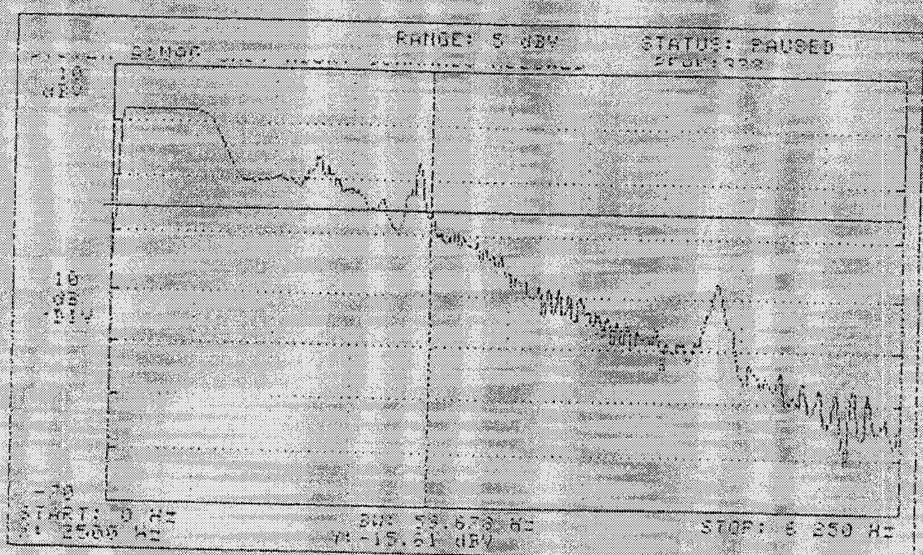
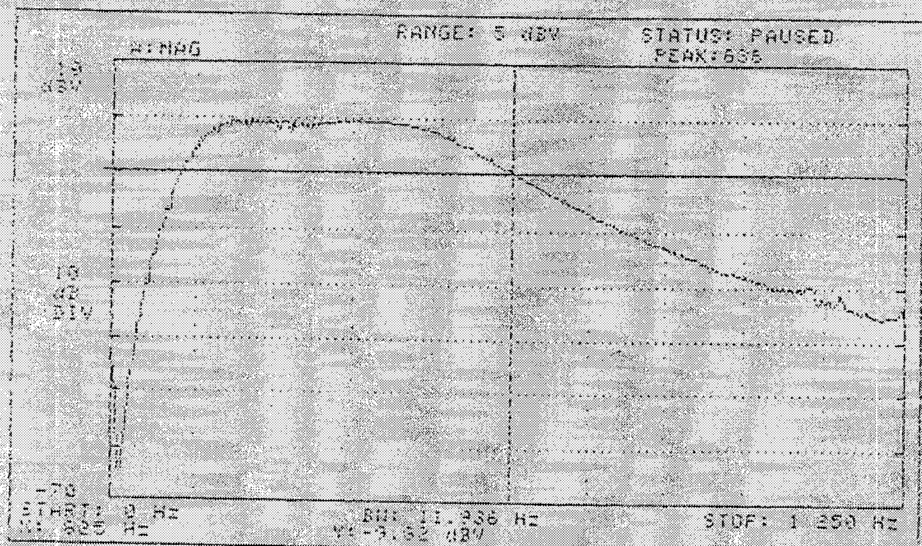
M131017: modulation signal, US mode, US iF-signal clipped
(+20dB overload)



H13/12 R: modulation signal, US mode, signal before clipping



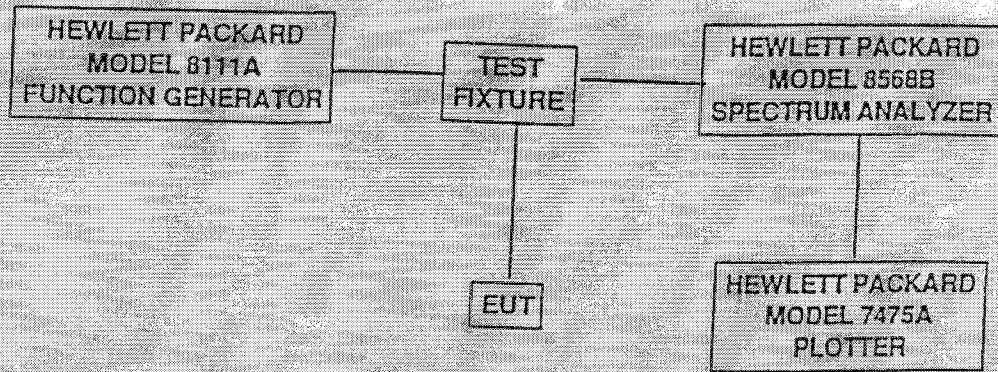
2.987(a) Digital Modulation Filter Response

