Cook/Sill Stereo Modulator C-1.2

Assembled and adjusted
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1. Introduction

This document contains my experience of assembling and adjusting the Cook/Sill Stereo Modulator version C-1.2, plans of which can be found at http://www.**solorb**.com/elect/**fmst**. Please note that this is a complex project that calls for some expertise in construction and soldering techniques. As for alignment, you will need to have access to an oscilloscope, a TRMS voltmeter, and a frequency counter.

Yet I have used the more professional method. Let me say that schematic, PCBs, alignment instructions, and construction notes make this one of the BEST and MOST DETAILED projects in the web at present. If you can work carefully and professionally —and are not put off by the need to find some more or less exotic parts— I heartily recommend this circuit. At the same time, you will learn a lot about stereo multiplexing.

2. Parts

All the parts for this project were found locally except for the Toko inductor coils, the polypropilene capacitors, and the 38 kHz quartz crystal for the generation of the subcarrier and pilot. If you live in the US, you may order everything from Digi-Key; but if you are based in Europe, you may have a difficult time finding the coils, the crystal, and even the capacitors, because having them sent from the USA generates unreasonable costs. However, if you find a suitable European supplier, please let me know for future projects.

3. Results

After preliminary alignment, I have achieved almost 40 dB of channel separation. This is not a professional figure, though I suspect that after some more tweaking this amount of separation could be improved. I have tested the modulator with a 1 W PLL Veronica exciter and a 15 W RF power amplifier, and the results are promising. Please remember to remove any low pass or pre-emphasis filtering that your exciter may have; otherwise distortion and lower channel separation will disappoint you. The stereo modulator has its own pre-emphasis stage. If you own a 1 W PLL Veronica exciter, look at figure 1 below for instructions to remove pre-emphasis.

High energy sounds of high frequency (for instance, the fall of coins at the beginning of Pink Floyd's "Money" in *The Dark Side of the Moon*) causes distortion whose kind and origin I am unable to specify. Suggestions as to how to overcome this problem are most welcome. It may be necessary to apply some processing to the signal being fed to the modulator. I am trying to build a compressor-limiter to keep the input level within steady limits, but I have not yet decided which circuit would be best. Again suggestions based on direct experience (not hearsay) will be welcome and appreciated.

4. Pictures and waveforms

Below you will find a collection of pictures, as well as of waveforms at different test points of the stereo modulator. Forrest Cook has looked at the waveforms and finds them all right.

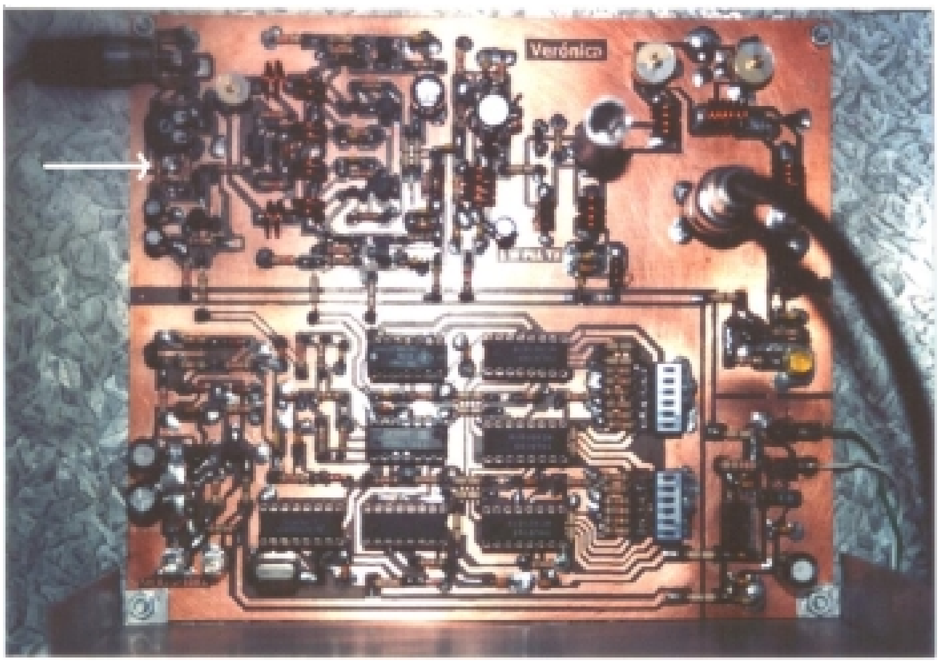

Figure 1:
To disable pre-emphasis, remove the 1.8 nF capacitor indicated by the white arrow. This 1 W PLL Veronica exciter was assembled from plans in the web at this address: http://radio.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fwww.geocities.com%2FArea51%2FNebula%2F3736%2F.

