Introduction to Legal CB

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AND

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* WHAT IS FM?
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PRACTICAL ELECTRONICS

Citizens' Band will shortly be legal in the U.K. and this booklet sets out to explain the new system and show why f.m., and not a.m., has been adopted. Some popular myths and misconceptions concerning f.m. are dispelled and the performance of typical 27MHz and 934MHz systems is discussed in detail. Readers will have doubtless already formed an opinion as to the desirability, or otherwise, of CB and, for anyone contemplating using the new system, this booklet is a "must"!

THE AUTHORS

Michael Tooley and David Whitfield are both professional electronic engineers who have become highly respected contributors to PE and other leading technical journals.

Both are licensed amateur radio operators; Mike has held G8CKT for 12 years and David G8FTB for 10 years. They have designed, built and used many items of equipment for the amateur bands and are thus highly qualified to write on this subject and to design the *PE Ranger 27FM* CB transceiver, published as a project in PRACTICAL ELECTRONICS.

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CITIZENS' Band is a short range low power personal two-way radio system in which anyone suitably licensed can participate. This system is shortly to become legal in the U.K. using frequency modulation in the 27MHz and 934MHz bands. Most readers will not need to be reminded that there is, at present, a large number (some estimates are in excess of 500,000) of existing users of an unauthorised Citizens' Band service using imported and mainly amplitude modulated (a.m.) equipment. CB users, or "breakers" as they like to be called, have been quick to point out the advantages of a CB network; not only is it fun, but it can also be helpful to society in general.

How many people have wished that they could quickly summon help to the scene of a road accident? Getting help and making friends is easy with CB and thus it has a great deal to offer the lonely, disabled and housebound. The motorist could benefit greatly from up-to-the-minute weather information, traffic reports and the facility to get immediate assistance in the event of a breakdown. Furthermore, in a strange town, CB can be a valuable asset to the driver needing route directions or local information.

Currently over sixty countries have a Citizens' Band service and the majority have opted for an a.m. system following that introduced over twenty years ago in the United States. Some countries also have a u.h.f. allocation for CB and this is usually in the 450 to 470MHz region. In Europe seventeen countries have CB and only five of these favour f.m. rather than a.m. It should be noted, however, that these five include France, Holland, Germany and the Irish Republic!

F.M. has several advantages to offer which undoubtedly underly its choice for the U.K. Citizens' Band service. A phenomenon known as capture effect ensures that, when several signals are present in a channel, the strongest will dominate provided it has a 6dB or more advantage over the rest. This, unfortunately, is not true of a.m. as witnessed by the numerous squeaks, buzzes and heterodyne whistles heard when monitoring crowded CB channels with an a.m. receiver. F.M. capture effect allows the same channel to be used by many more stations than would be possible with a.m.

Undoubtedly the most important reason why an a.m. 27MHz system was *rejected* lies in its relative susceptibility to television interference and audio breakthrough affecting such equipment as audio amplifiers, music centres, and tape recorders. De-modulation of strong 27MHz a.m. signals is almost unavoidable in nearby audio equipment and, once de-modulated, the audio signal receives the full benefit of amplification. The usual cure for breakthrough involves fitting filters on outside connections such as aerial downleads and loudspeaker cables. The aim being that of preventing the 27MHz signal from reaching the equipment with which it is interfering. In severe cases ferrite beads, chokes and r.f. decoupling capacitors may have to be fitted inside the equipment. Fortunately this problem does not arise with f.m. since de-modulation no longer occurs. This does not mean, however, that f.m. transmitters are any less susceptible to harmonic radiation than their a.m. counterparts and attention still has to be given to ensuring that the transmitted output is free from spurious signals.

One aspect of CB that has had a significant effect in the U.K. has been the rapid growth in both the number and membership of CB clubs. These, undoubtedly, have had a beneficial influence on operating standards and have acted as centres for the dissemination of information on CB. On a national basis there are two major CB organisations of note. These are the United Breakers Association (UBA) and the Citizens' Band Association (CBA). One furtner body of note is the National Committee for the Legalization of Citizens' Band Radio (NATCOLCIBAR) which has consistently fought for a viable U.K. Citizens' Band service and which will continue to lobby for the protection and interests of CB users.

CB IN THE U.K.

The Home Office's Specification for the U.K. Citizens' Band service differs markedly from that which many existing illegal CB operators would like. Thus the

Table 1. Channel numbers and frequencies for the 27MHz U.K. Citizens' Band (Frequencies given in MHz)

CHANNEL NUMBER	FREQUENCY	CHANNEL NUMBER	FREQUENCY
1	27·60125	21	27·80125
2	27·61125	22	27·81125
3	27·62125	23	27·82125
4	27·63125	24	27·83125
5	27·64125	25	27·84125
6	27·65125	26	27·85125
7	27·66125	27	27·86125
8	27·67125	28	27·87125
9	27·68125	29	27·88125
10	27·69125	30	27·89125
11	27·70125	31	27·90125
12	27·71125	32	27·91125
13	27·72125	33	27·92125
14	27·73125	34	27·93125
15	27·74125	35	27·94125
16	27·75125	36	27·95125
17	27·76125	37	27·96125
18	27·77125	38	27·97125
19	27·78125	39	27·98125
20	27·79125	40	27·99125

legalization of CB is seen as something of an empty victory by many "breakers" who, to become legal, will have to discard their existing equipment. This action may, at first sight, appear hard hearted on the part of the Home Office; however, there are some very good reasons which will soon become apparent.

The Home Office has released forty channels in the new 27MHz band. It should be noted, however, that these forty channels do not coincide with the most popular a.m. channels in current use (these are channel 1 to 40 of the U.S.A. CB service which extends from 26·965 to 27·405MHz). The reason for this choice lies not only in the incompatibility of a.m. and f.m. systems (a.m. is unreadable on a properly adjusted f.m. receiver although the converse is not necessarily true) but also in separating the legal from the illegal user. It should also be noted that there are a number of legitimate users of the 27MHz band who are currently facing considerable interference from illegal CB operators. An additional twenty channels has been released in the 934MHz band. Details of the channel numbers and frequencies are shown in Tables 1 and 2.

