Real-Time Spectral Analysis of the Data Sync MP3-DSP Player

The Audio Frequency

Alternating current in the range of approximately 10 to 20,000 Hz is called audio-frequency. When passed through a transducer such as a speaker or head-phones, these currents produce audible sounds. A person with excellent hearing can generally detect sine-wave tones from 10 to 20,000 Hz. An older person loses sensitivity to the higher frequencies and to the extremely low frequencies. The limits of the hearing range might fall to about 40 Hz to 10,000 Hz.

The Spectrum Analyzer

A spectrum analyzer is a test instrument that scans through a frequency spectrum and displays a plot of amplitude versus frequency of the input signal. Pink noise is generally used to check the system's overall sound balance. Pink noise is a form of signal in which the power level of each octave is equal. A full-band pink noise contains all frequencies between 20 and 20,000 Hz. When measuring pink noise on a spectrum analyzer, a flat frequency response would be expected.

MPEG

MPEG is a compression technique that is used to reduce the size of the original data. The basic technique to achieve this is to make use of the masking effect and the psychoacoustics of the human ear. MPEG layer 1 will reduce the amount of data four times, which corresponds with a transfer rate of 384 kb/s starting from a 16-bit PCM signal sampled at 44.1 kHz. Layer 2 reduces the data six to eight times. The popular layer 3 or MP3 has various compression levels to reduce the amount of data. For MP3, higher compression levels will produce smaller files at lower bit rates, but at some point, the audio quality will begin to sound "grainy".

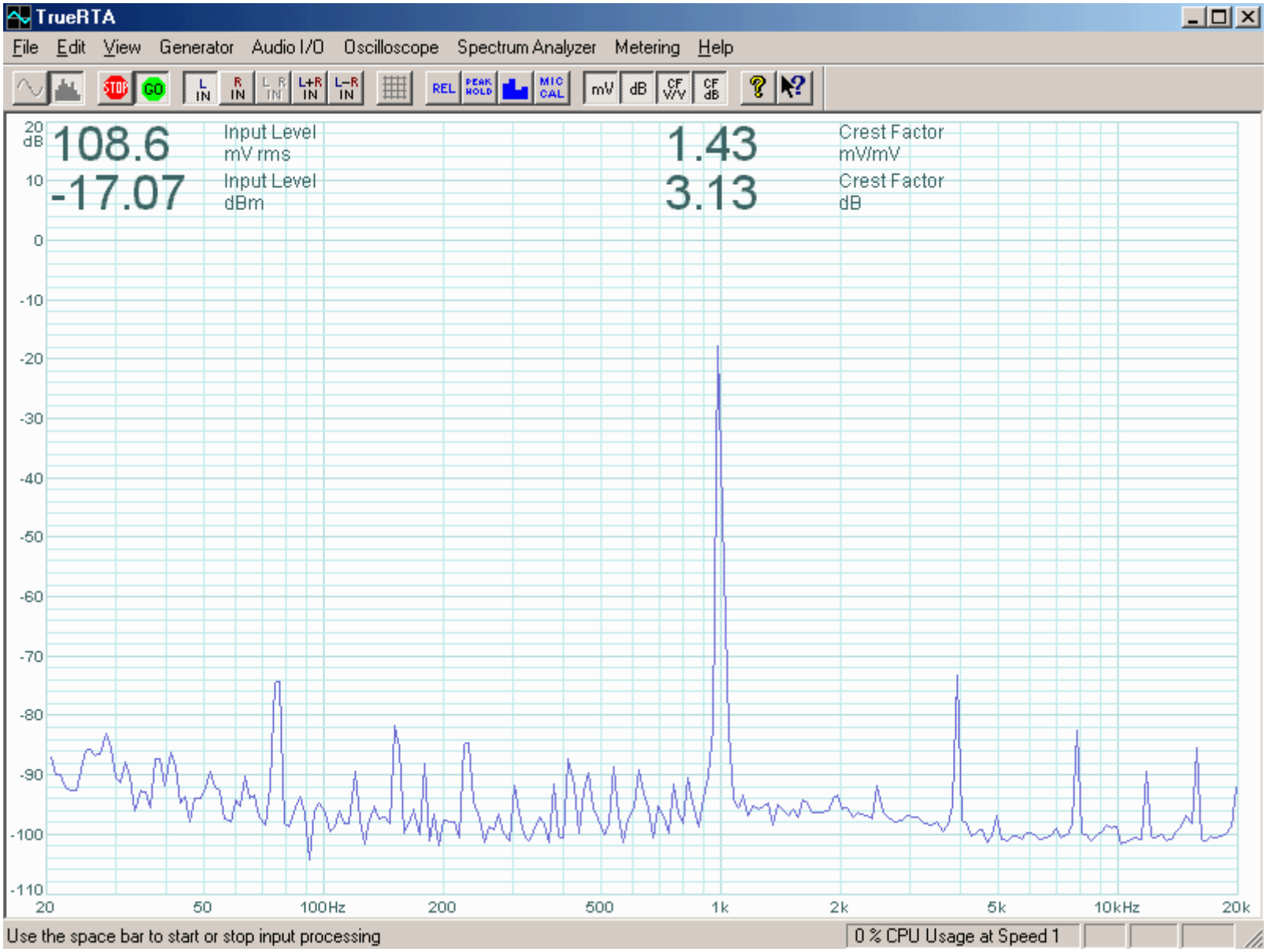
The following graphs are the actual audio tests of the Data Sync MP3 player.

