Self Configuration Analog Circuit by FPAA

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Abstract: The free programmable analog arrays (FPAA) circuits allow the using of dynamically reconfigurable analogue electric circuits that are most suitable for the desired functions. This is of major importance in the case of wide area of the using of analog circuit in any place of the electronic. From other spot we can say by the help of the FPAA and microcontroller (MCU) we can generate-, and/or fine tune lots of the adaptive circuits.

Keywords: self configuration circuit, electronically evolution, adaptive, FPAA, feedback, configuration policy, fine-tuning policy, fitting policy

1 The Traditional Creation Policy of Analog Circuit

About hundred years ago the construction of a circuit (in that time only analogue) was a very cautious activity, as today too. On the figure one we can follow the steps of the realization of real circuit-constructions. (Figure 1) The first we must a parametric subscribe of the circuit, to do from the input(s) to the output(s). It follows the realization of the circuit topology. As third step coming the select of the component basis. As the last step follow the parametric set of the part's value.

Every steps of the realisation are in interactivity of the earlier and the following steps. In practice it means for example the selections of the parts depend on the topology, and the topology depends on the circuit's function. In other hand, if any step isn't enough fit, we must back step of the earlier level.

So we can distinguish three different, but not independent, policy of the circuit creation: topology creating policy, part selection policy and parametric setting policy.

In mathematical formula:

$$S = f(T(C(P))) \tag{1}$$

Where: S: the circuit function, T: topology, C: component, P: parameter of components

$$T = g(C(P)) \tag{2}$$

and;

$$C = h(P) \tag{3}$$

Where: *f, g, h*: functions, and inner functions

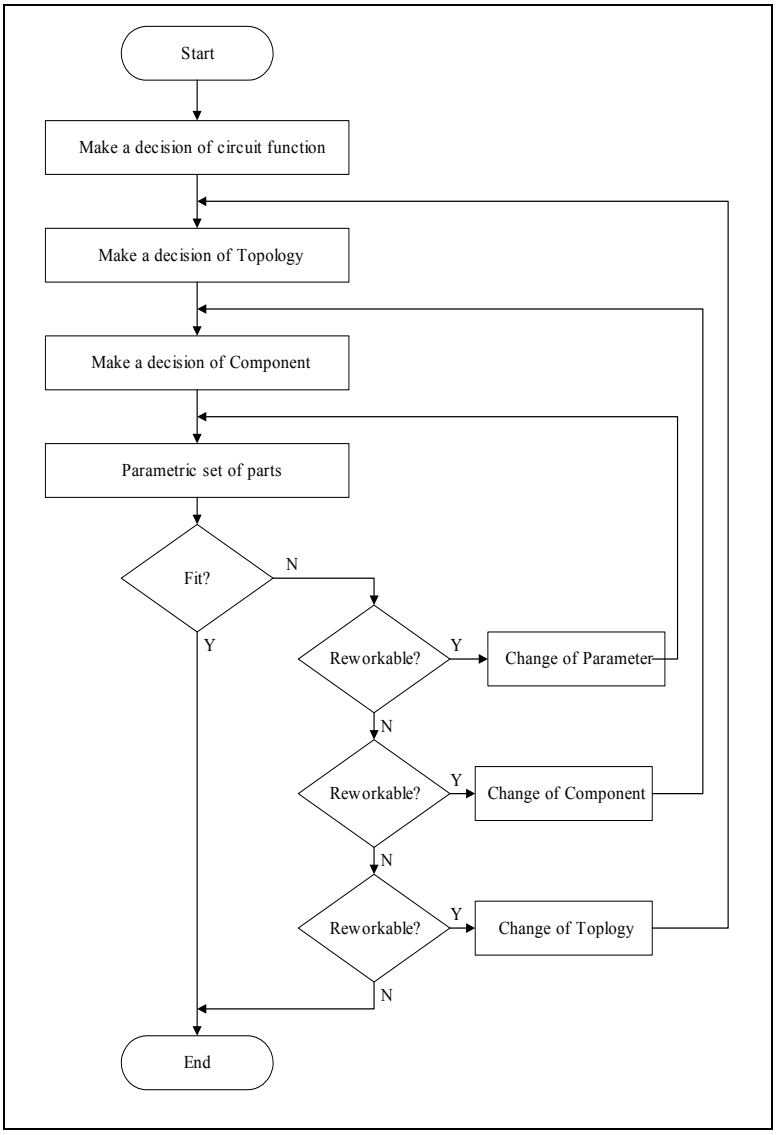

Figure 1
The logical steps of the analog circuit creation

2 Automatically Configuration of Electronic Circuits

After this introduction the question; if may algorithmised this policies, if yes; how can we do it? Of course the answer is not satisfied. But however we must look for the answer, because in the market about eight years ago are any type of the free programmable analog array-circuits, in short the FPAA.

