# CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction — <em>Let 1000 Aerials Radiate</em></td>
<td>1</td>
</tr>
<tr>
<td>Our Radio</td>
<td>3</td>
</tr>
<tr>
<td>Political Pirates</td>
<td>6</td>
</tr>
<tr>
<td>Jackie/Community Radio</td>
<td>7</td>
</tr>
<tr>
<td>Free The Airwaves</td>
<td>8</td>
</tr>
<tr>
<td>Pirate Scripts</td>
<td>9</td>
</tr>
<tr>
<td>International — A WORLD OF EXPERIENCE</td>
<td>12</td>
</tr>
<tr>
<td>Radio Vrij Keezer</td>
<td>14</td>
</tr>
<tr>
<td>Radio Dreyeckland</td>
<td>16</td>
</tr>
<tr>
<td>Radio Libertaire</td>
<td>19</td>
</tr>
<tr>
<td><strong>HOW TO BE A RADIO PIRATE</strong></td>
<td>24</td>
</tr>
<tr>
<td>The Broadcasting Site (FM)</td>
<td>25</td>
</tr>
<tr>
<td>How To Set Up</td>
<td>27</td>
</tr>
<tr>
<td>How To Get Away With It</td>
<td>28</td>
</tr>
<tr>
<td>Building Your Pirate</td>
<td>32</td>
</tr>
<tr>
<td>Medium Wave</td>
<td>36</td>
</tr>
<tr>
<td>BUSTS</td>
<td>38</td>
</tr>
<tr>
<td><strong>LEGAL BRIEFING</strong></td>
<td>40</td>
</tr>
<tr>
<td><strong>RADIO ELECTRONICS INTRODUCTION</strong></td>
<td>42</td>
</tr>
<tr>
<td>MW Transmitter Design</td>
<td>50</td>
</tr>
<tr>
<td>FM 4W, 25W Designs</td>
<td>51</td>
</tr>
<tr>
<td>FM SW Design</td>
<td>55</td>
</tr>
<tr>
<td>Low Amp</td>
<td>65</td>
</tr>
<tr>
<td>Aerials</td>
<td>70</td>
</tr>
<tr>
<td>Pre-amp and Filter</td>
<td>72</td>
</tr>
<tr>
<td><strong>CONTACTS, HOOLIGAN PRESS</strong></td>
<td>Inside Cover</td>
</tr>
</tbody>
</table>

---

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 guerrillas. 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 statements and let her go.
INTRODUCTION

This book was put together due to popular demand by a bunch of pirates, with a lot of help from the Free the Airwaves campaign and the D.R. Communications technical group in Bristol. It's been a long time coming but well worth waiting for. This is the First Edition, January 1987, its still a bit rough but we hope to update it regularly.

Its intended as a 'Do-It-Yourself' Pirate's Handbook, aimed at promoting neighbourhood, political and open-access radio pirates. But obviously you can use it as you wish...You can build the transmitters and use them to jam out Aunty Beb, or you can play your favourite music, or you can set up local open-access stations as we suggest...Or you can set up a fascist station and we'll come and kick your heads in!

This is an action propaganda book. We're not trying to 'cover the subject' or write an 'objective history'. We do include a brief section on recent political pirates in Britain, and another on radio pirates around the world. But the only purpose of this is to illustrate hard learned lessons and brilliant ideas to help and inspire the 'would-be' pirate of tomorrow.

The practical 'How To Be A Radio Pirate' section is a much longer and more detailed version of the pamphlet by Our Radio (the open-access pirate,1981-1983) which has been long out of print. This should kill off finally any 'technical mystery' on the subject which might be holding you back. It practically tells you how to do up your shoelaces before venturing forth to put your message on the airwaves. Its mainly about FM piracy, though we include a shorter section and a transmitter design for the less popular Medium Wave.

The aim of the large technical section is to spread the art of transmitter building from the few semi-professional technicians to the 1000's of eager electronics enthusiasts all over the world. Its just about possible for the complete beginner to build a transmitter from this book. And you can write to Free The Airwaves and D.R. Communications, who are more than happy to give you help and advice with problems as you go along. We also include projects for the more advanced, and contacts for obtaining still more advanced designs.

We also include a section on the legal situation in Britain, and a good range of contacts for current radio pirates and technical info sources. And 40 Elizabethan sonnets to round it all off.

Its quite logical really that this handbook was finally produced and printed by anarchists. No one else (least of all political parties) looks forward with glee to the undermining of the Institutions of The State, or to setting the radio media free for you and me and Joanna Soup to use as we wish!

Forward: LET 1000 AERIALS RADIATE

Welcome to 'Radio is my Bomb'. This is it, at least the manual of the guerrilla pirate, as complete as we can make it. Of course there have been radio pirates since radio was discovered, Marconi himself became the 1st pirate, when the authorities prevented him fully using his own discovery. But in the last 10 years, with the popularity of FM radio, becoming a pirate has become ever cheaper and more simple. You can't go out and buy a transmitter at the corner shop but you can buy all the components. Now at last using the information in this book, and for the price of a couple of dole cheques, you and your friends can come on air on the half empty FM band as a local station.

In other countries. (France, Belgium, Italy, Holland and now Spain), the State has tried to control and own the radio waves, and simply been flooded by an uncontrollable mob of largely commercial local FM pirates.

We want that to happen here too. Thats why we made this book. But we're not too keen on the commercial pirates, who spend their time trying to hog the technology imitate the commercial trash stations, and even sabotage the competition, and all to make quick cash for the businessmen who run them. The 'Free Market' is only free for the rich and powerful. Repeating tracks and ads at intervals designed by computer to wreck the new exicted average MAN after burning their crap, till every station sounds exactly the same.

Nor are we turned on anymore by the traditional pirate DJ's, who tend to be all the same white sexist macho morons, preening their ego's and spewing forth inane chatter in the hope of getting a fat career in the legal media.

We'd like instead to put everyone on air! To reclaim the airwaves from the parasites who infest it.
We'd like to see ethnic radio, women's radio, tenants' unions, anarchists, community groups, old people, prisoners, pacifists, urban gorillas, local info, gays, straights and of course every possible variety of musical entertainment.

A few people have tried to start these kinds of pirate stations in the recent past but have been stamped on by the State (by both Tory and Labour Governments). We can learn quite a lot from their experience, which we go into in following chapters. One thing that's clear is the value of numbers, simply that they can't stamp on everyone.

Another lesson is the value of being local, first of all because it's much more difficult for the masties to track and catch you, and less rewarding when they do, and secondly because there's a 'commercial gap', people can't make much money out of local stations, while anti-commercial pirates could survive and thrive. There is another reason why we're pushing for a new wave of local pirates, because we think radio should be a two way thing, with as much feedback as possible and lots of groups taking part and making their own shows. To hell with Broadcasting Authorities, Peers, Lords, Judges, M15 moles and pontificating middle class professionalists.

You may now be thinking this is an anarchist book trying to create chaos just to get back at Big Brother. Think what you like. We'd prefer radio chaos to the 'aural diarrhoea' we have right now! But in fact chaos has nothing to do with it. For a start there's plenty of room. Free The Airways have calculated there's room for 471 one mile FM pirates in London alone without interfering with anyone (then)

This may all seem a bit idealistic, and we're wrong with that! Any new wave of pirates re-emerges from people and popular culture. It will certainly NOT come from the 'broad left', divided as they are in 1000 fragments competing for power, membership, soft jobs in a Labour Party regime, new pirates come from the 'Community Radio' movement, called into being by nosy Norman bums and when denied licenses have proved incapable of putting a single pirate on air, for fear of breaking the law. Now the CR activists are waiting for and token controlled licenses under Labour. GUMPfies (Socialist leaning Upwardly Mobile groups) should beware. Socialists love state control more than Tories. Consider the Eastern Block, totally controlled media and pirates hunted down by police and army. The Labour Party has been busy setting pirate-buster of all (as well as bringing in Power, the Bomb, Intercom etc) and even tried jam Radio North Sea off the air (in 1970).

We are optimistic nonetheless, in fact we're sure the FM band will fill up with pirates simply because the technology is becoming so cheap and simple. The State knows this quite well and seeks to postpone it with the carrot of control. 'Community' Radio and the big stick of the anti-pirate laws. This is where the real battle lies and why we devote so much of this book to get away with it. In fact its a complete myth that 'political' pirates get busted more often than others and even a half dozen 'open access stations' could flood the present law with little more than a bit of luck and imagination. But the State has more strings to its bow than brute force, as the history of pirates in other countries such as the USA and France shows. For whatever reason, they may try to turn us off - legalise a few under their control, invest rate them with middle class professionals who spout their ideology (they don't have to arrive yet, these people will descend like locusts), and crack down harder on the rest. If this tactic fails work, for whatever reason, they might have to fall back on the 'Italian' solution. What happened there was there were suddenly so many pirates that the State just declared a free for all. In the conclusion that the big commercial, party and religious stations thus created would eventually swamp the autonomous pirates off the air.

Some people still naively think that radio is some show unbiased. Think again. Apart from the authoritarian BBC and IRA control by rich people with upper class views, the kind of people employed can be relied on to spout the prejudices and preconceptions of their class (and this before thinking of the non-infiltration by M15 state agents). Of course if you're a nationalist, sexist, fascist, Italy, SUN lover you may notice nothing amiss. Its interesting the way we're conditioned and controlled by the media, you can look at it by listing the people, events, views, music, languages etc left out or badly represented. Or consider where the news on radio actually comes from and why its chosen as it is.

When you say 'Free The Airways' you need to work out what you mean by Freedom. We know what you mean and its a hell of a lot more than a 2 minute phone-in slot carved in the media's laws. This book is for people wanting to think, who know quite well what they want, and are prepared to take simple practical steps towards making a better reality from their own dreams, even to have some fun in the process. The empty deck is turned over to you!

If you have any more, or better information please send it in to us for the next edition to: RATE, c/o BM Hurricane, London WC1N3XX.
'This is OUR RADIO, London's only open access community pirate, coming to you on 103.8 FM'.

Our Radio was the most successful open access pirate so far, and what happened to it gives us some useful lessons for setting up non-commercial, political, or community based pirates in the future. So we go into its interesting history in some detail.

Our Radio drew out of a campaign for open access radio called COM Radio, in the late 70's. This campaign got nowhere, and in 1980 some disillusioned members formed London Open Radio (LOR), a lobby group for alternative radio. It also got nowhere, but it was given a go-ahead, and decided to go pirate instead.

Thus Our Radio was born. Two of the real, unnamed heroes were a couple of blockes who set about building transmitters (TX's). At that time TX designs were even more a guarded secret of commercial pirate engineers. The aim was to liberate such decisions, copy them, and develop a version which was easy to mass produce by non-professionals. They failed in this last aim (they were also happy to train anyone interested) but left behind a lot of info which provides the groundwork for the technical section of this book. In the long run Our Radio was defeated on all fronts, after the last bust we had no TX's left (except a MW rig which turned out to be a dud) and no money, resources or energy to make more.

Regular Our Radio broadcasts began in Feb 82. It was announced as an open access station, and people were invited to make programmes. But the response was slow. We had chosen 105.8, at the top end of the waveband. The police, as our frequency as it was officially declared an unused channel (later a whole range of pirates followed us) but we were forced to move again. We had no ready made audience like the music pirates. We had to fight for our audience by putting out regular programmes. A big problem was that there was no support network, and no income but what we put in ourselves (but we were mostly on the dole) or raised from a few benefit gigs. We knew that at a certain point we'd gain publicity and a mass following, and we got the people and cash to expand and make us very hard to stop. We chose Wednesday nights, with the idea of getting quietly established. At that time raising money formally made us look uncool. For a long time this tactic worked, but listener support still didn't materialise. It seemed that passive consumption of the media was ingrained in our audience as any other. You could go out live, or do phone-ins for one thing we didn't have a 'link' TX (though we were close to this when the final busts began).

One programme to join early and stay with us was UTAPhA, an independent cassette programme, produced mainly by one bloke with amazing energy and extensive social contacts. It included poetry and plays as well as music which featured the Murphy Institute, Danny and the Dressmakers, Charles Bakov, etc.

Then there was GAYWAVES, the first programme this country made bt and for homosexuals. Most critics of GAYWAVES have been based on prejudice, I did suffer at first by being made mainly by just one man, but others quickly joined in and it became highly informative and entertaining, very soon it had to be extended to two hours. It was a magazine programme, with music, news, humour, games etc. It was also an open access programme for gay people, gay men as it turned out, though a lesbian show was planned... We wanted to involve other people to gather news and info, which would be spread into the show. This was known as the Gaywaves Network and we got a few things through that. We had an arts section with poets, stories and reviews of non commercial places... What we really wanted was a 4 hour show, with 2 hours of us, two of Lesbian programming and 2 of mixed humour, with a lot of camp fun and music to encourage it all out.

Gaywaves was attacked from all sides, not only by the press and the police, but by the straight gay media themselves, who were jealous and hated its success and influence.

Of course GAYWAVES wasn't restricted solely to gay issues. For example the first time Our Radio lost a transmitter we were playing a Gaywaves tape of ART, Scargill speaking at a CND rally, hardly a gay issue but an important one. To this day Gaywaves remains our most influential and brilliant example.

For Our Radio as a whole GAYWAVES was a big plus. Not just the kind of thing we were advocating, Phil Cox the presenter has since complained bitterly in print that we were slack, unreliable, unprofessional, not in stereo, and got up at 8.30 in the evening etc. This is pretty unfair, in fact a few people were working round the clock to keep all the gear going with no money or resources. For us the only problem with GAYWAVES was that they remained consumers...ie they wouldn't help with the broadcasting side of it at all. So they had no much idea what was involved. For example, after a hard day of problems like locating and checking a new site, borrowing long range repaired gear, collecting tapes, waiting for buses, missing rendezvous, setting up the aerial, hiding from neighbours... our bodies were made up of our bodies, rain, hail, wind and snow, we're finally ready to come on air and cover most of the London area, five minutes early... Then a lookout reports a police car parked by the next block could be a bust... we start to dismantle everything but he soon drives off. We switch on at last, only 20 minutes late. A Victory! Then we get complaints about being late, set up at 8.30pm and not being in stereo! So it goes. In all we broadcast about 40 Gaywaves programmes, a lot of them 2 hour shows, and a lot of them under severe pressure. In fact when the police broke down the door at 9.30pm on 23rd March 83, in the bust that finally finished Our Radio. It was Gaywaves that they interrupted. The next programme would have been Women on the Waves.

Women on the Waves

WOMEN ON THE WAVES was a later addition to Our Radio. It began with a couple of women playing their favourite tapes. It was a new and vital necessity of programme, a tiny women's space on the airwaves, in opposition to all the other media which were more or less openly pro-
mates sexism, exploitation attacks on women and the erosion of women's "rights". Women on the waves began doing news, information and interviews of things like Greenham Women Peace Camps, Women's Aid, prisoners, demos, music, women's music events etc. Unfortunately, Our Radio was closed down before Women On The Waves could develop much further. There wasn't any division between Women On The Waves and the station as a whole.

which was a good thing, some of the same women worked on the Message and other programmes, and were involved in organizing, publicity and were becoming involved in the broadcasting. Not that Our Radio was free of sexism, but it was being confronted on a daily basis.

The Message

"If the time is 9 o'clock, then this is THE MESSAGE on Our Radio, 103.6 FM. The Message magazine programme was radical radio at its best and really the heart and soul of Our Radio. Usually fantastic, occasionally abysmal. It was put together by four to ten people who brought material, prepared tapes and records to the Our Radio studio and crafted the whole lot together onto a one hour tape. Most of the time, the programme was political and for challenging the status quo that one word out of line will get you bashed immediately. In fact, Our Radio was only successfully busted twice in one year (compare this to London Creek radio's recent record of 3 busts in one week!).

One original purpose of The Message was to lobby for Community Radio licences on the lines of Australia or Canada. Another was simply to entertain, with music, mock advertising, outrageous spoofs and wild humour. A third purpose was to air the views and news that you never hear on the highly restricted, class-based and self-censoring British media. One advantage of The Message was that people with no experience could easily join in and quickly learn the basics of sound recording. For instance in Sept. 02 people from Brixton Squatters Aid heard the open access invitation and came along to do a spot. At that time there were only two such local groups among London's 30,000 squatters and BSA were promoting (and still are!) such self-organisation and resistance to evictions with their new sheet 'Crownbar'. But BSA was based at 121a Centre in the and within weeks half a dozen squatters in South London were reading out items on The Message and bringing some new energy into Our Radio. Almost everybody involved in Our Radio had something on the show, including one Labour Party member! Here's a short list of some of the".

The Freespace

This is THE FREESPACE. Anti Capital Radio on 103.6 FM. After a while I'll get so full that music and interviews were being crammed out. The Freespace was planned as a pure anarchist show, against all authority, but we only began getting it at the end when the crackdown had already begun and it was only broadcast once. Its hard to say how the programme would have developed. The first tapes were full of take offs, impressions, satire, attacks on the police and punk and reggae music. 'Here come BPPAC on 103'... but they never did. BPPAC was the Black Peoples Action Centre, a big youth scene and police monitoring group in Croyden, who had begun preparing tapes for Our Radio through anarchist contacts just before the final bust. The BPPAC buzz was burnt down by local fascists with blatant police collusion.

The Bag

THE BAG. Our Radio's late night show, was a programme of music and cut-ups without any nagging to bother you. It was beautifully and skillfully managed, each programme had a theme eg. Religion, Key Society, etc and a title eg. The Undercover Operation, The Good The BAG and the Ugly, The Fairground BAG, etc. Lots of clever dubbing and playing round with film and TV theme tunes. Sometimes if things were going well The Bag could stretch on for an hour or even three hours, since it was the last show on the right. The person behind the BAG was one of the best and anonymous organisers of Our Radio, and largely responsible for the open studio, music sound resources, as well as working with the broadcasting crew and promotion to the bitter end.

Radio Solidarnosc

RADIO SOLIDARNOSC was a late addition to Our Radio's programmes, and usually went out first at 5pm, half in English and half in Polish, and much good audience among London's Polish minority. It was produced by one small group out of the large of political Polish exiles, its purpose was to put on the air the activities of the embattled Solidarnosc Free Trade Union. It also provide contact news and info. Its worth noting that Radio Solidarnosc (London) was closed down by the BBC in far less well before Radio Solidarnosc (Poland) was finally closed down by Stanley Ulazweski and the KGB. The main producer of Radio Solidarnosc was a rather volitile character, who had a tendancy to remember the outrageous stuff we actually produced some serious researched material.
Mistakes and Failures

What went wrong with Our Radio, and what lessons are to be learnt. We were closed down by the State through the DRI and police, but they could only do this because we were already weak. By the start of 1983 the team of people around Our Radio were coming under heavy pressure. The main problem was lack of support reflecting the wider divisions among the 'left' in London. The lack of any people's movement, just single issue campaigns, created, exploited and finally killed off by parasitical Trotskyist and Stalinist middle class intellectuals, for the sole purpose of increasing their own membership, profit, and prestige. (penn, typist)

We decided to seek publicity, the alternative and music press weren't too interested so we tried to get on TV and did a good interview with Thames, but the only part they screened was the shot of one of us putting up an aerial, the only bit we were worried about.

On the technical front we were building our own digital frequency counter, and also a 'link' TX and receiver so that we could go live. But we still didn't have a reliable repeatable TX design. After the bust of Dec 15th 82 we scrapped the 'link' and put the bits into a new TX. We had no money for parts, it was a case of borrowing the bits from others. In a palace like London even keeping in touch with everyone can be a big hassle unless you have phones.

Our last broadcast at this period was through the GLC. This proved to be a blunder. Richard Barbrook, the sole Labour Party man in Our Radio set up a meeting through his friend and big shot, John McDonnell. In getting any Labour Party group to make tapes, we'd have probably refused to broadcast or 'lost' the tape (a bad solution) or called a general meeting and had a split. Open access can only work in this style. If we agreed with Parties, to support one which has been the biggest pirate bust of all, even trying to jam Radio North Brixton off the air (back in 1970) in true Labour style, we'd need police protection (like the Bomb, Interment, Nuclear Power, etc etc). So the reasons for the end of Our Radio weren't so much on the policy, but the fact that we had been that they disliked our politics, but it was also partly just cos 'our turn came up'. When they finally decided to get us we played 'out and about' with them for about six weeks, since we could not afford to lose our last TX and gear. This enraged them and they turned all their resources against us. For the broadcasting team it all got quite exciting, and we planned our next programme. Until the police saw it was decided. Here's a brief countdown to closure:

The End of Our Radio

Wed Dec 15th 82. The police and Home Office (now DRI) slap past our lookouts and raid us on top of a Tower Block in Kilburn. One person was nicked and we fined £80 plus costs in the same year. A 'bystander' gets fined for admitting to the police that we 'broadcast radio', we are off the air for 5 weeks building a new TX.