Table 2. Channel numbers and frequencies for the 934MHz U.K. Citizens' Band (Frequencies given in MHz)

CHANNEL NUMBER	FREQUENCY	CHANNEL NUMBER	FREQUENCY
1	934·025	11	934·525
2	934·075	12	934·575
3	934·125	13	934·625
4	934·175	14	934·675
5	934·225	15	934·725
6	934·275	16	934·775
7	934·325	17	934·825
8	934·375	18	934·875
9	934·425	19	934·925
10	934·475	20	934·975

The channel spacing on 27MHz is 10kHz whilst that on 934MHz is 25kHz. However the actual spacing on 934MHz is 50kHz and thus the u.h.f. system would appear to allow for future expansion. The maximum effective radiated power is 2W on 27MHz and 25W on 934MHz. However, in the latter band, a limitation of 3W e.r.p. is made on equipment possessing internal aerials. In both bands only equipment for angle modulation (either frequency modulation or phase modulation) will be permitted. Equipment which has facilities for any other form of modulation (e.g.: existing multi-mode or converted sets retaining the a.m. function) will not be approved.

There are also some further restrictions on the height of aerials that can be used in the 27MHz band. If the aerial is mounted at a height exceeding 10 metres the user will be required to reduce the output by 10dB. A brief summary of the specification is shown in Table 3.

934MHz COMPARED WITH 27MHz

A fair amount is known about the range and coverage that can be expected of a 27MHz f.m. system. There has, however, been much speculation as to the usefulness or otherwise of a low-power f.m. system on 934MHz! Most of this has been based on supposition and not on the results of any detailed investigation. Contrary to popular belief, 934MHz can provide a reasonable service but it is likely to be one that is reserved for the select few who can afford the rather high cost of the equipment involved. For this reason 934MHz is likely to be a very under-populated world!

Radio waves at 27MHz propagate both as ground waves and sky waves. The presence of sky waves (or "skip" as it is called by 27MHz operators) is very much

Table 3. Brief summary of specification for the U.K. Citizens' Band service

PARAMETER	27MHz	934MHz
Frequency range:	27·60125–27·99125	934·025–934·975
Mode of operation:	Angle modulation (f.m. or p.m.)	Angle modulation (f.m. or p.m.)
Channel spacing:	10kHz	25kHz
Maximum deviation:	± 2·5kHz	± 5kHz
Maximum r.f. output power:	4W	8W
Maximum effective radiated power:	2W	25W*

(*Equipment with internal aerials limited to 3W e.r.p.)

dependent on ionospheric conditions and can result in considerably extended propagation (several thousand miles in many cases). In a system which is intended purely for local communication this can be a severe nuisance. During a period of minimum solar activity the 27MHz band is relatively quiet; however, at the peak of the 11-year sunspot cycle, "skip" can be dominant and often override even strong local signals. On 934MHz signals only propagate as space waves which are the resultant of two components: a direct wave and a ground reflected wave, as shown in Fig. 1. Thus 934MHz signals tend to propagate on a "line-of-sight" basis and are much more critical of local topograhy than those at 27MHz.

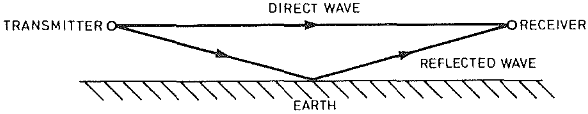

Fig. 1. The two components of a space wave.

Under certain circumstances a 934MHz system can give better penetration in densely built-up areas than a 27MHz system. This is principally due to multiple reflection of signals caused by large obstructions. This reflection is more effective at the shorter wavelength involved. Signals can also propagate by diffraction around the edge of an obstruction. There is some evidence that, in an urban environment, this may also be more effective at u.h.f. than at v.h.f. Despite this it must be admitted that there would be numerous shadows in the coverage of most 934MHz systems and the range would be very severely restricted if the transmitter were shielded by large obstructions or rising ground. A typical path profile showing the effect of obstructions on the coverage of systems at both 934MHz and 27MHz is shown in Fig. 2.

One obvious advantage of 934MHz is the size of aerials involved and the fact that even a relatively inconspicuous aerial can exhibit considerable gain. For example, an aerial having an approximate length of 450mm can have a gain of around 6dB (four times). On 27MHz the same value of gain would be achieved with a 17 metre aerial of the same design!

One serious disadvantage of 934MHz for the mobile user is attributable to local reflection and diffraction effects. Since propagation in built-up areas is very rarely line-of-sight, generally several signals are received at the mobile station via different reflection and/or diffraction paths. This gives rise to an interference standing wave pattern. The vehicle moves through this pattern and perceives a variation in the strength of the received signal. The shorter the wavelength the more noticeable is the effect. Thus a 934MHz mobile system is likely to suffer from severe "flutter". In some cases this can cause rapid drop-out of signals below the squelch threshold of the receiver.

Typical coverage that might be expected from comparable 27MHz and 934MHz systems is shown in Fig. 3. Note that there are numerous shadows in the 934MHz coverage and also that, on high ground at some considerable distance from the transmitter, the 934MHz signal will be stronger than that on 27MHz. Table 4 shows typical working range of various 27MHz systems assuming an e.r.p. of 2W from base and mobile stations.

FREQUENCY MODULATION

Modulation is the name given to the process of superimposing an audio frequency signal on to a high frequency carrier wave so that the information may be transmitted over a considerable distance either in a cable or as a radiated electromagnetic wave. One of the most common methods of modulation involves varying the amplitude of the carrier in sympathy with the instantaneous value of the modulating signal. This, of course, is known as amplitude modulation, or just simply a.m. Another method involves varying the frequency of the carrier wave in accordance with the instantaneous value of the modulating signal whilst the amplitude of the carrier remains constant. This is frequency modulation, or f.m.

