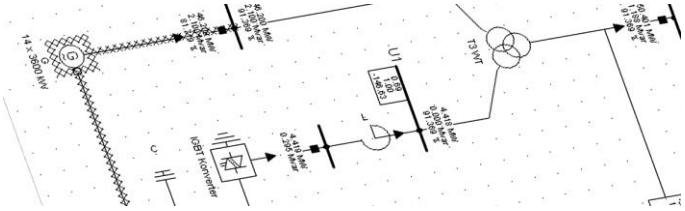

DIgSILENT Technical Documentation

Beckwith M-3425
PowerFactory
V001 Relay model description

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1 Model general description

The Beckwith M-3425 is a complete generator protection relay. The Beckwith M-3425 PowerFactory relay model has been implemented trying to mock up the more common protective functions used in a typical large generator protection scheme.

The Beckwith M-3425 PowerFactory relay model consists of a main relay model and 7 sub relays:

- Beckwith M-3425 Overcurrent (F50-51)
- Beckwith M-3425 Voltage (F27/59
- Beckwith M-3425 Frequency (F81)
- Beckwith M-3425 Power (F32)
- Beckwith M-3425 Loss of field (F40)
- Beckwith M-3425 Distance (F21-78)
- Beckwith M-3425 Differential (F87)

The main relay contains the measurement and acquisition units, the output logic and all other sub relays:

1.1 Measurement and acquisition

1.1.1 Available Units

The voltage and the current are measured by two current transformers ("Ct" and "Neutral Ct" blocks) and one voltage transformer ("Vt"_block). An additional current transformer is used by the differential elements: the "Remote Ct" block represents the CT located at the generator ground terminals.

Four measurement units ("Side 1 Measurement", "Delta Measure" , "Side 1 Measurement Seq", "Meas Neutral I" and "Side 2 Measurement" blocks) are fed by these CTs and the VT.

1.1.2 Functionality

The input signals are sampled at 16 samples/cycle; a DFT filter operating over a cycle calculates then the voltage and current values used by the protective elements.

1.1.3 Data Input

Please note that the nominal current and the nominal voltage values MUST be entered in all the measurement units.

1.2 Output logic

1.2.1 Available Units

The output logic is implemented by the "Output Logic" block located in each subrelay and by the "Output Logic" block located in the main relay.

1.2.2 Functionality

The "Output Logic" block located in the main relay is operating the breaker. Please disable the "Output Logic" block in the main relay to disable the relay model ability to open the power circuit.

The signal operating the breaker is "yout". Height additional output signals ("OUT1"… "OUT8") freely configurable are available.

1.2.3 Data inputs

The configuration of the "OUT1"…"OUT8" output signals can be done in the "Logic" tab page of the "Output Logic" block.

1.3 Beckwith M-23425 Overcurrent (F50/51) subrelay

1.3.1 Available Units

- Two 3 phase definite time overcurrent elements ("50 #1" and "50 #2" block)
- One 3 phase inverse time directional overcurrent element with voltage restraint ("51V3" block)
- One ground current definite time overcurrent element ("50N" block)
- One ground current inverse time overcurrent element ("51N" block)
- One ground direction detection block ("Ground Dir. Angle" block)
- One ground current definite time directional overcurrent element ("67N DT" block)
- One ground current inverse time directional overcurrent element ("67N IT" block)
- One thermal image element ("49" block)

- One negative sequence current definite time overcurrent element ("46 DT" block)
- One negative sequence current inverse time overcurrent element ("46 IT" block)
- One output block opening the associated breaker ("Output logic" block)

1.3.2 Functionality

The model contains a full choice of phase, positive sequence, zero sequence and negative sequence current overcurrent elements. There is a set of ground directional and a set of no directional ground elements.

The inverse time overcurrent elements support the following trip characteristics:

- "IEC extremely inverse"
- "IEC very inverse"
- "IEC inverse"
- "IEC long time inverse"
- "ANSI extremely inverse"
- "ANSI moderately inverse"
- "ANSI very inverse"
- "BECO definite time"
- "BECO extremely inverse"
- "BECO very inverse"
- "BECO inverse"

The voltage restraint feature supports both the "pure" restraint mode and the "voltage control" mode. The active mode can be set in the "Logic" tab page of the "V restraint" block. If the "voltage control" mod has been activated ("VcontrolON" flag equal to 1) the voltage threshold must be set using the "Vcontrol" variable which is set by default equal to 100 ("Vcontrol = 100")

1.4 Beckwith M-3425 Voltage elements (F27/59) subrelay

1.4.1 Available Units

- Three phase-ground time defined undervoltage elements ("27 #1", "27 #2" and "27 #3" block)
- Three phase-ground time defined overvoltage elements ("59 #1", "59 #2" and "59 #3" block)

- Three zero sequence time defined overvoltage elements ("59G #1", "59G #2" and "59G #3" block)
- Three positive sequence time defined overvoltage elements ("59pos #1", "59pos #2" and "59pos #3" block)
- One over flux inverse time element ("24IT" block)
- One over flux definite time element ("24DT" block)
- One output block opening the associated breaker ("Output logic" block)

1.4.2 Functionality

All the over/undervoltage elements available in the relay except the 3rd harmonic element have been implemented in the model.

