



POWERFACTORY

PowerFactory 2021

Technical Reference

Cooper Power Systems Form 6

PF2021

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

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Contents

1	Model information	1
2	General description	1
3	Supported features	1
3.1	Measurement and acquisition	1
3.1.1	Available Units	2
3.1.2	Functionality	2
3.1.3	Data input	2
3.2	Protective elements	2
3.2.1	Available Units	2
3.2.2	Functionality	3
3.2.3	Data input	5
3.3	Output logic	15
3.3.1	Available Units	15
3.3.2	Functionality	15
3.3.3	Data input	15
3.4	Phase HC lockout subrelay	16
3.4.1	Available Units	16
3.4.2	Functionality	16
3.4.3	Data input	16
3.5	Ground HC lockout subrelay	17
3.5.1	Available Units	17
3.5.2	Functionality	17
3.5.3	Data input	17
3.6	Q HC lockout subrelay	18
3.6.1	Available Units	18
3.6.2	Functionality	18
3.6.3	Data input	18
4	Features not supported	19

5 References	20
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1 Model information

Manufacturer Cooper Power Systems

Model Form 6

Variants The Cooper Power Systems Form 6 PowerFactory relay model simulates the features available in the Cooper Power Systems Form 6 pole mount and rack mount recloser control.

2 General description

The Form 6 recloser control is a powerful and flexible system to provide custom solutions for distribution protection. The Form 6 rack, yard, and pole mount microprocessor-based recloser controls include comprehensive system protection functionality, including phase, ground, and negative sequence overcurrent protection, over/underfrequency and voltage protection, directionality, sensitive earth fault, and sync check.

The Cooper Power Systems Form 6 recloser has been modeled using one PowerFactory Cooper Power Systems Form 6 relay model which include most of the protective elements available in the recloser.

The relay model consists of a main relay model and of the following sub relays:

- Phase HC lockout
- Ground HC lockout
- Q HC lockout

The relay model includes the measurement and acquisition units, the overcurrent, frequency, and voltage protective elements, and the output logic.

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

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) and one single phase core current transformer ("Residual Ct" block), the primary voltage is converted by one three phase voltage transformer ("Vt-3P" block). The converted current and voltages are then measured by one 3 phase measurement unit ("Measurement" block), by one 3phase sequence measurement unit ("Meas. sequence" block), by one single phase measurement unit ("Meas. Residual" block), and by one frequency measurement unit ("Meas Freq" block).

3.1.1 Available Units

- one 3 phase current transformer ('Ct' block).
- one single phase current transformer ("Residual Ct" block).
- one 3 phase voltage transformer ("Vt-3P" block).
- one 3 phase measurement element ("Measurement" block).
- one 3 phase sequence measurement element ("Meas. sequence" block).
- one single phase measurement element ("Meas. Residual" block).
- one frequency measurement element ("Meas Freq" block).

3.1.2 Functionality

The "Ct" and the "Residual Ct" block represent ideal CTs. 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 64 samples/cycle; a DFT filter operating over a cycle calculates the current values used by the protective elements.

3.1.3 Data input

The CT secondary rated current must be set in any measurement blocks, the VT secondary rated voltage must be set in the "Measurement" block.

If no core CT is available assign the 3 phases CT also to the "Residual Ct" slot.

3.2 Protective elements

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

The overvoltage, undervoltage and frequency (with minimum voltage inhibition threshold) protection elements are also modeled.

3.2.1 Available Units

- Four phase fault inverse time elements ("Phase threshold", "Phase TCC1", "Phase TCC2", "Phase TCC3" and "Phase TCC4" block). Please note that the current trip threshold is unique for any element and is stored inside the "Phase threshold" block.
- Four ground fault inverse time elements ("Ground threshold", "Ground TCC1", "Ground TCC2", "Ground TCC3" and "Ground TCC4" block). Please note that the current trip threshold is unique for any element and is stored inside the "Ground threshold" block.