The Model M1310A does employ digital modulation techniques. In accordance with the requirements of Paragraph 2.983(d)(12), the responses of these filters have been measured and are shown on the following pages.

2.989 Occupied Bandwidth

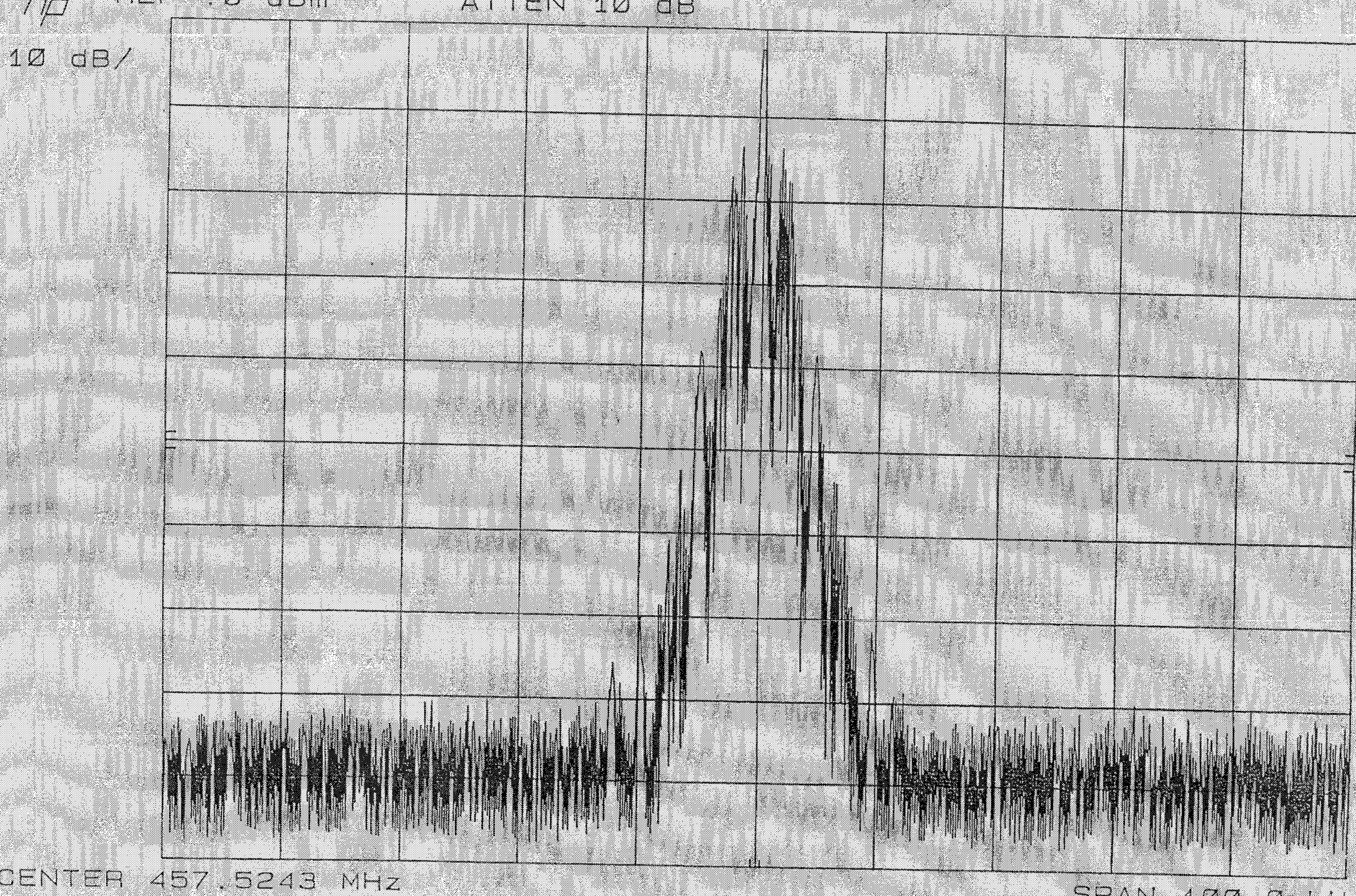
The occupied bandwidth of the transmitter's emission was measured using the test configuration shown on the following page. The test adapter (which was supplied by the manufacturer) was connected to the transmitter. A signal generator was connected to the BNC connection labeled "US" on the adapter. The generator's frequency was then set to 998580 Hz (which simulates a doppler shift of about 200 Hz, the nominal ultrasound frequency is 998380 Hz), and the output level was set to 500 uV peak to peak. A spectral plot of the display of the analyzer's response to this signal was taken. A spectral plot was also taken with the generator's output level set 20 dB higher. These plots are located on the following pages. The reference level in each plot indicates the level of the unmodulated carrier. The analyzer's resolution bandwidth was set to 300 Hz.