Thanks Hello_Nasty!!!

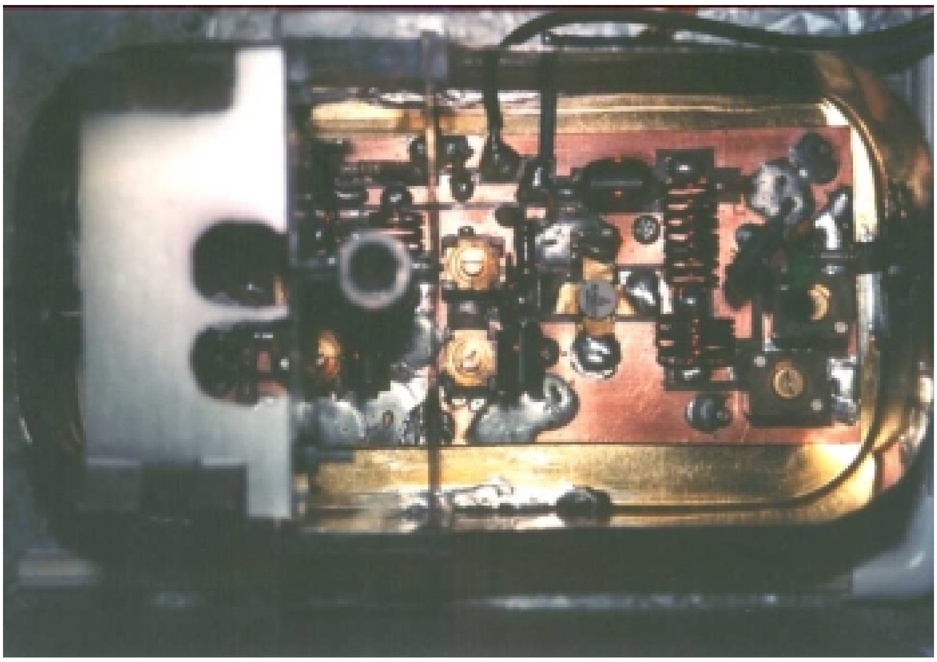

Figure 2:
BLY88C-based 15 W power amplifier for the FM band.
Note that the shielding is simply an empty can of preserve asparagus. In spite of this, the amplifier performs very well.