2.1 FPAA

To implement the above mentioned tasks, an excellent possibility is given by the use of the free programmable analogue array (FPAA) as a universal circuit. (Figure 2) In this case such a circuit can be implemented in which a FPAA circuit. In figure a configurable analogue block can be seen. In figure an AN221E04 type of FPAA integrated circuit inside architecture is shown. The I/O block connected to four cells, is able of analogue-digital conversion based on gradual approach. (Figure 3)

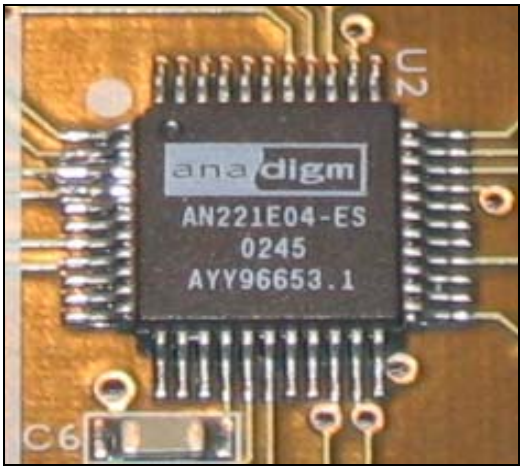

Figure 2
The AN221E04 FPAA

The FPAA circuits can be programmed in many different ways. The simplest way is by the help of a series E^2PROM, or with a connected micro-controller, through i^2c the line of which the inner structure of it can be created.

The new thing in the operation of this system is the fact that the micro-controller selects from a table or an algorithm the one of, these give result in output, of which the stored architecture and the stored domain can be measured on the FPAA circuit generating greatness. The FPAA circuit is such a universal analogue cell-array one that can be configured with C macros or their translated bit series respectively. This way, it is possible to form: a usual amplified inverter, non-

invertible amplifiers, integrators, differentiators, rectifier, etc. in these electrical circuits. Fortunately, in certain types an analogue digital converter can be found.

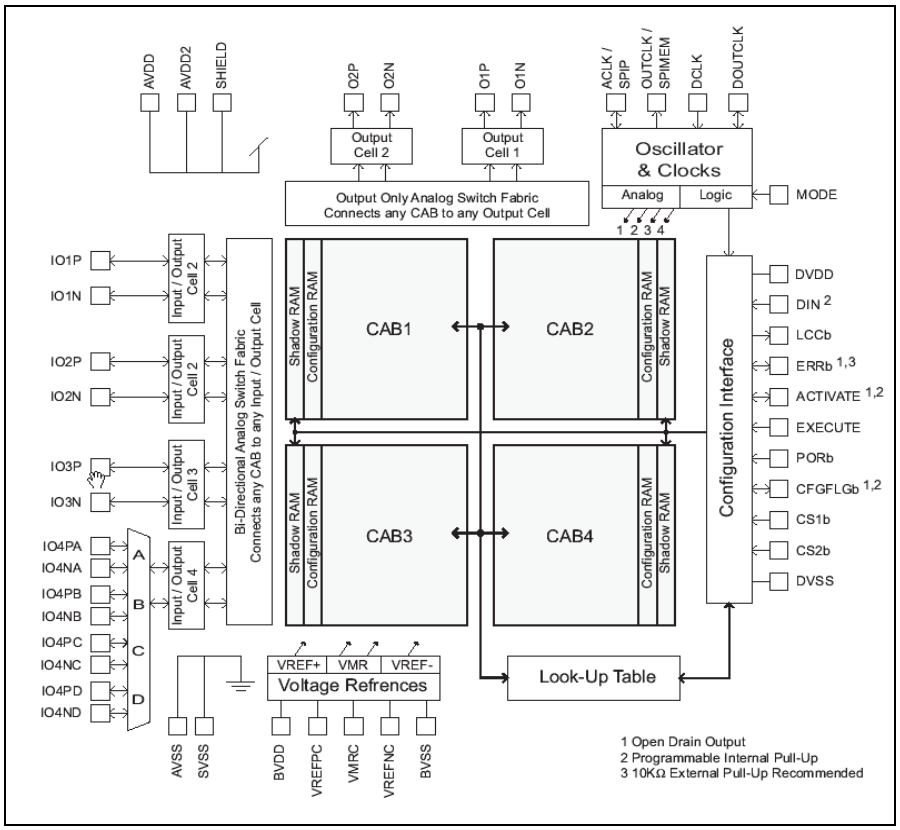

Figure 3
The inner structure of AN221E04 FPAA's (Anadigm)

On base of the above stated we examine whether, by means of a certain procedure, the configurable analogue block circuits can be re-configured to operate better (more suitably), automatically, with a self-configuring algorithm.

