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Transmission Line fault Detection using DWT based Artificial Neural Network

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ABSTRACT: Fault diagnosis is a major area of investigation for power system and intelligent system applications. When the fault occurs on the transmission lines, the current and voltage waveforms contain significant high frequency transient signals. This report presents a Discrete Wavelet Transform and Artificial Neural Network approach to fault detection and classification in transmission line faults. The discrete wavelet transform is applied for decomposition of fault transients, because of its ability to extract information from the transient signal, simultaneously both in time and frequency domain. The data sets which are obtained from the Discrete Wavelet Transform are used for training and testing the Artificial Neural Network architecture. The feasibility of proposed algorithm is tested on transmission line using MATLAB software and Raspberry Pi 3 processor. The proposed algorithm is very simple and accurate in fault detection and classification. Simulation results shows that the proposed algorithm gives satisfactory results and will be very useful in the development of a power system protection scheme.

KEYWORDS: Power System Faults, Transmission Line Relaying, Discrete Wavelet Transform, Statistical features, Intelligent system, High frequency transient, Artificial Neural Networks.

I. INTRODUCTION

Transmission system is the most vital part of Power system. Nowadays HVDC transmission system have become competitive in terms of power handling capacity, DC operative voltage, semiconductor losses, further as reliability and technology maturity. These days the fault detection technique has used high frequency elements as an indispensable basic signal part. These results transient based protection. In such a protection system, it's essential that the fault signal must be analyzed accurately. Fourier Transform was utilized in the early stage as a mathematical tool to analyze the transient fault signal [3]. However, it's been shown that the analysis supported by Fourier transform sometimes, isn't precise enough. In recent years, wavelet transform has been used extensively for signal and image process. It is been found that the wavelet transform is capable of working with the transient signals generated in an exceedingly installation. The prominent faults in transmission lines are line-ground fault, line-line fault and 3 phase short circuit faults. These faults will be known and classified using separate Discrete wavelet transform (DWT) [4]. DWT has the function of filtering, which can get rid of noise disturbance, decomposing the transient components of current signals. During the occurrence of faults, the grid current and voltages undergoes transients. These transients will be analyzed using Discrete wavelet Tranform (DWT) and also the fault will be classified, Analyzing the transients in every phase currents i.e, positive sequence and zero sequence currents and identifying that fault has occurred. Once the applied wavelet extracts the vector features also called as statistical features from energy of transients related to every phase and ground current signals, thus the part involving fault is determined.

Through the years artificial neural networks , have been invented with both biological ideas and control applications in mind, and the theories of the brain and nervous system have used ideas from control system theory[1]. The neural network represents a network with a finite number of layers consisting of solitary elementsvthat are similar to neurons with different types of connection between layers. The number of neurons in the layers is selected to be sufficient for the provision of the required problem solving quality. The number of layers is desired to be minimal in order to decrease the problem solving time. Basically, we can design and train the neural networks for solving particular problems which are difficult to solve by the human beings or the conventional computational algorithms. The computational meaning of the training comes down to the adjustments of certain weights which are the key elements of the ANN. This is one of the key differences of the neural network approach to problem solving than conventional computational algorithms. This adjustment of the weights takes place when the neural network is presented with the input data records and the corresponding target values. Due to the possibility of training neural networks with off-line data, they are found useful for power system applications. The neural network applications in transmission line protection are mainly concerned with improvements in achieving more effective and efficient fault diagnosis and distance relaying. NN used for overhead transmission lines , as well as in power distribution systems. This paper presents a method for detection and identification of the fault type in the line. Back propagation neural network approach is studied and implemented. Voltage and Currents signals of the line are observed to perform these three tasks. The detailed coefficients of all phase current signals that are collected only at the sending end of a transmission line are selected as parameters for fault classification . The transmission line models are constructed and simulated to generate information which is then channeled using the software MATLAB 2015a and accompanying Power System Block Set used to provides back-propagation neural networks. The results i.e, the type of fault so classified is also displayed using Raspberry Pi-3 processor.

II. METHODOLOGY

Any change of configuration on the line causes a traveling wave to be generated traveling from the point of change towards the ends of the line. In the simplest case this wave will be just a pulse step, but in reality will be accompanied by high frequency oscillating components.