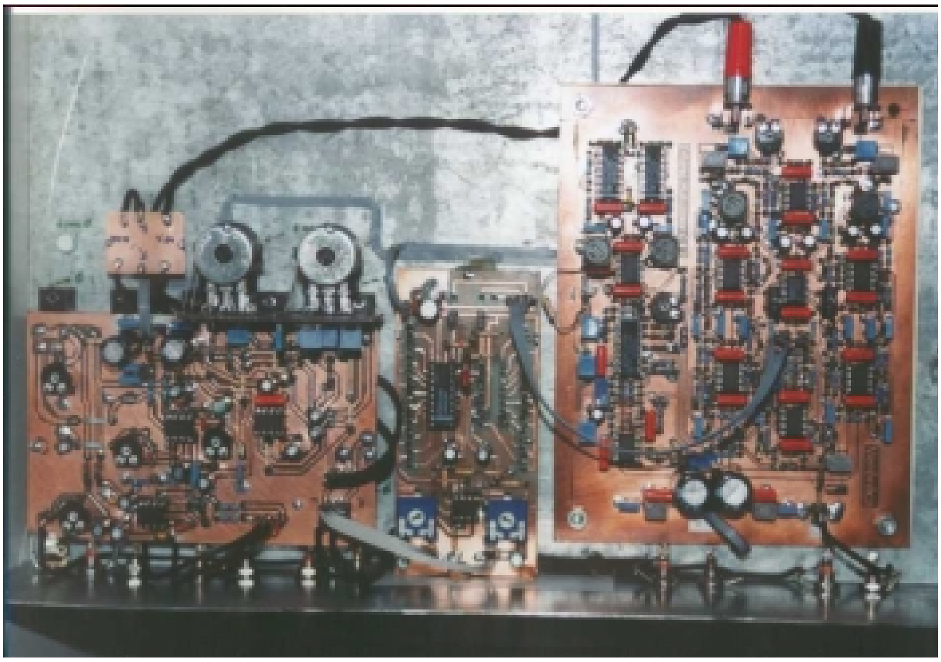

Figure 3: Left: three-channel stereo line mixer and mic amplifier with bass and treble controls; centre: stereo LED VU meter and clipping indicator; right: FM stereo modulator Cook/Sill C-1.2.

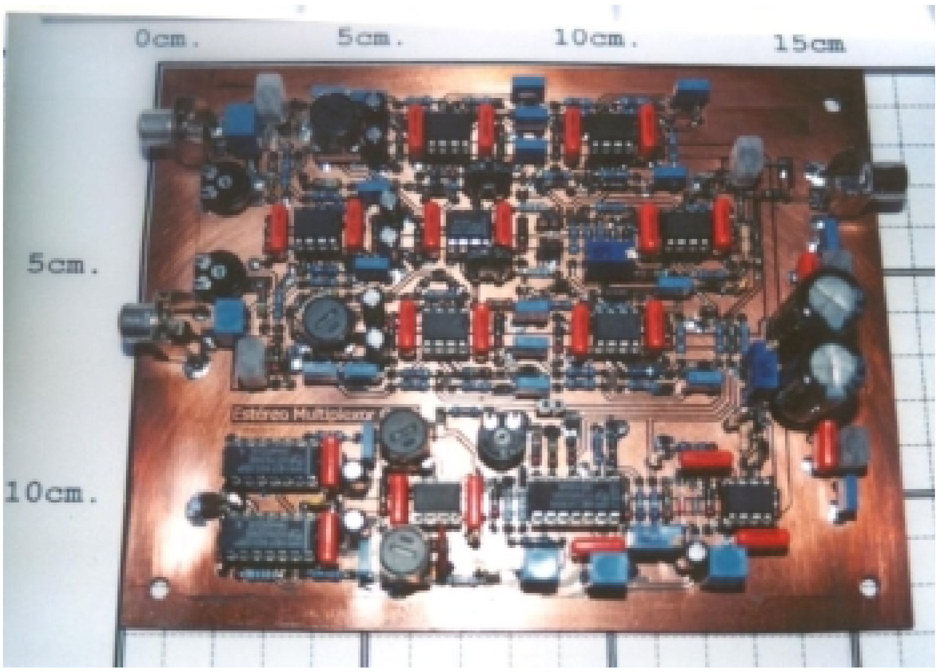

Figure 4: Mpx board before attaching a sticker with the Cook/Sill "trademark" at the top right-hand corner.

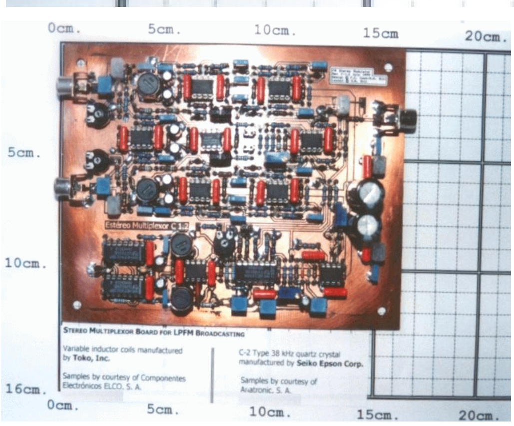

Figure 5: Another view of the mpx board.

