원전 온도 사고 조건에서 R-L-C회로 모델링 등가 회로의 저항 수동 소자 변화에 대한 출력 신호 분석

Output Signal Analysis for Variation of Resistance Passive Element in the R-L-C Equivalent Circuit Modeling under Temperature Accident Conditions in NPPs

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Abstract - Some abnormal signals diagnostics and analysis through an important equivalent circuits modeling for passive elements under severe accident conditions have been performed. Unlike the design basis accidents, there are inherently some uncertainties in the instrumentation capabilities under the accident conditions. So, the circuit simulation analysis and diagnosis methods are used to assess instruments in detail when they give apparently abnormal readings as an accident alternative method. The simulations can be useful to investigate what the signal and circuit characteristics would be when similar to a variety of symptoms that can result from the environmental conditions such as high temperature, humidity, and pressure condition. In this paper, a new simulator through an analysis of the important equivalent circuits modeling under temperature accident conditions has been designed, the designed simulator is composed of the LabVIEW code as a main tool and the out-put file of the Multi-SIM code as an engine tool is exported to in-put file of the LabVIEW code. The procedure for the simulator design was divided into two design steps, of which the first step was the diagnosis method, the second step was the circuit simulator for the signal processing tool. It has three main functions which are a signal processing tool, an accident management tool, and an additional guide from the initial screen. This simulator should be possible that it could be applied a output signal analysis to some transient signal by variation of the resistance passive elements in the R-L-C equivalent circuit modeling under various degraded conditions in NPPs.

Key Words : Abnormal signal, Circuits modeling, Simulation analysis and diagnosis, Designed simulator, Severe environmental conditions, NPPs ; Nuclear Power Plants

1. INTRODUCTION

In this paper, a validation of the signal patterns from an equivalent circuit under a severe accident circumstance condition is made as an accident control alternative method for the nuclear power plants. First of all, we prepared an ASSA (abnormal signal simulation analyzer) module to analyze the output signal patterns by using an input pulse wave as a reference signal. The module unit was applicable to a pulse transient signal analysis for the simulated equivalence circuit of the 4~20mA instrument under a severe accident temperature condition. This module's functions have some basic signal processing including a specific function of an ASSA with a one body system. This order system could be linked as one order function to the PSpice & Multi-SIM engine codes and the LabVIEW tool code. This system could also obtain the validation data by a comparative analysis according to the heat effective results from each PSpice and Multi-SIM code for the 4~20mA circuit modeling which consists of a R-L-C passive circuit to be able to change the elements for an accident temperature condition.

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2. ASSA MODULE DESIGN AND COMPOSITION

It has three main functions which are a signal processing tool, an accident management tool, and an additional guide for an instrument evaluation as well as an instrument performance diagnosis. The signal processing tools have the position information obtained from 5 areas in the containment building, which includes the information needs of the instruments as well as the circumstance parameters from the accidents class. As the next step in the signal processing tools, we need the decision making from some signals which means three kinds of signal patterns, of which the first one is normal condition signals, the second one is abnormal signals, and the third one is out of control signals. In the case of abnormal signals, they have to be processed by five steps and finally they can be shown on a CRT screen with enhanced signals.

The main function of each of PSpice & Multi-SIM engine code is to design an equivalent circuit to simulate some instruments affected by a temperature condition. It could be possible to obtain a transient response for the R-L-C circuit elements as an automatic run menu function according to a one step order system logic. The output data could estimated a transients changing value for an abnormal output signal through by comparing it with the reference input signal. The estimation procedure for a transients changing value of the output signal is as follows.

- ▸ The first estimation is the transient characteristic analysis of the output signal according to a R-L-C elements changing range for an equivalent circuit.
- ▸ The second estimation is the temperature changing range according to the transient characteristic analysis of a output signal.
- ▸ The third estimation is the diagnostic characteristic of a R-L-C elements for an equivalent circuit according to the temperature changing range.

Another important function of the module is also possible which is to connect it with a PC and an instrument using an I/O interface of the LabVIEW code.

3. COMPARATIVE ANALYSIS BETWEEN PSpice AND Multi-SIM CODE DATA

3.1 PSpice Code Data

A procedure to analyze the output signal needs to set the temperature range by a statistical analysis by using a PSpice SMOKE function.

- ▸ In the simulation settings dialog box, click the analysis tab.
- ▸ From the analysis type list, select a basic analysis type.
- ▸ From the options list, select a temperature sweeping.

The temperature sweeping in this simulation range of 27 degrees celsius to 800 degrees celsius for the resistance from an equivalent circuit that is a 4~20mA circuit. Figure 1 shows input & output voltage data from the Multi-Sim code, shows simulated pressure circuit fabricated as Multi-SIM code & output signal.