Our system aims at the automatic detection of transmission line fault. This is done by the algorithm. Fig. 1 shows the flow diagram of fault detection algorithm. The algorithm steps are summarized as follows.

1. At the beginning , any type of transmission line fault is created on the Transmission model so chosen using MATLAB software. Here the transmission model used is the section of 3-mchine 9-bus system. The system is shown in fig no.2.
   - The 3 Machines, 9 Bus Test Case (known as P.M Anderson 9 Bus) represents a simple approximation of the Western System Coordinating Council (WSCC) to an equivalent system with nine buses and three generators.
   - This model case consists of 9 buses, 3 generators, 3 two-winding power transformers,6 lines and 3 loads.
   - The base KV levels are 13.8 kV, 16.5 kV, 18 kV, and 230 kV. The line complex powers are around hundreds of MVA each.
2. After the creation of fault, the corresponding fault current signal is taken and Discrete wavelet Transform is applied to the signal.
   - Here for the proposed Method, DWT is the wavelet chosen from Daubechies family (db01) and of level 2.
   - Daubechies as mother wavelet so selected because it resembles like transient fault current waveform. This wavelet when applied to fault current signals, enables to retrieve feature **"Mean"** of the signal**.** using Scaling and shifting property of the wavelet.
   - Due to its uniqueness of automatic scaling and shifting property it expands or contracts its analyzing window for sampling the test (fault signal) signal. This window expands or contracts depending on the frequency of the transient signal. If the frequency is high ,then the window contracts i.e shifting take place of the wavelet. And if the frequency is low, then the window expands i.e, scaling of wavelet take place of the wavelet and thus of the faults test signal. Thus it is successful in analyzing only Transients part of the signal automatically.
3. Once the feature i.e mean of the fault signal is obtained, this then sent to artificial neural network for its training purpose.
   - In the proposed method Feed forward path propagation is used as kernel and algorithm used is back propagation neural network.
   - The back propagation neural network is an algorithm generalization of delta rule for training multi layer network. This algorithm updates the weight of the network by means of successive iterations,

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that minimizes the error value. This error value is the difference between targeted output and the actual output.

- There are total 12 types of fault for which ANN is trained . The proposed architecture of BPNN consists of 9 input layers, 20 hidden layers and 1 output layers.
- The network is trained with Levenberg-Marquardt back propagation (trainlm), so that, given example input vectors, the outputs of the third layer learn to match the associated target vectors with minimal mean squared error. Function is expressed as the sum of squares of non-linear real-valued functions.

4. After supervised learning of ANN, the proposed ANN is tested for different faulty conditions in the transmission model.
    - Here any type of fault is created for which ANN was trained . After creating the fault, the ANN try to match the input current signal feature with the previously trained feature of different fault. When the feature of the fault current signal matches most with one of the trained feature of particular type, then it diplays that type of fault.
    - Hence by supervised learning of the ANN, we can classify the type of fault. Here in the proposed method the ANN is trained for 12 types of fault namely, 3 line to ground fault, 3 line to line faults, 3 double line to ground faults, switching type fault and lightening type fault.
5. The Raspberry-Pi 3 processor is interfaced with the software based proposed system.
    - When Processor is interfaced with the proposed method, the system becomes more advantageous by contributing extra features like transmission of data output to remote computers, authentic sharing of data with other operator via internet or Bluetooth
    - When the fault is created over the transmission line, the ANN displays the fault type to the operator. This output can be seen on other screen using Raspberry-Pi 3 processor interfacing. It allows the operator to acknowledge himself about the fault taken place on transmission line immediately in a hassle free manner. The operator need not to reach the site to check it up. Hence it makes system ultrafast in detection of faults and thus can take immediate remedy without much damaging the system.
    - It makes an automated, hassle free, ultrafast fault detection system.

