THE WEST RAND AMATEUR RADIO CLUB

July 2001
Volume 2, Issue 1

ANODE

Editor's Comments

Well you got the committee you deserved, AGAIN!

There being no opposition parties, the committee was re-elected with a few exceptions.

The committee now consists of; ZS6REV, Bill van Zyl - Chairman ZS6BZF, John Brock - Vice-Chair ZR6AOC, David Cloete - Secretary/ Treasurer. With John Friend, Keith, Simon, Phillip and Cobus serving as committee members.

ZS6REV Om Bill van Zyl

Due to the large number of John's and 'van Zyl's' in the club, it was felt that all members should be addressed as 'John van Zyl'. A motion to this effect was defeated hugely.

Noise in HF Receivers

by G.P. Stancey BSc G3MCK

The standard books which deal with the design of h.f. receivers usually make the following statement: "At h. f., receiver noise is usually not too important as it is masked by the external noise level". They then go on to discuss other aspects of receivers. However, a closer study of this simple statement is well worthwhile as it provides a useful insight into such areas as receiver sensitivity and cross-modulation performance. By understanding the true significance of these parameters, it is possible to correctly appraise the suitability of a receiver for a particular purpose. In fact by the end of this article the reader may well conclude that his old World War II receiver is more than adequate for his requirements. Or that he can design and build a better receiver than he can afford to buy.

First, let us consider a receiver which is taking in a signal and its associated noise, and which amplifies both of them, Fig. 1. The noisiness of the receiver *NY* is the signal-to-noise ratio at the input divided by the signal-to-noise ratio at the output. This ratio is always greater than one, as the action of amplifying the signal degrades it and this effectively amplifies the input noise more than the input signal. Expressing the above words mathematically gives:

$$NY = (Si / Ni) / (So / No)$$

$$= Si / Ni \times No/So \quad \textbf{eq. 1}$$

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Special points of interest:

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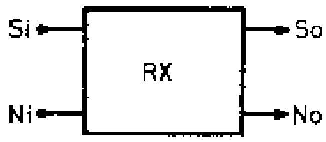
- Contact details on back page

Noise in HF Receivers

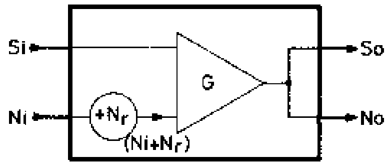
For a signal to be detected it must be stronger than the noise level. Hence the **minimum discernible signal** (m.d.s.) at the output is when So = No i.e. the signal is just at the noise level. Under these circumstances, which in amateur radio often occur when one is looking for weak DX signals, we can write $NY = Si / Ni$,. This tells us that the lower the noisiness of the receiver the weaker the signal (with respect to external noise) we will be able to hear. This statement does not appear to agree with the opening statement on the relative unimportance of receiver noise levels, so a little further mathematical analysis is required.

Let us now look more deeply inside the hypothetical receiver which we considered in



▲ Fig. 1.: Hypothetical receiver

Fig 1. We can consider the receiver to consist of two separate parts, a noiseless amplifier and an ideal noise adder, Fig. 2. For this hypothetical receiver, **eq. 1** still applies as all we have done is to de-



▲ Fig. 2: Hypothetical receiver showing noise adder and noiseless amplifier.

scribe what is happening inside the outlined box. The function of the ideal noise adder is to add the noise, which we have removed from the amplifier to make it noiseless, to the noise input. Now going into the realms of mathematics, if the gain of the noiseless amplifier is G, then we can write:

$So = G \times Si$
$No = G \times (Ni + Nr)$

where Nr is the receiver's internal noise. Substituting for *So* and *No* in **eq. 1** gives

$NY = Si / Ni \;\; * \;\; G\,(Ni + Nr) / G * Si$
$= (Ni + Nr) / Ni$
$= Ni / Ni + Nr / Ni$
$= 1 + (Nr / Ni)$ **eq. 2**

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The FRG7 Mods

by Peter D. Rouse Part 1

In this series of articles we will be looking at the FRG-7 short wave receiver manufactured by Yaesu-Musen. We will look at the shortcomings of the set and how to eliminate them as well as how to add extra facilities without major surgery to the front panel.

