Paris Session 2022

cigre
For power system expertise

Synchrophasor Application to Improve Fault Location and Identification

B5 PROTECTION AND AUTOMATION

PS2 – Applications of emerging technology for protection, automation and control, Q2.03

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Presentation Time to be Proposed: 3 or 4 min

Question 2.03: What are the experiences to fault identification and location and how to design the scheme to meet the practical application requirement?

PMU Class:

- According to IEEE and IEC Standards ➔ Class M (monitoring applications) and Class P (applications requering minimum delay times);

Digital Windowing:

- Main contribution ➔ weigth the samples of FT (Hann, Hamming, Flat-Top, Rife-Vincent, etc);
- Windowing type used in the simulation ➔ Haaming for class M ➔ presents a "sinusoidal" format (duration of 10 data cycles) and Triangular windowing for class P (duration of 2 data cycles);

PMU Phasor Estimation

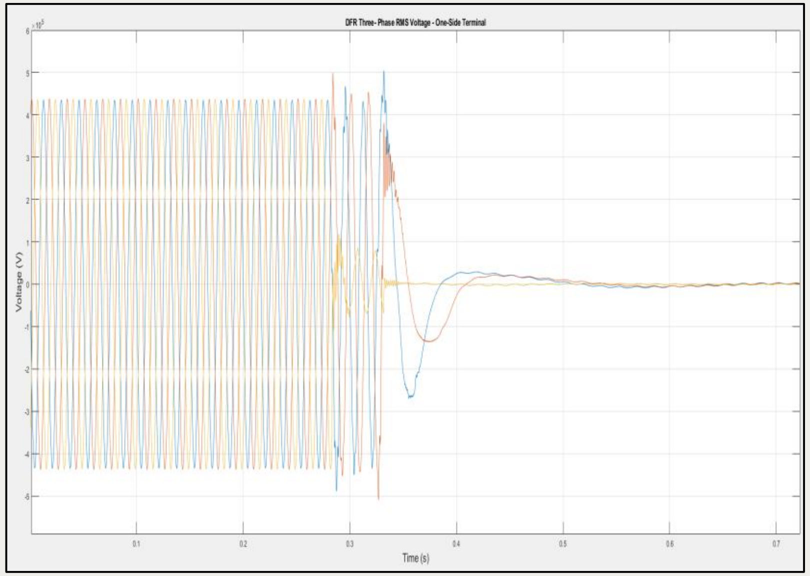
- Class M and P modeled in Matlab/Simulink with frame-rate of 60fps and also 480fps;
- DFT Recursive was used in ATP (Models);

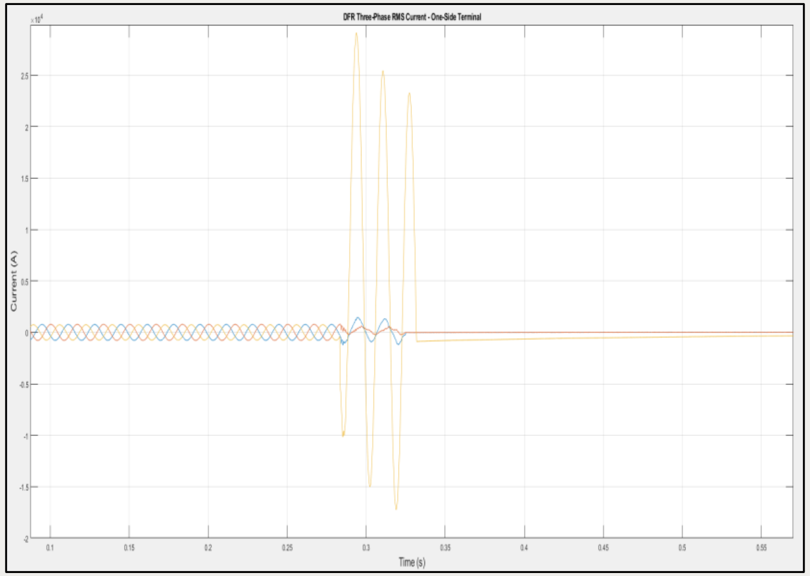
Método / Abordagem:

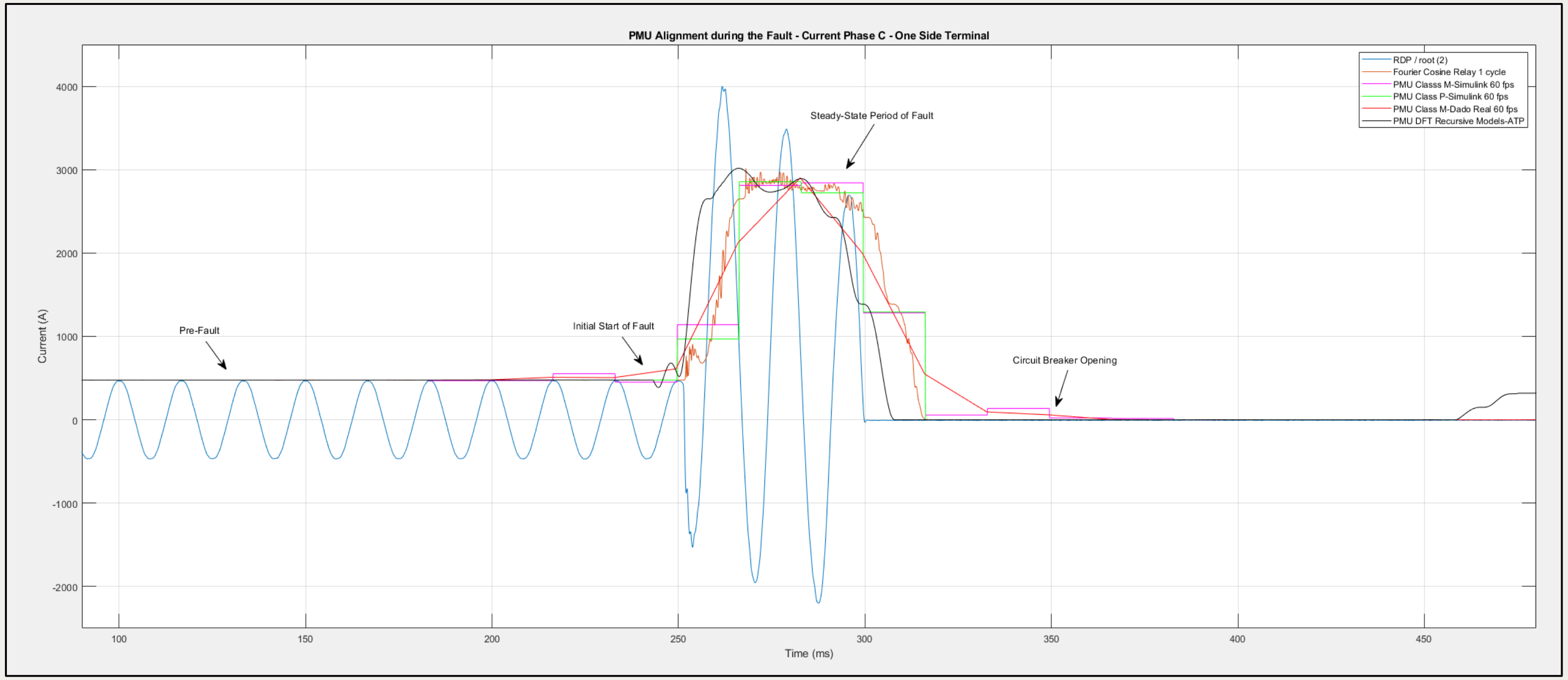
1) Real data from a disturbance was used and, via Matlab/Simulink and ATP software, the data was converted to PMU data,according to IEEE C37.118 standard, with frame-rate of 60fps and 480 fps, respectively;