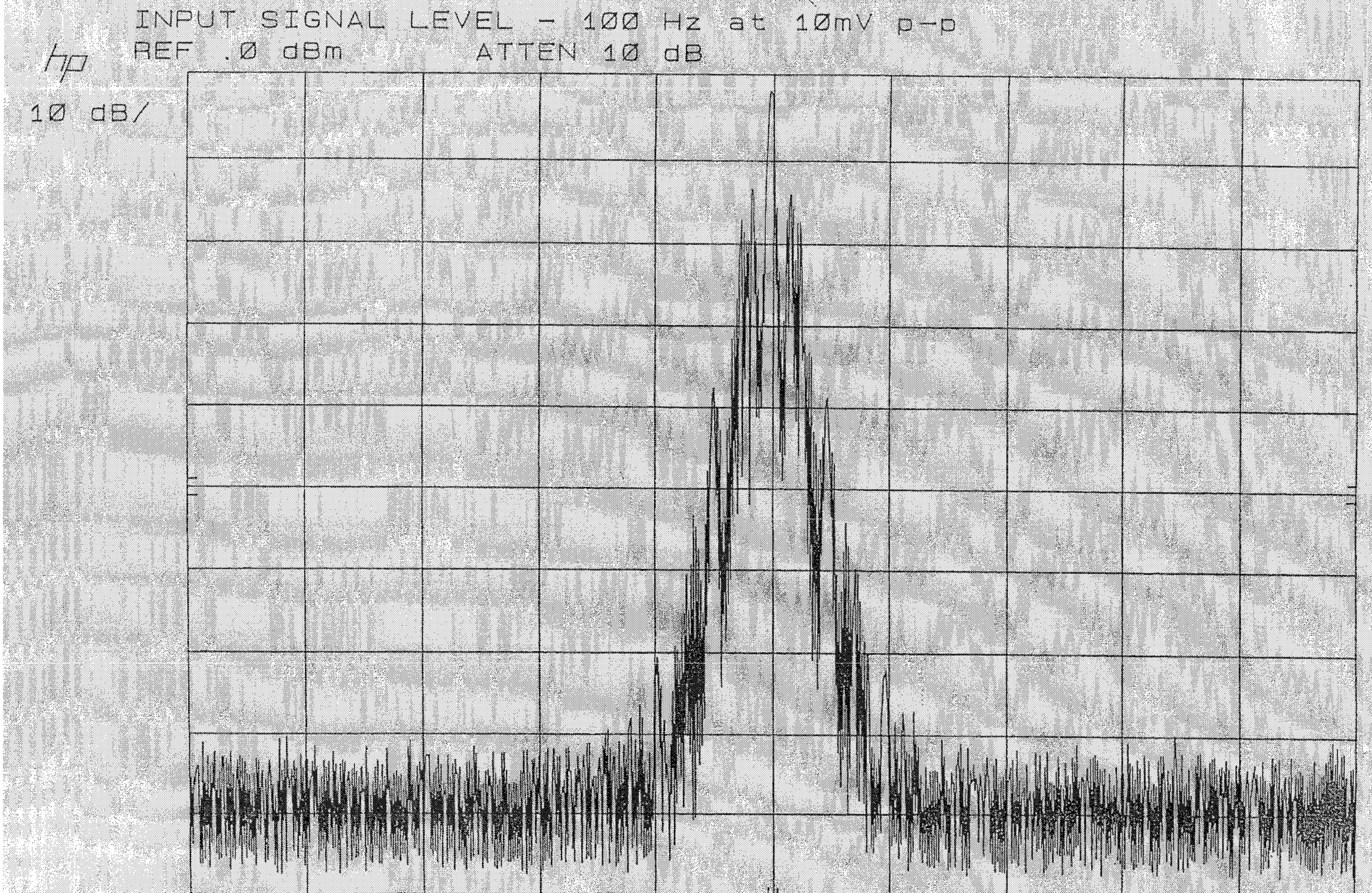
The exemption of Paragraph 90.217 requires that the sum of the frequency tolerance and the occupied bandwidth be such that all emissions removed from the carrier by more than 40 kHz be attenuated by at least 30 dB. Since the rated tolerance of the M1310A is ±4000 Hz, this would require that all emissions 36.0 kHz or more removed from the carrier be attenuated 30 dB. The M1310A easily meets this restriction as seen in Figures 3 and 4.