History

Development of the prototype FRG-7 started in 1975 and the first production sets went on sale in Japan early in 1976. Soon after the set was exported world wide and, between then and late 1981 when production ceased, 50,000 sets were made. Yaesu say the design policy had been to produce a general communications receiver at a reasonable price which would fit the middle of the range market. The numbers sold show that they clearly judged their market well and the set will rightly take its place amongst h.f. receiver history. Many buyers will clearly remember it for the introduction of technology that had hitherto only been seen on far more 'expensive amateur, commercial and military equipment. Many people, the author included. who had been weaned on traditional t.r.f.s and single conversion superhets with their image problems and vague dial readings. were delighted by the relatively accurate and drift free tuning together with up-conversion. However., it is not intended here to go into detail about the Barlow-Wadley loop tuning or other aspects of the circuitry as these have been quite adequately detailed in the FRG-7 handbook and previous articles.

Shortcomings

Having praised the set's main features, it must be said that there were a few shortcomings,

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This equation shows that when the external noise is large compared with the receiver's internal noise level, then *NY* will be close to unity. In other words, we have proved the correctness of the handbooks!

So far, apart from refreshing our minds with a bit of mathematics, we have not really learnt anything new. The useful bit now starts when we put values to **eq. 2** which correspond with the real world. **eq. 2** shows that the noisiness of a receiving system depends on two factors, the internal noise of the receiver and the external noise applied to the receiver. In order to make comparisons between receivers it is therefore necessary to make the external noise *Ni* some known standard, say *Ns.* When this is done the noisiness *NY* of the system is called the **noise factor** or **noise figure** of the receiver. This is the noise parameter which is published in receiver specifications. The noise figure is merely 10 log (noise factor), i.e. a noise factor of 5 is the same as a noise figure of 7dB. Whilst referring to receiver specifications it should also be noted that signal to-noise ratios are usually expressed in dB and are defined as 10 log (signal + noise) / noise. In the preceding analysis the writer chose to define the signal-to-noise ratio as being signal / noise. Both notations are correct: you just have to know which one is being used.

To put the noise figure of a receiver into true perspective, we need to analyse the situation that occurs when a receiver is attached to an antenna. Let's consider a receiver with a noise figure of MB which is typical for a high- performance modern receiver and see what happens when it is used at 3.5MHz. First of all lets calculate *Nr* the internal noise of the receiver, in terms of *Ns*, the standard of external noise, which will be explained later.

Noise figure = 7dB, therefore
Noise factor = 5

Applying **eq. 2** and substituting *N*s for *N*i

5 = 1 + *N*r / *N*s , therefore
*N*r = 4 x *N*s

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not least of which was the massive 6kHz bandwidth. This and the lack of any fine tuning control on early production sets (the addition of fine tuning was the only modification in the entire production history) was the only major gripe and other areas looked at in this series of articles are really just improvements.

These areas include the power supply, mains input and earthing arrangements on UK models., the rather high frequency span of the fine tuning and inaccuracies in the kilohertz reading dial.

Bandwidth

Selectivity in the FRG-7 takes place at the final i.f. of 455kHz and the characteristics are determined by a ceramic filter designated LFC6. Whilst 6kHz bandwidth may be alright for general listening to relatively powerful broadcast stations, it has serious deficiencies for the DX hunter particularly in crowded amateur bands when tuning for s.s.b. stations. The effect on the 3.5MHz band (80m) for instance can be that you hear several stations together and can make little sense of what any of them are saying.

The solution is to fit a narrow band filter. The problem then though is that such a filter will restrict the audio bandwidth of a.m. stations and although. a 2kHz filter will not cause too much degradation of speech it can make music unpleasant to listen to. Yet even in making that point it must be said that such a filter can be useful when trying to identify a weak broadcast station that is otherwise masked by more powerful ones when the 6kHz filter is used.

Clearly the answer is to have a switched Filter system although users who do not nor-

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To continue the analysis, we need to know *Ni* the external noise at 3.5MHz in terms of *Ns*. Reference to Fig. 3 and ref. (1) show that this is 40-60dB greater than *Ns* so if we consider the best case, i.e. 40dB, we can see that at 3.5MHz the external noise level is 10,000 times (40dB) greater than our standard of external noise *Ns*, i. e. *Ni* = 10,000 x *Ns*. We can now calculate *NY* from **eq. 2.**

$NY = 1 + (4 \times Ns / 10{,}000 \times Ns)$

$NY = 1.0004$

Now apply this to **eq. 1** for m.d.s. conditions, i.e. $So / No = 1$:

$1.0004 = Si / Ni$

In other words, for a signal to be just audible at the output it only needs to be 1. 0004 times as strong as the noise level at the input. Or to express it in dB, the signal must be 0.0017dB greater than the noise level. As an ideal receiver would not generate any internal noise it would be possible for it to receive a signal just on the noise level. The difference between an ideal receiver and a receiver with a 7dB noise figure is so small that we can say that we have virtually got an ideal receiver.