2.2 FPAA Coo Work by MCU

In Figure 2 the connection of a FPAA to a microcontroller (MCU) can be seen. The most suitable, and, from measurement and usage point of view, the most useful output signal (S_{out}) has to be processed from the input signal coming from the analogue electrical circuit, as the generally input source (S_{in}). Therefore the most suitable transmission function (T_τ) must be found. Whereas the input signals are in general functions of time (t), the transmission function is constant only compared to this, where the $\tau << t$.

$$S_{out}(t) = F\left[(S_{in}(t), T(\tau)\right] \tag{4}$$

Where; τ - the reconfigurations time; T – transfer function.

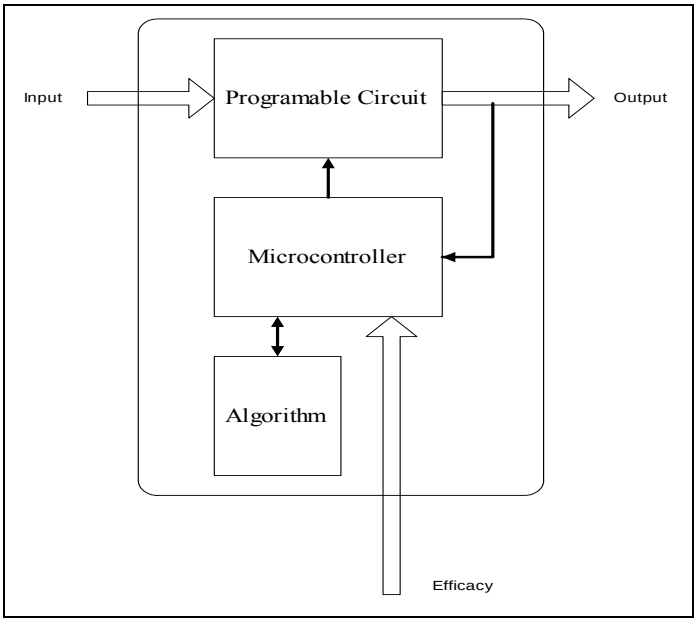

Figure 4
An external signal depend re-programmable FPAA-MCU cell

The τ parameter means the time needed for re-programming our analogue circuit before the next consecutively produced output signal (S_{out}). This timeframe is in fact the time of the generation of the new structure. From (4) following:

$$S_{out}(t) = F\left[(S_{out}{}^{-1}(t), T(\tau)\right] \tag{5}$$

Accordingly:

$$S_{out}(t) = F\left[(S_{in}\ (t), T^{1}(\tau)\right] \tag{6}$$

Where; T is the transfer function.

In Figure 2 the transfer function between the input and the „Programmable electrical circuit" provides output. The MCU is responsible for the loading of the actual transfer function. The latter obtains the transfer parameters considered adequate from an algorithm-store and contains the successful transfer descriptors. The MCU generates the feedback needed for reprogramming from the analogue output or reads it from another circuit processing the analogue signal.

This sort of preset and feedback can be interpreted as an inner response and correction to the environmental effects. (Figure 4)

$$T = F\left[(T^{-1}, C)\right] \tag{7}$$

Where; C is the environmental effect.

