Wavelet Based Fault Analysis on Multi-Terminal System in Presence of with and without Islanding Connected System

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Abstract— **This paper deals the novel method in fault detection on four fatal system in presence of islanding connected system (ILCS) using wavelet analysis. Wavelet analysis are used for recognition, cataloguing and position of fault on t/m/n line. The current signals are analysed with Bior1.5 to obtain detail coefficient (DC) of single decomposition. DC of current signals are calculated using wavelet resolution analysis. By using these DC's, fault indices are calculated. For detection and cataloguing of faults on the t/m/n lines, fault indices are used. These fault indices are compared W & W.O (with and without) ILCSs. For improved regularity, swift detection and more accuracy and smoother signal are possible only using these bior1.5 wavelet analysis. To supply reliable power to the customer more preciseness and swift detection of fault technique is needed to clear the fault. This system is tested under different types of faults applied on four fatal system. The proposed algorithm is verified all types of faults on four fatal system are detected and classified on the proposed system on the system are proved very effectively and more efficiently.**

Keywords—: Power system network, islanding, two area system, multi resolution analysis and faults.

Present day's world populace will be swelling swiftly. So, huge amount of energy will be needed to supply reliable power to the customer Continues power flow are interrupted by faults, mostly these are natural faults. The fault should be mostly affected the efficiency of the t/m/n system. Faster maintenance and refurbishment of supply are helpful for reliable supply and economy improvement to the customer [1]. To supply reliable power to the customer fault detection time period are less and more accuracy type techniques are needed.

Wavelet transform WT techniques are suited for swift and precise detection of fault. WT has different mother wavelets, mother wavelet are chosen for type of application [2]. But here using wavelet analysis, by using this method fault should be detected swiftly, precise and improved regularity to compare other fault detection technique. The main theme is to find out comparison between W & W.O ILCS and find out the best, precise and swift detection of fault detection technique and system.

There is always need to develop pioneering methods for t/m/n line protection. In this paper, Wavelet based MRA is used for detection, cataloguing and position of faults on t/m/n lines. Detail coefficients (DC's) D1 of current signals at both the ends are used to detect and classify the type of fault.

For t/m/n system protection system there are different methods. They are time-graded overcurrent protection, differential pilot-wire protection and distance protection. For very long high voltage t/m/n lines time-graded and pilot-wire protection systems are not appropriate. Differential protection scheme for long lines are more expensive. Differential relay are used for heavy and minor load connected faulty condition [3]. W & W.O ILCS are compared. To get more efficient and effective result from these system. Wavelet analysis technique are used to detect the fault on four fatal system with exact time and frequency [6]. By using this technique detection, cataloguing and position of faults are detected by applying all type of faults on four fatal system [7] and for obtained improved result.

I. ISLANDING

Any fault occur on distribution generation it will have been supplied without interruption of power flow, is known as islanding system. It acts as a parallel operating system. Remote and local detection techniques are used on islanding [8].

II. WAVELET ANALYSIS

It has various techniques for fault detection techniques, they were discrete Fourier transform, Fourier transform and short time Fourier transform. But DFT and FT both of these gives only data. STFT gives both time and frequency data also. But it doesn't gives better result for critical non-stationary disturbances like three phase and short circuit faults. For these reasons WT technique are chosen.

WT provides the time and frequency simultaneously and it is a linear transformation. WT are continuous, discrete and four -resolution techniques. Four -resolution are analyse time-and frequency for all type of faults precisely and gives efficient result that means more reliability and system stability. WT analyse the signal and it decompose the signal into different frequency components and each frequency component will be analysed with resolution matched to its scale. Higher and lower transients are analysed [4].

The following function defined the WT function:

$$\varphi(t) = \sqrt{2}\Sigma h(n)\varphi(2t-n)$$

$$\psi(t) = \sqrt{2}\Sigma g(n)\varphi(2t-n)$$

Where g (n) = $(-1)^n$h (1-n)

Mother wavelet are used for precise and exact decomposition of the signal [5]. WT has different type of mother wavelets, selection of mother wavelet is depend on the type of application.

Here chosen biorthogonal (Bior1.5) mother wavelet. It has a linear phase and symmetric property. It doesn't introduce any visual distortions on the image. For these reasons bior1.5 are chosen. By using these Bior1.5 mother wavelet detail coefficients of current signals are calculated and summation of detail coefficients are used to detect the fault precisely.

III. SYSTEM MODEL AND ANALYSIS

Single line diagram are given below on fig.1.

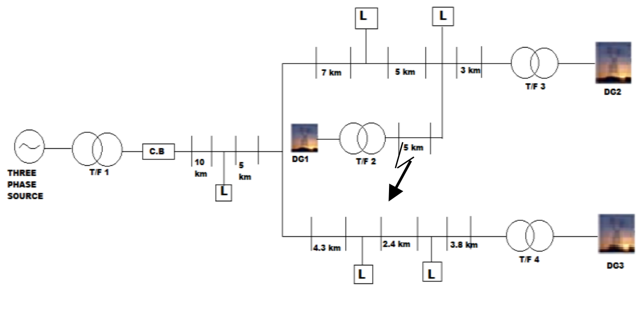


Fig .1 single line diagram for with islanding connected four terminal system

Table.1 System parameters and details

terminal 1	Three phase source	132KV ,900MW Y-g, Phase angle=5^0
terminal 2	DG1	4.16KV, 10.5MVA
terminal 3	DG2	4.16KV, 5MVA
terminal 4	DG3	4.16KV,7.5MVA
T/m/n line (Distributed)		R=0.173 OHM/Km R_0 = 0.432OHM/Km L= 1.15e-3 H/Km L_0=4.78e-3 H/Km C=11.33e-9 F/km, C_0 = 5.01e-9 F/km
Transformers ratings		T/F 1= 132KV/34.2KV T/F 2 = 4.16KV/34.2KV T/F 3 = 4.16KV/64.5KV T/F 4 = 4.16KV/34.5KV
Mother Wavelet		Bior 1.5
Sampling frequency		192Khz
Samples/cycles		32

Four fatal system has been taken, it consists of one three phase source and three distribution generation sources. And this system had alienated into nine zones and faults are applied at four fatal s. Fig.2 gives details and parameter.rs of the system.

W & W.O islanding systems had taken, and symmetrical and unsymmetrical faults should be applied at each four fatal on four fatal system. DC's of fault indices are calculated by using wavelet based MRA W & W.O islanding four fatal fault indices are compared at four fatal values to get precise, efficient and improved result for system stability and reliability.

Wavelet based fault indices on four fatal system W & W.O islanding system. Firstly consider without ILCS and it should be alienated into nine zones and it had four fatal s and at each fatal it had some length and applied fault between half of the distance of the length. Three phase fault should be applied between half of the distance of each fatal and all type of faults are applied. Same process will be done for W & W.O ILCS. By using MATLAB simulation, Bior1.5 program will be run. It gives 32 samples for cycle. Sampling frequency is 192 KHz and 60 Hz frequency. To obtained more efficiency and accuracy result for system protection these method are used.