Now let's consider the case of a World War II receiver at 3.5MHz. Such a receiver probably has a noise figure of 16dB which on the face of it makes it look very inferior to our modern 7dB noise figure receiver. However, repeating the above analysis:

Noise figure = 16dB
Noise factor = 40

$40 = 1 + Nr / Ns$

$Nr = 39 \times Ns$

$NY = 1 + 39 \times Ns / 10{,}000 \times Ns$

$= 1.0039$

That is, the incoming signal now has to be 0.017dB stronger than the noise level for it to be just detectable. From this result it can clearly be seen that for all practical purposes the old World War II receiver is just as good for weak signal reception at 3.5MHz as the modern high quality receiver. So why should you bother to change your old receiver? If your interests lie solely on the lower h.f. bands it is most unlikely that you will achieve any significant improvement in the area of weak signal reception.

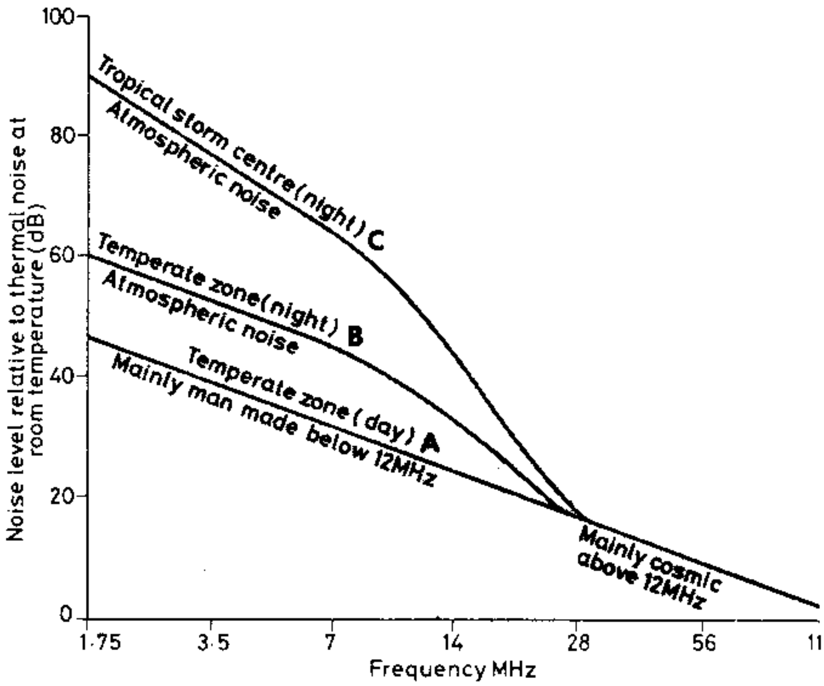

Fig. 3: Variation of external noise level with frequency. Curve A shows that during the day in temperate zones the noise is mainly man-made at frequencies below about 12MHz. In these zones, atmospheric noise adds considerably to the total noise level at night (curve B). In tropical zones the atmospheric noise is relatively severe: curve C represents the worst conditions in these zones. The vertical scale indicates the number of decibels by which the noise level in a perfect receiver would increase if it were disconnected from a dummy aerial and fed from an efficient aerial of similar impedance.

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However, if your interests are more with the higher bands, the story could well be much different. The reason for this is that at, say, 30MHz, the atmospheric noise is much lower, a typical value being 20dB over *Ns*. Analysis of this situation gives the following results:

Receiver figure (dB)	*NY*	*Si* over *Ni*
7	1.04	0.17dB
16	1.40	1.46dB

From this it can clearly be seen that the modern receiver shows a significant advantage over the World War 11 receiver.

It is of interest to note a professional viewpoint that it is pointless to aim for better than 12dB noise figures for h.f. communications receivers even if they are to be used at quiet sites (2).

