this in circuit, the equipment completely excludes the contribution of noise from the Boonton, the attenuator, and the input stage of the HP. Only on one amplifier did it make a significant difference, one of my own having a very narrow bandwidth.

I measured around 30 pieces of equipment, and only on 3 or 4 did I notice a significant change in noise figure, the improvement being between 0.2 and 0.4dB. Gain, however, quite frequently showed up as being significantly lower than expected, and so I could not trust the measurement on equipment having 3dB points tighter than around 5MHz or so, and so we decided to make all gain measurements with another set-up. Although the HP accuracy is quoted by them as being within 0.1dB, with all other things right, I must emphasise most strongly that the HP figures should be regarded as having an accuracy of + or – at least 0.2dB, despite the fact that my colleagues and I were extremely careful. I must here acknowledge the help of Hewlett Packard, and many other friends professionally involved in noise figure measurement.

Gain

After many discussions with colleagues, we felt the best way to measure gain was to use a Marconi *2019* generator as a source, connected via screened attenuators and Andrew's coax to the input of the preamp, with an attenuator right at the preamp as well, followed by the output feeding through a Marconi UHF attenuator, feeding through an attenuator again into an HP *8558B* spectrum analyser. All these attenuators were used to preserve an accurate 50 ohms throughout the measurement system, and to reduce any mismatching resulting from transformer action of lengths of 50 ohm coax with preamp input and output impedances. The attenuator before the analyser is used to load the line more accurately, thus allowing the Marconi variable attenuator to be accurate. We measured gain at a reasonable level of just over 100μV into the preamplifier, having set the analyser on the 1dB per vertical division position. The through loss was measured by observing the level on the analyser, whereas gain was measured at various frequencies by inserting attenuation on the attenuator, to bring the level to the same point on the screen as it had been on calibration. We measured the frequencies at which gain dropped by 3, 10 and 20dB, and the gain at 144, 145 and 146MHz.

Two-tone IM tests

We used two Marconi *2019* signal generators with frequencies 200kHz apart in the middle of the band for this test, with both generators operating at the same output level feeding a high quality hybrid transformer. The output port of this was connected to the input of each preamplifier. The output fed straight into the HP spectrum analyser, allowing us to read off the IM products from the screen. We determined the input level of the tones required to give both 60dB and 30dB 3rd order products, the ratio being the IM product level to the level of either of the two tones. An intercept point was derived from these two measurements. Sometimes the ratios were not quite linear and this is due to either distortion being slightly too high at lower levels, or IM increasing very rapidly as a clipping point was reached. We show in the charts both input and output approximate intercept points, bearing in mind the measured gain.

Laboratory test results

I thought it would be helpful to discuss how each product fared, one parameter at a time, and then in the conclusions section make some recommendations for various situations. I must admit that having done all these tests I feel that I have learned quite a lot about preamps!

Let's have a look first at noise figure, perhaps the parameter which will be of most interest, although oddly enough, one of the least important, within reason, if you have the preamp at the masthead. By far the worst in the survey, and the worst that I have ever measured on 2m, even including the once ubiquitous 6CW4 Nuvistor of about 20 years vintage, was the SEM *Sentinel.* A 5dB noise figure, with such a low gain is, frankly, a fat lot of use. We decided to attempt to improve the alignment, and noted a ferrite cored inductance, which when tweaked greatly affected gain. We tried removing it completely, and in passing, for a few seconds, noted a moderately respectable noise figure before the contraption went into oscillation. After this attempt at alignment, we put it back again, and after much tweaking improved the noise figure to 2.1dB, and the gain shot up to around 19dB. However, in this condition the preamp tended to be unstable if we even looked at it, let alone change the input load slightly. It was virtually impossible to achieve a stable, respectable performance

Dressler VV200 GaAs