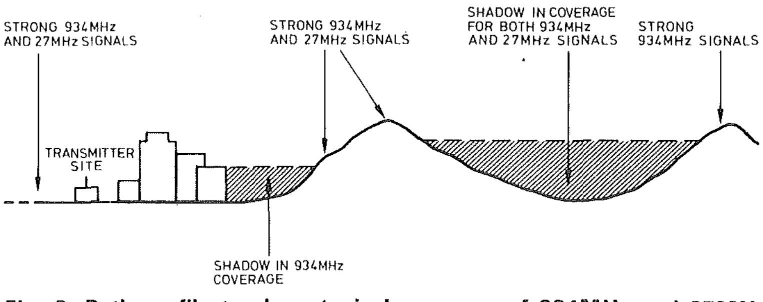

Fig. 2. Path profile to show typical coverage of 934MHz and 27MHz signals (effective radiated power assumed equal).

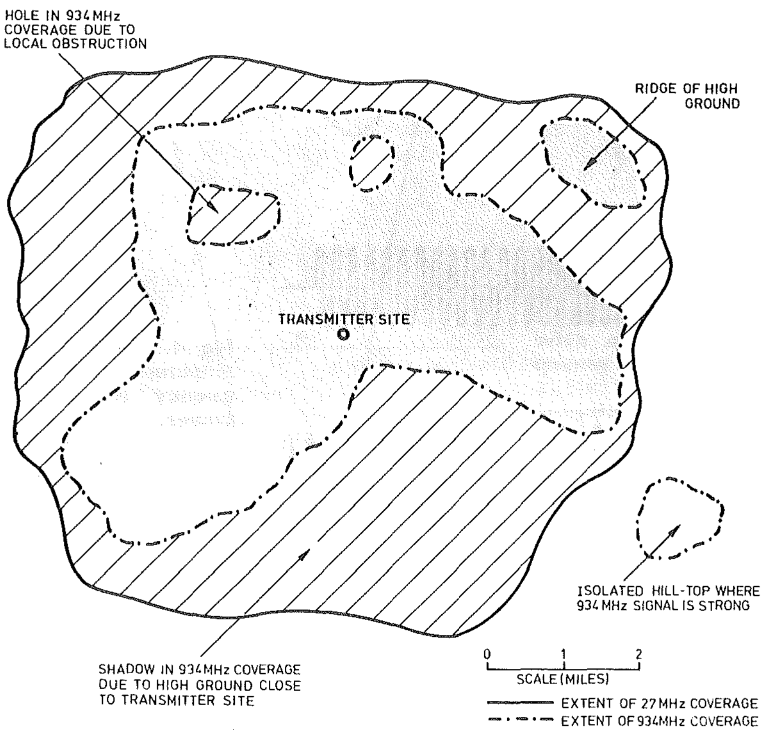

Fig. 3. Diagram to illustrate typical coverage of 27MHz and 934MHz systems (aerials assumed omni-directional).

Modulating signals, such as speech, consist essentially of two components: information conveyed by virtue of the *frequency* of the signal and information conveyed by virtue of the *amplitude* of the signal. In an a.m. system the amplitude of the carrier conveys the amplitude information and the rate of change of carrier amplitude is used to convey the frequency information. In an f.m. system the frequency of the carrier conveys the amplitude information whilst the rate of change of carrier frequency conveys the frequency information.

This may all sound a little heavy, so to put things into context here is a simple

Table 4. Typical working range for various types of 27MHz f.m. CB equipment (Base and mobile stations assumed e.r.p. of 2W)

SITUATION	TYPICAL RANGE (miles)
Base station to base station	7–12
Base station to mobile station	5–8
Mobile station to mobile station	3–6
Hand-portable to base station	1–3
Hand-portable to mobile station	1–2
Hand-portable to hand-portable	½–1

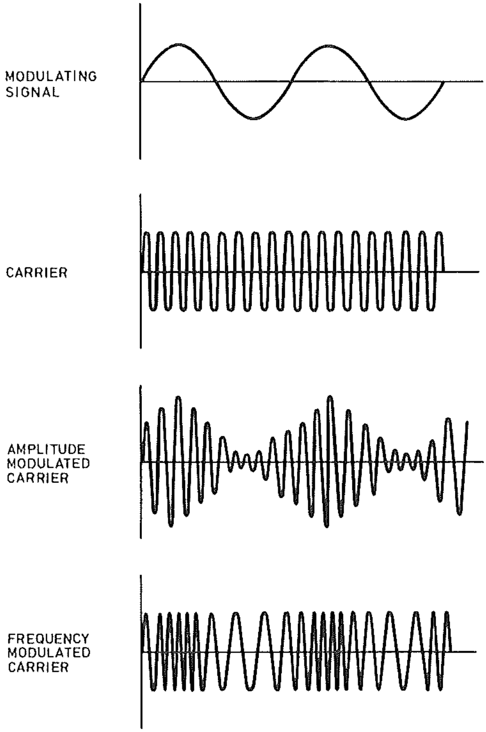

Fig. 4. Waveform of amplitude and frequency modulated waves.

example: A carrier at 27·600MHz is being frequency modulated by a sinusoidal signal at 1kHz having a peak value of 1V. Assuming that the frequency modulator produces a 1kHz peak deviation the graph of carrier frequency against time would appear similar to that shown in Fig. 5. If the peak value of the modulating signal were to increase to 2V and assuming that the modulator has a linear characteristic (with a slope of 1kHz/V) the new peak frequency deviation would be 2kHz and the new frequency/time graph would be similar to that shown in Fig. 6.