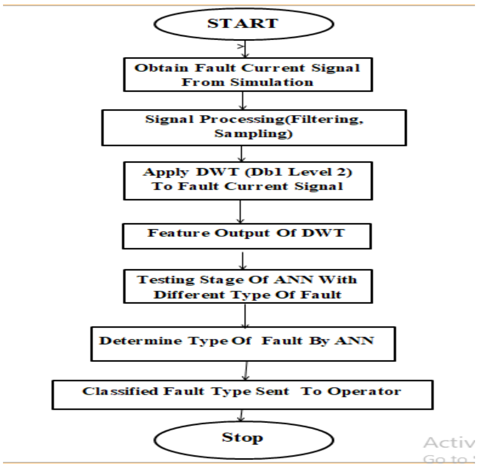

Figure No. 1 Flow diagram of fault detection algorithm

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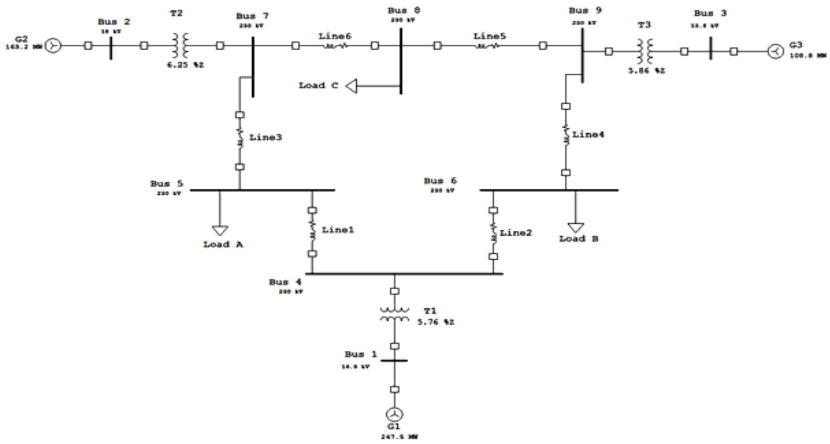

Figure No. 2 Single diagram of 3-machine 9-bus system.

III. EXPERIMENTAL RESULTS

Figures shows the results of A-G type fault created, Figs. 3 shows A-G fault current signal and Fig 4 shows the

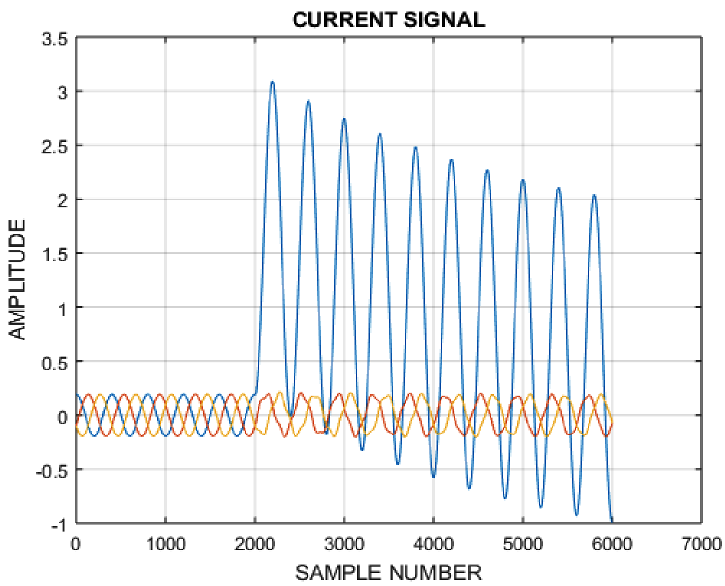

Figure No. 3 A-G type of Fault current signal

DWT transformed signal. When DWT is applied only in the segment from 2000 to 4000 samples changes are seen, where fault actually initiated. From segment 2000-4000 phase A and in segment 4000-6000 phase A current signal has undergone transient nature .This signal's mean feature is retrieve by DWT and mentioned in MATLAB excel as shown in fig 5.