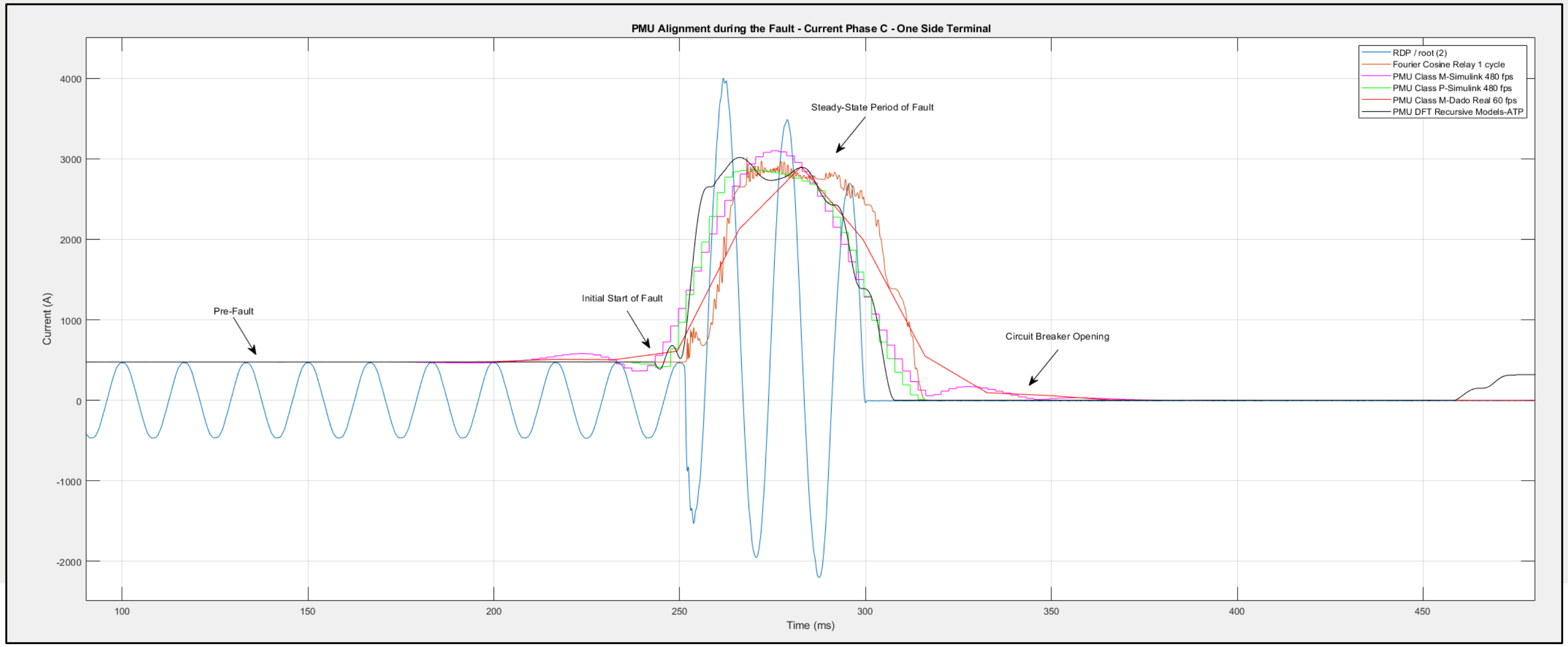
2) Results were compared.

PMU Phasor Estimation









Results

Table 1 – Data Obtained from DFR and PMU during the Fault for FL Algorithm Calculation

Terminal 'A'	VA (kV)	θVA $(°)$	VB (kV)	θVB $(°)$	VC (kV)	θVC $(°)$	IA (A)	θIA $(°)$	IB (A)	θIB $(°)$	IC (A)	θIC $(°)$
DFR	287,0	154,0	285,0	26,3	218,0	268,2	718,0	337,0	27,9	249,0	2736,0	188,5
PMU	289,0	85,7	296,0	-40,0	220,0	-158,0	707,0	89,0	15,0	-43,0	2902,0	-58,0
Terminal 'B'	VA (kV)	θVA $(°)$	VB (kV)	θVB $(°)$	VC (kV)	θVC $(°)$	IA (A)	θIA $(°)$	IB (A)	θIB $(°)$	IC (A)	θIC $(°)$
DFR	305,0	166,0	318,0	53,3	51,8	281,6	745,0	189,6	214,0	129,7	14215,0	211,2
PMU	169,0	28,3	251,0	-45,0	10,0	-12,0	99,6	-137,0	377,0	-86,0	11177,0	-56,0

The real TL data used in the implemented algorithm (two-terminals) were: $L = 147\ km,\ R^{+} = 3{,}35\ \Omega\ and\ \ X^{+} = 50{,}58\ \Omega.$

Using the two-terminal fault location algorithm (DFR and PMU data), according to the methodology described by (Tziouvaras, et al., 2004), the results presented in Table 2 were obtained, having the FL estimation from Relay as reference.

Table 2 – FL Estimation

Terminal	PMU (km)	RDP (km)	R_{falta} $Estimation$ (Ω)	FL $Protection\ Relay$ (km)	$PMU\ Error$ $(\%)$	$DFR\ Error$ $(\%)$
From A to B	139,94	139,46	0,38	140,17	**- 0,16**	**-0,51**

Conclusions

- Use of synchrophasor information for FL in power systems is still little explored, especially with class M PMUs;
- The results obtained with the real PMU data, referring to a real disturbance in BIPS, presented an excellent result, with an estimated error of only 235 meters (less than 1 tower for this 500 kV voltage level), when compared to the FL estimated by the algorithm of protection relays and DFRs;
- The results showed that although the M-class PMU had a larger data window when compared with P-class PMU, there were samples in the "steady state" window of the transient event available to the FL algorithm calculation;
- A PMU with 480 fps and a PMU with Recursive DFT showed a larger amount of data during the period under analysis, however, having a PMU with 480 fps may impose a very significant data load on the communication channel, so the need and application of the project should be evaluated.