February 1983. We notice the Home Office are shadowing us, by monitoring our radio channel, lookouts etc but manage to keep clear of them and broadcast normally.

Wed 22nd Feb 83. They stage a full scale raid on our building, broadcasting the Golden Day. But our security works and we move ourselves and all the gear into a friendly squatted flat, with some seconds to spare. Fuck you Eric Gotta! Then we put out the story that we ran down 15 stories and hid all night in a cupboard.

Wed 2nd March 83. We broadcast a full show from Edystone Tower in Deptford. Though the Home Office are about, watching us with night sights from a neighbouring Tower Block, and a police helicopter 'buzzes' us while putting up the aerial. We find out that they can't get enough police support to bust us (there were only 3 of us). Good sport.
Andromeda

Andromeda Independent Radio began on Jan 23rd 1979, broadcasting from the Peninsula to the Manchester, 5th East Lancashire area. Andromeda didn’t belong to any organisation, or rent its gear from anyone, they were non-profit making and decided everything at collective meetings. “We believe that community radio CANNOT be commercial radio... We broadcast: Greenpeace info, tapes of local bands, details of anti-nuclear/CND activities in our reception area and details of times/frequencies of land based pirates”. They also carried ‘inverted advertising’ which they called the ‘Instant Rip Off’ show, publicising goods making excess profits or just being shit.

Andromeda were an excellent advertisement for low-power local pirate. They claimed their transmitter had only ½ watt power, yet could be heard 35 miles away from their broadcast site in the hills, and they produced reception reports to prove it. The TX cost them a mere £6, and they were able to transmit so far due to their height and by using a directional aerial with ‘gain’. Andromeda were partly inspired by an earlier station, Radio Aquarius, which broadcast in the same area every weekend from April 1971 to May 1975. Aquarius finally gave up after repeated busts, one which followed a programme condemning the treatment of Black workers in South Africa. Andromeda too went for a long time and were busted several times before closing down around 1982.

Radio Active

Radio Active was another small anarchist pirate, who broadcast in the Tottenham area of North London in 1980. The collective put out a series of excellent programmes, concentrating on anti-nuclear and anarcha-feminist issues, before closing down due to other commitments. They weren’t busted. People inspired by Radio Active later went into Our Radio.

Radio Avalon

Radio Avalon was a ‘Festival Pirate’ a precursor of Sheffield Peace Radio, which took to the airwaves to entertain and inform the 30,000 crowd at the 1983 Glastonbury CND Festival, broadcasting 72 hours of programmes. It was very well received, and broadcast with a tiny 1 watt transmitter, which covered the whole site and nearby Pilton village.

Cambridge Community Radio

We’re sorry not to have a full report on CCCR (next edition!). Cambridge Community Radio began an access station broadcasting music and local community news from a house in the local, until it was put off the air, with a series of heavy busts in 1983. People from CCCR then took responsibility for developing the Free The Airwaves Network and Campaign over the next couple of years and produced a series of well researched technical legal and news bulletins, before passing the Job to a London based group.

SHEFFIELD PEACE RADIO

The idea of SPR came from Radio Avalon in 1979. At the time some CND supporters were flirting with the idea of setting up their own media in response to the almost total blackout by the press, TV radio of their activities.

SPR broadcast in Sheffield during the CND conference on 2nd to 4th Dec 1983 with a range of programmes on peace issues and actions. But the hierarchy were hostile, refusing to endorse or advertise SPR (this was the 1st and last pirate at a Conference). However the broadcast itself was a success, partly because of a cool-down by the DTI police, who persuaded Sheffield’s commercial station Radio Hallam to close down temporarily to aid the breaking SPR frequency. A number of the other pirates didn’t catch SPR, and when Radio Hallam closed everyone returned to SPR. Lots of good publicity.

Encouraged by this a new, non-party collective began broadcasting, and entered SPR in Feb 84. It consisted of music, news, features and interviews on themes like the Miners Strike. The policeman who shot and killed a strikers, the Police Bill, Legalise Cannabis, anti nuclear peace stuff, and not forgetting animal rights group developed quickly into a genuine radical alternative stated and received lots of exciting interest and feedback. They also produced booklet ‘Sound Advice’, advocating THAT MORE DO THE SAME THING. SPR was also active in the The Airwaves Campaign and friends with Rebel Radio in Bristol, Radio Pleb and Our Radio in London the short lived anarchist Radio Revenge in However on 20th May 83 the police and BTU sent the bus they took to their transmission site (61d) and nicked all four of the SPR team and
After the Axe

Community Radio Experiment

The Jackie Conspiracy

Rebel Radio
Free The Airwaves is still going strong, as an informal exchange and promotion group for radical local pirate stations. In this book we reprint their 5w transmitter design and add their new amplifier which takes it up to 25watts. (This amp, can be tuned for less power and used to feed the amp. design taking you up to 80watts). Any technical queries, write direct to Free The Airwaves and join the network. '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.

YOU AND THE HIT SQUADS

The idea of a community/neighbourhood Radio Station as part of a countrywide network has never been properly explored. In purely practical terms the viability of Free Radio has always been hampered by the activities of the 'Hit Squad' of the Dept. of Trade and Industry (The Radio Investigation Service). Stations able to afford highly sophisticated gear like a studio to transmitter microwave link have found themselves with court cases to be proud of and been put off the air with the confiscation of their gear. Few involved in 'propagandaist' radio can afford such losses.

Low powered radio transmitters are cheap to replace (around £25 for a 4 watt one) but the most important factor for such stations to survive is to have the protection of the community they serve - safe houses and flats to disappear into, guaranteed escape routes and refusal to co-operate with the R.I.S would make such a station hard to put off the air. London could support 480 such stations operating over 1½ square miles, which would in itself make enforcement impossible. In Japan the manufacture of small PM transmitters (just a third of a mile range) has produced over 700 stations in Tokyo alone. Normal, 'big' radio has produced only one way communication to a false community invented simply by the act of broadcasting.

A small number of high powered transmitters means a greater filtering of input into the station as pressure on airtime grows and necessarily makes it more remote from the people who are supposed to be providing the programming. The only people who benefit from this are the already organised pressure groups. Anyone with any pretentions to breaking down the mystification round transmitter and programme construction and providing a medium open to people together in mutual aid and defence. Pirate radio in the service of left wing causes has still enough novelty value to attract an audience, and unlike other forms of 'propaganda by deed' its more likely to win the sympathy and even the involvement of the unsigned.

The main contention is that this kind of broad- 
ning has to be on a 'hit and run' basis if it to have any chance of survival. The only way of producing an open access, de-mystified democratically controlled revolutionary radio out of the hands of the state is for it to be organised on a small scale neighbourhood basis.

ANTI AUTHORITARIAN RADIO

Every establishment radio station wants us to conform to its cozy image of the listener. They assume what we are and tell us what we should be, just to make sure. We're condescended to, given our turkey recipe (we all eat turkey, don't we?) a dose of God (we all believe in him/her?) train delays in Sun-

ey (where we live of course), the shares in the city (that we all have), flight arrivals from rich paradise (where we spend the winter). And then there's the token bit of 'community' charity as porky middle-

aged middle class males read out a few low paid jokes for the rest of us. Then its time for the news values straight from the 'Daily Mail', with anything not favourable to the state and its chicklets (the Nuke industry, the police etc.) laundered, suppressed and moved to some tiny 30 second slot after the latest on some royal.

When we're told we have 'Free Speech' its in a controlled way. In London we have Brian Hayes, an irritable pompous man who may give us one minute to 'air our views'. Well, Big Deal. In phone-ins, people are eaged in the radio zoo for entertainment...listen to the profes 'getting it off their chest'.

The broadcasting system in the UK reflects all the embracing State, Monolithie, Patriarchal and inaccessible. The existing system is designed to maintain and reinforce Law, Family, God, Men, Meat, Military, Might and Money and its not about to be voluntarily dismantled by the British Government. By handing out a few licenses (or not, as it happens) the State hopes to buy off and neutralise dissent, complain, protest and investigative news because these are harmful to its interests. The monster will not bite off its own head.

Some believe its possible to use the existing legal framework for back door radicalisation but the machinery of the IBA can easily pressurise or close down any of the stations (if they ever start up!).

Campaigning for change isn't easy but its been done by establishing alternative low tech stations a whatever types (specialist music, political, anarchist, everything). This would give broadcasting a volatile dangerous edge and create a climate for flushing the Brian Hayes and the Steve Wrights away forever and with this, a climate for more general political change. If we can reclaim the airwaves that will be a start.
There follows two examples of programme scripts, which may inspire or at least amuse you. The first is from the anarchist/squatters news section of a programme called The Message, which used to go out across London on the open access pirate Our Radio back in 1983. The second is from the Miners’ pirate, known by the media as Radio Arthur. Both scripts were produced and broadcast by people with very little experience. We have to print them small so that they can fit...

**SQUATTERS NEWS FROM LAMBETH**

**Intro and backing music ‘Dirty Squatters’ (punk song). Louder between items.**

**VICTORY**

The right wing alliance in Lambeth Council collapsed this week with the defection of Councillor Gordon Ley...for the 2nd time. Mr Ley has left the SDP and will now vote with the Labour group, giving them a one vote majority and bringing down the Thatcherite council. He claimed high motives for his defection, denying he has broken down under heavy pressure from local squatters.

**MUSIC**

In June when mass evictions of squatters became certain in Lambeth, Gordon Ley was one of the councillors who had his home graffitied with squatters slogans and got a fake Notice to Quit his home. Then his lorry was vandalised and then his shop windows were smashed several times, and finally his beautiful car was stolen, graffitied and burnt out...No wonder the poor man broke!

**MUSIC**

**JOY UNCONFINED**

The news of the Council’s fall (especially of the corrupt Thatcher imitation, Mary Leigh) was greeted with joy in the big squatted communities in Lambeth. It will mean at least a delay in the mass evictions and the demolition of the squatted streets in Heath Rd and Gypsy Hill, until the equally corrupt Labour Party get their act together.

**MUSIC**

**BARRICADEING FEVER**

But down in Brixton town the squatters are showing no faith at all in Ted Knight and his new Labour Council. After all, it’s only a fortnight since the Labour agreed to and signed the order to oviet and demolish the squatted club at the Front Line in Ralston Road.

**MUSIC**

Latest news is that at least five houses are being barricaded against the police and bailiffs, all face imminent eviction after losing their court cases. The collapse of the Tory-led council seems to have spurred on the squatters to defend their homes, and they are relying on strong doors and their own Alarm Network, rather than the whims of corrupt politicians.

**MUSIC FADROUT...CRACK OF THUNDER...**

Backing music from ITAL DUB or other suitable

And now for a COMMERCIAL BREAK... (woman’s voice)

“Are you homeless, sleeping out on cold winter streets? Or are you just fed up with rents or mortgages? Do you resent the Rat Race? Or are you lonely and just bored with life?”

(new voice)

“Well...TRY NEW SQUATTING TODAY!! Yes today, we can offer you a choice of 100’s of nice homes, abandoned by their owners, for ABSOLUTELY FREE. So why not come along to your friendly squatters meeting every Sunday at 121 Ralston Road in Brixton. Or phone 2746655 for more information.”

SO TRY NEW SQUATTING TODAY.

**THUNDER and PADEOUT**

(intro (Freedom/prison music) louder between items)

**RIOT CASES** (with ‘Brixton Incident’ starting in middle)

Last Tuesday people nicked in the previous Monday’s riot in Brixton came to court at last in Camberwell. Police had used severe brutality in at least one case, tried to get another remanded in custody and tried to stop another getting Legal Aid...

---

In another case they were forced to suspend a ban on entering the Ralston area. All cases were remanded to Dec.16th in Camberwell Court.

**MUSIC**

**BIG BROTHER** (with clips of ‘Left, Right, You’re nicked’)

This week we have more news of new security measure being tried in the Brixton area and Notting Hill. From now on the police will be using listening devices and ‘other surveillance techniques’. This was in the ‘Daily Express’ on Nov 15th. A new instant printout exchange, 1st of its type in Britain, which can ‘monitor’ 200 phone calls at once, will also be installed, in, guess where, Brixton.

**MUSIC**

**MORE BIG BROTHER**

It has been announced that the new Brixton police chief will be Alex ‘headbanger’ Marnoch, former head of the notorious SPG. An extra 20 osifers have been permanently assigned to Ralston Road (half of which is now demolished) under some pig called Inspector Bob Bligh.

**MUSIC** ‘...Dancing in The Streets’

**POLICE MADE FOOLS OF**

On Wed 18th a local black youth was stopped in Ralston he refused to be arrested, broke away, and led the police a long and merry chase. Even when a vanload of SPG joined in he managed to elude them all with a classic sprint.

End of

**Music.....LAUGHTER.**

And now back to our regular spot... it’s this weeks TOP OF THE SHITS

(new voice)

Well hello there. And this week we have a clearcut winner, in fact today is his birthday...yes it’s the Duke of Westminster, Howdy baby, who owns 15,000 acres in Cheshire, 11,000 in Wales, 100,000 in Scotland 900 in Shropshire and thats just for starters. He has an estate in Fermanagh, shopping centres in Vancouver, a land development in Hawaii, 13,000 acre sheep farm in Australia and 300 acres of Mayfair and Belgravia back home. This last little plot alone is worth a cool billion quid, making it probably the biggest
stash in Europe. He's in his twenties and terribly camera shy. We're sorry we can't find his phone number, but he's definitely our TOP OF THE SHITS.

LAUGHTER

NOTRE DAME OCCUPIED (Hymn music)
Supporters of the Radio Libertaire, the Paris based anarchist radio pirate occupied the Notre Dame Cathedral on Saturday 5th November to protest at continued State Harassment.

BREAK STRAIGHT IN

ANGRY...I'm Angry (poem with backing cue tape ready)

TRUMPETS (women's voice)

LADIES AGAINST WOMEN ('Gismo My way' fade in)
Yes girls, you too can be a real lady, just listen carefully to our MANIFESTO.
1) Make England a MAN again..invaade abroad.
2) Protect the rights of the unconceived..sparems are people too, yet millions are murdered daily!
3) Restore Virginity immediately as an O level requirement.
4) Suffering not Sufferage. Let's get women out of the polling booth and into the maternity ward.
5) £20.00 an hour is TOO MUCH for women. It's quite un-lady-like to accept money for working!
6) Burn homosexuals. What was good enough for the dark ages is good enough for the Thatcher years.
7) SPOFication not recreation...reclaimise sex close your eyes girls and do your duty for Britain.

That's it girls, so hurry up and join us now, yes we Ladies against Women are seen and not heard...join NOW and be seen at urgent un-ladylike events in proper polyester attire, defending Ladies against Women.

(Man's voice)
To find out more...send your name, address and husbands permission to Ladies Against Women, The Thatcher for Ayatollah Committee, 4 Whitehall St, London EC1.

Donations, including Krugerands or cheques from your bubbie or father are ALWAYS welcome. Mistrans is powerful! Why not ask them to join our men's club?...Ladies against Women supports the Moral MANopoly. We have the monopoly on morality...and God Incorporated is on our side!

TRUMPETS fadeout to Poison girl. I'm not your fucking mother.

Intro...INTERNATIONAL

And now listeners for some sad and serious news that has come to us from VOLYA, the bulletin for Solidarity with the Soviet Working Class.

We are sorry to report the arrest last summer of the mathematician Valery Senderov, a member of the Soviet Free Trade Union, SMOT, on a serious charge of preparing and distributing SMOT's underground info bulletin. He is still in prison.

Also arrested is Natalia Lazareva, for her activities in the unofficial women's movement. She has been charged with anti-Soviet agitation and propaganda.

Still in the Soviet Union, and Big Brother is here too. We report that the Soviet Press has recently been honouring the 50th anniversary of the death of a Young Communist informer, Pavlik Morozov, who effectively killed his own father by denouncing him in the purges of 1932. Pavlik was then killed by his grandfather and cousin in revenge and then they too were shot. Pavlik was then built up as a Stalinist hero, lauded everywhere by the State, with a statue and a Museum in his home village. Now the Morozov story is kept alive to revive the purge atmosphere. Most Russians assume that at least ten people work part time as State spies. The CP Centre will no doubt figure for instance bits on average 1500 letters of denunciation every day...

INTERNATIONAL fade up and down
And now a word from Hungary, where there is consensus to join the army, and a growing number of conscientious objectors. One of these, Tobor Paks, was arrested in the University church for staging a hunger strike to protest the confiscation of his passport. He was transferred to a psychiatric where he has 3 teeth broken by wardens while being forced. The institutions 'experts' stated that he was suffering "negation of food" and "erroneous belief". Happily he was eventually set free after protests by Hungarian Intellectual and Amnesty International. This comes from the Australian journal, Profil.

INTERNATIONAL

You can get a copy of the latest VOLYA bulletin for solidarity with the Soviet Working Class, from 83 Gregory Crescent, Eitham, London SE9.

And now for another poetry spot...this one was written on June 22nd this year by the 18 year old Jimmy Hayes at Ashford Remand Centre, the notorious youth prison, where he was being held for petrol bombing Teddington police station on 3rd March at the height of the Falklands War.

That July Jimmy was found mysteriously dead, hanged in his prison cell, alone...These are his words.

(St London voice)

"I don't want no part
Of your death and glory
I don't want to rot
Under wooden crosses
I ain't going to die
For your fat rich bosses
I don't want a letter
Saying I died a hero
I don't want a wreath
Its just a colourfull zero
I don't want no tales
Of patriotic deeds
Cos its off our deaths
That your system feeds".

MUSIC...For J.H.H..CRISIS...PG54.

We hope to have more of Jimmy Hayes' poems next week. Meanwhile, to round off this feature of The Message on a lighter note, we go over in a minute to our regular agony column with Auntie Annie.

OUR RADIO..JINGLE..AD...

Dear Auntie.....middle class man's voice...
I am a young go ahead business exec. in a consultancy firm. I have my own house and a sleek car and a nice little wife. All appears well, but still I'm dissatisfied. I'd really like to get to the top, or get involved in a really exciting hobby. Your advice please. Yours ever...Alienated.

Dear Alienated.....(women's voice)
Yes I quite understand your terrible problem. My advice is to go down today to the Centre Point building in London. Take a lift to the very top. Open a window, break it if it won't open. Consider the panoramic view, and throw yourself out.

......with love......Auntie Annie.

Sound Effects FALLING CRASH LAUGHTER

Dear Auntie.....(women's voice)
I have a problem. This man keeps following me home from the tube at night. Sometimes he follows me right up the stairs. Today I yelled at him to F**k Off, but he just stood there looking at me in the shadows. What can I do?

......yours.....desperate.

Dear Desperate
You're quite right to be worried. My advice is to get a gang of women together, wait for him in a quiet spot. Then beat the shit out of the bastard. Can I come?.....Auntie.

Barking Pink Panther theme fades in and out.
And here is a quick word from our sponsors

ARE YOU running a prosperous business? Wealthy but would like to get richer? Pompous? Self seeking? Open to corruption???

If you answered YES to all these questions then YOU are the sort of chap we want in THE FREE MASONs!

And here is what you get!! (faded in and out)

A super pinny to keep your pants clean when making Dirty Deals....The knowledge that you are part of an elite group helping to keep Britain where it is...a super clip to keep your trouser legs hoisted!

Sounds good?? but there's a little catch. We have to approve you (we can't have any old riff raff). A big car and wage packet are a definite plus.

Contact us now. If you're a suitable candidate you'll be fully trained in the art of corruption and finally will pass through a silly and embarrassing CEREMONY full of mystical gibberish and hoisted trouser legs!

Note: Sorry ladies, this isn't for you...But if you ask hubby nicely he might bring you along to an overpriced ad exclusive dinner!

Music fadeout

If time, Barrier Block + Berlin Evictions

Well we're sorry thats all we have time for this week. After a very short crackle and click we'll pass you on to an hour of Women on the lawns, then Gaywaves. Radio Solidarnosc and finally late night music from the good, the B&G and the ugly. fade in The Message theme. 'Don't push me cos I'm close to the edge.'

Radio Arthur

(JULY 1984, Breaking in on top of news bulletin of Radio Trent, ILR station)

A: Coal Grandad...what coal?
B: Coal's what made this country the workshop of the world.

From coal we've built an empire. We've fought two world wars and won. We exported coal all over the world. We had the finest coal industry in the world, and the finest miners.

A: But Grandad...what happened?
B: I'll tell thee, lad...Now, as I recall, a Tory government got into power and then the greedy, fool closed down the pits destroyed the mining villages and sold off beds' pits to highest bidder. In the end there was nowt left to the mining industry. It was a terrible and shameful waste to the nation's best assets. It were an absolutely terrible, terrible shame.

C: Mr Oppenham! Wake up Mr Oppenham, you've been dreaming.