- Four phase fault "high current" definite time elements ("Phase HC 1", "Phase HC 2", "Phase HC 3", "Phase HC 4", "Cold Load Phase HC" block). Please note that each block must be set to associate a definite time characteristic to the relevant inverse characteristic block ("Phase TCCx" block where $x = 1,2,3,4$).
- Four ground fault "high current" definite time elements ("Ground HC 1", "Ground HC 2", "Ground HC 3", "Ground HC 4", "Cold Load Ground HC" block). Please note that each block must be set to associate a definite time characteristic to the relevant inverse characteristic block ("Ground TCCx" block where $x = 1,2,3,4$).
- One sensitive ground fault definite time element with directional feature ("Sensitive Ground" and "Dir 1ph" block).
- One phase fault inverse time elements enabled during the cold load conditions ("Phase ColdLoadTCC" block).
- One phase fault "high current" definite time element ("Cold Load Phase HC" block). Please note that the block must be set to associate a definite time characteristic to the relevant inverse characteristic block ("Phase ColdLoadTCC" block).
- One phase fault inverse time element enabled when the fast trips are disabled ("Phase FTDTCC" block, set by the *Fast Trips disabled* parameter in the "Phase reclogic" block).
- One ground fault inverse time elements enabled during the cold load conditions ("Ground ColdLoadTCC" block).
- One ground fault "high current" definite time element ("Cold Load Ground HC" block). Please note that the block must be set to associate a definite time characteristic to the relevant inverse characteristic block ("Ground ColdLoadTCC" block).
- One ground fault inverse time element enabled when the fast trips are disabled ("Ground FTDTCC" block, set by the *Fast Trips disabled* parameter in the "Ground reclogic" block).
- One cold load phase lockout element ("Cold Load Phase HC Lockout" block).
- One cold load ground lockout element ("Cold Load Ground HC Lockout" block).
- Three independent reclosing logics for the phase, the ground and the sensitive ground element ("Phase reclogic", "Ground reclogic" and "SEF reclogic" block).
- Three undervoltage time definite elements ("Undervoltage alarm", "Undervoltage 3p", "Undervoltage 1p" block). Please notice that the voltage trip threshold is in secondary V instead of primary volts.
- Three overvoltage time definite elements ("Overvoltage alarm", "Overvoltage 3p", "Overvoltage 1p" block). Please notice that the voltage trip threshold is in secondary V instead of primary volts.
- Three under frequency time definite elements ("Underfrequency alarm", "Underfrequency 1", "Underfrequency 2" block).
- Three over frequency time definite elements ("Overfrequency alarm", "Overfrequency 1", "Overfrequency 2" 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:

- | | |
|-------|---------------------------|
| • 101 | • 135 |
| • 102 | • 136 |
| • 103 | • 137 |
| • 104 | • 138 |
| • 105 | • 139 |
| • 106 | • 140 |
| • 107 | • 141 |
| • 111 | • 142 |
| • 112 | • 151 |
| • 113 | • 152 |
| • 114 | • 161 |
| • 115 | • 162 |
| • 116 | • 163 |
| • 117 | • 164 |
| • 118 | • 165 |
| • 119 | • 200 |
| • 120 | • 201 |
| • 121 | • 202 |
| • 122 | |
| • 131 | • Constant |
| • 132 | • IEEE Extremely inverse |
| • 133 | • IEEE Moderately inverse |
| • 134 | • IEEE Very inverse |

The user can configure any protective block with an instantaneous or a delayed reset. The delayed reset time is calculated using a delayed reset characteristic ("Reset TCC" characteristic).

The reclosing procedure settings are available in the "Phase reclogic", "Ground reclogic", and "SEF reclogic" block.