IV. RESULTS AND DISCUSSION

DC's of fault indices are obtained from wavelet based MRA and three phase current signals are obtained. In figure.3 shows variation between W & W.O ILCS on fatal -1 and fault will be applied between 10 KM distance. Detection and discrimination of fault indices are observed below.

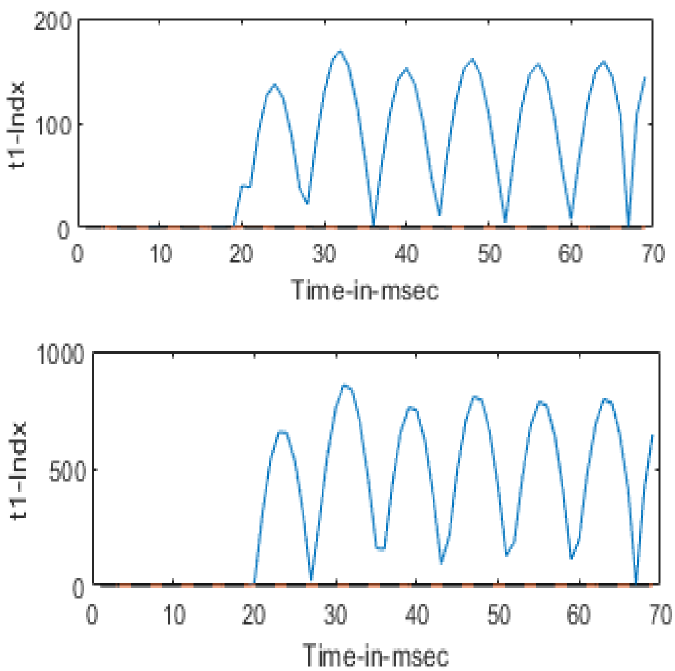
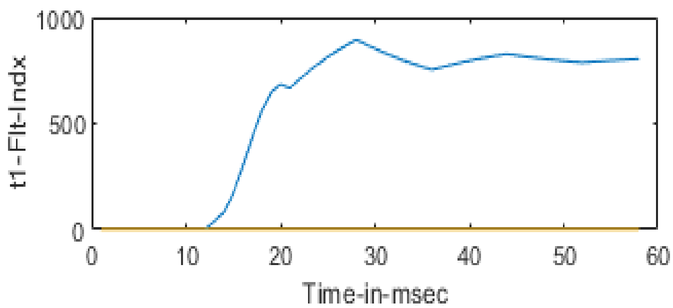


Fig.3 L-G fault analysis of summation of the detail co-efficient at fatal -1 W & W.O ILCS



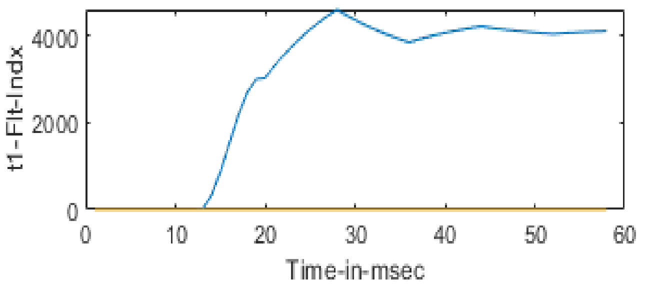


Fig.4 L-G fault detection at fatal -1 W & W.O ILCS

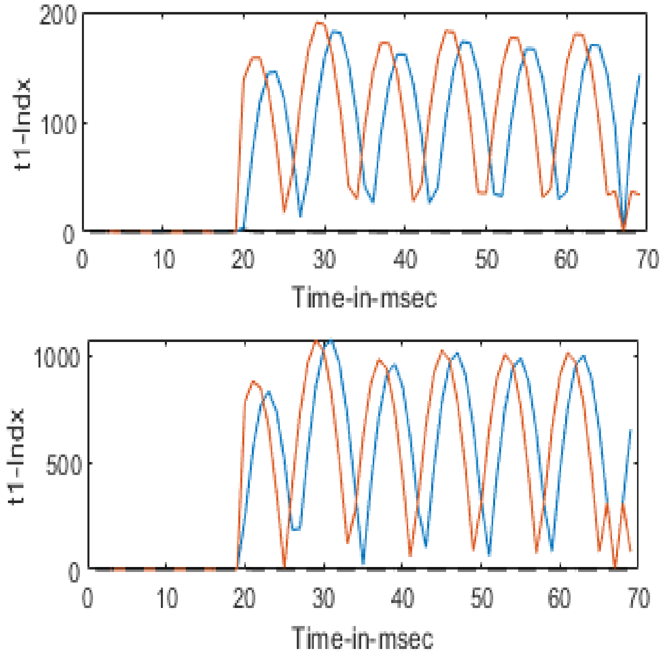


Fig.5 LL-G fault analysis of summation of the detail co-efficient at fatal -1 W & W.O ILCS

