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Technical Reference

Cooper Power Systems Form 4C

PF2021

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

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PowerFactory 2021
Revision 892

Contents

1   Model information

Manufacturer   Cooper Power Systems

Model   Form 4C

Variants   The Cooper Power Systems Form 4C PowerFactory relay model simulates the features available in the Cooper Power Systems Form 4C pole mount recloser control up to Control Version 15.XX.

2   General description

The Form 4C recloser control is a powerful and flexible system to provide custom solutions for distribution protection. The Form 4C pole mount microprocessor-based recloser controls include comprehensive system protection functionality, including phase and ground overcurrent, and sensitive earth fault.

The Cooper Power Systems Form 4C recloser has been modeled using one PowerFactory Cooper Power Systems Form 4C relay model which includes most of the protective elements available in the recloser.

The relay model consists of a monolithic relay model.
The relay model includes the measurement and acquisition units, the inverse and definite time overcurrent protective elements, the reclosing elements and the output logic.

The relay model implementation has been based on the information available in the recloser manual [1] [2].

3   Supported features

3.1   Measurement and acquisition

It represents the interface between the power system and the relay protective elements.

The primary current is converted by one three phase current transformer ("Ct" block). The converted currents are then measured by one 3 phase measurement unit ("Measurement" block).

3.1.1   Available Units

- one 3 phase current transformer ('Ct" block).

- one 3 phase measurement element ("Measurement" block).

3.1.2 Functionality

The "Ct" block represents an ideal CT. Using the CT default configuration the current at the primary side is converted to the secondary side using the CT ratio. The CT saturation and/or its magnetizing characteristic are not considered. Please set the "Detailed Model" check box in the "Detailed Data" tab page of the CT dialog and insert the data regarding the CT burden, the CT secondary resistance and the CT excitation parameter if more accurate simulation results are required.

The input signals are sampled in the relay model at 20 samples/cycle; the RMS values are calculated with a rectangular integration over a full cycle.

3.1.3 Data input

No user input is required.

Please notice that in the Cooper Power Systems Form 4C model all current threshold ranges are in terms of primary amperes as the settings of the Cooper Power Systems Form 4C recloser. For the reason the ratio of the CT and of the VT feeding the Form 4C PF model measurement block should be 1/1.

3.2 Protective elements

A set of inverse time and definite time overcurrent elements models the relay phase, earth and sensitive earth overcurrent protective functions. The inverse characteristics available in the relay are available as well in the inverse time model block.

3.2.1 Available Units

- Two phase fault inverse time elements (, "Phase TCC1", "Phase TCC2", and "Phase threshold" block). Please note that the current trip threshold is unique for any element and is stored inside the "Phase threshold" block.

- Two ground fault inverse time elements (, "Ground TCC1", "Ground TCC2", and "Ground threshold" block). Please note that the current trip threshold is unique for any element and is stored inside the "Ground threshold" block.

- One phase fault "high current" definite time element ("Phase HC" block).

- One ground fault "high current" definite time element ("Ground HC" block).

- One sensitive ground fault definite time element ("Sensitive Ground" block).

- One phase fault "high current" definite time element which, when tripped, puts the recloser to the *lockout* status("Phase HC Lockout" block).

- One ground fault "high current" definite time element which, when tripped, puts the recloser to the *lockout* status("Ground HC Lockout" block).

- Two independent reclosing logics for the phase and the ground elements ("Phase recllogic " and "Ground recllogic" block).

3.2.2   Functionality

The PF model contains all the protective elements available in the relay. The inverse time overcurrent elements support the following trip characteristics:

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The reclosing procedure settings are available in the "Phase recllogic" and in the "Ground recllogic" block. The "Ground recllogic" block contains the SEF reclosing settings. The Cooper Power Systems Form 4C relay model provides the following features:

- User configurable maximum number of operations before the lockout.

- Reset time of the reclosing procedure.

- Reclosing time for each reclosing attempt.

- Number of operations using *TCC1* as trip characteristic.

- *High Current* and *High Current Lockout* elements which can be independently enabled or disabled for each reclosing attempt.

- Sequence coordination.

- Ground Trip Precedence.

- Sensitive Earth Fault trips to lockout.

3.2.3   Data input

In the model a separated protective element is active for each reclosing attempt and must be set with the *TCC1* or the *TCC2* relay group of settings accordingly with the *Operation sequence* relay setting.

