Advantages of complementary symmetrical Input stages in Audio Amplifiers

Symmetry in audio power amplifier design is widely regarded as a desirable quality. If symmetry is good then surely more symmetry must be even better. this reasoning can lead to considerable extra complexity than a simpler asymmetric design. The concept of using complimentary input differential pairs to replace the single differential input pair was introduced by James Bongiorno in the 1970's by Great American Sound Company (GAS for short) James called his new input stage full-dual-differential, full-complementary amplifier topology concept. This technique was so successful that he continued this technique while with Scientific Audio Engineering (S.A.E. for short)

The advantage for symmetry is that such a design has a symmetric slew rate. This implies that the maximum slew rate of the Amplifier is the same for positive or negative-going outputs. What makes this important is that the decay or fall time of the musical event is as fast as its rise time. Most Amplifier Designs use only one single pair of differential input transistors. This technology is the standard in monolithic IC Op-Amp design. Audio amplifiers also universally adopted this single differential input topology in high End fully discrete component Amplifiers because on the surface this technique seems to offer the best performance.

The problem with this reasoning is the fact most IC op-Amps are intended to be operated in the inverting mode in order to obtain manufactures data sheet performance for Slew rate and Frequency response. to the reasonable Audio designer the reduction in slew rate and it being asymmetrical is unimportant since the maximum slew rate and bandwidth are far beyond what is required for high quality audio Amplifiers.

Most all Audio Amplifiers available today are not inverting, as such the performance of the typical Input stage is seriously degraded when used in the non inverting mode. The primary reason for the degraded performance in the non inverting mode vs. the inverting mode is the result of the inherent capacitance of the input devices. The worst offenders are FET inputs because of the High capacitance of FET transistors vs bipolar types, these Amplifiers generally have a faster slew rate in an inverting unity gain configuration due to the absence of the differential input capacitance. This capacitance is nonlinear and changes with applied voltage resulting in an erratic and complex mix of distortion components.

Because we want a non inverting Amplifier it is apparent that some method for controlling this undesirable capacitance be employed. To the rescue comes the complementary symmetrical input stage consisting of both PNP and NPN input differential amplifiers rather than just the one differential pair based upon one polarity of devices.

Unlike FET’s bipolar transistors have a lot of desirable qualities as an input device over the typical FET transistor with low capacitance and high transconductence being just a couple of them? When both PNP and NPN devises are used the input signal modulates both positive and negative devices equally and thus having devices of opposing polarity tend to cancel out these imperfections by virtue of the reverse current flow in the respective transistors. These qualities are responsible for the reduction in THD distortion products by virtue of the NPN/PNP cancellation effect. The utilization of true complementary symmetrical input stage allow natural flow of the signal within the Amplifier and allow the complementary concept to be utilized thought the amplifier in each and every stage including the output stage so as to utilize the distortion reduction qualities thought the Amplifier. Fully complementary amplifier, which inherently reduces distortion

Amplifier’s input stage also uses complementary inverse pre-distortion to lower this stage's contribution to the amplifier's final distortion figure by not adding excessive distortion to the mix. Thus the same principle of inverse-complementary-distortion cancellation that lowers the output stage's distortion is used to in the input stage. The same used to inverse symmetrically cancel the distortion from the input stage.