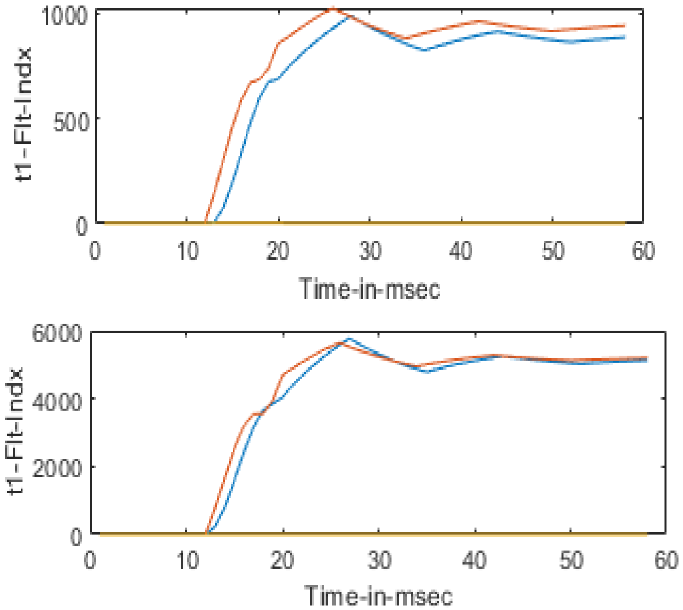


Fig.6 LLG fault detection at fatal -1 W & W.O ILCS

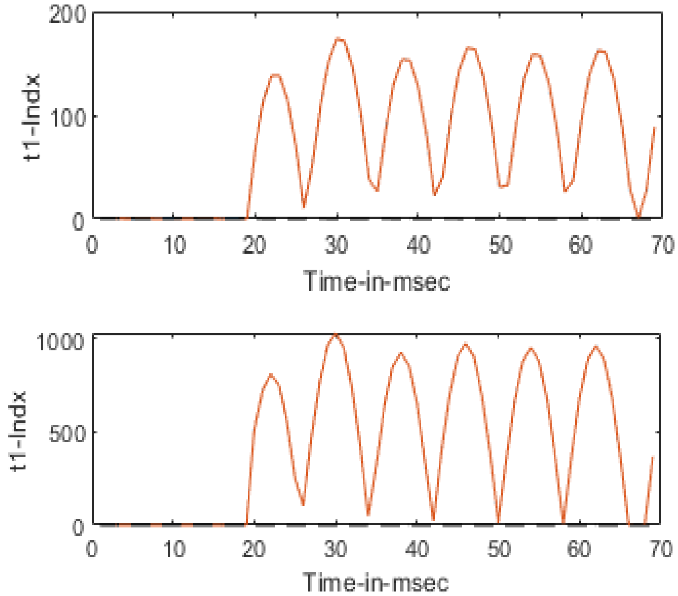


Fig.7 L-L fault analysis of summation of the detail co-efficient at fatal -1 W & W.O ILCS

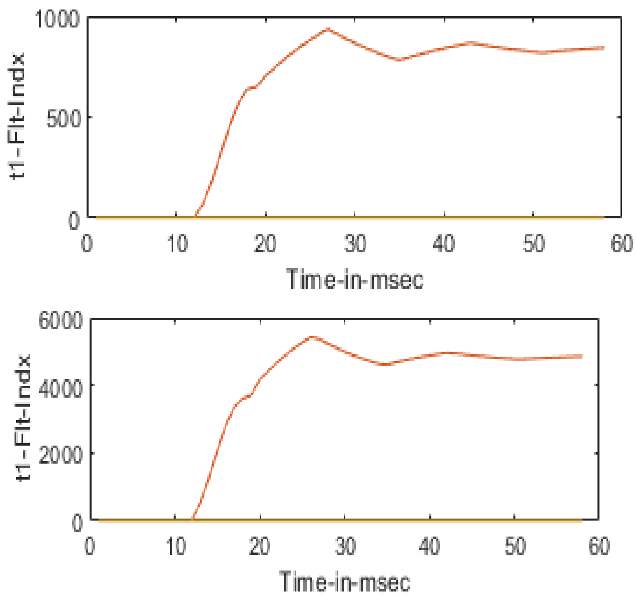
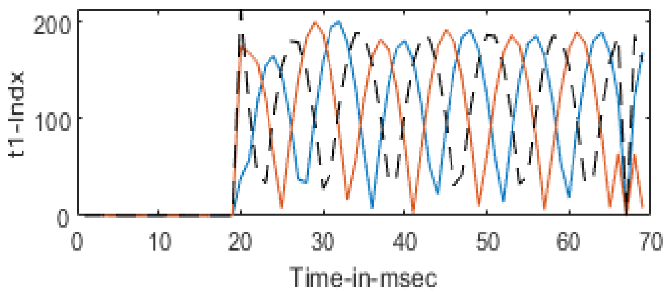


Fig.8 L-L fault detection at fatal -1 W & W.O ILCS



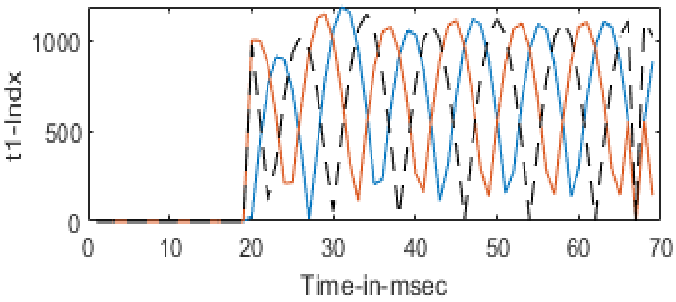


Fig.9 LLL fault analysis of summation of the detail co-efficient at fatal -1 W & W.O ILCS

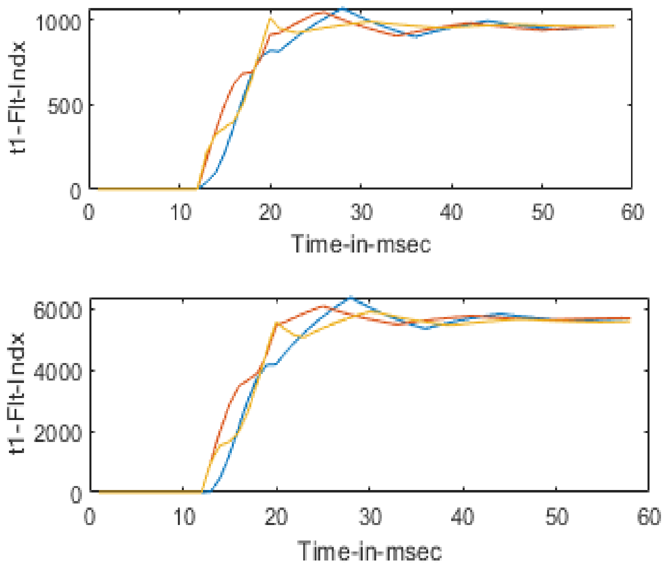
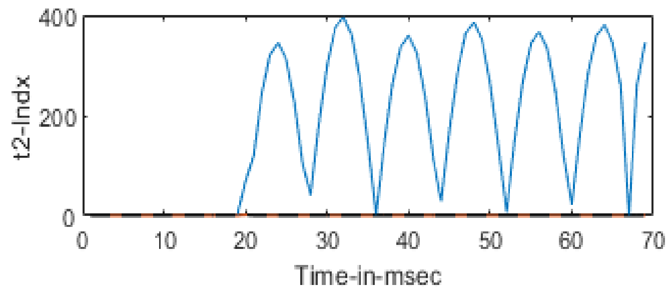


Fig.10 LLL fault detection at fatal -1 W & W.O ILCS

Fig.3 shows fault analysis of summation of the detail co-efficient at fatal -1 W & W.O ILCS. Applied L-G at fatal -1 with islanding system shown fault accuracy at 200 and without islanding system shown at 1000. So more fault accuracy will have been detected at without ILCS. And also detection time period had given 20msec, fault detected at 10msec. It means fault detection time period has been detected swiftly. Observed in figure-3. In fig.2 L-G fault detection W & W.O ILCS results are shown here, observed that more accuracy should be obtained on with ILCS and swift fault detection also possible here detection time at 10msec are observed.

At fatal -1 L-G, LL-G, L-L and LLL faults are applied on W & W.O ILCSs. From these more precision and swift detection are possible with ILCS.



