bandwidth measured in the selectivity tests.

This was the method that we adopted and we just could not believe our results, which were inferring that Chris Bartram of Mutek had designed a front end having a *negative* noise figure, which we thought was quite an invention. Maybe this might be possible for a nanosecond in the vicinity of a black hole, but not on *terra firma!* It was not until we measured the sensitivity that we could explain our amazing figures.

The 12dB SINAD on SSB was so incredibly good that we had to make up an Andrews *FSJ4* lead, together with specially screened 20dB and 10dB attenuators, and checking all earth bondings very carefully, in order to keep every bit of leakage out of the system. It seems we did this adequately, for our measurements tie in quite well with Mutek's 2dB noise figure measurement.

Front end circuit

The estimated noise figure of 2dB will, in effect, mean that this rig will be able to pick out extremely weak signals which many other rigs would not pick out at all. But it's no good having sensitivity without an excellent RF intermodulation (IM) performance, a reasonably shaped sensitivity curve, and good reciprocal mixing characteristics. What is all this about?

Let's have a look at Mutek's circuit. They don't use the Icom relay, but substitute a nitrogen filled reed relay, for a kick off, and this loses around 0.05dB, so it's a good relay. The front end device is a BF981 dual gate MOSFET. The input of this device is noise matched to the output of the relay, but its output is intentionally mismatched into a band pass filter which then feeds, with very accurate impedance matching, a Schottky diode ring mixer of +7dBm rating (5mW). This filter is a 3-pole Chebyshev having a 3dB bandwidth normally of 3MHz, but 4MHz for export. The overall front end gain to the mixer is around 12dB. The IF output is at 10.7MHz, and feeds straight into a matched 3SK74 which has very heavy negative feedback. This allows an extremely accurate match onto the mixer output port, as well as giving a very good noise figure. The output from this stage feeds a 15kHz wide crystal filter which is accurately matched into another 3SK74, again with negative feedback. The output from this stage feeds into the normal Icom electronics.

The normal local oscillator output from the Icom rig is fed through a buffer amplifier, and then carefully matched into the LO mixer input port. Mutek state that by very careful matching they can use the +7dBm mixer rather than a more expensive higher level one. They point out that poor matching can deteriorate performance dramatically in this area. An output from the board is available for feeding panoramic adaptors, or spectrum analysers, which is taken from the output of the first IF stage immediately prior to the crystal filter. This feed is, of course, centred on 10.7MHz and should have a bandwidth encompassing the 2m band. The level is extremely low, 9dB above the RF input level, and it is buffered from the feed to the filter in order to avoid degrading the receiver's internal performace.

By employing a front end stage with just 12dB gain, Mutek greatly enhanced RFIM performance at the input of the mixer. Furthermore, by employing the 3MHz band pass filter they are excluding way out of band signals from causing problems at the mixer and beyond. The employment of a Schottky mixer with its inherent superb IM performance at high levels, gives the entire front end an enormous dynamic range. Since the mixer is passive, it loses level, and so it is essential for the following stage, the 3SK74, to be noise matched. Mutek have sacrificed perhaps a ½dB of potential noise figure for a dramatic improvement in dynamic range, but a 2dB noise figure is, frankly, good enough for almost anyone for normal 2m operating. If you want to do better, for moonbounce or meteor scatter work, then you would be using a masthead pre-amplifier, and a luxury cable to achieve the finest possible system noise figure.

The 15kHz filter is placed at its early position in the circuit to knife out fairly close signals from the remainder of the IF stage. It is vitally important for the filter to be matched properly, again to avoid degradation of the system noise figure, and to preserve the filter passband characteristics.

The mixer requires a much higher drive level from the local oscillator, once again to preserve dynamic range, and hence the reason for the local oscillator buffer, which also has to match perfectly into its port on the mixer.

RFIM

From the description of the circuit you will see that out of band signals should not cause any IM problems with signals on 2m. Within the 2m band the IM performance is dictated by the levels reaching the mixer, and since there is the minimum of gain in the RF pre-amp, very high level signals can be present on the band fairly close to an extremely weak one without being evident, providing these signals are themselves clean. You can see that stations with superb receiving equipment are most disturbed by nasty spreading signals derived from grotty rigs, or wickedly overdriven linears. (*Angus, for once I agree with you without reserve. Why is that so much amateur gear is of inferior performance, yet the licenced operators never seem to notice! — Ed.*) After signals have passed through the 15kHz wide crystal filter to the final IF stage on the Mutek board you can see that the RFIM performance within the 15kHz pass band will be determined by the performance of the following stages. A clever touch here is that Mutek take the AGC voltage through to their last IF stage, so that if there is appreciably strong signal off-frequency on SSB, but within the pass band of the crystal filter, then the gain will be reduced at the beginning of the IF strip as well as within the IC251E IFs.

Selectivity and noise

When you measure noise figure, which is extremly difficult, it is a basic property of either the front end itself or, if you want it, it becomes a property of an entire receiving system, irrespective of bandwidth. Noise figure basically concerns a measurement of the degree of excess noise produced by the receiving system over the noise that would be produced from a perfect 50 ohms (or other rated impedance), resistor held normally at room temperature, although the temperature at which the measure-