The Cooper Power Systems Form 6 relay model provides the following features:

- Sequence coordination with an user configurable maximum number of operations.
- User configurable maximum number of operations before the lockout.
- Reset time of the reclosing procedure.
- Reclosing time for each reclosing attempt.
- User configurable number of operations of the SEF elements before the lockout.
- Reset time of the SEF reclosing procedure.

- Reclosing time for each SEF reclosing attempt.
- SEF elements with directional characteristic.
- *High Current* and *High Current Lockout* elements which can be independently enabled or disabled for each reclosing attempt.
- *Fast trip disabled* mode with alternative user configurable maximum number of operations before the lockout.
- *Fast trip disabled* mode phase and ground TCC.
- *Cold Load* condition detection.
- *Cold Load* condition phase and ground TCC.
- *Cold Load* condition user configurable maximum number of operations before the lockout.
- *Cold Load* condition reclosing interval.
- *Cold Load* condition maximum duration.
- Multiple operation modes (3ph trip-3ph lockout mode, 1ph trip-3ph lockout mode, and the 1ph trip-1ph lockout mode).

Please notice that in the Cooper Power Systems Form 6 model all current threshold ranges are in terms of primary amperes as the settings of the Cooper Power Systems Form 6 recloser. For the reason the ratio of the CT feeding the Form 6 PF model measurement blocks should be 1/1.

3.2.3 Data input

In the relay 2 groups of settings are present as *TCC1* (fast trip characteristic) and as *TCC2* (slow trip characteristic) for phase, ground and negative sequence. The *Operation sequence* relay setting defines for each reclosing attempt if *TCC1* or *TCC2* is active. 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
	TCCPMinTrip	Phase min trip	Pickup Current (Ipsetr)	
	TCGMinTrip	Ground min trip	Pickup Current (Ipsetr)	
	TCCQMinTrip	Negative seq min trip	Pickup Current (Ipsetr)	
	Block Phase trips	Phase min trip	Out of Service (outserv)	
	Block Ground trips	Ground min trip	Out of Service (outserv)	
	Block NegSeq trips	Negative seq min trip	Out of Service (outserv)	
	TCCP1Curve	Phase TCC1, Phase TCC2	Characteristic (pcharac)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase TCC3, Phase TCC4	Characteristic (pcharac)	As above
	TCCP2Curve	Phase TCC1, Phase TCC2	Characteristic (pcharac)	As above
		Phase TCC3, Phase TCC4	Characteristic (pcharac)	As above
	TCCG1Curve	Ground TCC1,Ground TCC2	Characteristic (pcharac)	Set accordingly with the <i>Operation Sequence-Ground</i> relay setting

