A NEW TECHNOLOGY FOR MEASURING STEREO CONTENT OF MUSIC

AUTHOR: Frank McClatchie, President

FM SYSTEMS INC.
3877 S. MAIN STREET
SANTA ANA CA. 92707
TEL # 800-235-6960

ABSTRACT: An entirely new technology is described that accurately measures the stereo separation that resides within an audio program. This measurement is made with whatever complex waveforms happen to constitute the left and right channel. A computer cross-correlates the multiple frequencies, phases, and amplitudes comprising the left and right channel at any given time, then computes and displays the resident stereo separation in deciBels.

STEREO CHANNEL CAPABILITY VS. STEREO PROGRAM CONTENT

Measurement of stereo channel capability is routinely accomplished by measuring the ratio between a test tone received in one of the two channels, then comparing that power level to that which is received on the other channel. This stereo separation (or cross-talk between channels) is usually expressed in dB. As such that measurement only expressed the upper limit of stereo separation of a program that may be conveyed over that transmission system.

The subject of this paper is the measurement of the actual stereo content within a particular musical passage that is recorded or transmitted on two channels (that is a "Left" and a "Right" channel). A higher number of channels can be measured by additional replication of this process to the other channels.

CROSS-CORRELATION MEASUREMENT CONCEPT

Measuring the stereo separation within music requires that there be a summation of the Left-to-Right channel crosstalk (L R) and also Right-to-Left channel crosstalk (R L) while both channels are simultaneously active. This is clearly a more complex undertaking than the simple process of measuring the crosstalk of stereo transmission systems. At first blush it would seem that a simple subtraction circuit would measure stereo separation. Unfortunately this is not the case. Subtraction of the Right channel from the Left channel will show whether or not a difference exists between the channels, but does not quantify the amount of stereo separation. There is no distinction between stereo separation and simple loudness of the program in a Left Minus Right measurement.

What is required is a cross-correlation computation in which every frequency comprising a particular musical passage, along with the phase and amplitude of each frequency at the moment of measurement, be identified in each of the two channels and then mathematically cross-correlated.

IMPLEMENTATION

A Cross-Correlation computer has been constructed that measures the phase and amplitude of all audio frequencies between 20 Hz and 20 KHz simultaneously present in the Left and Right channels and performs a cross-correlation computation. A further computation converts this Cross-Correlation from linear to logarithmic so that the result can be expressed in deciBels. The display is in the form of a 50 segment LED that is calibrated in 1 dB steps for 1 dB to 50 dB. Accuracy is +/- 1 dB up to 40 dB of separation and +/- 2 dB from 41 dB to 50 dB. The instrument is actually capable of measuring up to 65 dB of stereo separation, but the display tops out at 50 dB.

The two audio inputs to the SPM-1 Stereo Performance Meter are balanced and high impedance and so may be bridged directly across normal balance program level circuits. The stereo separation indication is not level sensitive, so the same stereo separation is displayed at any nominal volume level.

FINDINGS

Having at hand an instrument with such intriguing new measurement capabilities naturally resulted in great anticipation and interest with many experiments being performed. After all, no other instrument was known to the author or his acquaintances that could actually measure the stereo content of music rather that merely indication that some stereo was present.

First we measured various musical passages as recorded on Digital Disks and Tapes. In general the differences were **not** in the recording medium but rather in accordance with the type of music recorded.

Hard Rock music usually measured about 2-3 dB stereo separation, occasionally peaking up to 4-5 dB momentarily. This was true of all of the recording artists we had available. For all practical proposes they may as well have been recorded in monaural.

Country Western style music contained much more stereo content with 6-10 dB being common and occasionally rising to 12-16 dB.

Symphony music tended to stay in the 18-30 dB range, with many passages recording in the 35-50 dB range.

Obviously studio recording techniques are wildly different when recording Hard Rock, Country-Western or Contemporary, and Symphony music. I can't help but wonder if the Rock Stars know that they might as well record in Mono. Measurements were also made of the stereo received over the FM band. Of course the same general relationship between Hard Rock, Country-Western and Classical did exist, except that the stereo separation on Hard Rock especially was even lower, apparently due to the heavy compression common on the typical Rock stations. Heavily compressed (loud?) Hard Rock, Country Western, and Contemporary music stations reduced the recorded stereo separation even further so that some stereo (?) FM stations measured in the 1-2 dB range quite consistently. Several stations measured zero stereo separation even though the "Stereo Light" was on.

Many innovative techniques were discovered when the Stereo Performance Meter was employed in Recording, Mastering, and Post Production Studios. It was discovered that microphone placement for optimum stereo separation could be directly achieved and it was possible to determine what frequencies were causing phasing problems in the room. It was easy to ascertain the amount of stereo separation with particular microphone placements and if there were any phase problems in the program material. The meter visually reinforces what the ear hears instantaneously and thus enables decisions when preparing for a recording session and even during recording.

In Mastering the Stereo Performance Meter is extremely useful in determining the amount of stereo separation and if there are phasing problems in the material.

SUMMARY

An entirely new stereo measurement technology has been developed which makes it possible to measure the stereo separation of any mix-down. The recording engineer con now see a well as hear the stereo consequences of changing the proportion of mix from any track as well as placement of microphones in a recording studio or live performance.

With all the emphasis on stereo, it is about time to start quantifying stereo performance.