A-class Amplifier with FPPA as a Predictive Supply Voltage Control

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Abstract: A number so electro technique application exists, where it A-class regulation, control, or a circuit bias even only necessary. Circuit technique criteria like this, AB-, or C-class compared with applications the smaller sign distortion, more lineal transfer, bigger bandwidth, in a frequency range behavior. Together with this, we know it, that it A-class the dissipated power of a circuit technique passed on active device the largest, his efficacy the worst. Beside the correction of two latter parameters, the keeping of the benefits, energy yields a saving, and it increases the life expectancy of active device. To this using is a quite unusual mode of operation, programmable analog electronic circuit.

Keywords: Field Programmable Analog Array, predictive control, pulse width modulation

1 The traditional *A*-class setting

At the traditional *A*-class settings (figure 1.) the definition of the optimal bias-point of the active device, the very important feature defining the performance relations significantly. The dissipation power of active device in this case as the product of the current and the voltages of there (1,2). This value is the largest ones, when the output resistor is the half voltage for the full supply voltage.

$$P_{out} = \frac{U_{out}^{\ 2}}{R_t}, \tag{1}$$

$$P_{dev} = \frac{(U_t - U_{out})^2}{R_d}, \tag{2}$$

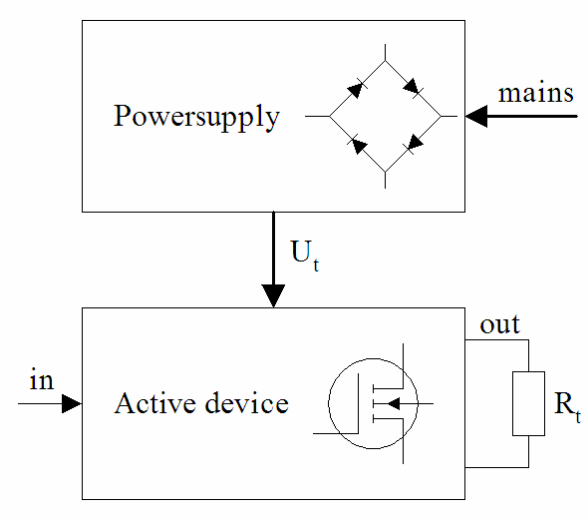

Figure 1
The traditional *A*-class setting

where U_{out} is the voltage of output, U_t is the voltage of power supply, P_{out} is the power of the load, R_t is the resistance of load, R_t is the resistance of semiconductor (for example R_{DS} of FET, at saturation).

2 The novel *A*-class setting

Onto the minimization of this or his reduction we suggest the procedure when we modify it dynamically in the function of the control signal *A*-class his strengthening supply voltage. (Figure 2.) The AC voltage (mains) is arriving from the power network after rectifying and filtering we get U_t. The pulse width modulation (PWM) policy settling value of U_t' in the output of this takes it to the necessaries voltage for de driving of R_t. The necessary means that it is active device here taking his characteristics into consideration, for it not let us not approach his nonlinearity. Of course to the correct function of the PWM controller, the production of the U_t' voltage we need time. The equal 3 shows how can generate the predictive control signal.

$$U_{in}'(t) = U_{in}(t+\delta), \tag{3}$$

where: δ is the necessaries time for the working of control electronic.