In the first graph, the 1 kHz sine wave at –20 dB is the level normally used as the reference point for digital systems. 0 dB is the highest level that can be digitally recorded.

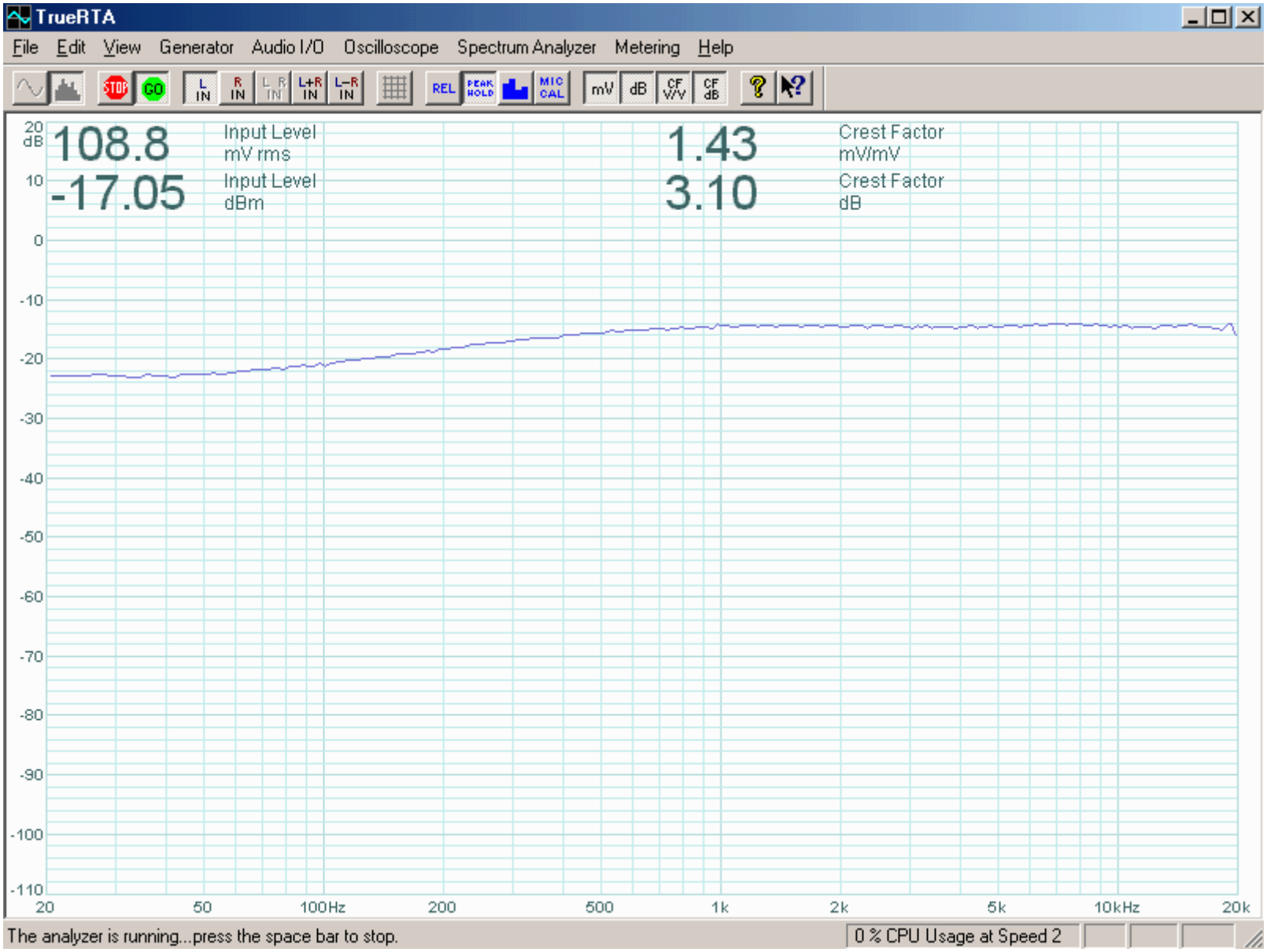
The next graph shows the audio frequency response using a pure sine wave sweep from 20 Hz to 20,000 Hz. The next graph uses the same signal with the MP3-DSP bass enhance feature set to +4.5 dB and tonal balance to –1.5 dB.