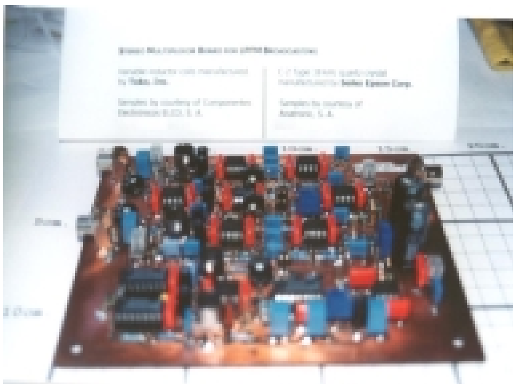

Figure 6: Yet another view.

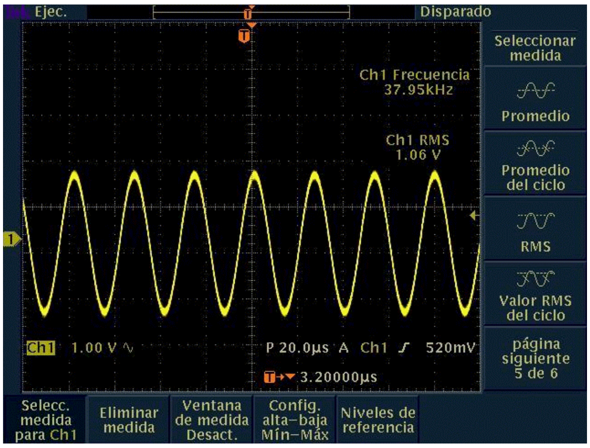

Figure 7: The 38 kHz subcarrier makes a perfect sine wave at TP5 (i.e. test point 5).

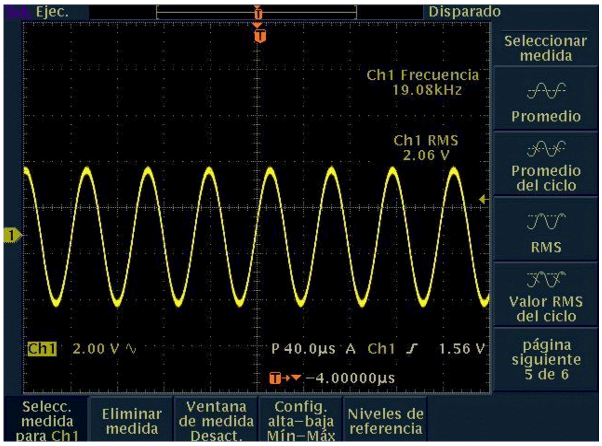

Figure 8: The 19kHz pilot tone should also make a perfect sine wave at TP3.

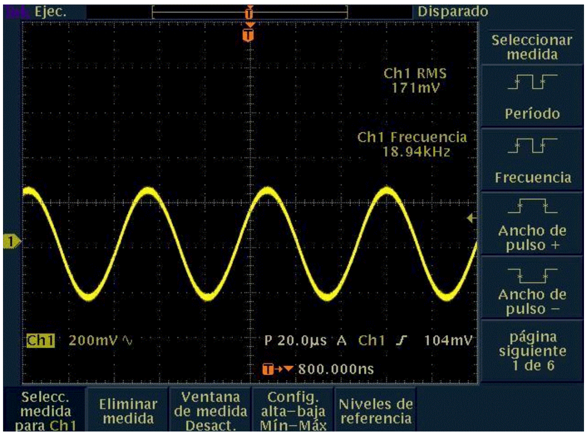

Figure 9: The 19kHz pilot tone after R53. The spectrum analyzer showed a large clean spike with no detectable harmonics.

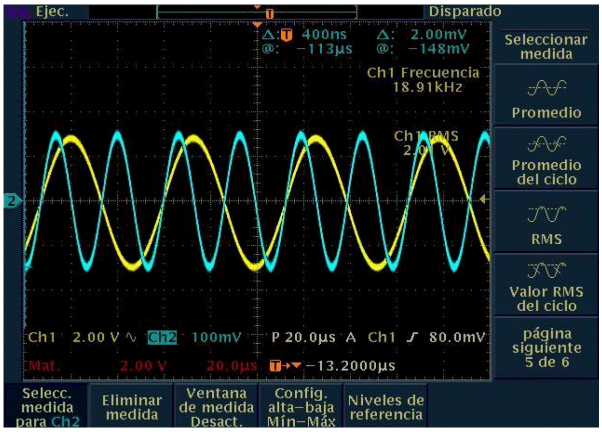

Figure 10: One of the musts of good FM stereo broadcasting is perfect phase coincidence of the 19kHz pilot tone and the 38kHz subcarrier. Channel separation largely depends on this coincidence.

