Analysis of the distortions caused by back-emf

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Some words about the test:

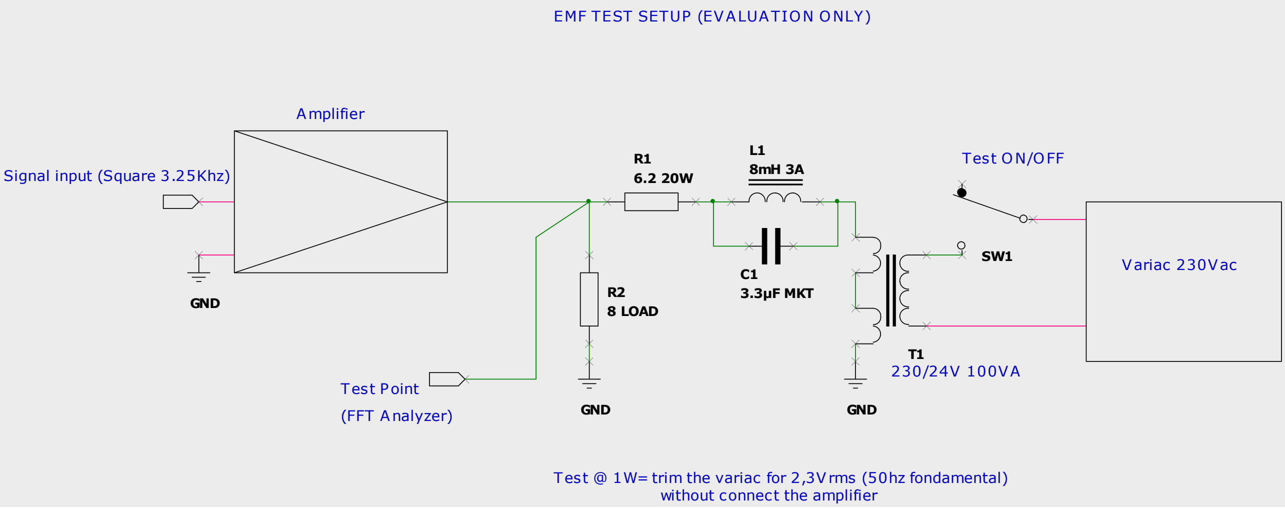
This test wants to demonstrate the presence of distortion caused by loudspeaker Back-EMF in amplifiers while passing complex signals.
While trying to reproduce the tests series described by Hiraga, aiming to individuate the intermodulations caused by EMF, I have noted that modern amplifiers are immune to a quite good level from such a phenomenon, indipendently from their “topology” construction. For obtaining notable distortion levels in those tests it is necessary to inject a high level signal (1:1), then, as it is clearly visible from the output waveform, the DUT resonates with the applied LC filter tank, which then obstructs the possibility of extrapolating absolut data (IMD structure). But during these tests I’ve noticed that apart from IMD, there are also other, more significant things happening to the test tones. For example, some amplifiers will modify the output signal amplitude while being excited by a low frequency Back-EMF signal. From this experience comes my version of the tests: instead of one test tone, applying a signal which consist of a series of harmonics [easy to monitor & extending high up in the audio spectrum] and measuring the variations induced in these harmonics. The first results had shown quite a characteristic response from each amplifier undergoing this test, and thus opening the possibility to collect “coherent” data. Dissimilarly from the IMD test, here it became evident the difference between DUTs not so much in function of Zout , but rather based upon the output stage’s “interfacing capacity” [drive capacity?]. For example, the JLH, which at the IMD tests was one of the worse, and which has a very low dumping factor, has demonstrated much lower error levels in this test. In the same time, a GC, which in the classic tests measures much better, here behaved worse. As a summary of all these tests, I have assembled a small table [TAB2].

Description of the test setup:

The hardware used is rooted in the IMD tests conducted by Hiraga. I have choosen to leave the 1KHz LC filter in place, so as to maintain realistic load conditions, using the reactive characteristics of this circuit. From a theoretical point of view it would be even possible to omiss this filter(but I believe that part of the effectiveness of the test is to attribute to the phase shift that this net provokes). So as to emphasise the contrasts in the test, a 2.4V @50Hz EMF test signal is applied. This signal is produced by a line transformer [240V/24V] supplied by a variac autotransformer from the line.
I have choosen such a “dirty” test signal for two reasons:
First, this generator is electromechanical, and as such, does not produce any “active” form of distortions (like dumping & THD) .
Second, because I suppose the real EMF signals will rather consist of a modulated waveform [like that produced by a transformer] than a series of individual pure tones. This kind of signal had proven to be really effective in revealing nonlinearities which could also be well heard.
The test signal applied to the amp under test [DUT] consists of a filtered square wave, 3225 Hz, so as it has clean odd harmonics in the audio spectrum. This is the same like the one used by Otala in his TIM tests, to which he has added the 16KHz tone. For the sake of simplicity I have omitted the

