MEASUREMENT AND CONTORL OF TOTAL HARMONIC DISTORTION IN FREQUENCY RANGE 0,02 - 10KHZ.

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The measurement and control of the non-linear distortion has always been a challenge with the qualitative reproduction of the audio signal. There are many methods and ways to determine the bad signal level. Some of the methods suggest filter separation of the useful signal and preserve only the unwonted distortion value. It is impossible to make a qualitative assessment of the distortion by this method. The present article deals with the qualitative assessment of the signal at the time of its optimal reproduction within the whole frequency range f=20 [Hz] – 10 [kHz].

Keywords: measuring, harmonic distortion, phase corrector

1. TASK OF THE ARTICLE

The electric signals passing through a given amplification or correction chain suffer an unwanted change in their form and phase. This king of change is called non-linear distortion. The value of this distortion is characterized by the so-called coefficient of non-linear distortion – equation.1. This coefficient represents the relation between the geometric sum total of the effective values of all harmonic without the first one and the amplitude of the first harmonic.

$$(1)\quad K_{THD1}=\frac{\sqrt{U_2^{\,2}+U_3^{\,2}+U_4^{\,2}+\ldots+U_n^{\,2}}}{U_1}$$

There is another way to represent mathematically the non-linear distortion coefficient – equation.2. Here we have the relation between the geometric sum total of the effective values of all the harmonics without the first one and the effective value of the full signal.

$$(2)\quad K_{THD2}=\frac{\sqrt{U_2^{\,2}+U_3^{\,2}+U_4^{\,2}+\ldots+U_n^{\,2}}}{\sqrt{U_1^{\,2}+U_2^{\,2}+U_3^{\,2}+U_4^{\,2}+\ldots+U_n^{\,2}}}=\frac{\sqrt{U_2^{\,2}+U_3^{\,2}+U_4^{\,2}+\ldots+U_n^{\,2}}}{U}$$

Equation.3. represent the relation between the two coefficients.

$$(3)\quad K_{THD1}=\frac{K_{THD2}}{\sqrt{1-K_{THD2}}}$$

With non-linear distortion of the signal under 15% coefficients K_{THD1} and K_{THD2} are equal. The suggested method to measure the non-linear distortion coefficient is used mainly to measure low value distortion. The method gives precision of up to 0,01%.

The general block scheme of the suggested measuring device of non-linear distortion is shown on fig.1.

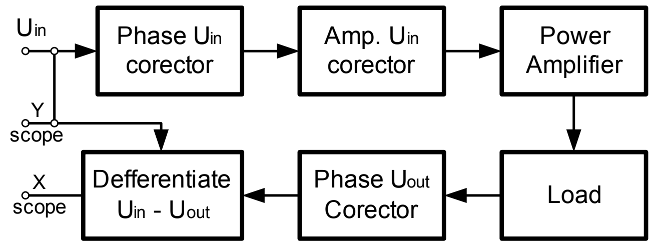


Fig.1. Bloc schematic

The method does not filter the input signal and has been known through Akulpiev's invention. A non-linear distortion assessment with this method is made trough the graphic comparison of the two signals. To set a similar interrelation if is necessary to introduce a model signal and to separate the non-linear distortion signal. This is achieved when we compare two levels of the signals which are simultaneously transmitted to a substractor. The substractor in turn sends out the signals, transmitted to both its entrances. To get only a harmonic distortion output signal in the substractor if is necessary ad it's both entrances for the signals to have the same phase and amplitude. This is easily achieved with model signals but what would happen if one of them had non-linear distortion? In this case the device well get only a non-linear distortion output signal. Now let's look at the principle scheme of the device.