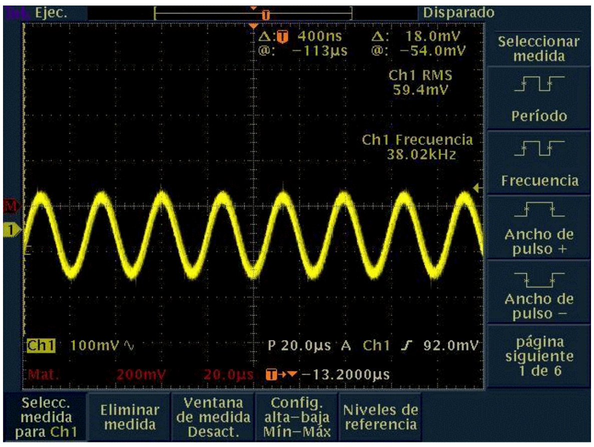

Figure 11: Subcarrier signal at TP6. Recommended voltage is 60mVRMS +/- 5mVRMS. I obtained 59.4mVRMS by tweaking R71. The value that worked for me is around 900 ohms.

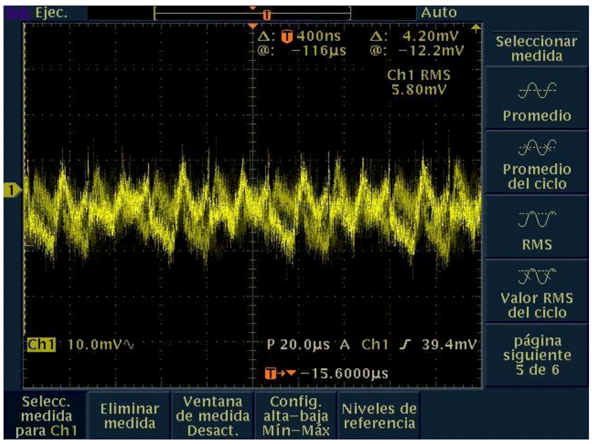

Figure 12: Signal at TP7 after adjusting R85 for minimum waveform. Voltage is 5.8mVRMS.

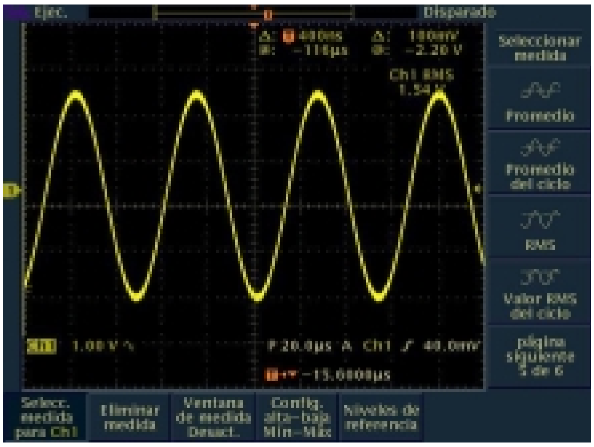

Figure 13: 19kHz signal at TP1 after adjusting the left notch filter for minimum waveform.

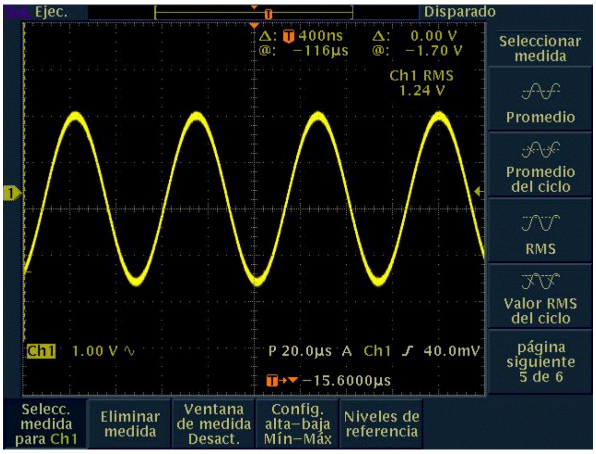

Figure 14: 19kHz signal at TP2 after adjusting the right notch filter for minimum waveform.