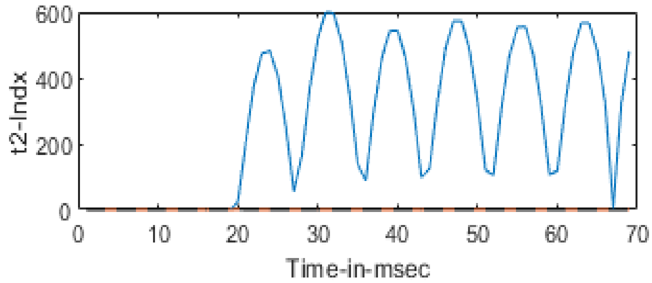


Fig.11 L-G fault analysis of summation of the detail co- efficient at fatal -2 W & W.O ILCS

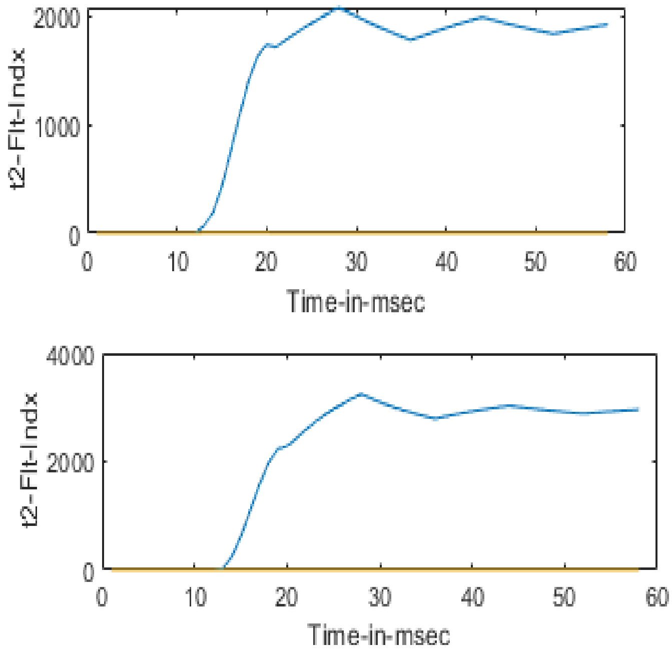


Fig.12 L-G fault detection at fatal -2 W & W.O ILCS

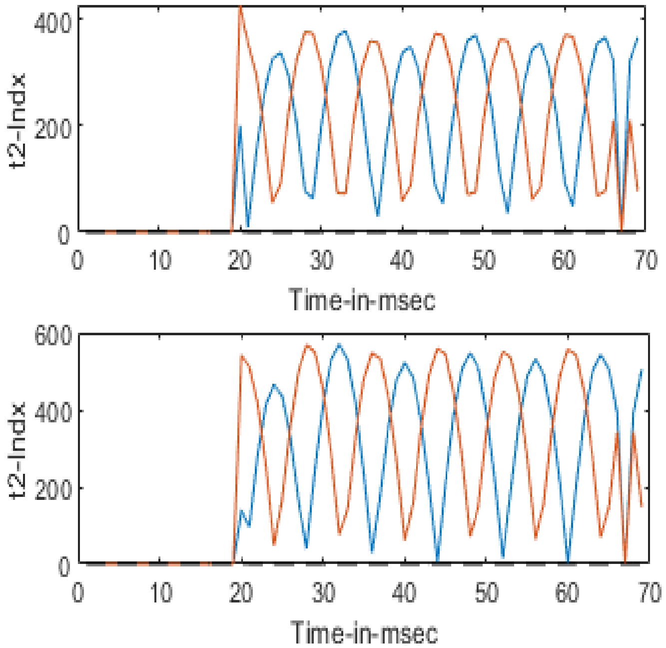


Fig.13 LL-G fault analysis of summation of the detail co- efficient at fatal -2 W & W.O ILCS

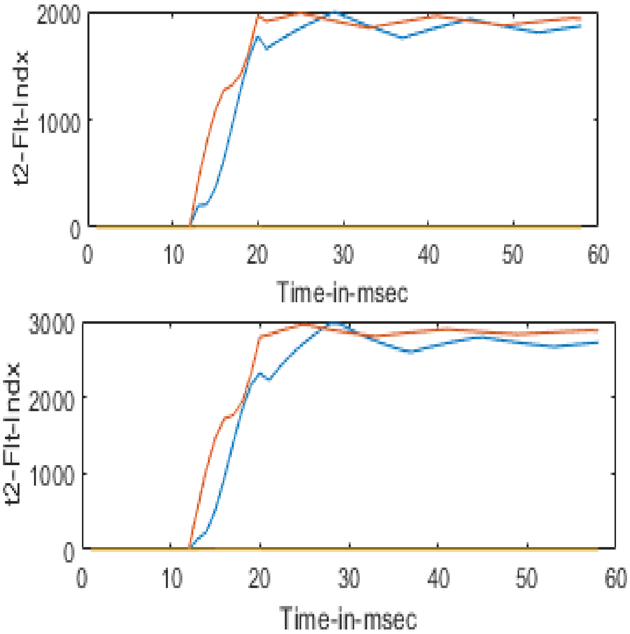


Fig.14 LL-G fault detection at fatal -2 W & W.O ILCS

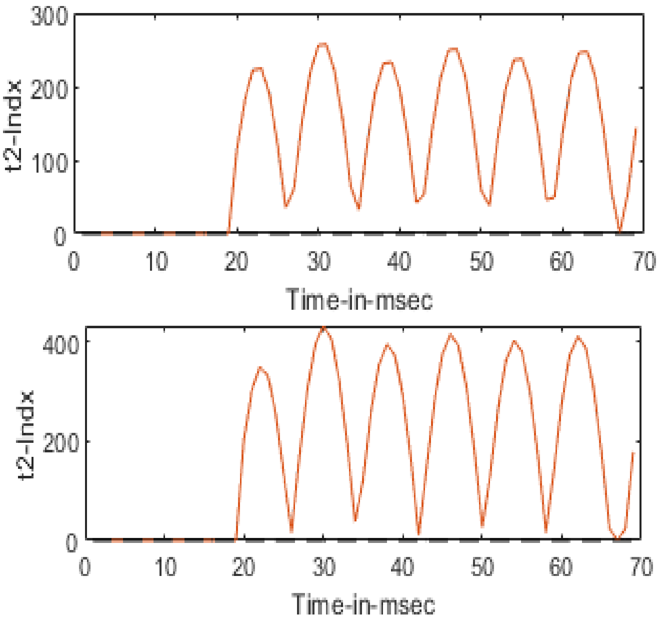
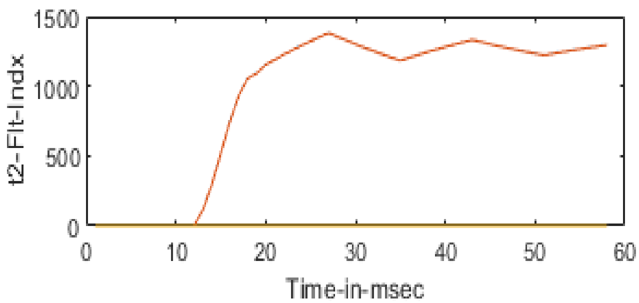