Having now put receiver noise figures into their true perspective, it is interesting to turn to the question of receiver sensitivities and show that for a particular band there is a sensitivity below which it is pointless to go. Again let's consider 3.5MHz where we have already shown that for practical purposes receivers can be considered as being noiseless, i.e. *NY* = 1. In this case the m.d.s. must be a signal equal to the noise input *Ni* which we know is equal to 10,000 x *Ns*. The question now becomes, what is *Ns*?

The basic standard of noise is the noise developed by random motion of electrons in a resistor. It is given by the following equation, known as the *kTB* equation:

Noise = k * T * B watts

Where
k = Boltzmann's constant = 1.38 x 10^ -23
T = temperature of resistor in kelvin
B = receiver bandwidth in hertz

For standardisation purposes T is taken as being 290K or (17C).

Hence for a receiver with a 500Hz bandwidth the noise power available from the

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mally. listen to s.s.b. may find that merely changing the existing Filter for a 4kHz one will improve selectivity. enough. Such filters are available as straight replacements from various suppliers. A list of suppliers will be given at the end of this series.

Switched Filtering

In the next part we will be presenting a switched filter system using the existing filter together with a 2.1 kHz filter which has an excellent shape factor. For those readers who prefer to buy a ready-made unit though, Cirkit (formerly Ambit) of Ten one specifically designed for the FRG-7. It uses diode switching to bring a 2kHz or 4kHz filter into circuit. At a cost of more than £30 users must decide whether or not this is a case of overkill on such a modest receiver. Having said that, it must be pointed out that you do get a superb filter for your money. The 2kHz filter is a mechanical one manufactured by Kokusai and is the same as the one used in the highly respected NRD5 15 professional monitor costing nearly £1000

Fitting the unit is very easy. It is wired in place of the existing filter and switching can be carried out using spare contacts on the MODE switch so that the narrow position Is automatically selected for s.s.b. Incidentally,, the next part will also offer several switching options which can be adopted for this unit as well.

Fine Tuning

The lack of fine tuning on early models can be nuisance particularly when tuning s.s.b. and even more so if a narrow filter is fitted. However, it is not too difficult to fit such a control and South Midlands Communications can offer a kit comprising a variable ca-

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noise standard is therefore

1.38 x 10 ^ -23 x 290 x 500 = 2 x 10^ -18 watts

Now we know that the external noise level is 40dB greater than this (1), so the noise power at the input of a 3.5MHz receiver is 2 x 10^ -14 watts. If the input is 50 ohms this corresponds to a voltage of one microvolt. Hence for c.w. reception on 3.5MHz there is no need to have a receiver with a better sensitivity than one microvolt for m.d.s. Note that if you require a 10dB signal-to-noise ratio at the output, you will require a signal of three microvolts at the input, so your minimum sensitivity requirements are even lower.

Also, if you wish to receive s.s.b. in a 2.5kHz bandwidth, the noise power at the input increases and this again means that a lower sensitivity is acceptable.

Three questions immediately arise:

Q1 Why do manufacturers proudly quote 7dB noise figures and 0.3 microvolt for 10dB signal-to-noise ratios?

A1 They make receivers that are expected to perform well at 30MHz where such low figures can be used. Most of the above analysis was done at 3.5MHz but sufficient information has been given to enable the reader to repeat the analysis at 30MHz.

Q2 What's wrong with having too much sensitivity and too low a noise figure?

A2 Nothing, except that improvements in sensitivity tend to be at the expense of cross-modulation performance. If your real need is to improve cross-modulation performance, the easiest ways will degrade sensitivity and noise figures. Historically the

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pacitor, two fixed ones and a control knob that matches the others on the front panel. For those wishing to go it alone, the FRG-7 circuit diagram shows a variable capacitor value of 5pF although the one actually fitted to production sets appears to be about 10 or 15pF. In fact these latter values appear to be the lowest commercially available and so note should be taken of the suggestions that follow.

Reduced Fine Tuning Span

The span of the FINE tuning control fitted to later models appears to cover several kilohertz and in practice it has little to offer over and above the geared-down main tuning. This is possibly because the actual variable capacitor fitted appears to have a higher value than that shown on the circuit diagram for the FRG-7. The result i's that s.s.b. stations are still a little difficult to resolve especially when a narrow filter is used.