The pink noise graphs show the gain or loss throughout the audio frequency range using different MP3 compression levels. A flat or straight line would be the ideal response. The drop off at the high end is the signal loss due to compression.

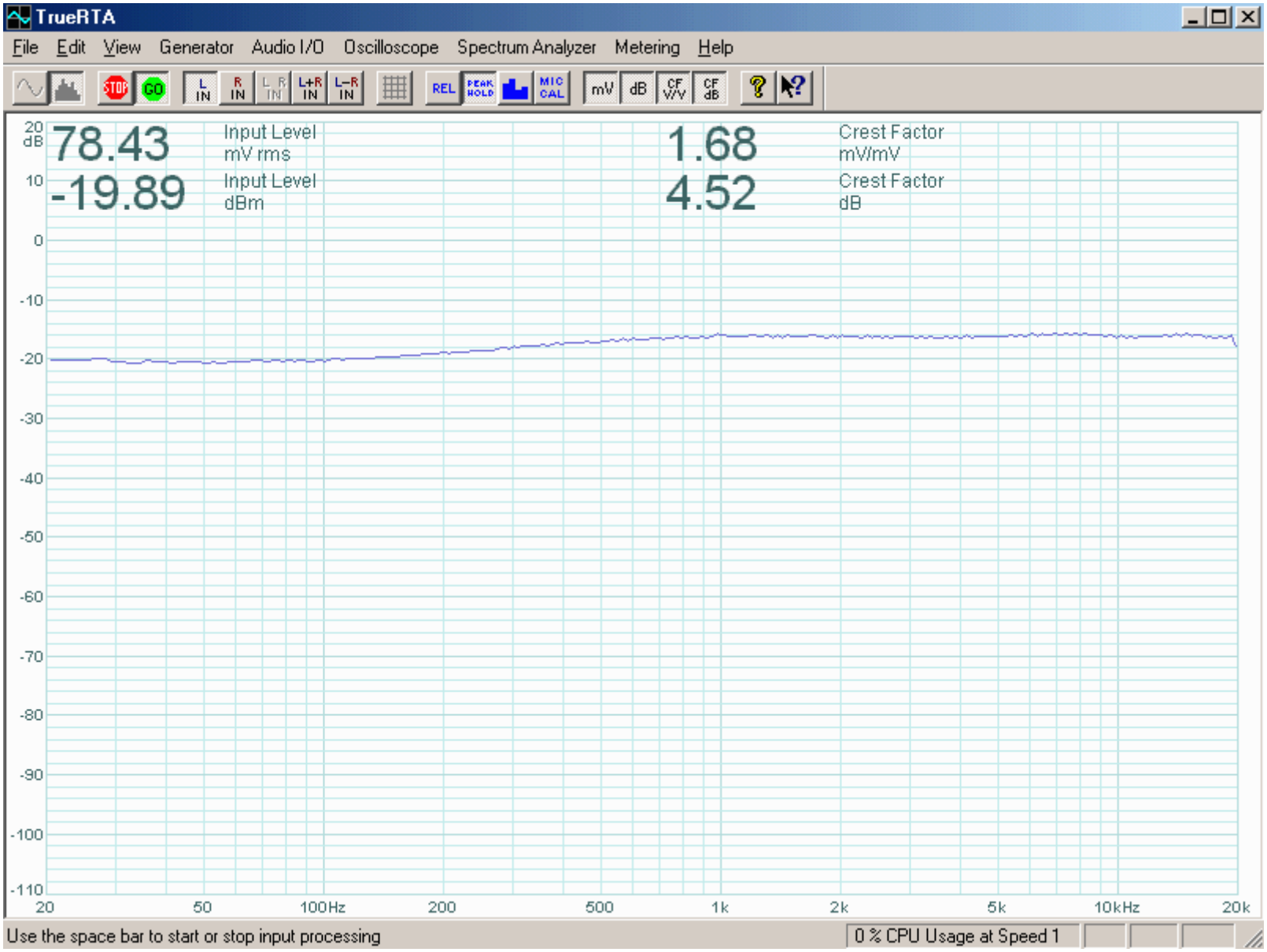
As a matter of comparison, CD's have a high-end cut-off at 20,000 Hz, XM Satellite radio at 15,000 Hz and FM radio at 15,000 Hz with a signal spike at 19,000 Hz (this is the stereo pilot carrier that is used to de-multiplex the left and right audio signals and is sometimes heard as a background hiss on low quality receivers). Most agree that 128 kb/s represents "Near CD Quality", 192 kb/s for "CD Quality" and 320kb/s for "Perfect Quality".