Fig.15 L-L fault analysis of summation of the detail co- efficient at fatal -2 W & W.O ILCS



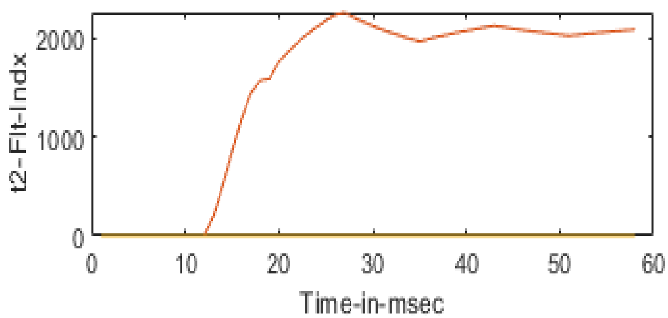


Fig.16 L-L fault detection at fatal -2 W & W.O ILCS

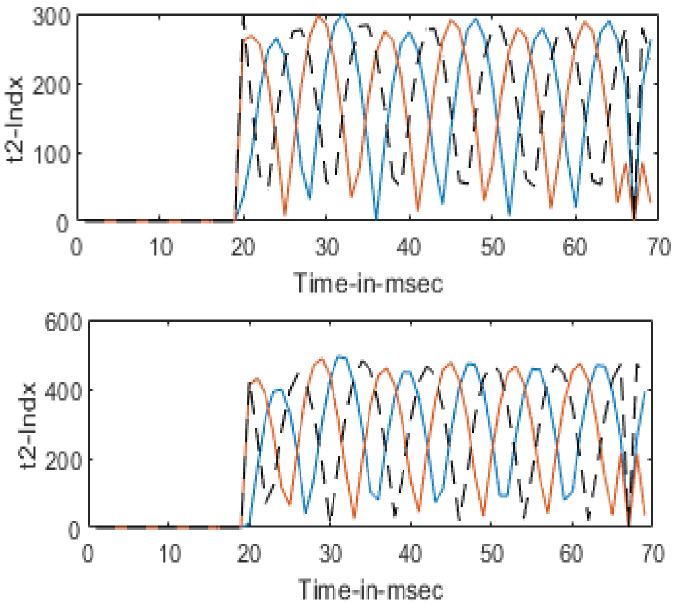


Fig.17 LLL fault analysis of summation of the detail co-efficient at fatal -2 W & W.O ILCS

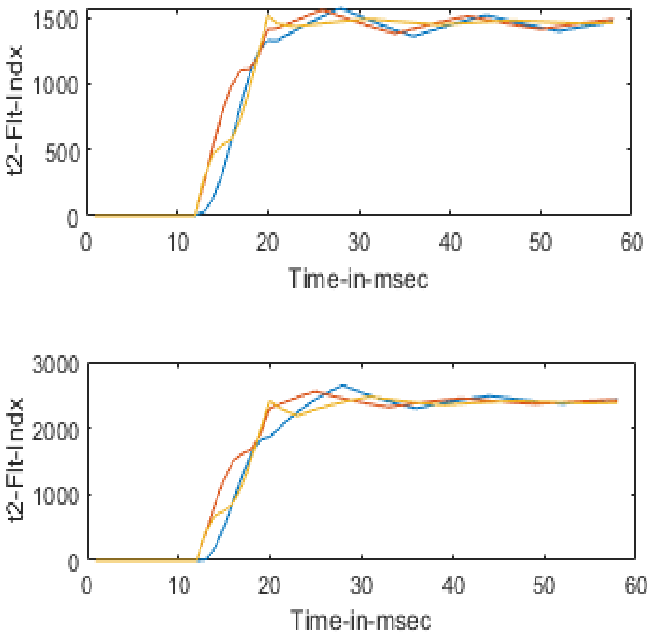


Fig.18 LLL fault detection at fatal -2 W & W.O ILCS

From fig.11 to fig.18 are fatal -2 faults. L-G, LL-G, L-L and LLL faults are applied at fatal -2. Figure-11 are summation of the detail coefficients of W & W.O ILCS. In figure-12 are fault detection of W & W.O islanding connected system.

More accuracy and swift detection are obtained. Compare to fig.11 and fig.12, in fig.11 W & W.O islanding systems, accuracy are 400 and 600. Fault detection time perion at 20msec. fig .12 W & W.O islanding detection resuls are shown from these W & W.O ILCS detection L-G fault accuracy are 2000 and 4000 and time period at 10.3msec. compare to these two figures more accuracy and swift detection are obtained on figure.12. Moreover ILCS gives improved efficiency. At all faults gives same result.

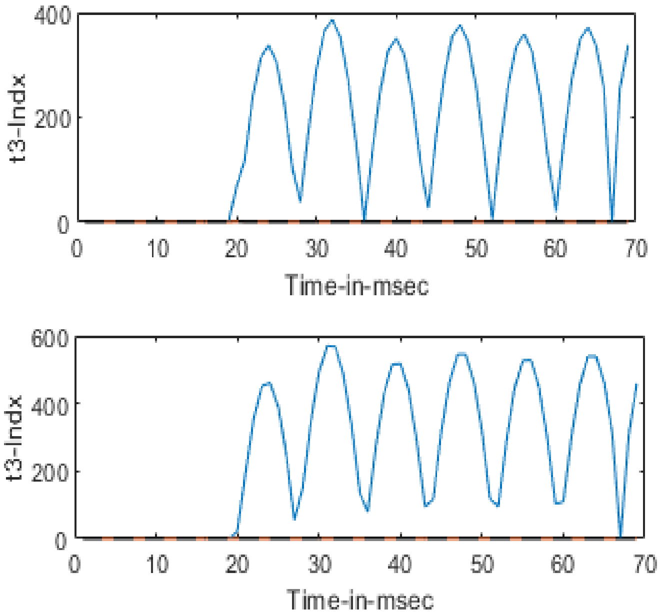


Fig.19 L-G fault analysis of summation of the detail co-efficient at fatal -3 W & W.O ILCS