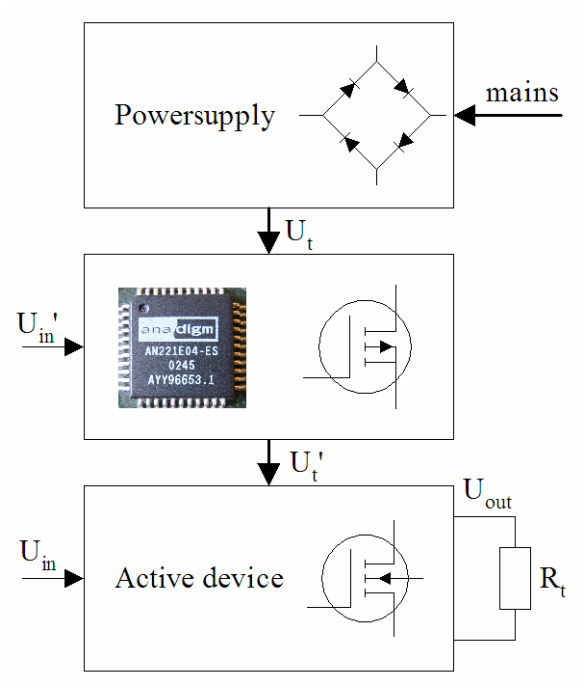

Figure 2
The modified *A*-class control

Therefore U_{in} is a really stochastic signal not able to generate prediction control signal from there. So we change of both function, we delayed the *A*-class unit drive signal, and promptly controlled the PWM unit, as the writes the equal 4.

$$U_{in}(t) = U_{in}'(t - \delta), \tag{4}$$

So the proposed equipment consists of three basic units (figure 3.): traditional *A*-class amplifier, PWM control electronic, and a non-distortion delay line. The last one very easy can to realization in the practice, enough then we thing for the digital form storage information. In this case we need two DAC and one data pipeline like shift register.

The value of U_t' depends of the input signal (U_{in}') and constant (*Ud*). In the equal 5 the *k* is a multiply factor.

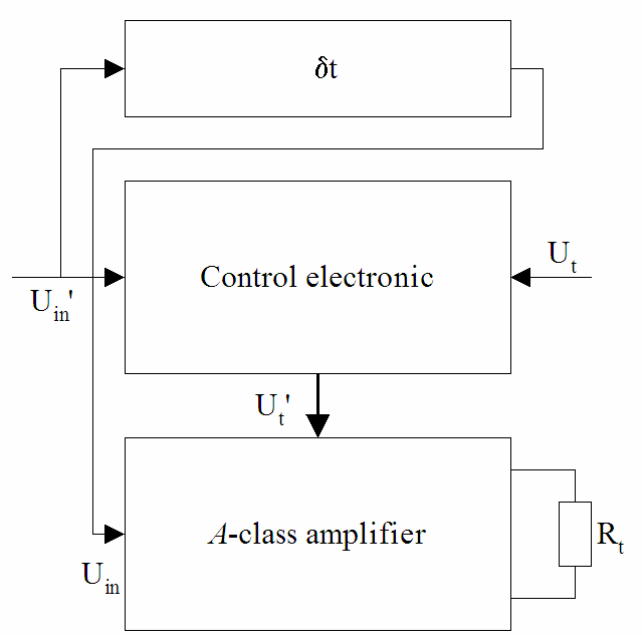

Figure 3
The block schema of proposed solution

$$U_t'(t) = k\int_0^t |U_{in}'|dt + Ud \ , \tag{5}$$

The value of the dissipation calculable from (6)

$$P_{dev} = \frac{Ud^2}{R_{dev}}, \tag{6}$$

where: P_{dev} is dissipation of active device, R_{dev} resistance of active device.

3 Realization with FPAA

To implement the above mentioned tasks, an excellent possibility is given by the use of the field programmable analog array (FPAA) as an universal circuit. In this case such a circuit can be implemented in which a FPAA circuit. In figure (4.) an AN221E04 type of FPAA integrated circuit inside is shown [13] [14] [15] [16]