OCCUPIED BANDWIDTH TEST CONFIGURATION

INPUT SIGNAL LEVEL - 100 Hz at 1mV p-p




INPUT SIGNAL LEVEL - 100 Hz at 10mV p-p
REF .0 dBm
ATTEN 10 dB
10 dB/
CENTER 457.5243 MHz
RES BW 300 Hz
VBW 300 Hz
SPAN 100.0 kHz
SWP 7.5 sec

Calculation of occupied RF bandwidth for M1310A fetal telemetry system

The modulation signal is composed of two components:
1. the ultrasound doppler signal or the ecg signal and
2. the FSK subcarrier signal

The RF FM modulator has a sensitivity of 1.6kHz/Voltpeak-peak signal.

The ultrasound signal has a bandwidth BWlf = 500 Hz and an amplitude of 1.875 Vpeak-peak which produces a RF carrier shift of 3.0 kHz.
The corresponding modulation index is:
mx = (frequency shift/modulating frequency) = (3.0kHz/500Hz) = 6
The ECG signal has a bandwidth BWlf = 100 Hz and also a carrier shift of 3 kHz the modulation index is: mx = (3.0kHz/100Hz) = 30

The FSK signal has as the highest frequency a 2.4 kHz sine carrier, its amplitude produces a RF carrier shift of 1.5 kHz.
The modulation index is:
mx = (1.5kHz/2.4kHz) = 0.625

For a modulation index < 1 the RF bandwidth is approximately BWrf = 2* BWlf (only BESSEL functions of order 0 and of order 1 have significant values > 0.01, width where the signal is 20dB down compared to the maximum at center frequency)

=> RF bandwidth (-20dB) of FSK carrier = 2*2.4 kHz = 4.8 kHz
For a bandwidth where the signal is 40db down (= 99.99% of the RF energy) also the Bessel function of 2nd order is of interest
=> RF bandwidth (-40dB) of FSK carrier = 4*2.4 kHz = 9.6 kHz

The measured values (see RF plot #2) clearly show this theoretical values.

For a modulation index > 1 the RF bandwidth is approximately
BWrf = 2(mx+1)*BWlf for a bandwith where the signal is 20dB down again. For a bandwidth where the signal is 40 dB down (= BW of 99.99% of RF energy) this bandwidth doubles again:
BWrf (-40dB) = 4(mx+1)*BWlf

With a modulation index of 6 the ultrasound signal produces a RF bandwidth of:

BWrf (-20dB) = 2(6+1)*500 Hz = 14*500 Hz = 7 kHz or
BWrf (-40dB) = 4(6+1)*500 Hz = 28*500 Hz = 14 kHz

With a modulation index of 30 the ECG signal has a RF bandwidth of:

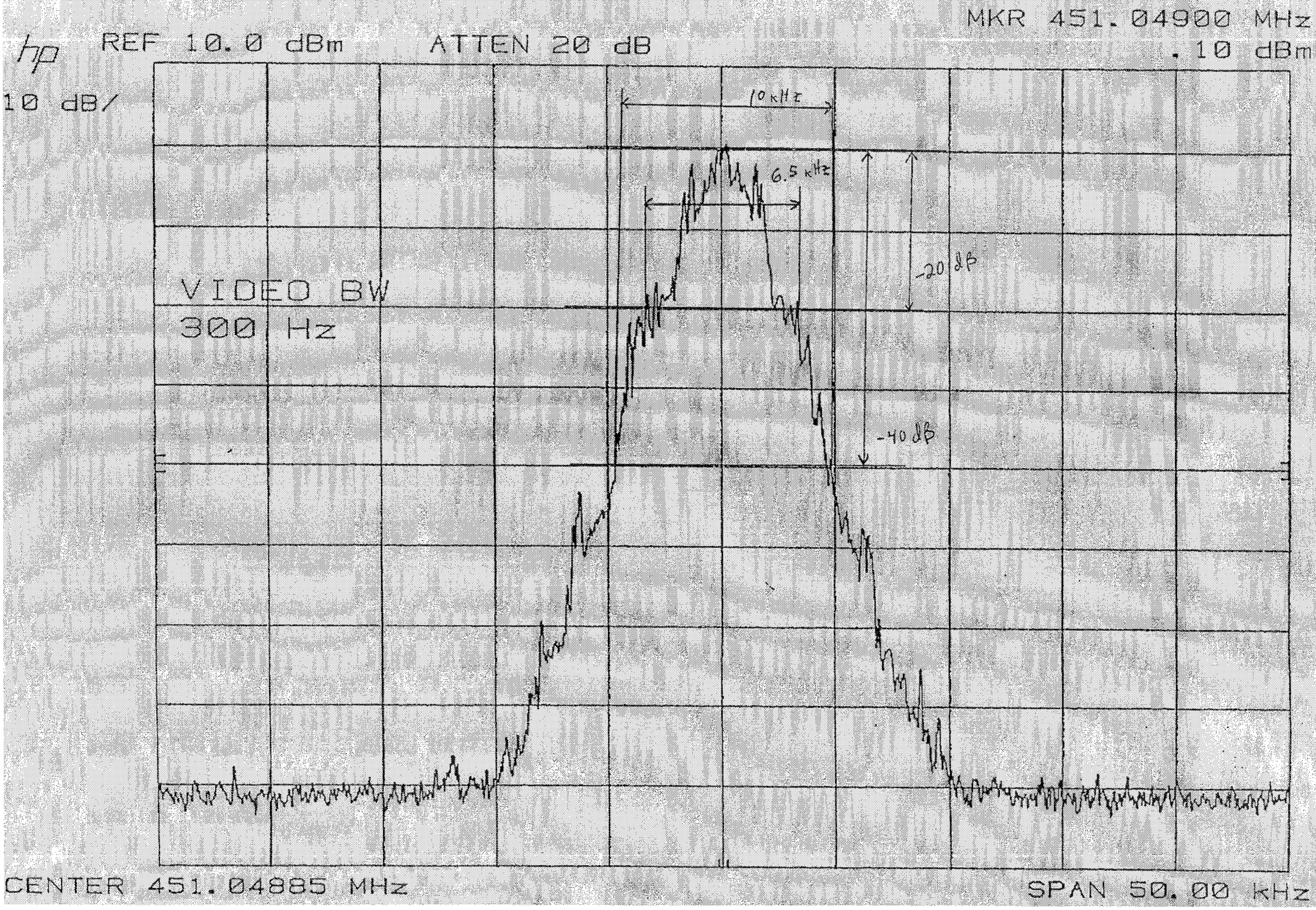
BWrf (-20dB) = 2(30+1)*100 Hz = 6.2 kHz or
BWrf (-40dB) = 4(30+1)*100 Hz = 12.4 kHz