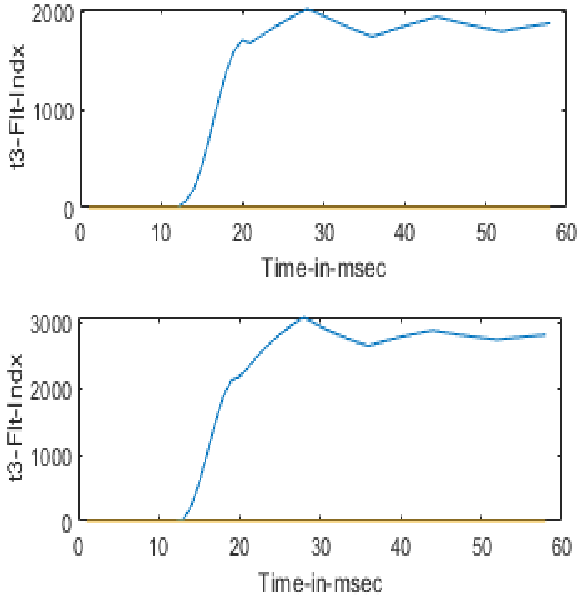


Fig.20 L-G fault detection at fatal -3 W & W.O ILCS

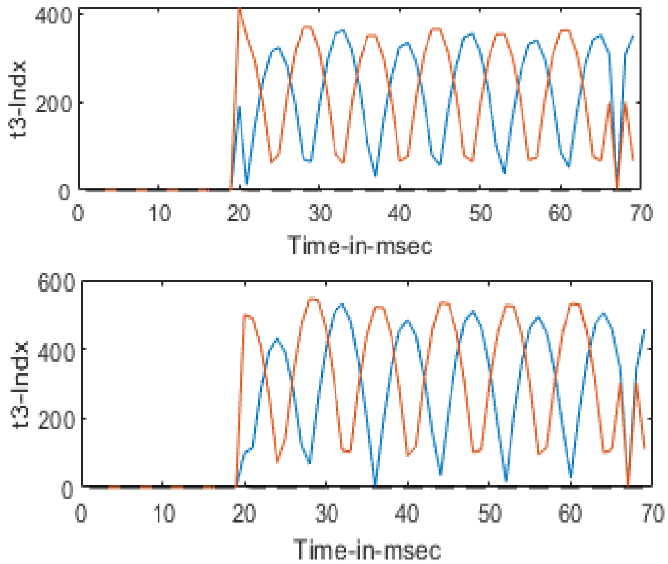


Fig.21 LL-G fault analysis of summation of the detail co-efficient at fatal -3 W & W.O ILCS

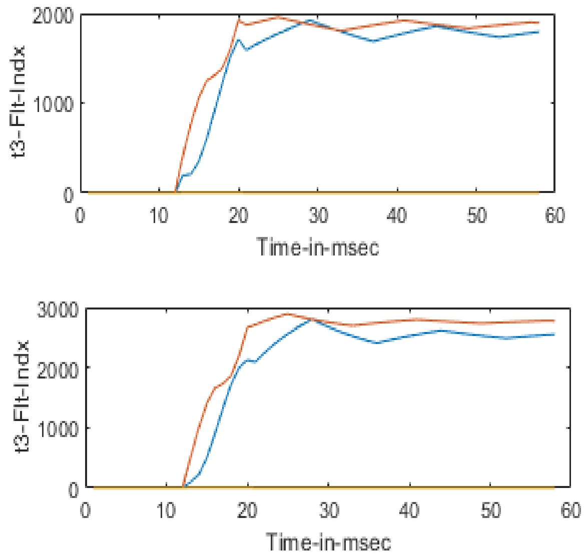


Fig.22 LL-G fault detection at fatal -3 W & W.O ILCS

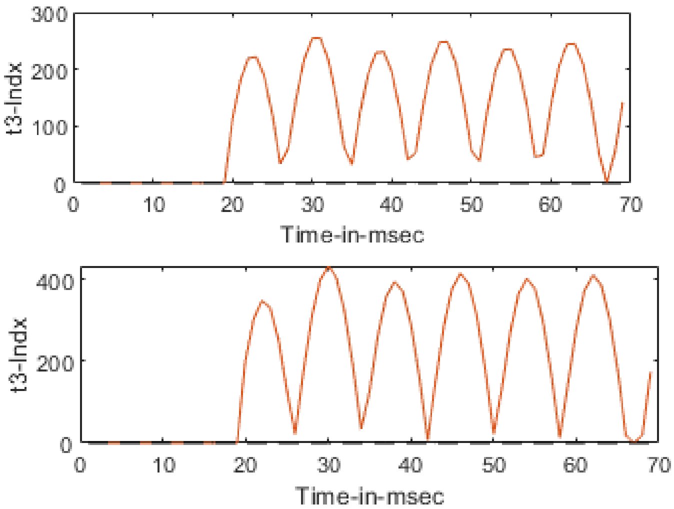


Fig.23 L-L fault analysis of summation of the detail co-efficient at fatal -3 W & W.O ILCS

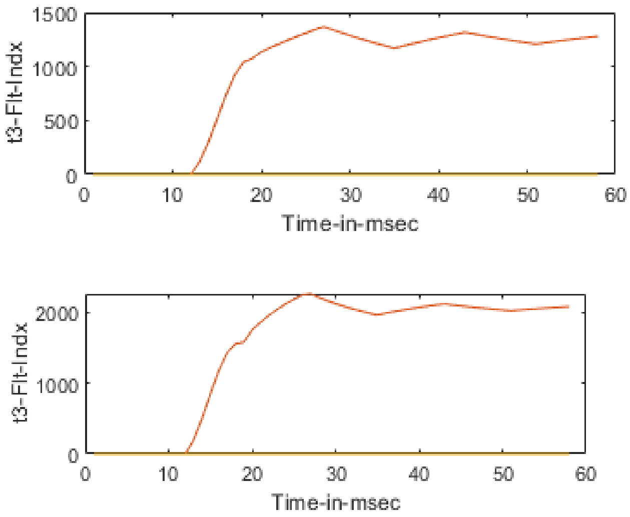


Fig.24 L-L fault detection at fatal -3 W & W.O ILCS

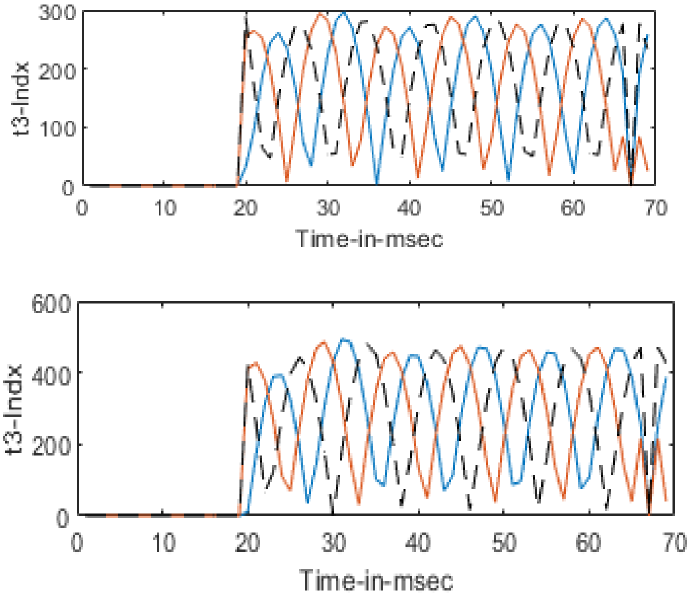


Fig.25 LLL fault analysis of summation of the detail co-efficient at fatal -3 W & W.O ILCS