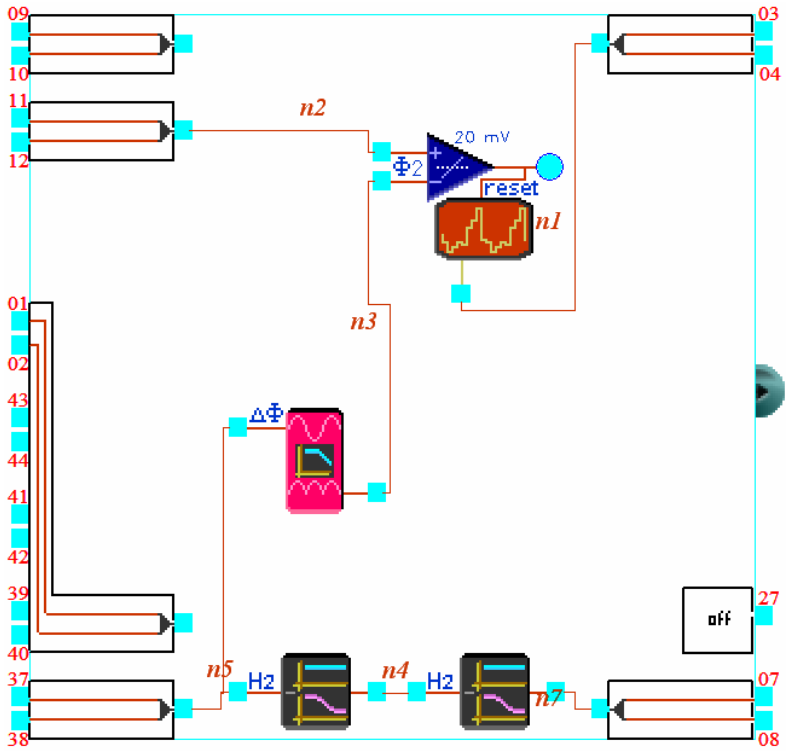

Figure 4
Control circuit and delay line in FPAA

[17]. These circuits being programmed via digital surface form analogous circuit topology together with the likewise programmable determined circuit parameters. As a consequence, they can be favorably used to create different functional units [18] [19].

On the figure 4 seen the control circuit and delay-line. The $pin_{37\text{-}38}$ connect to the U_{in}' signal. Between the n_5-n_7 nodes are two all pass filter, with constant delay time. The $pin_{07\text{-}08}$ gives the *A*-class amplifier the U_{in} signal. In other branch the input signal connects to de rectifier and low pass filter. The signal of n_2 resets the base generator of PWM. On the $pin_{03\text{-}04}$ we get the PWM impulses. The output of FPAA can drive directly a high power FET. From the Ut' connects a feedback to inner PWM generator reset function trough $pin_{11\text{-}12}$.

On the figure (5.) the current value of the supply voltage visible, in the function of the input signal.

A most interesting example of application when we use an electron tube triode with big current, in a new mode of operation strengthening when the leave is a cathode follower with the leaving of an output transformer suggested many times

nowadays. In this case the supply voltage of the electron tube with 300-400V anode voltage, while a desired current flowing through 16Ω loudspeakers is greatness about with a value of 1A. Easily reasonable, that the electron tube transit dissipation some 150-200W. This not only because of that problem, when the *A*-class unnecessary big power dissipates, but because it is necessary to ensure the cooling separately and naturally the damage of the electron tube significantly, accelerates up.

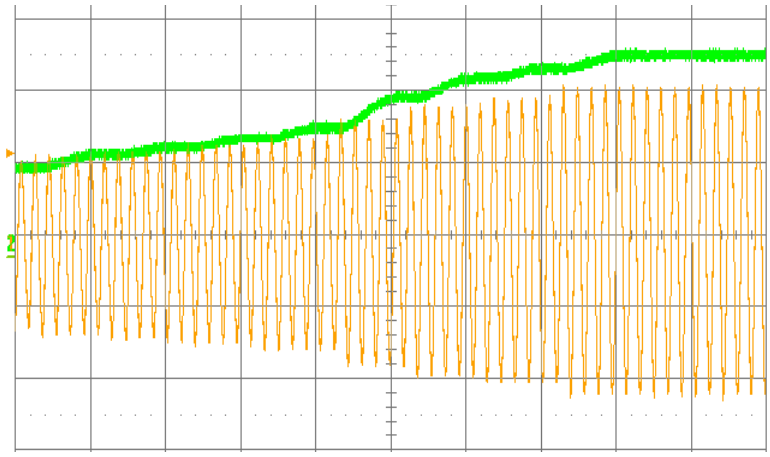

Figure 5
Input signal (U_{in}'), and U_t' (upper)

Conclusions

With the help of the proposed procedure can be kept the benefit of the A-class technique with a switching mode got it united energy with an efficient regulation. The few milliseconds of retardation is the disadvantage of the procedure. Additional benefit means from the procedure when the controlled electronic circuit accomplishes the desired control characteristics collaborating with an embedded microcontroller.

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