The specified maximum error, as per the draft DTI spec (section 4.1.3) is given as ±300Hz. Whether the equipment is locked or un-locked to a base station is unspecified in the DTI spec.

2.1.2 Peak Envelope Power.

The Peak Envelope Power (PEP) was measured using a BIRD RF Power Analyser into a dummy load, with the transmitter in FPP test mode. The measured power was 25W, as set before the trials began.

2.1.3 Audio Frequency Response.

The end-to-end audio frequency response, from mobile transmitter to mobile receiver via the base station, was measured. A swept audio tone was input at a level of 100mV, and the output audio spectrum is shown in Fig 2.1.

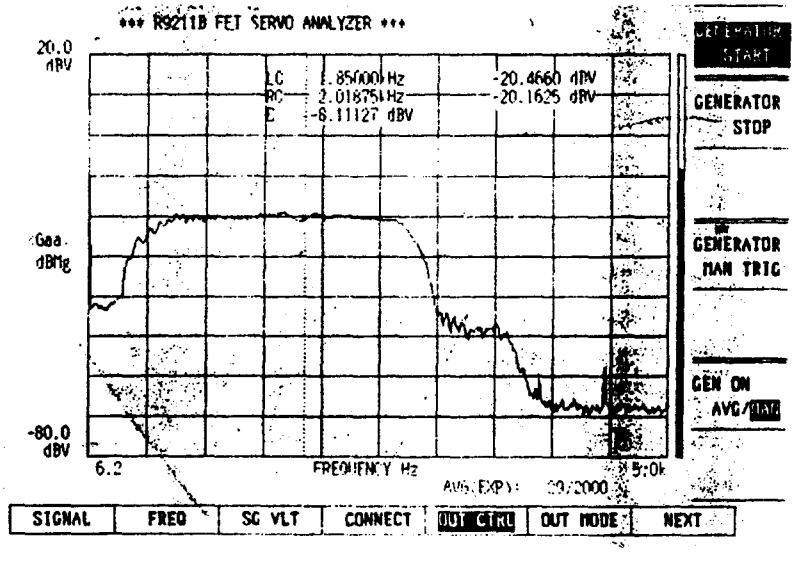


Fig 2.1 End-to-End Audio Frequency Response

2.1.4 Adjacent Channel Power.

The test was carried out as per the DTI spec, section 4.4.2. The transmitter was modulated with white noise having a flat spectral power density across a 100Hz to 10kHz bandwidth. The input level of the white noise was set at 10dB above that of a tone which would produce 50% PEP i.e a single tone that gave 25W out (full PEP) was found to be 80mV and 7dB above this was 400mV. This figure corresponds to 10dB above 50% PEP.

The test configuration used is shown in Fig 2.2 below. Note that numbers refer to Appendix (iii), Test Equipment List.

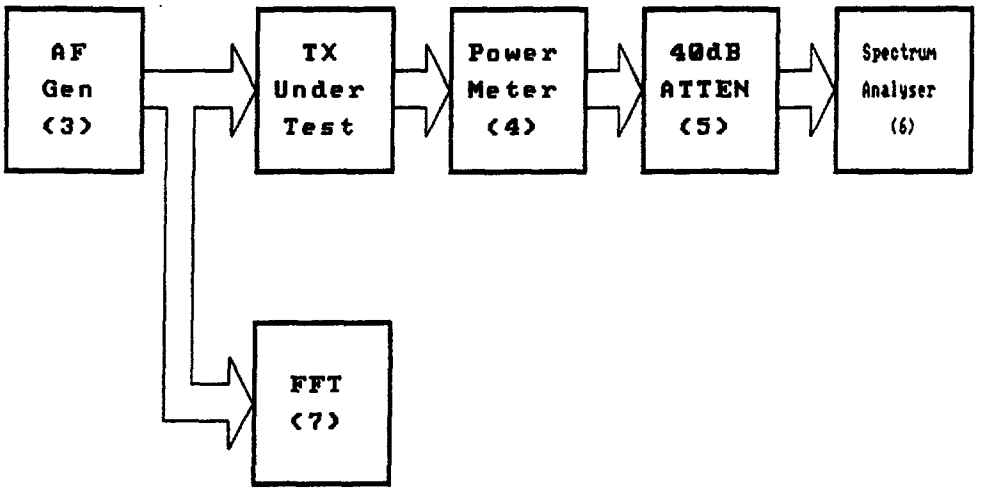


Fig 2.2 Adjacent Channel Power Measurements.

The specification requires that the measurements of adjacent channel power are calculated relative to PEP (in this case, Full Power Pilot or FPP). Hence figure 2.3 shows FPP which corresponds to the reference level on the plot of 0.43dBm.

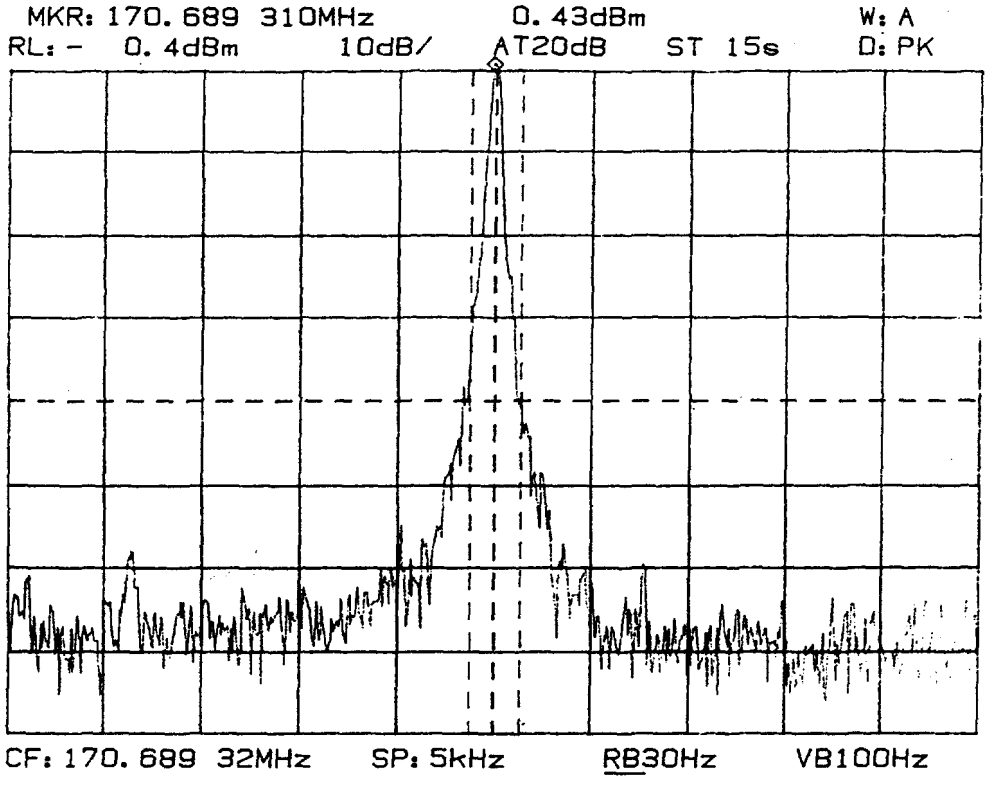


Fig 2.3 Full Power Pilot.

Figure 2.4 (a) and (b) show the input to the transmitter and the in-band response respectively. Note the pilot-in-band tone, a nominal 6dB below FPP (actual measured figure gives 6.6dB below FPP). This includes a nominal 4dB pilot tone level increase due to pilot pumping.

Figure 2.5 (b) shows the resulting spectrum in the upper adjacent channel, along with the associated input power spectrum for reference (Fig 2.5(a)). This shows the adjacent channel power, mid-band, to be 74.18dB relative to FPP.

Similarly, Figure 2.6 (a) and (b) show the lower adjacent channel performance to be better than 70dB relative to FPP.

Measurements were also taken for two channel spacings above and two channel spacings below the center channel (second upper and second lower channels) and the results summarised in Table 2.1. Figures 2.7 and 2.8 show plots of the results for the second upper and second lower channels respectively.

Channel	Mid-Channel Power,relative to FPP (dB)	Worst Case (dB)
Upper Adjacent	-74	-68
Lower Adjacent	-76	-69
Second Upper	-77	-73
Second Lower	-81	-78

Table 2.1 : Adjacent Channel Power

The worst case figures were arrived at by picking the peak in the relevant band. The DTI specification permits a level of 55dB down on FPP and hence the equipment has a margin of 19dB for adjacent channels. It was also noted that the lower channel performance was better than that of the upper channel.