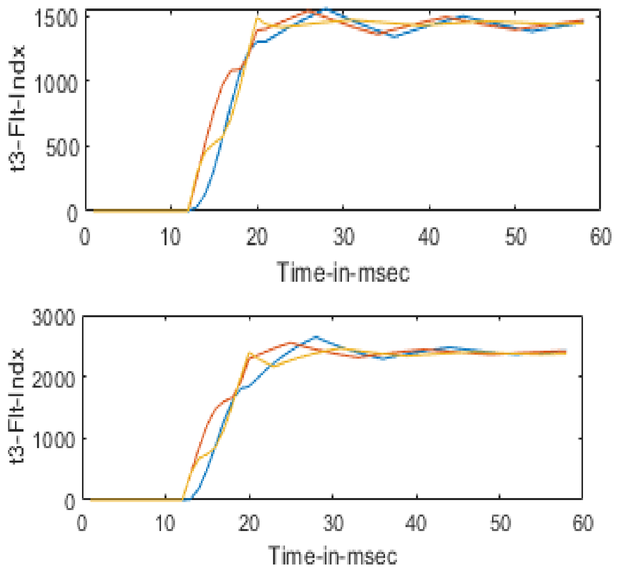


Fig.26 LLL fault detection at fatal -3 W & W.O ILCS

From fig.19 to fig.26 fatal -3 faults are detected. Here also L-G, LL-G, L-L and LLL faults are applied on W & W.O ILCSs at fatal -3. Compare fig.19 and fig.20, more accuracy and swift detection are obtained. Actually fig.19 detail coefficient accuracy 400 and 600 time period 20msec on W & W.O islanding systems but exact results are obtained on fig.20 detection accuracy are increased i.e., 2000 and 3000 and detection time period are less i.e., 10.5msec W & W.O islanding systems. At fatal -3 more accuracy and swift fault detection are possible only wavelet analysis technique and also ILCS gives more accuracy. Same results are obtained ferom remaining faults also.

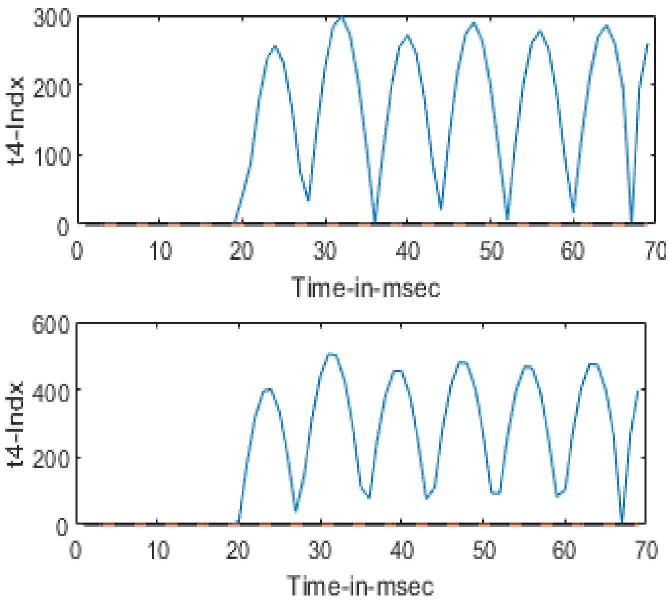


Fig.27 L-G fault analysis of summation of the detail co-efficient at fatal -4 W & W.O ILCS

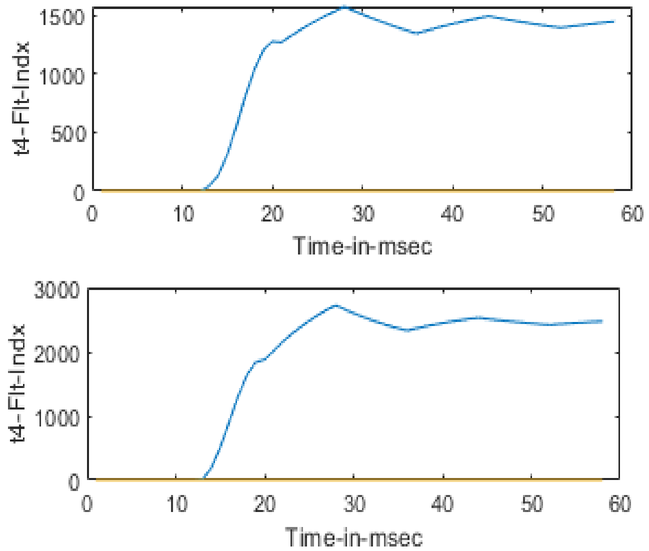


Fig.28 L-G fault detection at fatal -4 W & W.O ILCS

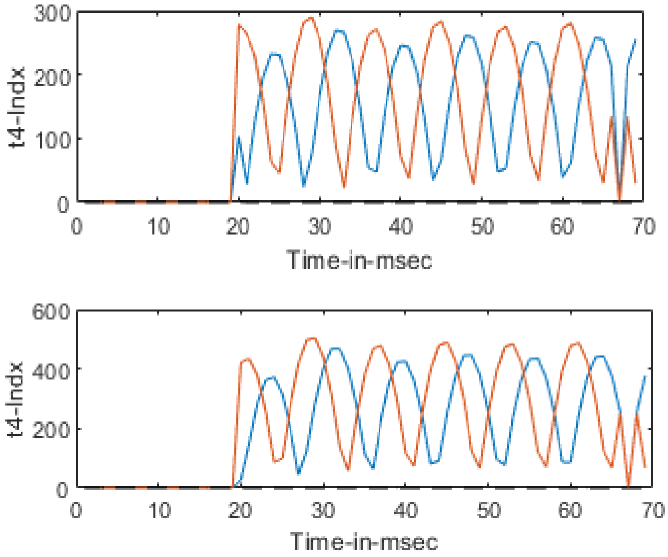


Fig.29 LL-G fault analysis of summation of the detail co-efficient at fatal -4 W & W.O ILCS