A: Dreaming? That were no bloody dream, that were a nightmare. Comrades, don't let your coal industry become a thing of the past...Join the strike now, and never forget that today's blacklegs are tomorrow's dole queues.

(Note: The start of this script is take-off of a Unigate Milk AD and not a piece of rightwing nationalism! Ed.)

(Choir music, followed by the epitomised Northern tune 'You're a Lady' by Peter Skellern. Fade to...)

B: It is not the normal practice of this radio station to read extracts from the newspapers, but this particular article has a special significance and highlights the real dangers of privatisation, which are to smash the trade union power, to make the work force totally subservient, and to close down and asset strip any section of the industry that does not show enough short term profits. The article is from the TIMES newspaper...

(Reading of a newspaper clip relating to a cabinet sub committee discussing 'private investment' possibilities for the NCB)

B: So there you are. And that from the TIMES newspaper. This could well be the fate of the Nottinghamshire coal pits...wholesale destruction of the industry. You have been warned. Join the strike now and help to fight against privatisation.

(More music...)

B: This government is committed to destroying the NUM at any cost and, according to the City Of London analyst. Phillips Andrew, has spent £5 million a week so far. Truly amazing. Millions of pounds spent on smashing a trade union...while doctors turn away sick people from hospitals and, in some cases, send them home to die in misery for lack of money for the health service. I wouldn't trust these Tories to run a public lavatory.

(Glory, Glory Hallelujah...)

B: We were very pleased to see our brothers from Cortwood in Nottingham on Thursday August 23rd. The men from Cortwood are marching to the TUC Conference in Brighton. We wish them well and Godspeed.

(Welsh Choir...)

B: To the Nottingham working miners I say this. If you want to save the pits, don't believe the lies that the Coal Board tells you. Don't believe the renegade strike breakers. Don't be fooled by what you see or hear on the media. Listen to what your union tells you. We care about the mining industry, jobs, the future...And now is the time for you to join the strike!

(Glory, Glory Hallelujah again, building to His truth is marching onwards!)

Voice of Arthur blights the air

GUARDIAN 22/8/84

Political pirate radio, a rarity in Britain, is rearing its head again. It has nudged its way into the collimbers' strike on the side of Arthur Scargill.

It is the first recorded instance of a pirate radio station going up in the face of official material from Radio Enoch stopped in its tracks by broadcasters.

When British Telecom announced its decision to 'gag' pirate stations got going. That was in the beginning of last year.

The pre-Scarfill pirate radio is causing the Department of Trade and Industry (which has now ordered the broadcasts from the air) to investigate the side of British Telecom prior to its privatisation, even more bywire. Britain. It is, of course, a problem, because it is the first time that a British Telecom order has been broadcast.

The Department of Trade and Industry's order directed at the owners of the radio station to cease operations immediately.

The Communications Act 1982 and the 'Carriage Service Agreement' have been going on in the Nottingham area on the same medium wave frequency (198 kHz) as Radio Trent.

NTV Trent. Earlier this week the transmissions were broadcast to the Home Office and the DTI, unfortunately the DTI is also short of staff in the Nottingham area which has cut down investigations.

Mr Nigel off the press would not say whether the raid would be 'punishment for the invasion of pirate stations' by independent Radio System.

'The transmissions were highly illegal and we would not hesitate to act,' said Mr Nigel off the press who was visiting the Enoch radio station.

For the past six weeks the 'pre-Scarfill Pirate Radio has been on air only spasmodically, exactly at the same time as Radio Trent news bulletins. Mr Cols said that he was not suggesting that Mr Scargill personally was broadcasting, but extracts from his speeches could have been smuggled into radio, television or live meetings.

Mr Cols has been informed that he will be investigated by the Broadcasting Standards Commission for his part in the 'broadcasting' of the 'Carriage Service Agreement' which has been broadcasting the 'exortations' of Mr Scargill against a background of martial music or 'Party's Jerusalem'.

'Rather they think that it is in the public interest and are angry, or they know it is not our interest, but think we are doing nothing to stop it,' said Mr Cols. 'But it is difficult to stop because it is too far away for even the police.

Mr Cols heard of the 'broadcasting' of the 'Carriage Service Agreement' from a fellow radio caller after it had been broadcast on VHF frequencies.

'It is at the heart of the government's attempt to control the airwaves,' said Mr Cols. 'If it were not illegal and we were able to stop it, we would have been done for a long time ago. Mr Scargill was not the only one to bebroadcast to, but it is the first time that a British Telecom order has been broadcast.'

Radio Trent has complained to the Independent Broadcasting Authority, the Home Office and the DTI. Unfortunately the DTI is short of staff in the Nottingham area which has cut down investigations.

'If there was no legislation, it would not be so difficult to stop,' said Mr Cols. 'But it is the first time that a British Telecom order has been broadcast.'
The aim of this section is not to attempt any comprehensive view of pirates around the world, but to illustrate some examples and experiences useful to the small ‘Do It Yourself’ pirate broadcaster today.

The Italian Explosion

It all happened in Italy after 1975, when hundreds of FM political pirates (left wing) took to the air. “The idealism of that first hour, when we thought we had found THE medium of communication... by and for the masses”. Round the clock discussions were the order of the day, as literally everyone seemed to be on the airwaves! There were ‘autonomists’, housewives, anarchists, squatters, workers, women’s groups, intellectuals, marxists, etc, all clamouring to get their views across. Everyone spoke and sang and put out an incredible range of programmes. It was a revolution on the airwaves. “We did it for contra-information, against the media and the monopoly of the RAI... what went wrong in the end? Or was it just the ‘live fast die young syndrome’ at work?”.

In 1975 there were suddenly hundreds of such stations in Italy. But by 1980 there were only 10’s, and by 1985 probably not one.

The first repression of 76 to 77 was quite severe, but the pirates just kept coming back on air and had plenty of support. Then in 1977 a new tactic by the state... the law was suddenly changed in our favour or so it seemed, as the RAI (State media body) was declared to be ‘without authority’.

But this soon proved to be a curse in disguise as swarms of commercial pirates began taking to the air. A long losing battle took place, as their more and high powered transmitters literally blotted off the airwaves, one by one. A prime example of “free” capitalism destroying the creativity and collectivity of the people. By the end of 1977, as their numbers increased above 2000, commercial party bosses began putting stations of up to 40 on the air.

The big commercials brought back uniformity of programming and less and less spoken word. To raise their advertising profits they formed national chains, buying each other out and standardising their reactionary ‘formula’ programming.

As all this was happening the political pirates were themselves being divided, reflecting and reproducing the arguments then tearing apart the Movimiento (Movement) itself, before stupid acts of marxist terrorist resistance gave the state...
Netherlands

Pirate radio here began back in 1974, with popular sea pirates like Radio Veronica, followed by a wave of successful land based Medium Wave pirates. In 1979 the police were prevented from seizing the transmitter of Radio Paloma by 100's of outraged listeners.

The first FM pirates appeared around 1980, and the growth of the autonomous squatters movement after 1979 led to the first wave of Action Stations. The Vrij (Free) Keizer Radio was named after the huge squatted complex in the Keizersgracht in Amsterdam centre, where it broadcast from, and which proved impossible to evict. Others of the Action Stations still broadcasting today are Radio Rataplan and Radio Vrij Den Bosch. These stations broadcast mainly squatters and resistance news and music, and went live during big demos and riots. The police mainly tolerated them, except during demos etc when there were some heavy confrontations.

The Vrije Keizer was the main alternative pirate, dividing up its wavelength to allow womens groups, local squat groups, anarchists,ethnic groups etc to do their own radio, but many other stations followed in other cities and towns (eg. Stads Radio, Oranje, Zware @ , etc.) Many of these no longer exist, partly due to the relative decline of the movement after 1988, and partly due to police raids. Also the format of such stations has changed, with more stress on sub- and anti-culture, and less on direct action (but this may change again). Nevertheless some excellent pirates, including the Vrije Keizer and also Radio Rataplan and Vrij Den Bosch survive as brilliant examples to the rest of the world.

The number of commercial FM pirates exploded after 1980, with estimates of 6 to 10 thousand (Insiders say 10 to 20 thousand) pirates totally overwhelming the authorities. But this does not seem to have 'blotted out' any of the Action Stations, as happened in Italy (perhaps this has some relation to the flat ground?). Each year about 3500 pirates are raided, and there has been heavier repression since the start of 1985, but it still fails to stop them. There is a State plan to open up Cable Radio, in 86/87 as a means to divide and rule the pirates.

At the end of 1985 there was a youth conference in Amsterdam for pirates from around Europe. At the same time a new station, Factum FM had opened up, and also the 'Radio Cafe Marconi' which was a development of 'open Microphone programmes, with the aim of direct participation.

By 1986 times were changing, though the squatters were being slowly defeated the struggle had broadened a lot, with a whole range of Direct Action groups attacking sexism, racism, militarism, nuclear power,apartheid, pollution etc, giving the pirates plenty to report. In 1984 Radio Got had developed a wild new style, starting from the Vrij Keizer 'stable' it soon distanced itself from the Movement to take in a wider audience. Activists saw Got as a trendy sellout, while the producers claimed they included all the action news, while adding their own music programmes. And they did broadcast live from mass squat centre of Wyers, during the struggle to evict and demolish it for a Holiday Inn. Got died soon after, and some of her crew went into legal stations, as predicted, while others joined Factum FM, to make radical news and documentaries, as well
as drama, experimental music and open access pro-

Vrij Keizer Radio

The Vrij Keizer Radio (VKR) was born of the Amsterdam squatters movement, and has stayed a part of it ever since, reflecting the breadth and creativity, as well as the internal contradictions of that movement. It began at the end of 1979, broadcasting from six heavily barricaded squats, known as the Grote Keizer, in central Amsterdam. After the victory of the Vondelstraat Riots in Feb. 1980 the Grote Keizer became a symbol of freedom and a bigger problem for the State. VKR began as a small local FM pirate at the beginning of the FM pirate boom, and broadcast on 101mhz throughout the gigantic 'Queens Day Uprising of April 30th,1980. The Grote Keizer could not be evicted, instead the Council bought the houses, and allowed the occupiers to stay there...on the condition that the Vrij Keizer Radio should MOVE OUT! But this divide and rule tactic turned out to be a blessing. VKR got itself a bigger transmitter and started broadcasting for 2 hours each day from a squat in a different neighbour- hood (moving each day). This brought much wider support and interest, and many different groups came and went. For a long time the line-up was Womens Radio (Vrouwenradio) on Tuesdays, Anarchist Radio on Wednesdays, the Pijp area on Thursdays, weekends from the Central area, etc. The radio went on like this for years, basically different groups sharing a transmitter and moving it about, but it wasn't strong enough (or high enough) to cover the whole city, and interest wasn't that high, except during actions or evictions.

RIOT RADIO.

Whenever there were actions, riots or evictions on a big scale everyone was suddenly tuning in to the Vrij Keizer for the real news. For instance during the Oct 82 'Lucky Luyk' evictions and resistance the VKR went live throughout, with on the spot interviews and instant information on police movements. This could be done through reporters and phone-ins, as well as a direct phone line we had with the 'Scanner Group'. This Scanner group are basically radio 'buffs' who tune in to the police radio (which is not on a public wave band as it is in the UK) and follow them with computer scanners. Important police communications are now 'scrambled' but it wasn't long till the Scanner Groep had their own de-scrambler. Activists carried small radios with them, often with earphones under their hoods, tuned to VKR, they often knew in advance the exact movements of the mass of riot police, and could decide their own response in instant street meetings. In fact it got to the stage that, with all resources and people, we had a better picture of the battle than the police themselves, and they too were tuning in to VKR to find out what was going on!

During that particular 'Lucky Luyk' eviction the police made a major attack on the Teaterode squatted buildings from where we were broadcasting, but when our listeneners heard it reinforcements rushed to the area, and the police had to fight their way in only to find they had seized two transformers instead of the transmitter! Within an hour VKR was back on the air, playing a crucial role in the struggle. There have been several other police attacks on VKR when broadcasting 'riot radio', but up to now they have never captured a transmitter.

By 1983 the weekend 'Central Amsterdam' group (mainly music) wanted to split off, with the reason that VKR was 'too unprofessional'. The solution was to build 2 new transmitters, and keep the present one as backup. These were payed for by donations, and the new 'Flux' squatters discos which had begun in the Teaterode. The weekend group became 'Radio Got' (Ggod) with a big new 200watt transmitter which they shared for a time with the Vrouwenradio (women's), while the Anarchists and the Pijp group shared a 100watt rig. All the groups still used the same 95.5mhz wavelength, and co-operated for evictions, but otherwise not with Radio Got, who the others considered too trendy and becomes. The new transmitters covered the whole city, and better aerials and broadcast sites were also used. More volunteers came forward and things got better, with lots of brilliant programmes, especially on squatting, anti-militarism, anti-nuclear anti-sexist and third world struggles, as well as many discussions, open microphone sessions and lots of recordings of live bands. VKR also occasionally broadcast gigs or conferences live from squatted buildings. By this time programmes had become more structured, with regular news times, and background programmes and features.

VRIJE KEIZER TELEVISION 1982 - 83.

In late '82 a gang of TV pirates suddenly appeared, broadcasting through the cable television networks. (Amsterdam is all cable) They did it after the regular channels had closed down, with a legal hitch in stopping them because the Cable company's constitution said the cable had to be used for commercial purposes, and not for squatters bars etc. This was the first ever anarchy squatters pirate TV, and of course it was superb. Making and editing videos is however time consuming, so they used the work of making a cassette tape (at least for radio. Before the VKTV really got itself going well the Cable company got around their legal problems and switched off the pirates. The VKTV group kept going for a while, making their own videos
trying to get a regular TV transmitter together. This latter proved too hard and expensive (since everyone was on cable) but the videos still come out.

RECENT HISTORY

1984 brought new problems and challenges, with the decline of the squatters movement. The Spuigroep (anarchists) finally stopped broadcasting on VKR, and 'non-commercial' music pirates began on the same frequency, these were WHS, Rabotnik and RVZ (a student pirate) and co-operated with Radio Got who had become popular, had their TX stolen twice (probably by commercial pirates). The Womens Radio stopped sharing with Got, which split in two and Radio Twist (an anti-commercial music and politics group) was born. Then the Black Womens Radio began as well, and the new line-up was VKR... Tues,Wed,Thu, Radio Got..Fri & Sat, Radio Twist... Sun afternoon. Womens & Black Womens. Sun Eve.

Due to regular fortnightly meetings the various groups managed to co-operate in sharing equipment, frequency and often studios, despite their obvious political diversity.

At the present time VKR reckons to have about 1000 listeners at any one time, with everyone tuning in for evictions or major demos. Recent feature programmes have included: Anti-prison, the junkie problem, the anti-Olympics campaign, Co-ops, Ireland/Nicaragua/Iran/Sth Africa etc, a regular squat news programme, the anti gas price increases campaign, phone-ins, music, etc. Just now we’re interviewing old people about their youthful experiences.

For a while a left wing Turkish group joined in on Monday evenings, before getting their own station together. But shortly afterwards their station (Halk Der) had to close after heavy fascist attacks. VKR itself then came under attack, after we made a programme about the Turkish Fascists, the Grey Wolves, and their “democratic” fronts, with the names of those involved (often getting Council grants) The programme was jammed out twice by the fascists, but went out the third time, starting a scandal. They did not attack our transmitter site, which is a heavily fortified squat with good escape routes.

In 1985 there were further changes. Radio Twist split off and Got died finally. Radio Factum began their Radio Cafe Marconi. A new Grachten Radio (Centre) joined in, based on the big Frankrijk squat, cafe and pub, and finally a German group began International Radio (½ Dutch ½ German) on Fridays.

Due to regular meetings these diverse groups got on OK for a while, but eventually Rabotnik, WHS and Factum got together on 100mHz. By late 86 VKR had actually closed down, but may now be back on the air.

ZENDER: good mag about Amsterdam pirates. From Postbus 10696, 1000 LB Amsterdam.
SWITZERLAND

LORA. Postfach 477, 8034 Zurich, Switzerland.

West Germany

"Radio must be changed from a means of distribution to a means of communication" wrote Bertold Brecht in 1932, and it is as true today. In East Germany the State has taken total control of the media, while in the West an unholy alliance of State and big business contrives to be nearly as authoritarian and restrictive. Historically the German workers have been among the first to practice free radio. During the 1918 uprising and Revolution people took control of radio stations and illegal radio broadcasts (ArbeiterRadioBund) persisted throughout the Weimar Republic.

Despite well organised and very serious efforts, pirate radio has now been all but wiped out (but for one notable exception) in the whole of West Germany.

The Action Radios still exist, but have been reduced to doing 10 minute programmes, with new names every time. And unfortunately there aren't enough 10 minute pirates on one wavelength to make them worth listening out for. The repression of any non conformist views, actions or even dress is now very heavy, with the squatters movement wiped out completely and activists continually persecuted by the computer controlled police force. It takes ten minutes from when you switch on your transmitter before a gang of riot police break down your door. Hence the 10 minute pirates. Such pirates can also occasionally be heard in the Eastern Bloc (eg Radio Solidarnosc) and in the USSR. The action stations are always trying to reappear, for instance during big demos (eg the broadcasts from moving cars during the StartBahn West campaign against the new US airbase at Frankfurt). In Berlin, Radio Metropolis now broadcasts from the Eastern Sector, where the position is slightly easier, and Radio Gaga still exists as far as we know. There are no commercial pirates to worry about in Germany. Another popular method pioneered in Germany is Break Ins (See How to Broadcast Section), quick interceptions of programmes on local or national radio, usually a quick message about a demo, or a responsibility claim for an action by one of the increasing number of guerrilla resistance groups.

RADIO DREYECKLAND

The only and total exception is Radio Dreyeckland, whose story is an inspiration. It was begun back in 1977, by a coalition of French, Swiss and German anti-nuclear activists, who broadcast across the borders from mountainous forest to France and to the Freiburg area of Germany.

Radio Dreyeckland began with a weekly dual language programme and the police and PTT (French) had no luck finding the transmitter, despite attempted raids. After 1981 they were tolerated by French authorities and the station split into five different transmitting sites, serving different local areas in Germany and France. By 1984 they were doing 2 hours a day, and then jumped to 6 hours a day, with broadcasts from France beamed to mountain/forest transmitter and re-directed into Germany. The original anti-nuke pirate was also still going strong.

The daily news programmes deal in subjects like the environment, 3rd World, gays, prisoners
ethnic minorities and the independent music scene. By this time Radio Dreyeckland had much support in Freiburg, with democratic listeners meetings, support gigs, membership, donations etc. The pirate receives no state, party or commercial backing of any kind and is all volunteer, except for a few office workers. The French part is now legalised, but in Germany you can’t even apply for legalisation! However in 1985 the German State put out feelers about licensing some commercial stations. Radio Dreyeckland responded by coming down from the mountains and attempting to broadcast in Freiburg itself!

On 20th April 85 Radio Dreyeckland began to broadcast in Freiburg, from a studio open to the public. Five days later in a massive police raid the entire building was smashed to bits, despite hundreds of people turning out to defend the station. But the transmitter could not be found anywhere, and meanwhile a second hidden transmitter was continuing the programme! Ha Ha.

In July there was a second raid, again everything was destroyed, and people were badly beaten up by the riot police. But again...the police COULD NOT FIND THE TRANSMITTER! Obviously Radio Dreyeckland had spent years in the mountains planning this strategy! There followed house raids on radio staff and supporters, confiscating much gear and personal possessions. But by now support and goodwill were at a very high point, especially in Freiburg, and after a summer break Radio Dreyeckland came back on the air, broadcasting 6 hours a day from Freiberg.

Radio Dreyeckland. Hatsburgerstr. 9, 78000 Freiburg

Spain The next to Go

At the end of the 1970’s Spanish radio was still much like that before World War Two in the rest of Europe, thanks of course to the fascist dictatorship of General Franco. A year after his death the State monopoly of radio was broken, and a year after that the first Free Radios appeared, along with commercial pirates.

In 1983 all the Free Radios in Spain united in the CRLE Federation and agreed on a common charter, to fight against commerce on the one hand, and State censure on the other. They voted to:

1) Keep independent of political parties and trade unions.
2) To promote independent artists labels.
3) To transmit only with a limited power, so as many as possible could get on the air.
4) etc.,

There are by now hundreds of good Free Radios in Spain, for example Radio Pica, broadcasting alternative culture, news and listener participation, 22 hours a day. Or Radio Luna in Madrid, more interested in anti-militarism, prison struggles, squatting, etc., broadcasting 6 hours a day and supported by its workers.

There are also some independent anarchist stations among the pirates, for example Radio Libertaria in Valencia.