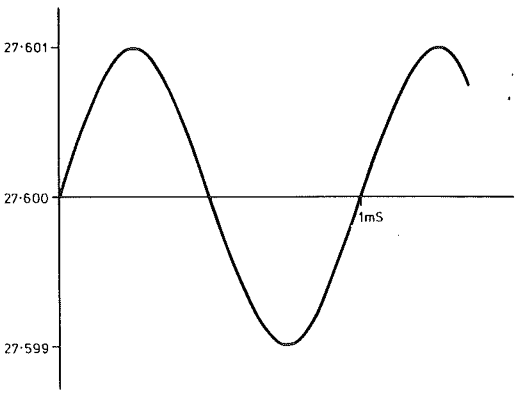

Fig. 5. Frequency/time graph for a 27·600MHz carrier with a peak frequency deviation of 1kHz and modulating signal frequency of 1kHz (sine wave).

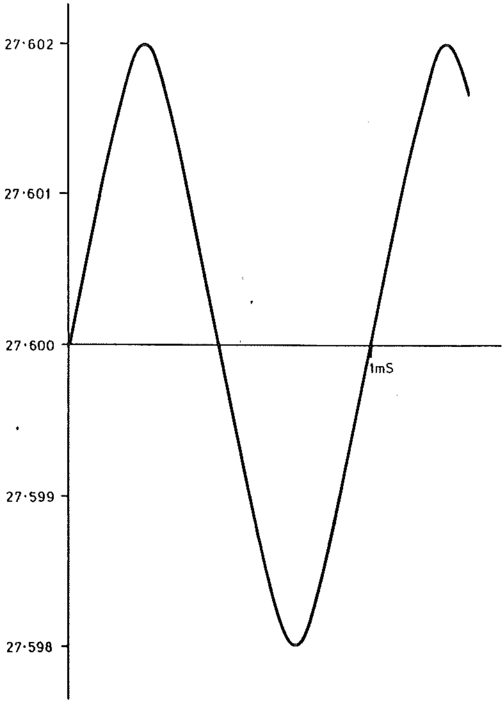

Fig. 6. Frequency/time graph for a 27·600MHz carrier with a peak frequency deviation of 2kHz and modulating signal frequency of 1kHz (sine wave).

MODULATION INDEX AND DEVIATION RATIO

The modulation index, m, is given by the ratio of frequency deviation to modulating signal frequency. Hence $m = \frac{f_d}{f_m}$ where f_d is the frequency deviation and f_m is the frequency of the modulating signal. In the first example $m = \frac{1\text{kHz}}{1\text{kHz}} = 1$ and in the second example $m = \frac{2\text{kHz}}{1\text{kHz}} = 2$.

The deviation ratio, d, is given by the ratio of maximum frequency deviation to the highest modulating signal frequency employed. Hence $d = \frac{f_{d(max)}}{f_{m(max)}}$ where $f_{d(max)}$ is the maximum permitted frequency deviation and $f_{m(max)}$ is the highest modulating signal frequency allowed. Hence in a system using 2·5kHz maximum deviation with a maximum modulating signal frequency of 3kHz the deviation ratio is $d = \frac{2{\cdot}5\text{kHz}}{3\text{kHz}} = 0{\cdot}833$. The importance of this will be seen later on, however it should be noted that, whereas the deviation ratio is fixed for a given system, the modulation index varies with both the frequency and amplitude of the modulating signal.

FREQUENCY SPECTRUM OF AN F.M. SIGNAL

The frequency spectrum of an f.m. signal is not quite so predictable as that for a comparable a.m. system. The frequency spectrum of a carrier amplitude modulated by a single sinusoidal tone consists of three components as shown in Fig. 7. The modulated signal comprises a carrier and a pair of side frequencies spaced from the carrier by a frequency equal to that of the modulating signal.

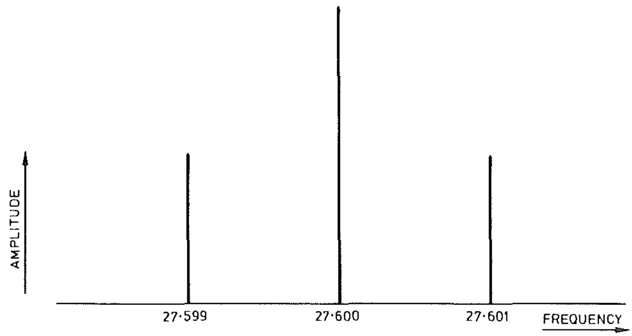

Fig. 7. Frequency spectrum of an amplitude modulated wave. Carrier frequency = 27·600MHz. Modulating signal frequency = 1kHz. Upper side frequency = 27·601MHz. Lower side frequency = 27·599MHz. Total bandwidth = 2kHz.

Hence the bandwidth of an a.m. signal is quite simply twice the highest value of modulating signal frequency (assuming that it is sinusoidal).

The frequency spectrum of a carrier frequency modulated by a single sinusoidal tone consists not only of a carrier and pair of side frequencies each spaced from the carrier by a frequency equal to that of the modulating signal, but also a number of other side frequencies are present both above and below the carrier spaced by integral multiples of the modulating signal frequency.

As an example consider a frequency modulated carrier at 27·600MHz. If the modulating signal frequency is 1kHz the first pair of side frequencies occur at 27·601 and 27·599MHz, the second pair are at 27·602 and 27·598MHz, the third at 27·603 and 27·597MHz, and so on. The amplitude of the modulated carrier and side frequencies, relative to that of the unmodulated carrier, depends on the value of modulation index employed. The relationship between relative amplitudes of the components present and the modulation index is not a simple one, as can be seen from the Bessel function derived diagram shown in Fig. 8.

