 EG AMSTERDAM.

t.a.v. ALFRED DEBELS.

Veel plezier bij het bouwen en tot volgende maand.

Finnish Free Radio
FM 96 MHz & SW
RIGHT-WING RADIO
P.O. Box 22 03 42
D-5600 Wuppertal 22
West Germany

PRINT: f 17,50.

Bouwpakket: print + componenten zonder kast en koelprofiel f 91,--

Tevens is er een bouwpakket met koelprofiel, 1 OW. kast, doorvoercondensator voor de voeding en 2 amphenol chasisdelen + bevestigingsmateriaal. Dit pakket kost f 120,50

Deze prijzen zijn incl. BTW en verzendkosten. Bij verzending onder rembours wordt f 7,50 extra berekend.

Overboeking naar giro 909515 t.n.v. A.DEBELS, POSTBUS 10252, 1001 EG AMSTERDAM.

Telefonische bestellingen : 020 - 32.08.07

Winkelverkoop: Asian Electronics, Papaverhoek 22, Amsterdam-Noord.

Koperdraadtabel.

Omdat in Amerikaanse en Engelse publikaties bij de spoelen in HF-schakelingen voor de draaddikte geen maten in mm of inches worden opgegeven, maar alleen nummers, hierbij een tabel met deze nummers en de omgerekende draaddikte in mm:

AMERIKAANS:

12
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40

A.W.G
(B & S)

NEDERLANDS:

2.053
1.828
1.628
1.450
1.291
1.150
1.024
.912
.812
.723
.644
.573
.511
.455
.405
.381
.321
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.255
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.202
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.160
.143
.127
.113
.101
.090
.080

ENGELS:

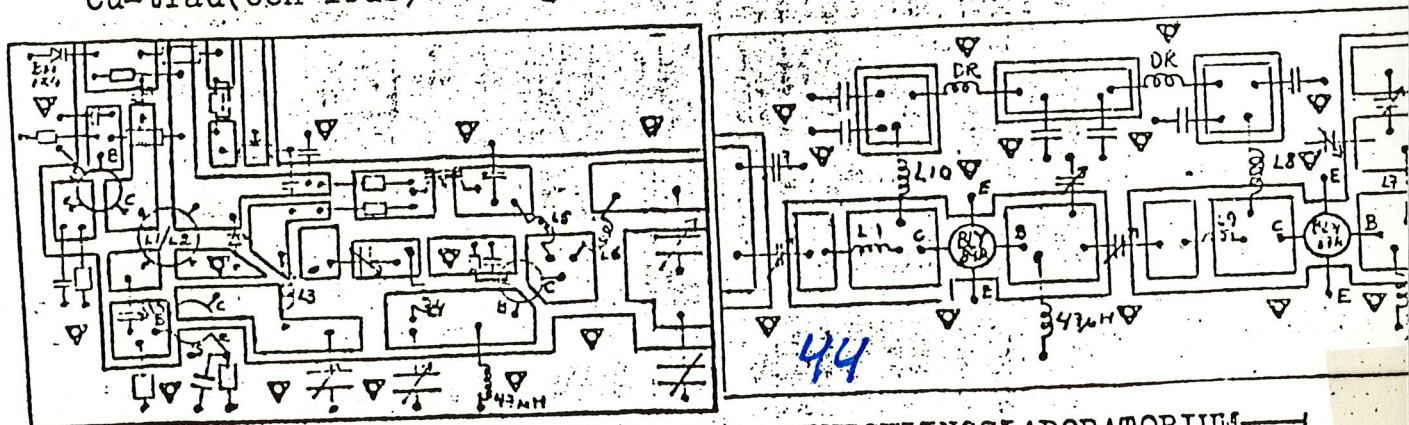
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38-39
39-40
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44

S.W.G

(Dank je, FRM)

[illegible]

Sändaren byggs lämpligast så som den är ritad här, d v s som två separata enheter. Dessa monteras i varsin skärmbbox Elfa best.nr: 50-0010-4. L1 4varv och L2 2varv lindas på samma spolistomme Elfa 58-6160-4. L3 luftlindas 4varv, mittuttag tas 3varv från sidan närmast kollektor 2N918. L4-6 luftlindas 4varv. För L4-6 är tråddia 0,5mm Cu-tråd, för L3-6 är spolens innerdia 5mm. L7-11 luftlindas 4varv (innerdia 8mm) 1mm Cu-tråd. Drosslarna 47uH Elfa best.nr: 58-4590-4. Drosslarna DR är 0,5mm Cu-tråd lindad 2varv genom ferritkärna Elfa 58-3160-7. Trimmrar är Elfa 68-7980-3, 68-7930-8 & 68-7940-7. Alla fasta kondensatorer är av keramisk typ, utom 15p, 33p, 100p & 330p i oscillatorsteget, de senare är av styroltyp. De bägge effekttransistorerna kräver god kylning. Kiselfett måste användas vid monteringen av dessa i boxen, och en kylfläns skall monteras på boxens utsida. Kretskort görs av dubbelfolie-laminat men etsas bara på en sida. Till andra sidan genom-nitas med 2 mm Cu-tråd (och löds) vid angivna ∇ -markeringar på layouten nedan:



RADIO 98

Udgå kommentarer.....

För att undvika att layout-skissen skulle bli för "klottrig" har ej alla komponenter ritats in där. Följ därför kopplings-schemat vid inmonteringen av komponenterna och använd layout-skissen då endast som vägledning.

Äre i kopplingschemaet angivna komponentvärdena behöver inte tas som mer än rekommendationer. För den experimentlysnen bör här finnas en utrymme till eventuella modifieringar och kanske förbättringar. Och; som ett exempel så fungerar sådaren säkert lika bra om man istället för angivet 4,7k Ω använder 3,9k Ω , eller 5,6k Ω . Mer kända är så är faktiskt inte komponentvärdena. Alla motstånd är 1/4Watt.

Kort om funktioner.....

Oscillatorn (BFP90) svänger på halva frekvensen, frekvensdubbling sker i steget 2E918, i efterföljande steg effektivförstärkning. Efterom alla steg efter oscillatorn arbetar i "klass C" krävs inga kraft-don för att sätta av skandaren. RÄcker att man byter strömen till oscillatorn så att denna upphör att svänga, därmed upphör också all strömeförbrukning i de efterföljande stegen. Oscillatorn kan exempelvis bytas av en extra switch i bandspelarens autostop-mekanis-

Exteriören.....

På drivstegs-boxens ena kortsida har vi monterat en "Freh mikrofon-kontakt" (Elifa 42-2280-8) för IF-ingången. På andra kortsidan har vi kontakt till slutsteget, en EMC-kontakt (Elifa 46-2620-6). På slutstegets ena kortsida sitter en likadana BMC som ingång, men som utgång - på andra kortsidan - har vi en "UEP-kontakt" (Elifa 46-0070-6). Att vi inte valt BMC även där beror endast på att vi ville undvika förväxling av in- och utgång. Strömtilförsel: för positiv pol har vi via kabel från vardera skärmboxarna, kablarnas avslutade med alligatorer. Negativ pol är fast kabel från MC-batteriet, denna kabel avslutas med benamkontakt, pluggas in i polarurav på slutstegets ena kortsida. Här har vi alltså tillsett så att förväxling ska undvikas. Det är ju väsentligt eftersom det oftast är netsvarva mörkret när man ska montera upp sändaren inför sändningen....

ringen.....

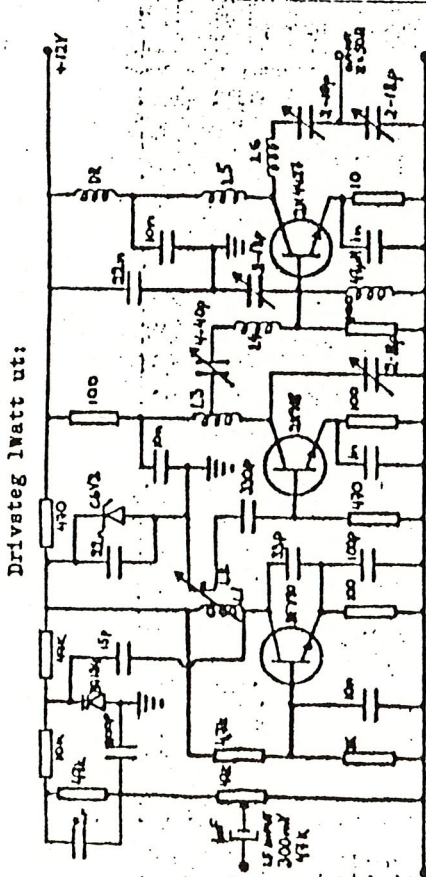
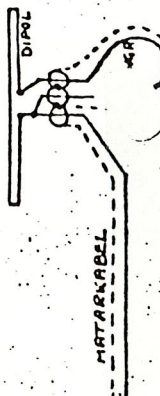
För detta ändamål krävs en ständevägmeter. Sådana kan köpas ex.vis hos World Import. Denna inkopplas till slutetegets utgång, och till utgångens utgång kopplas en konstanten. En primitiv men funktions-
mässig sådan kan tillverkas av en konservburk där man monterar en
axialkontakt i botten. Från konservburkens vägar löds 10 st 470-
ohms-motstånd (1Watt) liksom 1 krasa, och andra änden på alla motstånd
löds till centrumsstiftet på kontakten. Summan blir alltså 470ohms....

Antennen.....

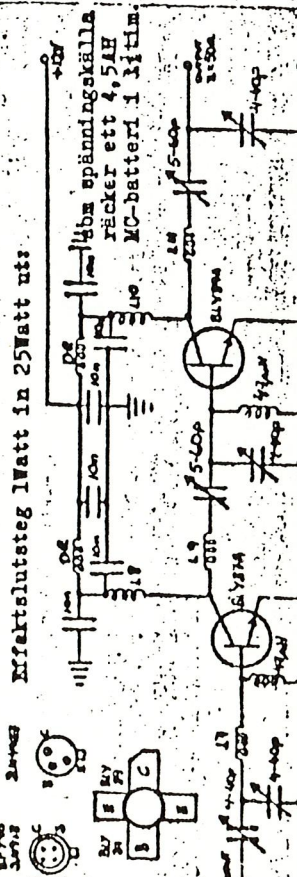
i använder en vanlig Y-elementets Yagi-dipol, d. v. s. i princip en "mot-
vagningsantenn". Eventuell inbyggd anpassningsstraf måste bortmonteras
för att den dels har fel impedans, dels tål den inte effekten. Den
rättvis istället av en traf enligt skissen nedan. För slinga och ma-
rkabel används "professionell"-kabel typ RG-58 (Zlfva 55-9050-0).

Med vänlig hälsning och Lycka till
från

RADIO 98:s UTVECKLINGSLABORATORIUM
ENKÖPING - SWEDEN

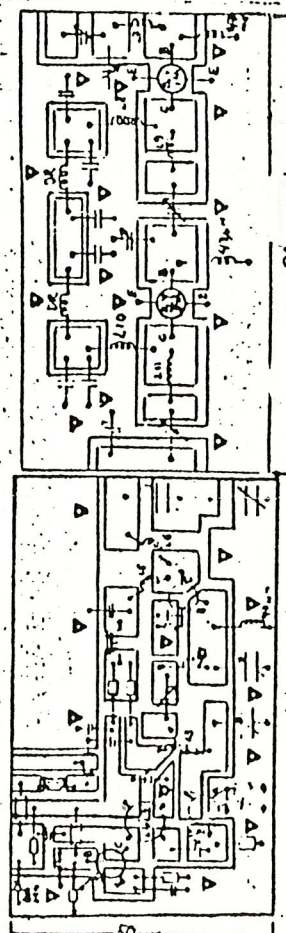


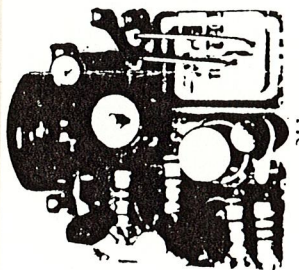
Drivsteg lwatt ut:



Effektivitätsgrad 1 Watt in 25 Watt nt:

Sändaren byggs lämpligast så som den är ritad här, då s som två separata enheter. Dessa monteras i varsin skåpbox Elfa best.nr: 68-09-0310-4. I1 4varv och I2 2varv lindas på samma spolestomme Elfa 68-09-0310-4. I3 luftlindas 4varv, mittuttag på 25 varv från sidan av bärmast kollektor 2N918. I4-6 luftlindas 4varv. För I1-6 är trådlängd ca 5 mm Cu-tråd, för I3-6 är spolens innerdiameter 5 mm. I7-11 luftlindas 4varv (innerdiameter 8 mm) 1 mm Cu-tråd. Drosslarna 47uH Elfa best.nr: 68-09-0310-4. Drosslarna DR är 0,5 mm Cu-tråd lindad 21varv genom keramiskt rör Elfa 58-316C-7. Trilmurar är Elfa 68-7960-3, 68-7930-3 och 68-798C-7. Alla fasta kondensatorer är av keramisk typ, utom de bägge effektt transistorerna kräver god kylning. Kiselstoft måste monteras på boxens utsida. Kretakort görs av dubbelfolie-laminat av en etas bara på en sida. Till andra sidan genom-nitas med 2 mm Cu-tråd (och löds) vid angivna v-markeringar på layouten nedan:





Kuva HF 65.1 ULA-lähetin HF 65.

HF65 ULA-LÄHETIN

HF 65 on pieni ULA-koehäetin lähinnä radiohuoltamoja tai laboratorioita varten. Se toimii 60 MHz ja 145 MHz välisellä taajuuksalueella ja sitä voidaan myös moduloida.

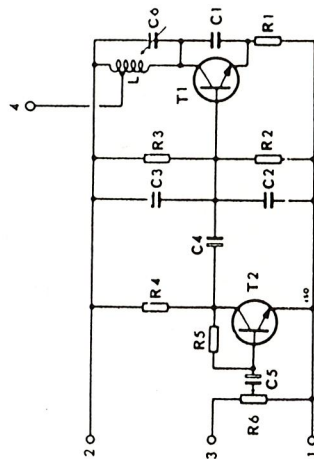
Missään tapauksessa ei HF 65:tä saa liittää antenniin: tällöin se nimittäin toimisi ulottuvuudeltaan varsin hyvänä lähettimenä ja häiritsisi vastaanottimia. Sitä tulee käyttää ainoastaan vain vaihtojohdon avulla kokeiluvastaanottimen antenniliitäntään kytkettynä. Lisäksi HF 65 on rakennettava maatettuun metallikoteloon, ei-toivottujen säteilyjen estämiseksi. Suomessa ei tällaisia lähettäviä saa langattomasti käyttää ilman Posti- ja lennätinlaitoksen asianmukaista lupaa.

Transistori T1 toimii oskillaattorina, jossa tarvittava takaisinkytkentä tapahtuu kondensaattorin C1 kautta kollektorilta emitterille. Sen kanta on suuritaajuisesti maitettu C2:n ja C3:n kautta. Siihen voidaan kuitenkin johtaa pi-signaali C4:n kautta, jolloin tämä signaali moduloi lähetintä. T2 on modulaatiovahvistin, ja R6:n avulla voidaan moduloinnin voimakkuutta säätää.

Jos liitäntöjen 3 ja 1 väliin kytketään vaikkapa äänigeneraattori, saadaan laitteeseen kytketyn tv-vastaanottimen kuvapinnalle pysty- tai vaakasuora palkkikuvio. Jos otoliitäntään kytketään mikrofoni, laitteella voidaan välittää myös musiikkia tai puhetta. Normaalissa käytössä HF 65:n käyttöteho ei tulisi ylittää arvoa 0.3 W. Jos T1 varustetaan lisjäähdytyslevyllä, käyttöteho saa nousta 5 W saakka.

HF 65:n tekniset arvot

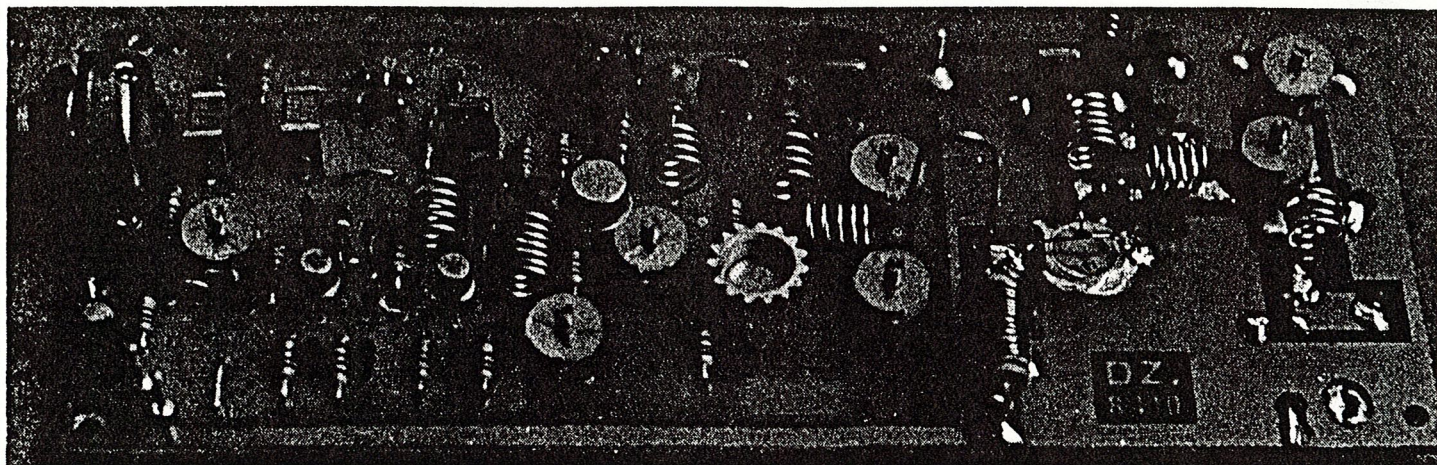
Käyttöjännite	4.5...15 V=
Virtankulutus	10...50 mA
Suurin st-antoteho (40 V)	300 mW
Taajuusalue	n. 60...145 MHz
Pt-ottoherkkyys	10 mV
Ottoimpedanssi	n. 22 k Ω



Kuva HF 65.2 ULA-lähetimen HF 65 kytkentä.

R1	100 Ohm	C3	470 pF
R2	10 kOhm	C4	6.8 μ F/40 V
R3	10 kOhm	C5	6.8 μ F/40 V
R4	4.7 kOhm	C6	20 pF
R5	220 kOhm	T1	2N2219 tai 2N3300
R6	22 kOhm		oder BSY 88
C1	3 pF	T2	BC 172
C2	470 pF		

5-WATT FM-ZENDER



(MET DE OUDE DUBBELZIJDIGE STUURZENDERPRINT)

Op veelvuldig verzoek herhalen we hierbij een eerder ontwerp. De stuurzender van deze 5-watter is vrijwel gelijk aan de vorige omdat deze bij vrijwel iedereen probleemloos werkte en er veel vraag was om deze print weer in de handel te brengen. De oscillator is op dezelfde print ondergebracht wat het geheel iets goedkoper maakt. De print is daardoor iets groter geworden en iets duurder, maar nog altijd goedkoper dan de twee printen van de vorige 5 Watt zender.