Denmark

There aren’t any pirates that we know of in Denmark. Two years ago 84 stations were legalised for a 3 year experiment on local radio and were given 10watt FM transmitters. Of these about 10 could be described as progressive, but only one, Radio Sokkeland, in Kopenhagen, is run by alternative groups. In Radio Sokkeland about 100 activists put together 45 hours of radio a week. Its mostly aimed at young people. Commercials are prohibited, cash is given by groups linked to the stations who can make programmes on the same basis as the workers, taking a part share in the technical and administrative work. Some of the Sokkeland people had tried a pirate station, a year earlier, but it was raided and sunk by the police within 48 hours. Now as long as they can say what they like, they don’t mind being legal. There is some frustration, however, for instance an anarchist radio worker was put in jail in Aarhus for advocating an action on the air.
France: Political Battle

The pirate explosion in France in the late 70's was heavily repressed by the right wing regime led by Giscard D'Estaing, and there were a long series of busts, seizures and arrests. In France the battle was intense from the start, with many thousands of people involved in Free Radio (partly due to heavy political control of the 'straight' media) and the State taking the 'danger' very seriously.

The first to transmit regularly was Radio Verte in 1977, soon followed by stations like Radio Lorraine of the Longwy steelworkers and Radio Verte Fessenheim, an anti nuclear station in Alsace. The Federation, L'Association pour la Liberation des Ondes, ALO, (Free The Airwaves) began also in late 77.

In the run-up to the May 1981 General Election the continued repression of the pirates became an election issue, with the ascendant socialists supporting legalisation, and even setting up Radio Riposte, their own pirate, which of course got legalised when they won. After May '81 there was a huge explosion of cultural, music and political pirates all over France, with seeming 'carte blanche' from the new Socialist Government. But the State moved quickly to control the situation. From 1982 a number of 'Radio Projects' were indeed legalised, along with some of the Free Radios, but those favoured were the big commercial pirates, with their uniform music and style, while the State tried to keep a monopoly on the 'serious' radio listeners. It became very difficult for the smaller militant radio pirates to survive and fight off the superior power (in watts and money) of these commercial and State stations. There were by now several Federations, the FNRL with 300 stations wanted to remain non-commercial, with 'civic participation'. Repression began again, gradually, against the smaller militant stations who couldn't or didn't want licences, but also against the wave of unlicensed commercial pirates. The government was hostile to an 'Americanisation' of the airwaves, and took note of what had happened in Italy. This worked in favour of the militant anti-commercial Free Radios, though some left/cultural pirates also wanted to sell advertising.

One major success story is that of Radio Libertaire, the station of the French anarchist federation, which was raided, legalised, banned, raided and is now tolerated with an extensive listenership. (See next section).

Another from this stable is Radio Mouvance, which was started by an Anarchist-Syndicalist from Radio Libertaire in March '83 as a very radical 'youth experimental' station with open access to a range of left wing and minority groups and campaigns. Radio Mouvance refused to even consider legalisation, and began to broadcast 24 hours a day on an anti-racist, anti-fascist, anti-imperialist basis. It soon became a platform for many extreme left groups as well as anarchism, foreign workers, prisoners, 3rd World independence fighters (like the PLO and militant Kanaks), gays, etc. But it was the style of Radio Mouvance that made it so different..."it is a daze-hotch-potch, one minute hunger striking prisoners, the next minute press releases from Action Directe, then music etc. To facilitate this style and lively participation 5 different phone lines were plugged into the mixer at all times, leading to a brilliant, cacaphonic effect..."We don't want to be legalised at present 3,000 'projects' are still awaiting the licence. We say that licensing one means ceasing the rest, and the licensing process has everything to do with promoting business and becoming commercial. For example 15 of the 22 legalised stations have already been bought and sold again, even the 'radical' newspaper Liberation!"

Big money had indeed become one of the factors in the struggle. Mouvance itself had 3 failed attempts to seize their transmitter, followed by a successful raid by the police in July '85, but straight back on air, despite more threats of and arrests. The station is anti-commercial, much so, and functions by the support of listeners, workers, and from benefits. Its main demand is part of the FM band, 104 to 106 mhz be given for non commercial radio, with no further regulations by the State. With the return of Chirac and the right in 1986 the days of stations like Radio Mouvance were strictly numbered. There have been further raids and persecution, and as far as we know Mouvance is not presently on air."


FRANCE...LATE NEWS...Dec. '86

In Paris there are now about 89 stations on the FM band as opposed to a mere half dozen in most parts of Britain. Of course many of the French stations are pirates, including a lot of rock stations and minority stations, often sharing frequencies, for a dozen different international tastes. Still strong at the end of 1986 are Radio Libertaire (94.8mHz), Radio Mouvance (106mHz), Fresnais, anti-commercial station (97.2mHz), Radio Ici at Maintenant, Ca Remagnon, 105.2mHz, and many more.

The CIA station Voice of America, has a pirate repeater on 94.8mHz, and there seems to be one right wing pirate, Radio Solidarite, on 99.3mHz.
Radio Libertaire: long, hot Summer

There follows an interesting interview with "Laurent" of Radio Libertaire on the attacks on the pirate in the summer of '83, and how they were successfully resisted.

Magazine Libertaire: At the start of summer '83 what was happening with the FM pirates, was Radio Libertaire prepared for an all-out attack?

Laurent: The campaign began with a concert in support of Radio Libertaire, featuring Bernard Lavilliers, at the Olympia on June 30th. It was typical of the 2 months that were to follow: heated, rhythmic, intimate and full of surprises.

"Free Radios. Watch out for the Holidays" warned the headline of our weekly, Le Monde Libertaire, on July 7th. A few days before, Fillioud, the Minister responsible, had said that 11 complaints had been lodged against stations in Paris for "using frequencies without permission" and promised such pirates would be removed after a short delay to allow appeals under a plan by the Media Ministry. We saw this as a Declaration of War and began mobilising our supporters, listeners and sympathisers. A hot summer was upon us.

Magazine Libertaire: Was this kind of campaign really possible in mid-summer?

Laurent: During a June broadcast Leo Ferre (an anarchist who is also the most popular singer/songwriter in France) had proclaimed "You can count on me if things get rough and you're put off air". And furthermore 1000's of listeners were saying "We are with you". This mass support in July '83 hadn't come by the flick of a magic wand. Friendships and political alliances had been forming on a daily basis since our first broadcast in Sept. '81. Through Radio Libertaire (mainly) the idea of "an anarchist milieu" had come back after a long absence, allowing us to escape from the "folkloric marginality" the media and politicians had relegated us to. Radio Libertaire reached 1000's of people. A minority were anarchists, libertarians and sympathisers, but the vast majority weren't in any broad agreement with our politics. Yet everyone had got a strong attachment to the station, and this was clear as early as summer '82 when the 'List of Authorised Stations' was announced without Radio Libertaire on it. With this support we were already facing up to our old enemy, the State, in confident mood.

The holiday season was however a big drawback, as a big proportion of our listeners were away from Paris.

Magazine Libertaire: How did the summer's events unfold?

Laurent: It started with a long period of waiting.
Radio Libertaire proposed a 'common front' of all the Free Radios, but unfortunately there was no lack of manipulations, provocations and attempts at recuperation (even the rightwing paper Le Figaro was doing somersaults, waxing lyrical about 'justice and freedom for the Free Radios'). We steered well clear of this type of activity, and our stubborn determination was to be seen far away from the backrooms where the government and Free Radio representatives were plotting...the liquidation of the Free Radios themselves! Our attitude gained us respect and we became an important example to the rest. On 17th Aug., just as it was being suggested that the government might back down, 'Carbone 14' was busted off the air, sending a shock through the FM pirates. Radio Libertaire acted immediately against the 'vandalism of the Carbon 14 studios'. But another station 'Frequency Gai' were quick to begin broadcasting on the same frequency, now allocated to them, and so shattering the so-called unity of the Free Radios.

At 6.00am on 20th August six more stations were raided by the CRS (French paramilitary police). These were 'Lumiere 101' (fundamentalist catholic), 'Made In Italy', 'La Voix du Cedre (Lebanese pirate), 'Radio Tiers Monde' (3rd World) who had all their gear smashed, and 'Radio Arabie Paris'.

That evening Filioud announced that 'the radio waveband is saturated, when a plane has 145 seats there's no room for 50 extra passengers'....

Magazine Libertaire: In this tense situation, what was the mood at Radio Libertaire?

Laurent: Tragic, cos we knew the seizure of our equipment was imminent, but our mood was fantastic. All of us there and the listeners and the militants of the Federation Anarchiste were prepared to fight to protect our station. We had no idea when they'd come so several teams were set up to patrol the area and to warn us by CB's if the police were coming. The studio was barricaded and we stayed on air 24 hours a day. The phones were ringing day and night with support calls. The government was mistaken if they thought the holidays would stop our support. We waited, hot and tense, till 5.40 am on Sunday August 28th...A militant had spotted police and the information was put on the air immediately. But by the time we could say they were definitely coming for us it was too late for supporters to get in. The police quickly cordoned off the surrounding area. The door was broken down by the CRS, those present were being beaten and kicked, and the aerial was cut. But we had got a phone call through to the pirate 'Ici Et Maintenant' (Here & Now), who began broadcasting news of the raid. Listeners and anarchists were already arriving, despite the early hour, but couldn't get through the CRS police lines. Further away militants in cars were being stopped by plainclothes cops pointing guns in their windows! Some Radio Libertaire listeners were beaten up as they were forced to watch the painful spectacle without being able to help. Technicians cut down the aerial, the equipment was loaded into a truck and driven away, and all those present in the studios were hauled off to the police station.

And that was that. Worse than the expected silence on the Radio Libertaire frequency 'France Culture' came on broadcasting early morning Mass!

There was no question of giving in. The raids were given the number one slot in the media. From the Anarchist Federation's HQ in Amelot Street the news went out to the 4 corners of the world: the response will be worldwide!

A little later in the morning the 'clean-up' of the FM band, so dear to Monsieur Filioud, was completed, as the CRS, using tear gas, seized first 'Radio Voice then 'Radio Mouvement' and finally 'Jet Théorique'. Twenty two pirates had been seized since 17th August.

Magazine Libertaire: What kind of support work took place.

Laurent: Outside of Paris the French Anarchist Federation groups did a variety of actions as well as petitions. But the international anarchist movement responded, with actions in Switzerland, Belgium, Germany, Italy, Australia, Japan, the USA, Mexico etc. In Madrid the CNT (anarch-syndicalist union) was received by the French ambassador, as was ANORG in Norway and the @ syndicalist Fed. in Sweden. The IFA, SIA and numerous groups, organisations and publications sent telegrams to the French Minister. In Paris a demo was called for 3rd Sept., which all the other Free Radios were invited. At this point the only way to contact Radio Libertaire was through the @ Fed. bookshop. A few other stations did great work, especially 'Ici Et Maintenant' in giving access to pirates who had been raided. Without stations of our own, we heard our listeners on other stations!

In a few days 1000's of tracts, posters and a special edition of Le Monde Libertaire were printed to tell our listeners of the demo. On the morning of the 3rd, militants who had hardly slept for 2 months were making the final preparations, putting loudspeakers into cars, finishing up banners, etc. The bookshop was packed, beating all previous records, and the 2 phones couldn't cope any more. The hour of truth was approaching. By 2.00pm there was no suspense...Supporters in their 1000's were streaming into the Place De La Republique. The demonstration streamed into the Boulevard de Magenta, shouting 'Radio Libertaire will not be silenced'. Banners...
ried reading 'Civil Liberties Union', 'Pacifist Union', 'CNT', 'Les Occupants Renouveurs', 'Libre Pense', 'CGT proofreaders', etc. People were in great mood. No one wanted to be a sombre funeral procession. Other pirates, including Radio Voka, Carbune 14 and Amplitudes FPI had responded to the call. The mood was festive as we began to arrive at the Barbes. Not far away, in the studio devastated by the riot police, Julian, our technician, was preparing the highlight of the day: Radio Libertaire, back on the air!

The microphones were attached to sticks of wood, and thanks to Julian's brilliant improvisation, it worked! The transmitter was set up and purring on the toilet seat. At 4 o'clock Lavilliers' 'Belonging To No One' was ready to be broadcast. If the cops returned this time there was nothing to stop them except the door which had already been smashed in!

The broadcast was heard, on some radios and via the sound gear we had set up in the demo, and was well received by the 1000s of people present.

Magazine Libertaire: What conclusions do you draw from this period of Radio Libertaire's history?

Laurent: By our determination we were able to go back on the air, and later to force the State to give us an infamous 'permit', whereas our enemies, who are very numerous, were saying our chances of survival were nil. Though the anti-anarchist laws are still in place, we have forced the state, the media and the rest to admit the existence of the anarchist movement.

The main thing that summer was that we discovered something new, which I think is crucial for the Federation and Movement: Radio Libertaire had found a true place in the heart of the public.

Translation by M.W. (thanks)

Belgium: Victory for Pirate Flood.

As in Italy and France the first Belgian 'Radios Libres' began in the late 70s, followed by a deluge of commercial pirates. After a period of tolerance the State began legalising some stations after '81, and by mid '83 380 stations had been legalised on FM. Those especially favoured being stations which had fallen back into the standard 'professional' routine.

There are two federations, Free The Airwaves is the voice of the 'Radios Libres', but is losing out steadily to the commercial Federation (GRIB). There is still a deep gap between the Flemish (dutch speaking) and French speaking communities, and this is reflected among the pirates. In addition the 'straight' Belgian media is quite politicised, with the French channels mainly supporting "socialist" parties, while the Flemish being mainly Christian Democrat. The "Liberals" (the fascist party) don't get much air time, and have sometimes joined up with right wing commercial pirates to get on air. In a recent scandal Radio Free Europe (a CIA channel) made use of a Belgian pirate. So there's a deep division between the 'radios Libres' and the commercial pirates. In addition, in the French speaking areas commercials aren't allowed on any channel. Its a bit confusing.

One of the least commercial and oldest of the FM pirates in Flanders is Radio Toestel in Ghent. Its half financed by benefits and donations and has a democratic structure with at least 80 volunteers. In 1985 Radio Toestel was given a whole frequency and went legal, merging with Radio Central from Antwerp. In Brussels Radio Air Libre has now also been legalised, despite its name its mainly an art and culture station, though it does allow groups to make their own programmes. It was with Radio Air Libre that Chantal Piatenostre was working at the time of her arrest and frame up for CCC bombings (see inside cover). We don't have more info at present about the radical FM pirates in Belgium.

Ireland

After a decade of confusion and a growing herd of mainly music pirates the Coalition Government have agreed amongst themselves to license a number of 'non-commercial, community managed' stations. There are already maybe a half dozen pirates calling themselves 'Community Radios' up and down the country, and this is good news for them, especially the famous Bray Community Radio. But the music pirates, some of which claim higher audiences than RTE the State system, will face a crackdown. Typical 'divide and rule' tactics. There aren't really any alternative music or politics stations on the air that we know of. Surprisingly Sinn Fein haven't got a pirate together, considering they're banned from speaking on state radio or TV. The Irish republic has also been a haven for international short-wave pirates.
The Rest of the World

Once you move outside Europe you're talking about very different cultures and political situations, and the experience of such pirates is not so relevant.

Radio is a part of the international battleground, the medium, for instance was used effectively both by Hitler's fascists, who excelled at mass propaganda, and by the French and other resistance partisans. After the 2nd world war almost every conceivable guerrilla and national liberation movement had its own 'pirate' stations...the Irgun, the IRA, Basque separatists, Kurdish rebels, Spanish or anti-communist exiles, etc., etc. During the Cuban revolution, for instance, there were at least 9 stations battling it out, 3 revolutionary and 6 run by the CIA and the Right. These included the famous 'Radio Rebelle' set up by Che Guevara in the Sierra Maestra in 1958, which set the tone for later resistance and 'people's' radio.

For the purpose of examining overseas pirates we can divide them roughly into five groupings: Commercial / Sub-cultural, alternative / subversive, anti-state / Community, participatory / and Revolutionary, nationalist.

In fact the label 'pirate' itself becomes quite meaningless, for instance in civil war struggles. And are not the superpowers, BBC World, Voice of America and their Soviet and Chinese equivalents, gaining of much worse than piracy in flooding wavelengths in every corner of the world with their more or less subtle power propaganda?

Central America

EL SALVADOR.

A good example of a classic revolutionary / nationalist pirate is Radio Venceremos in El Salvador, broadcasting from the liberated Marazan mountains despite continuous army and air force attacks by the right wing US funded regime. Radio Venceremos is the voice of the FMLN federation of guerrilla movements and began regular broadcasts on 10th June 1981, after a year of sporadic 'people's revolutionary radio' in the capital city. During the '82 elections the air force failed to bomb Radio Venceremos off the air, and they had to be jammed out by US vessels offshore. The station gives a completely different world view to the State media, and is well supported by the poor and dispossessed (50% of the people). Such radios are an essential part of building and participating in a pre-revolutionary movement, in this case one postponed indefinitely by US intervention and the Death Squads campaigns. One danger of such radio, is that it can perform be cut off from its supporters, and also lends itself too easily to institutionalisation as the 'party radio' of the new state after such a left nationalist revolution. Radio Venceremos has tried novel ways to gain audience participation, for instance in Jan '86 when they invited their audience to gather information on stunning targets for sabotage, and send it to a Box Number in Mexico City!

BOLIVIA.

Believe it or not there is, or was till recently a tolerated 'community radio' system in Bolivia, existing alongside the State and commercial networks. Since the 60's, for instance radio has been used by Bolivian miners in the course of their struggles and many mining towns have for various periods sustained decentralised, autonomous and self managed radios with permission from nobody, in the face of military dictatorship. Now most mines have been closed, resistance smashed and the miners dispersed as penniless day labourers amidst total economic collapse.

We don't have info on other 5th American pirates except that they are many. One is Radio Liberación, the voice of the Chilean Resistance, which does 'breast-ins' onto State radio and TV broadcasts, calling for strikes, demos etc., against the fascist Pinocchio regime.

The USA

In the US everything is free if you have the money. Radio and the media at large seem to be in private commercial hands, though much of it is controlled by huge corporations emmeshed in the State and the 'military industrial complex'.

So, its free to go on the airwaves, but: 1) It takes years to go through the licence procedures of the controlling body, the FCC. 2) It costs many 1000's of dollars. 3) To get such a licence you need to be a 'respectable hierarchically organised group'. With Boards of Directors, etc. 4) What they give, they can take away, if you did by some miracle get a non-commercial licence they would stop it at the first wrong move.

"Public" radio in the US began to be licenced in the '60s (in the US context 'public' means non-profit and NOT run by the state directly). By now one in eight stations are 'public'. One in five of these 'public' stations are in the Community Federation and thus claim to 'have no institutional affiliation', in fact they see themselves as some kind of social workers. The community radio movement (now 250 stations) was begun by the anarchists and pacifists of the KPFA station in Berkeley, SF, in 1949, and the anarchist principles were incorporated into the charter. KPFA still exists today, and is the mainstay of the Pacifica Foundation (5 stations one in...
Canada

Canada has a fairly liberal radio system and few if any pirates. In Quebec, 'Community Radio' is a legal alternative, and in some places is the main local station. This idea is also strong in Vancouver.

Japan, mini TX boom.

An intriguing loophole has created the possibility of legal piracy in Japan.

Technical ingenuity has created wireless microphones, remote control devices for TVs, garage doors and model planes all of which use small transmitters. To ensure they are legal, all transmitters which generate less than 15 microvolts per metre 100 metres from the source are excluded from the regulations requiring broadcasters to be licenced.

A tiny FM transmitter, broadcasting in the 76-90 MHz band, and within legal limits, can reach a radius of 0.3 of a mile, an exciting prospect in a crowded city. Manufactured primarily for CB enthusiasts, and costing £20, the technology was easily available, and with 9 months of the first tentative experiment 100 stations were broadcasting. Soon the media picked up on the phenomenon and there was an explosion. By August '82, just three months later, there were 700 mini stations! Once again the fantastic demand for access all over the world was evident. And, as always there were very different interests involved. The first stations included two which illustrate the differences. Radio Polybucket, started by free radio enthusiasts from Waso University; and the media wise Radio KIDS wanting an audience for their home-produced music cassettes.

KIDS was backed by advertisers wanting a liberalisation in Japanese broadcasting law, and when publicised widely ensured most pirates were what one Japanese, in his first encounter with a style which seems all too familiar to us, described incredulously as 'childish monologues with American pop music.'

Radio Kids

In Tokyo there are severe restrictions on street life because of the riots in the late 60s and after. Even stopping on the street without police permission is illegal. But the freedom of the airwaves enabled Radio Contemporain to create a completely new kind of event. Broadcasting from vans they put out a mix of rock music and political protest against the visit of the US nuclear carrier Enterprise. As youngsters walked the streets listening on their walkmen, the radio station drove amongst them. A mobile station and a mobile audience managed to have a demonstration, a public meeting and a benefit all at the same time!