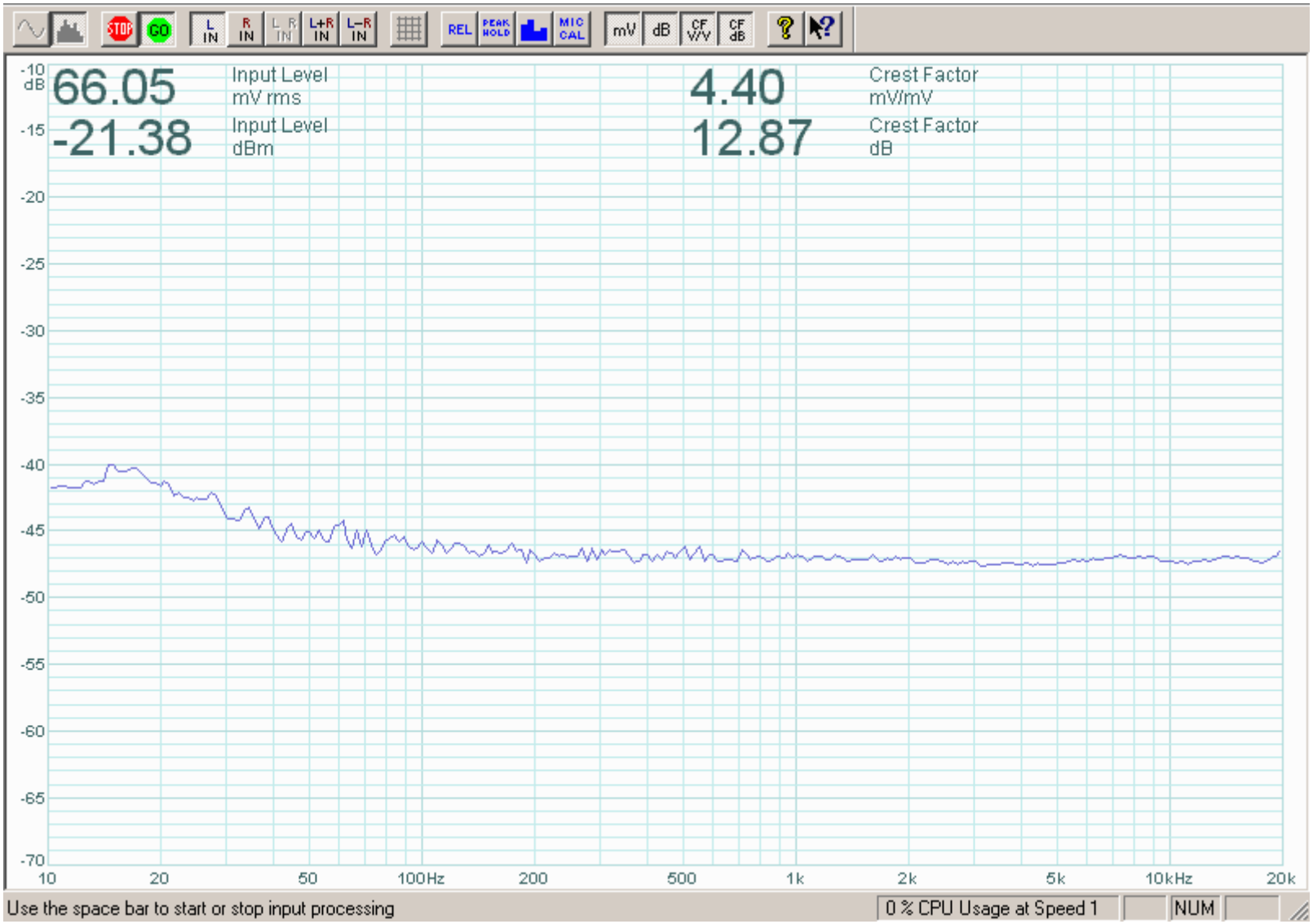
1 kHz sine wave at –20 dB, LAME compressed to 320 kb/s
MP3-DSP Settings= Bass enhance: 0 dB, Treble enhance: 0 dB, Attenuation: 0 dB