De iets grotere print maakt het bouwen wat makkelijker omdat de componenten wat ruimer zijn opgesteld en het grotere formaat komt ook ten goede aan de koeling van de eindtrap.

Het oscillator gedeelte is vrijwel geheel gewijzigd. De VFO is hetzelfde, maar de 3-traps buffer uit het vorige ontwerp is vervangen door 1 transistor. Alleen bij aansluiting van een PLL moet nog een tweede transistor op de print worden gebouwd. (Dit is het gestippelde gedeelte rond transistor T6).

Het gedeelte voor T6 is reeds op de print aanwezig en geboord en kan al dan niet van componenten worden voorzien. De VFO is weer gestabiliseerd met een 78L09 en de frekwentieregeling gebeurt met een 100K potmeter welke ook op de print kan worden geplaatst.

Let op dat bij gebruik met een PLL deze potmeter komt te vervallen, anders wordt het regelbereik te klein. De gebruikte varicap (BB405B) kan vervangen worden door een andere met als enig verschil dat de grootte van het regelbereik verandert.

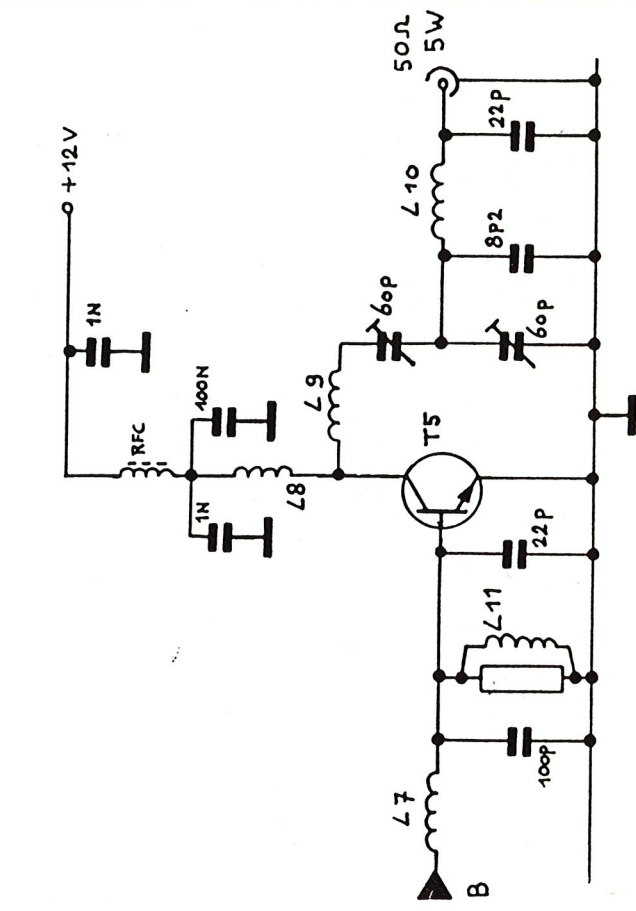
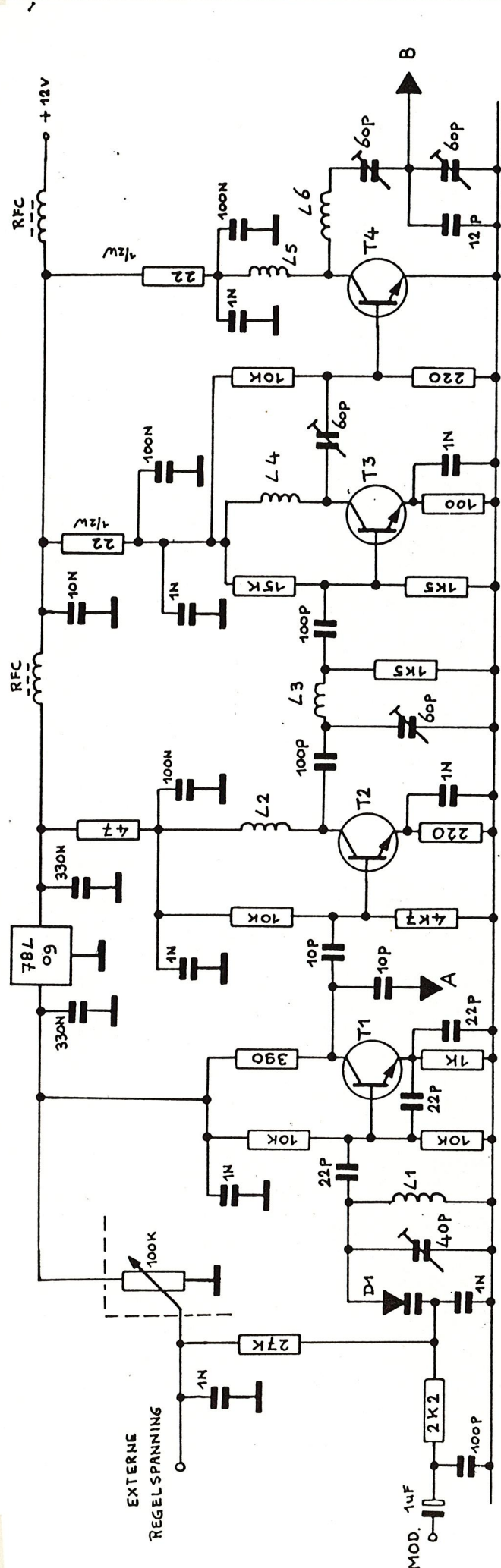
De stuurzender is vrijwel gelijk aan de vorige. Er kunnen in plaats van 2N4427 transistoren ook 2N2219s worden gebruikt. Met de 2N2219 is het afregelen iets moeilijker, maar met de 2N4427 gaat de stuurzender iets sneller oscilleren. Voor het vermogen maakt het niet uit welk type er gebruikt wordt. Het geheel moet bij voorkeur weer in een metalen kastje worden gebouwd en het verdient aanbeveling het geheel zo in te bouwen, dat de MRF237 de behuizing raakt om wat extra koeling te krijgen.

Behalve de 2 weerstanden van 22 Ohm naar de plus en de weerstand van L11 zijn alle weerstanden 1/4 Watt. De condensatoren zijn keramisch. Ook hier moet alles weer zo dicht mogelijk op de print worden gesoldeerd met zo min mogelijk aansluitdraden. Het is nog steeds noodzakelijk dat de spoelen rond zijn, dus op een ronde spoelvorm (b.v. 6 mm. boortje) wikkelen.

Het afregelen gebeurt weer met een dummy load, een SWR-meter, en bij voorkeur een dipmeter. Eerst de oscillator op de gewenste frekwentie instellen en dan trap voor trap de volgende transistor instellen. Dit enige malen herhalen. Het uitgangsvermogen bedraagt dan bij 13 Volt c.a. 5 Watt. De fotos laten zien hoe een en ander opgebouwd en gesoldeerd is.

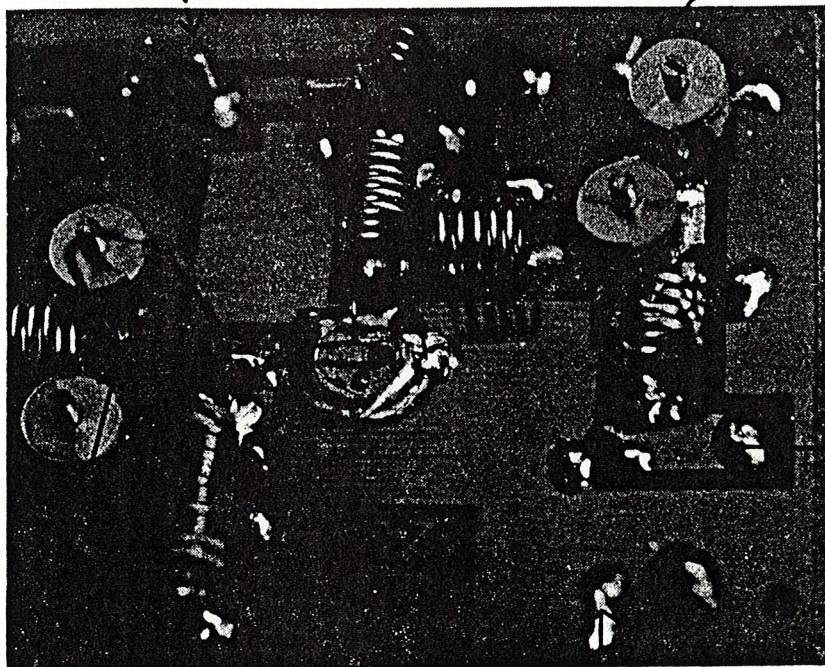
Het is zonder meer mogelijk deze schakeling anders te bouwen (b.v. zwevend) daar sinds de vorige publikatie is gebleken dat deze schakeling bijna altijd probleemloos werkt.

Succes met het bouwen.....Alfred.



DOORVERBINDING VAN DE PLUS
VAN DE VOEDING.

DOORVERBINDING VAN DE MASSA.

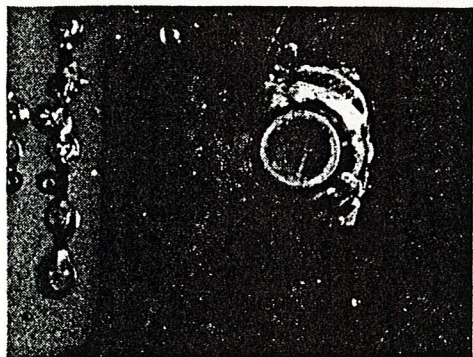


ANTENNE (coax 50 Ohm).

SPOEL L7

SPOEL L11

DOORVERBINDING VAN DE MASSA.



ONDERZIJDE VAN DE PRINT MET
DE EINDTRANSISTOR.

Van deze schakeling is weer een print leverbaar. De print is dubbelzijdig en voorgeboord en kost Fl. 35,00.

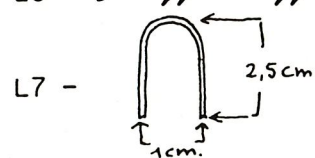
Tevens zijn enige gebouwde exemplaren te koop; deze kosten Fl. 100,00.

Bestellen door het bedrag in een aangetekende brief te sturen naar onderstaand adres of door overmaking op Giro 909515 t.n.v. A.Debels, Postbus 10252 1001 EG Amsterdam.

De prijs is inkl. verzendkosten. Bij verzending onder Rembours wordt Fl.8,75 extra in rekening gebracht.

SPOELEN

- L1 - printspoel (ca.3 wind.)
- L2 - 4 windg. doorsn. 6 mm.
- L3 - 7 " " 6 mm.
- L4 - 4 " " 6 mm.
- L5 - 4 " " 6 mm.
- L6 - 5 " " 6 mm.

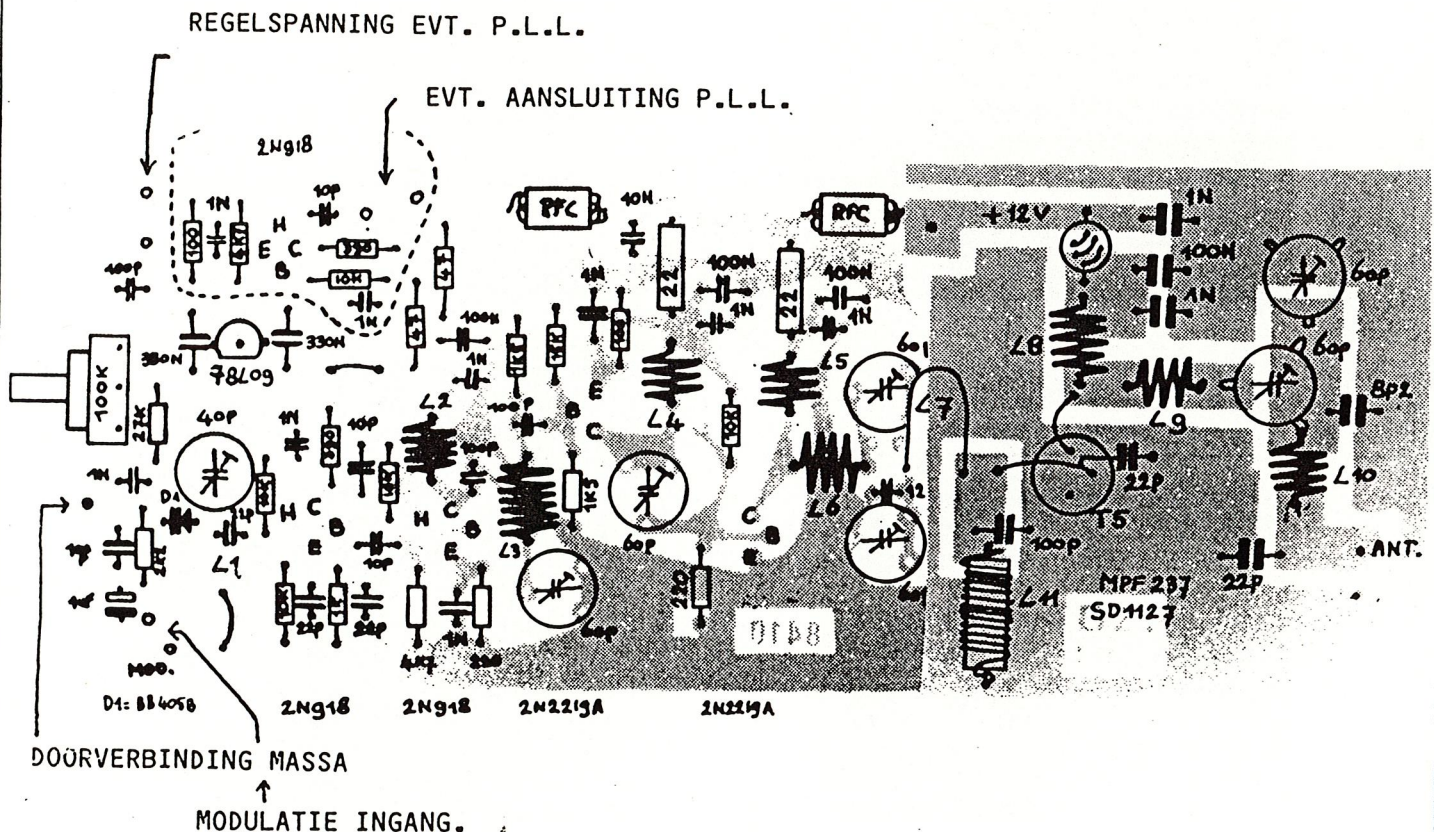


- L8 - 5 windg. doorsn. 6 mm.
- L9 - 5 " " 6 mm.
- L10 - 4 " " 6 mm.
- L11 - 15 windingen geëmailleerd koperdraad gewikkeld op een 33E koolweerstand van 1 Watt.

** Alle spoelen behalve L7 en L11 zijn gemaakt van 0,8 mm verzilverd of vertind koperdraad.

D1 = BB405B
T1,T2,T6 = 2N918
T3,T4 = 2N2219A of 2N4427
T5 = MRF237 of SD1127
RFC = 6-gats ferrietkraal.

Bij L11 moeten de draaduiteinden van de spoel blank gemaakt worden en met de draden van de weerstand worden verbonden. Het geheel moet zo op de print worden gesoldeerd, dus niet alleen de spoel!



Het gedeelte binnen de stippellijn is alleen nodig bij gebruik van een PLL. Bij de VFO hoeft dit stukje niet gebouwd te worden. Wanneer een PLL wordt aangesloten, moet de potmeter vervallen; anders wordt de regelspanning te klein. De laatste transistor voor de eindtrap moet een koelster hebben.

STILON

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3430 AM
NIEUWEGEIN.

SONY M.T.L. 10 CASSETTEWISSELAAR

INSCHRIJFPRIJS: FL. 675,00

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STILON SAMEN STERK BETER WERK !

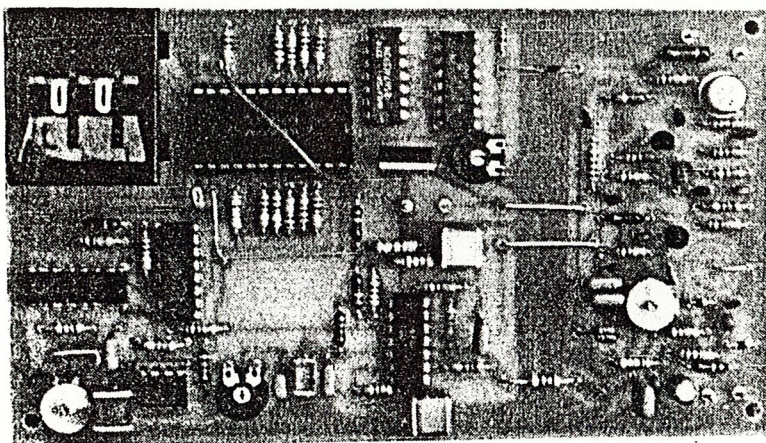
FM OMROEPZENDERS

VERMOGENS TOT 10 KILOWATT !

OP BESTELLING

POSTBUS 232,
2950 AE ALBLASSERDAM.

PLL OSCILLATOR



Om een zo stabiel mogelijk osc. signaal te krijgen gebruiken we bij voorkeur een kristalosc. Rechtstreekse Freq. Modulatie is echter niet mogelijk, daar een kristal niet voldoende in freq. gevarieerd kan worden; vandaar een oplossing met een fasevergelijker. We nemen zowel een x-tal osc. als een VFO en stoppen beide signalen in een fasevergelijker. Zolang beide signalen gelijk zijn gebeurt er niets, maar zodra de VFO verloopt krijgen we een ongelijke freq. wat tot gevolg heeft dat de fasevergelijker een signaal afgeeft, waarmee de VFO met een afstemdiode wordt bijgesteld tot de beide frequenties weer gelijk zijn. (zie afb. 1).