The Japanese Government is worried, and have proposed ways of closing the loophole. But every day that passes brings new stations. How can they confiscate so many tiny transmitters, especially because they are so cheap to replace? And the draconian powers, not to mention the resources, needed to fully extinguish the movement would be out of all proportion to the harm they do.

Reflecting

Perhaps our own pirates are too eager to mimic normal radio, not just in content but in service area as well. Wanting to broadcast to a large population makes for relatively expensive equipment, and for fewer stations. If London were a maze of hundreds of small pirates enforcement would cease! And perhaps, as in Japan, the small scale would stimulate some real community radio.

CONTACT: TETSUO ROGAWA 20-1 NISHIHARA 2-Chome, Shibuya Ku Tokyo 151 Tel: (03) 466 3347
How To Be A Radio Pirate

What You'll Need

A. A group of committed people who get on with each other, and have plenty of time and energy.

B. A program, 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 on good quality cassette tapes.

C. A Transmitter. Ideally over 10 watt power, but 5 watt is fine for local broadcasting. This means that you can work on building the studio to the tower block, and be 'on the air'. A further advantage is that there are usually electric sockets in the lift or heating rooms on the roof, so you can plug in, provide your own sound equipment, and play your own music, or whatever you want, until you have your own station, or buy your own.

1) Buy one from another pirate (borrow of zip-off).
2) Buy one over the counter abroad (Impressions). In Italy for instance you can get a high quality 5W transmitter for under £50. You can buy kits in Belgium, but is not only cheaper but more

VHF: Pros and Cons

First let's deal with VHF (Frequency Modulated) broadcasting, which is your program. The advantages of VHF are many. The transmissions are small, light and quick cheap. Reception tends to be either very clear or non-existent. It is excellent for you and recording and you can safely be adapted to transmit stereo (capable with AM). A major plus for the pirate is that its easy to hide and transport the set, set, and cars are comparatively small and can be easily transported. Its also possible to put it in the trunk, in a car, or even on a bicycle, and go mobile, albeit with a matter and changing reception area. The average 5 to 10 watt transmitter would be in a net (not to be larger than 12-18k) by 12-18k by 12-18k in size, and weigh not more than 6 lbs with the rest of the gear and not including the one battery if you're using one. The aerial is 5 to 10 feet above the ground level, and the receiver is 2.5 to 5 feet. Something like this is a very good basic, and can be expanded to thousands of watts and miles. This is the reason why VHF is so popular for its ability to communicate in a line of sight, which means that you should be able to receive it from a distance of miles. The disadvantage is that VHF FM is essentially a line of sight communication...Which means that your reception area depends on your height of your aerial above large buildings. Objects which are closer to your aerial block the signal of the transmitters. A solution is to use an aerial in a distant city. A tower block is often a good aerial to use in a distant city. If you have a tower block you need a crowbar, better a key. The 'fireman's key' has to be standard for all areas, so once you have one you can get on most roofs easily. Try asking other pirates or possibly a friendly caretaker or landlord. Ce can be broken down the most normal look, get keys made up (or 1st, then replace, and keys may not fit all locks.

When on the roof BE CAREFUL (sudden gusts of wind can blow you over in this height)! Always wear soft soles and keep quiet. Lots of people have been hurt simply because the tenants below heard them and called the police. It is very dangerous to dress like a repairman, and claim you are or challenged, to be a lift mechanic. The main problem with Tower Blocks is that they are owned by the landlord, so you can easily be caught. (See How To Get Away With It)

How To Be A Radio Pirate...continued

The Broadcasting Site (FM)

TOWER BLOCKS

In cities tower blocks have been a real answer for good coverage and wide reception and are especially favored by commercial pirates (who often use the FM tower to broadcast 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 plug in, provide your own sound equipment, and play your own music, or whatever you want, until you have your own station, or buy your own.

POWER FROM GROUND

VENT

UPPER LIFT ACCESS

POWER FROM INSIDE LIFT

UPPER LIFT POWER

GROUND LIFT ACCESS

GROUND LIFT POWER

MEDIUM SIZED BUILDINGS

If you're a local station, or have a high power rig or a complex with 'rings' (or if you're just testing) you don't need to be on a Tower Block. Any building higher than the average office block is a good possibility, but make sure there is plenty of room on the FM broadcast band (literally half empty, and there will be more when the police eventually move on). On MW it is pretty crowded, and at night you're likely to be blasted out by continental interference.

THE BROADCASTING SITE (FM)

POWER FROM GROUND

VENT

UPPER LIFT ACCESS

POWER FROM INSIDE LIFT

UPPER LIFT POWER

GROUND LIFT ACCESS

GROUND LIFT POWER

MEDIUM SIZED BUILDINGS

If you're a local station, or have a high power rig or a complex with 'rings' (or if you're just testing) you don't need to be on a Tower Block. Any building higher than the average office block is a good possibility, but make sure there is plenty of room on the FM broadcast band (literally half empty, and there will be more when the police eventually move on). On MW it is pretty crowded, and at night you're likely to be blasted out by continental interference.

THE BROADCASTING SITE (FM)

POWER FROM GROUND

VENT

UPPER LIFT ACCESS

POWER FROM INSIDE LIFT

UPPER LIFT POWER

GROUND LIFT ACCESS

GROUND LIFT POWER

MEDIUM SIZED BUILDINGS

If you're a local station, or have a high power rig or a complex with 'rings' (or if you're just testing) you don't need to be on a Tower Block. Any building higher than the average office block is a good possibility, but make sure there is plenty of room on the FM broadcast band (literally half empty, and there will be more when the police eventually move on). On MW it is pretty crowded, and at night you're likely to be blasted out by continental interference.
drills'. Best place for the aerial is a high, easily climbable tree. If it's too obvious leave it up there and have a readymade aerial. Any major problem with its. is that you normally have to hijack at least one car battery about which a sensible guide if you have to climb fences, silhouette against night (wear gloves and old clothes against acid spills) and take something like a purse or change to help. You can't leave the batteries on site as they need recharging for your next broadcast. So maxin' electric is a big help if you can run a lead from somewhere else. Otherwise phone radio pirate friends, roadproof 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 if you need at least six people to operate a car battery. Hot drinks, food, sweetie strops for lookouts etc are good ideas. It gets boring after a few hours. Crib is excellent, but get ones with earphones if possible to avoid noise.

SOD THE HOUSEWORK! IMAGENNA BE A RADIO PIRATE!!

If on a hill you can even use an ordinary house, flat across or dormit, and just set up your aerial as high as practicable on the roof (escalating it up, top a spade pole, through a skylight). Its better to get a high aerial squating or if you're rich by nesting, specially as a broadcast site, no one has time to live under constant threat of the police storming in. In practice you may have to use someone's house, then down use is too often. If you must use your own place DON'T leave dope, stolen goods, fake ID's or other noughties 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 coax cable going to your aerial. More of this in the How to get away with it chapter NEVER have your antenna 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 low rig will do fine. Set up on high ground in a tent or vehicle, and invite the festival goers to protect you from police attack/such much unlikely

in these circumstances. If possible, make a 'live' studio in a tent/corner or truck and get everyone involved. Do some promotion, go to festivals, put up Free Radio Publicity, do your own stuff, people will be banning. This is pirate radio at its best.

HEMOS, 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 car can be used as a base for discussion information and warnings of political movements, as well as for entertainment and music.

BARRICADED SQUADS 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 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.

EIT-INS and protest occupations (e.g. Greenspace) are another good possibility, which we don't think has been used. Especially occupations of high, towers, or phone boxes for that matter. But your cause really, capture is pretty certain, therefore a small disposable transmitter would be ideal. A good strategy is for everyone to deny it and use any following trial for more publicity eg. on the lines that the array 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 many more true 'no go' areas in London, but there are plenty of inner city estates where the police rarely venture, especially in the evenings in the winter season, for fear of 'concrete rain' or worse from the roof. A high lock-in position such as this could be an excellent site, especially if you can top off the local youth to lend a hand. Whenever major rioting begins large areas are suddenly deserted of police, all the police groups in numbers and to take the area. This is another opportunity for 'on the ball' local pirates. By monitoring police radio, runners, and phones in reports such as 'uprising radio' could be brilliant aid to the fighters on the streets. (see Amsterdam in Int. Section) through you would need good security, disposable transmitter, quick getaway routes/disguised voices etc.

LIBERATED ZONES! (Let us know if you find one!) Practically every guerilla or Nat. Liberation movement has a high or left wing, has their own pirate radio, which are often crucial influence in

such wars, broadcasting from freed zones or neighbourhoods. Take care, but you're not likely to come across this in Britain.

INTERNATIONAL WATERS is of course a favourite

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.

HOW TO SET UP YOUR GEAR. (FM)

BEFORE YOU GO

Before setting out you had best brief everyone, newcomers, on what will or might happen. Talk about getting caught, for instance you have good evidence of being set 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 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 is left at home five miles away.

HERE IS A SAMPLE LIST OF THINGS YOU NEED

Transmitter (TX) / TX mains lead or 2 clips on battery leads (large & well insulated) / TX lead to cassette deck if not attached / cheap cassette deck plus mains lead or 3 clips or 3 main and 6 volt baterry / charged up battery / 12 volt isolated mains / antenna aerial / check you have the batteries fits / collapsible / or if you have a mast then you need a mast / mast not too thick / mast not too thin / mast not too long / mast / mast / mast (optional) plastic 'gaffer tape' / soldering iron and solder in case of broken leads / torch / warm clothes / matches / bus fare.

ON THE WAY

Ideally you need four people, at least two. Carry the gear as inconspicuously as possible, in holdalls or plakky bags. The antenna is a problem. If its a big long one make it collapsable, stringing 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, the judge might be a bit suspicious, 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 guy or a long enough lead. If there are two doors to the roof have access through both. Take your gear to the lift/lift room and find a plug in wall socket (on main.). Check it works. Wear gloves when handling gear, and clean it regularly with cloth and alcohol. They don't usually bother with fingerprint evidence but they might start. The antenna must be cleaned regularly anyway for good transmissions. Set up your antennas as high as possible, if possible on top of extension pole or length of scaffold pipe. Often there's a pole already, left by earlier pirates. Attach the antenna securely with bolts or strong gaffer tape, to a length of wood, in the bottom of the wood to the metal pole (if there). The antenna must NOT be touching or blocked by metal. The co-ax can be soldered or bolted onto the antenna, or attached with strong rust free one battery clips. The clips are recommended for fast dismantling and for testing and developing antennas mark clearly which goes where. The co-ax should be no longer than necessary, you lose power with every extra foot, and should be good quality and well insulated. Your lookouts should already be on station, with torches or Cine, one at the foot of the tower (preferably sitting in a car or flat) and one on the roof. Keep low and quiet and wear soft shoes (in one court case Eric Gotta (head of the DTI squads) claimed he recognised our Radio member from the ground.)

When the antennas is up securely, lend the coax back and plug or sew in to the back of your transmitter. Now plug in the TX to the cassette deck (TX-transmitter keying) and set the TX for the correct frequency, if possible blocked by something solid like a wall, to
GUERRILLA RADIO

This is one of the main ideas this book is trying to promote (see Chapter One). Guerrilla Hit and Run radio is the way of the future. First of all you can reduce the risks of getting caught. Secondly, it is broadcasting not at fixed times or with a fixed name, or by doing it only for half an hour periods. The program of course is that your audience is also random and small. This guerrilla idea is to get together a few stations broadcasting on the same frequency with cheap mass produced transistors, thus forming a whole bunch of stations which listeners would have a good chance of catching. The problem is being very difficult for the DTA age police to stop.

BREAKINS

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 (under legal radio) that 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 TV broadcasting that the strong signal is what's wanted. Blowing out the weaker one completely. With a small transmitter you'll only win for a short distance, but even a few hundred yards can cover a whole high density area. For break-ins strength of signal is the main factor, a big powerful transmitter (100w to 200watts) would be ideal, and your TX needs to be built and tuned carefully. The idea is that you can break-in with your signal on the most popular channel on prime time. For break-ins all preparations should be detailed, also be as clear as possible, use as much space as possible, 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 a short distance. Break-ins are most common in countries where prisons have been replaced, e.g. in W. Germany or the Eastern Block, and are ideal for sentencing demonstrations.

There is another and better way of doing break-ins on FM, which may have been used by Radio Arthur. The idea is to use the UHF transmitter beam, beam your signal on the microwave dish receiving the signals of their station. This dish then picks up your signal, and providing it is close enough (at least three to five degrees) to your signal, you will be rebroadcast by their main transmitter, thus giving your break-in perfect coverage throughout their entire coverage area.

However, we don't have technical plans to build such expensive UHF transmitters, and it would be quite expensive. Even if this type of break-in is possible, it's (to draw back) that they have to do it outside the entire station. They will probably make it more difficult by using access codes to receive dishes, and since it is 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 radio and watch, but you can also be better off having a separate 12 Volt battery to power the transmitter. One problem is the serial, if you use a bigger car, more efficient one will be very difficult. It's also very difficult to pack a complete talk on a roof rack. A bigger problem is the height, unless you park or drive up to a high hill, your coverage will be tightly blocked. And then you're running a long time, especially if you're driving any distance. Not much use for monitoring or developing an audience. The main advantage is that you will be much more difficult to detect.

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.

BREAKINS

In this way would be great fun in the early days.

LINKS, TIMER, SQUARE WAVES.

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

1. VHF RATHER LINK FROM STUDIO
2. MICROPHONE LINK
3. FM LINK
4. FM BROADCAST SIGNAL

CONFRONTATION

A good trick if you can get away with it. The DJ, and police, think you are bringing a few new wide open attack (the mouse becomes the cat) when coming to get you. The problem is that a future will have to change your station name, frequency, even your transmitters. They force you to switch them off on your trail. The good thing is that if they start thinking that they have to bring many more police with them, can only do it when police arrive, and then they are always lost on their way, and have to be more careful with their surveillance work.

One easy way is to use the VHF links, on tower blocks. Using a receiver instead of a cassette deck, then beam your signal from your studio or wherever, using a small UHF transmitter (eg on 270 mHz) or adapted cordless telephone, or an FM exoter on a different frequency (e.g. over an ordinary phone line, though sound quality suffers). You also have to make a small directional high gain antenna. If using a low power link and a narrow beam it has to be well tuned, so they are always lost on their way. The best way to do this is to switch the gear off and on remotely. Timers are pretty easy to build, and you can buy kits, but good ones are hard to find (technically) as they can be used to make a good one to buy a transistor that is in a plug in vane, used for timing engines when you are on holidays, or by teachers to design squirts. For remote switching you can also make sound activated switches, via a phone line (see diagram in Their Sect). What none of these devices can do however is turn over a tape, so you still have to go to the site to play it, unless you want to broadcast for less than an hour.
Building Your Pirate Station.

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

We're talking about the 'do it yourself' commercial pirate, starting from scratch, 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, repetetive, capitalist, sexist elitist and even 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, more commercial pirates are in a different situation, and can only survive and develop by cooperation, 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 hold of a microphone, radio and pluck into the air. Build your own, record yourself, record everyone. Listen and record off the radio, off TV, off people's stereos, in the street. Play back your tapes, see what you've got. Note down your results and ideas and discuss them with others. Read and find out everything you can about sound and recording and thinking 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 'bangers out.' 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 the tasks, risks and finances equally according to where they want to get. (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 tricks, ego trippers, party builders, etc., who are sure to turn up sooner or later.

A good point to start with is fund raising, running a stall, selling tickets, sponsoring events or whatever, which can count as a group.

gene and move it (switch off the TX first, then the sbox). Don't rip out the aerial when the TX is still switched on! 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 liver stuff on air, through fear 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, pooling of technical abilities, more political clout, more participation, bigger audiences etc. A good way to approach this idea is by having public meeting, contact Free The Airwaves Campaign, etc. Read the Open Access guidelines for regular democratic meetings of all involved (at least monthly) and insist on full attendance. You need a few good people to go into organizing and making it work. Another problem is with broadcasting. You should aim for everyone having their own gear and broadcasting team as soon as you can, so you will be more difficult to stop by the police and DTT. So you should insist on every group producing tapes providing at least two tapes. People rely on the broadcast team and to work on the technical and backup side of it (building, repairing, purchasing etc.).

Open Access stations depend on cooperation, you have any and all advantages you can get into play, but you are fighting all the time against our training, in this society, to be competitive and individualistic. 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 group. 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 (e.g. Community Policing). The old style communities are a thing of the past, they ever really existed. Instead we have Soap Operas, as the system breaks us all down into individual consumers. So if you're talking about "Community Radio" you should be quite clever what it is. "Community" means by proposing (and then cancelling) such an idea?

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 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 is far 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, 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 would be much easier to get, as is the possibility of mobilising people to defend you when attacked.

a popular station in the middle of a large housing estate. Local broadcasting in inner city areas can never reach the hundreds of thousands of potential listeners. Many of these 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 your going to want to make a studio. If you have no cash don't let that stop you, you can get a small studio in a small room, a couple of turntables and cassette decks, a small recording machine, a small disc player, a desk top mixer, a tape machine, a 'voiceover' machine, a microphone, a small amplifier, a small recorder, a small mixer...
HOW TO MAKE A STUDIO

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

Hanging 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, boxes or styrofoam are all good. Try to plan it out before you start so as to have everything within reach of the operator, while having enough room for the equipment itself. (See Diagram example).

If you build your own control desk you can drill holes and arrange for all the leads to disappear and jump up underneath, much less hassle. If you're buying cassette decks try to get something also suitable for outdoor use. 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 lesser if you're going to produce your final product from the mixer onto a reel to reel tape recorder, though that means re-recording onto cassette for broadcasting. and a good cassette deck can give you as good results as in paper.

If buying a microphones its worth getting a good directional type suitable for studio and outdoor interview, and make sure the 'impedance' suits your mixer. A cheap 'AEP' mixer will do the job (you can even mix through some stereo units). If you have the cash go for the flashy new £1000 solid state mixer, this kind is in every way superior, with which you can do wonders. Another tip, make leads, signal 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 'lump problem' with cassette decks try plugging in the lead the other way round (so that it goes into the deck). Use cheap headphones, not audiophiles, as you don't have as good results as in paper.

While thrashing out conventions don't forget that we all conditioned to quick variety and short attention span. Long single person interviews are not on, no matter how interesting, but need breaking up, also remember people are continually tiring in half hour periods. Use in the first tape recorder, allow the needs to go into the reel for music recording, but only half way up for speech recording. For group interviews an omnidirectional mike can be used, and pay special attention to sound recording levels and background noise. Don't use a telephone in the studio. Though the phone is the lifetime of cassette's radio, in the present climate its mean you'll be bust and/or have everything in the room recorded by the police. You really do need two mics, and at least two cassette tools. All these tips, and none you 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 a plug-out switch well out of the reach of the lead, and don't allow coffee or beer near the gear. Read a book on basic sound recording.

One last tip, look it up well, especially if its not your own home, and headphones 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. Just 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. It's good to talk with all concerned before starting, make a list of all the possible material gathered, (music, interviews, sound effects, news items, jokes, whatever) and try to put it into some kind of order. A signature tune or jingle isn't such a bad idea, as people recognize the programme by it, after they've forgotten the name. Repeat the same 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) as its always possible you may be toasted before the programme. In a short piece of time, try to 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 microphones and control desk.

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 develop a rapport with your listeners, otherwise why bother?

Style and themes are your department. Its easy on radio to get arrogantly carried away with an idea of your own, or with the 'right' voice or political stance, watch out for this. Practice with using the gear, good preperation and research make anything go much more smoothly. Background music and faint music is often 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 cold a whole right making a good one hour programme in half an hour.

More than this its hard to say, so much depends on the people, the subject, the projected audience, the time of breakfast etc. You should give out a feel and seek feedback and opinions from people you know have listened. Probably you won't able to do phone ins and mail in slow and erratic (don't worry if you don't get a big posting, few stations or programmes really do). Its easy to become out of control and feel like you're talking in a vacuum, or get a completely wrong idea of what your audience is listening.

Take a break occasionally, however bad and inexperienced you are. You can only 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 mainstream audience to tune in specially you need to advertise a lot where those people are likely to see or read it. Be warned, there is probably an underestimation of the large scale support for pirates, and people often underestimate the media. The media is often used to promote your programme, and the solid support you need to attract new blood, break even financially.

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 as many magazines, trade periodicals etc as possible. Keep releasing pieces to the local and national press, and try to cultivate contacts among the slimy politicians (journalists). Almost any publicity is good, as those programmes which is the best will also attract listeners by word of mouth. Oddly, one place you should certainly seek publicity is on radio, try for instance getting onto phone ins. On raids you are already talking to people who listen to TV, if you can find any way of stunt to get onto it.

It is the most powerful publicity and you should certainly count the benefits running the local TV. The idea of appearance only does stick in people's minds and get them talking. However enough the media are not only hostile to pirates, providing you're just an oddity, not a direct threat. More you show that they're forced to produce and admire the 'romantic': pirate station. They 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 virulent crime!