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

Overcurrent   :

Address	Relay Setting	Model block	Model setting	Note
	Min Trip - Phase	Phase min trip	Pickup Current (Ipsetr)	
	Min Trip - Ground	Ground min trip	Pickup Current (Ipsetr)	
	Complex TCC1 Setup - Phase	Phase TCC1	Enable TCC Modifiers (ModFrame)	
	Complex TCC2 Setup - Phase	Phase TCC2	Enable TCC Modifiers (ModFrame)	
	Complex TCC1 Setup - Ground	Ground TCC1	Enable TCC Modifiers (ModFrame)	
	Complex TCC2 Setup - Ground	Ground TCC2	Enable TCC Modifiers (ModFrame)	
	TCC 1 Selection - Phase	Phase TCC1	Characteristic (pcharac)	
	TCC 2 Selection - Phase	Phase TCC2	Characteristic (pcharac)	
	TCC 1 Selection - Ground	Ground TCC1	Characteristic (pcharac)	
	TCC 2 Selection - Ground	Ground TCC2	Characteristic (pcharac)	
	TCC1 Multiplier Value - Phase	Phase TCC1	Time Dial (Tpset)	
	TCC2 Multiplier Value - Phase	Phase TCC2	Time Dial (Tpset)	
	TCC1 Multiplier Value - Ground	Ground TCC1	Time Dial (Tpset)	
	TCC2 Multiplier Value - Ground	Ground TCC2	Time Dial (Tpset)	
	TCC1 Constant Time Adder - Phase	Phase TCC1	Time Adder (Tadder)	
	TCC2 Constant Time Adder - Phase	Phase TCC2	Time Adder (Tadder)	
	TCC1 Constant Time Adder - Ground	Ground TCC1	Time Adder (Tadder)	
	TCC1 Constant Time Adder - Ground	Ground TCC2	Time Adder (Tadder)	
	TCC1 Minimum Response Time - Phase	Phase TCC1	Min. Response Time (minresptime)	
	TCC2 Minimum Response Time - Phase	Phase TCC2	Min. Response Time (minresptime)	
	TCC1 Minimum Response Time - Ground	Ground TCC1	Min. Response Time (minresptime)	
	TCC2 Minimum Response Time - Ground	Ground TCC2	Min. Response Time (minresptime)	
	High-Current Trip - Phase (ON/OFF)	Phase HC	Out of service (outserv)	
	High-Current Trip - Ground (ON/OFF)	Ground HC	Out of service (outserv)	
	High-Current Trip - Phase	Phase HC	Pickup Current (Ipset)	
	High-Current Trip - Ground	Ground HC	Pickup Current (Ipset)	
	High-Current Trip - Phase (Trip Time Delay)	Phase HC	Time Setting (cTset)	
	High-Current Trip - Ground (Trip Time Delay)	Ground HC	Time Setting (cTset)	

Address	Relay Setting	Model block	Model setting	Note
	High-Current Lockout - Phase (ON/OFF)	Phase HC	Out of service (outserv)	
	High-Current Lockout - Ground (ON/OFF)	Ground HC	Out of service (outserv)	
	High-Current Lockout - Phase	Phase HC	Pickup Current (Ipset)	
	High-Current Lockout - Ground	Ground HC	Pickup Current (Ipset)	

Reclosing :