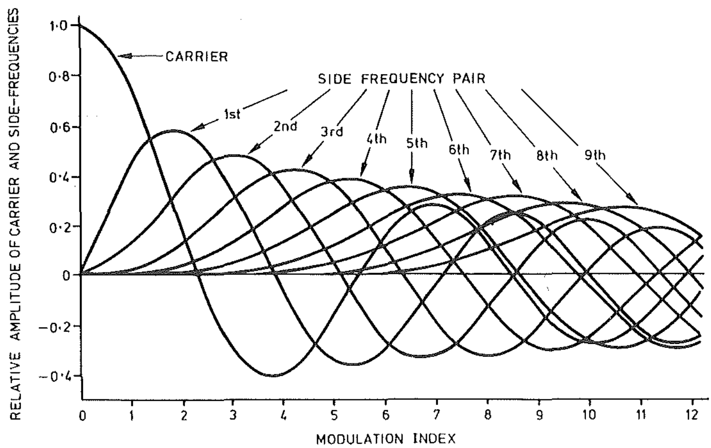

Fig. 8. Diagram showing the relationship between carrier, side frequency components and modulation index in an f.m. system.

This may look somewhat complex at first sight since it conveys a considerable amount of information. The main points are summarised below:—

(a) When m = 0 the carrier is unmodulated. Therefore its amplitude is 1.

(b) As m is increased the amplitude of the carrier decreases and that of the side frequency components is increased. The total energy of the frequency modulated wave is constant. In other words, the energy in the side frequencies during modulation is derived from the carrier.

(c) At some values of m the relative value of the carrier is zero. At these values the carrier disappears altogether. The first of these values occurs at m = 2·4.

(d) Negative values of relative carrier and side frequency amplitude indicate a phase shift of 180 degrees.

(e) When m = 1 the relative carrier amplitude is 0·7 while that of the first pair of side frequencies is 0·4. The relative value of the second pair of side frequencies is less than 0·1.

(f) For large values of m the number of side frequency components becomes appreciable and the bandwidth therefore increases rapidly.

BANDWIDTH

For small values of modulation index (i.e.: m less than 0·5) the bandwidth of an f.m. signal is comparable with that of an a.m. signal since the amplitude of the second and higher order side frequency components are negligible. With larger values of modulation index the amplitude of the second and higher order side frequencies can no longer be ignored and the bandwidth is correspondingly increased; Fig. 9 shows the effect of modulation index upon the frequency spectrum and bandwidth of a frequency modulated 27·600MHz signal.

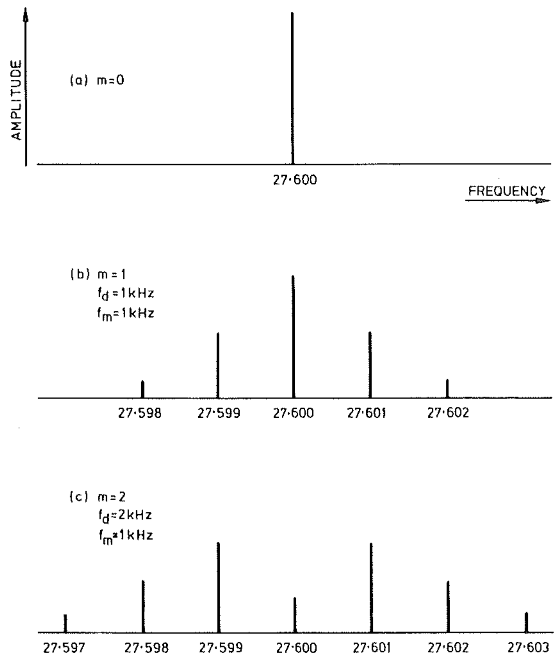

Fig. 9. Frequency spectra of a 27·600MHz frequency modulated carrier for various values of modulation index.

The maximum or rated system bandwidth is governed by the deviation ratio employed. An approximate relationship for the rated system bandwidth is given by $(2f_{d(max)} + f_{m(max)})$. In the case of an f.m. system with a maximum deviation of 2·5kHz and highest modulating frequency of 3kHz the rated system bandwidth will be approximately 8kHz. An equivalent a.m. system would require 6kHz. Note that, for obvious reasons, the channel spacing employed in any system must be greater or equal to the rated system bandwidth.

F.M. VERSUS A.M.

Both methods of modulation have their own peculiarities and particular applications. A.M. requires only a simple receiver and is thus eminently suited to medium and long wave broadcasting. F.M., on the other hand, requires a more complex receiver but offers some impressive advantages over a.m. when it is

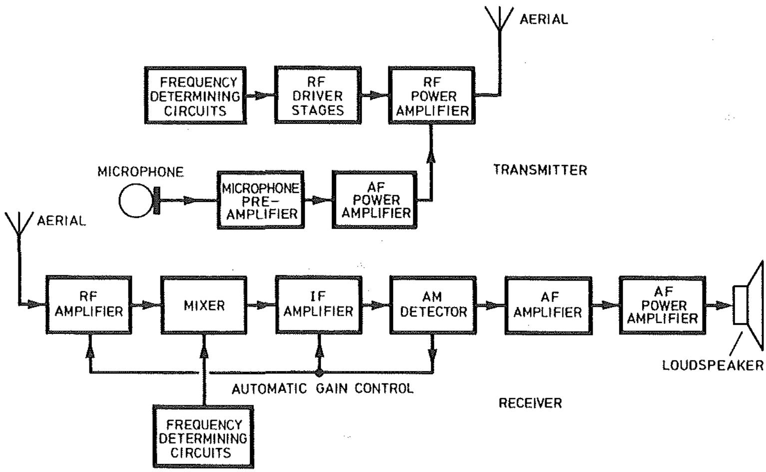

Fig. 10. Simplified block schematic of a typical a.m. transmitter and receiver.