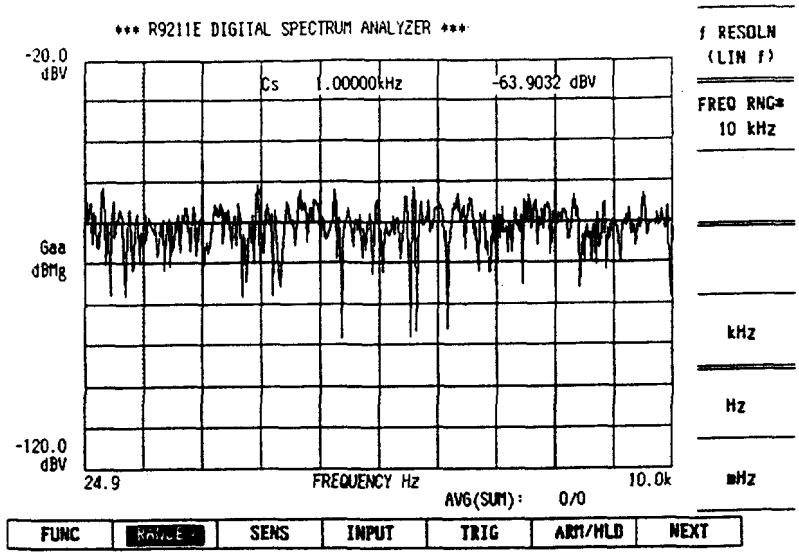


Fig 2.4 (a) Input to Transmitter.

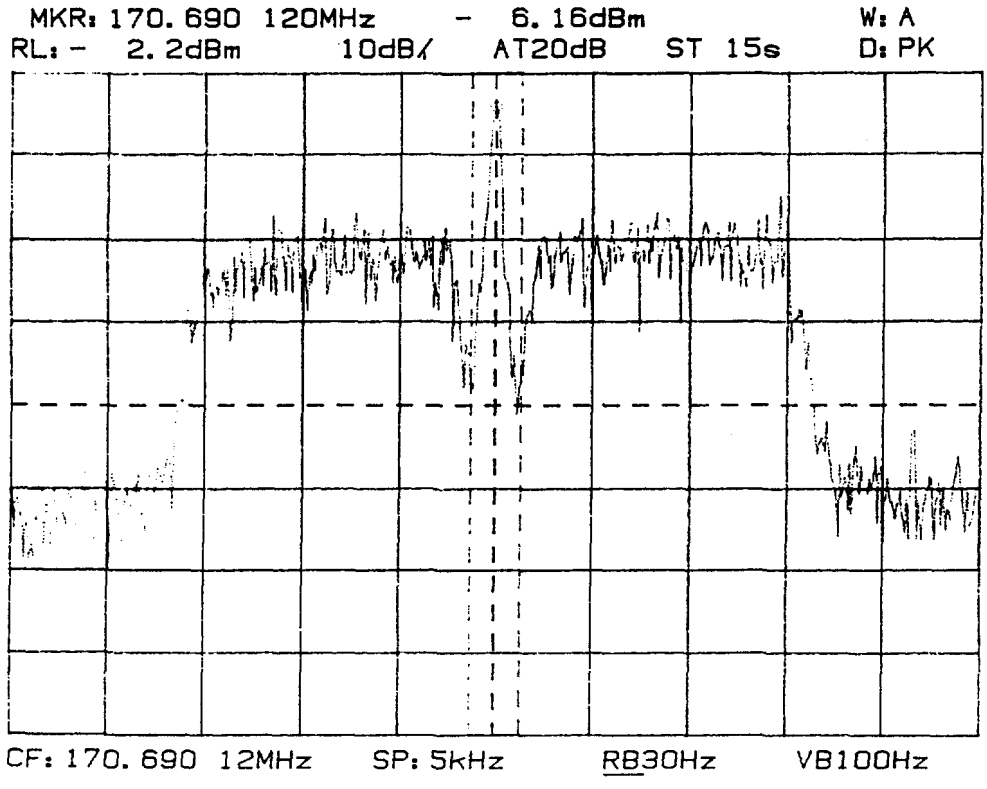


Fig 2.4 (b) In-Band Response.

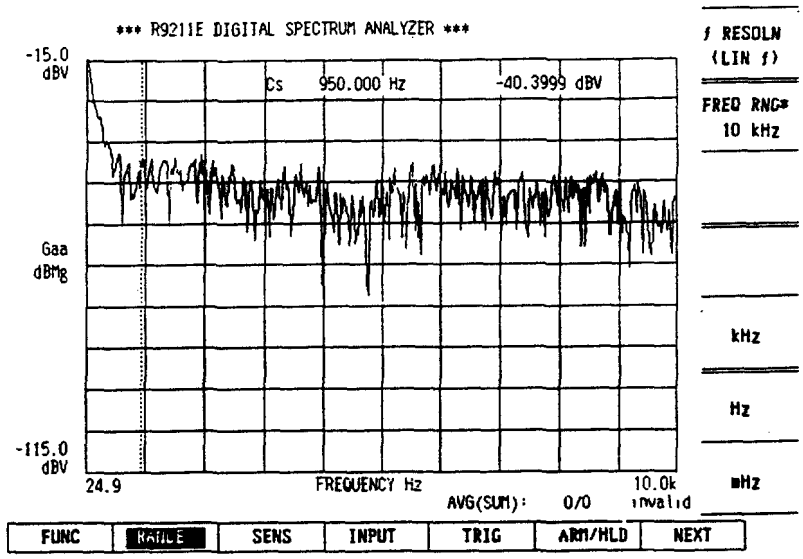


Fig 2.5 (a) Input Power Spectrum.

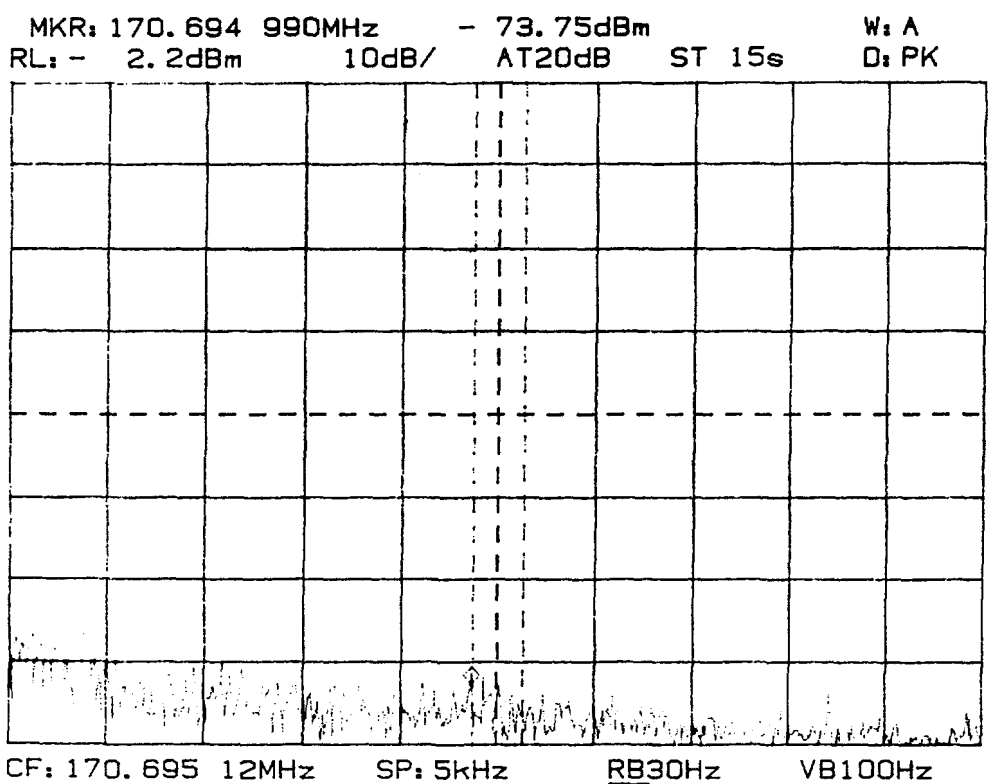
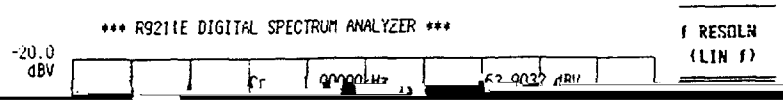
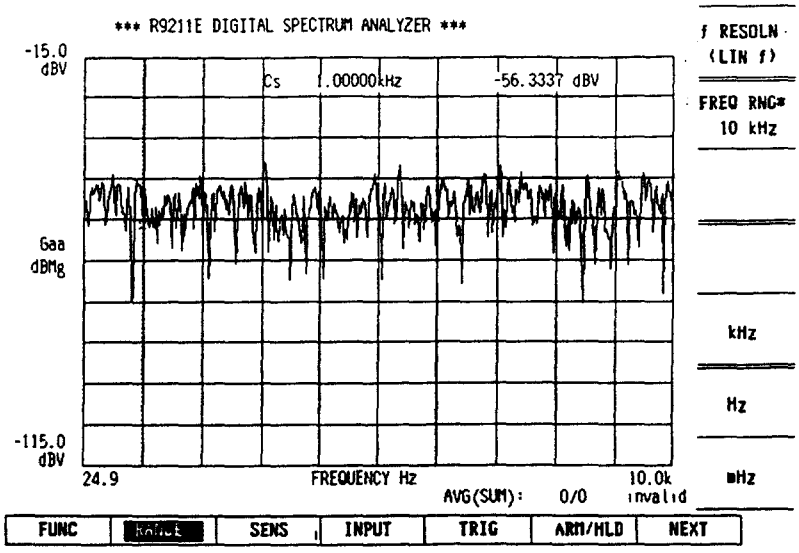


Fig 2.5 (b) Upper Adjacent Channel.


