Critical Comparison among some Analog Fault Diagnosis Procedures based on Symbolic Techniques

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The parametric fault diagnosis techniques hold an important part in the field of analog fault diagnosis. These techniques, starting from a series of measurements carried out on a previously selected test point set, given the circuit topology and the nominal values of the components, are aimed at determining the effective values of the circuit parameters by solving a set of equations nonlinear with respect to the component values. Here the role of symbolic techniques in the automation of parametric fault diagnosis of analog circuits is investigated. Being in fact the actual component values the unknown quantities, symbolic approach results particularly suitable for the automation of parametric fault diagnosis techniques, as shown, for example, in [1]. Obviously all this is applicable to linear analog circuits or to nonlinear circuits suitably linearized. On the other hand, present trend is moving as much as possible to techniques of design that lead to linear analog circuits, so this is not a so serious restriction [2].

It is important to note that in the analog fault diagnosis two phases can be considered: the first one is the phase of testability analysis and ambiguity group determination, while the second one is the phase of fault location. Testability gives theoretical and rigorous upper limits to the degree of solvability of fault diagnosis problem once the test point set has been chosen, independently of the method effectively used in phase of fault location. For what concerns ambiguity groups, they can be considered as sets of circuit components that, if considered as potentially faulty, yield an undetermined system. For the testability evaluation problem symbolic approach is a natural choice, because a circuit description made by means of equations in which the component values are the unknowns is properly represented by symbolic relations. Also for ambiguity group determination symbolic approach gives excellent results, as reported, for example, in [3].

For the fault location phase several different approaches can be used and all of them can be considered as an optimization problem, because, starting from measurements carried out on the circuit under test, the component values better fitting them have to be determined. Generally symbolic techniques are suitable for optimization problems, because the relations required by specific optimization strategies are easily generated using symbolic methods.

To this end three different methodologies were used by authors during last few years, based on Newton-Raphson type algorithms, neural networks and genetic algorithms, and a comparison has been made by means of programs developed for this goal [1,4-5]. In all the three cases the quite realistic hypothesis of bounded number of faulty components (k-fault hypothesis) is made, taking into account component tolerances.

The results of comparison can be so summarized: if frequency domain measurements are considered, symbolic approach can give good results with both a Newton-Raphson type algorithm and a hybrid neural network approach [5]. However good results are obtained also with a neural network approach based on time domain measurements, without using symbolic network functions [4]. On the other hand, genetic algorithms based on the use of symbolic network functions and frequency domain measurements are very slow and, then, they are not advantageous.

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