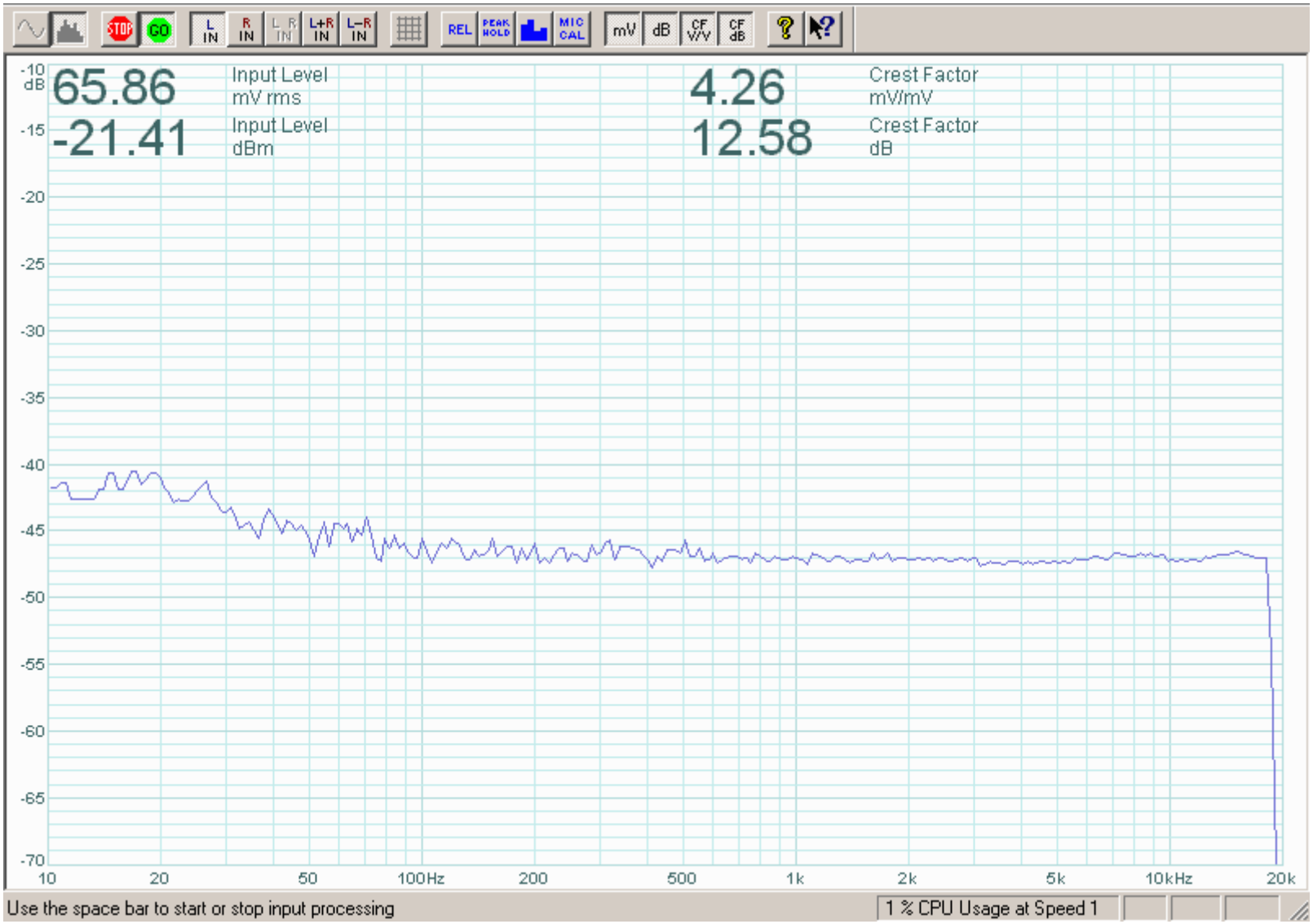
Pure sine wave sweep 20 Hz to 20,000 Hz, LAME compressed to 320 kb/s
MP3-DSP Settings= Bass enhance: 0 dB, Treble enhance: 0 dB, Attenuation: 0 dB