*** R9211E DIGITAL SPECTRUM ANALYZER ***
-20.0
dBV
f RESOLN
(LIN f)



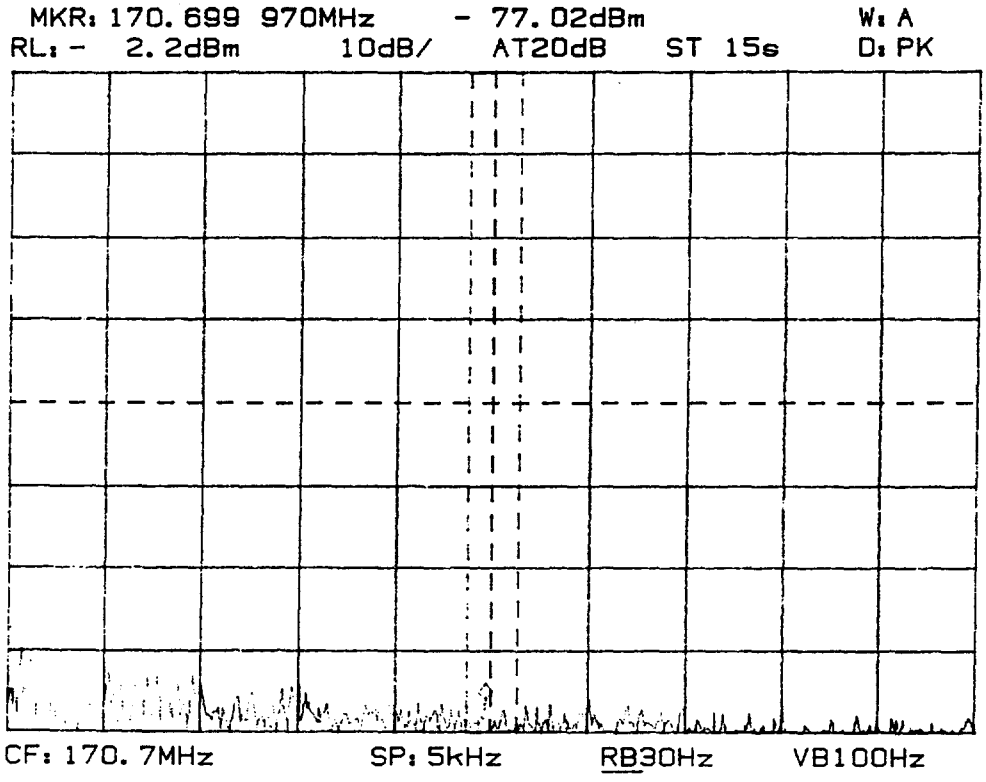
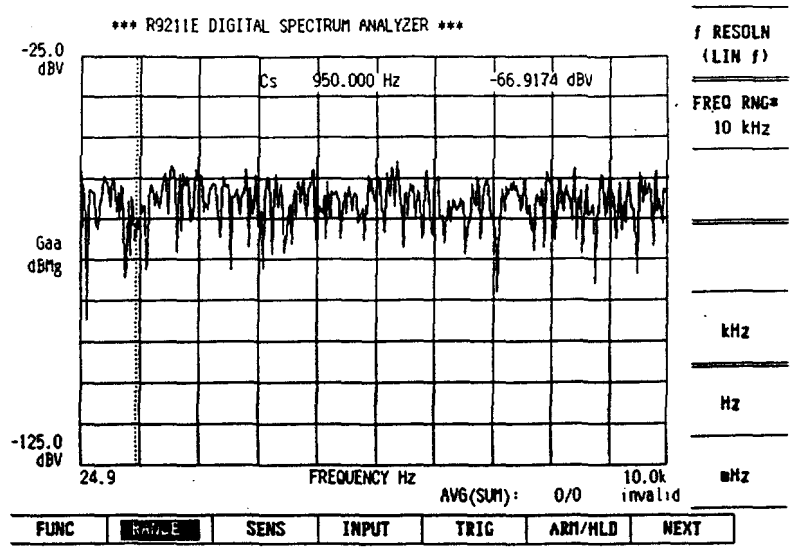


Fig 2.7 Second Upper Channel.



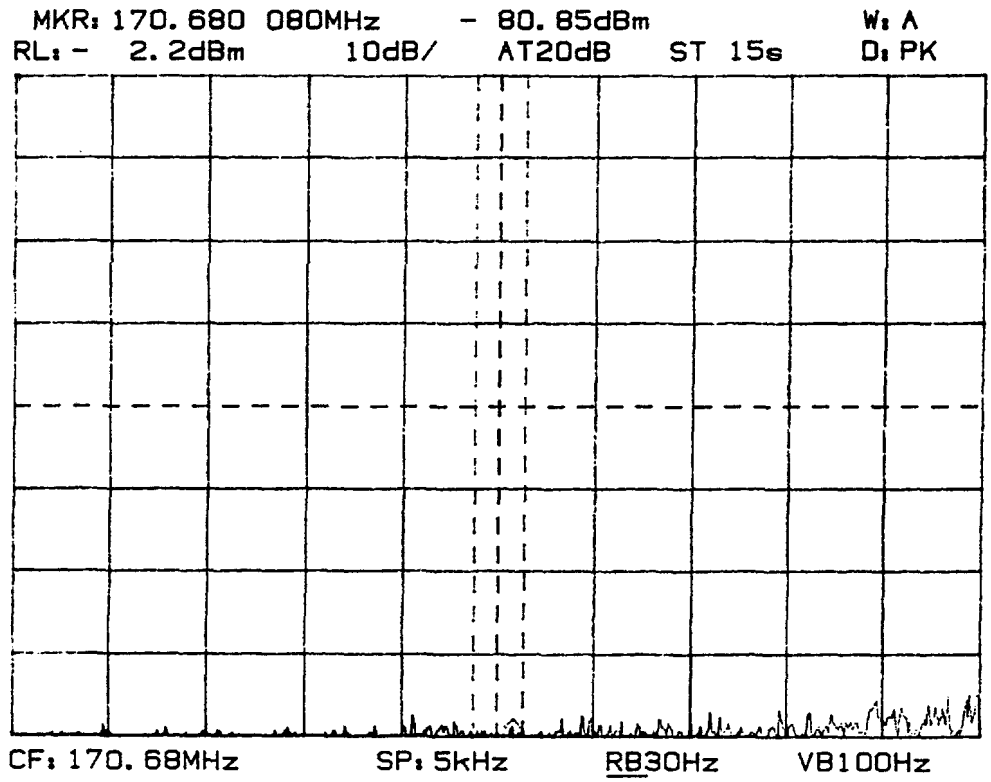
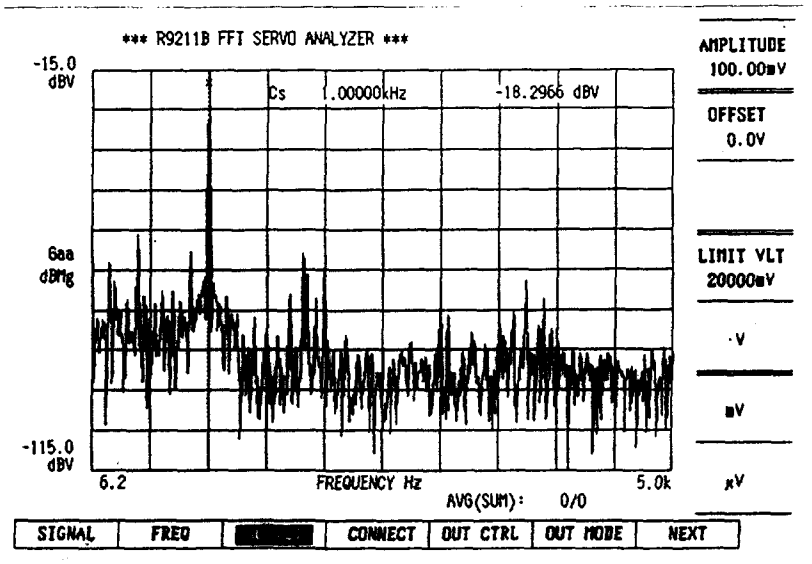


Fig 2.8 Second Lower Channel.

2.1.5 Spurious Emissions.

The transmitter under test was modulated with a 1kHz audio tone (Appendix (iii) item 3) at such a level as to produce 12.5W PEP at the output of the transmitter (corresponding to 50% rated PEP). The outputs in the frequency range 100Hz to 1GHz were then examined on a spectrum analyser (Appendix (iii) item 6). Plots of the outputs in this range, along with the associated inputs, are shown in Figures 2.9 to 2.13. Noting the presence of the DC marker and test signal in Figure 2.9, it is evident that two main spurious emissions exist in the specified bandwidth. These are shown in more detail in Figures 2.14 and 2.15. The first occurs at 341MHz and the second at 512MHz. The measured levels were found to be −87dBm at 341MHz and −81dBm at 512MHz. The in-band response is shown in Figure 2.16.

The draft DTI specification states an acceptable level for spurious emissions to be 0.25μW for mobile equipment in transmit mode, which corresponds to −36dBm.