If you're a mainly music station you should be able to program all the people you need, all the time. If you have your own club of course, you're laughing.

Join The Airwaves and get publicity in their paper. Write articles for radio papers, and do benefit gigs, public meetings, media shows whatever you can manage. Choose a catchy, leading billing for your station. If you're doing political stuff they're going to go for you anyway, so you might as well gain 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. Talk to the real audience, however bad and inexperienced you are. You can easily improve on some of the 'aural shit' being pumped out by legal stations over the airwaves 24 hours per day!

BUILDING UP YOUR PIRATE STATION

It's hard to give advice about longer term development, but there's a few things worth saying. First all its important to pace yourselves. Its easy to start up with a lot of enthusiasm and get nothing off the air, or just burn 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 support overnight. Though your potential number of listeners may be huge you expect response to be slow. Breaking down passive consumption of the media is not easy. Having your own clubs, events, meetings etc, will take time to establish and get off the ground. 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 keeping your licence. (which is a lot of a fiasco and a pipedream). Ideally you should plan ahead and gradually increase your broadcasting times, while developing all aspects of your station, rather than all at once and then collapsing at the first burst. 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. Your longer term aim, as a pirate, should be to reach a situation where you have so much support (money, volunteers, media shows, etc) that the state can't 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 it seems, in Spain. This does not imply chaos, but cooperation,
Medium Wave

Advantages and Problem.

At the moment FM broadcasting, with all its advantages, is the favourite for pirates. But it's 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 hang-up is that some hilly or mountainous areas have a very bad coverage area. As a third advantage, you can cover a very much bigger area on MW, at least potentially. MW can be used in any country in the world, in a country area, or in hills or mountains, or only want to broadcast to 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 'tunes'.

Of course there's lots of other disadvantages, one is sound quality, and stereo is one of the questions, and there's not much free space on the waves, which means that you'll have to share the band with other stations, which become stronger at night, blocking out your relatively weak signal (this is due to atmospheric changes we are talking about). The other is also big, especially for European stations, which become stronger at night, blocking out your relatively weak signal (this is due to atmospheric changes). The medium wave is still broadcast in several countries for some years longer.

It is also argued that you're generally less likely to be successful in the present competitive climate, which is less competitive.

How to Broadcast on MW (540 - 1600 KHz)

Your Transmitter

Enough general talk, so you want to broadcast on MW. So let's start with the transmitter. First, your transmitter. Medium Wave transmitters aren't as hard to build, any good amateur radio build could do it, and there's people around who will build them (to speed things up).

Setting up your Aerial (Medium Wave)

Security precautions and preparation are the same as for FM. But there is one similarity for the start. You need a start your aerial length is ¼ your wavelength, so on 600 KHz your aerial would be 1000 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 should point straight up, but if not just point it to the horizon and fix it. If your aerial isn't feasible, unless you hang it up from the side of a tower block or a crane, or suspend it from a balloon (only the balloon blows away). The most common method is the 'glen'.

The ideal site is a field, or deserted common land, far away from houses, with two tall trees (only 2 if possible, preferably about 30 to 40 meters apart. Now string the 'glen' 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 catapulta, and a long reel of 500' of strong fishing line, and plenty of lead fishing weights (not too heavy for the catapulta). Also some small plastic rings (cut out sides of plastic containers work fine).

Sample Checklist. Things to bring along when broadcasting on Medium Wave.

Transmitter, TX battery leads, Cassette Deck. and battery, Cables to TX, a large reel of 500' of 30 volt and 6 volt batteries (charged). Earth leads and stakes. Aerial wire. 70 ohm fishing line and weights. Catapulta, Plastic rings. Disguise gear (dog radio, fishing, etc). Fishing line, strong fishing weights, fishing wire, iron & wooden, 12v transformer, Radiant Cassette. CB's or torches or whistles. Plastic sheet or large umbrellas (for gear in rain). Field glasses. Food, Radio receivers. Waterproofs (warm). Possibly a tent.

The one end of the fishing line to a lead weight, lead, a long reel of 500' of 30 volt and 6 volt batteries (charged). Earth leads and stakes. Aerial wire. 70 ohm fishing line and weights. Catapulta, Plastic rings. Disguise gear (dog radio, fishing, etc). Fishing line, strong fishing weights, fishing wire, iron & wooden, 12v transformer, Radiant Cassette. CB's or torches or whistles. Plastic sheet or large umbrellas (for gear in rain). Field glasses. Food, Radio receivers. Waterproofs (warm). Possibly a tent.

When tuning your aerial you will have to adjust the antenna gain filter, which is located between the 2nd and the driver.

When buying such a 2nd hand aerial transmitter you need to get one with 150 meter capability. And don't pay more than £1000 for one. Once you are sure it has plate modulation (look inside and check there are two transistors) and power supply is not a problem. And don't get a 'kit built' one with dodgy wiring and bad components. One final piece of advice. Don't put your aerial too close to the earth. Just a few hundred feet away is as good as any.
SWITCHING ON
Connect up your batteries, load up your antenna, and plug in your receiver. 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 reads 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 150 Ma on a 0.1 watt transmitter, or 1000 Ma on a 10 watt rig. Your last tuning adjustment should produce strongly no dip on the meter needle.
6. Adjust modulation in relation to other channels to get your beat sound. Use a radio receiver held at least 50 yards away for testing.
7. If there is clicking, knocking, or sound, repeat from the beginning. Check that your wires are in well to diny ground, that all lines are well separated, that aerial isn’t touching trees, hold receiver further away, etc.

PACKING UP
When you’ve finished switch off immediately. Then disconnect everything and pack into holdall or large plastic bag. Be especially careful carrying it on a wet day. You should have several wires, and switch as often as you can. Don’t use a site after an overcast day or at night. If you see a cross patch, and are coming back late leave your transmitter and motor off, and just take the batteries back for recharging. Such a patch should be in cover, be quite a good aerial site or bowl with利用ers, doesn’t spill your station away for gear. If likely that the DTI will seek 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 of “How To Get Away With It.” A lot of these 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 radio, power line etc., and to grab or hide it fast when they get the signal danger. On many sites you can work out lookout points to give plenty of warning. However you might as well abandon the whole idea and just listen to the local people.
- If you have transport or good escape routes you can try a closer gateway, but such a method is to hide the gear well (not too close to the local if its left up) and be safe. We favour tunnels, holes pre-cut and lined with waterproofs, under rocks, with heavy lids covered with earth and bushes. In theory they could find these with dogs or metal detection, but we’ve never heard of them ever being found or tried. (You could always bury lots of metal all over the site.)
- 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.

RUSTS... IF ALL GOES WRONG
You’re nicked. (See Legal Section.) What you say to them depends on circumstances. If they haven’t got you, deny it point blank, give them your cover story kept a verifiable silence, 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’ve 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 change you, legal procedure is still normally treated as a “summary offence”. Which means they question you, let you go (eventually), then summons you by letter to appear in court. This opens possibilities of getting away with it — you may be able to build them a false name etc. (though they may 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 nicked your flat may interrogate you there and then. If you refuse to go to the police they will arrest you for obstruction, insulting words, suspicion of stealing etc., etc., and take you where you can be interviewed by police and DTI. The ‘present charge’ is often dropped later. When interrogated in the station it’s better to say anything, especially if there are several of you, concentrating really fast to find the 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 picked your best bet is to remain calm. Don’t panic, it’s not the end of the world. Smile at the bastards. Have a good grip 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 law, pretty complex legal situation. Ready NOT GUILTY, but beware of having money, they may award costs against you if you lose.

Get your Bust Fuel together, with genuine, write appeals, etc. It’s good to campaign for your news on the air if your station is still going. Most commercial (legal ‘conservative’) pirates don’t do this, worrying they might lose their license for responsibility — so far as to ignore their own arm weapon. Make sure the address you gave when arrested is ‘clean’ they could possibly void it for further evidence. If you’re a political station watch out for suspicious break-ins where nothing is stolen, the Branch will do this.

Get your story straight, get any witnesses to write out their statements together, make copies and give them to your solicitor. During that time trust your solicitor too far, they sometimes say ‘plead guilty’ just to save themselves trouble. If he does start no cold feet get yourself a new one they don’t like this at all but the law is the law. It’s better to ask for copies of the proceedings, witnesses statements in advance of the case and make sure you see them, in court dress neatly and polite to the bastard (magistrate) and the Tiff. Have a good hard luck story for your solicitor to tell, it’s always good to say you’ve just got married/starter a new (olive) bus don’t say you have money or the fires will be hanging 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 case, we will focus on these lines and your solicitor to cross-examine on these lines.

Especially any police witnesses, who are more wise and inexperienced in this kind of case. Demonstration 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 ‘dubious bystander’ how come all these people are so concerned about it? If you want some, send out Press Release at least a week in advance, so the packs can put it in their diaries, and phone sound with reminders the day before.

Your Eye should be paid by the Bust Fuel 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 basted once you shouldn’t, legally, work on the broadcasting again, though you could still do knockabout, meeting monitoring etc. as second offenders normally get the maximum fine.

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

If you win then there is also some possibility, of theory of proving the gear back, 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 is before the bust.

Radio Support Group
To join Radio Support Group and get updates and development aid write to Radio Support Group, c/o Drewood Hat
Communications, Box 019, 27 Stokes Croft, BRISTOL, AVON BS1 6PY

Free The Airwaves

JOIN NOW
THE OFFENCES

The main offence is under section 1.1 of the 49 Act as follows:

"No person shall establish or use any station for wireless telegraphy or install or use any apparatus for wireless telegraphy except under the authority granted by the Secretary of State, and any person who establishes or uses any station for wireless telegraphy or installs or uses any apparatus for wireless telegraphy except under and in accordance with such a licence shall be guilty of an offence under this Act".

The terms 'station for wireless telegraphy' and 'apparatus for wireless telegraphy' are interpreted (s19.1) as referring to stations and apparatus for emitting or receiving over paths which are not provided by any material substance constructed or arranged for that purpose, of electromagnetic energy of a frequency not exceeding 3 million milliHz, for purposes of conveying messages, sound or visual images, or for the actuation or control of machinery or apparatus, or for purposes of radar.

So 'apparatus for wireless telegraphy' includes relay transmitters (links) and remote control devices as well as broadcast transmitters. (And also TV transmitters but possibly not infra red 'links' Ed.) The term 'station' is ambiguous and isn't interpreted more under the 49 Act. Slightly speaking a station refers to a 'place set apart and equipped for some particular purpose' and in this case should only refer to the transmitting site, and only include the studio if props. are live, or possibly if broadcasting takes place from the same premises as the studio.

For an offence to be made out under this section it has to be shown that you have been involved in setting up or using a transmitting site, or installing or operating transmitting gear. Any of the site crew could be charged on the angle of being 'involved in establishing or using a transmitting site'. But unless programmes are live it shouldn't include people who make programmes, supply tapes or interviews, advertise or provide a mailing address. The DTI did once threaten to do advertisers for aiding and abetting but this hasn't happened. (also not till 1986, Ed)

Under the 49 Act its unlikely that you'd be prosecuted unless the transmitting gear has been tracked down or traced. ....... (but under the 84 Act you can be, Ed) ... and you had to be more or less caught in the act.

Section 7 of the 67 Act (as substitute by s77 of the 84 Act) provides for the Secretary of State, for the purpose of preventing or reducing the risk of interference with wireless telegraphy, to make orders applying restrictions to wireless telegraphy apparatus of any class or description. Any of the following actions are subject to restriction under this section:

a) manufacture (whether or not for sale)

b) selling or offering for sale, letting or offering to let on hire or indicating one’s willingness to let on hire

c) having in one’s custody or control

d) importation

Free The Airwaves is still going strong, as an information exchange and promotion group for radical local pirates. In this book we print their transmitter designs, up to 25W, (any queries write direct to them).

RADIO CRIMES is the name of the FTA Bulletin (with full technical updates), to join and receive it send £2.00 (minimum donation) £10 for organisations to the above address.

FREE THE AIRWAVES

BM Box 1502, London WC1N 3XX

Free The Airwaves is still going strong, as an information exchange and promotion group for radical local pirates. In this book we print their transmitter designs, up to 25W, (any queries write direct to them).

RADIO CRIMES is the name of the FTA Bulletin (with full technical updates), to join and receive it send £2.00 (minimum donation) £10 for organisations to the above address.

THE PENALTIES

49 Act (Section 1.1) The main offence of unlicensed broadcasting. Its a summary conviction (ie magistrates court) and the maximum penalty is 3 months in prison or a fine of up to £2,000 or both. In practice present penalties (1986) range from £200 to £1000 for a first offence. It depends where you are (in Central London fines tend to be much higher than elsewhere) and on the mood of the magistrate (check they haven’t got shares in your local IBA franchise!) Fines are likely to be greater for persons seen as ringleaders, and for 2nd or 3rd offences, with the chance of a suspended sentence after summary convictions. (But we have no reports of anyone going to prison yet, and some people have a dozen convictions. Ed 1986)

Also under the 49 Act (s1.1) its an offence to listen to pirate radio. So your entire audience is breaking the law! We have a record of one member of an Our Radio team being done for this (they couldn’t get him on anything else). He got a £50 fine.
Under Section 7 of the '67 Act (manufacture, sale, possession, not importing) the penalty is a max. fine of £2000, when such 'Restriction Orders' are in force (see above).

Under Section 5a of the 49 Act (as amended by schedule s75 of the 84 Act) you can get a max £2,000 or 6 months prison or both for 'sending false or misleading messages by means of wireless telegraphy, which are likely to affect any safety of life service or endanger the safety of any person or of any vessel, aircraft or vehicle.

Under Section 13 of the 49 Act (as amended by schedule 3 of the 84 Act) its an offence if you're 'Using any apparatus for the purpose of interfering with wireless telegraphy'. (Deliberate interference or 'jamming'. The penalties are the same as for section 5a above.

POWERS OF ENFORCEMENT

To bring proceedings under the Wireless Telegraphy Act requires the consent of the Sec. of State. In practice this means that the DTI decides whether to press charges. So it was usually (and usually still is) a 'summons offence'. If you were taken to the copshop unwillingly it was either on a pretext charge (like suspicion of stealing electricity) or unlawfully. But the 84 Act (s75) (which applies to offences under s1.1, s5a, and s13 of the 49 Act) gave a constable power to arrest without a warrant a person who has committed, or whom the constable has reasonable cause to suspect has committed, an offence to which this section applies, if the name and address are unknown to and cannot be ascertained by the constable, or the constable has reasonable grounds for doubting whether the person has given their real name and address, or whether the person will be at that address for a sufficiently long period for it to be possible to serve them with a summons.

This hampers wily pirates from slipping off with a false name and address (but if such an address is easily verifiable it should still be possible. Ed) and in practice gives the fifth power to arrest on suspicion.

UNDER ARREST

Once you've ticked its like any other arrest. You should try and take notes, get the number of the cop who nicked you, ask to see a solicitor immediately under the new 'Duty Solicitor' scheme, refuse to answer any questions, refuse to be photographed or fingerprinted (though they don't need a magistrate's warrant now to force this), only sign for your own possessions and not for the TX gear they may add on the list, etc.

In practice since its the DTI and not the cops who bring prosecutions under the Wireless Telegraphy Acts you won't be charged then and there. What they will do is interview you separately and then let the DTI (radio Investigation Service) interview you. You don't have to say anything to them either, especially don't talk to that old charmer Eric Gotts who will try and trick info and admissions out of you.

They're supposed to let you go as soon as they've decided not to charge you (you get that by a summons). But they can hold you up to 3 days. Keep banging on the door and asking for your phone call. The only delay should be while they check out your address, though of course they'll be checking if you're wanted for anything else. There should be no question of bail if you haven't been charged.

SEARCHES, CONFISCATIONS, FORFEITURES....

Section 19 of the 49 Act provides for the issue of search warrants. They last for a month and authorise anyone named by the Sec. of State to search a premises or vehicle and examine or test any apparatus they find. This didn't allow them to seize anything till the case came to court, but this loophole was never realised till 83, when there followed an upsurge of pirates till the 84 Act brought in new powers.

The search powers were extended by the 84 Act and brought in wholesale confiscation powers. (By s79 of the 49 Act which applies to offences under s1.1, s5a and s13 of the 49 Act and s7 of the 67 Act). Subsection 79.2 provides for the inclusion in such search warrants of the authority to seize and detain, for the purpose of relevant proceedings, any apparatus OR OTHER THING found in the course of the search, which appears to have been used in connection with or to be evidence of the commission of any of these offences.

This new power allowed the current practice of tracing and raiding studios and confiscating everything, and was reaffirmed by the Horizon Radio case of 1985, when a studio valued at £20,000 was confiscated (down to chals and carpet) and, though the case was denied and the TX gear was never found, the DJ's were found guilty and fined in addition to the confiscation.

When faced with a Search warrant don't open the door, examine it through a window or letter box. Check the date. (If its valid) who it allows to search, if it allows for raiding, if it allows for seizure of evidence, any names etc. Then ask them for ID. to check if they are those authorised. After that its an offence to obstruct them. If you have an escape route, use it!

Under s80 of the 84 Act they can order forfeiture of any gear restricted under s7 of the 67 Act whether anyone is charged or not. If you're convicted they must order forfeiture.

Proceedings must be brought within six months. After that you can forget it.

Apparatus of the station does NOT include the studio unless programmes are done live.

CLAIMING BACK YOUR GEAR

If you haven't been charged after six months, or if you've won your case (sometimes happens!) you can in theory claim back anything seized. You write to the Radio Regulatory Dept. of the DTI or your local Radio Interference Division, or better get a good solicitor to write, giving a clear description of the gear and saying you're the owner and can prove it. Such proof could be receipts for items like batteries, cassette players or an identifying mark on the gear. Don't admit to anything else but ownership, any other evidence that you've committed an offence and you could still be prosecuted. (Ask your solicitor first if there is an 'Order in force under Section 7 of the 67 Act prohibiting 'custody or control' of TX gear).

GOING TO COURT

Usually its by Summons, (unless under s5a or s13 it'll be in the magistrates court) if you get one get yourself a solicitor who knows something about it and Legal Aid if at all possible. Even if you're caught red handed you can deny everything and sometimes get away with it. If you're bending the truth a little don't tell your solicitor as they won't go along with it. If you think you have any chance at all plead Not Guilty, often solicitors will tell you to plead guilty just to save themselves the bother. But remember that the Magistrates Court is basically controlled by the police and most magistrates are right wing totes (the old ones are often more liberal than the young Thatcher lovers). The police and the DTI witnesses will lie through their teeth if necessary to nail you. For instance the head of the DTI's RIS squad; Eric Gotts once told a magistrate he recognised an Our Radio member putting up an aerial on top of a 22 story tower block at night, from ground level, the evidence was accepted.

Be polite and courteous and smile at the bastards if you want to get off, and get your station to organise a bust fund and bonoiff to pay your fine. You can appeal against the decision, and you can use the Crown Court with a barrister, check with your solicitor if its worth it, you may have to pay high costs if you lose.
Radio Electronics (FM)
A General Introduction

CONTENTS

Foreword.
Introduction.
FM.
Choosing a Frequency.
Mono or Stereo.
Compressors and Limiters.
Buffers.
Ampifiers: Bandwidth/ Gain and Maximum output power / input and output impedance/ VSWR / The Dummy Load/ 
Harmonics: Waveformers.
Bandpass Filter / Connectors / Feeders.
Aerials: Polarisation / Siting.

FOREWORD

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 concepts involved in radio broadcasting that are relevant to the pirate radio operator or 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 (c/s), which these days are known as Hertz (Hz). 1000Hz = 1kHz. 1,000,000Hz = 1MHz The amplitude is how much 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 30MHz and 300MHz 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 DEVIA-TION. Legal CB radio 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.
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 it’s 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 let’s 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) A tape or cassette player.
b) 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 bussed, 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 player, TX and aerial, 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 ¼” 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 advantages of stereo 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

\[ \text{Composite stereo output} \]

\[ \text{L+R} \]

\[ \text{L-R} \]

\[ \text{BALANCED MODULATOR} \]

\[ \text{CRYSTAL REFERENCE OSCILLATOR} \]

\[ 30kHz \]

\[ 1MHz \]

\[ 2 \]
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 10kHz pilot tone. The pilot tone switches on the stereo decoder in peoples’ receivers.

![Composite modulating signal](image)

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 2 eight times is 19 kHz. This can easily be done by digital logic chips. But it’s 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 it’s 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 are less energy than the low ones and so produce less deviation of the carrier. This in turn makes it 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 75μS, but in

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

**COMPRESSORS AND LIMITERS**

Compressors and Limiters operate on the same principle 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 only a fraction of that range. The graph shows a 3:1 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 as 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 ‘tweedle fatigue’ as constant compression can become boring and irritating to the ear, as if the music were rammed into it!
Compression has other use, 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 N570 or N571 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 VARIOCAP 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 e.g. 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, is 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 amp, 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 return as you r 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 flicking some little switches. (Seats me...typists).

