



Protection Lines with Series Compensations New tools

AUTHORS:

Francisco A. Reis Filho

**Farfilho Consulting, Trading and
Representations LTDA**

Eduardo Cesar Senger

University of São Paulo(USP)

Rodrigo A. Benes Ferreira

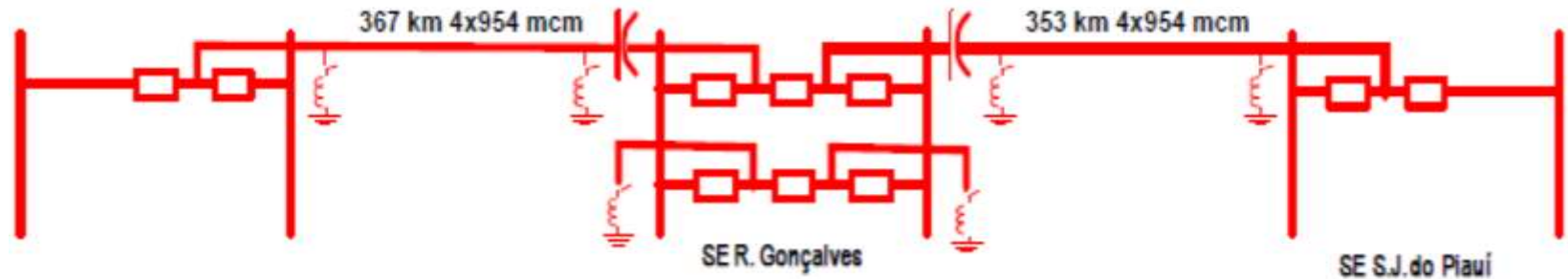
Siemens

Giovanni Manassero Junior

University of São Paulo(USP)



Introduction :



System of 500 kV – IENE – SE's Colinas – Ribeiro Gonçalves – São João do Piauí.

Note: all reactors are banks of 3x60 Mvar

Capacitive compensation series of 48% in LT COL-RGO and 49% in LT RGO-SJP.

Changing settings of the 500 kV line – Ribeiro Gonçalves – S.J do Piauí.

Settings	Initial Value		Proposed Value	
	Z1P	Z1N	Z1P	Z1N
Ribeiro Gonçalves	30.67 Ω	26.22 Ω	15.94 Ω	13.11 Ω
S.J do Piauí	2.49 Ω	2.22 Ω	2.24 Ω	1.99 Ω

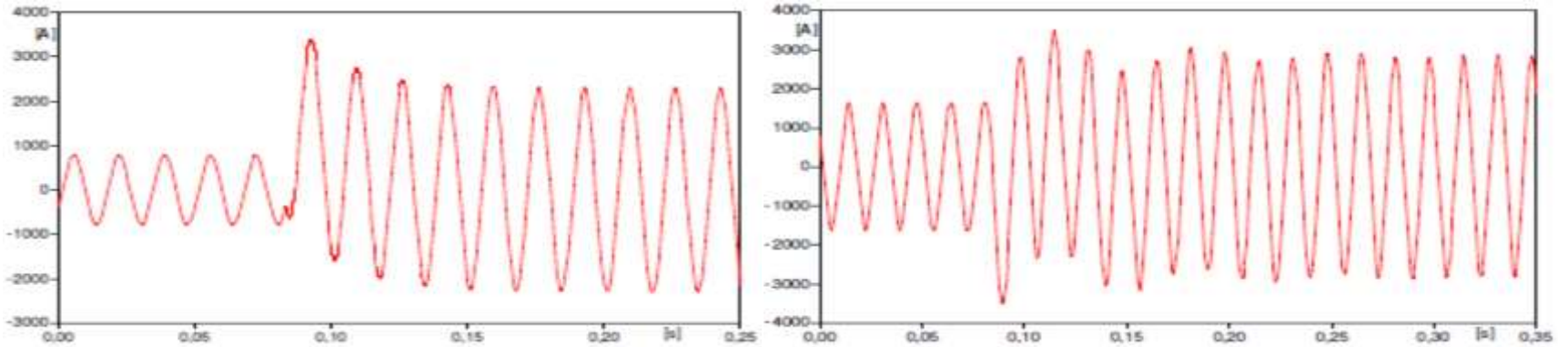
Changing settings of the 500 kV line – Ribeiro Gonçalves – Colinas.