The over flux inverse time element is supporting the following trip characteristics:

- V/Hz Inverse family curve # 1
- V/Hz Inverse family curve # 2
- V/Hz Inverse family curve # 3
- V/Hz Inverse family curve # 4

1.5 Beckwith M-3425 Frequency (F81) subrelay

1.5.1 Available Units

- Four over/under frequency elements ("81 #1", "81 #2, "81 #3" and "81 #4" block)
- Three rate of change of frequency elements("81R #1", "81R #2" and "81R #3" block

1.5.2 Functionality

Each frequency element can be used as over frequency element setting the frequency threshold to a value greater than the system rated frequency or as an under frequency element setting the frequency threshold to a value smaller than the system rated frequency.

1.6 Beckwith M-3425 Power (F32) subrelay

1.6.1 Available Units

- Three active forward direction underpower elements ("32#1 P< Forward", "32#2 P< Forward" and "32#3 P< Forward" block)
- Three active forward direction overpower elements ("32#1 P> Forward", "32#2 P> Forward" and "32#3 P> Forward" block)
- Three active reverse direction underpower elements ("32#1 P< Reverse", "32#2 P< Reverse" and "32#3 P< Reverse" block)
- Three active reverse direction overpower elements ("32#1 P> Reverse", "32#2 P> Reverse" and "32#3 P> Reverse" block)
- One reactive forward direction underpower element ("32#1 Q< Forward" block)
- One reactive forward direction overpower element ("32#1 Q> Forward" block)
- One reactive reverse direction underpower element ("32#1 Q< Reverse" block)
- One reactive reverse direction overpower element ("32#1 Q> Reverse" block)
- One block calculating the active/reactive power ("Power Calculator" block)
- One output block opening the associated breaker ("Output logic" block)

1.6.2 Functionality

The subrelay implements multiple flavours of the three power elements available in the device to provide an usable power element for any possible configuration of them.

1.6.3 Data Input

Please enable only one element for each of the following sets:

- "32#1 P< Forward", "32#1 P> Forward", "32#1 P< Reverse", "32#1 P>Reverse".
- "32#1 P< Forward", "32#1 P> Forward", "32#1 P< Reverse", "32#1 P>Reverse".
- "32#1 P< Forward", "32#1 P> Forward", "32#1 P< Reverse", "32#1 P>Reverse", "32#1 Q< Forward", "32#1 Q> Forward", "32#1 Q< Reverse", "32#1 Q>Reverse".

1.7 Beckwith M-3425 Loss of field (F40) subrelay

1.7.1 Available Units

- Two three phase mho elements ("40-Loss of field #1" and "40-Loss of field #2" block).

- Two timers ("40-Loss of Filed #1 Delay" and "40-Loss of Filed #2 Delay" block)
- One polarizing block ("Polarizing" block)
- One output block opening the associated breaker ("Output logic" block)

1.7.2 Functionality

The subrelay implements the two mho zones with offset impedance available in the relay. Separated time delays can be set for each zone.

No user input is required in the "Polarizing" block.

1.8 M-3425 Distance (F21-78) subrelay

1.8.1 Available Units

- Three under impedance elements ("21 #1", "21 #2" and "21 #3" block).
- Three timers ("21 #1 delay", "21 #2 delay" and "21 #3 delay" block)
- One polarizing block ("Polarizing" block)
- Three minimum current supervision element ("#1 OC supervision"," #2 OC supervision" and "#3 OC supervision" block)
- Three load encroachment blocks ("21 #1 Load Encroachment", "21 #2 Load Encroachment", and "21 #3 Load Encroachment" block)
- One out of step mho element ("78 Mho" block)
- Two out of step blinders ("78 Blinder A" and "78 Blinder B" block)
- One output block opening the associated breaker ("Output logic" block)

1.8.2 Functionality

The subrelay implements:

- Three mho operating characteristics with separated time delays, load encroachment zones and overcurrent supervision elements.

- A out of step detection element consisting of a mho characteristic and two blinders

1.8.3 Data input

No user input is required is the "Polarizing" and in the "Output Logic" block.

1.9 Beckwith M-3425 Differential (F87) subrelay

1.9.1 Available Units

- One three phase differential element with double current biased restrained threshold and time delay ("87" block).
- One single phase (ground) differential element with time delay ("87GD" block)
- One output block opening the associated breaker ("Output logic" block)

1.9.2 Functionality

The phase transformer differential feature has a trip threshold with double I bias characteristic. The ground differential is a simple differential threshold element with bias characteristic and time delay.

1.9.3 Data input

Please notice that for the phase differential element the "Restrain Percentage 2" setting value must be set manually by the customer equal to a value 4 times the value which has been set for the "Restrain Percentage 1" setting value.