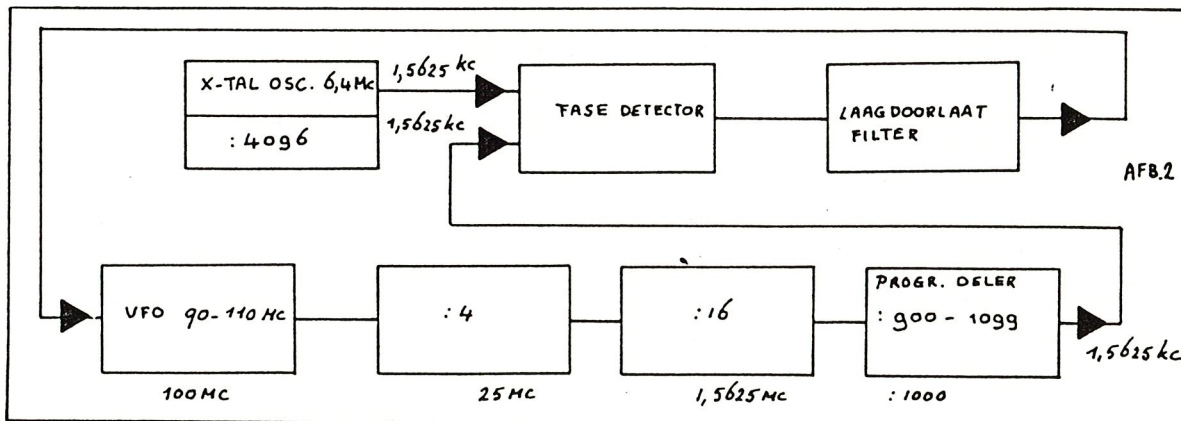
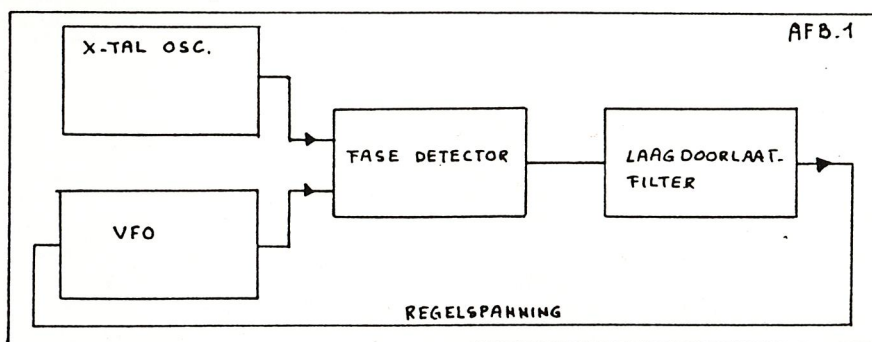
het verloop van de osc. is dan ook nooit groter dan de afwijking van de x-tal osc. en deze is zeer gering. Onder normale omstandigheden niet meer dan 500 Hz. Daar het freq. bereik van de 4046 beperkt is, moet het VFO signaal eerst worden gedeeld, om in het werkgebied van de 4046 te komen. Nu zijn we er nog niet, want we willen ook nog van freq. kunnen veranderen, zonder elke keer een ander kristal te gebruiken.

Daarom het gebruik van een programmeerbare deler (CD4059). Dit is niet de goedkoopste oplossing, maar wel de eenvoudigste en de kleinste. Bij gebruik van losse instelbare delers heb je al gauw een stuk of zeven IC's nodig en daardoor een grotere print. De instelling van de progr. deler is trouwens ook minder kritisch.

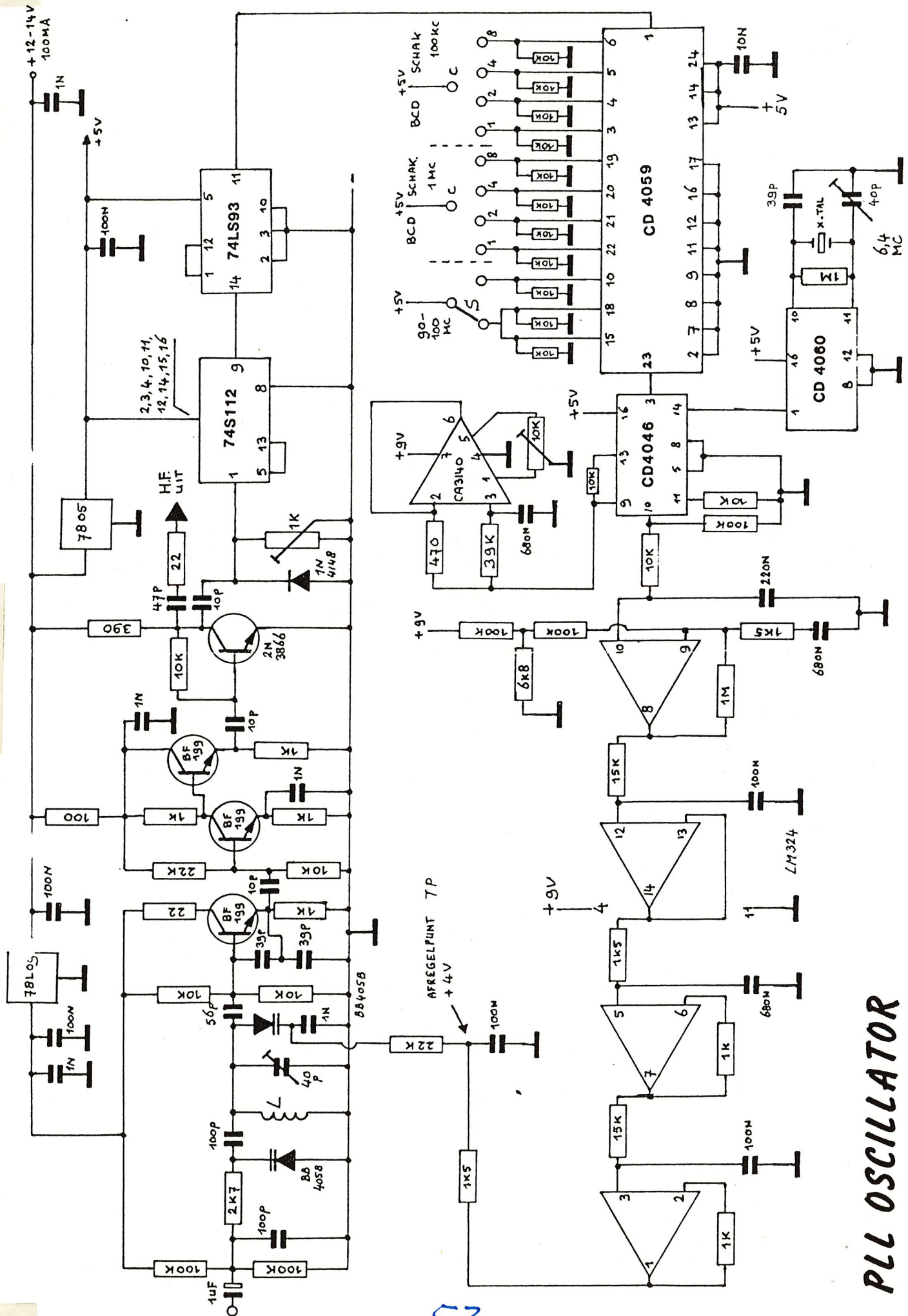
Dit was dan wel zeer beknopt de werking van de PLL, en wie hierover meer wil weten, kan ik verwijzen naar de volgende boeken: "Transistorhandboek Deel 4" waarin div. schakelingen met PLL-IC's en progr. delers; en "The Radio Amateurs Handbook 1982" waarin een complete 2-meter PLL zender staat met dezelfde CD4046.

De hier beschreven PLL osc. werkt als volgt (zie schema):

De VFO is bijna gelijk aan de VFO uit FRM Sept. 1982. De ingang is aangepast aan gebruik met een stereocoder en de uitgang heeft een extra aftakking naar de eerste deler; de 74S112. Deze deelt het signaal door 4 en hierna volgt nog een 16-deler en de programmeerbare deler. Wanneer we met de BCD-akelaars een freq. instellen van 100 MHz. krijgen we bij een osc. signaal van 100 Mc de volgende freq: $100 \text{ Mc} : 4 : 16 : 1000 = 1,5625 \text{ kHz}$. Dit signaal gaat naar de fasevergelijker en wordt vergeleken met een x-tal osc. signaal. Hiervoor gebruiken we de CD4060 met een kristal van 6,4 MHz. en de uitgang : 4096, wat ook weer gelijk is aan 1,5625 kHz., zodat de lus nu rond is. (zie afb. 2).



Bij ongelijkheid van de signalen geeft de 4046 een regelspanning af, waarmee we een varicapdiode in de VFO besturen, die ervoor zorgt, dat de VFO weer op de goede freq. wordt gezet. Het enige moeilijke aan de hele schakeling is het verwerken van het regelsignaal. Dit signaal moet worden versterkt om een zo groot mogelijk regelbereik te krijgen, en het regelsignaal zelf moet worden uitgefilterd, omdat dit anders hoorbaar is.

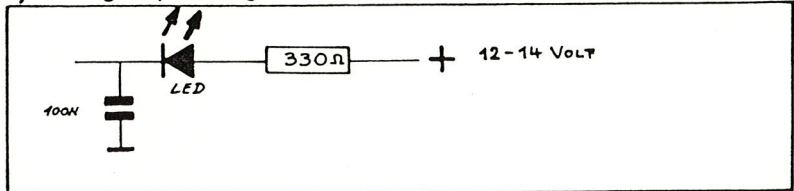


PLL OSCILLATOR

STEREOCODER VOOR ZELFBOUW - A. Debels

Na het voorgaande theoretische betoog storten we ons meteen maar in de praktijk: we hebben om te beginnen twee signalen nodig, één van 19 kHz. en één van 38 kHz. We gebruiken (ultraard) een kristaloscillator met een goedkoop en overal te verkrijgen kristal van 7,6 MHz. en de 74LS00 voor de oscillator. Hierna delen we door 100 met de 74LS390 en vervolgens krijgen we een dual flip-flop, de CD 4027 waaruit we dan de vereiste 19 kc en 38 kc draaggolven halen.

Omdat de 74 IC's op 5 Volt werken, zijn er een zenerdiode van 5 Volt en een weerstand van 390 E in de voedingsleiding opgenomen. De zener is eigenlijk niet nodig, maar er wordt nogal wat afgeprutst in dit landje en met alleen een weerstand gaan bij te hoge spanningen de TTL IC's zeker stuk. Voor de zelfverzekeren is er nog een andere oplossing: Als de coder onder spanning staat, gaat het LEDje branden -meteen een mooie aan/uit indicatie- echter de voedingsspanning mag absoluut niet boven de 14 Volt komen.



Daan de ingangen: slechts 1 x de 741 per kanaal voor zowel de pré-emfase als het 19 kc filter, plus nog een extra 741 voor het DC niveau, wat van linker- en rechter kanaal gelijk moet zijn en is in te stellen met een 10k instelpotje.

Verder hebben we nog een schakelaar: de CD 4066, welke het MPX-sigitaal levert. Hierna gaan we er r zorgen, dat we ook nog kwaliteit krijgen, want de meeste in de handel zijnde stereocoders houden het nu wel voor gezien en proppen dit MPX-sigitaal + het 19 kc sigitaal meteen in een uitgangstrapje d.m.v. een transistor of een opamp met de bekende ellende: fluiten, piepen, ruisen en vervormen. Want zowel het 19 kc sigitaal als het MPX sigitaal moeten eerst uitgefilterd worden om deze fluitjes e.d. te voorkomen. Zomaar een R-C filter heeft geen zin, want voor een behoorlijke kanaalscheiding hebben we fasegelijkheid van beide kanalen nodig. Het 19 kc sigitaal gaat door een R-C filter waarvan 1 weerstand als instelpotmeter is uitgevoerd, waarmee fasedraaiing kan worden gerealiseerd.

Het 38 kc filter is een L-C filter. De spoeltjes zijn van het merk Toko, maar daar deze toch niet overal verkrijgbaar zijn, kunnen de IPS printen met de 2 spoeltjes geleverd worden. Na de filters nog een som-versterker + impedantie-omzetter, zodat de coder probleemloos met een stukje afgeschermd kabel aan de oscillator gekoppeld kan worden.

Let echter op in het modulatiegedeelte van de oscillator kan weer faseverschuiving optreden! Met het schaamrood op de kootjes moet ik bekennen, dat ik een volle dag op zoek ben geweest naar een fout in de coder, omdat ik slechts een kanaalscheiding had van ca. 10 dB, terwijl dit geheel te wijten was aan de modulator. IPS heeft in het verleden ook stereocodermodule verkocht van een zeer goede kwaliteit met een kanaalscheiding van maar liefst 55 dB. Maar ook over deze coders kwamen klachten, die allen terug te voeren waren tot de modulator, vandaar hier nog even een schema voor een modulator, welke goed voldoet met bijna elke stereocoder (mits er filters inzitten). (Schema modulator pag.36).

KOMPONENTEN.

WEERSTANDEN 1/4 W.

1 x 1 E of draadbrug
3 x 390 E
1 x 470 E
2 x 560 E
1 x 1 k instelpot
1 x 1k8
1 x 3k3
2 x 8k2
1 x 10k instelpot
2 x 10k
5 x 12k
1 x 15k
1 x 25k instelpot
5 x 33k
2 x 47k
1 x 82k
1 x 150k
1 x 220k
2 x 560k
1 x 680k

HALFGELEIDERS:

1 x 74LS00
1 x 74LS390
1 x CD 4027
1 x CD 4066 of 4016B
4 x uA 741
1 x TUN
1 x Z 5,1 Volt

DIVERSEN:

1 x 18 mH
1 x 33 mH
1 x X-tal 7,6 MHz.

CONDENSATOREN:

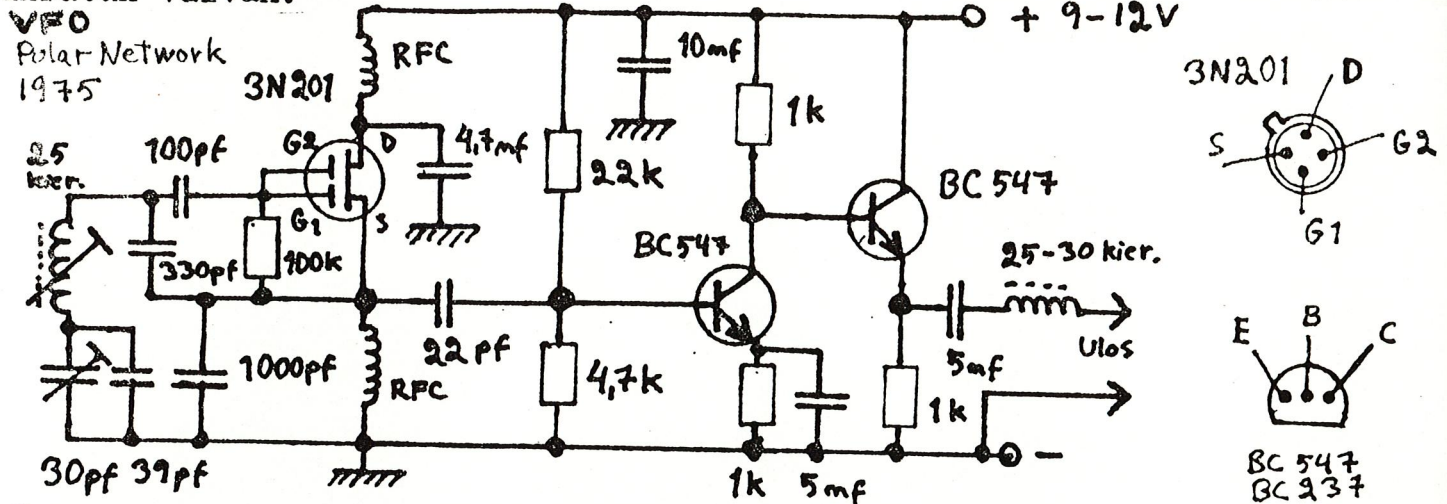
1 x 40 pF folietrimmer
1 x 47 pF styroflex
1 x 100 pF "
1 x 150 pF "
4 x 470 pF "
2 x 1N2 MKT
1 x 3N3 "
3 x 10 N ker.
1 x 15 N MKT
1 x 22 N "
1 x 100 N ker.
2 x 2,2 uF/25 V. printelco
2 x 4,7 uF/25 V. "
1 x 250 uF/6-10 V. "



- PILOOTTOON SINUSVORMIG, THD 11%, BINNEN 8 Hz.(onafgeregeld)
- PRE-EMFASE 50 μ SEC. TOT 12 kHz.
- FILTERING 19 kHz. UIT AUDIO ca. -2 dB
- SIGNAAL/RUISVERHOUDING ca. 70 dB
- 38 kHz. DRAAGGOLFONDERDRUKKING BETER DAN 40 dB
- SIGNALLEN BOVEN 53 kHz. MEER DAN 19 dB DOWN!
- OVERSPRAAKDEMPING NA AFREGELING BETER DAN 40 dB.

(Red.: ASSH heeft met deze advertenties of de artikelen van Alfred Debels helemaal niets te maken. Het heeft dus geen enkele zin hen daarover te benaderen).

Tämä Polar-Networkin vuonna 1975 kehittämä VFO on helpohko rakentaa, käyttövarma, stabiili, ja vielä halpakin... Sitä käyttämällä pääset aina vapaalle kanavalle. VFO on lyhenne sanoista "variable frequency oscillator" eli säädettävä taajuuksinen oskillaattori. Se synnyttää lähettimen tarvitseman suurtaajuuden värähtelyn joka sitten sopivasti vahvistettuna ohjaa lähetintä halutulla taajuudella. Normaalistihan suurtaajuuden synnyttämiseen käytetään halutulle taajuudelle leikattua kidettä jollaisten hankkiminen voi olla vaikeaa ja kallista. Kiteiden hankkiminen monille varataajuuksille muodostaisi melkoisen investoinnin joten VFO kyllä maksaa takaisin siihen uhratun vaivan.