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
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 happened 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. Its 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 EXCITOR 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 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 disadvantage 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 used when 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 circuits 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 resonate frequency is the same as the input frequency from the oscillator. 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 easier to design. The bandwidth is a trade-off with gain, the wider the bandwidth the less the gain. The disadvantage 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 have to return 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 max

\[
\text{power gain} = \frac{\text{output power}}{\text{input power}}
\]

and is a measure of the amps ability to make its input bigger. Power gains are often expressed in DECIBELS (dB) which are defined: 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 wont 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 lets consider the popular 2N2222 transistor. According to the makers data sheet this has a max output power of 4W and a gain of 12dB. First we have to convert the gain in dB to ordinary gain:

\[
\text{gain} = 10^{\frac{\text{gain in dB}}{10}}
\]

for example gain = \frac{10^{12}}{10} = 10^{1.2} = \text{?}

\[
\text{gain} = 10^{1.2} = 16.6
\]
The VSWR Meter

A Typical Class C tuned VHF power amplifier

---

\[
\text{Input power} - \text{Output power} = \frac{4}{15.35} = 0.25 \text{w}
\]

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:

a) It should be suitable for the frequency we're interested in, about 100MHz.

b) It should be rated to take the power we're trying to make.

c) 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 left 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 amps’ 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, and 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 WAVEMETER 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 BANDPASS 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 watt and you’ve offered a 1000w amp its 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 coax 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 input and output impedence 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 reduced drastically. 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 TX should be well screened for the same reason. Say for example you used a shoebox and had your oscillator on a shelf at frequency of 92.25mHz—you could be interfering with power of a local hospital as they use 91.75mHz. Proper screening and a bandpass filter will eliminate such possibilities.

CONNECTORS

As you may have guessed you can’t use any connection on VHF as they have to match the amp and feeder. Use BNC on the UHF series (p1.259 plug and SO239 socket). UHF is better for higher powers as you can get a wider cable into the plane. 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 you need 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 means a bit like the TX’s output, the connectors and the aerial has an impedance and to match this should be 50 ohms. 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 RG78 and RG58U. For longer runs or higher powers use UB67. (UB67 and RG78 are available from Ciritkit).

AERIALS

At last, the aerial! You can run a pirate knowing little about 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 Judy G2RBCX. It’s a paper back by Newnes technical books at £15.95. You might 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 144mHz.

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 X 145 = 1377mm for 108mHz.

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. 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:

![Diagram of a half wave dipole](image)

The elements can be bits of thin aluminium or copper tube. The lengths of each dipole, L, you get from your frequency by: \( L = \frac{71}{\lambda} \) metres

\( \lambda \) (in MHz)

The impedance is about 72  \( \Omega \) which is close enough to 50 to be fed from 50 \( \Omega \) 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:

![Fig of eight coverage](image)

which isn’t very 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 50 \( \Omega \) 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 ohm meter before plugging in, to be sure its what its 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, whereas 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 its hard to say how much. GO for it!

To join the Radio Support Group and get updates and development aid write to RSG, c/o Box 010, 37 Stokes Croft, Bristol. Avon BS13FP. 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 its 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 slipped 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 receive or a wavemeter if you’re not sure). Its a bit of an art but you’ll soon get the hang. For our purposes a frequency must have:

a) The bandwith, up to at least 150MHz.
b) 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 Circit.

**APPENDIX B**

UHF PLUG ASSEMBLY

UHF type (clamped screen)

1. Cut end of cable even. Remove vinyl jacket from. Slide coupling ring and adapter on cable.
2. Fan braid slightly and fold back as shown.
3. Position adapter to dimension shown. Press braid down over body of adapter and trim to fit. Bare wire of centred conductor. Tin exposed centre conductor.
4. Screw plug sub-assembly onto adapter. Solder braid to shell through solder holes. Use enough heat to create bond of braid to shell. Solder centred conductor to contact.
5. For final assembly, screw coupling ring on plug sub-assembly.

UHF type (soldered screen)

1. Cut end of cable even. Remove vinyl jacket from.
3. Screw the plug sub-assembly on cable. Solder assembly to braid through solder holes. Use enough heat to create bond of braid to shell. Solder centred conductor to contact.
4. For final assembly, screw coupling ring on plug subassembly.
How to Draw and Make your own PCB by R.A.Pettifer 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 info aimed at Radio Amateurs.
Some is relevant, most isn't. The chapter on aerials is worth a look. About a tenner.

60 Watt Medium Wave Transmitter

MISCELLANEOUS

\[ V1 \] 500 pf (opt. apa)

\[ V2 \] 1000 pf

\[ N1 \] 350 mA meter

\[ X1 \] medium wave crystal (IMFs = 1.5 MHz)

\[ T1 \] modulation transformer (choose 10 k or similar)

Metering point. Disconnect R1 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 C3 & C4.
FREE THE AIRWAVES
TRANSMITTER PLANS

4WATT VHFM Transmitter, parts and instructions

* Get some double-sided copper clad PCB, enough to make boards in Diags. II and IV, and a piece 1/4" x 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 Loctite superglue - one drop will do. Clean islands of any glue. Apply liberal amount of solder to islands with a decent iron, 25 watt Weller is a good buy, small style.

DIAGRAM I. ASSEMBLY ORDER

1. 3SK51 or 4067/3 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. 330Ω resistor, 1/4 watt (orange/orange/brown)
   Keep close to 3, island F to board.

5/6/7/8. 4 x 220KΩ. 1/4 watt (red/red/yellow)

9. 33pf

10. 50pf

11. BB105B or BB205B varicap diode
   Spot nearest island.

12. 91V1 zener diode
   Line nearest island.

13. 4N7 capacitor (or 4700pf, or .0047uf)

14. 68KΩ (blue/grey/orange)

15. .1UF capacitor (or 100N, or 100,000 pf)

16. 110Ω (brown/brown/brown)

17. Single piece of insulated 3-amp wire .17a. Same

18. 2-12 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 μH
   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.

MC108 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.
21. 56pf
22. 2.2kΩ
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 screw-
   driver. Bend legs and cut. Solder. Make sure with crossover that no legs touch.

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

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

The first board can now be tested once we have added piece of URO7 coax, or any heavy-duty
7mm CB Coax. (See diag. VI). We must fix Coax to a UHF 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/motorhome 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 Th又有
   F1M200A is the best value.
   We could do without a frequency counter, but if anything is slight
   out, ie off the VHF band, then a radio receiver is no good to find
   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
   Tandy's). Put in your favourite tape, turn on radio, and if every-
   thing'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.
33. 3-90 pf variable capacitor (foil trimmer).
34. As above
35. 2 and a half turns of 18 guage tin coated SWG using a 1/4" drill as former.
36. 47Ω resistor.
37. RF choke, same components but only 3 turns.
38. MRF227 transistor, Large heatsink.

40. 10 Ω resistor.
41. 'uf.
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 1½" 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 TC SWG 18 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 di. 6 and 8 for positions).

If all well on testing, using same procedure as with first board - you should get nearly 5 watts with the 1.3.8v 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 ½" 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 ½" 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)**

- ¼" Jack plug socket.
- ¼" to 10m ax. (see fig.3.)

4 WATT OUTPUT TO AERIAL OR 25 Watt.
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 VHFM communication 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. WC1N 3XXX.**
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 diemeter and preferably a RF power meter.

With just a modicum of effort this ‘people’s 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. T6 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 96 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 3/4 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 1/4 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.

---

55.
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 ammeter, 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-amps (mA) (without the LED connected). Tune a receiver to the desired frequency and adjust R16 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 now been connected to do this; adjust the two preset 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 is much easier to check whether the oscillator only oscillates on one frequency. If it does oscillate on more than one frequency, re-solder R25/C19 onto the coil L1 a turn from the cold end. The best point of contact is when the oscillator only oscillates on one frequency. 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 D8, D5, 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 3 mm above the PCB.

Rotating R19 anticlockwise increases the transmitted frequency as does unmeshing C16. The frequency should be adjustable between 50 - 150 MHz. (If you want a higher frequency see later 2M Modification.)

The final adjustment of the oscillator and tuning the aerials 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 to 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 B9204 for D3 you can tune across the whole FM band with R16. The circuit is designed so that the modulation 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 D6 is threaded onto one of the R27's leads. All connections which go to earth (X in the circuit diagram) are soldered onto the top and bottom of the PCB. In all other cases, the solder only on top. Construct the transformer L2:L3 (see F. K.).

Use 0.2 diameter enamelled copper wire for L3. Around a ferrite bead 3 times and tighten carefully. Don't use 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 self-adhesive tape on the ends so as not to confuse them with L2. Same thing now with L2, only its 6 windings. Time them, then right and then left of L2, spread equally over the bead. Now mount L2:L3, keeping the wire ends short, and tin it in place with glue.

Next mount the trimmers. All the legs that are going to be soldered or top of the PCB should be tinned with solder beforehand, as should their respective contact points on the PCB. Bed these legs outward at right angles so that the trimmer will lie flat against the PCB. Use a little soldering paste (35-20w) and be very careful, 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 trimmer easily.

Oscillator Layout Diagram (Fig. C)
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 heatlink 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 heatink 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 be filed off 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 6v 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 open. 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 ¼ 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 the check there is no spurious output on other frequencies. Switch off again.

Finally mount Dr4 and Dr5 and clip a heatink onto the buffer stage...
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 ratio meter (VSWR) meter with power indication. Alternatively use the circuit in Fig. 6 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...¾ C27...¾ C32...¾ C33...¾ (i.e., C26 ¾ meshed, C27 ½ meshed etc.)

After switching on watch simultaneously power output and input current. Tune for max output power. Use a brass or aluminium turning tool with an insulated handle. Tune C25, then C27 (doesn’t have much effect) then C32, lastly C33. For the Ist 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. It is 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 = outputs. 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 meshed at maximum output power then pull the turns of LA 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, and round the edges of the screening walls. Solder on the sides of the PCB and the screening walls. Now using spacing etc., mount the PCB. Don’t forget heatsink compound for MRF237. Mount the sockets and switch with all the connections 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 50-70% approx.

2m MODIFICATION.

oscillator (Fig. 8)

oscillates at ½ the frequency

R22

oscillator now oscillates at half

R21 33F black

replaced in module

By modifying the circuit it is possible to transmit in the

the transmission frequency. ½v is now configured as a frequency

2m band (135-180MHz). The oscillator now oscillates at half

of the frequency of the output. The output doubler is 0.6 over the frequency of the input.
Transformer L2: L3 wound on FX1115 ferrite bead. (Fig. K)

COMPONENT LIST FOR 5 WATT TRANSMITTER.

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R10</td>
<td>220Ω</td>
</tr>
<tr>
<td>R2, R11</td>
<td>470Ω</td>
</tr>
<tr>
<td>R3, R12</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>R4, R13</td>
<td>1Ω</td>
</tr>
<tr>
<td>R5, R14</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R6, R15</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R7</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R8</td>
<td>not required</td>
</tr>
<tr>
<td>R9</td>
<td>220Ω</td>
</tr>
<tr>
<td>R16</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R21</td>
<td>470kΩ</td>
</tr>
<tr>
<td>R22</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R23</td>
<td>1Ω</td>
</tr>
<tr>
<td>R24</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R25</td>
<td>2.2kΩ</td>
</tr>
<tr>
<td>R26</td>
<td>2.2kΩ</td>
</tr>
<tr>
<td>R27</td>
<td>2.2kΩ</td>
</tr>
<tr>
<td>R28</td>
<td>220Ω</td>
</tr>
<tr>
<td>R29</td>
<td>470Ω</td>
</tr>
<tr>
<td>R30</td>
<td>62 or 47kΩ</td>
</tr>
<tr>
<td>C1</td>
<td>Inf ceramic</td>
</tr>
<tr>
<td>C2</td>
<td>Inf ceramic</td>
</tr>
<tr>
<td>C3</td>
<td>47μF 160V elect. PCB mounting</td>
</tr>
<tr>
<td>C4</td>
<td>10μF 160V elect.</td>
</tr>
<tr>
<td>C5</td>
<td>1nF ceramic</td>
</tr>
<tr>
<td>C6</td>
<td>10μF 160V elect.</td>
</tr>
<tr>
<td>C7</td>
<td>15μF 160V elect.</td>
</tr>
<tr>
<td>C8</td>
<td>Inf ceramic</td>
</tr>
<tr>
<td>C9</td>
<td>1nF ceramic</td>
</tr>
<tr>
<td>C10</td>
<td>16μF 16V tantalum</td>
</tr>
<tr>
<td>C11</td>
<td>47μF ceramic</td>
</tr>
<tr>
<td>C12</td>
<td>20μF polystyrene foil</td>
</tr>
<tr>
<td>C13</td>
<td>680μF polystyrene foil</td>
</tr>
<tr>
<td>C14</td>
<td>16μF 16V tantalum</td>
</tr>
<tr>
<td>C15</td>
<td>680μF ceramic</td>
</tr>
<tr>
<td>C16</td>
<td>2.22μF min. foil trimmer 7.5mm, green (eg. Circuit 06-22001)</td>
</tr>
<tr>
<td>C17</td>
<td>0.8μF ceramic</td>
</tr>
<tr>
<td>C18</td>
<td>plus C18', C19, and C20 1nF ceramic</td>
</tr>
<tr>
<td>C21</td>
<td>100nF ceramic</td>
</tr>
<tr>
<td>C22</td>
<td>Inf ceramic</td>
</tr>
<tr>
<td>C23</td>
<td>100nF ceramic</td>
</tr>
<tr>
<td>C24, C25</td>
<td>Inf ceramic</td>
</tr>
<tr>
<td>C26</td>
<td>2.27μF min. foil trimmer 7.5mm, red (eg. Circuit 06-36001)</td>
</tr>
<tr>
<td>C27</td>
<td>5.5-80μF min. foil trimmer 10mm, red (eg. Circuit 06-80001)</td>
</tr>
</tbody>
</table>

C28 Inf ceramic
C29 100nF ceramic
C30 16μF 16V tantalum
C31 Inf ceramic
C32, C33 As C27

D1 LED
D2 1N4148
D3, D3' either BE105G (two) or one BB204G
D4 1N4001

T1 BC549, BC239, BC109 (pref C type)

T2 as for T1
T3 BC516
T4 BP2556 or BP245B (not C type!)
T5 BP2556 or BP245B (C type possible!)
T6 BP254 or BPY90
T7 2N3866 or 2N4427
T8 MRF 237

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 ½ 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)
S0230 UHF socket with earthing tag copper foil
braided wire
power supply connectors
input connectors
1A fast blow fuse and holder

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 or wire in VHF circuits increases the chances of undesirable oscillations (properly called parasitic oscillations). To guard against this soder components as close to the Pb 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, i.e. 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 end 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 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 transistor overheats and is destroyed, or the heat melts the case and then it overcools and is destroyed.

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

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 transistor, 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 10 feet 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. That way its a basic piece of test gear. See later under AERIALS.

WHERE TO GET THE PARTS:
Cricklewood Electronics, for instance, stock everything except the ferrite beads and the wire. Their MRF237 is much more 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 Cricklodeon Broadway, Lut NW28BT. Tel. 01-450-0998 or 01-462-0161. Free catalogue on request.
Maplin and Cirkit catalogues from your local W.H.Smat.

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 49, (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. It's 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 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 manufacturer's data sheet says don't 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 MRF245. 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 characteristics in the frequency band we are interested in are not published by the maker and we'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 Uniloc mica capacitors or Eric high Q chip capacitors with low pass C3-G 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 as 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...
amplifier, if the supply is connected the right way round. If the relay fails by, eg, the contacts welding together, which can happen with 13A, 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 temperature switch. Decide how you’ll mount and position 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 the earth plane on the PCB. The best thing is to connect thick wire from the PCB earth plane to the case next to sockets. Either solder directly to the case material, or preferably use tags bolted through the sockets, mounting holes. M RNC 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 M3 or larger bolts. Solder brass or copper strips along the edges of the PCB to connect the top and bottom earth plane together, do the same by soldering strips through the holes on the other side of the PCB 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. Your PCB is much wider than our design so we recommend you to solder through with 100um thick wire 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 as above. Solder the whole length of the emitter flanges. This are the ones on the outside. The collector is the smaller of the two inner flanges. Then mount capacitors C4 and C5. Cut a piece of copper or brass sheet and mount these in the same way as shown on the diagram together with C1 to C5. When soldering the capacitor make the joint as large as possible to keep stray capacitance low and allow better heat conduction. The leads 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 M11, M12 and M13, then M14 and M15. Leaving M14 out would be disastrous as the base voltage = high collector current = new transistor.

The feedthrough capacitor C14 can be fitted now, or later, depending on which construction you’ve chosen.
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 8BA or M3 bolts. The PCB is then bolted to the heatsink in 4 places, using shakerproof washers above and below the PCB at such a height so as not to flex the PCB or put any stress on the transistor leads. 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 shakerproof 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 recommend 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 pentometer gang 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 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 15mA 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 uncovered (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...it can get real hot and start smelling.

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 of 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 aperiodal 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 ext. emes 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 Racedek Electronics at £23 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 Circkit 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. Circkit 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 C6 don't try to use the large dipped mica. If you can only get ceramic chip use two in parallel to reduce the 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 coil 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 beautifully from craft shops. The silver coated copper wire is available from Circkit. You could use insulated copper wire for L7.

The heat sink largely determines the looks and construction of the amp. There are special heat sinks the above described PCB can be sunk into. If you can't find one best use standard heat sink of enough cooling capacity, i.e. thermal resistance less than 0.5 degrees C/W. The shape of the heat sink will determine the problems when designing the heat sink 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 Circkit.

PARTS LIST FOR THE 80 WATT AMPLIFIER

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>MRF245 or MRF247 (Racedek)</td>
</tr>
<tr>
<td>D1</td>
<td>IN5402</td>
</tr>
<tr>
<td>D2, D6</td>
<td>IN4002</td>
</tr>
<tr>
<td>D3</td>
<td>Red LED</td>
</tr>
<tr>
<td>D4</td>
<td>Green LED</td>
</tr>
<tr>
<td>D6</td>
<td>Yellow LED</td>
</tr>
<tr>
<td>SC1</td>
<td>16A fuse and fuse holder</td>
</tr>
<tr>
<td>FL1</td>
<td>Din socket 5 pin 240 degree, or what you fancy</td>
</tr>
<tr>
<td>FL2</td>
<td>two 4mm sockets, one red, one black</td>
</tr>
<tr>
<td>FL3</td>
<td>BNC socket or UHF 50230 socket with earth tag</td>
</tr>
<tr>
<td>FL4</td>
<td>50239 UHF socket with earth tag</td>
</tr>
<tr>
<td>SW1</td>
<td>90 degree C thermal switch (not thermal fuse)</td>
</tr>
<tr>
<td>R1, R2, R3, R4 ohm</td>
<td></td>
</tr>
<tr>
<td>RL1</td>
<td>Relay 12v 1500ohm, 16A contacts</td>
</tr>
<tr>
<td>C1</td>
<td>500pF dipped mica capacitor artwo nf ceramic in parallel</td>
</tr>
<tr>
<td>C2</td>
<td>10 or 16pF Unelco or Semco or Erie high Q C3G dielectric</td>
</tr>
<tr>
<td>C3</td>
<td>10 to 60pF or 15 to 115pF or 30 to 120pF mica compression trimmer</td>
</tr>
<tr>
<td>C4</td>
<td>500pF (440 to 510) Unelco or Semco or two Erle 220pF in parallel</td>
</tr>
<tr>
<td>C5</td>
<td>as C4</td>
</tr>
<tr>
<td>C6</td>
<td>100pF Unelco, Semco or Erie</td>
</tr>
<tr>
<td>C7</td>
<td>as C3</td>
</tr>
<tr>
<td>C8</td>
<td>22pF Unelco or Semco or two 10pF Erle in parallel</td>
</tr>
<tr>
<td>C9</td>
<td>as C3</td>
</tr>
<tr>
<td>C10</td>
<td>5 to 15pF Air trimmer</td>
</tr>
<tr>
<td>C11</td>
<td>3.3nf ceramic, preferably chip ceramic</td>
</tr>
<tr>
<td>C12</td>
<td>100nf ceramic</td>
</tr>
<tr>
<td>C13</td>
<td>10 pf 35v tantalum</td>
</tr>
<tr>
<td>C14</td>
<td>4.7nf feedthrough capacitor, bakelite</td>
</tr>
<tr>
<td>C15</td>
<td>3.3nf ceramic</td>
</tr>
<tr>
<td>L1</td>
<td>3 X 35 X 0.1mm &quot; &quot;</td>
</tr>
<tr>
<td>L2</td>
<td>3 X 35 X 0.1mm &quot; &quot;</td>
</tr>
<tr>
<td>L3</td>
<td>3 X 15 X 0.1mm &quot; &quot;</td>
</tr>
<tr>
<td>L4</td>
<td>3 X 25 X 0.1mm &quot; &quot;</td>
</tr>
<tr>
<td>L5</td>
<td>3 X 35 X 0.1mm &quot; &quot;</td>
</tr>
<tr>
<td>L6</td>
<td>3/4 turns 1mm (18SWG) silver coated copper wire on 6mm former</td>
</tr>
<tr>
<td>L7</td>
<td>6 turns 2mm (14SWG) silver coated copper wire on 7mm former</td>
</tr>
<tr>
<td>Dr1, Dr2</td>
<td>wideband ferrite choke (see parts list of 5w transmit filter for details of these)</td>
</tr>
</tbody>
</table>

Copper or brass sheet
Heat sink, thermal resistance less than 0.5 degrees C/W

CIRKIT, Park Lane, Broxbourne, Herts, EN10 7NQ. Tel. (0992) 444111.
RACDEK Electronics, 102 Priory Road, Stibbenden Lane, Hall Green, Birmingham B28 0TB. Tel. 021 474 6000

Also useful are Circkit and Maplin catalogues, from your local W.H. Smith.
FM Aerials: Construction Plans

These plans include details for the construction of antennas suitable for the FM broadcast band. There 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. An 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 antenna 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-9 coax allows only 60% of the power to reach the antenna.
16. A 100 foot piece of RG-59 coax allows only 30% of the power to reach the antenna.
17. Radio waves travel at 186,278 miles per second (3 x 10^8 m/s) in a vacuum.
18. Radio waves travel at 186,278 miles per second in air, water, or other media.
19. Radio waves travel at 186,278 miles per second in all media.
20. Radio waves travel at light speed over very thin wires (uninsulated).
21. Radio waves travel at sound speed over very thin wires.