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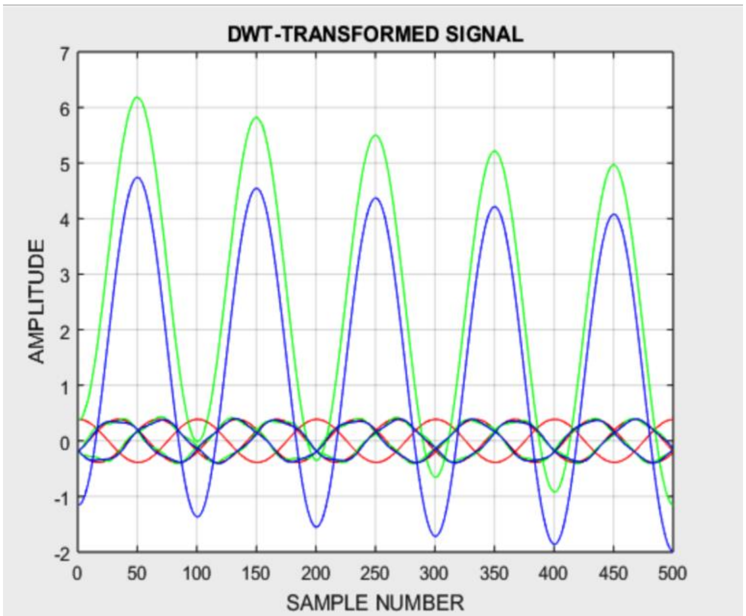

Variables - FV

TRNMDL | P | ik1 | F | FV1 | FV3 | FV2 | FV

1x9 double

	1	2	3	4	5	6	7	8	9
1	318.3979	318.2160	318.4216	217.7049	285.6055	272.7392	224.3041	296.0421	291.8047
2									
3									
4									
5									
6									

Figure No. 5 Mean values of each phase of every segment for A-G type of Fault current signal

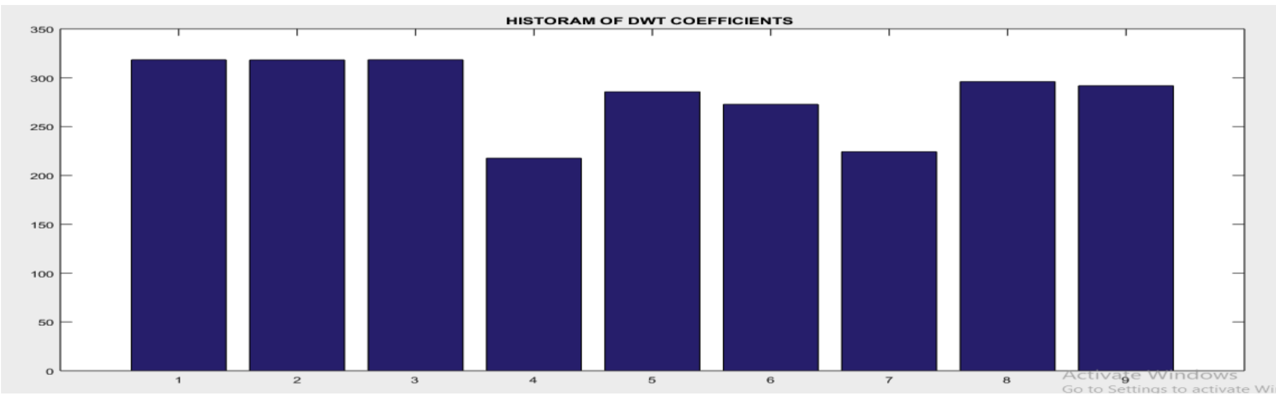

Figure No. 6 Histogram representation of Mean values for A-G type of Fault current signal

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Here in fig 6, the histogram format of feature magnitudes are displayed. This format allows us to clearly differentiate between the magnitudes of various phase currents. The bars are divided into segments. Segment 0-2000 consist of first 3 currents of phase A,B and C. similarly with segment 2000-4000 and segment 3 from 4000-6000. In all segments one can observe only changes have occurred in phase A magnitude current from the point of segment when fault have initiated.