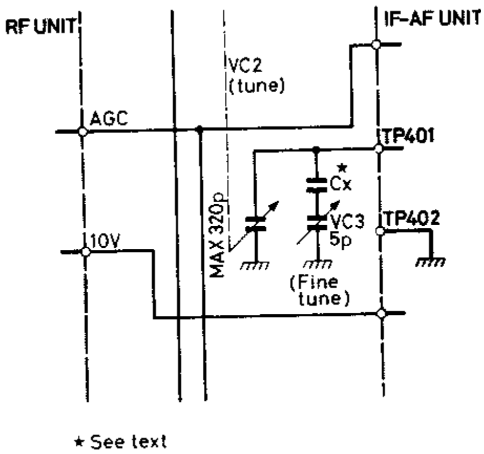

Fig 1.1

Luckily it is quite easy to alter the actual capacitance swing merely by incorporating a low value fixed capacitor in series with the variable. Just break the fixed wire connection between the variable and TP401 on the IF/AF Board and insert a 5pF capacitor. There is no reason why other values should not be tried so as to get the tuning span to meet personal preference.

However, with the 5pF shown, the author finds the tuning rate to be very similar to the r.i.t. or clarifier controls found on other equipment.

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Digital Readout

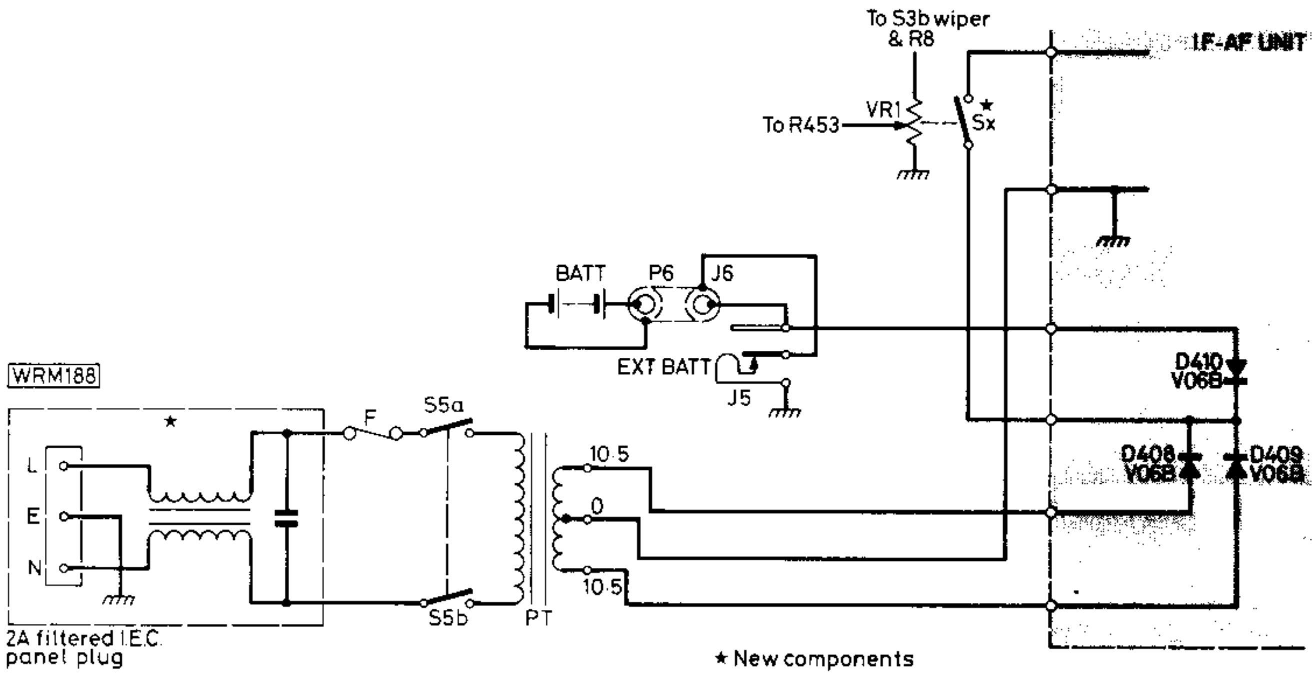
Although the FRG-7 dial is accurate at worst to a few kilohertz, many people have found a digital readout to be a useful extra. It also has the added advantage that it turns the set into quite a useful 1,550kHz-30MHz frequency meter. Quite a number of commercially made units have appeared over the years using both l.e.d. and l.c.d.s. Digital frequency meters are still available from several sources from upwards of about £20.

