Current Restrained Low Impedance Current Differential Relay Model

The MathCAD sheet below implements some basic relay calculations. The file takes data read from a Comtrade file and postprocesses it.

Read Comtrade File Data

1. Read Comtrade Configuration File

config :=

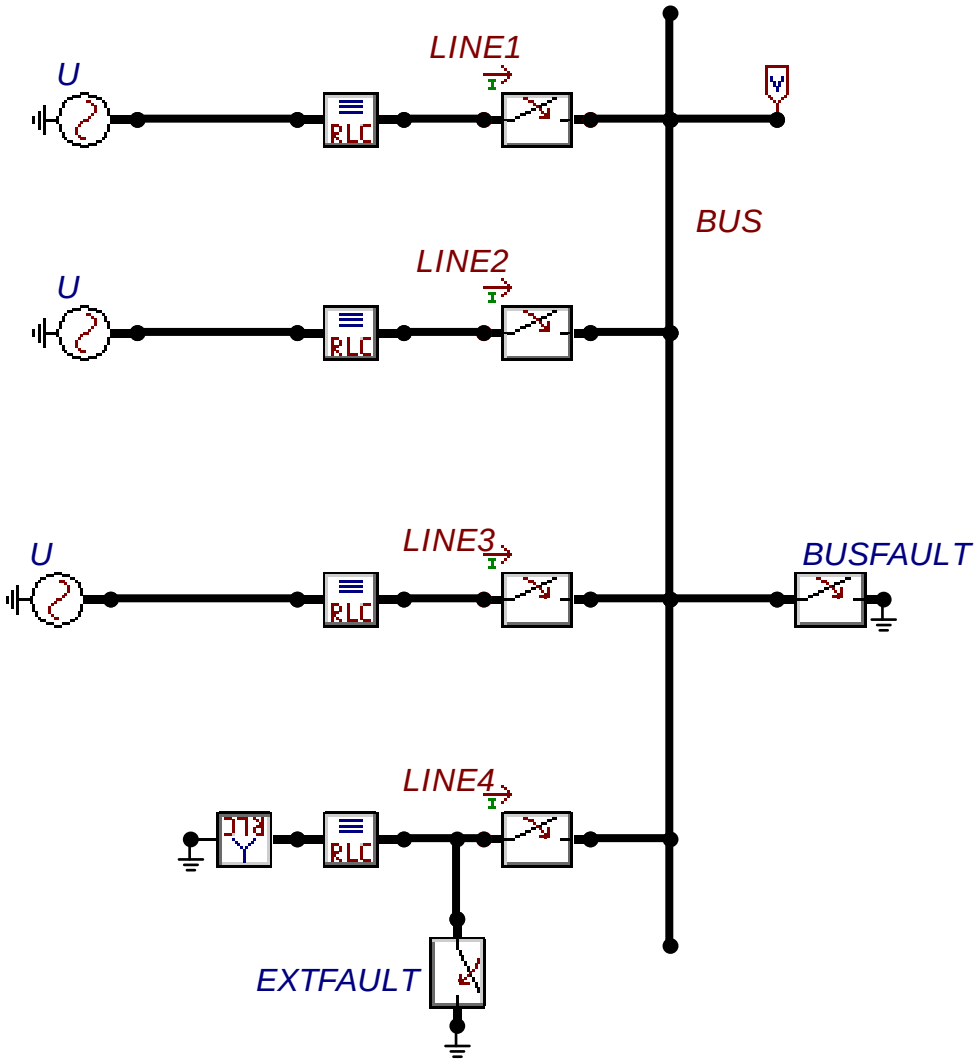
Right click on the floppy disk icon and select "Choose File" to open a file browser. Choose the *.cfg file from the contrade file (you will need to type the extension)

data :=

Right click on the floppy disk icon and select "Choose File" to open a file browser. Choose the *.dat file from the contrade file (it should be an accepted file type)

COMTRADE configuration file format:

1. The first fow states how the file was created and the version of the standard
2. The second row gives the total number of inputs (7 for these cases), number of analog inputs (7 here) and number of digital inputs (0 here)
3. Rows 3 - 10 are the analog inputs, in the following order:
   - I1a (feeder one, phase A)
   - I2a (feeder two, phase A)
   - I3a (feeder three, phase A)
   - I4a (feeder four, phase A)
   - Van
   - Vbn
   - Vcn
4. Data sampled 16 times per cycle (960 Hz)


LINE1
U
RLC
V
BUS
LINE2
U
RLC
LINE3
U
RLC
BUSFAULT
LINE4
RLC
RLC
EXTFAULT

Model CT Saturation (%):

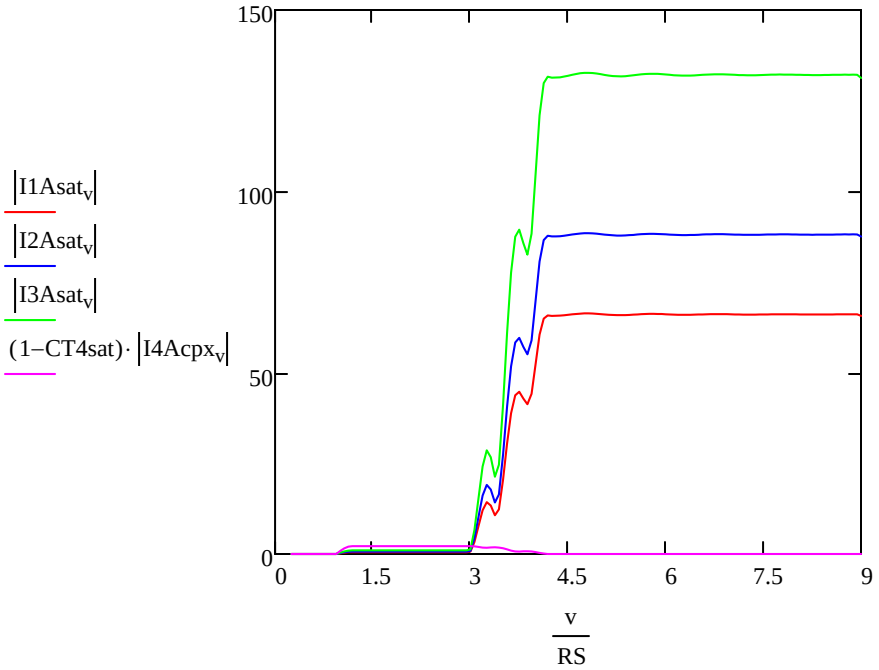
$CT1sat := 0\%$ $CT3sat := 0\%$

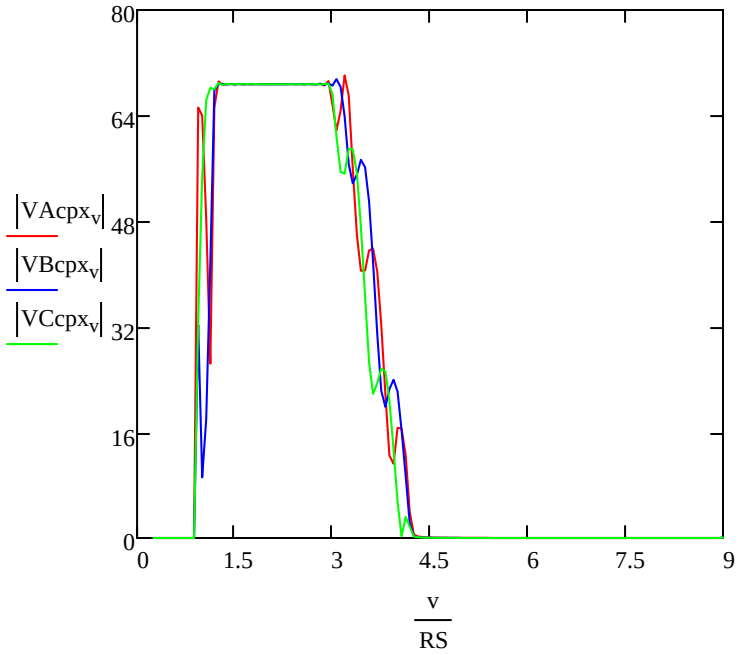
$CT2sat := 0\%$ $CT4sat := 0\%$

$I1Asat_v := (1 - CT1sat) \cdot I1Acpx_v$ $I3Asat_v := (1 - CT3sat) \cdot I3Acpx_v$