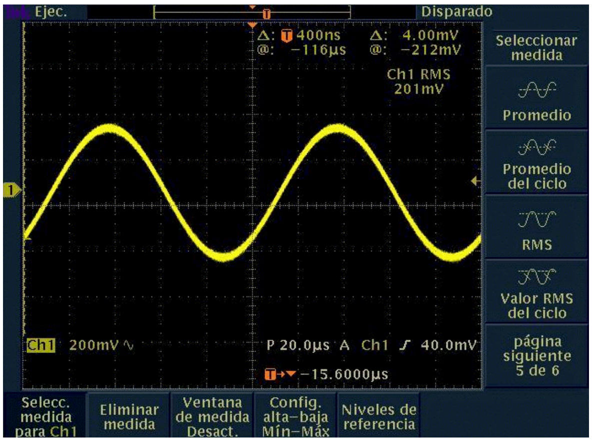

Figure 15: Signal at TP8 after adjusting the left input trimpot. The other channel looks exactly the same.

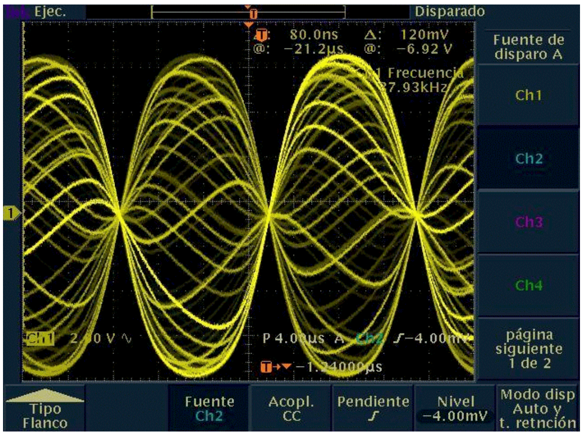

Figure 16: Waveform at TP7 resulting from modulating the 38kHz subcarrier with a 10kHz sinewave. For this, feed the right channel with a 10kHz sinewave, connect the scope to TP7, and trigger it from TP5 (the 38kHz test point).

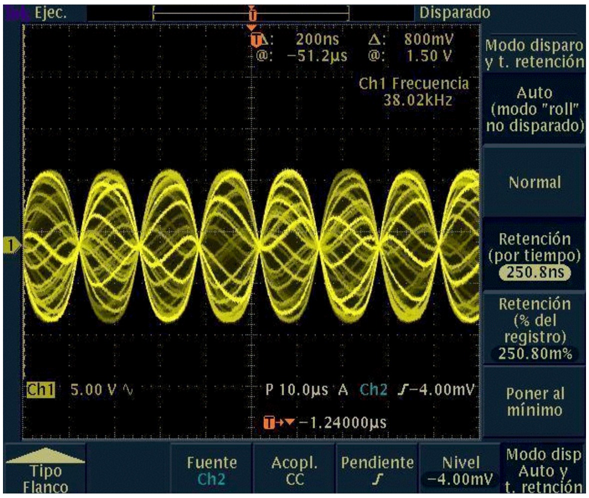

Figure 17: Waveform at TP7 resulting from modulating the 38kHz subcarrier with a 1kHz sinewave. To obtain this, feed the right channel with a 1kHz sinewave, connect the scope to TP7, and trigger it from TP5 (the 38kHz test point).

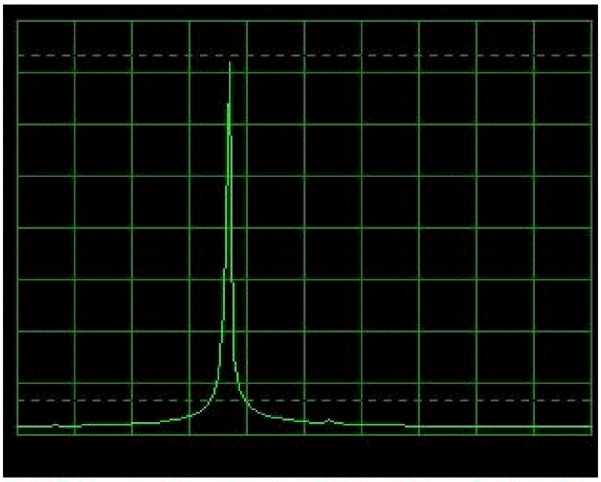

Figure 18: Left channel input: 800Hz tone; right channel input: 1200Hz tone. Spectrum shown belongs to the left channel of FM tuner. Large spike is 800Hz tone; the 1200Hz tone is almost invisible: a small undulation on the right of main spike.