1.1. Graphic measurement of non-linear distortion.

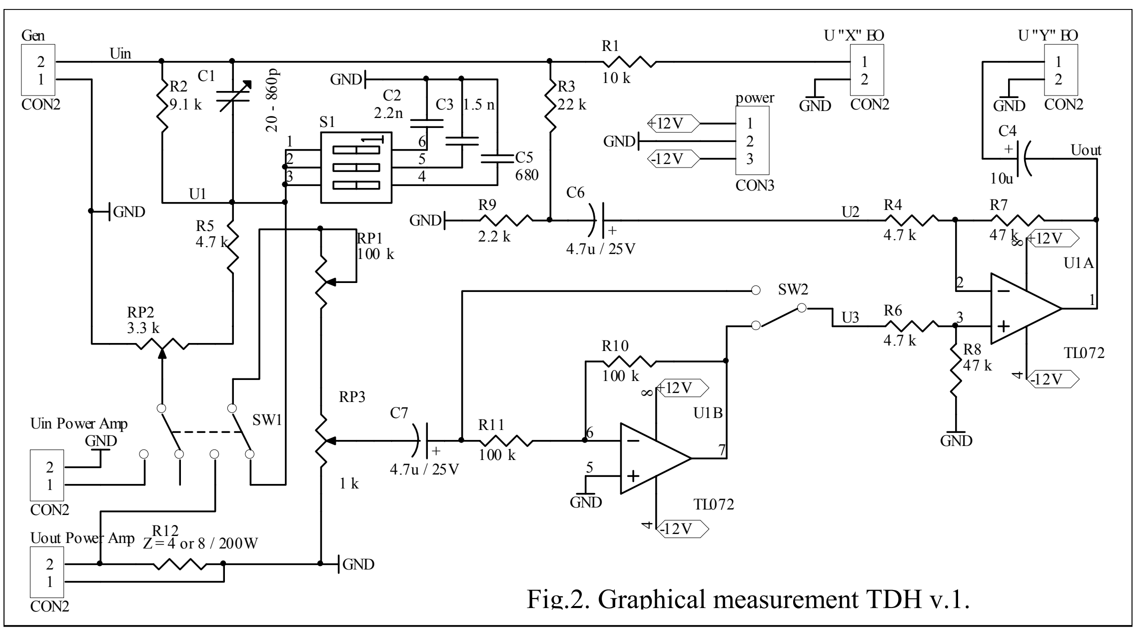


Fig.2. Graphical measurement TDH v.1.

A way to measure the THD graphically is show on Fig.2. The measurement and according to this scheme is optimal for the frequency range f=20 [Hz] – 10 [kHz] in the following order:

- calibration of the device – switch SW1 is in the suggested position and the input signal of the generator is transmitted simultaneously to channel "X" and channel "Y" of the electronics oscilloscope. The signal, transmitted to channel "Y" has a changed phase (group C_1, R_2 and the chosen capacity C_{2-5}). Amplitude correction is achieved by variable impedance RP_1 (rough regulation) and RP_3 (precise regulation). This the signal in switch SW2 goes to the non-inverting entrance of U1A. A signal to this second entrance is transmitted by chain R_3, R_9. Operation amplifier U1A in this case functions as a substractor i.e. it sends out its defense input signals. Calibration is achieved when the signals transmitted to the two entrances of the substractor are equal in amplitude and phase. Only in this case the output voltage to channel "Y" of the electronic scope will be equal to zero. Then the device is calibrated. This method allows for the usage of signal generators with lower technical requirements. They are calibrated the basic of this scheme.

- measurement of the non-linear distortion coefficient – the measurement is made after we have already calibrated the device and we turn switch SW1 to position two. In this case the input generator signal goes to the entrance of a measured low-frequency amplifier. Load impedance Z=4/8 [Ω] is connect to the output of this amplifier. The output signal in SW1 is transmitted to the second entrance of substractor U1A. We again compensate for the amplitude by RP1 and RP3 without changing the phase of the signal. When the amplitude is leveled only the non linear distortion signals well be seen the scope screen. A shortcoming of the suggested scheme is the non-linear phase regulation in the input generator and the hi-value of variable capacity C_1.

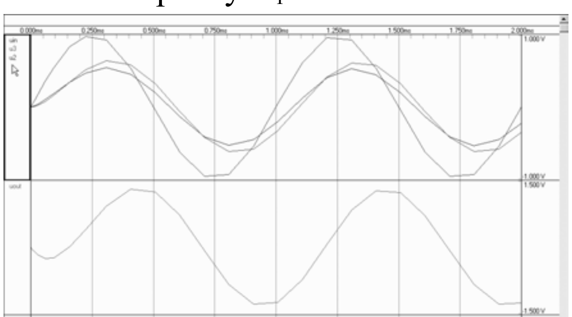


Fig.3. Phase correction v.1.