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

ANTENNAS DISCUSSED:

<table>
<thead>
<tr>
<th>Simple Stacked Vertical Dipoles</th>
<th>(Vertical Polarization)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverted F Antennas</td>
<td>(Horizontal Polarization - some vertical)</td>
</tr>
<tr>
<td>Half-Wave Phased Collinear</td>
<td>(Vertical Polarization)</td>
</tr>
<tr>
<td>Stackable Vertical Dipoles</td>
<td>(Vertical Polarization)</td>
</tr>
<tr>
<td>Stackable Horizontal Dipoles</td>
<td>(Horizontal Polarization)</td>
</tr>
<tr>
<td>Circular Polarization</td>
<td></td>
</tr>
</tbody>
</table>

CALCULATIONS:

Answers for 100 MHz

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Coax Diameter</th>
<th>Coax Length</th>
<th>Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Wavelength in Inches = 11811/1000 = 118.11</td>
<td>11811/100 = 118.11 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) 1/4 Wavelength (poly) coax = .66 x .25</td>
<td>.66 x .25 x 118.11 = 25.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) 1/4 Wavelength (foam) coax = .62 x .25</td>
<td>.62 x .25 x 118.11 = 26.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) 1/4 Wavelength (large wire)</td>
<td>.90 x .25 x 118.11 = 32.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) 1/4 Wavelength (thin wire) = 1.0 x .25</td>
<td>1.0 x .25 x 118.11 = 29.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 118 1/2 &quot;</td>
<td>(7) 48 3/8 &quot;</td>
</tr>
<tr>
<td>(2) 19 1/2 &quot;</td>
<td>(6) 56 1/8 &quot;</td>
</tr>
<tr>
<td>(3) 24 1/4 &quot;</td>
<td>(9) 59 &quot;</td>
</tr>
<tr>
<td>(4) 29 &quot;</td>
<td>(10) 64 1/2 &quot;</td>
</tr>
<tr>
<td>(5) 29 1/2 &quot;</td>
<td>(11) 68 5/8 &quot;</td>
</tr>
<tr>
<td>(6) 39 &quot;</td>
<td>(12) 147 5/8 &quot;</td>
</tr>
</tbody>
</table>

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-9 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 Single 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 also has a 3/4" hole drilled through it. An RG-58 connector is fastened into the hole. The antenna is then fed with a 50 ohm coax such as RG-9. The feed impedance is closer to 50 ohms than 60 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 mast it will be "shaded" 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 5 dB gain (4 X power) as shown 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 1/4 wave transmission line (2V). The bottom dipole consists of sections (V) and (V).

Dimensions (using RG-5 poly coax, design frequency of 100 MHz):

<table>
<thead>
<tr>
<th></th>
<th>1/4 wave (thin wire)</th>
<th>1/4 wave (poly coax)</th>
<th>3/4 wave (poly coax)</th>
<th>1/4 wave (large wire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>3/8&quot;</td>
<td>1/2&quot;</td>
<td>1/4&quot;</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>V</td>
<td>1/2&quot;</td>
<td>1/4&quot;</td>
<td>5/8&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>2V/3V</td>
<td>1/4 wave (poly coax)</td>
<td>3/4 wave (poly coax)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>1/4 wave (large wire)</td>
<td>20&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.

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 as selected determines how much horizontal and how much vertical polarization will impart 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 unidirectional. 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" to all directions. It completes one trip "around" during each cycle of your frequency. At 100 kHz this is 100,000,000 times each second.

**Fig. 3 Phase delay harness**

This is a balanced antenna, if it is to be fed with unbalanced line (coax) it needs a decoupler. Four or five long 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 1/4 copper pipe. A 1/4" to 1/2" reducer is soldered to one end. The 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-9) 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-9) 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**

<table>
<thead>
<tr>
<th></th>
<th>1/4 wave (thin wire)</th>
<th>1/4 wave (poly coax)</th>
<th>3/4 wave (poly coax)</th>
<th>5/8 wave (thin wire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>3/4&quot;</td>
<td>1/2&quot;</td>
<td>0.5/0.5&quot;</td>
<td>0.6/0.6&quot;</td>
</tr>
<tr>
<td>P</td>
<td>1/4 wave (poly coax)</td>
<td>10/10&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>1/4 wave (poly coax)</td>
<td>20&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Effective power gain**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>1/2</td>
</tr>
<tr>
<td>U</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>9</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**Fig. 4 1/4 wave decoupler**

**Halve-Wave Phased Collinear (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 collimated 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...
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 (Y) (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 (3). The hole should be threaded for a 0-32 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 "L" 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 #4 ( 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.

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

<table>
<thead>
<tr>
<th>P</th>
<th>1/4 wave (pipe)</th>
<th>1/8 wave (pipe) X 0.63</th>
<th>1/32 wave (pipe) X 0.24</th>
<th>1/64 wave (pipe) X 0.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>L = any length of 50 ohm coax such as RG-8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>1/4 wave (poly) X 0.11</td>
<td>3&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 21. A 4 bay antenna may have a gain of up to 4.6! Figs. E through I show various stacking arrangements. These stacking arrangements are discussed later on.

The dipole is constructed from 1/2" copper pipe, two 1/2" "Y" 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.

Cut 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".

Cut 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 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 now in the plastic pieces. Use a 3/8" 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 1/8" 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 1/2 size hole (6-32 self-tapping screw) through the "T" fitting, the filler bushing, and partway 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 in the plug later will help keep moisture out.

POINTING UP to maintain the proper phase relationships between units. The length of the little mounting stub (too "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. 1/4 wave (pipe) 28" O large enough for wire 3/16"
B. Standard "T" fitting 2" D 1/4 wave (pipe) 26"

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 (end of "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 the 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. C Vertical Coverage (Top view)  Fig. D Vertical Coverage (Side view)
STACKING ANTENNAS FOR MORE GAIN (Figs. E - H)

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 increases the coverage area. Fig. 5 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 increased ERP. The increase in 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 per horizontal omni-directional horizontally 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:

<table>
<thead>
<tr>
<th>Power Increase</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.4 X</td>
</tr>
<tr>
<td>3</td>
<td>1.73 X</td>
</tr>
<tr>
<td>4</td>
<td>2.0 X</td>
</tr>
<tr>
<td>5</td>
<td>2.25 X</td>
</tr>
<tr>
<td>6</td>
<td>2.45 X</td>
</tr>
<tr>
<td>7</td>
<td>2.66 X</td>
</tr>
<tr>
<td>8</td>
<td>2.83 X</td>
</tr>
<tr>
<td>9</td>
<td>3.0 X</td>
</tr>
<tr>
<td>10</td>
<td>3.18 X</td>
</tr>
<tr>
<td>12</td>
<td>3.32 X</td>
</tr>
</tbody>
</table>

This holds true for increases in transmitter power also. Doubling your transmitter power results in only a 1.42 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 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 of each one 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 (M) 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 3-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 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. 1. Dimension E is still 94 1/2" at 100 MHz.

The length of connecting cables "V" 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 (V² + 1/2). 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 the 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 300 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 PANAMIS RFI are:

<table>
<thead>
<tr>
<th>Pass Band</th>
<th>Insertion Loss (dB)</th>
<th>Power Output (%)</th>
<th>Resultant Field (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 MHz</td>
<td>.40</td>
<td>90</td>
<td>95</td>
</tr>
<tr>
<td>1 MHz</td>
<td>.70</td>
<td>85</td>
<td>82</td>
</tr>
<tr>
<td>.5 MHz</td>
<td>.97</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

As an example, with the RFI adjusted for a 1 MHz pass band, the insertion loss would be .7 dB, resulting in 95% 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 density. In this example the range would be cut back to 95% of the range obtained 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 far from that of the center frequency. In the 100 MHz range, 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 90 ohm input/output. SWR will be about 1.2 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 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 extra wire and run it through the 3/8" hole in the shank. Secure the coil in place with electrical tape.

If you want to feed it with 75 ohm coax you’ll need another 1/4 wave transformer, just like that used in Fig. E. 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 that 1 is the same length, all 2’s are the same length, and 11 (see Fig. I) all 3’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 83% 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 that the support poles are actually touching, and the horizontal unit straddles the vertical you are close!

Look at Fig. I for a moment. Picture the top horizontal unit resting right on top of the top vertical element. Their radiation elements would be almost at the same point. Now make the vertical’s Y1 cable any length that is 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 reflected 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 (somehow). 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 bender! Here is a typical example of what you will be fighting to get out a decent signal:

Transmitter power = 10 watts
100% of 95-9 = 90% efficiency = F
4-bay horizontal x gain of 4 (H) = G
4-bay vertical = gain of 4 (V) = G

Thus, TPO x F x G = actual ERP

Therefore:
10 x .90 x 4 = 36 watts
4-bay horizontal = gain of 4(V) = G

However, only 1/2 of the power is going to each polarization, so... you have only 16.5 watts (H) and 18 watts (V).
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 and 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 passband. Further apart will narrow the passband and reduce power transfer.

Cut 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**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cast aluminum box, 2.4&quot; x 4.4&quot; by 1.0&quot;</td>
</tr>
<tr>
<td>2</td>
<td>All variable capacitors, 0.4&quot; x 0.4&quot; square, 1/4&quot; mount, 10 Pfd max.</td>
</tr>
<tr>
<td>2</td>
<td>Coax connectors of your choice, Type F, BNC, CH-220, etc.</td>
</tr>
<tr>
<td>4</td>
<td>4-40 x 1/4&quot; machine screws</td>
</tr>
<tr>
<td>2</td>
<td>4-40 nuts</td>
</tr>
<tr>
<td>2</td>
<td>solder lugs, 84 hole</td>
</tr>
<tr>
<td>1</td>
<td>Aluminum strip, approx. 1.5&quot; long, .01&quot; wide, 1/16&quot; thick</td>
</tr>
<tr>
<td>2</td>
<td>Feet #14 or #12 bare copper wire (silver plated best if you can get it but not absolutely necessary.) (Try hardware store)</td>
</tr>
</tbody>
</table>

**MOUSER ELECTRONICS**

11430 Woodside Ave
Santee, CA 92071
(619) 645-2222

**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 wire your coils and bend your aluminum slip 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.

**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 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.
PARTS LIST & SOURCES

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cast Aluminum box, 2.5&quot; x 4.4&quot; by 1.0 &quot;</td>
</tr>
<tr>
<td>2</td>
<td>All variable capacitors, .4&quot; x .4&quot; square, 1/4&quot; mount, 10-100 max</td>
</tr>
<tr>
<td>2</td>
<td>Coax connectors of your choice, Type F, BNC, CH-639, etc.</td>
</tr>
<tr>
<td>4-40 x 1/4&quot; machine screws</td>
<td></td>
</tr>
<tr>
<td>4-40 nuts</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>solder lugs, #6 hole</td>
</tr>
<tr>
<td>1</td>
<td>Aluminum strip approx. 4.5&quot; long, .06&quot; wide, 1/16&quot; thick</td>
</tr>
<tr>
<td>2</td>
<td>Feed #14 or #12 bare copper wire (silver plated heat if you can get it but not absolutely necessary) (Try hardware store)</td>
</tr>
</tbody>
</table>

MOUSER ELECTRONICS
1480 Woodside Ave
San Jose, CA 95131
(408) 486-8222

RADIO SHACK
Check local phone listings

PANAXIS
(Pull list)

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, 3/8" up from the bottom of the box.

Install the variable capacitors and coax connectors. The feed (inductors) are installed almost last. Position the capacitors so the "open" part of the plate 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 aerial.

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.

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 output.

Adjust each variable capacitor in to 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 to 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 several times until both capacitors have been "pushed" for maximum output.
CONTACT

Radio Support Group

D.R.COMMUNICATIONS: c/o 37 Stokes Croft, Bristol. A technical advice, development and research group for radio pirates. Membership £5, for which you get a free copy of this book, and advice, updates and help building the designs in it. Money goes to buy better test gear and parts. Donations welcome.

Free The Airwaves

FREE THE AIRWAVES: BCM Box 1502. London WC1N3XX. Produce RADIO CRIMES (same address and all good book shops, 30p + stamp). Campaigns for local neighbourhood pirates. A clearing house for pirate info. Membership £2.00 for individuals £10 for organisations. Design simple transmitters and answer technical queries on them.

TRANSMITTERS BUILT TO ORDER: write to LEE, 71 Ave de Fontainbeau, B.P. 38, 77310 Pringy-Ponthierry, France. Tel (6) 438 1159. (cost: expensive. Send reply coupon).

RESEARCH COMMUNICATIONS: Unit 3, Dane John Works, Gordon Rd, Canterbury, Kent. Offering transmitters of 50 W for a mere (wait for it) £780 plus £30 post plus VAT. Who are they kidding?

PANAX PRODUCTIONS: p.o.Box 130, Paradise, CA 95969 USA. Sell TX’s, and everything else by mail order. Good catalogue. But Paradise don’t come cheap. Even to buy the design and building instructions for e.g. their Stereo Encoder (Model SG - P) will cost you 15 dollars. Don’t go for their cheap exciter, it’s a dud toy. (In USA standard preemphasis is 75 us, here its 50 us, so a few values have to change in stereo generators etc.).

CRYSTALS MADE TO ORDER: from IQD Communications, 6th St, Newkerm TA187AR, or from Colledge Electronics, Merrittor, Somerset YA165NS. Tel 0460 73718...

RADIO AMATEURS HANDBOOK: published by American Radio Relay League (ARRL) yearly. Goldmine. Costs 20 dollars but second hand books often available. From Radio Ad Sales, PO Box 1105, Lima, Ohio 45802, USA.

OUR RADIO, c/o RATS, BM Hurricane, London WC1N3XX.

RELAY MAGAZINE (may be dead after loss of grant, middle of the road) STOP PRESS. STILL GOING STRONG AT: GUN MACHINE, BRITISH 90, LONDON STOP.

TX. LONDON’S ALTERNATIVE RADIO MAGAZINE contains excellent rundown of current pirates, commercial but will print news, boasts that dreadful sexist bigot, Chris England on the ‘crew’. from BCM Box 225, Lon WC1N3XX. 90p.

ANORAKS UK: Distributors, do TX, Free Radio Waves and a weekly report called AUK (good). Also distribute all kinds of pirate paraphernalia (that you know you will soon have) Have a catalogue. From PO Box 539, Blackpool, Lancashire FY14RE.

THE FREE RADIO RENDEYU: (TFR): Short wave pirates, inc news and logs of stations on air. From Pengarth, Penmaen Lane Llaner, Redruth, Cornwall TR165TW.

LONDON SQUATTERS PIRATES: 3 local stations starting April 87. Nth 8th and East London. Radio Interference (S.Lon) can be heard at present on 106mhz around 6pm Fri. All c/o BCM 1502, Lon WC1N3XX.

MEDIEA MONITOR: Nice little mag. Covers short wave and FM and legal. Weekly. 50p + stamp. No 37 has good feature on worldwide jamming wars. (28pp A6). From Roger Tidy, 11 Wyatt Philip Hae, Lloyd Baker St, London WC1 9BA.

HACKNEY BROADCASTING AUTHORITY: Common pirate, started on Oct 4th Day of Action called by CRA, we were drowned out due to broadcasting too close to the powerful Kiss FM (maybe they could be heard in Hackney). Big prog on Battle of Cable St, housing, Latin American music and history etc. Have 2 paid workers and went for CR licence supported by Hackney Council. Not heard since. 94 mHz. Address lost.

SPECTRUM RADIO: Open access group, developed from CCR which developed from Our Radio etc. At one time had 8 paid workers from a GLC grant. Went for CR licence. Never broadcast (not the rock station of same name). Interchange, 15 Wren St, London NWS 3NG.

VOICE OF NICARAGUA: English broadcast Mon-Sat 1000 and 5.00pm on 6015kHz.

PEOPLES COMMUNITY RADIO LINE: have returned in Birmingham after 2 busts. 103.7mHz. c/o 151 Dudley Rd, Edgbaston, Birmingham B19 7QY.

JBC-BLACK MUSIC FOR BREN: Best and most regular (mostly 7 days) of the good dozen black music stations, have recently started Irish and Asian programmes. Not much, maybe too low power and more TX regularity. Supported by Brent Council in CR licence bid. 104.7mHz. 126A Roundwood Road, London NW10.

SINA RADIO: seems to be the last Asian pirate left. Broadcast with low power, 7 days to the Southall area, don’t seem to be busted as much as others. Bilingual Hindi/English.

LONDON GREEK RADIO: has been busted at least 100 times, but survives by sheer persistence while other Greek pirates have vanished. Secured a legal precedent in Aug 86 when the landlord of their TX site was busted and fined £1250! Commercial. 106mHz. Po Box 225, London N19 4EN.

FREE TEC: most efficient, reliable and helpful place to get ready made technical gear. Bandmaster FM 36w, £85. Sw complete £40 etc. Have no address, but Free Radio Waves will forward mail. Free tec, c/o Free Radio Waves.

FLAGSONES, West Heath Lane, Sevenoaks, Kent TN13 1TA.

BROADCASTING: VHF rigs etc. forwarding address c/o BCM Box 225, London WC1N3XX.

ANFIELD COMMUNITY RADIO: c/o111 Pinehurst Ave, Anfield, Liverpool, L4 TUG. 1413 kHz. MW.

RADIO LIBERTARIA: Spanish anarchist pirate. San Martino 6, 1a, Valencia, Espana.

NUOVA ELECTRONICA: sell complete TX’s and all kinds of gear and kits, including PLL exciters. Write in Italian (all instructions also come in Italian) to Via Cracovia 19, Bologna, Italy.


FREE RADIO WAVES: Pirate buffs. some good info, worth a read. from Flagstones, West Heath Lane, Sevenoaks, Kent 90p (40pp A6).

CROSSIAR, LA SCART PAPER & BLACK PEARL, & NEWS
FORTNIGHTLY: BM HURRICANE, LON WC1N3XX.
Here is a list of all our titles. All prices include post and packaging.

**The Free £1.80**
Best selling thriller set in a revolution in the near future.
Last of the first edition still available.

**Ideal £2**
Selfhousing handbook. How to squat, travel, truck, make benders, floating homes, teepees etc.

**A year of our lives £2**
The miners and families of Hatfield Main tell in stories and pictures how they organised and fought the great strike 1984/85.

**The Faction File £2**
Full sized souvenir edition. Fantastically vicious and hilariously graphic illustrations. Plus Tales from the Front line.

**Radio is My Business £2.40**
Complete DIY guide to Pirate Radio—from A to Z. Advocates a pirate in every street.

**Squatting in West Berlin £1**
Photographs of a creative political movement and how it was destroyed

**From Beneath the Keyboard £2**
A collection of new short stories and poetry from the lunatic fringe

**Written in Flames £1.50**
For the first time the names and addresses of the British ruling class and a trip through the corridors of Power, Privilege and Property.

**HOOLIGAN PRESS. BM Hurricane, London WC1N 3XX**