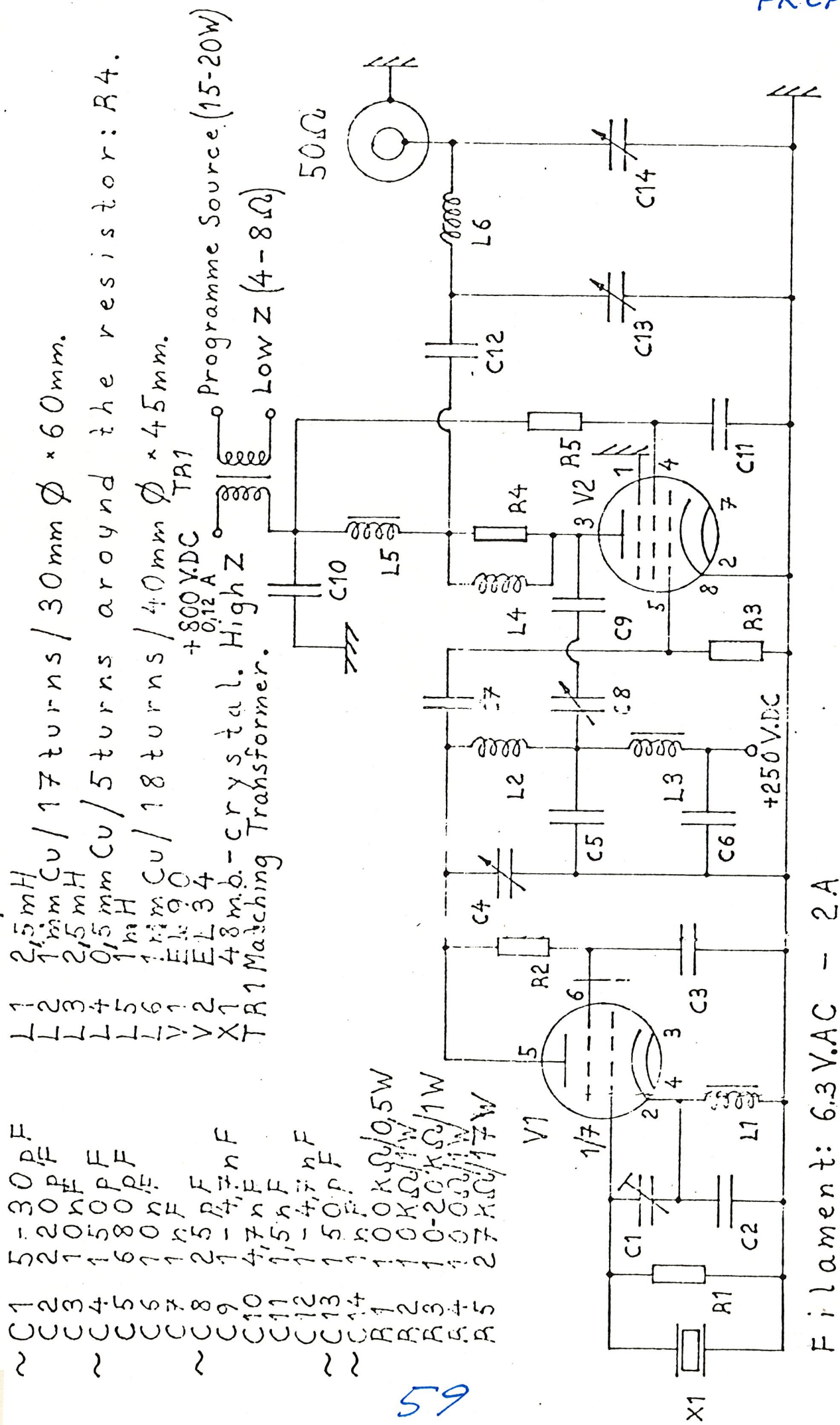
Koko laitteen hienous piilee ensimmäisessä transistorissa joka on diodi-suojattu kaksoiskanta-MOS-FET. Tämä VFO on erittäin stabiili, käyttöjännitteen pudotus 12:sta 9:ään volttiin ei vaikuta yhtään taajuuteen. Tämä johtuu transistorin suuresta sisäisestä vastuksesta ja suojauksessa käytetyistä zener-diodeista.

Tämä on syytä rakentaa metallikoteloon ja painokytkentälevyn käyttö on suotavaa. Osat on kiinnitettävä erittäin tukevasti paikoilleen ettei taajuus vaihtuisi esim. kotelon kolahtaessa johonkin. Koko VFO:n toiminta riippuu ensimmäisen transistorin ympärillä olevien osien laadusta. Niitä hankittaessa ei ole syytä pihistellä. Käytettävien 330 ja 100 pf kondensaattorien täytyy olla erittäin pienihäviöistä styroflex tyyppiä, muuten homma ei suju. Kela käämitään 0,3-0,5 mm paksusta emalieristeisestä Cu-langasta n. 25-30 kierrosta vierä vierä ferriittisydämellä varustetun kellarungon päälle. Taajuuden karkea säätö suoritetaan ferriittisydämellä, loppusäätö käytettäessä tehdään säätökondensaattorilla jollaisten voi löytää esim. jostain vanhasta ula-radiosta. Kuristimet (RFC) voi tehdä itse käämimällä 1 Ma:n (1W) vastuksen ympärille paljon ohutta Cu-lankaa ja langan päät juotetaan vastuksen johtimiin. Oskillaattoritransistorin johtimiin liimataan pienet ferriittihelmet jotka toimivat ula-alueen kuristimina. Koska VFO kehittää harmoonisia on näitä helmiä käytettävä jotta välttyttäisiin ikäviltä häiriöiltä ula-alueella. Oskillaattorin jälkeen kytkennässä on tasavirtakytketty vahvistinaste jonka transistoreiksi käyvät monet NPN tyyppiset joiden rajataajuus on suurempi kuin 200 MHz, eli BC 547, BC 237, BC182 jne. Tämän vahvistimen jälkeinen ulostulo riittää yleensä ohjaamaan lähetintä siitä kohdasta missä normaalisti olisi kide. Kuitenkin käytännössä saattaa olla niin että lähettimen kytkentää joudutaan muuttamaan poistamalla kondensaattorit putken sisäänmenopiiristä välillä hila-katodi ja katodilta maahan kytkettyä kondensaattoria voidaan suurentaa. VFO:n vahvistimen ulostulossa on kela jolla laite saadaan sovitettua paremmin putken sisäänmenoon. Kela viritetään resonanssiin taajuudelle joka on vähän suurempi kuin suurin suunniteltu toimintataajuus. Resonanssitaajuutta suuremmat jaksot vaimenevat. Oskillaattori viritetään esim. 6300 kHz:lle ja kytketään lähetin päälle ja viritetään kela niin että ulostulo on maksimissa. Kun resonanssitaajuus on saavutettu heikkenee ohjaus voimakkaasti, silloin sydäntä kierretään vähän takaisin päin ja voidaan lukita siihen. Huom.: Viritys aloitetaan ferriitti kokonaan ulos kierrettyinä, sitä kierretään vähitellen sisään päin.

Jos käyttöjännite putoaa alle 9 voltin niin ulostulo eli lähettimen ohjaus heikkenee. Tämän jännitteen voi yrittää ottaa putkien 6,3 V hehkujännitteestä tasasuuntaus-siltakytkennän ja 1000 pf:n elkon avulla jolloin tasajännite on n. 9 voltia.

40-60W

FRCF '88



Filament: 6.3 V.AC - 2A

$\Delta f_c: 2.5 \text{ mHz}$ in
 Kuristin.
 $5 \times 25 \text{ k}$, 0.2 mA Cu
 1 MA massa vast.
 umõõrille.

Modulaattoriksi kelpaa mikä tahansa putki- tai transistorivahvistin n. 15-30 watin väliltä. Mikäli verkkoinvertteriä käytetään, kannattaa rakentaa tx'n ja invertterin muuntaja yhteiseksi.

- Modulaatiomuuntajaksi käy vanhan putkiradiion tms kovaäänismuuntaja.Modulointi siihen missä ennen oli kaiutin ja jonka imbedanssi on noin 4-8 ohmia
- Kiteen tilaus on helpointa tehdä lähettämällä IODM setelin osoitteeseen:Wuttke Quarze,Hainerwegg 27I 6000 Frankfurt/M.70 FRG.Kiteitä on saatavilla mm.6200;6206,7;6225;6240;6250;6273,3 ja 6275kHz. Päätekelaa vaihtamalla päästään myös muille,kuin 6.2-6.3MHz alueille.

Oskillaattoriputken anodilla on myös mahdollista käyttää rinnakkaisresonanssiipiiriä, jolloin saadaan suurempi ohjaus pääteputkelle.

Kaaviossa esitettyä viritysmittaria voi käyttää vain taittodipolin kanssa. Puoliaaltodipolilla mittari nousee välittömästi tappiin. Mikäli taittodipolilla mittari ei näytä kovin suuria lukemia vaikka tx on vireessä voidaan käyttää esim. OA90 diodia, jolloin IOOuA'n mittari näyttää lähes täyttä lukemaa kun ulostuloteho on max. I5-tai jopa I8W riippuen siitä, että käytetäänkö EL84-tai EL 86 putkea.

DIPOLI: 1:1 BALUN

Pituus: 2.095

DIPOLI: 1:1 BALUN

Pituitary: $\Delta = 0.95$

Pituitary: $\Delta = 0.95$

~~60 Ω (50 Ω)~~

koaksiaalikaapeli

I:I balun

1: ei o

1: ei o

3002 121
3400 TWIN LEAD 2* 1148m

...

← Balun

三

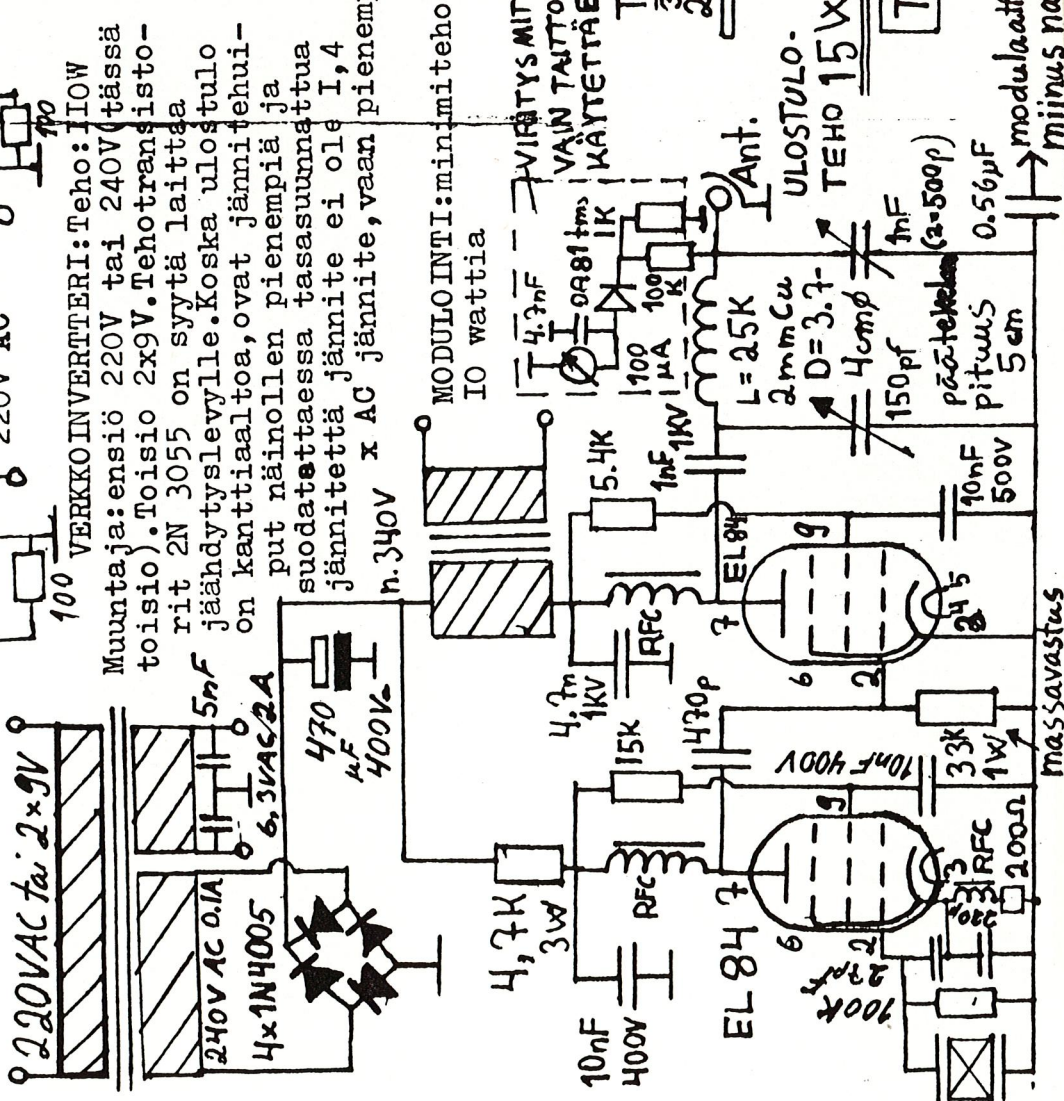
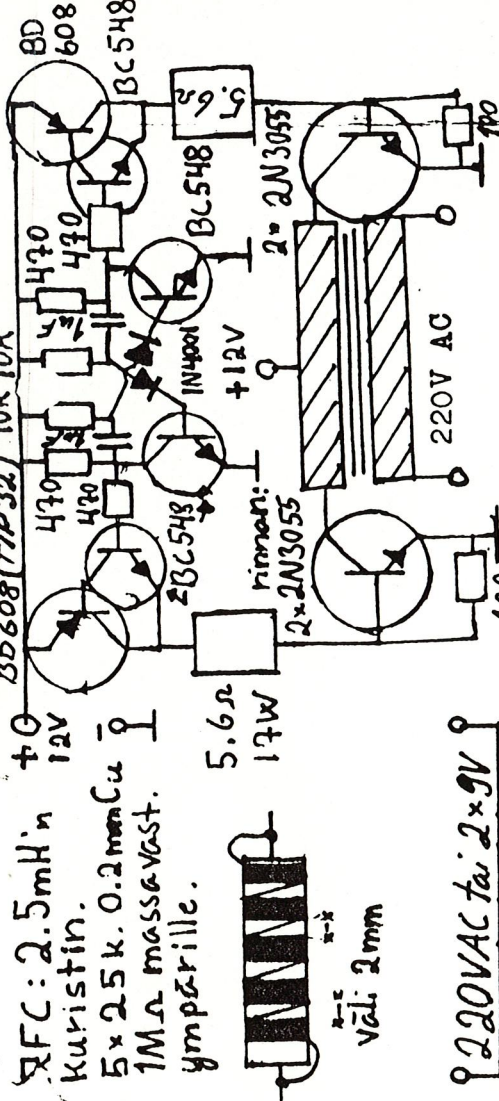
752 + 01
609

koaksiaali:

Kaapeli

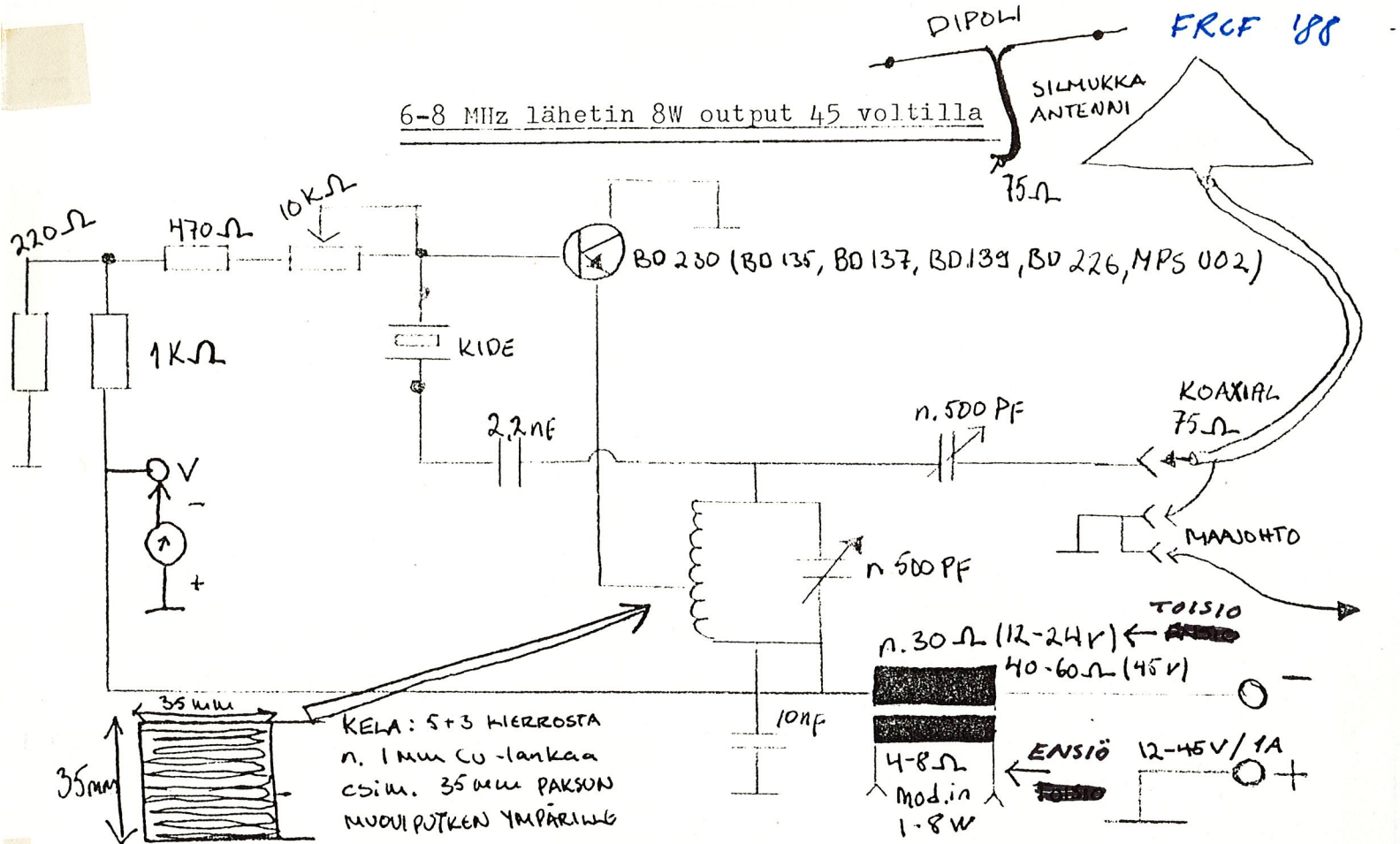
\$-\$.4:I balun käämitään 36mm viol.
toroidi-rungolle joita myy mm.Yleiselek-
troniikka Oy.I0 kierrosta ImmCu.2-lankaa.

toroidi-rungolle joita myy mm. Yleiselektroniikka Oy. IO kierrosta ImmCu.2-lankaa.



massavastus

6-8 MHz lähetin 8W output 45 voltilla



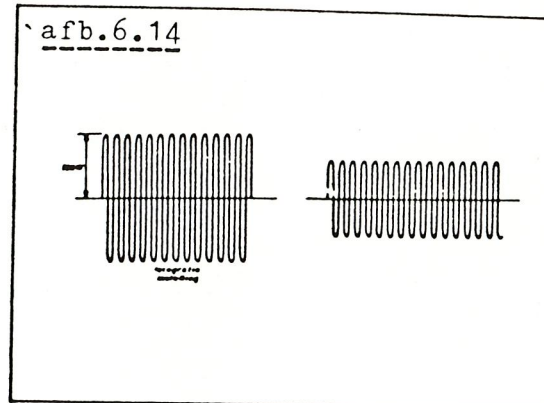
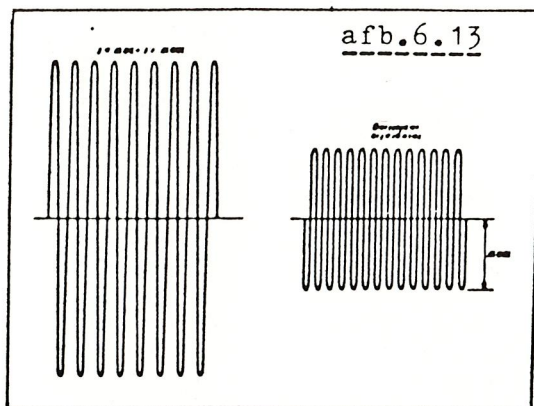
Laite on plussarunkoinen joten transistori jäähdytyslevyineen voidaan kiinnittää ilman eristeitä esim. metallikoteloon joka voi samalla toimia jäähdytyslevynä (lisä) sillä transistori tarvitsee hyvän jäähdytyksen. BD 230 on kestävin mutta pienemmällä käyttöjännitteellä voi muutakin transistoria käyttää mutta silloin saadaan tehoa vähemmän ulos. Modulaatiomuuntajan toisio pitäisi olla vähintään 0.3 mm Cu-lankaa mieluummin ohuempaa esim. 0.4-0.5mm. Käämin vastus saisi olla enintään ohmimittarilla n. 30 Ω jos käytetään 45 V jännitettä, pienemmällä jännitteellä se saisi olla hiukan pienempi. Jos käämin vastus on pieni, voi transistori tuhoutua helpommin ja jos vastus on suuri, ei tehoa saada ulos niin paljon. Lähettimen voi virittää siten että säädetään 500pf kondensaatteja kunnes jännite pisteessä V on suurimmillaan. Näin viritettynä laite ei saisi ottaa virtaa yli 0.45 A (45 voltilla). Sen voi säätää 10 k trimmerillä johonkin 0.4 A:han. Pienemmällä käyttöjännitteellä virta ei ehkä nousekaan noin korkeaksi. Virittämättömänä laite ottaa hiukan enemmän virtaa, ehkä noin 1 A, joten virtalähteen pitää olla tarpeeksi tehokas. **Lähetintä ei saa pitää kauan päällä virittämättömänä!** Tuo 10 k potikka voi olla myös 4.7 k. **Se asetetaan kes-**
kiasentoon ennen ensinmäistä kokeilua! Jos laitetta kytketään päälle ja pois kytkemällä tuota 12-45 V jännitettä, syntyy kytkentähetkellä jännitepiikkejä jotka saattavat vioittaa modulaatiovahvistinta joten kytkentä olisi paras suorittaa virtalähteen verkkojännitteellä tai varminta olisi ottaa modulaatiovahvistin irti muuntajasta kytkentähetkellä ja sammuttaessa.