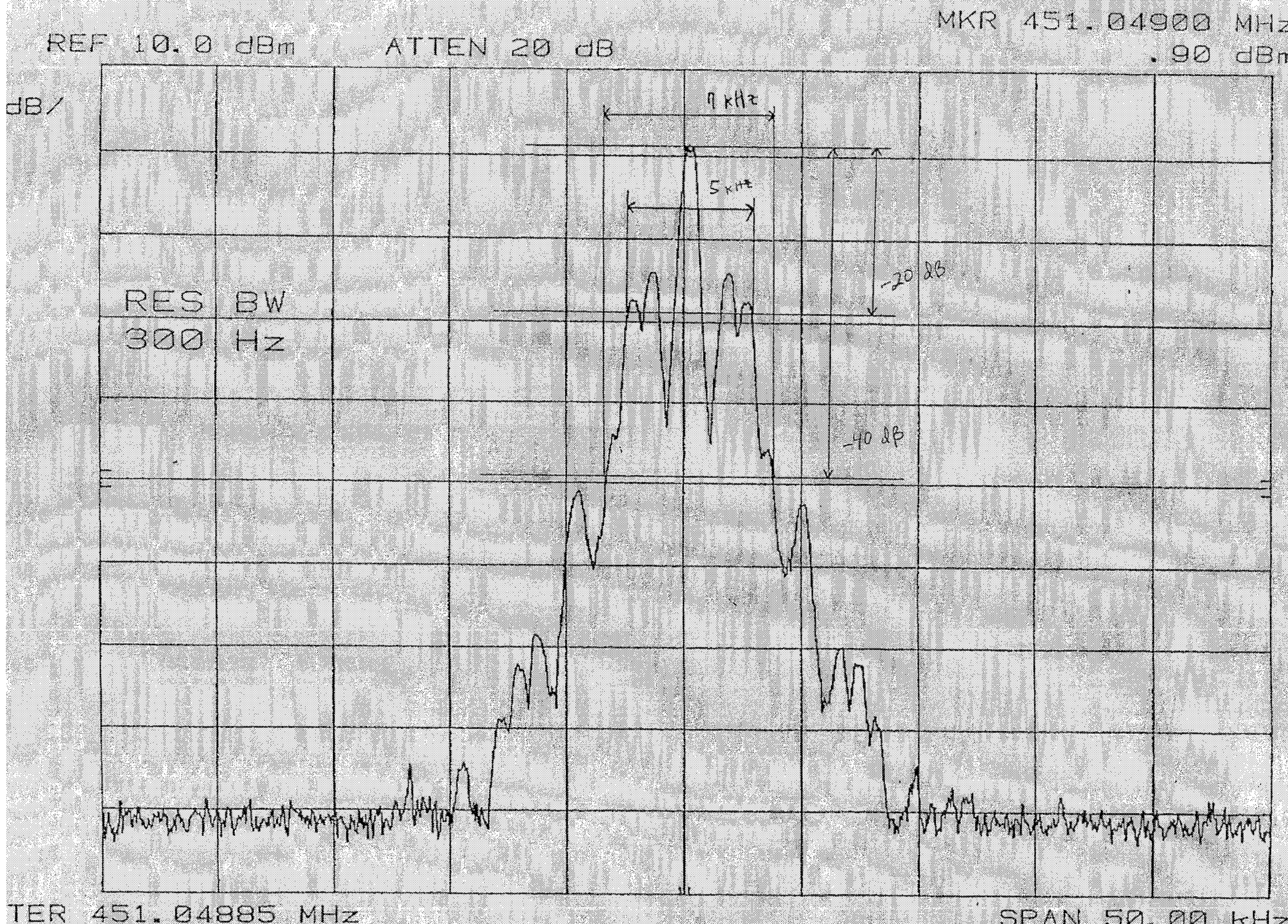
The overall RF bandwith is mainly determined by the ultrasound signal(or the ECG signal) and not by the FSK signal!

The measured RF bandwidth with the combined ultrasound and FSK signal clearly shows the calculated bandwidth (see RF plot #1)

Result: The M1310A telemetry system has a bandwidth of max 14kHz!

combined FSK + US signal (signal sweep 50 ... [illegible], max Hold on at Spectrum analyzer)




REF 10.0 dBm
ATTEN 20 dB
MKR 451.04900 MHz
.90 dBm
dB/
RES BW
300 Hz
9 kHz
5 kHz
-20 dB
-40 dB
TER 451.04885 MHz
RES BW 300 Hz
VBW 300 Hz
SPAN 50.00 kHz
SWP 1.0 sec