$I2Asat_v := (1 - CT2sat) \cdot I2Acpx_v$ $I4Asat_v := (1 - CT4sat) \cdot I4Acpx_v$

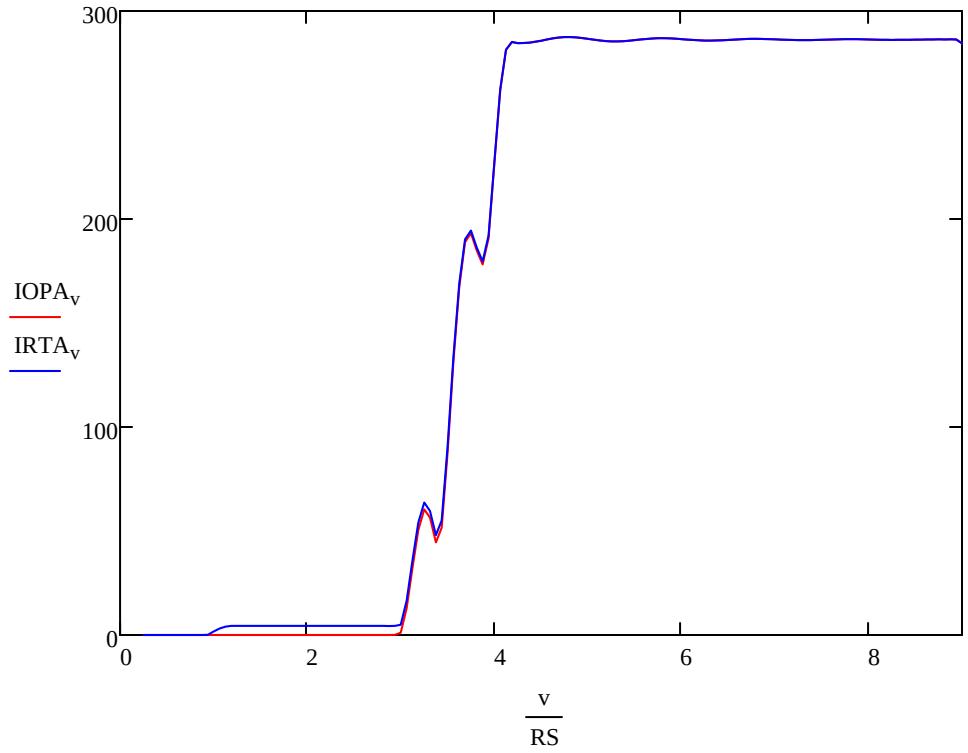
- Each of these terms is a phasor with magnitude and phase (we are only uses magnitude for now).





$IOPA_v := \left|I1Asat_v + I2Asat_v + I3Asat_v + I4Asat_v\right|$ Operate Current

$IRTA_v := \left|I1Asat_v\right| + \left|I2Asat_v\right| + \left|I3Asat_v\right| + \left|I4Asat_v\right|$ Restraint Current



Relay Model:

- ***Relay Settings***

Instantaneous Overcurrent Elements (secondary Amps, again leave off units) for zero sequence (ground) and negative sequence (designated with a Q). elements. These numbers are just made up so don't base your answers on these. Use magnitudes from the phase A components.

