low noise 2 metre preamplifier

This preamplifier is intended for use in receivers of the 2 metre amateur band wave (144 MHz). By changing a single resistor, it can be made for either very low noise or a low intermodulation distortion.

Internal noise

This low noise VHF preamplifier operates with a particular type of extremely low noise, high frequency transistor, the BFT 66. This transistor ensures that the noise contribution of the amplifier stage thus obtained is small, for usually the lion share of noise produced is caused by the transistor.

The noise contribution of an amplifier is rather an abstract concept and it is not the purpose of this article to define it. However, it will be clear that even this can be expressed as a factor: the noise factor. Basically, this indicates the relationship between the quantity of noise present in the output signal of an amplifier and the quantity of noise which it would contain if the amplifier would merely amplify without adding to the noise itself. Usually this ratio is expressed in dB.

An amplifier which produces no internal noise at all has a noise factor of 0 dB. The output signal will then contain exactly (relatively speaking) the same amount of noise as the input signal. Such amplifiers unfortunately do not exist, although there are a few which come near to meeting this figure.

The amplifier described here has a noise factor of less than 1 dB, which means the signal to noise ratio only deteriorates by 1 dB. For a VHF preamplifier this is an excellent performance.

The circuit diagram

The circuit diagram of the 2 metre preamplifier is not nearly as complicated as most circuits of this nature. It is possible to connect a normal 50 ohm aerial to the input. However, since the impedance of the aerial often deviates from that required for an optimum noise factor at the base of the transistor, the aerial cannot be directly connected to the base. For this reason a pi network is placed between the base of T1 and the aerial input. This consists of trimmers C1 and C2 and the coil L1. The pi network literally matches the impedances.

In the collector lead of T1 there is a resonance network consisting of L and C4. The ferrite band FB is included to prevent oscillation. In many cases it may not be necessary. An alternative is to replace it with a 15 Ω resistor.

The collector current of the transistor will be the main determining factor in the noise contribution of the amplifier. The preset P1 is used to adjust this. With the component values given in the figure, the collector current may be preset to 3 mA since at this figure the BFT 66 gives its best noise performance. The collector current can very easily be determined by measuring the total current consumed by the circuit, or the voltage across R3.

With a collector current of 3 mA, the internal noise contribution of the amplifier will be less than 1 dB. To give some idea this means that in a receiver bandwidth of 3 kHz, an input signal of only 25.6 nV (0.025 μV) will already produce an output signal that can be detected. The 3 dB bandwidth is 5 MHz.

Intermodulation distortion

It is clear that the collector current has a great influence on internal noise. However, something else is also highly dependent on the collector current, namely, intermodulation distortion. This is the creation of all kinds of by-products in the output signal which were not in the input signal. The reason for this is that the transistor is not linear.

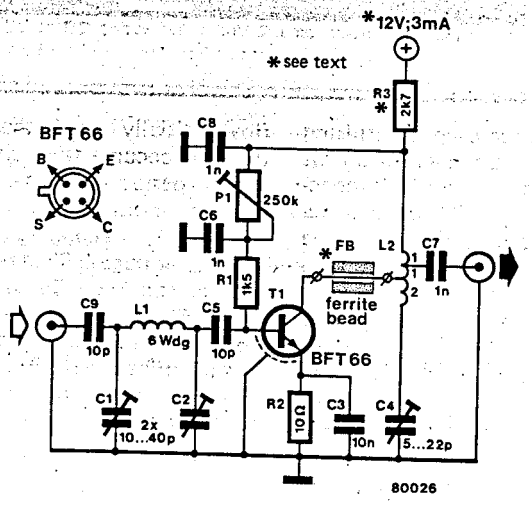
The intermodulation distortion can also be expressed in dB, as the ratio between the desired signal and the intermodulation products. For obvious reasons, this ratio should be as high as possible. In other words, an ideal amplifier would have virtually no intermodulation distortion coupled with an extremely low noise factor. It would be ideal if the collector current producing the lowest possible noise could at the same time ensure the lowest possible intermodulation distortion. This however is wishful thinking.

From the noise point of view the ideal collector current would be 3 mA. However, this would produce intermodulation products of only 10 dB (for 800 MHz admittedly). By increasing the collector current to 10 mA, the intermodulation can be reduced to −60 dB — a considerable improvement. The price that has to be paid for this is an increase in the noise factor by approximately 0.5 dB.

Depending on what you want, the amplifier can be tailored quite simply. A collector current of 3 mA will give a low noise amplifier. Taking the current up to about 10 mA and changing the value of R3 to 330 Ω will produce an amplifier with very little intermodulation distortion.

Constructional details

It is advisable to use low noise metal foil resistors for R1 and R2. Both the coils L1 and L2 are 'air cored', that is, wound on an 8 mm diameter former which is then removed. The 1 mm copper wire used for the coils should be silver plated. The winding details are x =, for L1 6 turns, and for L2 4 turns with taps at the first and second turns as shown in the diagram.



With this simple circuit low noise or low intermodulation distortion is possible.