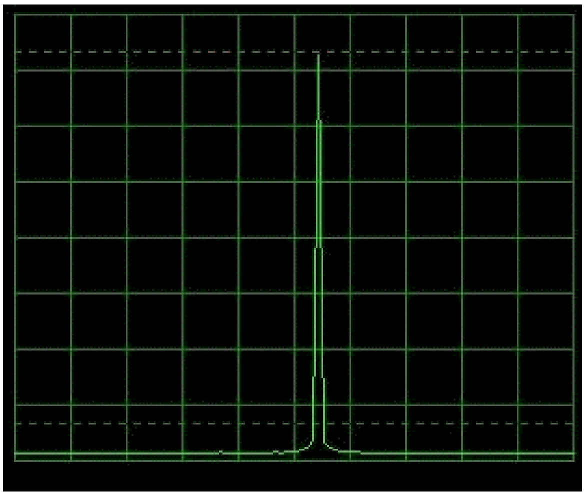

Figure 19: Left channel input: 800Hz tone; right channel input: 1200Hz tone. Spectrum shown belongs to the right channel of FM tuner. Large spike is 1200Hz tone; the 800Hz tone is almost invisible: a hardly detectable undulation on the left of main spike.

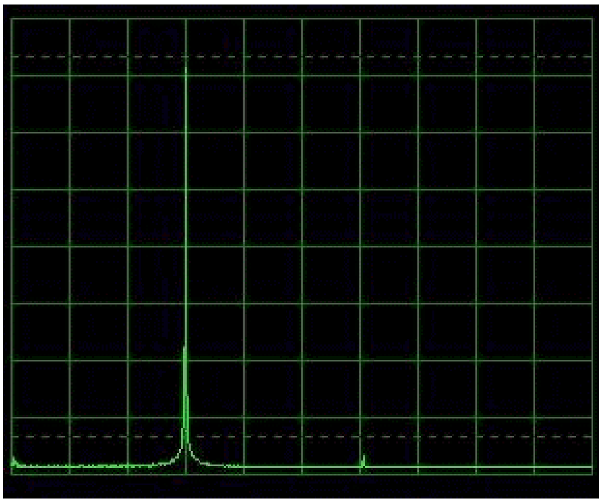

Figure 20: Left channel input: 5kHz tone; right channel input: 10kHz tone. Spectrum shown belongs to the left channel of FM tuner. Large spike is 5kHz tone; the 10kHz tone is a very small spike on the right of large spike.

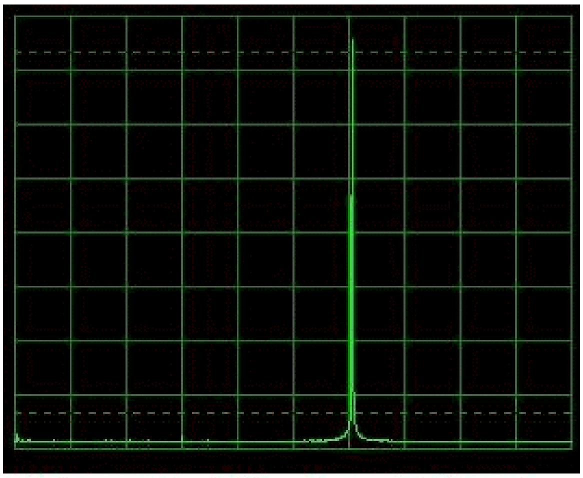

Figure 21: Left channel input: 5kHz tone; right channel input: 10kHz tone. Spectrum shown belongs to the right channel of FM tuner. Large spike is 10kHz tone; the 5kHz tone is almost invisible: a very small spike on the left of main spike. In the four spectrum images, spectral purity of both tones is remarkable.