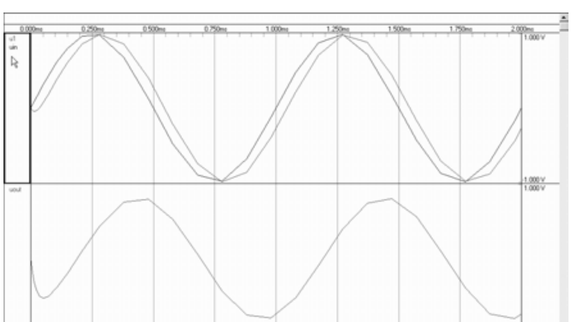


Fig.4. Phase correction v.2.

The simulation results of this kind of phase regulation are shown on Fig.3. To avoid this basic shortcoming we correct the scheme in the way shown on Fig.5. Here the phase correction group has been replaced by operation amplifier which compensates for the amplitude reduction and regulates the phase trough controlled impedance RP1. The simulation results are shown on Fig.4. To make this scheme universal there is a switch regulation of the phase in the different research stages. The amplitude regulation in its turn is achieved trough a linear regulation group, which is restricted to the study of output power P_{out} = 200 [W] of the investigated stage with load impedance Z_t = 4 [Ω]. In the scheme there is an additional inversion of the signal before it is transmitted to the substractor (difference operation amplifier). In this way we can study the functioning of both an inverting and non-inverting power amplifier.