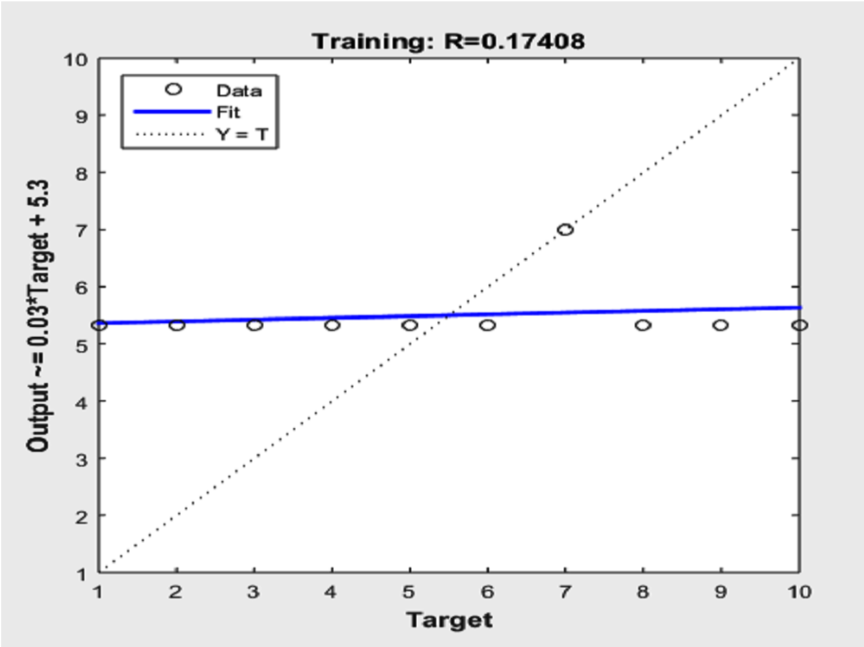

Figure No. 7 shows the regression plot of ANN

Fig 7 shows the regression plot of ANN supervised learning output. It shows that actual output value is equal to the desired output value and there is least error. It means after supervised learning ANN have successfully recognised in classifying the fault type which have occurred over line by matching the present input signal feature with the trained ones. And which matched the most it have given its type as output.

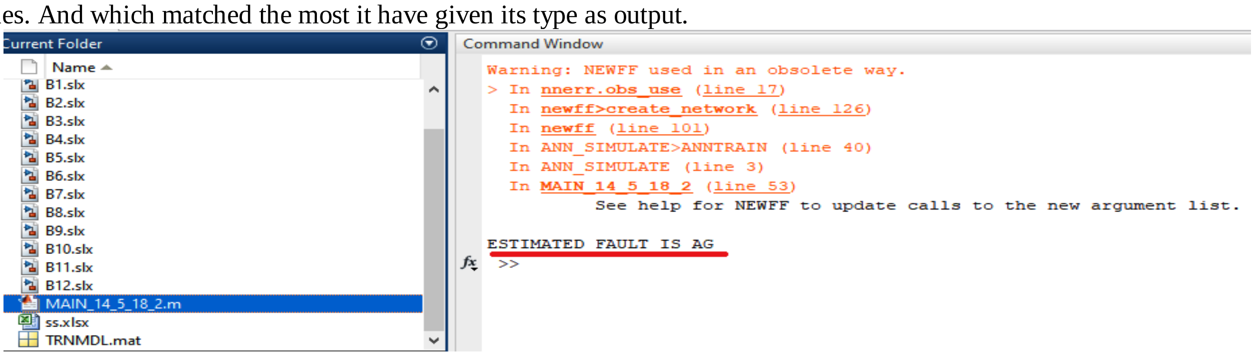

Figure No. 8 shows the ANN output as fault type

It depicts the result of ANN. It have classified the fault type as A-G type of fault which is desirable. This snapshot is taken from MATLAB command window.

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S.No.	Fault Type	A	B	C	G
1	A-G	1	0	0	1
2	B-G	0	1	0	1
3	C-G	0	0	1	1
4	A-B	1	1	0	0
5	B-C	0	1	1	0
6	A-C	1	0	1	0
7	AB-G	1	1	0	1
8	BC-G	0	1	1	1
9	AC-G	1	0	1	1
10	ABC	1	1	1	0
11	Switching fault	1	1	1	0
12	Lightening fault	1	1	1	0

Figure No. 9 BPNN Classification Network Truth Table

There are three phases (A, B, C) and neutral or ground G or Ground. Their combinations are subjected to faults. The data required to differentiate between these types of faults are the three phase voltages and currents. This data generates four output statuses associated with the four fault categories. The outputs contain variables whose values are given as either 0 or 1 corresponding to the existence of that class of fault. The proposed ANN should classify if the specific phases involved in the fault scenario or not. The combinations generate twelve different categories of faults as illustrated in fig 9. This designed ANN should be able to distinguish between them.

