Technicalities

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Building RF projects

Talking to people both on the air and over a pint, it becomes clear that many potential constructors are put off from building involved RF projects because they consider such things a black art which they stand no chance of mastering . . . even less of getting a finished project to work.

I have to confess that RF things require a different sort of skill in building than, say, a photographic -darkroom - timer - cum - baby -alarm. The logic (as in digital) part of this hypothetical design will work without problems providing that the builder has put the chips in the right way round. Similarly, the baby alarm portion will nearly always work first time even though there may be a bit of hum on the output because of an unintentional earth loop.

Ridiculous? Perhaps but it does illustrate a serious point. RF design and construction does require a special appreciation which is what makes it about ten times more interesting and rewarding than any other facet of the electronics hobby. Furthermore, the joy of powering up a £1300 Japanese black box comes nowhere near to that of making your first cross town 2m contact with a tacky looking bird's nest that you built yourself. Even better, you've still got the £1300 left to spend on food, coke or whatever may happen to be your money burning interest.

For those with some knowledge

It's not possible to provide a complete guide to RF engineering in the space of one monthly column but it is quite realistic to outline a few of the most common problems. Furthermore, it is quite amazing how a great variety of symptoms can be traced to a small handful of faults almost regardless of the piece of equipment being worked on. I propose to use a 2m RF pre-amplifier as a discussion example although many of my comments could be applied equally to a receiver IF strip, transmitter output stage or whatever.

There is nothing particularly special about the pre-amp circuit of Fig. 1. It shows a dual gate MOSFET connected as a receiver pre-amp with the basic configuration suitable for use at any frequency between 2 and 200MHz depending on the tuned circuit values.

The input signal feeds into the bottom of L1, resonated by C1. A core inside L1 adjusts the first tuned circuit for resonance. The 'live' end of L1 feeds the signal voltage to the 'live' end of L2 via a low value coupling capacitor, C2. A tap towards the top end of L2 couples the signal into gate 1 of the dual gate MOSFET. Resistors R1 and R2 form a potential divider ensuring that the DC voltage on gate 2 biases the transistor into the region of maximum gain. Capacitor C4, the gate 2 decoupling capacitor, is crucial since it ensures that the transistor, RF wise, is isolated into two halves: the input and the output. Resistor R3 sets the transistor drain current (the higher the value, the lower the standing current and gain) while the parallel capacitor C5 short circuits RF current present on the source circuit to ground. L3, tuned in the main by C7, provides both resonance and DC feed for the drain circuit (from the supply via R4) while C8 offers capacitive matching from the high impedance of the transistor drain to the 50 ohm nominal output impedance of the amplifier. C6 decouples the pre-amplifier as a whole from the supply. As a general point the amplifier will draw in the region of 10mA and, when adjusted correctly, provide around 20dB of gain (a voltage gain of ten times) at 144MHz.

Here are a few symptoms and their causes. Remember that they could be applicable to many kinds of RF circuit although the discussion example is a 2m pre-amp.

1) "I've built it as per the instructions and it acts more like an attenuator than an amplifier . . . The amplifier seems to be drawing the right amount of current but nothing much else happens. . . Turning the slugs of L1, L2 and L3 seems to have little effect. I can't find any tuning point for maximum signal no matter what I try."

The starting point for this particular problem will depend very much on the source of the circuit. If the unit was built from a reliable kit, the outlined fault symptom will almost always be due to incorrect assembly and hardly ever from unserviceable components. For instance, it is all too easy to identify ceramic capacitors wrongly. I've spent many a miserable hour trying to locate an intractable hiccup in my latest masterpiece only to find that I have confused Ks, Js, Ns and, just occasionally, Zs. The hallmark of a healthy RF circuit is the presence of clear resonance points in the tuning of the various inductors. Naturally, it would be very unhealthy

Fig. 1. Typical dual-gate MOSFET preamp for HF/ VHF