Settings	Initial Value		Proposed Value	
	Z1P	Z1N	Z1P	Z1N
Ribeiro Gonçalves	28 Ω	25.78 Ω	14.56 Ω	12.89 Ω
Colinas	13.40 Ω	12 Ω	11.39 Ω	9.96 Ω

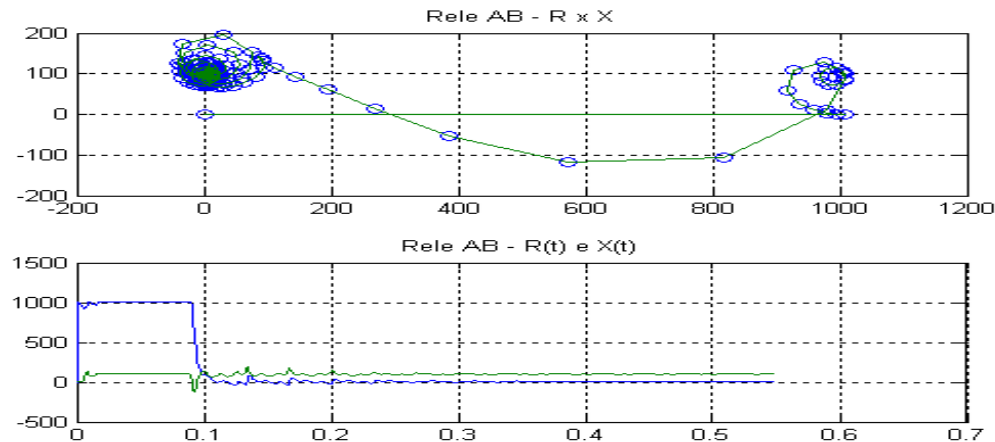
Introduction

- Main Objectives :
- Identification the presence of series capacitor in the fault loop ;
- Protection block 21 (Zone 1);
- Determination of the fault direction;
- Action decision until $\frac{3}{4}$ of cycle.

Introduction

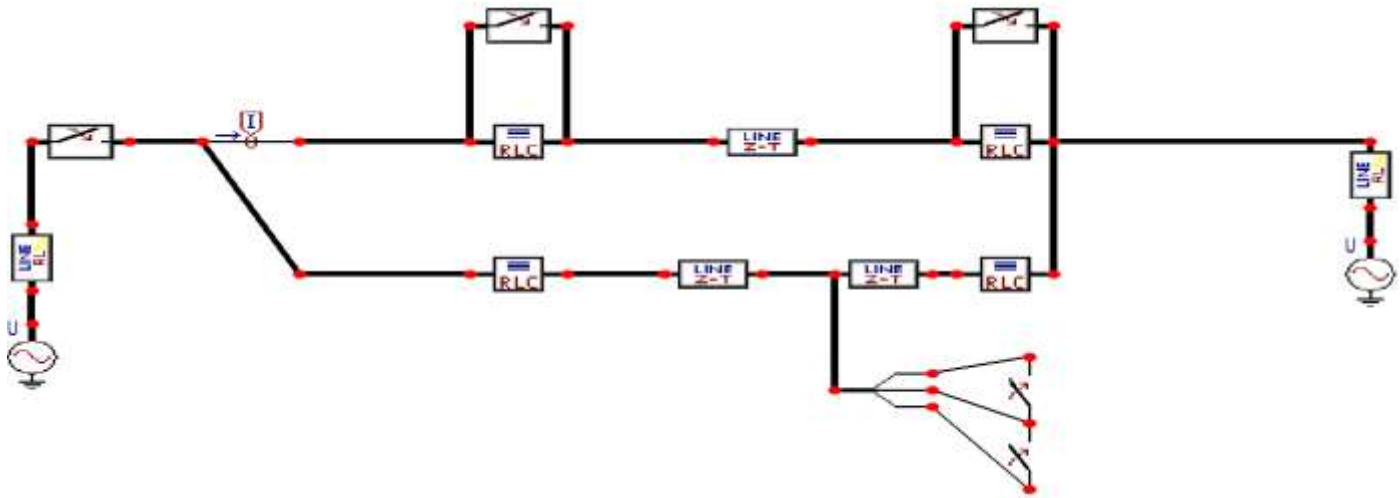


Typical waveform-R-L Circuit and typical waveform-R-L-C Circuit.