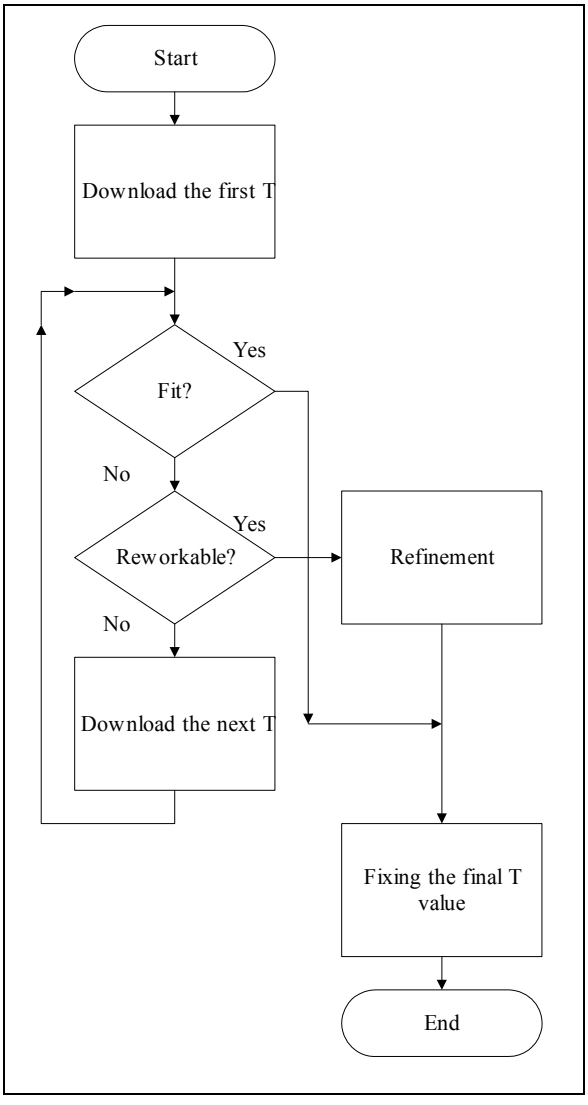

Figure 5
One art of fitting algorithm

The external environmental effects can be such quality-parameters that characterize the suitability and usability of the configurable electrical circuit output signal. At this time only the transfer function modification is needed. $T=\mathbf{f}(T^{1})$ If the modification is unsuccessful the external feedback has a value of "not suitable", thus a new function has to be introduced $T=T^{*}$. (Figure 5)

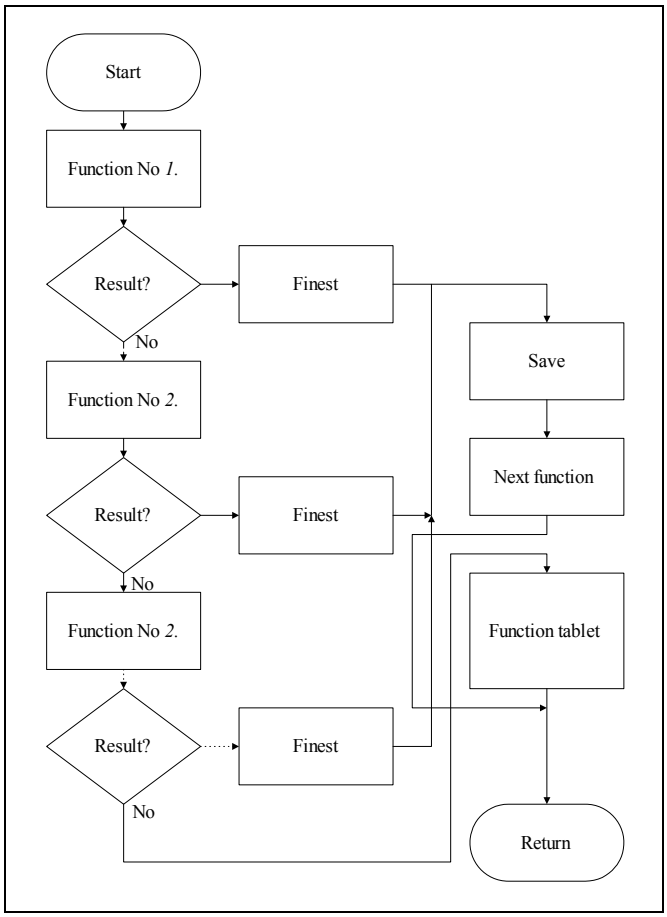

Figure 6

One art of database reference creation algorithm

If the expected value of the input signal is unknown (first measurement) it is important to know which transition function should be used. A solution could be the latent operation of the electrical circuit by means of some predefined input signal series for which the given responses are known. This way the actual transition function to be generated shall be known, so the algorithm can be controlled. ($t_T=t/n$) in these equation the t_T not less than the time for enough the reprogramming.

2.3 Strong-, or Weak-algorithm

In this point we must put on a question: What kind of algorithm may be configuration of the topology may be selection of parts, and parametrical setting of component. First and trivial answer is; the method of the strong algorithm. Their steps are:

1 Making a connection between the input(s) and output(s)

2 The transfer function is correct –of course not- select a new transfer

3 Parametric finest of the transfer function.

In this computational environment the bottleneck is the finite calculating capacitance of the computer (of the microcontroller unit). We can a little bit efficiency by the help of the artificial intelligence. By there is one starting database, which contain a database of the abilities topology, of the abilities components and so on. This database (function tables in Figure 6) is dynamically refreshable, by the result of the earlier configuration methods.

Conclusions

The suggested arrangement and algorithm could be a procedure for the implementation of such a self organizing analog electronic circuit which is able to correct environmental changes within a certain range. If corrections are performed several times by a device, its actual version will own totally new features in comparison to the ones of its ancestors.

Acknowledgement

Special thanks for our kindly colleagues and students in Department of Computer Technology of Budapest Tech for their help.

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