Antenniksi dipoli on hyvä esim. 2x11.45 m 48 mb:lle. Myös kokoaallon silmukka on hyvä. Esim 47-49 m lankaa kolmion tai melion muodossa ja syöttöjohto 75 coaxiaalilla keskijohdon langan toiseen päähän kiinni ja toinen vaippa toiseen. Kiteitä voi tiedustella osoitteesta: Wuttke-Quarze, Hainerweg 271, 6000 Frankfurt /M 70, Länsi-Saksa. [redacted] kiteitä määrätuille taajuuksille 10 DM kappale: 6225, 6240, 6237,3, 7316, 7325, 7366, 7373. Lisäksi kiteitä voi tiedustella [redacted]

Tämä lähetin toimii hiukan kiteen taajuuden alapuolella. Noin 1-5 KHz, kiteestä riippuen. Sopivin kidetyyppi tähän on FT-243.

Finnish Free Radio
FM 96 MHz & SW
RIGHT-WING RADIO
P.O. Box 22 03 42
D-5600 Wuppertal 22
West Germany

HYVIN YKSINKERTAINEN, MUTTA TE HUKAS
KITEITÄ MYÖS [REDACTED] HINTAAN 40 MK/KPL



Als we nu bij 100% modulatioestand zijn aangeland -de amplitude van de draaggolf is dan twee maal zo groot als die in ongemoduleerde toestand- en we gaan L.P. modulatie toe- passen, dan moeten we de P.A. in niet-gemoduleerde toestand zodanig instellen, dat de RF-amplitude in de antenne op 25 à 30% komt te staan van de waarde, die we bij telegrafie -con- tinu maximaal vermogen- zouden instellen. De energie be- draagt dan ongeveer een kwart van de nominale.

We kunnen dit bereiken door de toegevoerde RF-sturing op et rooster van de P.A. buis terug te nemen.

Gaan we in rooster- of in remrooster moduleren, dan kunnen we met weinig AF-vermogen toe. Dit geeft een besparing, maar helaas wel ten koste van de uitgestraalde energie.

Slechts bij 100% modulatie levert een P.A. zijn maximaal mo- gelijke energie, die zoals we dan nu heel duidelijk kunnen zien inderdaad het 4-voudige is van de waarde in ongemoduleerde toestand. Wat we dus eigenlijk nooit anders dan met CW kun- nen bereiken.

De L.P. modulatiemethode komt tot maximaal -en dan zit alles wel erg goed in elkaar- 70 à 80% van de theoretisch bereikba- re vermogenswaarden.

Met nog een kleine toelichting voor afb. 6.13 en 6.14 waarin de grafiek van 6.13 aangeeft dat indien men een zenbuis perma- nent 100 Watt kan leveren, als hij wordt gebruikt als telegrafie- zender, deze buis 150 Watt zou kunnen leveren -slechts bij de 100% modulatie- bij modulatie vanuit een AF-modulator. Links zien we de telegrafie-instelling en rechts de AM-instelling.

De grafiek in 6.14 geeft de situatie aan indien deze buis deze 150 Watt niet zou kunnen verwerken omdat de maximum dissi- patie wordt overschreden.

Inplaats van meer vermogen -door AF-insturing- te krijgen, moeten we dat vermogen reduceren tot 30%.

Ook hier links de telegrafie-instelling en rechts de AM-instel- ling.

GEERT - ASSH.

POSTBUS 360,
1700 AJ HEERHUGOW.

MIDDENGOLFZENDER 50-130 Watt.

Alvorens aan de categorie "enge schema's" te beginnen, eerst even een kleine inleiding van de redactie: na veel aandringen plaats ik op de pagina hiernaast dan een MG-schema, maar wel onder het nodige voorbehoud. Zoals onderhand wel bekend is, is kennis op het gebied van buizen hier miniem en de enige, die

hieromtrent om raad kan vragen is Nico Peeters van Asian E-lectronics. Enkele andere buizenschema's, die ik eerder toege- stuurd kreeg werden door hem afgekeurd, maar volgens Nico is dit wel een aardig ontwerp, alleen vraagt hij zich af, waar bij deze zender de modulatie vandaan moet komen. Het schema

heb ik door Alfred laten uittekenen en die viel het op, dat er bij de buizen geen aansluitgegevens zijn vermeld. Ik hoop dus, dat de MG-zelfbouwers er uit komen. Naam en adres van de In- zender zijn mij bekend, maar deze wilde niet, dat die gegevens in het blad vermeld werden, dus lijkt het me 't beste, dat diege- nen, die vragen hebben omtrent dit schema een brief onder nummer "MG 2-83" sturen naar de postbus van het F.R.M. ver- gezeld van een retourpostzegel. Die brieven zal ik dan doorstu- ren en dan hoop ik dat de inzender van dit schema er de nodige antwoorden op kan geven. Zelf heeft hij ook nog enkele vragen, die hieronder aan de orde komen. Misschien dat Geert van ASSH hierover de volgende keer wat kan vertellen en anders een collega-amateur?

José.

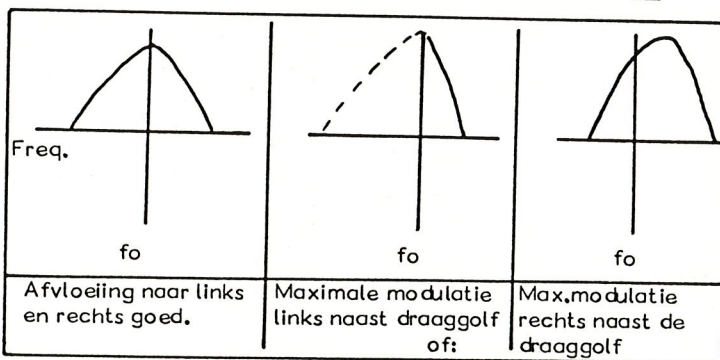
Beste F.R.M.

Hier eens iets van een middengolfer. Ik vind jullie blad heel in- teressant (vooral afdeling techniek). Er staat wel veel in over F.M. maar dat ligt aan onszelf. De middengolfer is vaak een an- der "slag" volk dan de F.M.-er.

Ik bouw regelmatig wel eens een "gestuurde" zender en voeg dus ook een schema bij.

Zelf zit ik met enige problemen. Misschien dat jullie mij infor- matie kunnen verstrekken!!!!

Wat is het zogenaamde "naast de draaggolf zitten met de modu- latie" precies. Hoe ontstaat het en hoe is het te verhelpen?



Vraag B.: Originele middengolfantenne (max. lengte ca. 20 à 30 meter) 50 Ohm / 75 Ohm coaxkabelaansluiting. Hebben jullie daar misschien gegevens van?

KOMPONENTEN.

L1 Ca. 30 wdg. Cul. 0,4 mm. Ø 34 op PVC
L2 Ca. 40 wdg. Cul. 1 mm. Ø 40 " " ; aftakking elke 8 wdg.
L3 Ca. 60 wdg. Cul. 1,5 mm. Ø 40 op keramische vorm (i.v.m. warm worden). Aftakking elke 5 windingen.

Koppelcondensatoren liefst keramisch en de waarden aangege- ven in het schema niet vergroten i.v.m. frequentiestabiliteit.

Buffer afstemmen op max. uitgangsvermogen v/d eindtrap. Eindtrap eerst afregelen C1 op min. anodestroom, dan C2 op max. vermogen i/d antenne bij een bepaalde spoellengte (met schakelaar spoel verkorten of verlengen tot max. vermogen bij minimale anodestroom.)

Oscillator, buffer en eindtrap goed afschermen!!!!!!

A circuit diagram showing a 150 ohm resistor connected in series with a 0A2 vacuum tube. The resistor is represented by a rectangle with the value '150' above it. The vacuum tube is represented by a circle with a small circle inside, and the label '0A2' is written above it.

**SPOELEN EN CONDENSATOREN LIEFST HAAKS OP
ELKAAR i.v.m. BIJWERKINGEN ZOALS SLECHTE
AFVLOEIING ENZ.**



Scherstroospanning:

300 V.

300 V.

275 V.

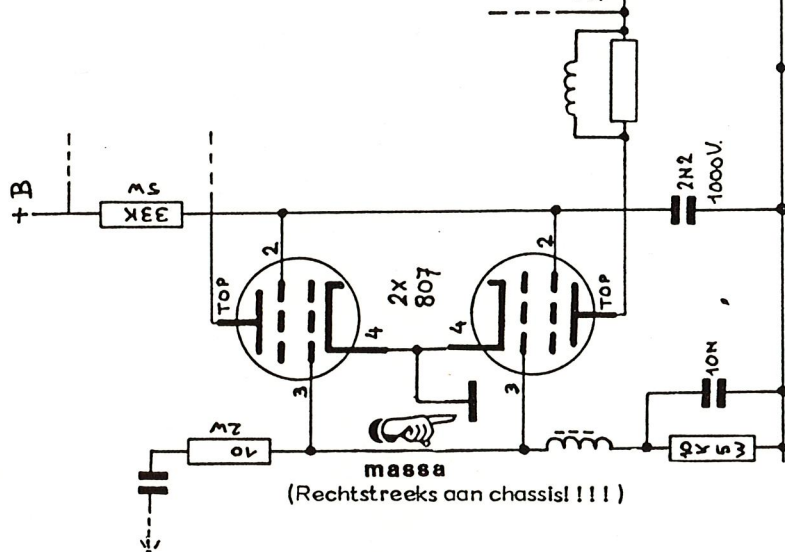
Opgegeven vermogen (50 – 130 W.) Is het nuttig vermogen!

FRUF '88

AANVULLING MG-ZENDER uit FRM 2-'83

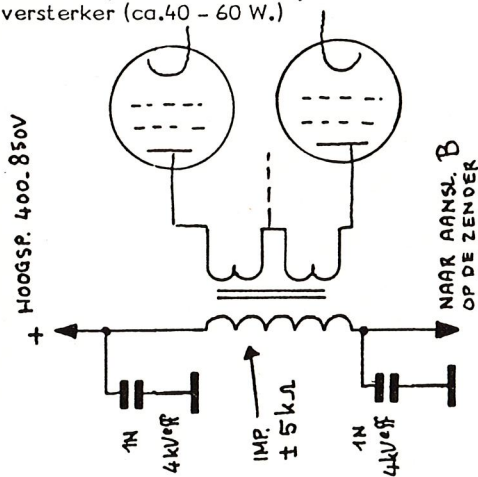
EINDTRAP

(Hierin zat een grove tekenfout rooster niet aangesloten)



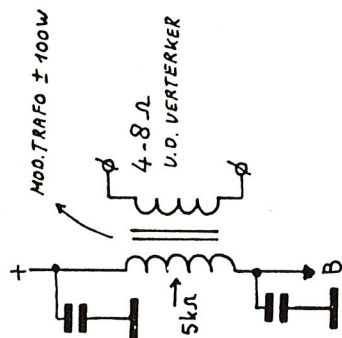
MODULATIE

Balanseindtrap met bv 2 x EL34, 2 x 807 v/d versterker (ca. 40 - 60 W.)



Modulatiesoort: anode/schermerroostermodulatie (Zie ook pag. 40)

Bij gebr. transistor/buizenversterker met 4/8 Ohm uitgang een modulatie trafo van 4/8 Ohm naar 5 kOhm secundair plaatsen

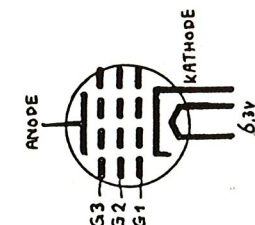
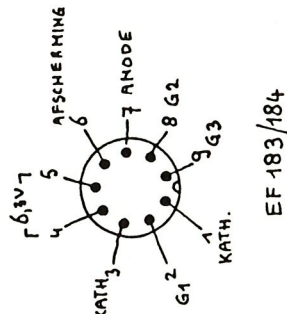
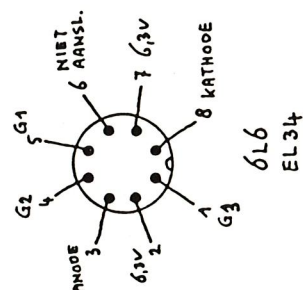
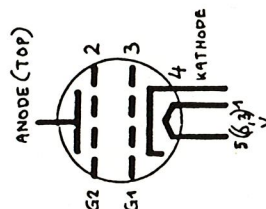
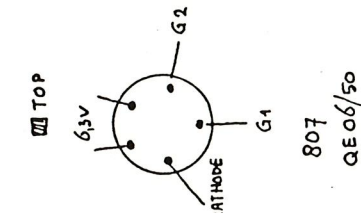


ENIGE BEDRIJFSWAARDEN:

Osc. 1 Anode EF 183 → 8,3 mA bij $U_a = 165$ V, DC
 Buffer: 1 " 6L6 GWB → 40 mA bij $U_a = 330$ V, DC
 Punt C bij optimale aanpassing buffertrap op eindtrap:
 → - 105 V (500 V → + U_b eindtrap)
 → - 95 V (800 V → + U_b eindtrap)
 Voedingsspanning eindtrap 8
 1 anode eindtrap van 2 x 807: 225 mA; Ig2 (schermerrooster) eindtrap van 2 x 807: 21 mA. Schermerroosterspanning 385 V. Pop = 800 V x 225 mA → 180 W. → $P_o \approx 110$ Watt.
 Pd iss anode ≈ 180 - 110 W. = 70 W. - 35 W. per buis. keramisch
 Condens. 1000V/polyester, tenzij anders vermeld. Koppelc's 100 pF

BUFFERTRAP: Spoel L2: de aftakking op deze spoel naar de eindtrap (via C - 100 pF) hoeven we niet variabel te maken en we kunnen deze ook op ca. 15-25 w dg. v/d "koude kant" van L2 zetten.

De weerstanden in HF-leidingen liefst van het type koolfilmweerstand nemen!



AANSLUITGEGEVENS VAN DE BUIZEN

100 Watt medium wave transmitter

FRCF '88

RESISTORS - all $\frac{1}{2}$ watt unless stated

R 1 15K 1W
R 2 22K
R 3 18K 10W
R 4 15K
R 5 220 3W
R 6 33
R 7 33
R 8 15K 10W

CAPACITORS

C 1 0.1 mfd 450v
C 2 0.01 mfd 450v
C 3 30pf 50v
C 4 200pf 50v
C 5 0.001 mfd 500v
C 6 0.1 mfd 50v
C 7 0.01 mfd 600v
C 8 0.01 mfd 1Kv MICA

VC 1 500pf (wide spaced)
VC 2 1000 pf

VALVES

V 1 6V6 = EL 84
V 2 807
V 3 807

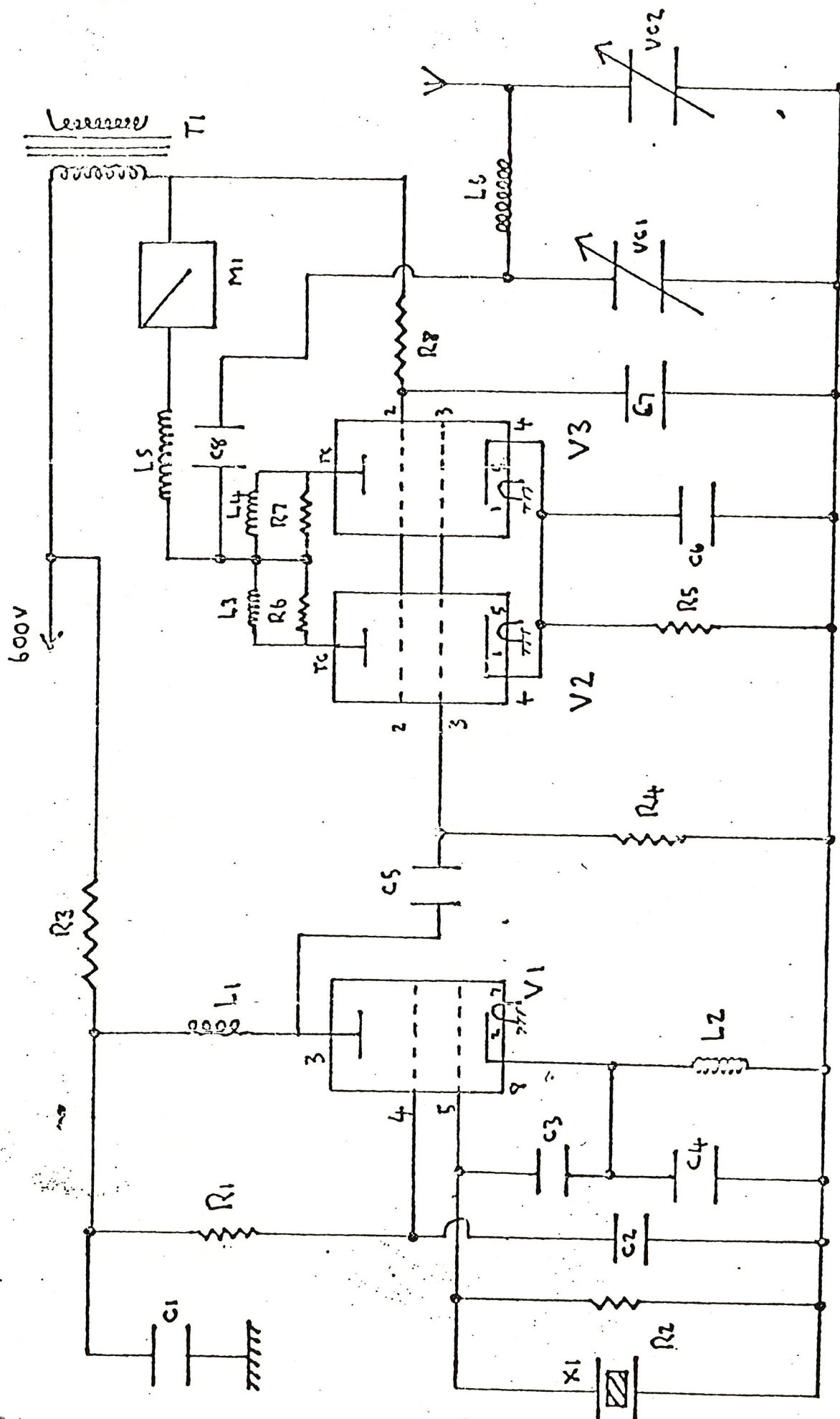
COILS

L 1 2.5 mH RF Choke
L 2 2.5 mH RF Choke
L 3 6 turns 22 swg en. cu. wire round resistor
L 4 6 turns 22 swg en. cu. wire round resistor
L 5 2.5 mH 500 mA RF Choke
L 6 70 turns 22 swg en. cu. wire round $1\frac{3}{4}$ " former. Tapped at 40 turns and then every 5 turns.