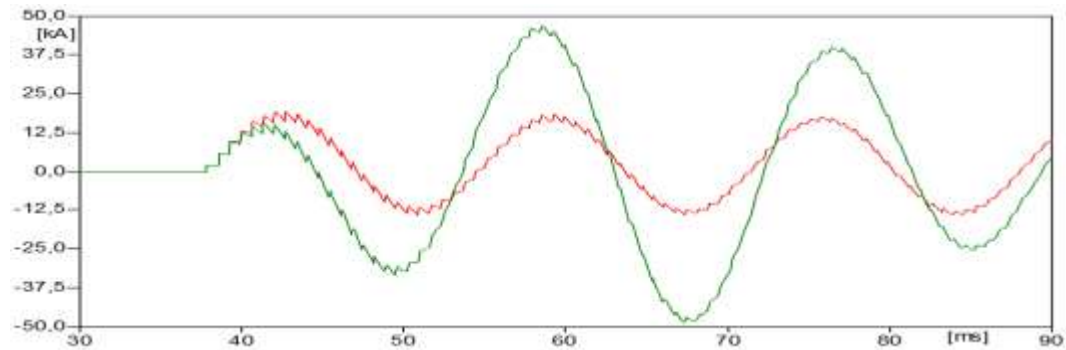


Excursion of Impedance vector – Loop Inductive – Capacitive.

Modeling



Circuit in ATP.



Typical waveforms for fault Loops.

Red → Inductive Loop

Green → Induction-Capacitive Loop

Theoretical Foundation

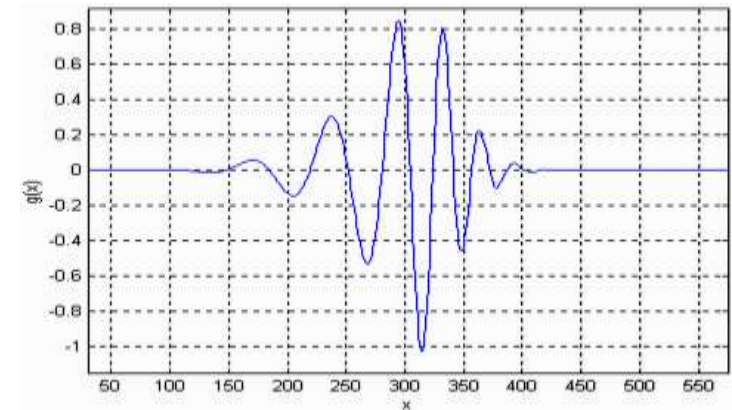
Discrete Wavelet Transform:

$$(W_{\psi} x)(m, n) = \frac{1}{\sqrt{a_0^m}} \int_{-\infty}^{+\infty} x(t) \cdot \psi \left(\frac{t - n \cdot a_0^m \cdot b_0}{a_0^m} \right) dt$$

Where:

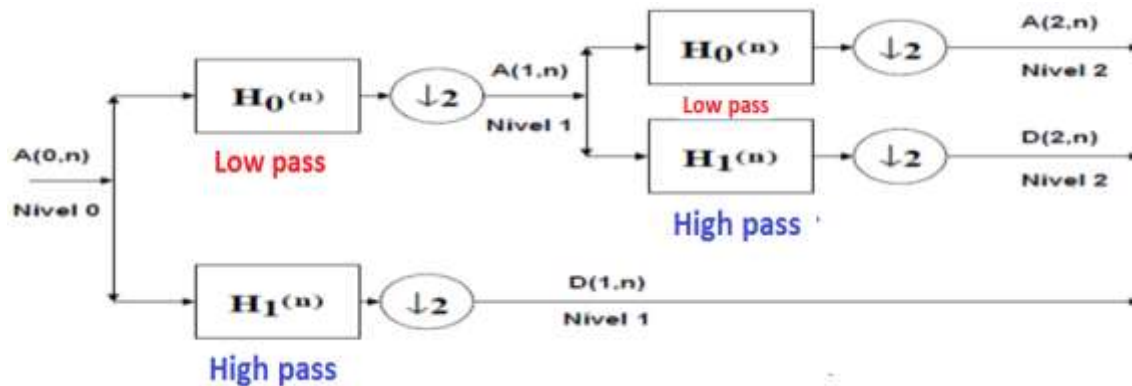
$a \rightarrow$ Parameter scale,

$b \rightarrow$ Translational Parameter with m and n and Z , $a_0 > 1$ and $b_0 \neq 0$.



Mother Wavelet – Daubechies 10.

MRA Pyramidal Algorithm:



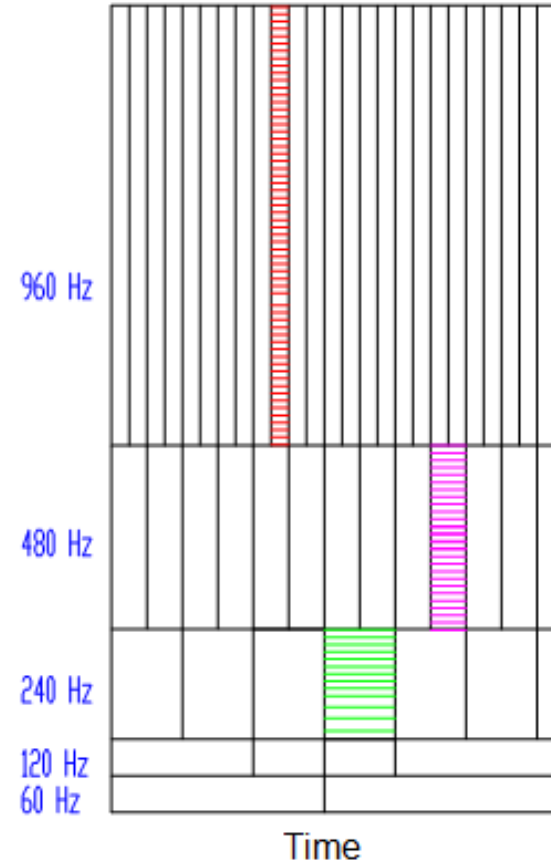
MRA Algorithm - Multi Resolution Analysis.

Theoretical Foundation

Discrete Wavelet Transform:

Fa = 30720 Hz (512 samples/cycle)

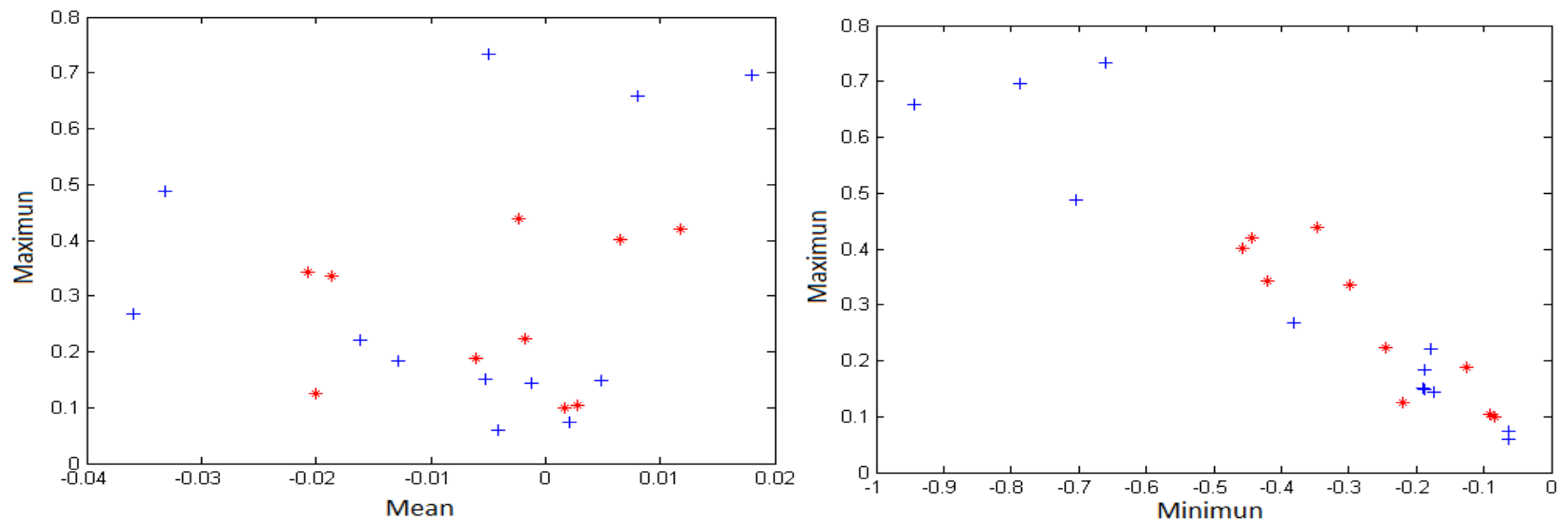
Wavelet Level	Frequency Range(Hz)	
	Min	Max
1	7680	15360
2	3840	7680
3	1920	3840
4	960	1920
5	480	960
6	240	480
7	120	240
8	60	120
9	30	60