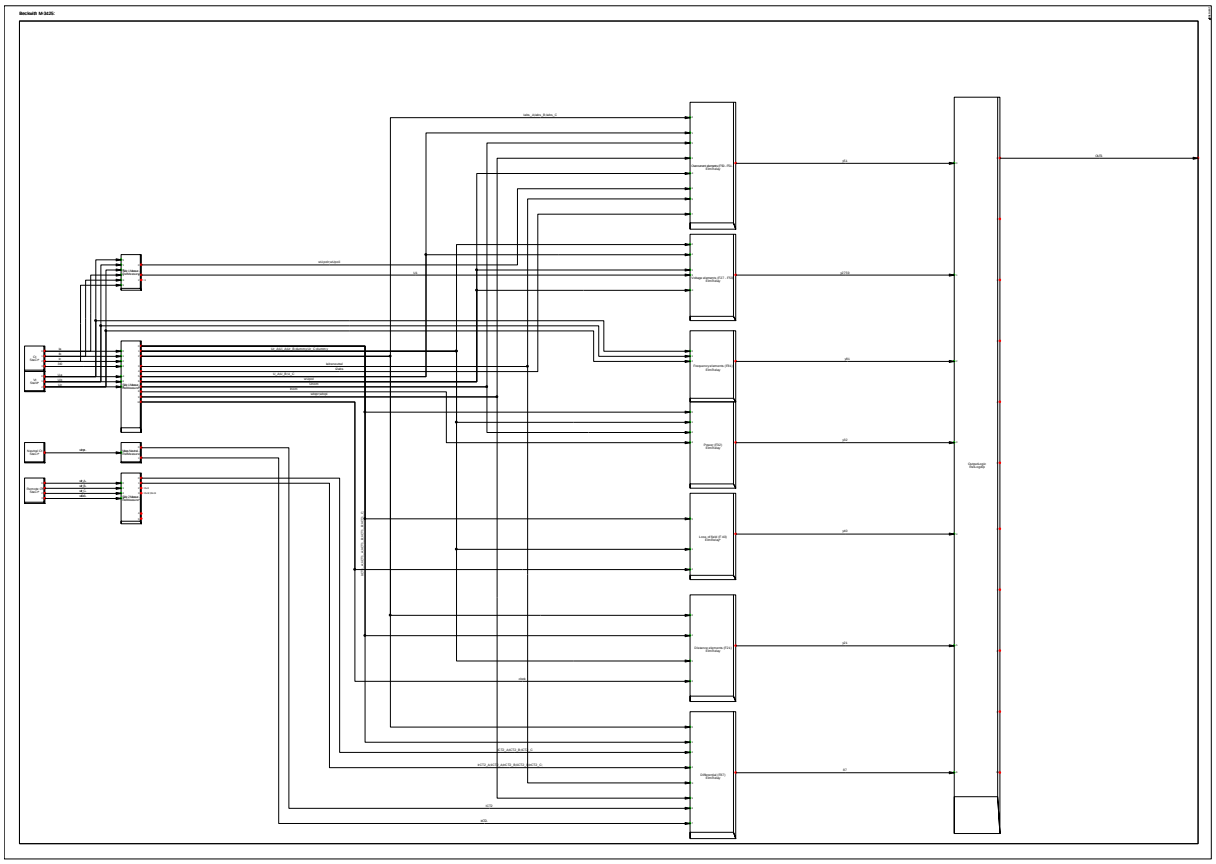
2 Relay not supported features

The following features are not supported:

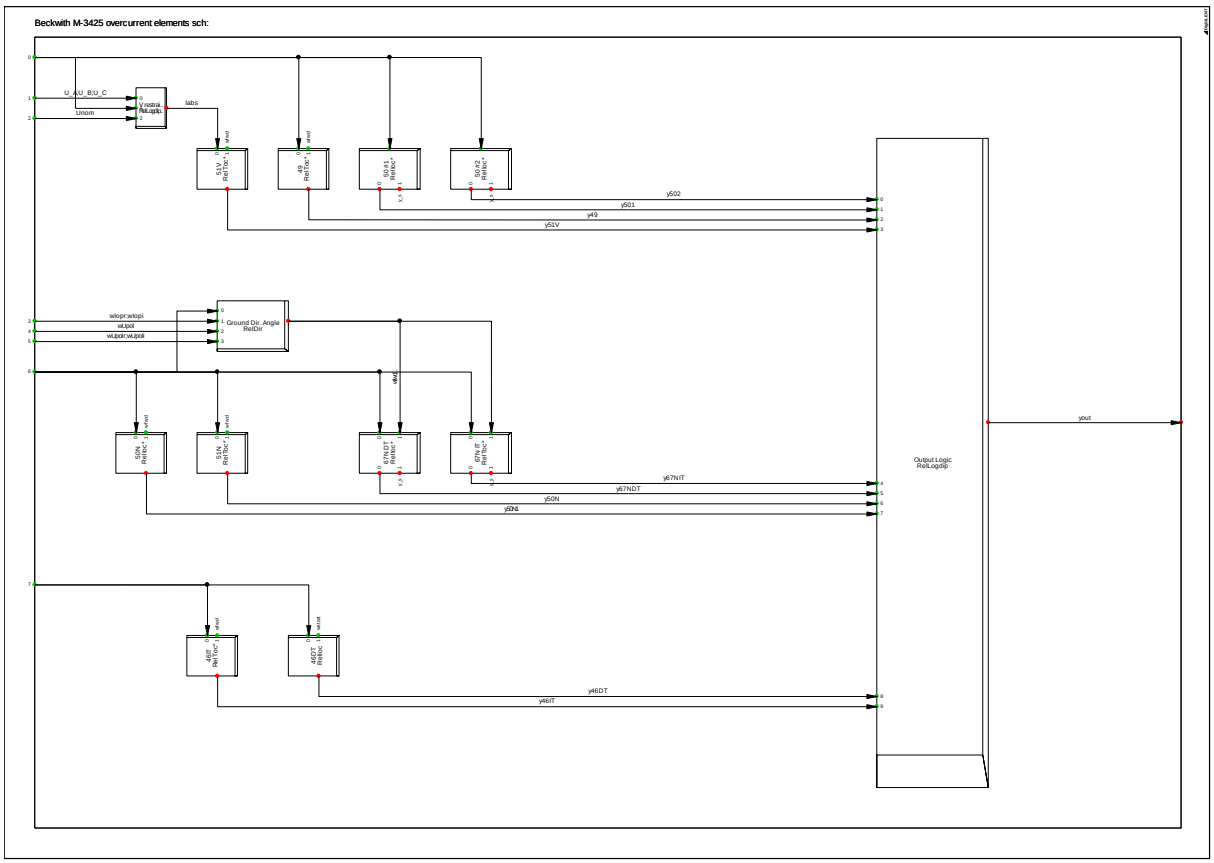
- Double measurement approach (RMS or DFT). The DFT measurement is always enabled in the model
- Differential CT correction
- 81A frequency accumulator elements
- 64S
- 64B Brush lift off Detection
- 64B/F field ground protection
- 60FL VT Fuse loss
- 59x Multipurpose overvoltage
- 59D Third harmonic voltage differential
- 59/27 In adverted energizing
- 50 BF Breaker failure
- 27TN third harmonic undervoltage