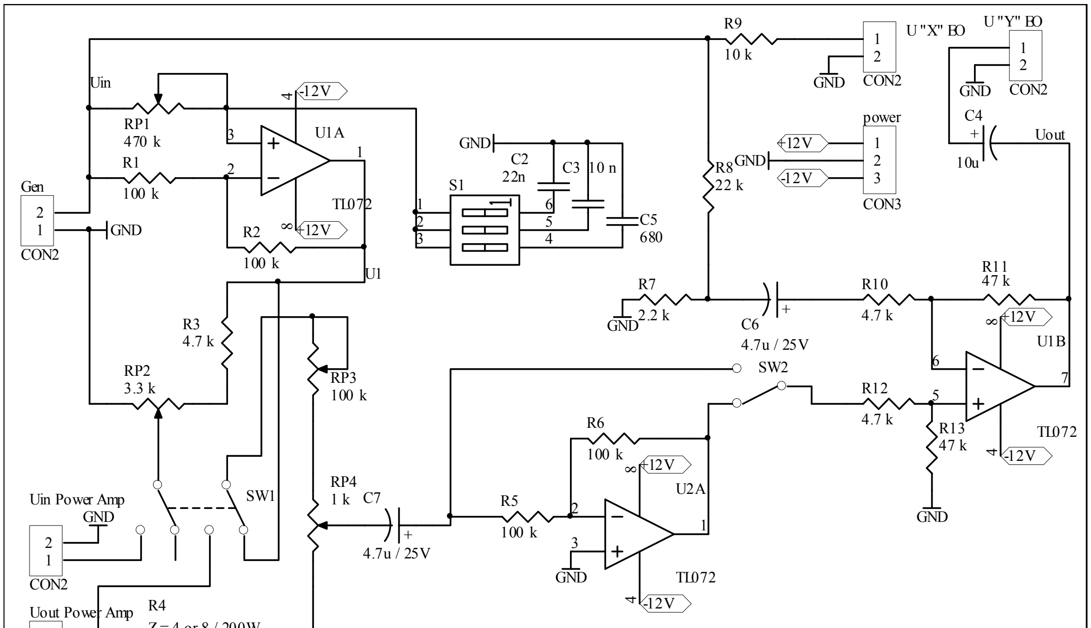
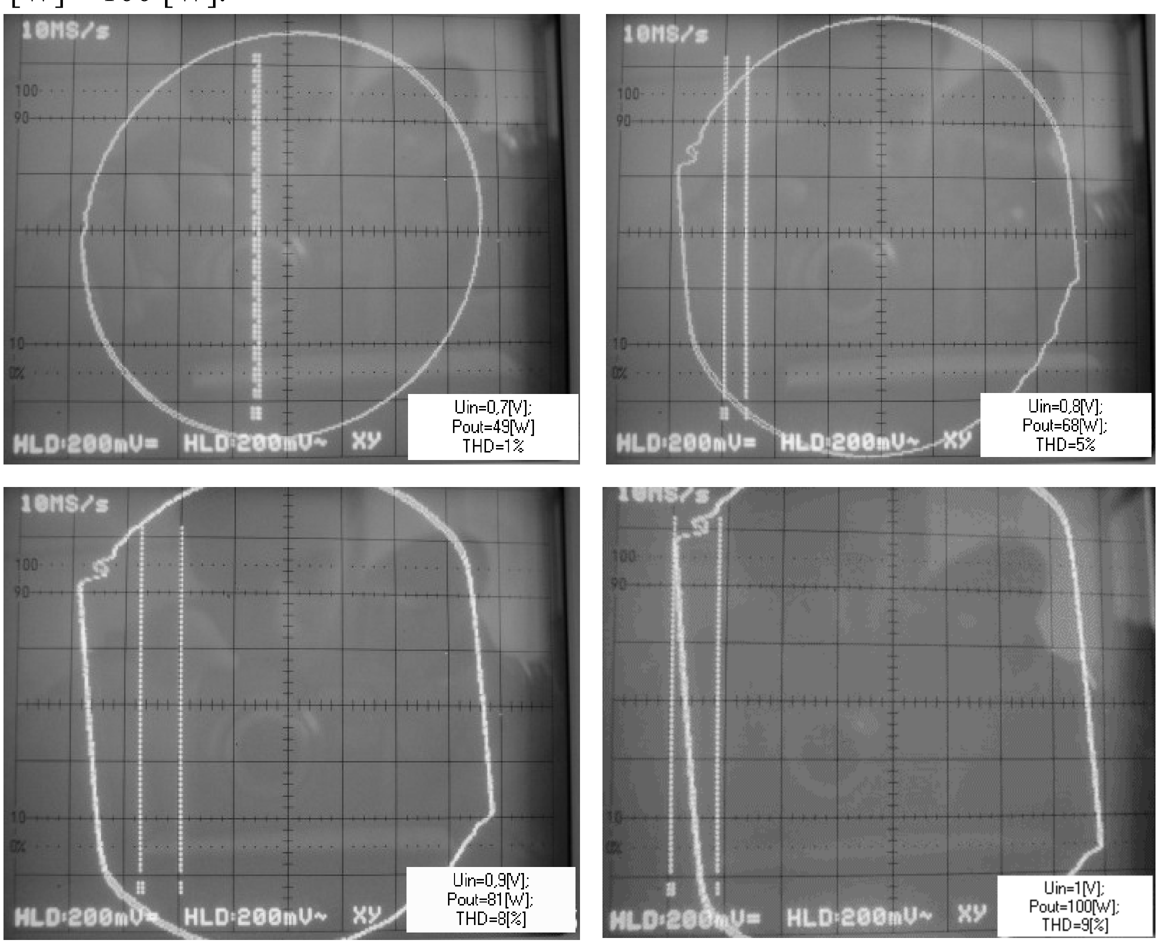


Fig.5. Graphical measurement TDH v.2.

1.2. Test the project

Experimental result of the measurement of the total harmonic distortion (THD) of TDA7294 with load impedance Z=4[Ω] and output power within the limit of P_{out} = 50 [W] – 100 [W].



2. Conclusion:

The present research suggests a practical way to achieve a programmed time delay. A system to suppress the output signal level has been introduced in order to limit the amplitude. This kind of stabilization does not produce a large harmonic distortion in the signal which makes if suitable for the Hi-Fi sound range. The enclosed simulation result show the principle of work and what has already been achieved By the project.

3. References

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