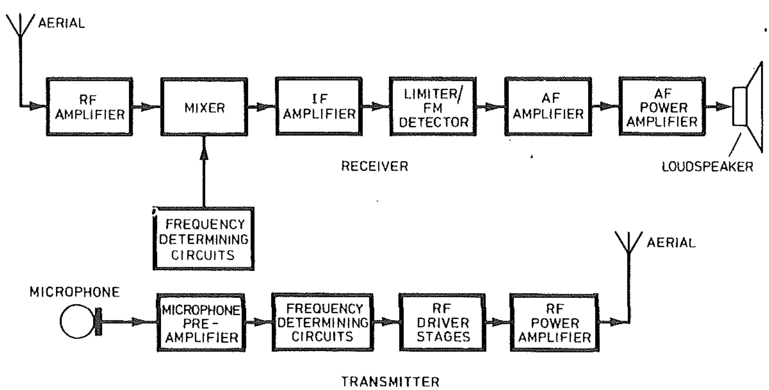

Fig. 11. Simplified block schematic of a typical f.m. transmitter and receiver.

necessary to recover a high signal-to-noise ratio from a signal of only moderate strength transmitted over a "noisy" communication channel. For this reason f.m. has been adopted for the vast majority of v.h.f. and u.h.f. radiotelephone systems in current use, the performance of a comparable a.m. system being somewhat inferior.

Furthermore, a correctly set-up f.m. receiver can be almost impervious to ignition interference and electrical noise generated by a motor car engine. Thus there is no need for additional vehicle noise suppression which is usually considered essential with mobile a.m. equipment. F.M. receivers also possess excellent strong signal handling capabilities indeed, in many cases, no form of a.g.c. (automatic gain control) is incorporated since the modulation information is recovered from the frequency of the signal and not from its amplitude as is the case with a.m.

In an f.m. transmitter modulation occurs at low power levels and the signal is amplified, and sometimes frequency multiplied, in subsequent class-C power amplifier stages. Thus linearity is good and there is no need for a separate high level modulator stage. This not only reduces the component count but it also reduces the overall power consumption and removes the need for relatively bulky modulation transformers. These latter two considerations are, of course, very important in the case of portable and battery operated equipment. The block diagrams of typical a.m. and f.m. transmitters and receivers are shown in Figs. 10 and 11 respectively.

GENERATING F.M.

There are two basic methods of producing f.m. One involves operating directly on the frequency determining elements of an oscillator stage in the transmitter and the other acts indirectly by changing the phase of the signal in a subsequent stage. This second method is called phase modulation and the result is identical to f.m. provided that the audio frequency response is correctly tailored prior to the phase modulator stage. The reason for this is that, in a true f.m. system, the deviation produced is the same for all signals of equal amplitude regardless of their frequency (assuming that the microphone amplifier has a "flat" response) whereas, in a phase modulated system the deviation is also proportional to the

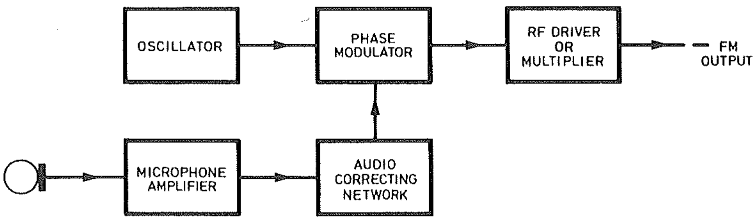

Fig. 12a. Phase modulator using an audio correcting network to produce f.m.

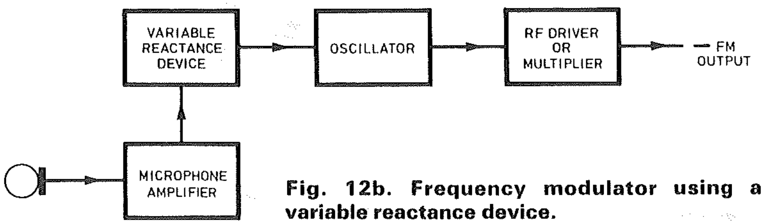

Fig. 12b. Frequency modulator using a variable reactance device.

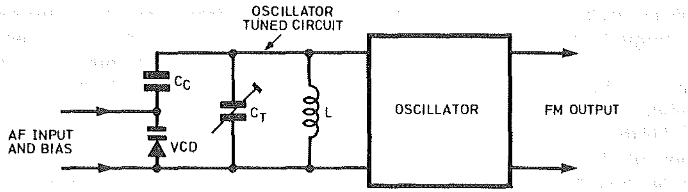

Fig. 13. Basic arrangement of a f.m. oscillator using a variable capacitance diode.

frequency of the modulating signal. Thus, in a p.m. system, a signal at 2kHz will produce twice as much deviation as an equal amplitude signal at 1kHz. Thus the desired audio response prior to the modulator is a roll-off of 6dB/octave and this can easily be accomplished by means of a suitable C-R low pass network connected between the microphone amplifier and phase modulator. Typical block schematics of frequency and phase modulators are shown in Fig. 12.

The simplest method of achieving f.m. is with the use of a variable capacitance diode as shown in Fig. 13. The diode is operated with reverse bias (i.e.: in its non-conducting state) and the capacitance of its junction varies inversely with the square of the voltage applied. The resonant frequency of the tuned circuit, however, varies inversely with the square root of its capacitance and thus, over a limited range, the frequency of operation is directly proportional to the applied voltage. A steady bias voltage is used to define the operating point about which the audio voltage swings. The operating point is chosen so as to provide linear frequency/voltage change whilst ensuring that the diode never becomes forward biased during extreme negative excursions of the modulating signal. A small value capacitor, C_C, is used to couple the capacitance change to the main tuned circuit, L and C_T. The value of the coupling capacitor is chosen so as to provide only the desired value of deviation when the diode is fed with a few hundred millivolts of audio. This ensures a high degree of linearity whilst maintaining reasonable stability of the oscillator. A practical realisation of Fig. 13 is shown in Fig. 14. The oscillator is a series tuned Colpitts type using a junction gate f.e.t.