3 Model schemes

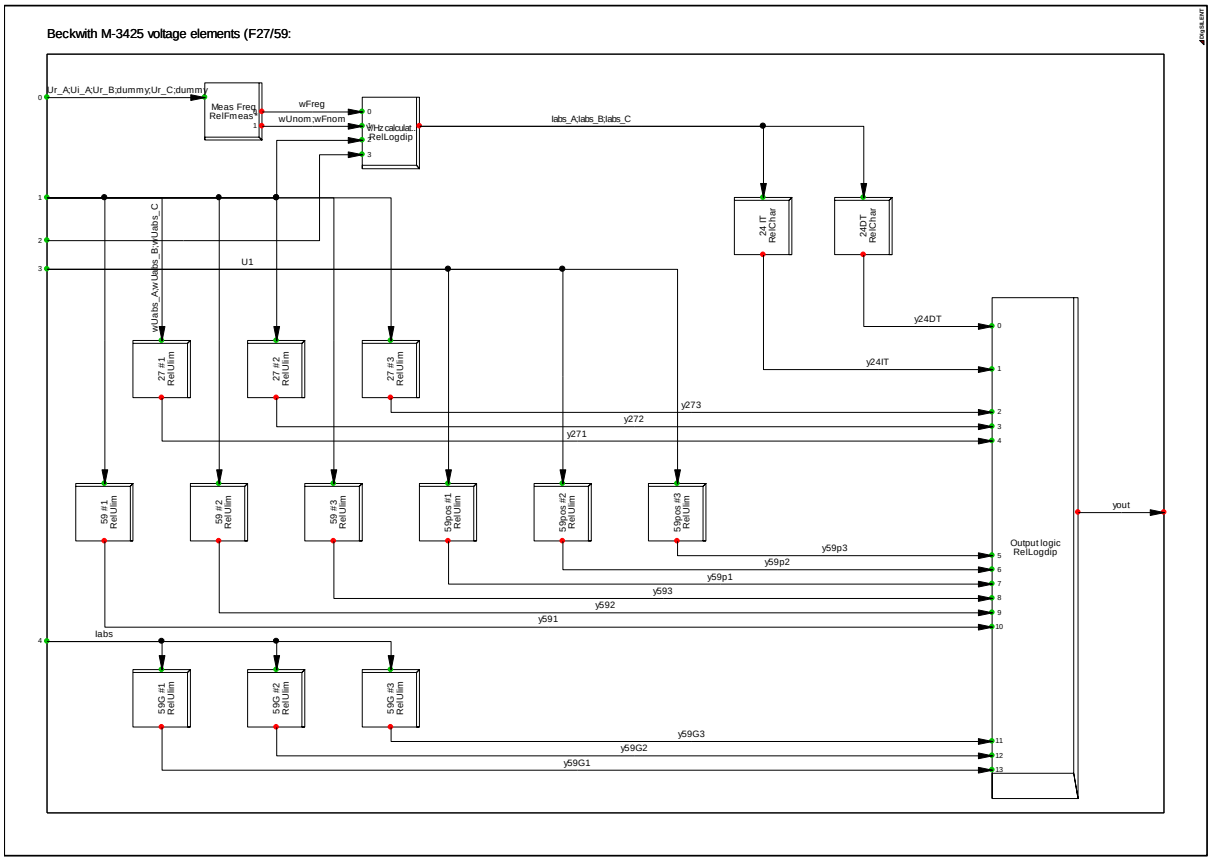
3.1 Main relay



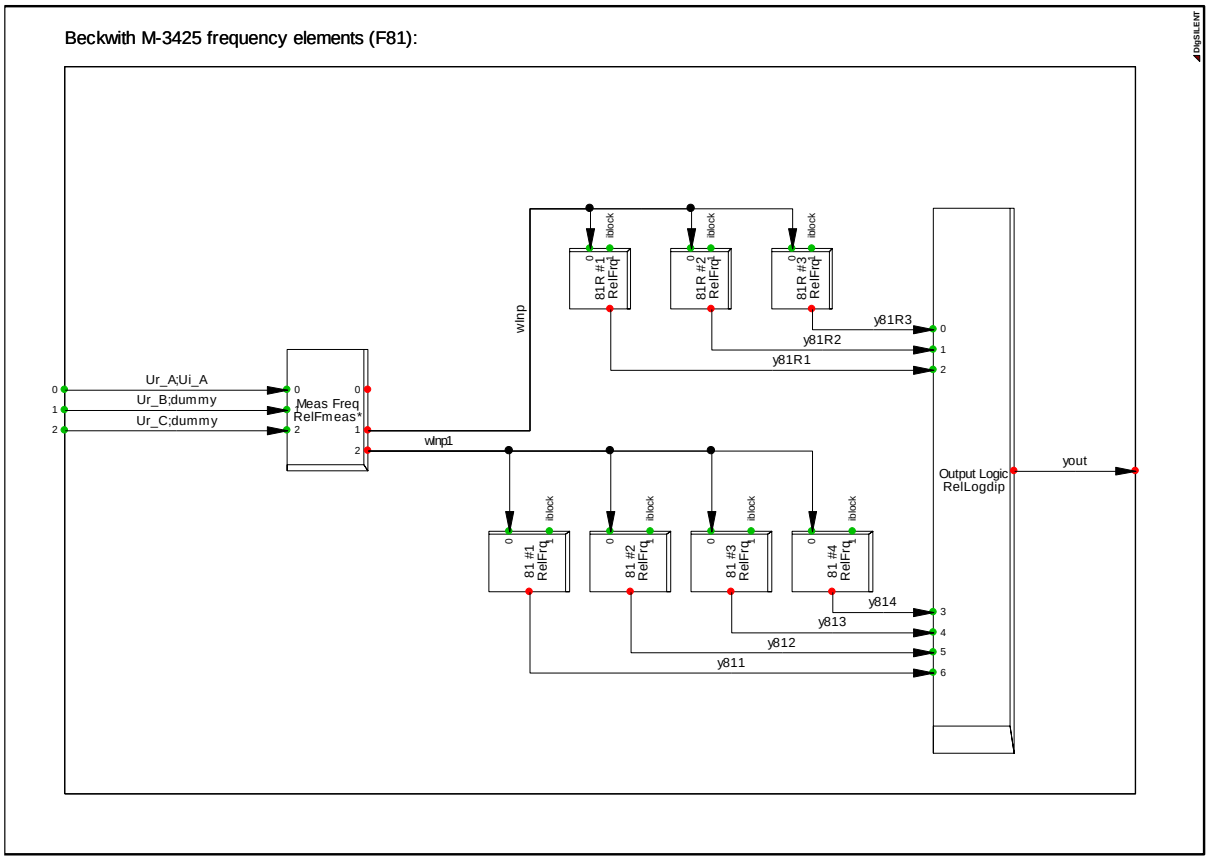
3.2 Overcurrent



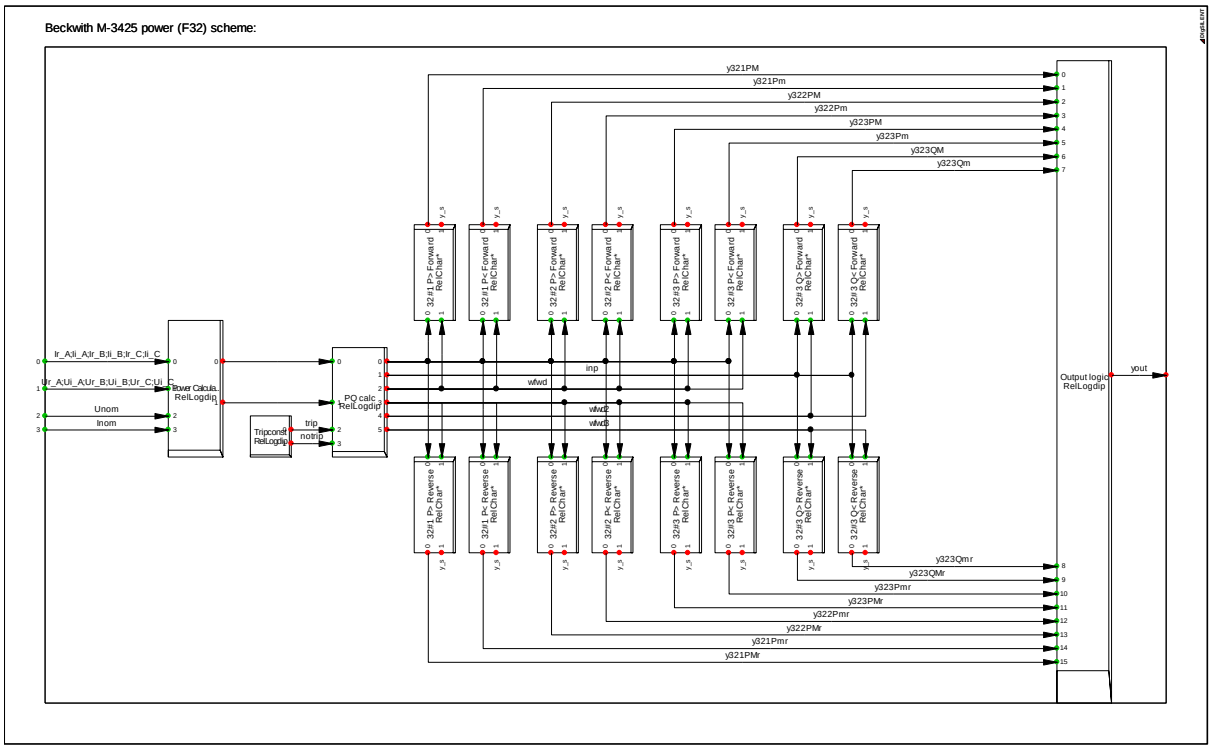
3.3 Voltage


Beckwith M-3425 voltage elements (F27/59:
Ur_A;Ui_A;Ur_B;dummy;Ur_C;dummy
Meas Freq
RelFmeas
wFreq
wUnom;wFnom
RelLogdip
labs_A;labs_B;labs_C
24 IT
RelChar
24DT
RelChar
U1
y24DT
y24IT
27 #1
RelUlim
27 #2
RelUlim
27 #3
RelUlim
y273
y272
y271
59 #1
RelUlim
59 #2
RelUlim
59 #3
RelUlim
59pos #1
RelUlim
59pos #2
RelUlim
59pos #3
RelUlim
y59p3
y59p2
y59p1
y593
y592
y591
Output logic
RelLogdip
yout
labs
59G #1
RelUlim
59G #2
RelUlim
59G #3
RelUlim
y59G3
y59G2
y59G1