4,46cm

MISCELLANEOUS

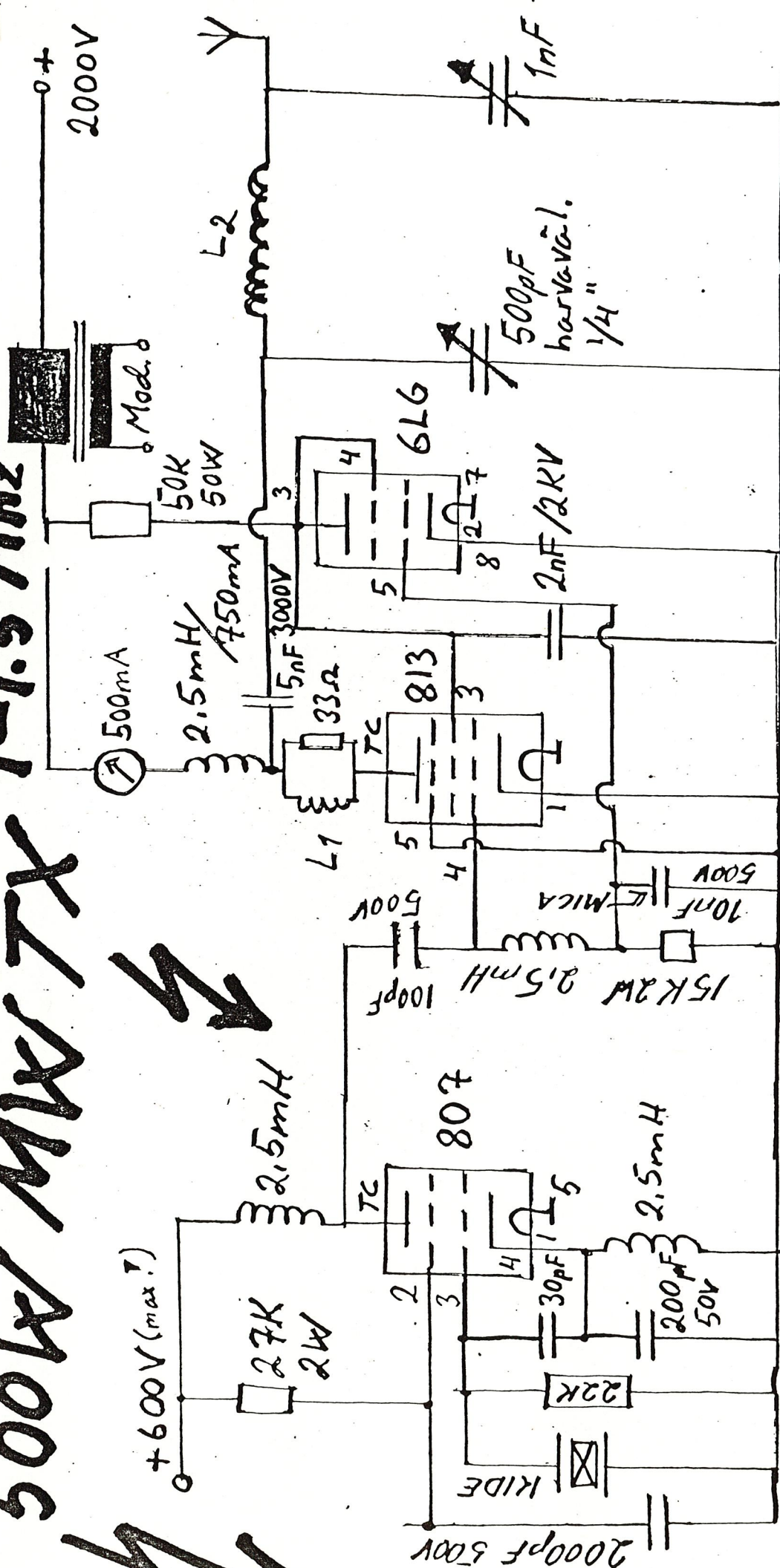
M 1 300 mA meter
X 1 medium wave crystal (1 MHz - 1.5 MHz)
T 1 modulation transformer (Woden UM 2 or similar)











L1: 6 bierr 18 swg (1.3 mm Cu) 33 Ω Vastuksen ymp.

L2: 60 kierr. 18 swg. 2" Ø rungolle. 40 kierr. jonka jälk. väliälosotto
joka 5. kierros!

Finnish Free Radio
FM 96 MHz & SW
RIGHT-WING RADIO
P.O. Box 22 03 42
D-5600 Wuppertal 22
West Germany

FRCF '88

67

FM Aerials: Construction Plans.

These plans include details for the construction of antennas suitable for the FM broadcast band. Their is nothing magical about their design, just basic rules governing the construction of antenna systems. They can therefore be modified to work at other frequencies as well. They work equally well for the transmission of AM, FM, PM, PCM, and CW.

BASIC RULES:

- (1) An antenna and its transmission line should have the same value of impedance.
- (2) A half-wave dipole antenna has a nominal feed impedance of 75 ohms.
- (3) Two similar antennas connected in parallel have 1/2 of the normal impedance.
- (4) Generally, the effective power increases directly to the number of antennas used.
- (5) An effective power gain in one direction results in a power loss somewhere else.
- (6) There is always a loss of power in a transmission line.
- (7) The smaller the size of a transmission line, the greater its loss.
- (8) A 1/4 wavelength of transmission line can act as an impedance transformer.
- (9) A 1/2 wavelength of transmission line exhibits the same impedance at both ends.
- (10) A 1/4 wavelength of transmission line can act as an RF decoupler.
- (11) A 1/4 wavelength of transmission line delays a signal by 90 degrees (1/4 cycle).
- (12) Radio waves travel at the speed of light through space (and air).
- (13) Radio waves travel slower over wires and through cables.
- (14) A super low VSWR is not needed, a VSWR of 1.5 or even 2 to 1 is acceptable.
- (15) A 100 foot piece of RG-8 coax allows only 63% of the power to reach the antenna.
- (16) A 100 foot piece of RG-59 coax allows only 50% of the power to reach the antenna.
- (17) Radio waves travel at .66 light speed through cables with "poly" insulation.
- (18) Radio waves travel at .82 light speed through cables with "foam" insulation.
- (19) Radio waves travel at .95 light speed over large wires (pipe, etc) (uninsulated).
- (20) Radio waves travel at light speed over very thin wires (uninsulated)

The above are simple rules that do contain exceptions. But for our purposes they will do just fine.

ANTENNAS DISCUSSED

Simple Stacked Vertical Dipoles	(Vertical Polarization)
Inverted Vee Antenna	(Horizontal Polarization - some Vertical)
Half-Wave Phased Collinear	(Vertical Polarization)
Stackable Vertical Dipoles	(Vertical Polarization)
Stackable Horizontal Dipoles	(Horizontal Polarization)
Circular Polarization	

CALCULATIONS:

	Answers for 100 MHz
(1) Wavelength in inches = $11811 / f_{\text{MHz}}$	$11811 / 100 = 118.11$ inches
(2) 1/4 Wavelength (poly) coax = $.66 \times .25 \times$	$.66 \times .25 \times 118.11 = 19.49$
(3) 1/4 Wavelength (foam)coax = $.82 \times .25 \times$	$.82 \times .25 \times 118.11 = 24.21$
(4) 1/4 Wavelength (large wire)= $.95 \times .25 \times$	$.95 \times .25 \times 118.11 = 28.05$
(5) 1/4 Wavelength (thin wire) = $1.0 \times .25 \times$	$1.0 \times .25 \times 118.11 = 29.52$

(6) 1/2 Wavelength (poly) coax = $.66 \times .50 \times$	$.66 \times .50 \times 118.11 = 38.98$
(7) 1/2 Wavelength (foam)coax = $.82 \times .50 \times$	$.82 \times .50 \times 118.11 = 48.43$
(8) 1/2 Wavelength (large wire)= $.95 \times .50 \times$	$.95 \times .50 \times 118.11 = 56.10$
(9) 1/2 Wavelength (thin wire)= $1.0 \times .50 \times$	$1.0 \times .50 \times 118.11 = 59.06$
(10) .8 Wavelength (space or air)= $.80 \times$	$.80 \times 118.11 = 94.49$
(11) 3/4 Wavelength (thin wire) $.75 \times$	$.75 \times 118.11 = 88.58$
(12) 5/4 Wavelength (thin wire) $1.25 \times$	$1.25 \times 118.11 = 147.64$

Above answers "rounded-off" to the nearest 1/8" for 100 MHz

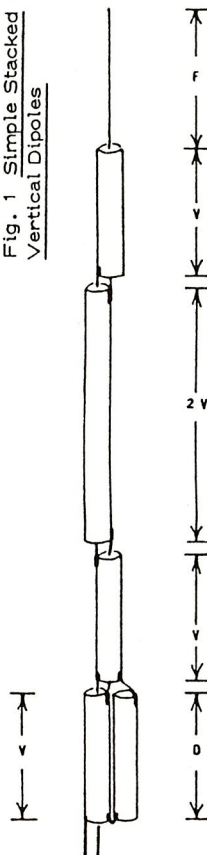
(1) 118 1/8 "	(7) 48 3/8 "
(2) 19 1/2 "	(8) 56 1/8 "
(3) 24 1/4 "	(9) 59 "
(4) 28 "	(10) 94 1/2 "
(5) 29 1/2 "	(11) 88 5/8 "
(6) 39 "	(12) 147 5/8 "

The above calculations have been made for 100 MHz as a "center" frequency for the FM band. For precise results you may wish to do your own calculations for your particular frequency of operation. Simply divide 11811 by your frequency in MHz to obtain your wavelength in inches. Use that figure with the other equations to obtain the necessary dimensions.

SIMPLE STACKED VERTICAL DIPOLES (Fig. 1)

This is a very simple yet effective antenna. It is constructed from lengths of RG-8 coaxial cable. The uppermost radiator is just a small wire of 1/8th inch or less in diameter. It may be soldered to the center conductor of the coax, or you may simply use the inner conductor of the coax itself. You can hold it up straight by attaching a wood splint along its length and securing that splint to the coax below.

Fig. 1 Simple Stacked Vertical Dipoles



The center conductor of one coax is soldered to the outer conductor of the next coax, and so on down to the bottom. The bottom section on the right is a piece of coax with the center conductor cut off completely. It is used as a 1/4 wavelength

"decoupler". This allows the antenna to be fed with an unbalanced transmission line (coax). Without this decoupler the feed coax would also radiate signal and upset the coverage pattern of the system.

When completed the whole thing can be slipped into a section of 3/4" PVC pipe. The top end is covered with a PVC cap glued in place. The bottom end cap has a 5/8" hole drilled through it. An SO-239 connector is fastened into the hole. The antenna is then fed with a 50 ohm coax such as RG-8. The feed impedance is closer to 36 ohms than 50 ohms so the VSWR will be about 1.4 to 1.

If the antenna is free standing or mounted on a wood support the coverage pattern will be omnidirectional (see Fig. C, pattern #1). If the antenna is mounted 1/4 wavelength out from a metal support (such as a tv mast) it will be "shadowed" on the mast side but will show some "gain" toward its front side (see Fig. C, pattern #4).

The antenna itself exhibits a 3 dB gain (2 X power) because of the two dipoles and would have a coverage distance (in respect to a single dipole) similar to Fig. D, pattern #2. If it is mounted 1/4 wavelength out from a metal mast it could give up to a 6 dB gain (4 X power) as seen in Fig. D, pattern #4. The increased distance however is at the expense of lost coverage area in the "shadow" of the mast (Fig. C, pattern #4).

The top dipole consists of two 1/4 wave sections (F) and (V). The top dipole is fed from the bottom dipole by a 1/2 wave transmission line (2V). The bottom dipole consists of sections (V) and (V).

Dimensions (using RG-8 (poly) coax, design frequency of 100 MHz)

F	1/4 wave (thin wire)	29 1/2"	NOTE: If the lowest V section
V	1/4 wave (poly coax)	19 1/2"	is made from foam type coax it
2V	1/2 wave (poly coax)	39"	will be almost as long as the D
D	1/4 wave (large wire)	28"	section for easier connections.

INVERTED VEE ANTENNA (Fig. 2)

Although simple in construction this antenna can get out quite well. Part of its appeal is that it doesn't look like any more than a regular TV mast. You can even have your tv antenna on top without spoiling its operation.

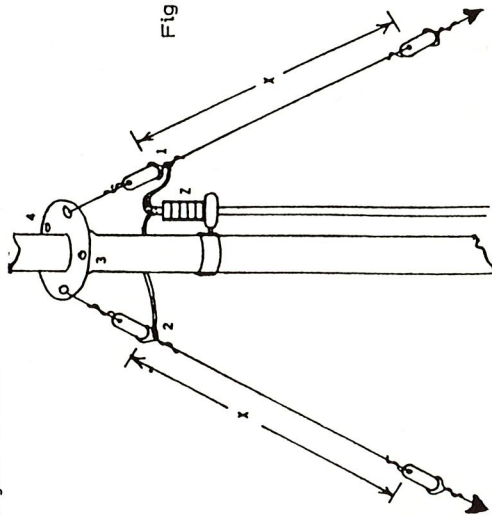


Fig. 2 Inverted Vee Antenna

In its simplest form the antenna is unidirectional with a pattern similar to Fig. C, pattern #4 (even though this antenna is horizontally polarized). The wider spread between the guy wires selected determines how much horizontal and how much vertical polarization will be imparted to the signal. If the guy wires are almost straight up and down the signal will be mostly vertical. A wide spread between wires makes the signal more horizontally polarized. This simple form is where two guy wires on the same side of the mast are selected. Maximum power is radiated in that direction.

If you have a four-wire guy system and select opposing guy wires you will have a bi-directional coverage similar to Fig. A, pattern #2. Much the same as any horizontal dipole.

If you connect the 1/4 wave phase delay harness (Fig. 3) to the other two opposing guy wires (four-wire guy system) you'll make it omnidirectional. This is because you'll be feeding the second set of guy wires (second dipole) 90 degrees out-of-phase with the first. The result is the radiated signal "spins" around the two dipoles thereby "pointing" in all directions. It completes one trip "around" during each cycle of your frequency. At 100 MHz this is 100,000,000 times each second!

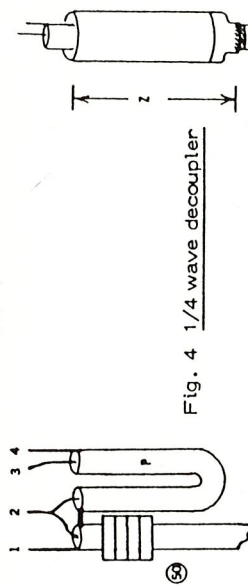


Fig. 3 Phase delay harness

Fig. 4 1/4 wave decoupler

This is a balanced antenna. If it is to be fed with unbalanced line (coax) it needs a decoupler. Four or five large ferrite beads may be slipped over the coax, close to the end, to act as the decoupler. If you prefer a decoupler can be made from a piece of 1" copper pipe. A 1" to 1/2" reducer is soldered to one end. The whole thing is slipped over the coax. A bit of coax insulation is removed and the small end of the reducer is soldered to the coax shield. The other end of the pipe is left open (see Fig. 4).

When the phasing delay harness is used you'll have two antennas connected in parallel. When fed with a 50 ohm cable (RG-8) you'll have a VSWR of 1.4 to 1. A lower VSWR can be had if the 1/4 wavelength of coax leaving the antenna is a 50 ohm impedance (RG-8) acting as an impedance matching transformer. The rest of the coax all the way back to the transmitter would have to be 75 ohm coax.

Dimensions, design frequency of 100 MHz	Effective power gains		
	Uni-	Bi-	Omn-
X 1/4 wave (thin wire)	29	1	1/2
3/4 wave (thin wire)	38	2	1
5/4 wave (thin wire)	147	8	2
P 1/4 wave (poly coax)	19	1/2	(use 75 ohm coax such as RG-59)
Z 1/4 wave (pipe)	28		(Fig. 4 decoupler)

HALF-WAVE PHASED COLINEAR (Fig. 5)

This is a fairly rugged antenna. It is constructed from 1/2" copper water pipe and 1/2" copper pipe fittings. It mounts to mast with a single "U" bolt. It may be polished and then sprayed with a clear lacquer for a real professional appearance.