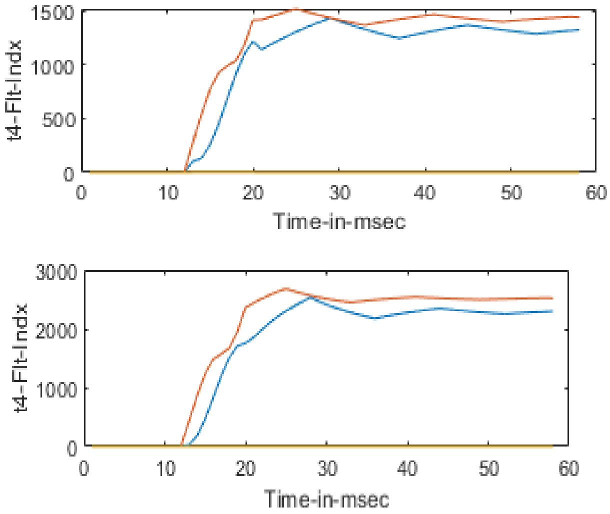


Fig.30 LL-G fault detection at fatal -4 W & W.O ILCS

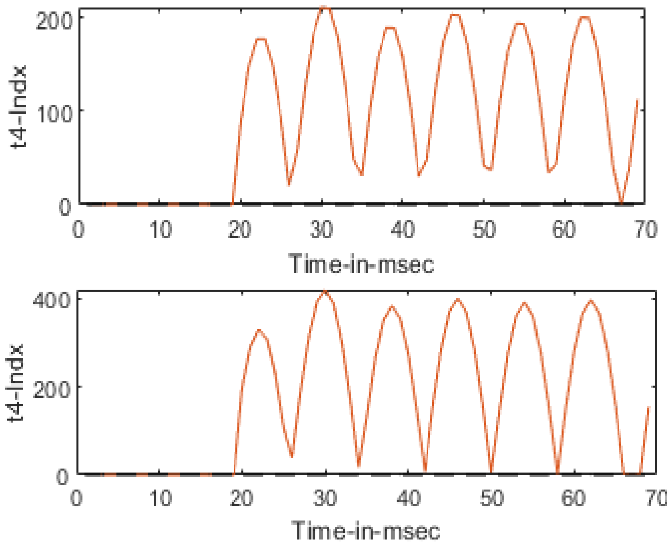


Fig.31 L-L fault analysis of summationmation of the detail co-efficient at fatal -4 W & W.O ILCS

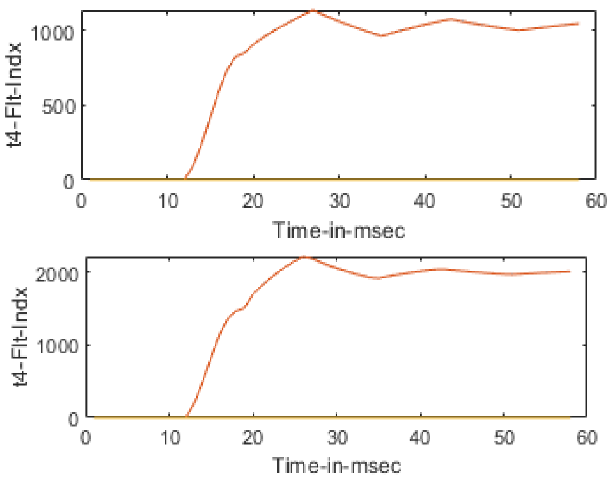


Fig.32 L-L fault detection at fatal -4 W & W.O ILCS

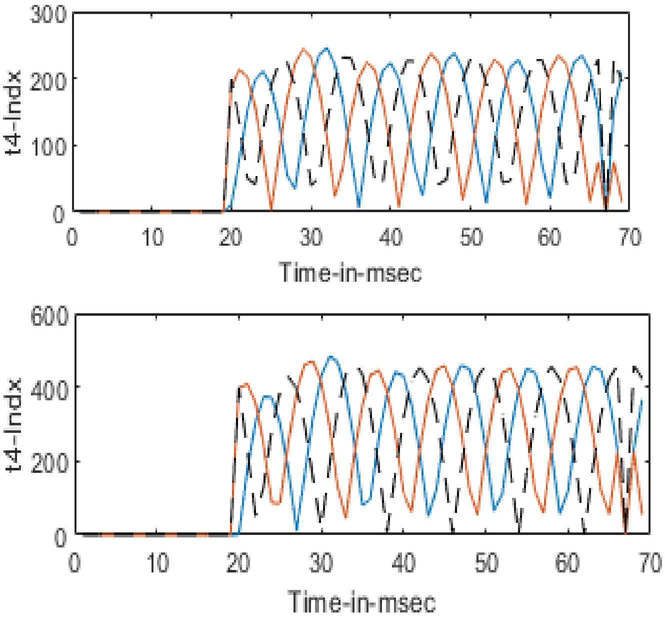


Fig.33 LLL fault analysis of summation of the detail co-efficient at fatal -4 W & W.O ILCS

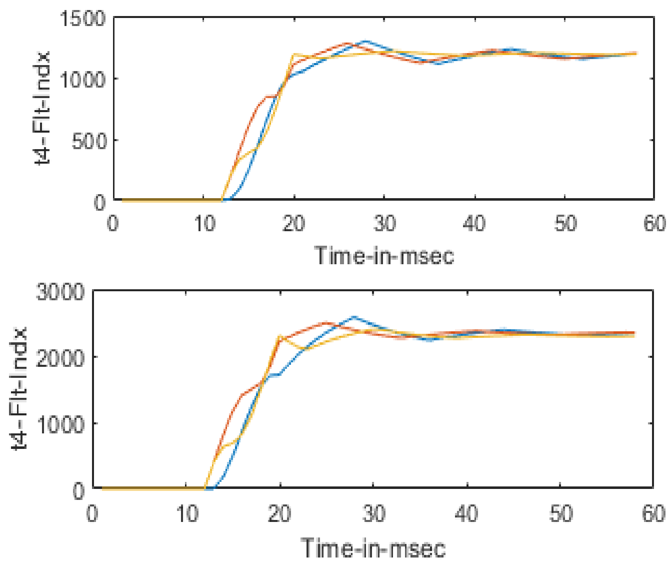


Fig.34 LLL fault detection at fatal -4 W & W.O ILCS

From fig.27 to fig.34 are fatal -4 faults. In fig. 27 L-G fault summation of the detail coefficient on fatal -4 W & W.O ILCS. Accuracy are 300 and 600, time period are 20msec. But on fig.28 same L-G fault detection accuracy are 1500 and 3000. Time period are 10.4msec W & W.O ILCSs. From these more accuracy and swift detection are obtained on fog.28 i.e., wavelet analysis technique. Compare to W & W.O ILCSs more accuracy and swift detection are obtained in ILCSs. Same results are obtained on remaining faults at fatal -4.

V.CONCLUSION

By using four fatal system fault analysis are obtained from W & W.O ILCS. Symmetrical and unsymmetrical faults are applied on these two systems. Single line to ground fault, double line to ground fault, line to line fault and three line faults are applied. One three phase source and three distribution generation sources are used on four fatal system. The main theme is swift, precise and clear fault detection. These outputs are obtained comparing W & W.O ILCSs. Comparing these two system DC swift, precise and clear fault detection are possible by using with ILCS.

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