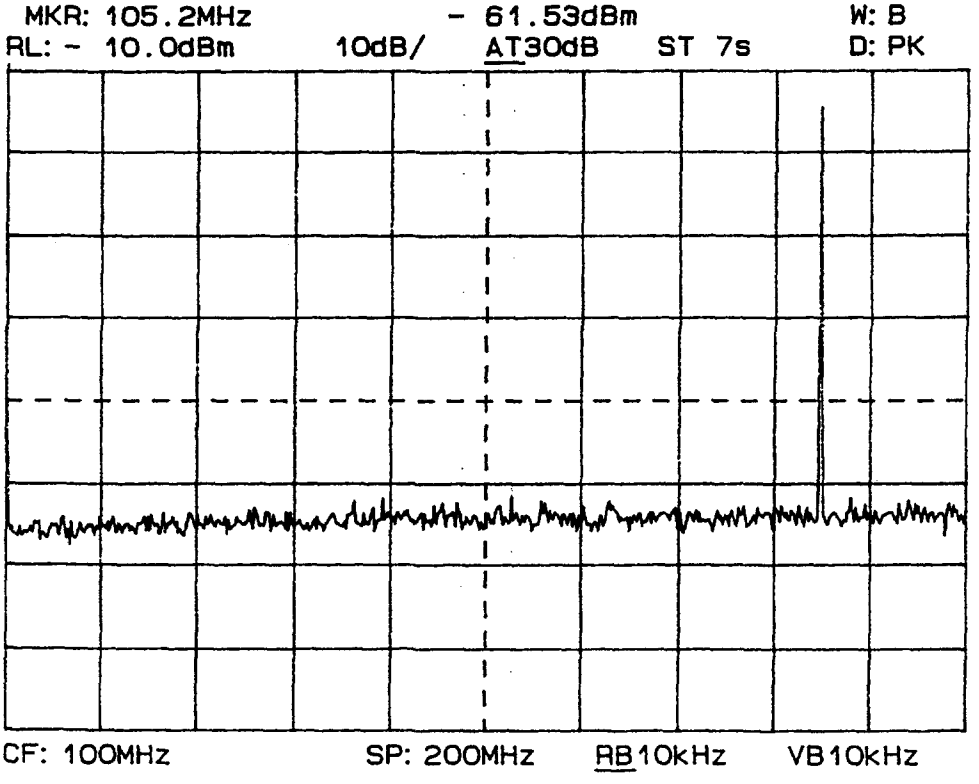
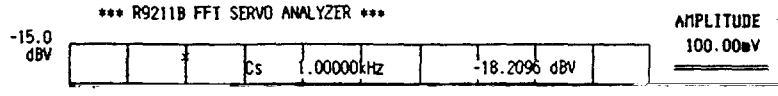
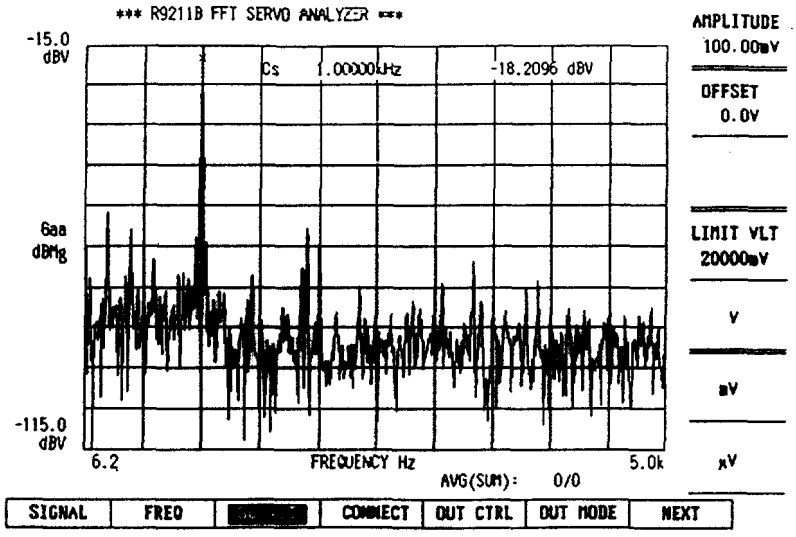


Fig 2.9 Spurious Emissions: 0 to 200MHz.


*** R9211B FFT SERVO ANALYZER ***
-15.0
dBV
Cs
1.00000kHz
-18.2096 dBV
AMPLITUDE
100.00mV



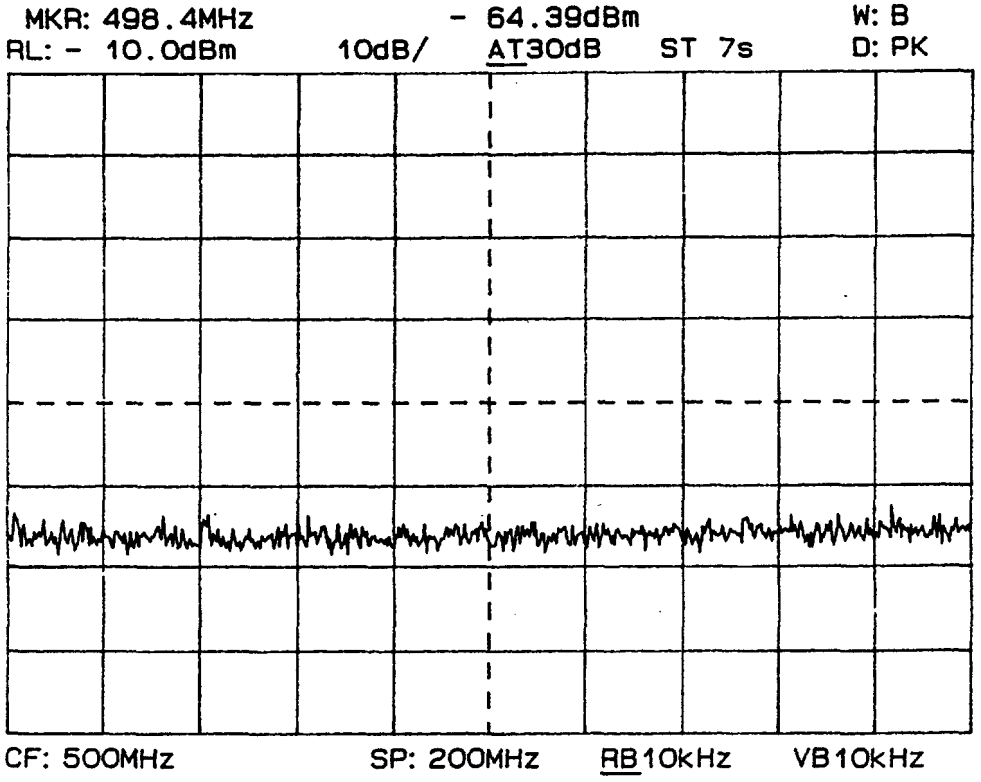
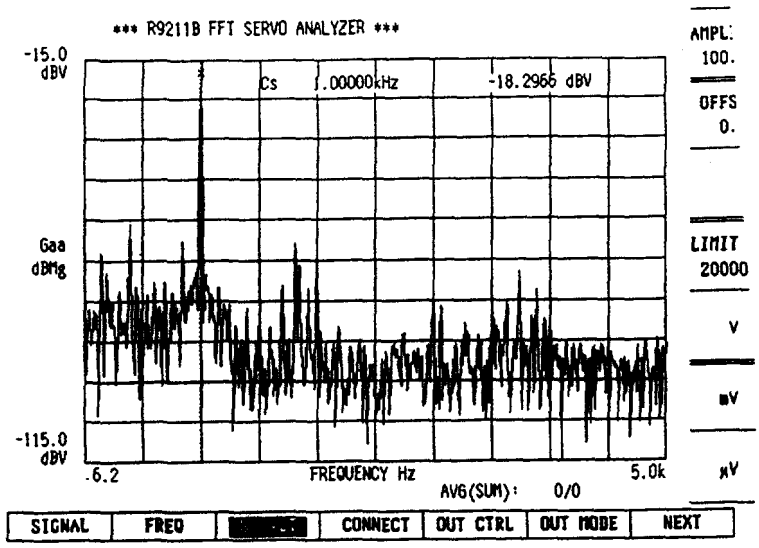


Fig 2.11 Spurious Emissions: 400MHz to 600MHz.