Detection of Subsynchronous Component

1st Approach: Transitional

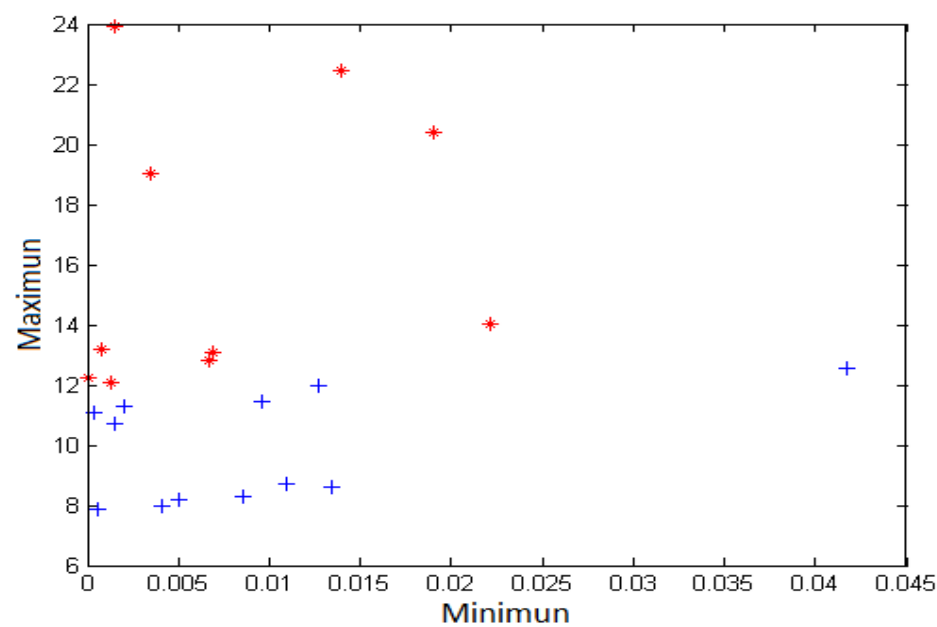
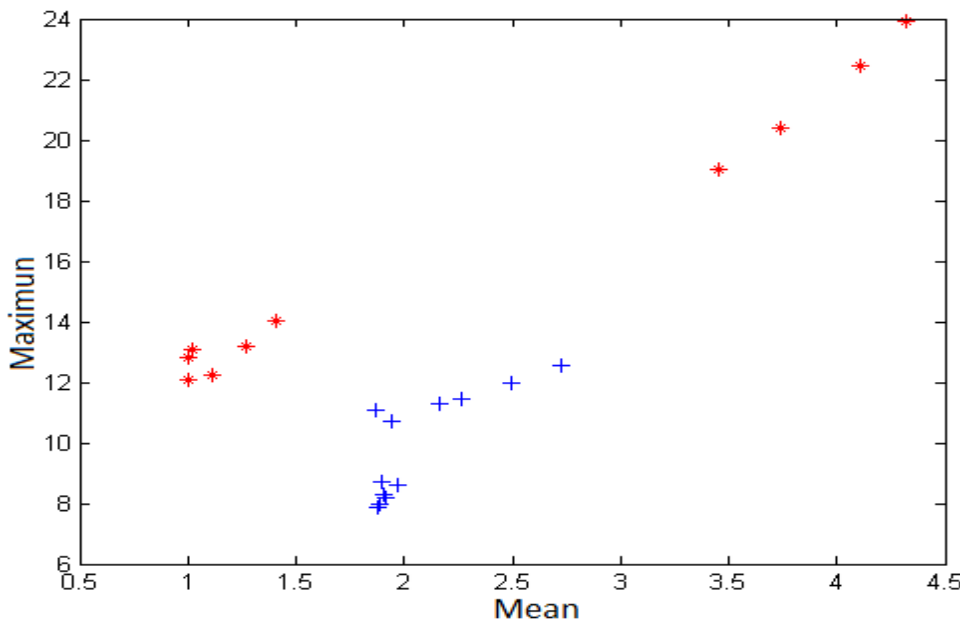
Separation Plan: Wavelet Detail level 5