Enable the relay elements you want to use (1 means enabled, 0 means disabled)

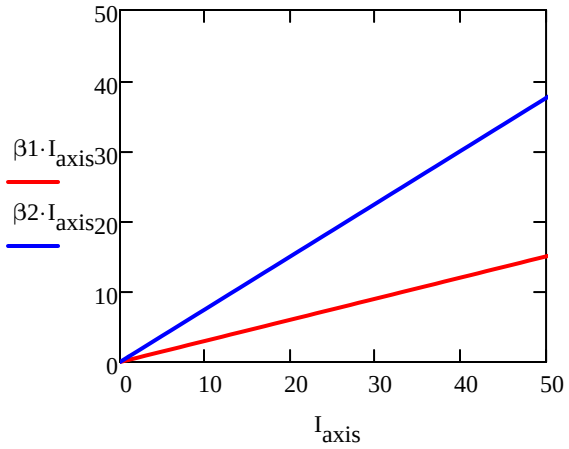
$E87\beta1 := 1$ $E87\beta2 := 1$

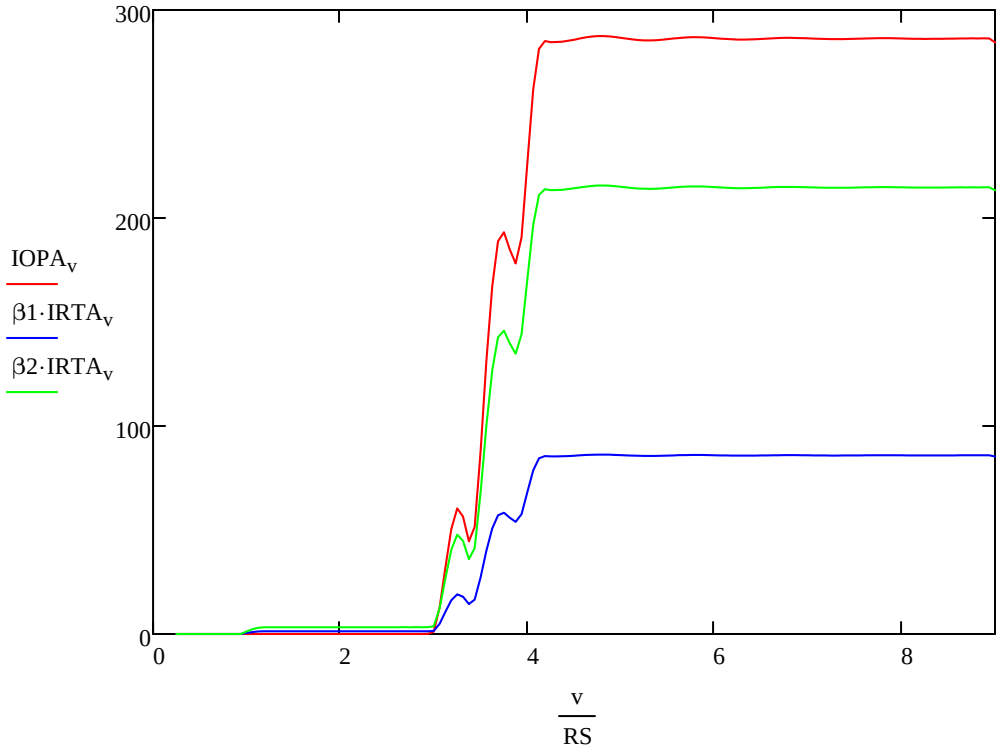
Relay restaint slopes

$\beta1 := 0.3$ Sensitive restraint slope

$\beta2 := 0.75$ More secure slope

$I_{axis} := 0, 1 .. 300$




300
200
100
0
0
2
4
6
8
IOPA_v
β1·IRTA_v
β2·IRTA_v
v
RS

- ***Relay Element Pick Up Logic***

  Negative sequence element (modified to latch and stay one, no drop out for now)

$$Tr1_v := \begin{cases} 1 & \text{if } IOPA_v > \beta 1 \cdot IRTA_v \\ 0 & \text{otherwise} \end{cases} \qquad Tr2_v := \begin{cases} 1 & \text{if } IOPA_v > \beta 2 \cdot IRTA_v \\ 0 & \text{otherwise} \end{cases}$$

- ***Relay Response***