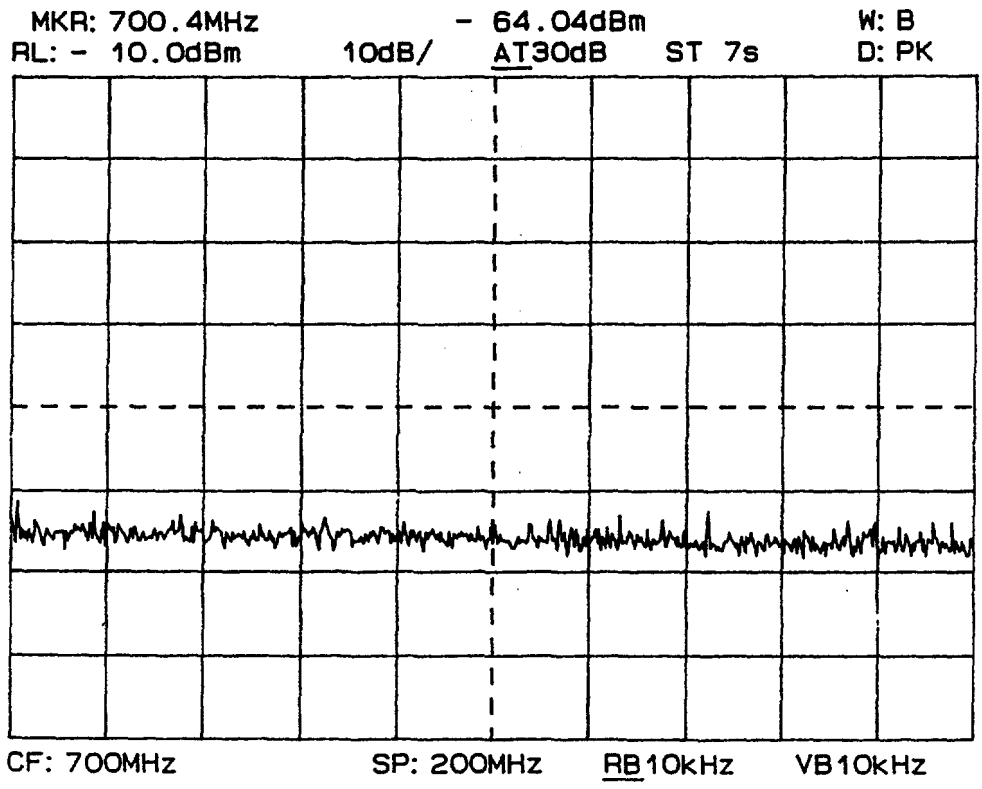
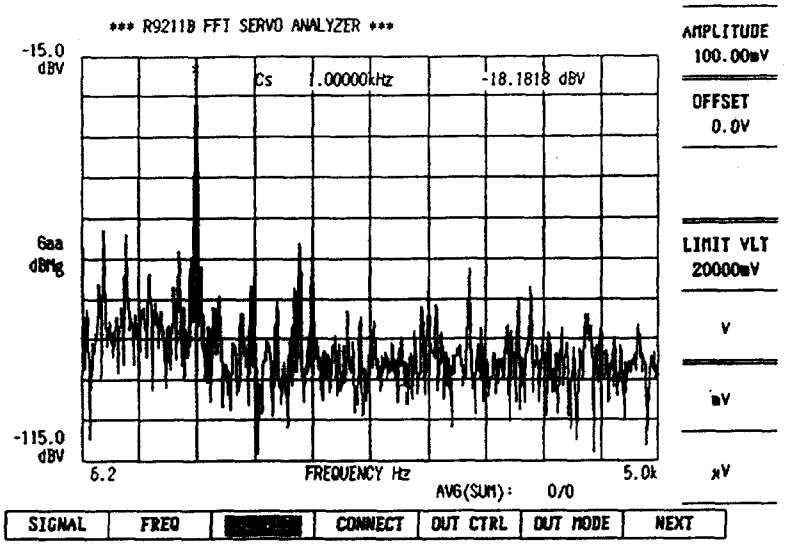


Fig 2.12 Spurious Emissions: 600MHz to 800MHz.



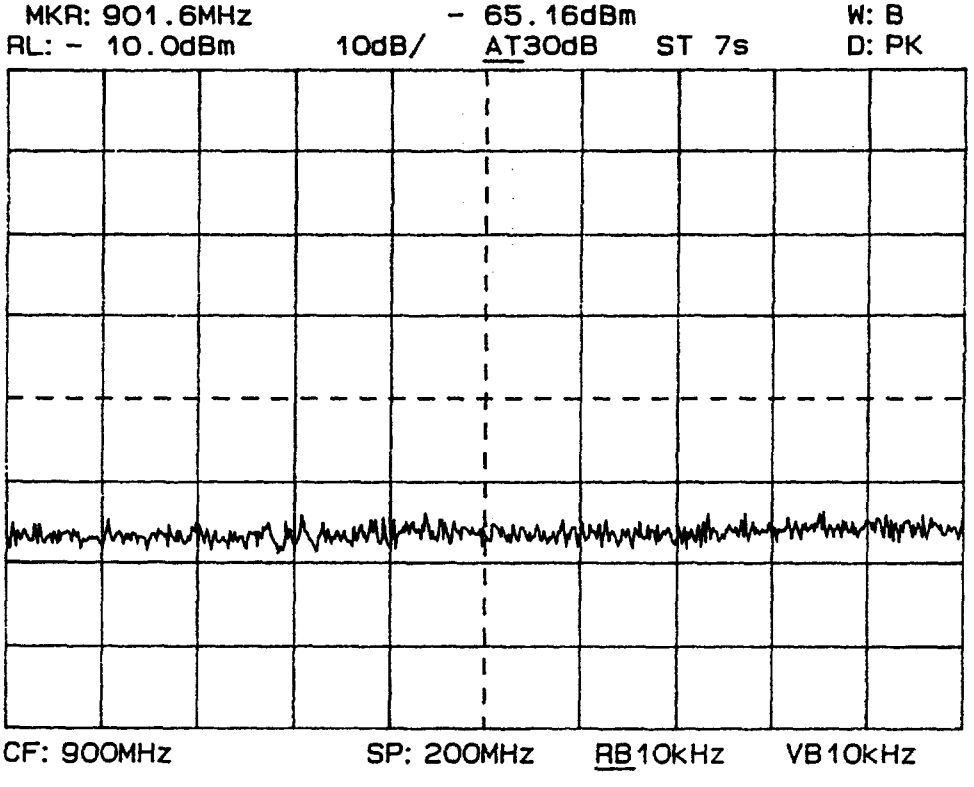


Fig 2.13 Spurious Emissions: 800MHz to 1GHz.

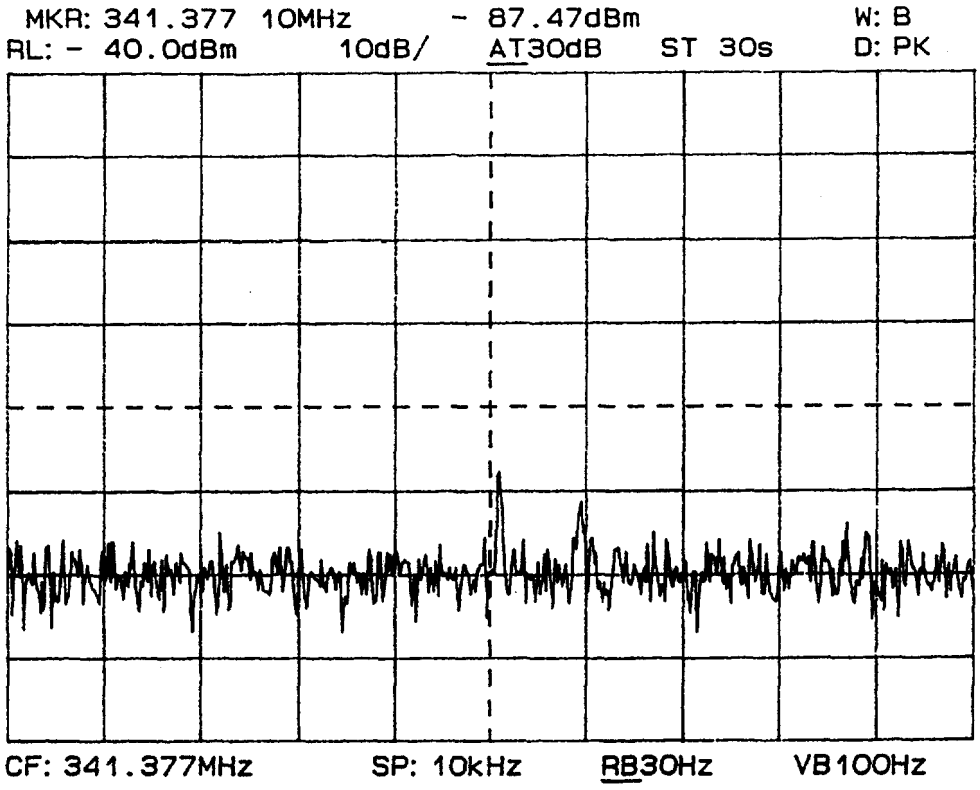


Fig 2.14 Spurious Emission at 340MHz.