Fitting instructions are supplied with these units but is perhaps worth mentioning two areas that can give rise to problems. First, if batteries are used to power the set it may be advisable to wire the supply of the d.f.m. to the light switch circuit so that power can be conserved. Secondly, most of the d.f.m.s available use c.m.o.s. circuitry which can introduce a noticeable degree of noise into the rest of the receiver through the positive supply line and direct radiation. The d.f.m. should be housed in a well shielded box and if severe problems are encountered it is advisable to try extra de-coupling capacitors on the d.f.m.

D C Problems

Talking of d.c. problems brings us to the power supply. Users may have noticed that if the audio is driven hard, distortion sets in and even the dial light will start to dim on peaks. This problem is caused by the mains transformer not being able to supply enough current. A simple test showed that it can only deliver about 600mA whereas the current consumption of the receiver peaked well over 750mA when a beefier outboard 13.8V supply was fed into the external d.c. socket.

For many users this will not be a problem but, if like the author, the user occasionally feeds the set into such things as RTTY units then there can be drawbacks. Tests on the receiver under such conditions have shown that the internal supply., which on the unregulated side runs at about 14.5V., can drop alarmingly. In fact it can go so low on peaks that even the regulated supply sags and can cause slight pulling on the b.f.o. which in the case of RTTY can pull the signal tone out of the pass band range of the f.s.k. decoder.



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trend has been to improve these figures. However, we are now at the point where receiver sensitivity and noise performance are governed by the external noise level, and perhaps the real limiting factor to receiver performance is strong signal handling. For example, on 7MHz it is likely that most receivers are limited by their strong-signal handling performance well before they reach the theoretical sensitivity level of the band.

Q3 How can I use the preceding information?

A3 You should assess exactly what you want your receiver for, e.g. mode(s), band(s), weak signal reception (i.e. m.d.s. work), listening to "S9" signals, etc. Then determine NY and sensitivity requirements (hint, assume NY <= 1.1 for a practical ideal receiver). Then compare the calculated value with the actual values of your receiver and decide whether you really need to change it. Perhaps if your major interest is single band, single mode, e.g. 7MHz c.w., you may well conclude that you can make a better receiver than you can buy. (3)

Summary

This article has shown that high sensitivity and low noise figures in h.f. receivers are not necessarily needed to obtain near optimum results, especially on the lower bands. A knowledge of what you really need can save money and disappointment by preventing one from unnecessarily replacing an older receiver by a newer more expensive one.

References:

(1) Radio Communications Handbook RSGB, chapter 15.
(2) Report on I.E.E. HF Communication Convention, RSGB Bulletin 1963 p 165.
(3) Solid State Design for the Radio Amateur, ARRL, p 113.

From
Practical Wireless, August 1984

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The Solution

The obvious answer is to fit a larger transformer and there is certainly plenty of space inside the FRG-7 to do this. The transformer already fitted is rated at 10.6V a.c. which is a non-standard value but tests by the author have shown that a 12V transformer does not cause either the regulator transistor (Q41 1) or the audio i.c. to run any warmer than usual. The latter by the way is run from the unregulated d.c. supply.

There is however an even better solution, sadly though a more expensive one, and this is to use a well regulated 12V d.c. (in fact 13.8V now seems to be the norm) supply separate from the set. The supply should be capable of delivering at least IA, preferably more., and its use will help us cure yet another problem: noise from the mains earth.

Hums and Buzzes

FRG-7s sold in the UK through the official suppliers were fitted with a three core mains cable which had the earth wire soldered to a tag on the chassis. It has long been recognised that the mains earth can be a source of r.f. noise and is only intended as a safety path. The use of a separate earth is highly recommended but even this will have little effect if the mains earth is still connected to the set. It must be remembered that at r.f. the potential between actual earth and the earth connection on the set will be very different.

The answer may at first appear to be to disconnect the mains earth from the set but this is against current safety regulations. The only acceptable solution appears to be the use of a separate power supply as mentioned above and this must have a floating output (i.e. not connected to the earthed case of the p.s.u.).