Address	Relay Setting	Model block	Model setting	Note
	Phase Operations to Lockout	Phase reclogic	Operations to lockout (oplockout)	
	Ground Operations to Lockout	Ground reclogic	Operations to lockout (oplockout)	
	Phase Reclose Intervals 1st Interval	Phase recllogic	Reclosing interval 1 (recltime1)	
	Phase Reclose Intervals 2nd Interval	Phase recllogic	Reclosing interval 2 (recltime2)	
	Phase Reclose Intervals 3rd Interval	Phase recllogic	Reclosing interval 3 (recltime3)	
	Ground Reclose Intervals 1st Interval	Ground recllogic	Reclosing interval 1 (recltime1)	
	Ground Reclose Intervals 2nd Interval	Ground recllogic	Reclosing interval 2 (recltime2)	
	Ground Reclose Intervals 3rd Interval	Ground recllogic	Reclosing interval 3 (recltime3)	
	Reset Time	Phase recllogic	Reset Time (resettime)	
		Ground recllogic	Reset Time (resettime)	
	Ground Trip Precedence	Phase recllogic	Ground Trip Precedence (groundtripprec)	
		Ground recllogic	Ground Trip Precedence (groundtripprec)	
	Allow sequence coordination	Phase recllogic	Sequence Coordination (seqaccessory)	
		Ground recllogic	Sequence Coordination (seqaccessory)	
	Up to	Phase recllogic	Max sequence coordination operation number (maxseqcpsno)	
		Ground recllogic	Max sequence coordination operation number (maxseqcpsno)	
	High-Current Trip-Phase Active Trip Number	Phase recllogic	Trip 1 Enable (hctrip1enable)	In the "High Current Trip" frame
		Phase recllogic	Trip 2 Enable (hctrip2enable)	In the "High Current Trip" frame
		Phase recllogic	Trip 3 Enable (hctrip3enable)	In the "High Current Trip" frame
		Phase recllogic	Trip 4 Enable (hctrip4enable)	In the "High Current Trip" frame
	High-Current Trip-Ground Active Trip Number	Ground recllogic	Trip 1 Enable (hctrip1enable)	In the "High Current Trip" frame
		Ground recllogic	Trip 2 Enable (hctrip2enable)	In the "High Current Trip" frame
		Ground recllogic	Trip 3 Enable (hctrip3enable)	In the "High Current Trip" frame
		Ground recllogic	Trip 4 Enable (hctrip4enable)	In the "High Current Trip" frame
	High-Current Lockout-Phase Active Trip Number	Phase recllogic	HCL active on operation - 1st (hcl1active)	In the "High Current Lockout" frame
		Phase recllogic	HCL active on operation - 2nd (hcl2active)	In the "High Current Lockout" frame

Address	Relay Setting	Model block	Model setting	Note
		Phase recllogic	HCL active on operation - 3rd (hcl3active)	In the "High Current Lockout" frame
	High-Current Lockout-Ground Active Trip Number	Ground recllogic	HCL active on operation - 1st (hcl1active)	In the "High Current Lockout" frame
		Ground recllogic	HCL active on operation - 2nd (hcl2active)	In the "High Current Lockout" frame
		Ground recllogic	HCL active on operation - 3rd (hcl3active)	In the "High Current Lockout" frame

Sensitive Ground/Earth Fault :

Address	Relay Setting	Model block	Model setting	Note
	Sensitive Ground/Earth Fault (ON/OFF)	Sensitive Ground	Out of Service (outserv)	Set *outserv*
	Sensitive Ground/Earth Trip Level	Sensitive Ground	Pickup Current (Ipsetr)	
	Definite Time to Trip	Sensitive Ground	Time Setting (Tset)	
	Operations to Lockout	Ground recllogic	Sensitive Earth Fault trip to lockout (SEFtriptolock)	
	Sensitive Ground/Earth Fault Status	Ground recllogic	Sensitive Earth Fault Block (SEFtripblock)	

3.3 Output logic

It represents the output stage of the relay; it's the interface between the relay and the power breaker.

3.3.1 Available Units

The output logic is implemented by the following blocks:

- Output Logic.
- Closing Logic.

3.3.2 Functionality

The "Output Logic"block has the task to operate the power breaker when a trip command has been issued by any protective element. The relay output signal used to operate the breaker is "yout".
The "Closing Logic" block controlled by the reclosing feature ("Phase recllogic", and "Ground recllogic" block) has the purpose of generating a closing command for the power breaker when a reclosing attempt is triggered; the associated relay output signal is "yout1".

3.3.3 Data input

To disable the relay model ability to open the power circuit breaker disable the "Output Logic" block.

To disable the relay model ability to close the power circuit breaker and start a reclosing procedure disable the "Closing Logic" block.

4   Features not supported

- Alternate Minimum Trip - Phase and Ground.

- Supervisory Close Reset Time.

- Alternate Sensitive Trip Level.

- Hot line tag.

5   References

[1] Cooper Power Systems, P.O. Box 1640 Waukesha, WI 53187 USA. *Form 4C Microprocessor-Based Electronic Recloser Control and Accessories 280-77 November 2001*, 2001.

[2] Cooper Power Systems, P.O. Box 1640 Waukesha, WI 53187 USA. *Kyle Form 4C Microprocessor-Based Recloser Control Programming Guide S280-77-3 November 2003 KA2048-446 Rev.: 02*, 2003.