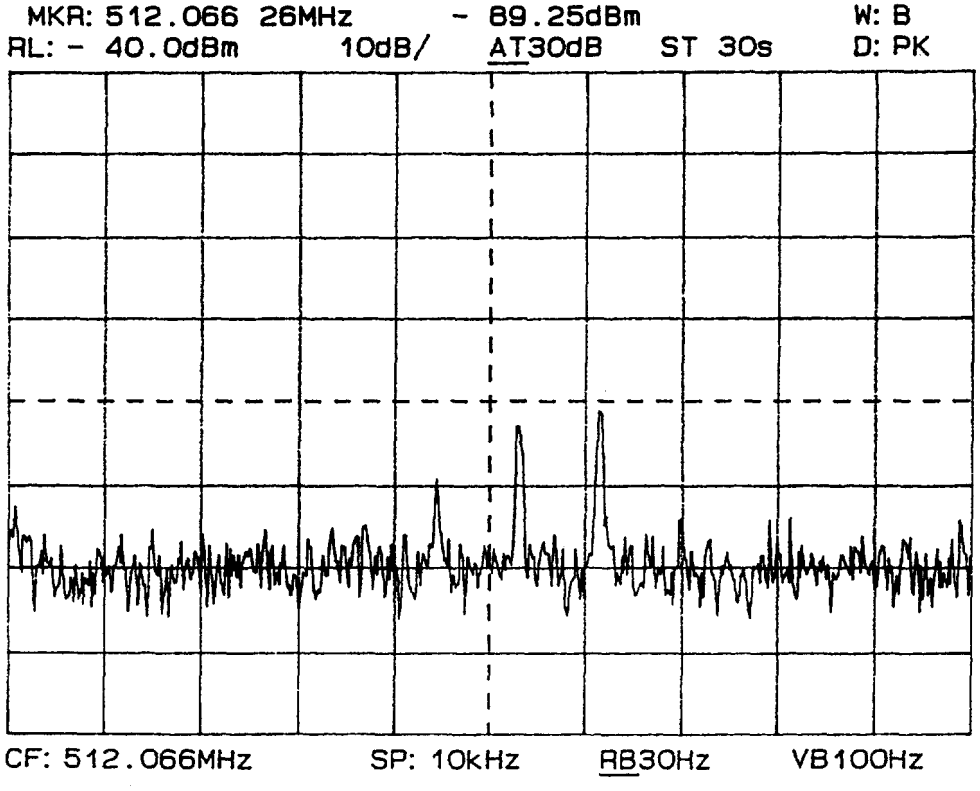


Fig 2.15 Spurious Emission at 500MHz.

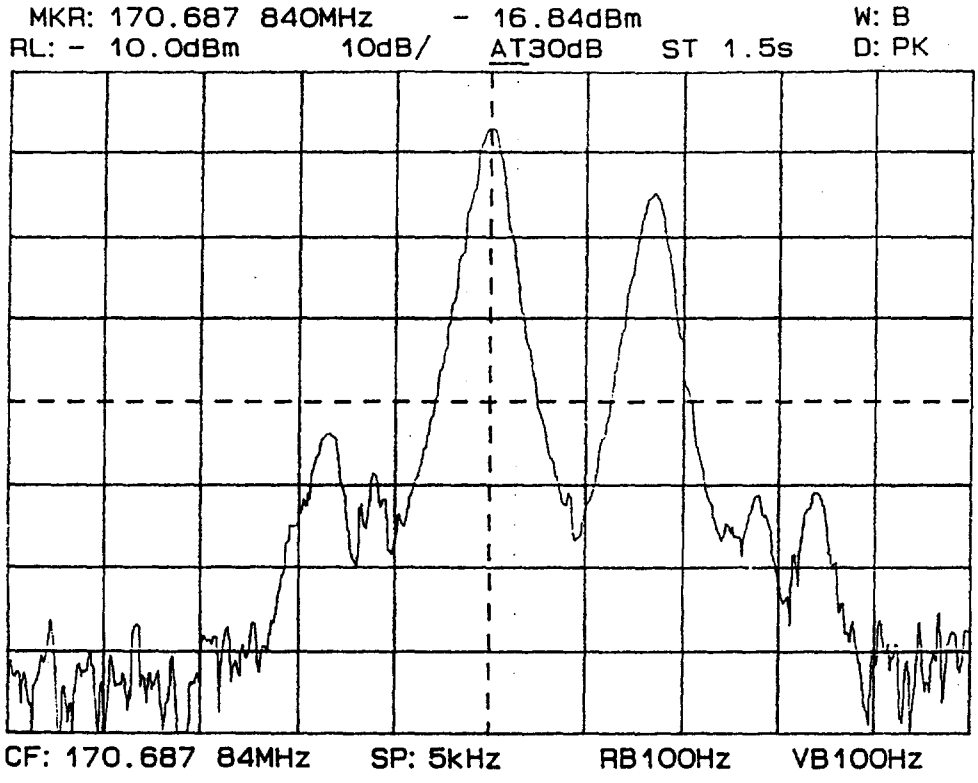


Fig 2.16 In-Band Response.

2.1.6 Intermodulation Attenuation.

The measurements were taken using the circulator test configuration as shown in Figure 2.17 below.

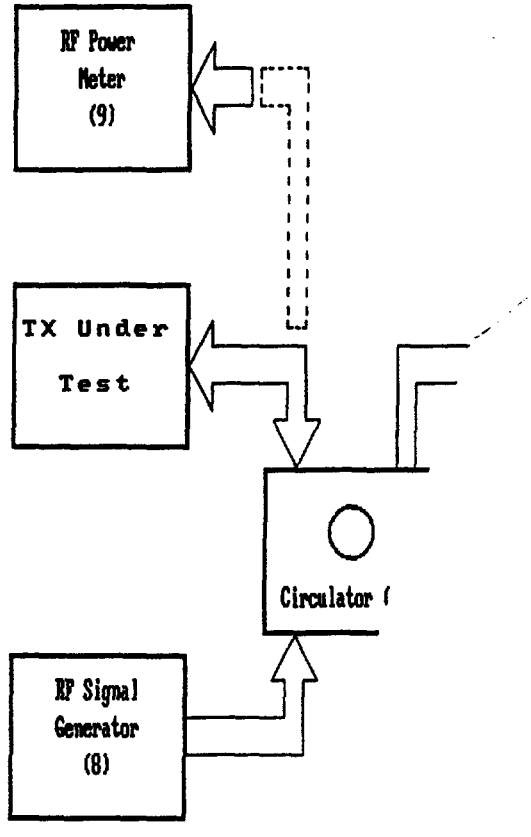


Fig 2.17 Intermodulation Test Configuration.

As required in the test specification, the interfering signal was adjusted so as to be 30dB down on the rated PEP of the transmitter. This corresponded to 14dBm and was measured at the output of the transmitter i.e after being transmitted through the circulator. The power meter was then removed and the resulting intermodulation products measured at the spectrum analyser. The results can be seen in Figure 2.18. The intermodulation product can be seen to be 48dB down on the test signal level. This is well within the 15dB permitted in the draft DTI spec.

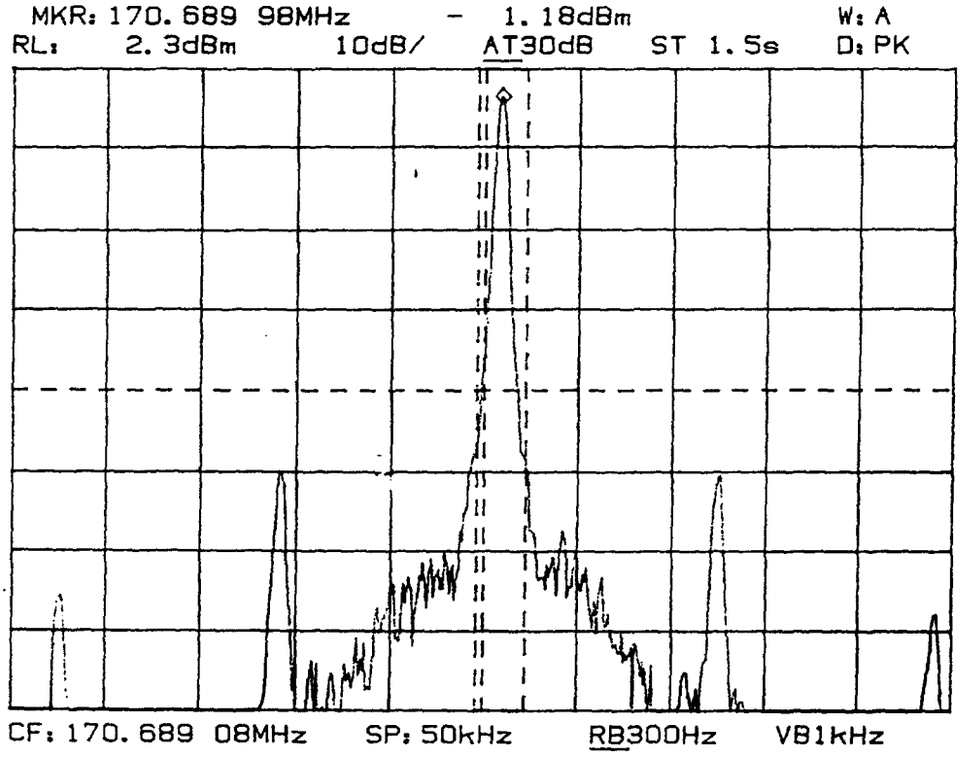


Fig 2.18 Intermodulation Attenuation.

2.1.7 In–Band Intermodulation Response.

Although this test is not required by the draft DTI spec, it was felt important enough to include in the report. The test gives a measure of the transmitter power amplifier non–linearities which result in intermodulation products. Two tones were applied to the transmitter input, at 1kHz and 1.8kHz and set at a level of 80mV. The transmitter was then run at full rated PEP (25W) and measurements taken on a spectrum analyser. The test configuration is shown in Figure 2.19.