All of this may seem like a sledgehammer to crack a nut but for anyone living in an area where there is a high level of r.f.i. the improvement can be quite dramatic (the author's home. like most in Guernsey., is surrounded by vineries with

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automatic ventilators, thermostats,, electronically ignited heating, etc).

Power Switching

Having mentioned safety regulations, owners may care to update the power switching arrangements on their sets which certainly do not meet present safety standards. The problem lies in the power switch S5 which carries both mains and d.c. Making the set safer is neither complicated nor expensive but consists of using S5 to switch both live and neutral and transferring the d.c. to a switched volume control. This will mean that the existing volume control will have to be replaced but note that a standard European style one with lin. shaft will not be suitable. Don't discard the existing volume control if you intend adding the f.m. unit as it will fit the space behind the RECORD socket and so act as the squelch control. However, a replacement Japanese version with 6mm shaft is available from Cirkit (Alps 10k Ohm log with d.p. switch).

When the set is used with a separate supply or on batteries the mains lead is something of a nuisance and so one final improvement in this area is to remove it and fit a mains chassis plug to the back panel and a line socket to the lead. One of the small circular types made by Bulgin is ideal or a rectangular IEC type can be used which may, if desired, incorporate mains filtering (useful for flat dwellers who can't run a proper earth).

Battery Packs

Later batches of FRG-7s sold in the UK were supplied with a slide-in battery pack that houses eight U2 type cells. Owners who do not have one can still get one from South Midland Communications but they warn that supplies are limited. Anyone who uses batteries regularly may find that it is worthwhile fitting Ni-Cads. Even though the U2 types are very expensive, they could still be a worthwhile investment in the long run and it is an easy matter to incorporate a charging circuit in the set.

Hearing it Sideways

Another worthwhile add-on for the set is an f.m. demodulator. This allows reception of the increasing amount of f.m. traffic on both the 27MHz CB band and 28MHz Amateur band and also provides good results when using a 144MHz converter.

It is of course possible to use slope detection where the set is tuned slightly to one side of the carrier but this does have drawbacks. Results with weak stations are poor and when trying to listen to stations of unequal signal strength it is usually necessary to have to retune slightly between overs.

There is plenty of space inside the set to fit a separate demodulator ant at least one company (Timestep) make one specially for the FRG-7. Other units are available from the companies listed and for owners who wish to build their own, a suitable circuit featuring all-mode squelch will be included later in this series.

How and Where to Switch

At the start of this article we mentioned that no major surgery would be involved on the front panel and so we now include a list of how certain existing controls can be modified to cope with other functions. Owners who intend carrying out modifications are advised to plan ahead as various options are available and the final choice will depend on what or how many add-ons are to be included.

(i) Narrow Filter Only. Several options are available:

(a) Using existing spare wafer contacts on the MODE switch so that the narrow filter is selected when switched to s.s.b. Although this is a quick and easy solution the disadvantage is that the narrow filter cannot be used for a.m.

(b) As above but disconnect the noise-blanker so that the switch position can be used to give narrow band a.m.

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(c) Re-site the RECORD socket on the rear panel and use the space to fit a miniature toggle switch. This has the advantage of retaining all facilities.

(ii) FM Demodulator Only. Again several options:
(a) The logical place is on the MODE switch in the noise-blanker position with the squelch control replacing the RECORD Socket (an Alps potentiometer will fit).
(b) Use a Pull-on switched potentiometer for the squelch (again Alps potentiometer with push-pull switch). Cut the connection from the MODE switch to the volume control and wire the control to the centre pole of the switch. Outputs from the MODE switch and demodulator are then taken to the two other contacts.

(iii) Switched Filters and FM. Here the options are very limited and the suggested method involves forfeiting the noise-blanker (it has little effect anyway in the author's view).
(a) Use the NB position on the mode switch for FM selection (full details of which contacts to use will be included in a later article).
(b) Re-site the RECORD socket on the back panel, use
the hole for a squelch control with push-pull switching and transfer the dial light wiring from the existing switch to the one on the potentiometer.
(c) Use the dial light switch (which has the necessary d.p.d.t. contacts) for switching the Filters.

Whatever switching arrangements are made, the new functions of each switch can be re labelled by using small strips of dark grey card with suitable wording in white rub down lettering. These can be attached to the front panel with a light adhesive such as Copydex which can be removed later if required.