other test tones here, but it's also possible to immagine a full TIM test executed with our additional "low frequency excitation".
Also the choice of this particular test signal had a series of motivations:
First, isolating the single harmonics makes it easier to [automatically] evaluate the errors generated by the EMF signal.
The relatively high frequency tone permits to separate the EMF-generated-products from those produced by IMD; watching the changes in the harmonics gives a better general view of the "dynamic dumping factor", as it develops across the full (high) audio spectrum.
(It should be noted, that while also the 3225 Hz test signal itself becomes modulated by the injected EMF noise, I'm only analyzing the harmonics, so as to make life simpler..)
While it is possible to further extend this test by applying higher signal levels & other frequencies as well, one should be careful about not saturating the DUT, and so analyzing results which sprang not from Back-EMF but the circuits dynamic limits.

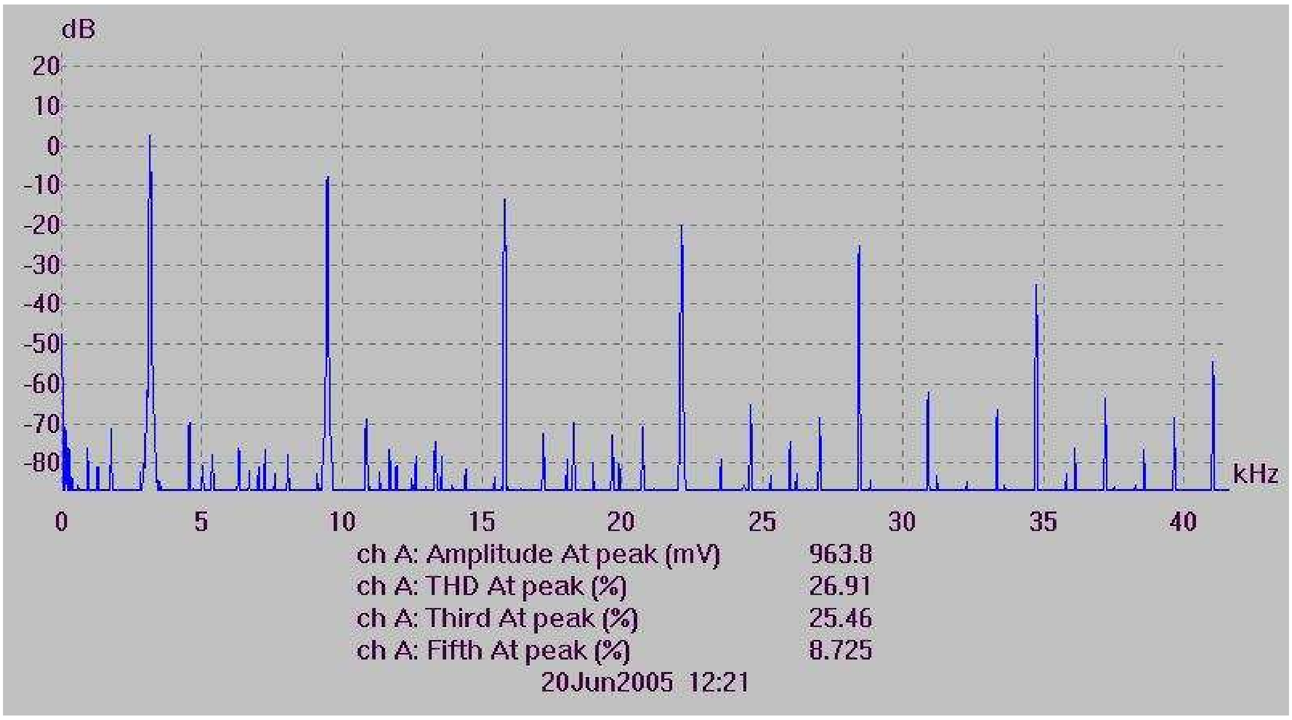
TAB1 setup schematic:



TEST CONDITIONS:

OUTPUT LEVEL= 3Vrms / 8 OHM LOAD
Back-EMF LEVEL= 2.4Vrms / 8 OHM LOAD
INPUT SIGNAL= Square 3.225Khz (slew rate filtered)
FFT analyse Band = 42Khz

SQUARE SIGNAL FORM (DUT input signal):



EMF SIGNAL FORM (on 8ohm load):