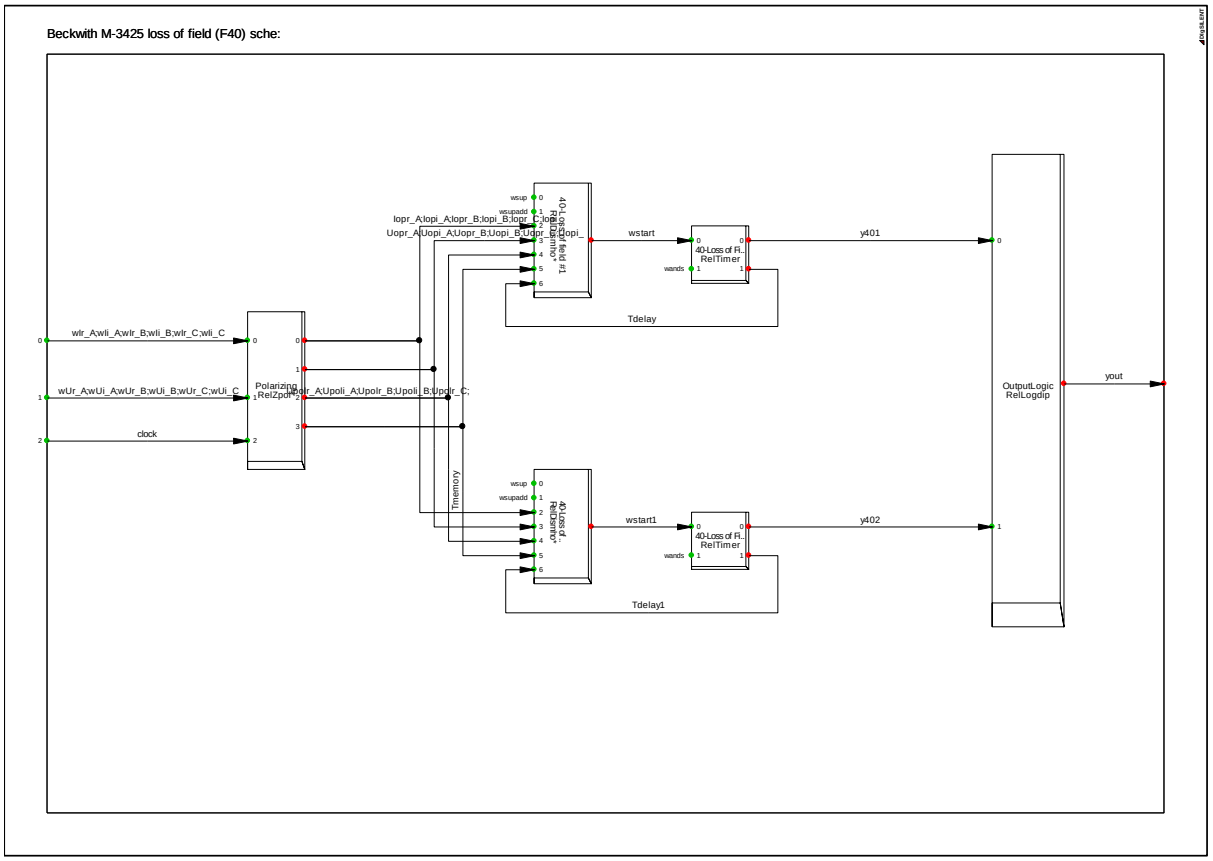
3.4 Frequency



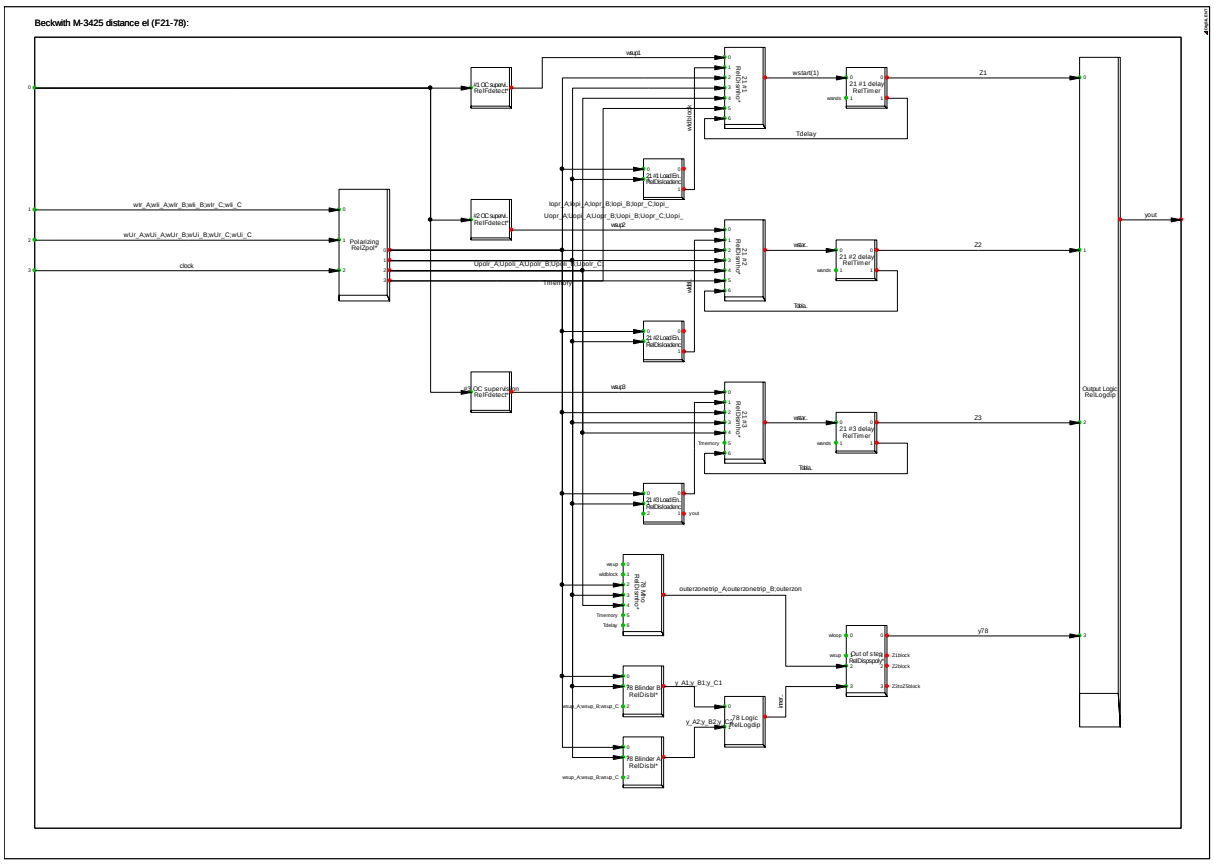
3.5 Power


Beckwith M-3425 power (F32) scheme:
y321PM
y321Pm
y322PM
y322Pm
y323PM
y323Pm
y323QM
y323Qm
32#1 P> Forward RelChar*
32#1 P< Forward RelChar*
32#2 P> Forward RelChar*
32#2 P< Forward RelChar*
32#3 P> Forward RelChar*
32#3 P< Forward RelChar*
32#3 Q> Forward RelChar*
32#3 Q< Forward RelChar*
Ir_A;Ii_A;Ir_B;Ii_B;Ir_C;Ii_C
Ur_A;Ui_A;Ur_B;Ui_B;Ur_C;Ui_C
Unom
Inom
Power Calcula.
RelLogdip
Tripcond
RelLogdip
trip
notrip
PQ calc
RelLogdip
inp
wiwd
wiwd2
wiwd3
32#1 P> Reverse RelChar*