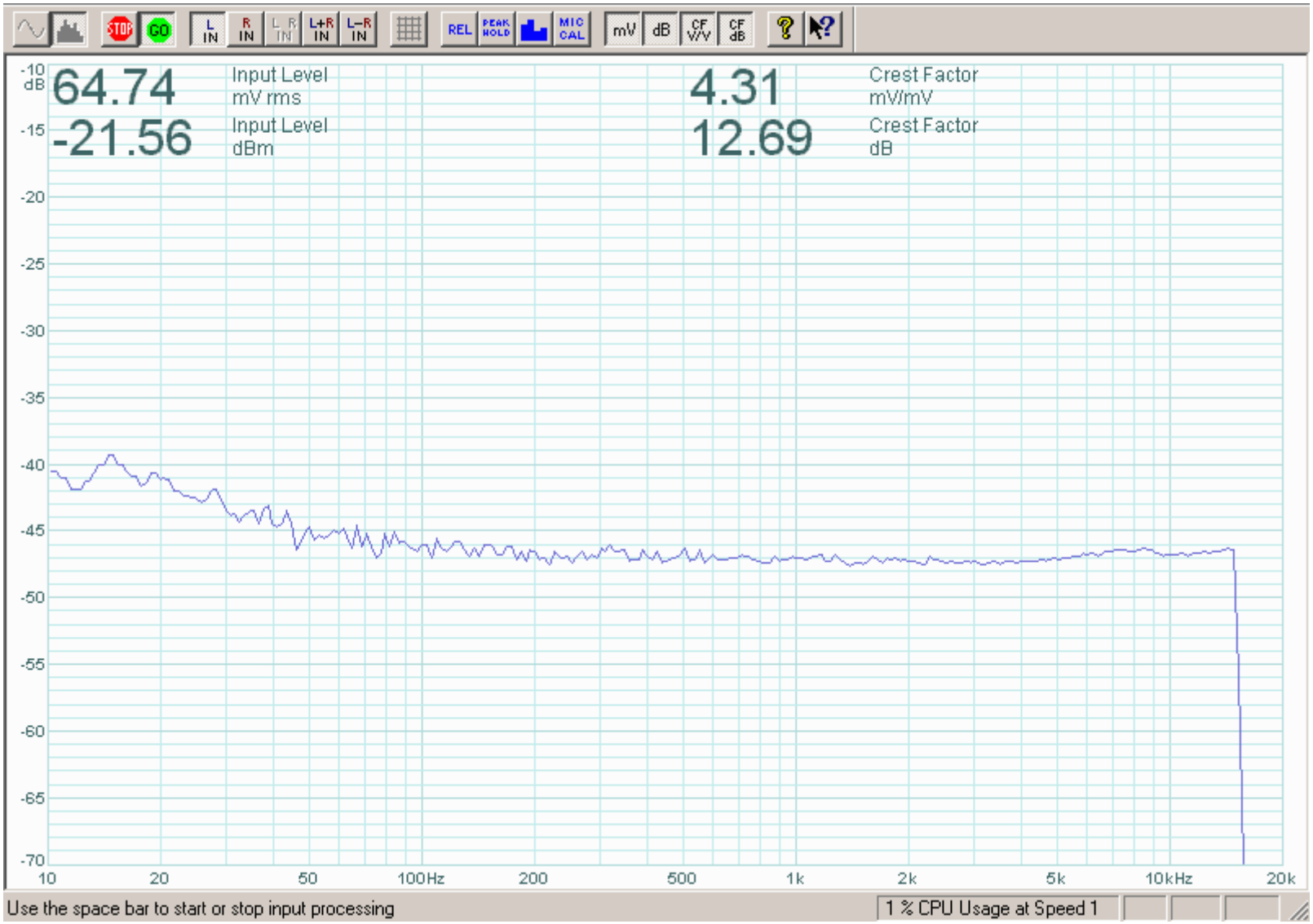
Pure sine wave sweep 20 Hz to 20,000 Hz, LAME compressed to 320 kb/s
MP3-DSP Settings= Bass enhance: +4.5 dB, Treble enhance: 0 dB, Attenuation: -1.5 dB