F.M. RECEIVERS

An f.m. receiver is basically similar to an a.m. receiver, the important difference being in the de-modulator stage. The object of an f.m. de-modulator is that of producing an output voltage proportional to the frequency of the signal from the i.f. amplifier. A simple a.m. detector may be used to receive f.m. if the signal is deliberately off-tuned so that the actual intermediate frequency lies to

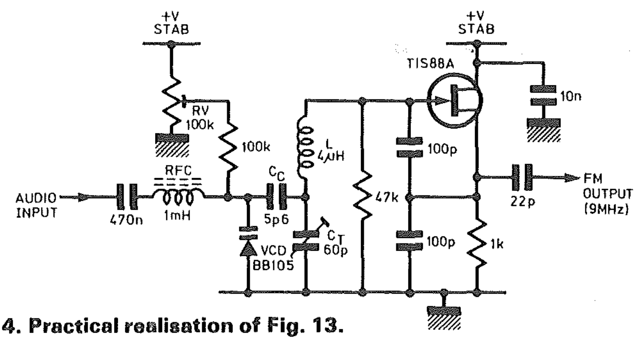

Fig. 14. Practical realisation of Fig. 13.

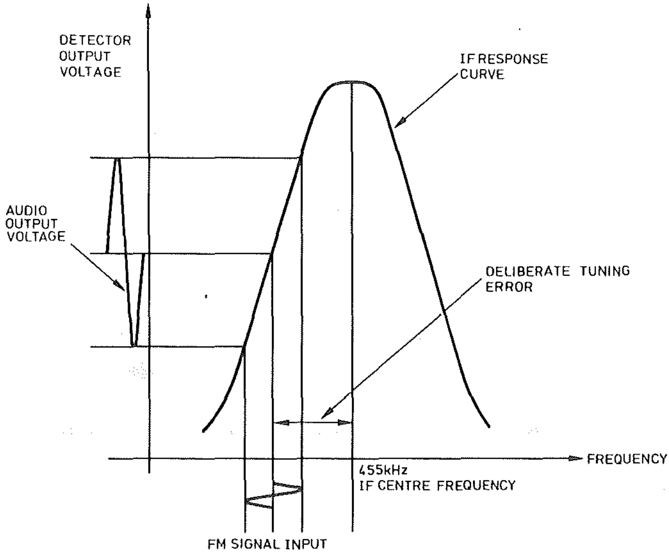

Fig. 15. Diagram to show the principle of "slope" detection of f.m. using an a.m. receiver.

one side of the i.f. response curve, as shown in Fig. 15. A better method is to make use of a properly designed f.m. detector and usually the signal is amplitude limited prior to its application to the detector stage.

A simple ratio detector is shown in Fig. 16 and a more modern quadrature detector and i.f. system is shown in Fig. 17. This makes use of an i.c. designed specifically for the amplification and detection of f.m. signals in narrow band communication equipment. A typical i.f. response curve for Fig. 17 is shown in Fig. 18.

OPERATING PRACTICE AND PROCEDURE

For the newcomer common operating practice on CB can be quite baffling. Indeed this can be one area which can act as a positive deterrent to many potential

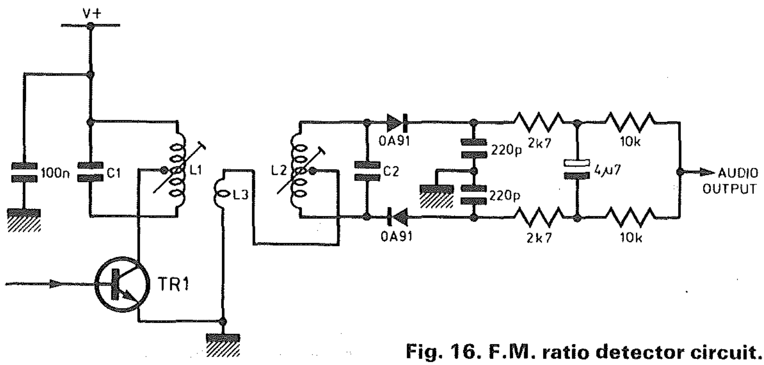

Fig. 16. F.M. ratio detector circuit.

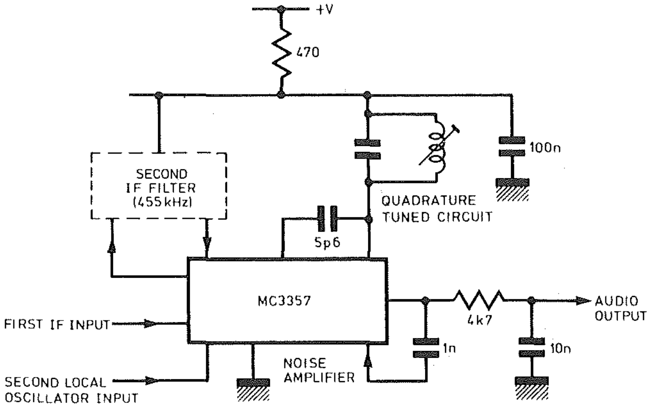

Fig. 17. Simplified form of i.f. system and quadrature detector using MC3357.

users who see CB as a cult for those "in the know" rather than as an extension of their normal social activities. This is a great shame particularly as the basic rules are so simple. CB jargon is fun but it is of limited use unless *everyone* knows what you are talking about. For example: "This is Juliett-Three stationary on the M3 at Sunbury" is far better than "This is the Old Moon-Dog square wheels on the super slab at Smoke City"! For CB to *really* catch on we need a system which can be understood by everyone not just by those who fancy themselves as American truck drivers.

The 'CB Operator's Code' which we have prepared covers all the main points of CB operating—follow it and you won't go far wrong!