It consists of two 1/2 wave elements, one above the other, which are fed from a 1/4 wave "shorted stub". The "stub" is the "U" shaped section whose dimensions

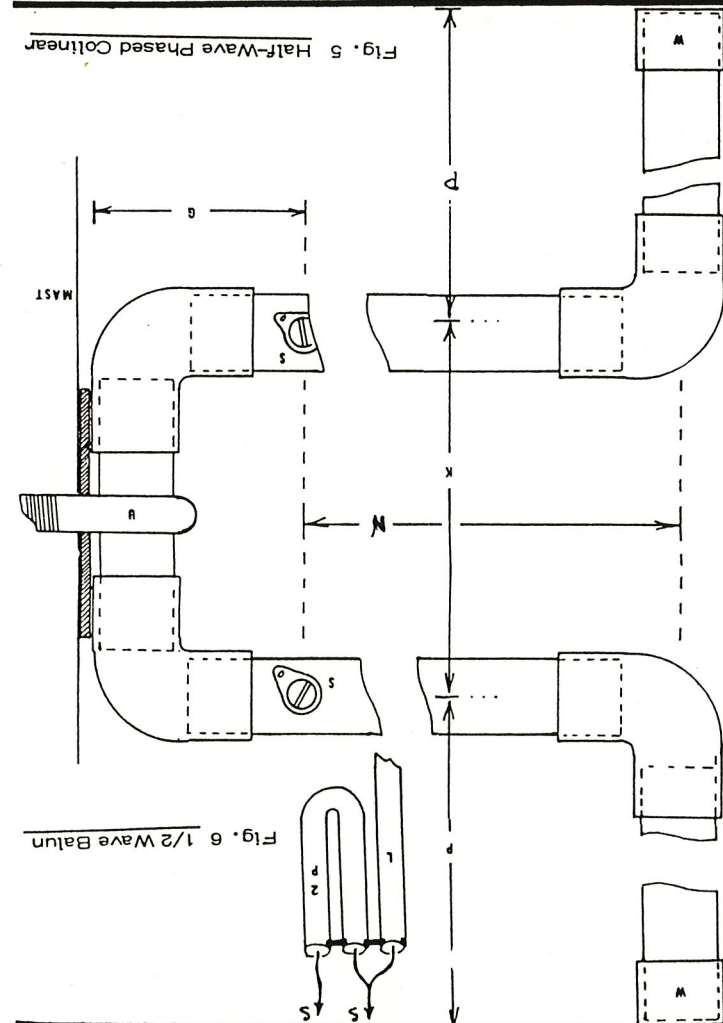


Fig. 6 1/2 Wave Balun

$N + G = 1/4$ of a wavelength. Since this is a balanced antenna which will be fed by an unbalanced line (coax) it will need a "balun". A balun is a device that adapts a BALANCED line to an UNBALANCED load. Both antenna elements must be fed in the proper phase relationship so a 1/2 wave balun is used. This is shown in Fig. 6.

The balun is made from 50 ohm coax (RG-8) with the shields of all ends connected together. The shields will not connect to the antenna however. Only the center conductors, marked with an "S" will connect to the antenna screws, also marked "S".

Begin by cutting all your copper pipe to the appropriate lengths. Fit the sections of pipe into the 90 degree elbows. Slip on the end caps (W) (to keep water out when it rains). Lay the whole thing down on a flat surface and check your overall dimensions. Adjust the pipe lengths if required so your dimensions are exactly as shown below. Now solder each joint (fitting). After it has cooled, drill two holes for the screws (S). The hole should be threaded for a 6-32 screw. A self-threading screw may be used (not a sheet metal screw). Use a solder lug under the screw for connection of the balun.

If the antenna is mounted on a metal mast a piece of hard rubber should be used as an insulator. Only the exact center of the 1/4 wave stub may be connected to a metal object. If a wooden support is used this is not a concern. You can even use two "U" bolts if you want.

The antenna gives a power gain of at least 2 when mounted on a wooden support. The coverage pattern is similar to Fig. C, pattern 1 (omnidirectional). The distance and angle of the radiation is similar to Fig. D, pattern # 2. If the antenna is turned so it is horizontally polarized it will have a bi-directional (horizontal) coverage as shown by Fig. A, pattern # 2. A metal or wood mast may be used.

Fig. 5 Half-Wave Phased Collinear

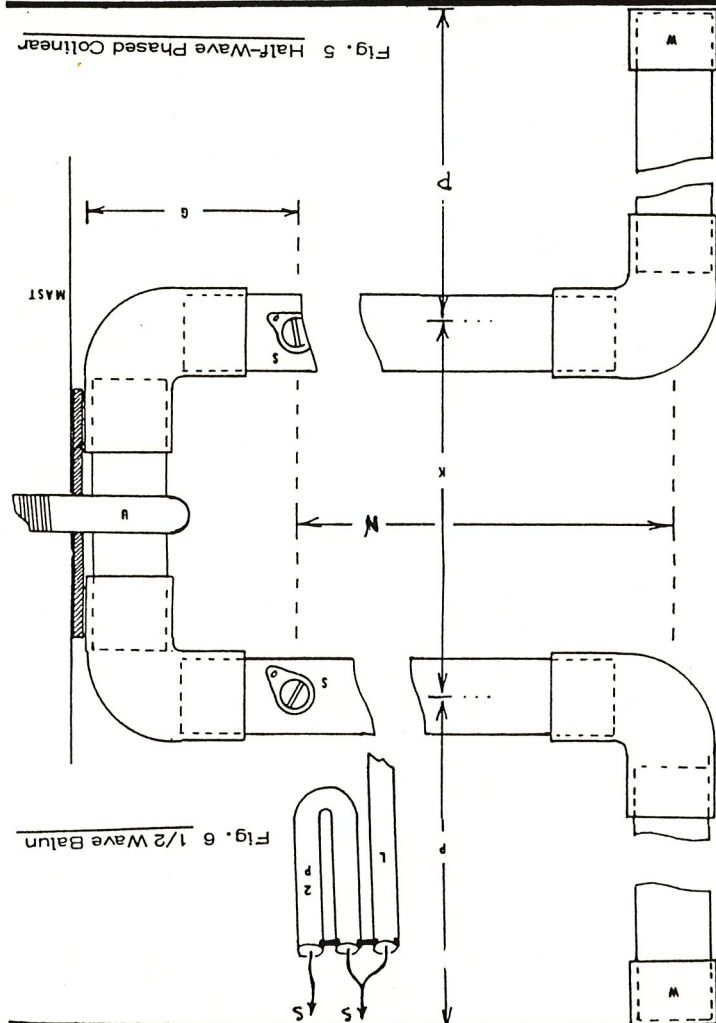


Fig. 5 Half-Wave Phased Collinear

When the antenna is mounted on a metal mast it will exhibit additional gain (up to a gain of 4) but will be unidirectional as in Fig. C, pattern # 4.

Dimensions, design frequency of 100 MHz

P	1/2 wave (pipe)	56 1/8"	L = any length of 50 ohm coax such as RG-8
N	1/4 wave (pipe) X .63	17 5/8"	
G	1/4 wave (pipe) X .34	9 3/4"	
K	1/4 wave (pipe) X .11	3"	
2P	1/2 wave (poly) coax	39" (RG-8)	

A STACKABLE VERTICAL DIPOLE (Fig. 7)

This is a rugged vertical dipole which, when stacked with others, gives a power gain of a little greater than the number of dipoles used. A stack of 2 (also known as 2 bays) has a gain of about 2.1. A 4 bay antenna may have a gain of up to 4.5! Figs. E through I show various stacking arrangements. These stacking arrangements are discussed later on.

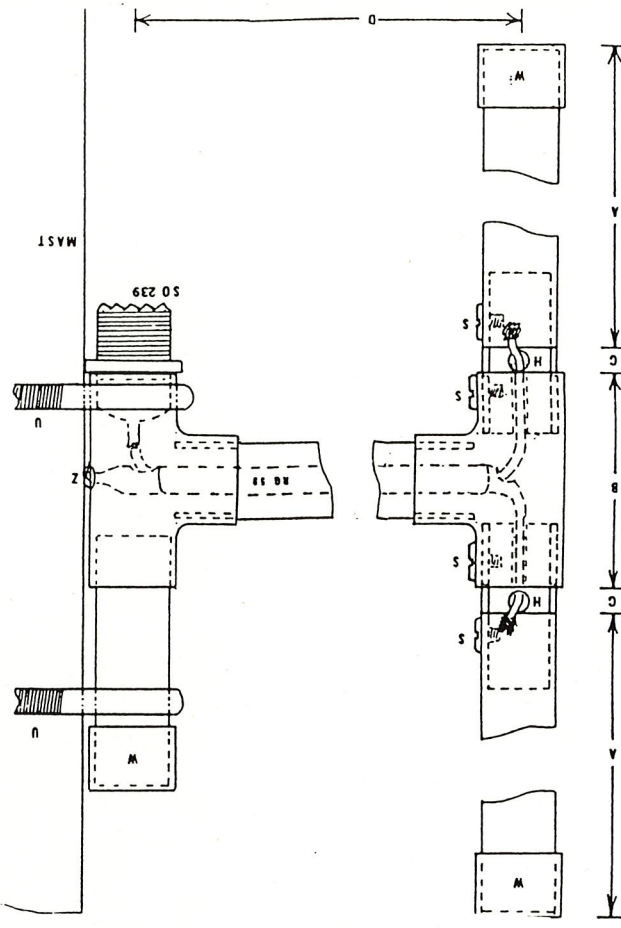


Fig. 7 Stackable Vertical Dipole (Side View)

The dipole is constructed from 1/2" copper pipe, two 1/2" "T" fittings and three end caps. The area marked "H" show pieces of 1/2" diameter plastic such as lucite or polystyrene. These plastic pieces are the last pieces to be installed.

Out all the pipe sections to the appropriate length. Slip on the fittings and check your dimensions. Do not install the coax, plastic, or SO-239 yet! Solder all the fittings and end caps into place. Keep it all straight by holding it against a flat surface. Drill a 3/16" hole at point "Z".

Out a piece of RG-59 coax to a length longer than dimension D. Remove some of the outer insulation as shown in the drawing. Spread apart the braided shield a bit and carefully pull out the center conductor (still insulated). Prepare the cable as shown in the drawing. Solder the center conductor of one end of the coax to the solder pin of the SO-239. Twist the braided shield at that end so it can be pushed through hole Z from the inside. Do it, while showing the SO-239 into the

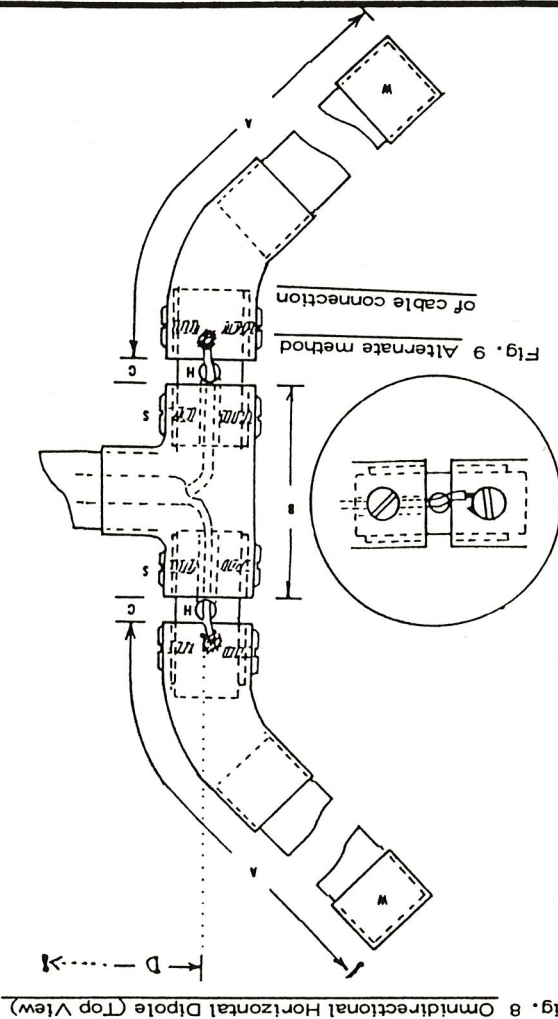
open end of the "T" fitting. Solder the shield to the outside of the "T" fitting. Now solder the SO-239 into place. If the SO-239 has been plated it may be necessary to file off some of plating before it will solder well. CAREFULLY - not too hot!

Two holes have to be drilled, a now in the plastic pieces. Use a 3/16" drill bit. One hole starts at the end of the piece and ends half-way through. The second hole starts at the side of the piece and goes half way through to meet the first hole. You may drill this second hole at an angle toward the first hole to make pulling wires through it a lot easier.

The inside of the "T" fitting is made for the outside diameter of the 1/2" pipe. The plastic piece will fit too loose if installed directly. So...cut filler bushings out of 1/2" pipe (about 1/2" long) and slip into the open ends of the "T" fitting.

Bring the center conductor of the coax out the bottom end of the "T" fitting and feed it through one of your plastic pieces. Bring the coax braid (twisted) out of the other end and pull it through a plastic piece. Slip the plastic pieces into the "T" fitting. Drill a tap size hole (6-32 self-tapping screw) through the "T" fitting, the filler bushing, and part way into the plastic (Caution- not too far!). Install the screw to secure the plastic piece in place. Now do the same for the coax braid end of the fitting.

Now slide on the dipole sections of pipe. Secure to the plastic with a 6-32 self-tapping screw. Solder the coax leads as shown in the drawing. An alternate method of connecting the coax leads is shown in Fig. 9.



Finishing touches include polishing the copper pipe and coating it with clear lacquer. Close up any holes with silicone sealant to keep out moisture. Check with an ohmmeter for shorts between dipole elements and shorts between the elements and the supporting boom. Check also for continuity between the center pin of the SO-239 and the lower dipole element.

Mount on the mast so the SO-239 is facing down. A little grease on the threads when you screw on the plug later will help to keep moisture out.

When stacking these units the dipole connected to the coax braid MUST BE

POINTING UP to maintain the proper phase relationship between units. The length of the little mounting stub (top "U" bolt) is not critical, 2" to 4", it's just for a mounting spot for the "U" bolt anyway.

Dimensions, design frequency of 100 MHz

	A	B	C	D
1/4 wave (pipe)	28"	2"	large enough for wire	3/16"
Standard "T" fitting			1/4 wave (pipe)	28"

AN OMNIDIRECTIONAL, STACKABLE, HORIZONTAL DIPOLE (Fig. 8)

The previous vertical dipole can be modified to make a horizontally polarized antenna. By simply rotating the dipole elements (and the "T" fitting) at the end of support boom 90 degrees you have a horizontal antenna. The coverage pattern would be bi-directional however, similar to Fig. A, pattern # 2.

By bending the dipole elements forward slightly we can further modify the antenna so it will present a nearly omni-directional coverage. The coverage would then look like Fig. A, Pattern # 1.

Of course bending copper pipe is a bit of a chore so we'll use 45 degree 1/2" copper fittings instead. With the exception of the above modifications and the addition of two 45 degree fittings, the construction is the same as the vertical dipole. Just use those instructions for its assembly.

When completed the dipole arms should be horizontal, the mounting end of the support boom vertical, and the SO-239 pointing down. When stacking these units be sure that right dipole element is the one with the coax braid connected to it. This is necessary to maintain proper phasing. If proper phasing is not maintained one antenna will tend to cancel out the radiation from one of the other units - result is terrible coverage or no coverage at all!

Dimensions, design frequency of 100 MHz All same as stackable vertical dipole.

Fig. A Horizontal Coverage (Top view) Fig. B Horizontal Coverage (Side view)

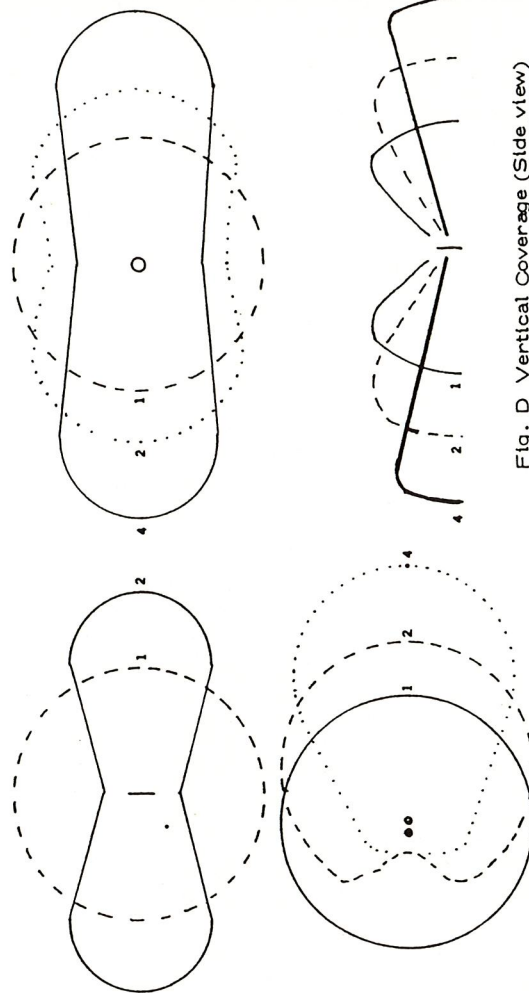


Fig. D Vertical Coverage (Side view)

Fig. C Vertical Coverage (Top view)

STACKING ANTENNAS FOR MORE GAIN Figs. E - I)

When we speak of an antenna as having gain we are really talking about its EFFECTIVE RADIATED POWER or simply its ERP. The antenna can be made to concentrate the power fed to it by sending it out in one or more directions. This means however that some other direction will not receive as much power. Simply, more distance in one direction means less distance in another direction.

Stacking of vertical antennas tends to lower the radiation angle. Less power is radiated up toward the sky, being channeled outward instead. This of course in creases the coverage area. Fig. D shows the relationship of stacking versus the effective distance. Pattern # 1 is for a single antenna. Pattern #2 shows the results of 2 stacked verticals with an ERP of about 2 X. Pattern # 4 shows a 4-bay antenna.

The above is the case where the antennas are mounted on a wooden support. If a metal tower or mast is used it will reflect some of the power forward. This also results in additional ERP. This raises the overall ERP by a factor of about 2. This means that a 4-bay vertical on a metal mast could have an ERP of 2 times 4 for a total of 8 times the power! Of course coverage area is lost behind the tower as we see in Fig. C, pattern # 4.

Stacking of horizontal antennas compresses the radiation angle. Instead of the signal being sent off into space or toward the earth, it is "focused" outward. This can be seen in Fig. B. Pattern # 1 shows a single horizontal dipole. Pattern # 2 shows a flattening and pushing outward of the radiated energy. Pattern # 4 shows the results from a 4-bay antenna.

Although a metal tower will produce a shadow area behind omni-directional horizontals also, it is not nearly as pronounced as with verticals. In most cases it is not worth worrying about.

The most practical number of horizontal bays seems to be 4. More than that tends to concentrate the "beam" of radiation too much. It gets out further but can actually travel "over" nearby receiving antennas.

The amount of distance obtained related to effective increases in power is equal to the square root of the power increase. These relationships are shown below:

Power Increase	Distance	Power Increase	Distance
2	1.4 X	7	2.65 X
3	1.73 X	8	2.83 X
4	2.0 X	9	3.0 X
5	2.23 X	10	3.16 X
6	2.45 X		

This holds true for increases in transmitter power also. Doubling your transmitter power results in only a 1.4 X increase in distance.