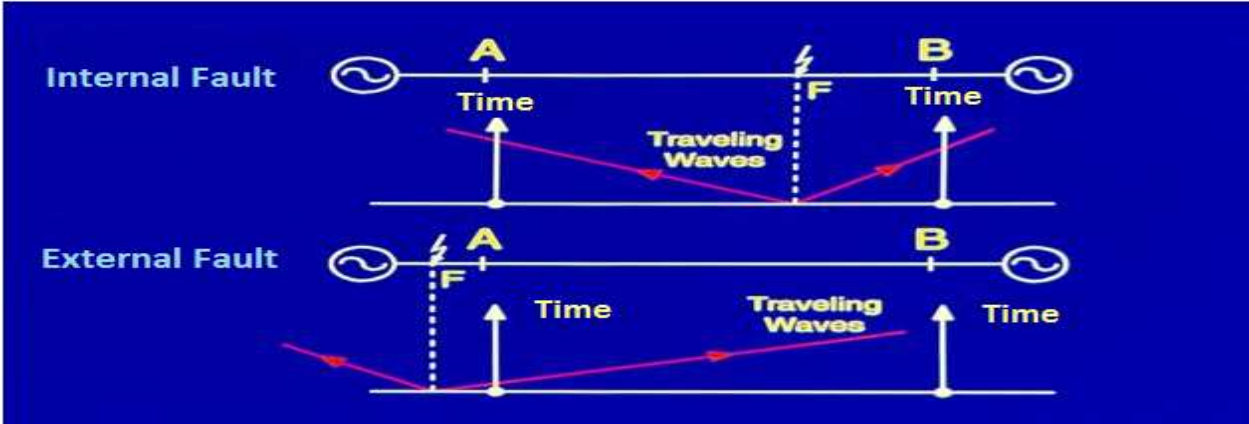
Detection of Subsynchronous Component

2st Approach: Transitional

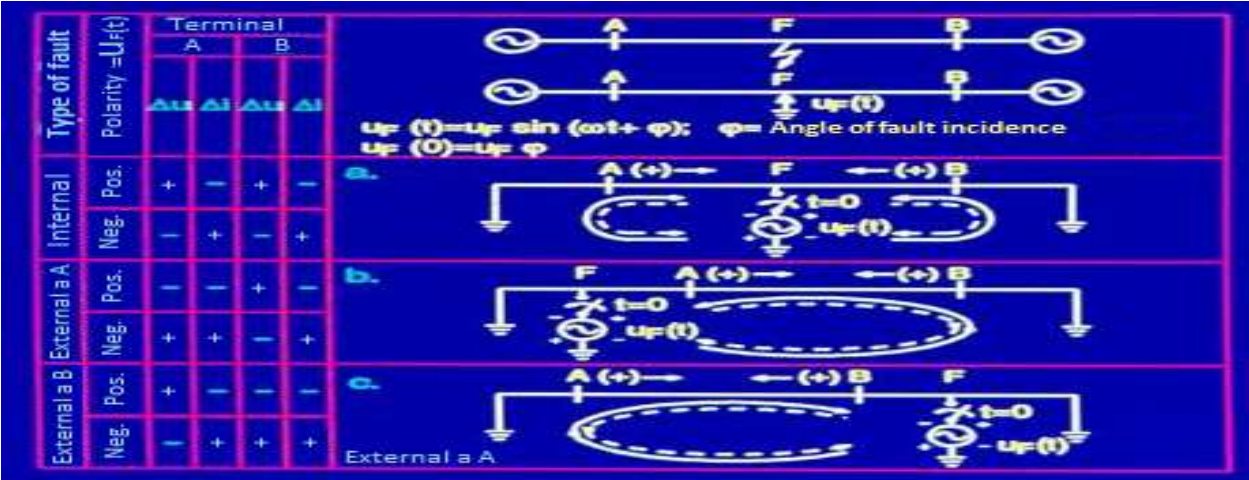
Separation Plan: Faster current decay



Directionality and Polarity

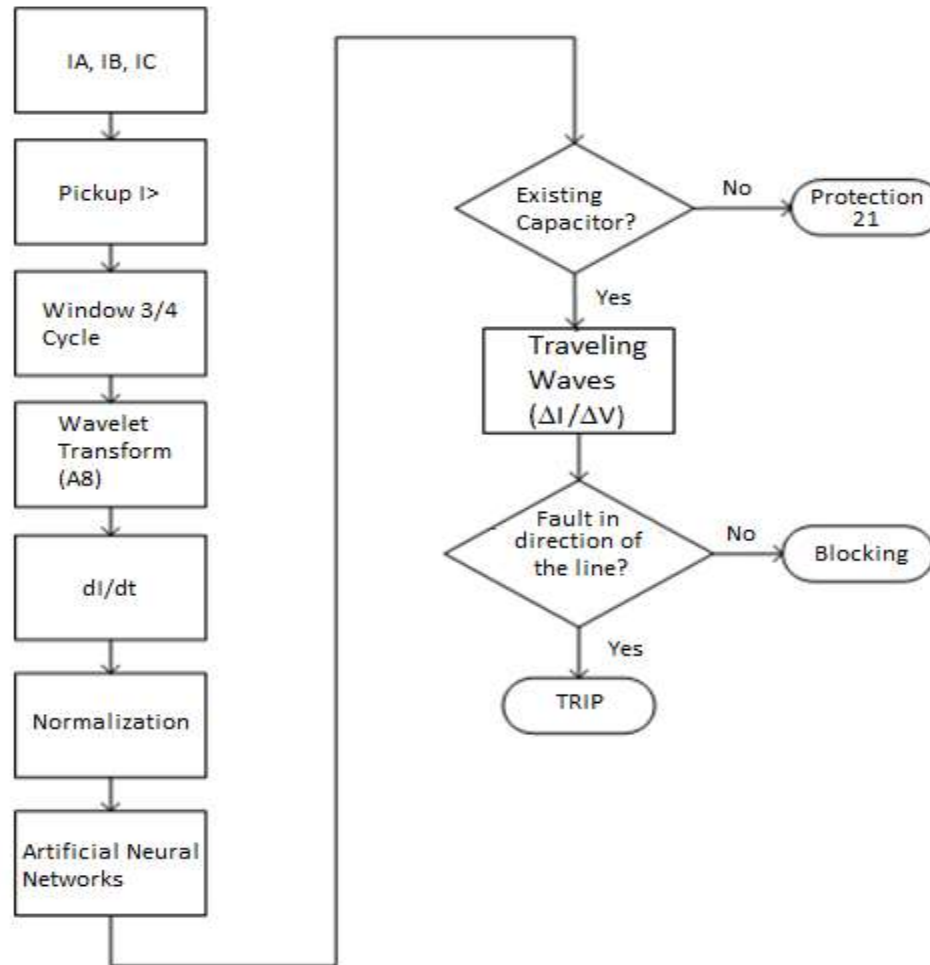


Directionality

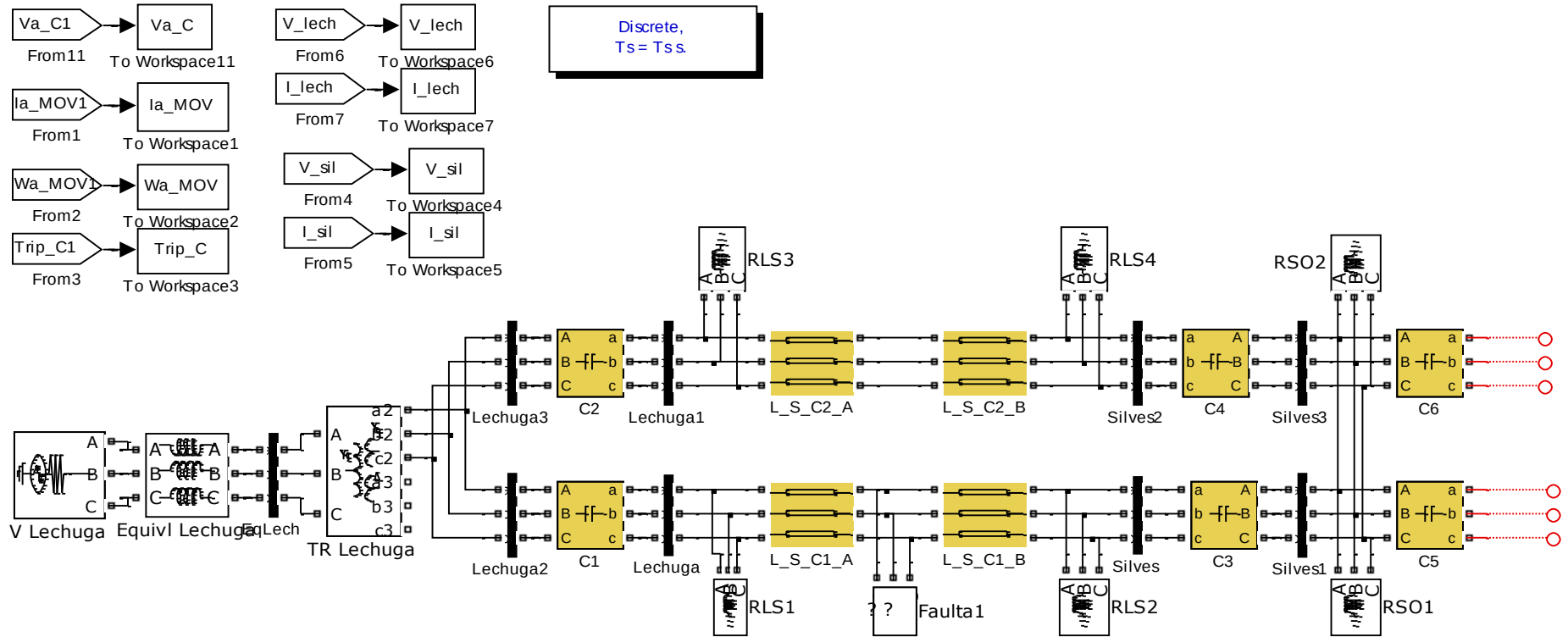


Polarity

Algorithm Summary



Testing Circuit



Conclusions

- *The methodology developed has presented a satisfactory performance, around 100%.*
- *The combination of function 21 with the traveling waves algorithm, increases substantially the reliability of the protection in question.*

Future works:

- *Generation of a greater number of tests*
- *Model the system taking into account values less than 5 Hz and greater than 55 Hz for the sub synchronous frequency generated by the transmission system.*

Thanks!!!

Contacts

Francisco A. Reis Filho

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farfilho@farfilho.com.br

Eduardo Cesar Senger

University of São Paulo

senger@pea.usp.br

Rodrigo A. Benes Ferreira

Siemens

rodrigo.benes@siemens.com

Giovanni Manassero Junior

University of São Paulo

giomanjr@pea.usp.br