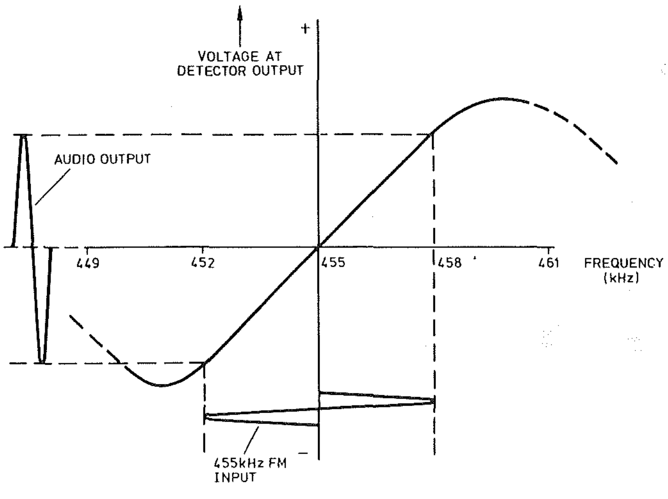

Fig. 18. Typical detector "S"-curve for Fig. 17.

THE CB OPERATOR'S CODE

1. Always give your callsign and location when first making a call and when ceasing transmission. Make sure that you give this information clearly as it identifies you to other CB users.

2. Keep all messages short and simple. Never use three words when one will do. Avoid long-winded rambling, introduce one subject at a time and seek confirmation of each point before going on to the next.

3. Use only clear, concise and consistent speech. Where necessary use the International Phonetic Alphabet to confirm letters.

4. Only talk when you have something to say, otherwise maintain a listening watch. Be receptive and responsive. Try to avoid one-sided conversations. There is nothing worse than a monologue—remember that CB is for the interchange of information and this is always a two-way process.

5. Always listen on the channel which you intend to use before putting out a call. Just because the channel is quiet does not mean that it is unoccupied. An initial call saying "Is this channel in use, please?" will quickly establish whether or not the channel is free. If someone comes back to say that the channel is busy the caller should either wait until it is vacated or seek another empty channel.

6. Use jargon and "10-code" only where you are certain that you will be understood by the other party and when conditions are so poor that normal speech is unreadable.

7. Avoid misleading and facetious remarks. These will not help your popularity, neither will they benefit the cause of CB in general.

8. Help the newcomer. Always make special allowance for the inexperienced operator. Give him or her all the assistance you can—remember that everyone has to start sometime!

9. Make signal reports meaningful. "A loud signal slightly broken up" means nothing. A more useful report would be "A strong signal reading 9 on my meter but suffering from interference from a local station on the next channel".

10. Always use the least power sufficient to make your signals fully readable at the other end. If your transceiver has a power reduction facility or if you have an aerial attenuator use it whenever possible. This allows other users to operate on the same frequency without suffering interference from you.

11. Always keep the designated calling and emergency channels free. Once a contact has been established on the calling channel move away to a working channel so that others may use the frequency. Never operate on the emergency channel unless there is a genuine emergency. If an emergency does arise and you are monitoring, leave the frequency clear for those stations best equipped and situated to render assistance. If that happens to be you keep a cool head and remember that lives can be saved by the correct use of CB!

AFTER CB—WHAT NEXT?

Many CB users will only see CB as a means of providing them with a personal two-way radio system. A means of keeping in touch with home, and finding a way through traffic jams. Some, however, will want to go further—radio can be an exciting and absorbing hobby. If you want to talk regularly right across the world, use satellite communication links, operate your own television station, or just simply build and maintain your own transmitting equipment you should be thinking of moving to amateur radio. The amateur licence offers a great deal of freedom but it is not given away—it has to be earned. The essential requirement is a pass in the City and Guilds of London Radio Amateur's Examination

Many Technical Colleges and Evening Institutes run courses and will be glad to provide details. The Radio Society of Great Britain at 35, Doughty Street, London WC1N 2AE, serves the interests of the radio amateur in the U.K.

SIGNAL STRENGTH REPORTING CODE

STRENGTH	EFFECT ON INTELLIGIBILITY	EFFECT ON BACKGROUND NOISE
1	Very poor— barely readable	Noise and signal of about equal strength
2	Poor— readable with difficulty	Considerable noise present
3	Acceptable—adequate readability	Moderate noise present
4	Good— fully readable signal	Slight noise present
5	Excellent— fully readable signal	No background noise whatsoever

"TEN CODE"

10–0	Be careful
10–1	Poor signals received
10–2	Good signals received
10–3	Stop transmitting
10–4	Message received and understood
10–5	Relay message
10–6	Stand-by
10–7	Closing down
10–8	Maintaining listening watch
10–9	Repeat message
10–10	Message complete
10–11	Talking too rapidly
10–12	Visitors present
10–13	Advise weather and traffic conditions
10–16	Collect
10–17	Urgent business
10–18	Any message for me?
10–19	Return to base
10–20	Location
10–21	Call by telephone
10–22	Come in person
10–23	Stand-by
10–24	Assignment complete
10–25	Can you contact
10–26	Disregard last message
10–27	Moving to channel
10–28	Identify your station
10–29	Time is up for contact
10–32	Give a radio check (signal report)
10–33	Emergency message
10–34	Trouble at this station
10–35	Confidential information
10–36	Time check
10–37	Breakdown at
10–38	Ambulance needed at
10–39	Message delivered
10–41	Move to channel
10–42	Road traffic accident
10–43	Traffic jam
10–44	Message for you
10–45	Any station within range report
10–50	Break channel
10–62	Unable to copy—use telephone
10–63	Network directed to
10–64	Network clear
10–65	Awaiting your next message
10–67	All stations comply
10–69	Message received
10–70	Fire at
10–71	Proceed with message
10–77	Negative contact
10–81	Reserve hotel room for
10–82	Reserve room for
10–84	My telephone number is
10–85	My address is
10–88	Advise telephone number of
10–90	I am causing television interference
10–91	Talk closer to the microphone
10–92	Adjust your transmitter
10–93	Check my frequency
10–94	Give me a long count
10–95	Transmit plain carrier
10–97	Check signal
10–99	Mission completed
10–200	Police needed at