There are three phases (A, B, C) and neutral or ground G. their combinations are subjected to faults. The data required to differentiate between these types of faults are the three phase voltages and currents. This data generates four output statuses associated with the four fault categories. The outputs contain variables whose values are given as either 0 or 1 corresponding to the existence of that class of fault. The proposed NN should classify if the specific phases involved in the fault scenario or not. The combinations generate nine different categories of faults as illustrated in Table 2. This designed NN should be able to distinguish between them.

IV conclusion

This paper fault detection, classification and location in a transmission line system have been investigated using neural network back propagation (BP) algorithm. MATLAB-2015a, software were used for simulation of the transmission line models. Data generated is used for single phase to ground faults, double phase faults , double phase to ground faults, switching fault and lightening fault. The multi-layer neural networks were trained with the generated data. When real values are then used as an input to trained NN; fast evaluation of errors obtained. The results obtained for transmission line fault detection and classification were highly satisfactory using BPNN architecture.

REFERENCES

[1] A. Abur, M. Kezunovic, "A simulation and testing laboratory for addressing power quality issues in power systems", Power Systems IEEE Transactions on, vol. 14, no.1, pp. 3-8, 1999.

[2] E. O. Schweitzer, A. Guzmn, M. V. Mynam, V. Skendzic, B. Kasztenny, S. Marx, "Locating faults by the traveling waves they launch", Proc. 2014 67th Annu. Conf. Protective Relay Eng., pp. 95-110, 2014.

[3] S. Santoso, E. J. Powers, W. M. Grady, "Electric power quality disturbance detection using wavelet transform analysis", Proceedings of the IEEE-SP International Symposium on Time-Frequency and Time-Scale Analysis, pp. 166-169, 1994-Oct.-25-28.

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[4] J. Thorp, A. Phadke, S. Horowitz, and J. Beehler, Limits to impedance relaying, Power Apparatus and Systems, IEEE Transactions on, vol. PAS-98, no. 1, pp. 246260, Jan 1979.

[5] S. G. Mallat, "A theory for multiresolution signal decomposition: the wavelet representation," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 11, no. 7, pp. 674-693, Jul 1989.

[6] W. A. Wilkinson and M. D. Cox, "Discrete wavelet analysis of power system transients," in IEEE Transactions on Power Systems, vol. 11, no. 4, pp. 2038-2044, Nov. 1996.

[7] F. H. Magnago and A. Abur, "Fault location using wavelets,"in IEEE Transactions on Power Delivery, vol. 13, no. 4, pp. 1475-1480, Oct 1998.

[8] T. Dalstein and B. Kulicke, "Neural network approach to fault classification for high speed protective relaying," in IEEE Transactions on Power Delivery, vol. 10, no. 2, pp. 1002-1011, Apr 1995.

[9] Kherchouche Younes, Savah Houari, Identifying Defects in the Transmission Lines by Neural Networks, American Journal of Energy Engineering. Vol. 3, No. 2, 2015, pp. 16-20.

[10] M. Oleskovicz, D. Coury, and R. Aggarwal, A complete scheme for fault detection, classification and location in transmission lines using neural networks, in Developments in Power System Protection, 2001, Seventh International Conference on (IEE). IET, 2001, pp. 335338.

[11] K. M. Silva, B. A. Souza, and N. S. D. Brito, Fault detection and classifiation in transmission lines-based on wavelet transform and ann, IEEE Transactions on Power Delivery, vol. 21, no. 4, pp. 20582063,2006.

[12] P. L. L. Mao and R. K. Aggarwal, A novel approach to the classification of the transient phenomena in power transformers using combined wavelet transform and neural network, IEEE Transactions on Power Delivery, vol. 16, no. 4, pp. 654660, 2001.

[13] F. Martin and J. A. Aguado, Wavelet-based ann approach for transmission line protection, IEEE Transactions on Power Delivery, vol. 18, no. 4, pp. 15721574, 2003.