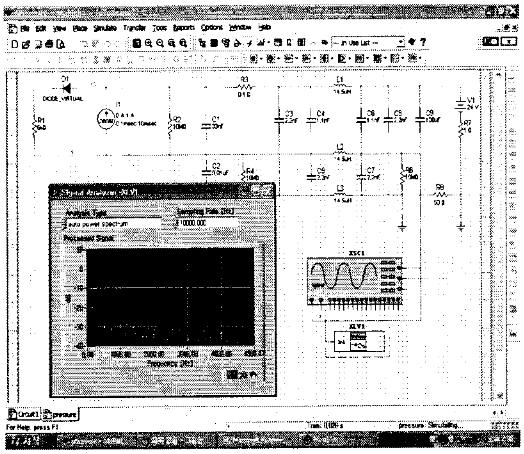

Fig. 1 Simulated pressure circuit fabricated as Multi-SIM code & output signal

Table 1. Output data of the pulse parameter according to the temperature sweeping

Temperature Parameter	27 C	250 C	550 C	650 C	750 C
Risetime_No Overshoot (V(R8:1,0))	8.00049u	25.73798 m	23.45396 m	22.98626 m	23.78005 m
Falltime_No Overshoot (V(R8:1,0))	8.00049u	25.69798 m	23.47396 m	22.97800 m	23.77999 m
Pulsewidth (V(R8:1,0)	319.3699 6m	328.3199 6m	332.0100 0m	330.5899 7m	329.8199 8m

The output data in the table 1 could be used to diagnosis the logic data for the circuit in the temperature conditions. The result of the parameter data could be obtained from the resistance value changed by the correlation function between the voltage parameter and the temperature. Table 1 is the output data of the pulse parameter according to the temperature sweeping. These data could be compared to the input data and the output data of the pulse parameters according to the sweeping temperature. In this simulation, we know that the output data has a linearity characteristic at the temperature range of 27C-650C for the rising time, the falling time, and the pulse width, but there is a non-linearity characteristic at the temperature of 750C for all the parameters of the out transit pulse.

3.2 Multi-SIM Code Data

Figure 2 shows the output voltage curve when R1 has the changing range of 1KΩ~1T Ω at 0.0004sec. The output voltage begins with 1.1068V as the normal value of 1kΩ. The output voltage for the changing value of 1kΩ~ 10kΩ reduces rapidly with 0.11614V as a decreasing voltage. The output voltage for the changing range of 10kΩ to 100kΩ reduces slightly with 0.0118V as a decreasing voltage. The output voltage curve of more than 1000kΩ reduces slightly as a little voltage. The output voltage curve of more than 10000kΩ indicates an unchanging one.

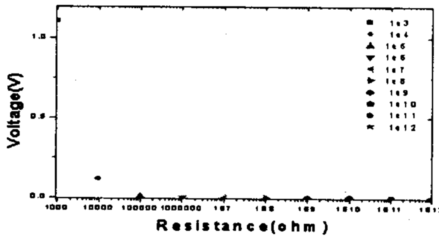

Fig. 2 Output voltage curve for changing R1

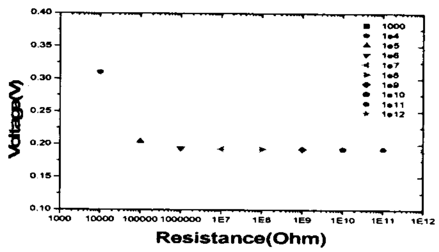

Fig. 3 Output voltage curve for changing R2

Figure 3 shows the output voltage curve when R2 has a changing range of 1KΩ~1T at 0.0004sec. The output voltage for the changing range of1K to 10K indicates 1.0059V as a decreasing value. The output voltage for the changing range of 10K to 100K indicates 0.0958V as a little change value. The output voltage for the changing range of more than 100K indicates 0.01061V as a no change value.

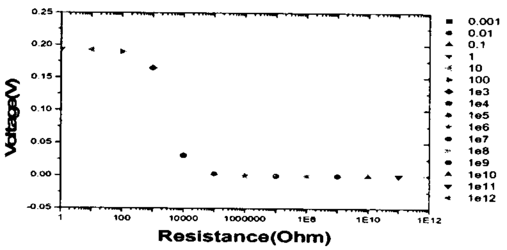

Fig. 4 Output voltage curve for changing R3

Figure 4 shows the output voltage curve when the R3 has the changing range of 0.001Ω~1T Ω at 0.0003sec. The output voltage for the changing range of 0.001Ω~1kΩ appears unchanged at 0.2V. The output voltage for the changing range of 1kΩ ~ 10kΩappears as a linearity curve. The output voltage for the changing range of 1MΩ ~1TΩ appears as no more change.

4. CONCLUSIONS

In the case of the PSpice code for the pre-examination analysis, it is possible to estimate that the output parameter data, and the output transient signals have linearity characteristics at the temperature range of 27C-650C, but the data has a non-linearity characteristics for the temperature of 750C. In the case of the Muti-SIM code for the pre-examination analysis, it ispossible to estimate good linearity characteristics in the resistance range of1K~10K from each R1, R2, and R3. In the case of R4, it also has a linearity characteristic when the output voltage is 0.12V at 100Ω. From these simulations, we could obtain the validation data from the comparative analysis of the PSpice and Multi-SIM codes for the 4~20mA circuit modeling which was made by a composition of an R-L-C passive circuit by changing the range of the resistance elements for the temperature condition.

ACKNOWLEDGEMENTS

This paper was supported as part of the long term nuclear project by MOST

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