32#1 P< Reverse RelChar*
32#2 P> Reverse RelChar*
32#2 P< Reverse RelChar*
32#3 P> Reverse RelChar*
32#3 P< Reverse RelChar*
32#3 Q> Reverse RelChar*
32#3 Q< Reverse RelChar*
y323Qmr
y323QMr
y323Pmr
y323PMr
y322Pmr
y322PMr
y321Pmr
y321PMr
Output logic
RelLogdip
yout

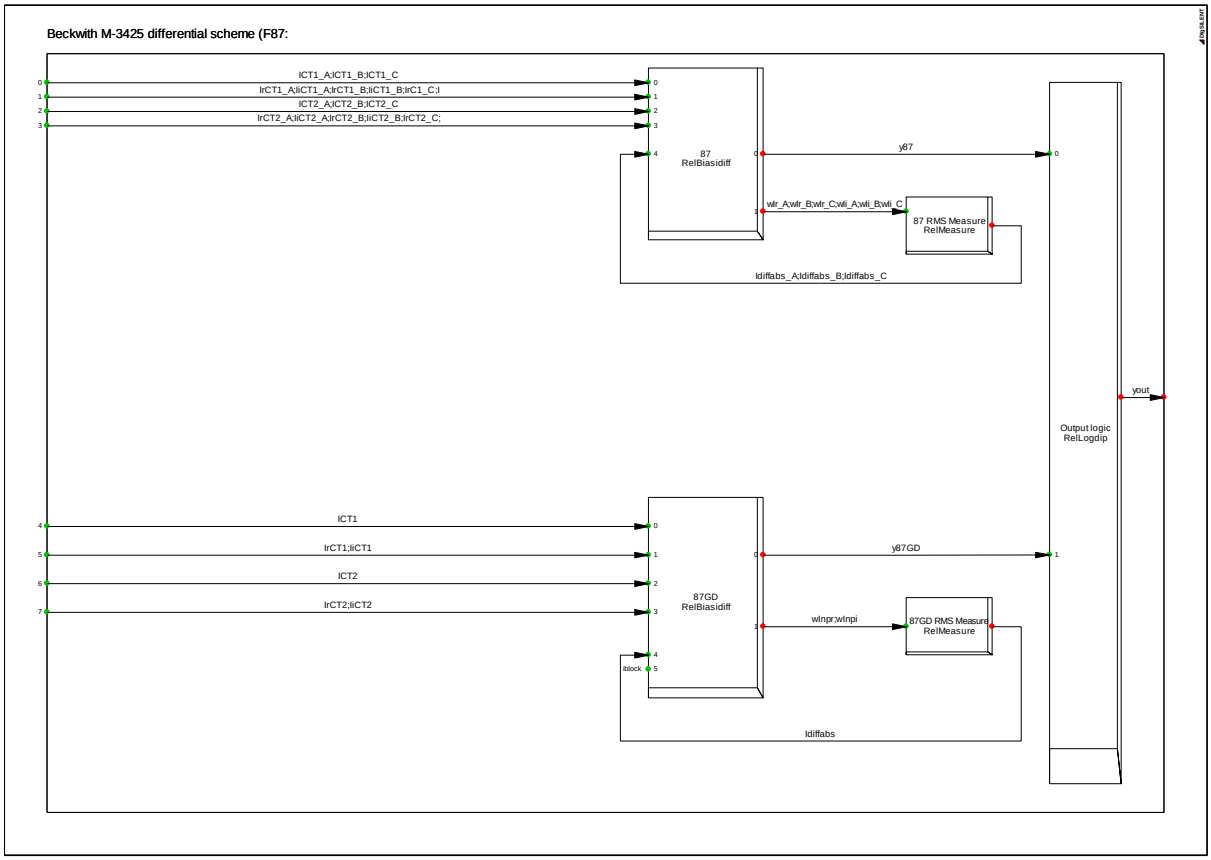
3.6 Loss of field



3.7 Distance and out of step



3.8 Differential



4 References

The model implementation has been based on the information available in the "Beckwith Electric co.in. M-3425 Generator Protection Instruction Book part 1 800-3425A-IB-01MC6" document.