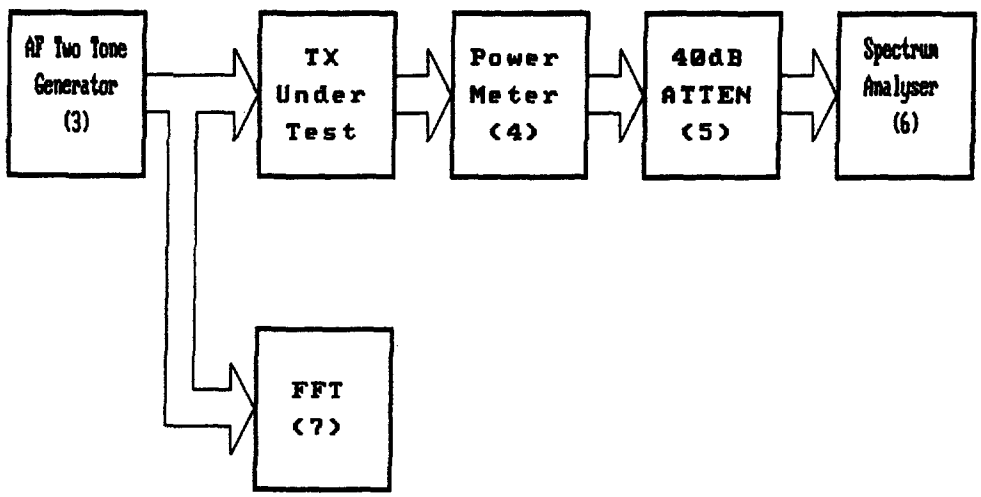
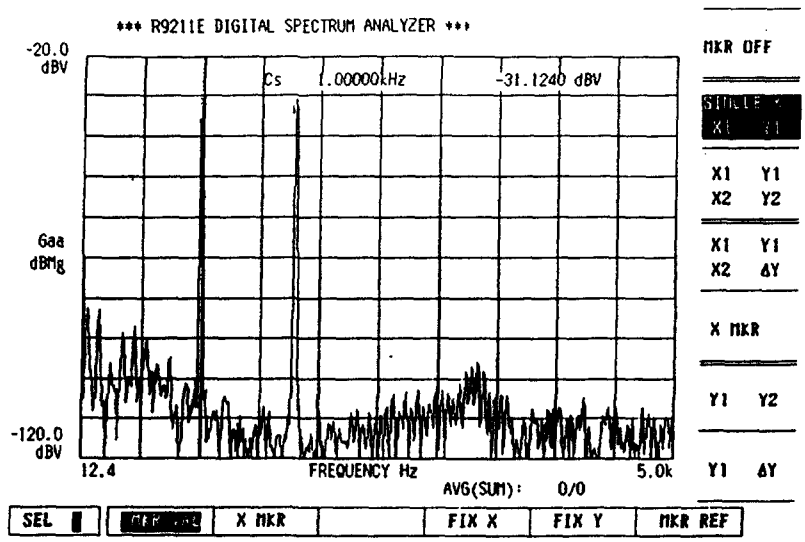


Fig 2.19 In–Band Intermodulation Test Configuration.

The results are shown plotted in Figures 2.20, 2.21 and 2.22 for in–band, upper and lower adjacent channels respectively. As a result of having three tones present in the RF spectrum, the in–band intermodulation products appear confused, although the largest can be seen to be 30dB down on the pilot. The two adjacent channel powers are 60dB down at mid–band, with the lower adjacent channel showing a slightly worse performance closer in to the center band. A measurement was also taken with only a single 1kHz input tone, which effectively results in a two tone RF test (two tone tests are more usual). The result is shown in Figure 2.23 and the intermodulation products are clearly visible at about 35dB down on pilot (the transmitter was again run at rated PEP i.e 25W).



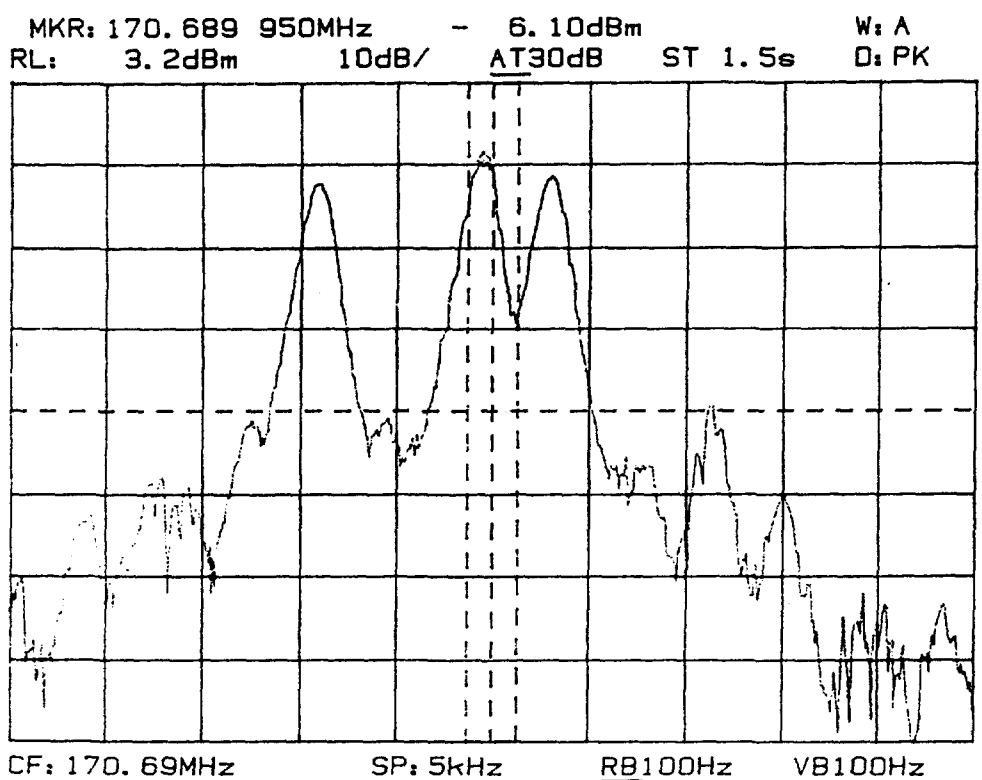
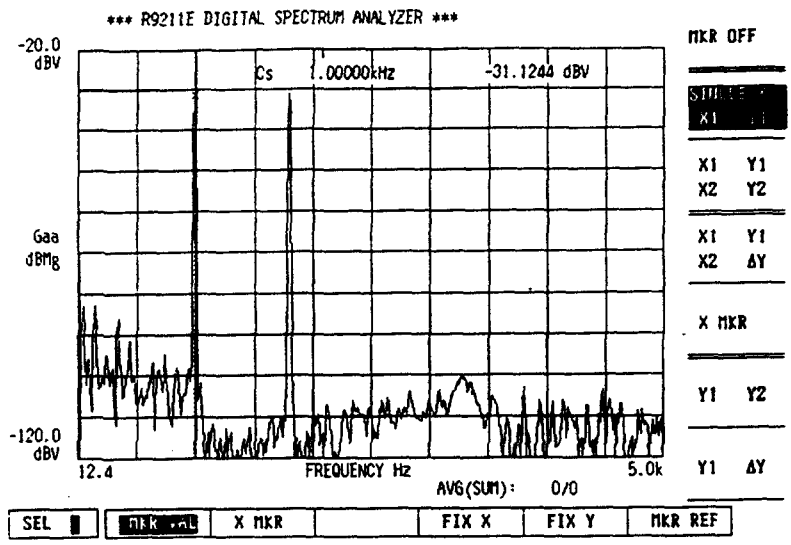


Fig 2.20 In-Band Intermodulation Test.