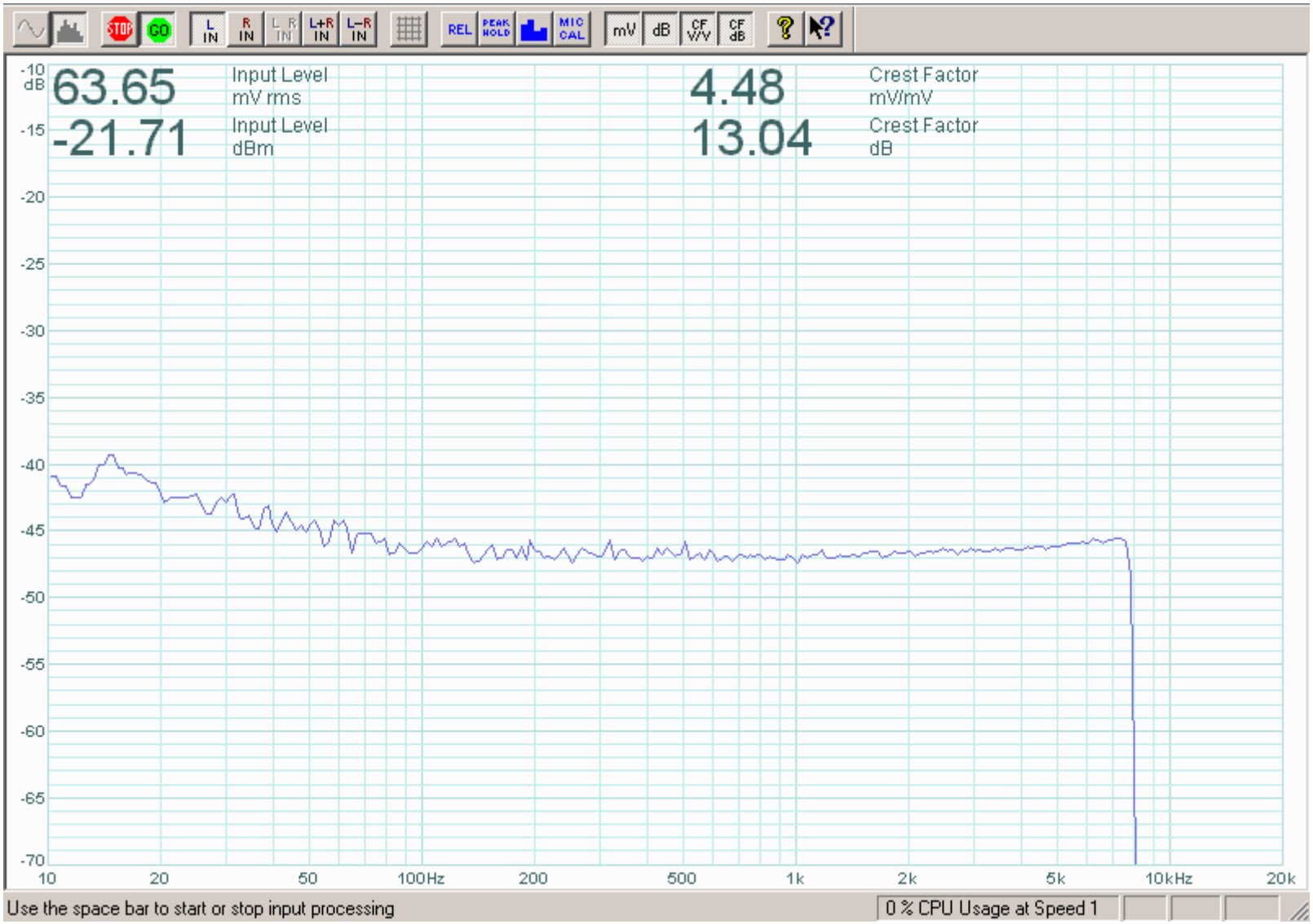
Pink noise (20 to 20000 Hz), LAME compressed to 320 kb/s
MP3-DSP Settings= Bass enhance: 0 dB, Treble enhance: 0 dB, Attenuation: 0 dB



Pink noise (20 to 20000 Hz), LAME compressed to 192 kb/s
MP3-DSP Settings= Bass enhance: 0 dB, Treble enhance: 0 dB, Attenuation: 0 dB



Pink noise (20 to 20000 Hz), LAME compressed to 128 kb/s
MP3-DSP Settings= Bass enhance: 0 dB, Treble enhance: 0 dB, Attenuation: 0 dB



Pink noise (20 to 20000 Hz), LAME compressed to 56 kb/s
MP3-DSP Settings= Bass enhance: 0 dB, Treble enhance: 0 dB, Attenuation: 0 dB