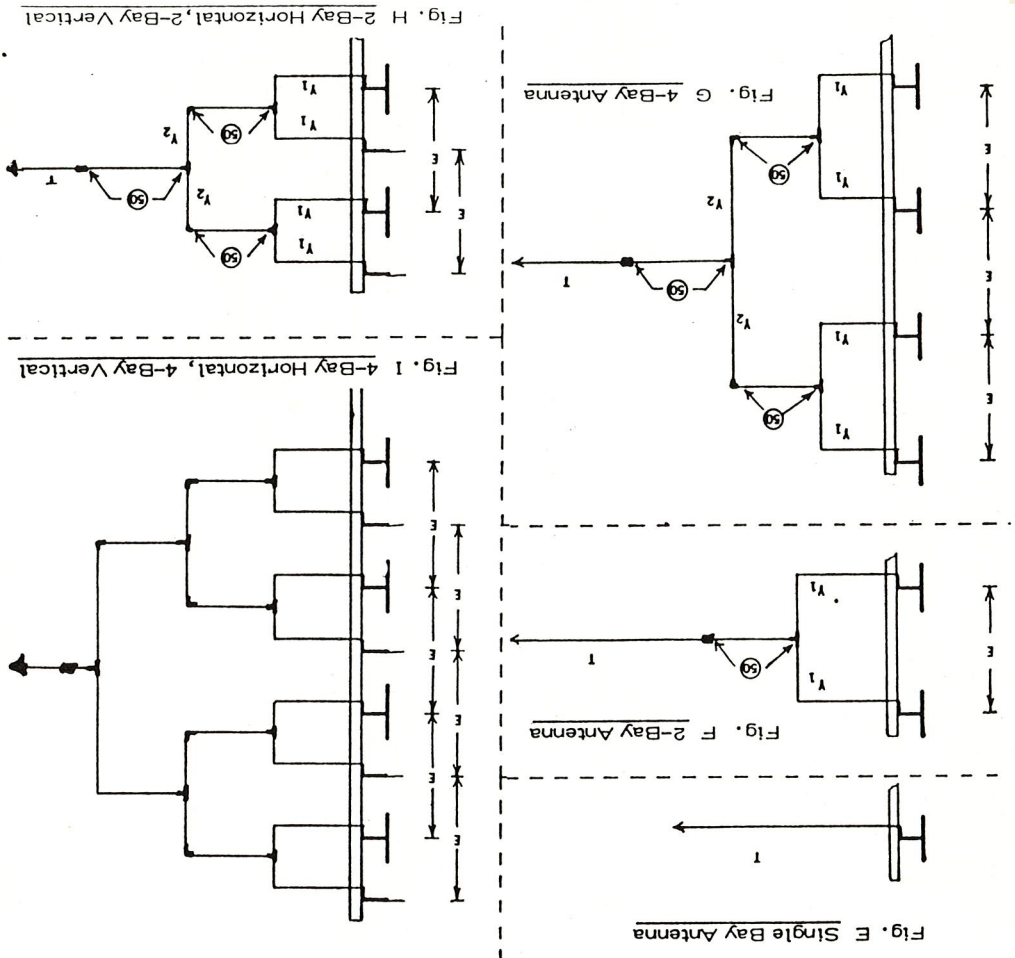
Fig. E shows a single antenna. It may be a vertical or a horizontal unit although a vertical one is shown here. Its feed impedance is about 75 ohms. The horizontal antenna's feed impedance is slightly less due to the elements being angled forward. For lowest VSWR it should be fed with a 75 ohm coax. It may be fed with a 50 ohm coax however with only a 1.4 to 1 VSWR.

Fig. F shows two stacked antennas. They may both be vertical, or both horizontal, or may be one of each. If both antennas are the same polarization it would have an ERP of 2. If you have one of each then the ERP is 1 - but with both horizontal and vertical polarization. The total feed impedance at the coax T is now 1/2 of 75 ohms. This 37.5 ohm impedance can be fed with a 50 ohm coax with only a 1.33 to 1 VSWR. If you want to feed it with 75 ohm coax you must have a 1/4 wave impedance matching

transformer. This is shown as the # 50 with a circle around it. This is piece of 50 ohm coax 1/4 wavelength long. This is either 19 1/2" or 24 1/4" long depending on whether you are using poly or foam coax. The cables from the antennas to the coax T (Y1) may be of any convenient length BUT...they must be the SAME length. If they are different lengths the phasing between antennas will not be correct! Highest gain is achieved when the spacing between centers of antennas is about .8 X wavelength in air. This is 94 1/2 inches at 100 MHz. (E = 94 1/2")

Fig. G shows a 4-bay vertical system. Fig. H shows a 2-bay vertical with a 2-bay horizontal. You could just as easily have a 4-bay horizontal for Fig. G. In the case of Fig. H the vertical antennas can be fitted in between the horizontal units. This takes up a little less tower space. Note this is also done in the 4-bay vertical, 4-bay horizontal system of Fig. I. Dimension E is still 94 1/2" at 100 MHz.

The length of connecting cables Y2 may also be of any convenient length BUT both must be of the same length! Again in Figs. G and H you are paralleling two 75 ohm impedances (Y2 + Y2). This point may be fed with a 50 ohm coax (VSWR of 1.33 to 1).



Suppressor and Filter: Construction Plans.

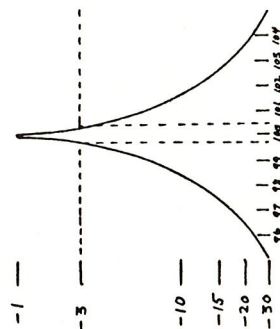
One of the biggest problems with any transmitter is the production of undesired frequencies. These may be produced by secondary resonant circuits within the oscillator stage or amplifier stages. These frequencies have no relationship to the desired frequency whatsoever and may appear anywhere on the band or out. Harmonic frequencies, multiples of the desired frequency, are produced by the non-linear characteristics of the amplifying devices themselves, either tubes or transistors. This means an FM transmitter operating at 100 MHz may produce harmonics at 200, 300, 400, 500, etc. MHz. The most common non-linearity produced frequencies are the odd harmonics, 3rd, 5th, 7th, etc.

A filter which will reduce or eliminate all but the desired frequency must have a finite pass-band. In the FM band we have a channel width of 200 KHz. This means the filter's pass band must not be less than 200 KHz or signal quality will suffer. Unfortunately as band width is made narrower in a filter the insertion loss becomes greater. A compromise then is where an acceptable band width (pass band) joins an acceptable insertion loss (power loss). The RFI is tunable from 80 to 120 MHz.

General pass band and insertion loss characteristics of the PANAXIS RFI are:

Pass Band	Insertion Loss (dB)	Power Output(%)	Resultant Field (%)
2 MHz	.45	90	95
1 MHz	.70	85	92
.5 MHz	.97	80	90

As an example, with the RFI adjusted for a 1 MHz pass band, the insertion loss would be .7 dB, resulting in 85% of the power being transferred from input to output. This sounds bad until you consider that the field strength voltage decreases as the square root of the power decrease. In this example the range would be cut back to 92% of the range obtainable without the filter.



The graph at the left illustrates a 500 KHz bandwidth (-3dB point) and a 1 dB insertion loss. Output drops off rapidly for frequencies farthest away from the center frequency, in this 100 MHz is being used as the center. Up to 30 dB of attenuation at 5 MHz away from the center frequency is possible with proper adjustment. SWR is approximately 1.05 to 1 with a 50 ohm input/output. SWR will be about 1.5 to 1 with 75 ohm input/output, unless taps are adjusted for 75 ohm operation only.

The coils are a little tricky but if you take your time you should have only a little trouble. The two coils are wound in OPPOSITE DIRECTIONS. This is important because when they are installed you'll want the "tap" point to be correct. The tap is at one full turn from the bottom of each coil. The long leg at the bottom of each coil is part of the impedance of the tap and is required - do not shorten it by more than 1/2 inch!

Wind the coil on a 3/8" drill bit shank or other 3/8" diameter object. You'll want 8 full turns with extra wire left at each end. Take a short piece of the same wire size and push it in between a couple of the turns near the end of the coil. Rotate the coil while holding the spacer wire between the turns. In this way you'll space

If you want to feed it with 75 ohm coax you'll need another 1/4 wave transformer, just like that used in Fig. F. All 50's with a circle around denote 1/4 wave-50 ohm transformers.

By now you should be an old pro and can figure out the harness arrangement for Fig. I. Just remember: all Y1's are the same length, all Y2's are the same length, and (for Fig. I) all Y3's are the same length, and all junctions need an impedance matching transformer.

A bit of information you may find discouraging. 100 feet of RG-8 coax allows only 63% of the transmitter power to reach the antenna system. RG-59 is worse! It only allows 50% of the transmitter power to reach the antenna (100 feet). In other words, use RG-8 as much as you can, keep the transmission line short between the antenna and the transmitter. Of course the higher up your antenna the better it will get out, but this means longer transmission lines. You'll have to come up with a compromise between antenna height, transmission line length, and antenna gain.

CIRCULAR POLARIZATION

You may modify your antenna system to achieve circular polarization. If you stack a horizontal unit directly above a vertical unit, so the support booms are actually touching, and the horizontal unit straddles the vertical you are close!

Look at Fig. H for a moment. Picture the top horizontal unit resting right on top of the top vertical element. Their radiation centers would be almost at the same point. Now make the vertical's Y1 cable any length that's convenient, BUT, make the horizontal's Y1 cable 1/4 wavelength longer! Repeat the above for all vertical/horizontal pairs. All the other cables and transformers remain the same as before.

The extra 1/4 wavelength of cable going to the horizontal unit delays the signal by 90 degrees. The signal is first radiated by the vertical, then 90 degrees later by the horizontal, then the vertical, then the horizontal, and so on. The signal is now spun out in all directions at 100,000,000 times each second! While the other systems of stacked antennas gave both horizontal and vertical polarizations, this method gives all other polarizations in between!

The gain in any one polarization does not change however. When you mix the polarizations equally you have 1/2 power going horizontal and 1/2 power going vertical (or somewhere in between). This also holds true for the stacked verticals and horizontal without circular polarization.

Example: 1/2 power goes to 2-bay vertical with gain of 2...total gain = 1
1/2 power goes to 2-bay horizontal with gain of 2...total gain = 1

Therefore: a 4-bay antenna, with 2 horizontal and 2 vertical has a gain of only 1 but its a gain of one in each polarization.

Now, a final mind blower! Here is a typical example of what you will be fighting to get out a decent signal:

Transmitter power = 10 watts = TPO
100' of RG-8 = 63% efficiency = F
4-bay horizontal = gain of 4 (H) = G
4-bay vertical = gain of 4(V) = G

Therefore:
 $10 \times .63 \times 4 = 25.2$ watts

However:
only 1/2 of the power is going to each polarization, so....you have only 12.6 watts (H) and 12.6 watts

GOOD LUCK!

each of the turns a wire diameter apart. You could do it of course by simply pulling the turns apart but the spacing would not be uniform or look all that neat!

With a pair of long (or needle) nose pliers bend the wire ends of the coil at right angles to the coil turns. See Fig. 2 for more detail. The "top" end of the coil is the toughest. It must be bent so the end wire comes up and over the supports of the variable capacitor.

The second coil is made in the same manner except it is wound in the OPPOSITE DIRECTION. Again, bend the top end wire so it will center the coil between the bottom and top of the box when the end wire is resting on the variable capacitor's supports.

Solder the coils to their respective capacitor supports as shown. The wire ends at the "top" of the coils are placed very close together and cut off just before it can touch the opposite capacitor. These two wires, one from the "top" of each coil, are purposely placed close to each other. A very small capacity exists between them - this is your coupling capacitor between resonant circuits! The closer they are the greater your passband and the greater the power transfer. About 3 thicknesses of this paper fitting between these wires will give about a 2 MHz pass band. Farther apart will narrow the pass band and reduce power transfer.

Out the bottom wire of each coil to the proper length to solder to the solder lugs. The solder lugs should not be attached to the box when you do this. The box will act as a heat sink making soldering difficult. After soldering attach the lugs to the box with the 4-40 screws. Install the shield at this time.

Now solder the center pin of each coax connector to tap position of the appropriate coil. This should be about 1 full turn. Put the lid on the box and put it to work!

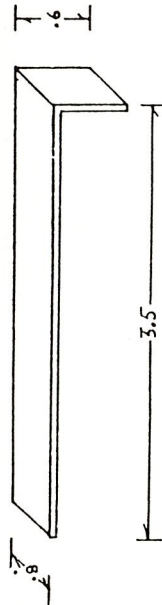


Fig. 3 Shield detail

PARTS LIST & SOURCES

Quantity	Description
1	Cast Aluminum box, 2.4" x 4.4" by 1.0"
2	Air variable capacitors, .4" x .4" square, 1/4" mount, 10 Pfd max
2	Coax connectors of your choice, Type F, BNC, CH-239, etc.
2	4-40 x 1/4" machine screws
2	4-40 nuts
2	solder lugs, #4 hole
1	Aluminum strip approx. 4.5" long, .8" wide, 1/16th" thick
2	Feet # 14 or # 12 bare copper wire (silver plated best if you can get it but not absolutely necessary.) (Try hardware stores)

MOUSER ELECTRONICS
11433 Woodside Ave
Santee, CA 92071
(619) 449-2222

RADIO SHACK
Check local phone listings
PANAXIS
(Full kits)

ASSEMBLY INSTRUCTIONS

Begin by drilling the appropriate mounting holes. Dimensions are given in Fig. 2 at right.

The cast aluminum box is just 1" thick (deep). All holes are drilled midway on each side, in other words .5" up from the bottom of the box.

Install the variable capacitors and coax connectors. The coils (inductors) are installed almost last. Position the capacitors so the "open" part of the plates is toward the bottom of the box. This puts the bottom of the cap with its support brackets at the top so you can solder your coil to it.

Next wind your coils and bend your aluminum strip to make your shield.

THEORY OF OPERATION

The filter consists of two parallel resonant circuits very loosely coupled by a small capacitor. Coupling between inductors by their magnetic fields is kept to a minimum by a shield. ETC.

OPERATION

Operation is very simple. Just connect the output of your transmitter to one of the coax connectors. Connect the other coax connector output to your antenna. The unit is symmetrical so either coax connector may be used as an input or an output.

Adjust each variable capacitor to be about the center of its range. Connect some means to monitor the filter's output. This can be an RF voltmeter, an SWR meter or power meter. The antenna should be connected or false tuning may result. You may also use a field strength meter to indicate when you have tuned the filter for maximum power output. As a last resort you can even use the tuning meter of your FM receiver. Tune it to your frequency.

Turn on your transmitter. Tune one filter variable until you get an output. Then tune the other variable capacitor to increase that output. Repeat this several times until both capacitors have been "peaked" for maximum output.

Yleistä:

Kaikista käsitellyistä aiheista on saatavissa tietoa muualtakin, ja niinpä varsinkin perustiedot elektroniikasta ja antenneista kannattaa lukea asiaa perusteellisemmin käsittelevistä lähteistä, joita ovat mm. useat radioamatööri- ja muut elektroniikkarakentelukirjat. Komponentteja löytyy myös kotimaisista elektroniikkaliikkeistä, mutta joitakin osia joutunee hankkimaan ulkomailta.

Kontakteja:

FREE RADIO CAMPAIGN - FINLAND, PL 82, 40101 JYVÄSKYLÄ. auttaa kaikissa vapaa radio asiaan liittyvissä ongelmissa, välittää monenlaista tavaraa (äänityksiä, valokuvia, paitoja, jinglejä, julkaisuja...) ja tarvittaessa mm. välittää postia. Suomalaisen vapaan radion asiantuntija.

SKANNERI, Pl 82, 40101 JKL. on lehti joka keskittyy niihin aloihin, joista muualla ei puhuta. Sähkömagneettisen viestinnän erikoislehti. Näytenumero 5 mk postimerkkeinä.

WUTKE-QUARZE, Hainerweg 271, 6000 Frankfurt/M.70, West-Germany. myy kiteet lähettimiisi.

BHIAB Electronics, Box 216, 76100 NORRTÄLJE, Sverige. hyvä elektroniikan komponenttifirma.

TRIFUNIC, PL 552, 20101 TURKU. monenlaista elektroniikkaa.

VERONICA FM (Yorks.), Heights Bungalow, Heights, Kilpin Hill, Heckmondwyke, West Yorkshire WF16 ODE, England. myy valmiita lähettimiä ja mm. stereo-koodereja.

POWERTRONICS UK, Box 46, Stockton, Cleveland TS17 6YR, England. myy valmiita lähettimiä.

FREE RADIO CAMPAIGN - SWEDEN, Box 412, S-89101 ÖRNSKÖLDSVIK, Sverige. myy mm. äänitteitä.

PIN, Box 220342, D-5600 Wuppertal 22, West-Germany. piraattilehti ja mm. postilokeropalvelu vapaa radio asemille.

ANORAKS UK, Box 539, Blackpool FY1 4RE, England. englantilainen vapaa radio alan asiantuntija, postimyyntiliike ja lehtien julkaisija.

Suomalaisia vapaita radioita:

Right-Wing Radio, c/o FRCF, Pl 82... tai Wuppertal box
Radio Meteor, c/o FRCF tai Box 41, 7700 AA Dedemsvaart, Holland.
Voice Of Free Radio, c/o FRCF.
Radio Scanwood, Box 41, Dedemsvaart.
Kouvola seudun piraatit, c/o FRCF tai Box 9242, Barcelona, Spain.
Radio Caroline, c/o FRCF.
Radio Olympia, c/o FRCF tai Box 220342, Wuppertal.
Radio Bristol, Box 41, Dedemsvaart.

Tätä kirjasta välittää FRCF, Pl 82, 40101 JKL hintaan 50 mk.

Radio is my bomb - A DIY Manual for Pirates

on ensimmäinen Suomessa yleisesti saatavilla oleva opas, joka keskittyy Vapaan Radioaseman perustamiseen ja toimintaan liittyviin ongelmiin ja jakaa yleisradiolähettimein liittyvää tietoa.

Tämän kirjasen avulla sinäkin pystyt rakentamaan pienitehoisen ja yksinkertaisen, mutta edullisen ja toimintavarman yleisradiokäyttöön soveltuvan radiolähettimen käytettäväksi keskipitkillä, lyhyillä tai ultralyhyillä aalloilla.

Tätä opasta välittää Free Radio Campaign - Finland, P1 82, 40101 JYVÄSKYLÄ hintaan 50 markkaa, joka sisältää postituksen. Ole hyvä ja lähetä maksu tilauksesi yhteydessä.

FRCF on suomalainen vapaan radion monitoimiyhdistys, joka välittää lisäksi mm. äänitteitä, valokuvia, T-paitoja, muita julkaisuja, sekä tarvittaessa lähettimiä, postia ja hoitaa puolestasi luottamuseslliset tullaus yms. operaatiot. Kirjoita FRCF:n osoitteeseen vastauspostimaksun kera, ja pyydä myyntilistat.

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