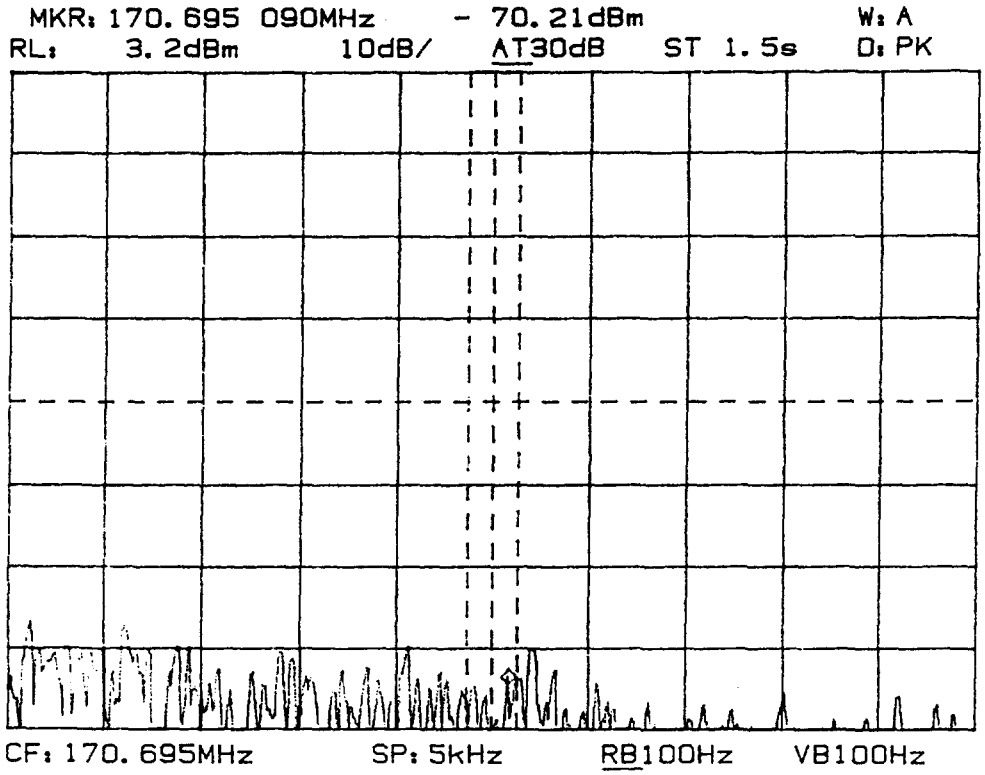
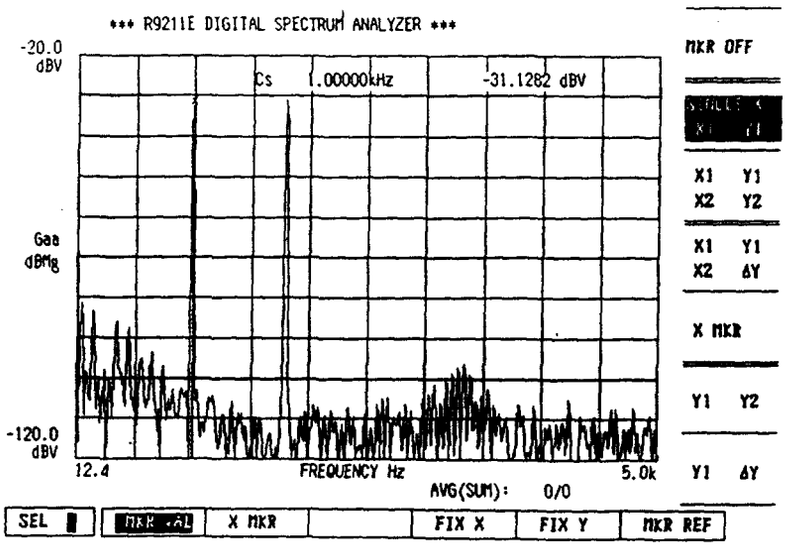


Fig 2.21 Upper Adjacent Channel Response.



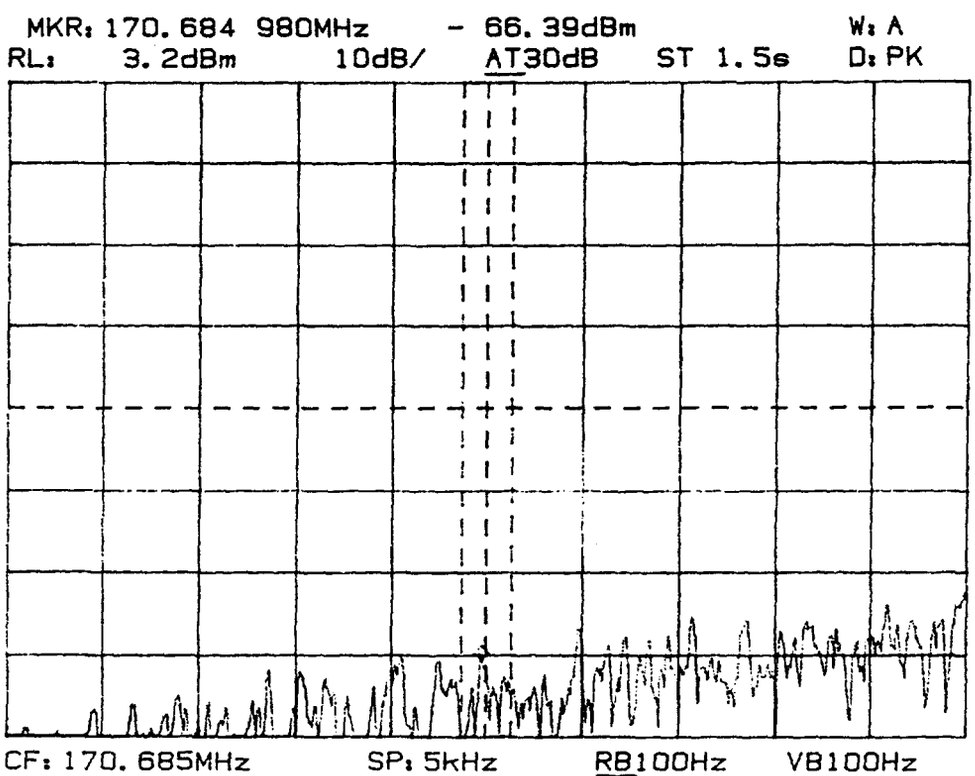


Fig 2.22 Lower Adjacent Channel Response.

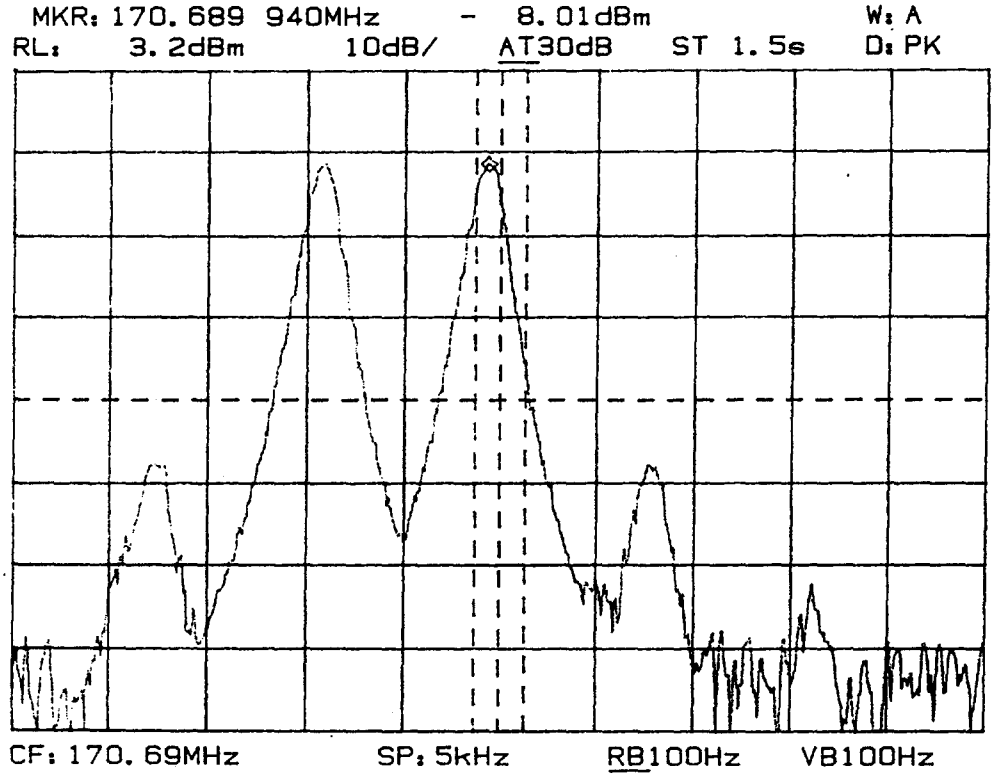


Fig 2.23 Two Tone Intermodulation Test.

2.2 Receiver Measurements

Sensitivity, adjacent channel selectivity, spurious response and intermodulation tests all require the use of an applied RF signal which produces a 1kHz tone at the output of the receiver. This is then used to take a SINAD measurement. Also, the TTIB technique that is employed in the system requires a tone at 1.85kHz (relative to the 5kHz RF channel) as a pilot tone. This tone is a nominal 10dB below Full Power Pilot with audio present. Therefore, a signal generator is used to generate a carrier signal amplitude modulated with a 850Hz tone. The upper sideband forms the pilot tone, the carrier forms the 1kHz audio tone at base band and the lower sideband then falls out of the audio passband. A 50% modulation depth set the pilot 6dB below the carrier, representing a typical input situation. All the following input voltage levels refer to the signal generator carrier signal, which is equivalent to the 1kHz test tone that results at the receiver output. This was used as a reference because it is on this signal that SINAD and other measurements are made.

A Hewlett Packard 8644A RF signal generator (Appendix (iii) item 10) was used to generate the test signal, as it was found that the intended HP8640B was neither stable or accurate enough for the task.

2.2.1 Maximum Usable Sensitivity.

The test was carried out as outlined in the draft DTI specification (Appendix (ii)). The test signal was set at 1mV and the audio output of the receiver set to 50% rated output (5V peak-to-peak). This was achieved by adjusting the output until the signal was just about to start clipping. This level corresponds to the maximum output and was measured at 10V peak-to-peak. Hence the output was set at 50% of this figure. The test signal was then reduced so as to produce a 12dB SINAD level at the output of the receiver. This level was found to be 0.30μV, or -117dBm. The limits given in the specification state an upper limit of 1μV for the maximum usable sensitivity.

2.2.2 Adjacent Channel Selectivity.

The test configuration used is given below in figure 2.24 (all numbers refer to the test