Parting Thoughts

These notes together with the articles that follow will turn the FRG-7 into a more versatile machine and better performer; the switched filter unit in particular provides a stunning improvement to the point where it is difficult to believe you are using the same receiver. All the modifications and add-ons should be well within the scope of anyone who can use a soldering iron and read a circuit diagram and no special test gear is needed for setting tip.

Further Reading

Owners of FRG-7s are reminded that the January, 1984 edition of Practical Wireless featured an article by A. J. Cawthorne which looked at ways of improving the antenna input stage. Details here given to reduce problems of interference from television receivers, fluorescent lights and antenna static and how to modify the set for single antenna input for both m.f. and h.f.

Modification Techniques

Great care should be taken alien modifying any piece of commercially made equipment. Apart from the obvious consideration of safety, with regard to mains power supplies it is generally, regarded that modifications devalue the equipment when it comes to re-sale.

In this series of articles, great care has been taken to ensure that with the exception of the fine tuning control. no holes need be drilled in the front panel aid most modifications and add-ons can be removed.

Standard of Workmanship

Having made the above warning. it is the author's view that modifications can in fact add to the Calibre of equipment as long as certain guidelines are followed.

The standard of workmanship must be high and with present day materials and tools there can be little excuse for it not being so. A vast range of hardware for mounting circuits, harnessing wire and so forth is available and often a few pence spent on such items can give a thoroughly professional look. The final requirements cost nothing, only patience and care.

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Proof of success is when you look at the work and it seems as if it was there in the first place.

Documentation

In keeping with standard workshop practices, all mods should be documented together with notes and circuit diagrams kept with the main service manual/circuit diagram of the equipment.

This is not only useful for later servicing or removal of modifications but will impress a buyer that the work has been done competently.

See you at the Boot Sale on the 28th (Starts at 12:00) at the Club House

July 2001

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	Club Meeting 9	10	11	12	13	14
Braai at Club house 15	16	17	18	19	20	21
22	23	24	25	26	27	12:00 Boot Sale 28
29	30	0				

The West Rand Amateur Radio Club
26.14122 South - 27.91870 East

P.O. Box 562
Roodepoort
1725

Phone: +27 11 726 6892
Email: john.brock@pixie.co.za

Bulletins (Sundays at …)
11h15 Start call in of stations
11h30 Main bulletin start

Frequencies
145,625 MHz (West Rand Repeater)
10,135 MHz (HF Relay)
14.160 MHz (HF Relay)

Radio Amateurs do it with more frequency!

We are going on the Web
www.zs6wr.org.za

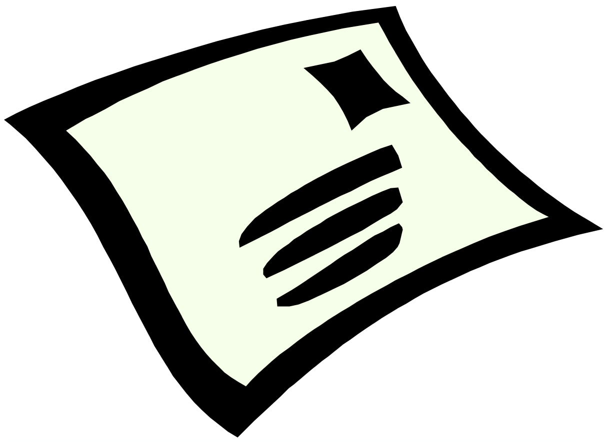
Please note this has been just been registered. Our site will be up in the new year.

Chairman	Bill	ZS6REV	726 6807	---
Vice-Chairman	John	ZS6BZF	768 1626 (A/H)	john.brock@pixie.co.za
Treasurer	Dave	ZR6AOC	475 0566	david.cloete@za.unisys.com
Webmaster	Simon	ZR6SS		ssnyman@feedemgrp.co.za
	Cobus	ZR6COB		support@feedemgrp.co.za
	John	ZS6FJ		
	Keith	ZS6AGF	763 6929	mwbronie@iafrica.com
	Phillip	ZS6PVT		

West Rand members input - we need your input!

To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

Please send plain text with no formatting to the email address



We need your input! Email us articles, comments and suggestions please.
john.brock@pixie.co.za