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	TCCG2Curve	Ground TCC3,Ground TCC4	Characteristic (pcharac)	As above
		Ground TCC1,Ground TCC2	Characteristic (pcharac)	As above
	TCCQ1Curve	Ground TCC3,Ground TCC4	Characteristic (pcharac)	As above
		Q TCC1, Q TCC2	Characteristic (pcharac)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCCQ2Curve	Q TCC3, Q TCC4	Characteristic (pcharac)	As above
		Q TCC1, Q TCC2	Characteristic (pcharac)	As above
		Q TCC3, Q TCC4	Characteristic (pcharac)	As above
	TCC1MultE	Phase TCC1, Phase TCC2	Enable TCC modifiers (Mod-Frame)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase TCC3, Phase TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC2MultE	Phase TCC1, Phase TCC2	Enable TCC modifiers (Mod-Frame)	
		Phase TCC3, Phase TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC1GMultE	Ground TCC1,Ground TCC2	Enable TCC modifiers (Mod-Frame)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
		Ground TCC3,Ground TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC2GMultE	Ground TCC1,Ground TCC2	Enable TCC modifiers (Mod-Frame)	
		Ground TCC3,Ground TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC1QMultE	Q TCC1, Q TCC2	Enable TCC modifiers (Mod-Frame)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q TCC3, Q TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC2QMultE	Q TCC1, Q TCC2	Enable TCC modifiers (Mod-Frame)	
		Q TCC3, Q TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC1PMult	Phase TCC1, Phase TCC2	Time Dial (Tpset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase TCC3, Phase TCC4	Time Dial (Tpset)	
	TCC2PMult	Phase TCC1, Phase TCC2	Time Dial (Tpset)	
		Phase TCC3, Phase TCC4	Time Dial (Tpset)	
	TCC1GMult	Ground TCC1,Ground TCC2	Time Dial (Tpset)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
		Ground TCC3,Ground TCC4	Time Dial (Tpset)	
	TCC2GMult	Ground TCC1,Ground TCC2	Time Dial (Tpset)	
		Ground TCC3,Ground TCC4	Time Dial (Tpset)	
	TCC1QMult	Q TCC1, Q TCC2	Time Dial (Tpset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q TCC3, Q TCC4	Time Dial (Tpset)	
	TCC2QMult	Q TCC1, Q TCC2	Time Dial (Tpset)	
		Q TCC3, Q TCC4	Time Dial (Tpset)	
	TCC1PAddEn	Phase TCC1, Phase TCC2	Enable TCC modifiers (Mod-Frame)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase TCC3, Phase TCC4	Enable TCC modifiers (Mod-Frame)	
	TCC2PAddEn	Phase TCC1, Phase TCC2	Enable TCC modifiers (Mod-Frame)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	TCC1GAddEn	Phase TCC3, Phase TCC4 Ground TCC1,Ground TCC2	Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
	TCC2GAddEn	Ground TCC3,Ground TCC4 Ground TCC1,Ground TCC2 Ground TCC3,Ground TCC4	Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame)	
	TCC1QAddEn	Q TCC1, Q TCC2	Enable TCC modifiers (Mod-Frame)	
	TCC2QAddEn	Q TCC3, Q TCC4 Q TCC1, Q TCC2 Q TCC3, Q TCC4	Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame)	
	TCC1PAdd	Phase TCC1, Phase TCC2	Time Adder (Tadder)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2PAdd	Phase TCC3, Phase TCC4 Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Time Adder (Tadder) Time Adder (Tadder) Time Adder (Tadder)	
	TCC1GAdd	Ground TCC1,Ground TCC2	Time Adder (Tadder)	
	TCC2GAdd	Ground TCC3,Ground TCC4 Ground TCC1,Ground TCC2 Ground TCC3,Ground TCC4	Time Adder (Tadder) Time Adder (Tadder) Time Adder (Tadder)	
	TCC1QAdd	Q TCC1, Q TCC2	Time Adder (Tadder)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2QAdd	Q TCC3, Q TCC4 Q TCC1, Q TCC2 Q TCC3, Q TCC4	Time Adder (Tadder) Time Adder (Tadder) Time Adder (Tadder)	
	TCC1PMRTE	Phase TCC1, Phase TCC2	Enable TCC modifiers (Mod-Frame)	
	TCC2PMRTE	Phase TCC3, Phase TCC4 Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame)	
	TCC1GMRTE	Ground TCC1,Ground TCC2	Enable TCC modifiers (Mod-Frame)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
	TCC2GMRTE	Ground TCC3,Ground TCC4 Ground TCC1,Ground TCC2 Ground TCC3,Ground TCC4	Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame)	
	TCC1QMRTE	Q TCC1, Q TCC2	Enable TCC modifiers (Mod-Frame)	
		Q TCC3, Q TCC4	Enable TCC modifiers (Mod-Frame)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	TCC2QMRTE	Q TCC1, Q TCC2 Q TCC3, Q TCC4	Enable TCC modifiers (Mod-Frame) Enable TCC modifiers (Mod-Frame)	
	TCC1PMRTA	Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Min. Response Time (minre-sptime) Min. Response Time (minre-sptime)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2PMRTA	Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Min. Response Time (minre-sptime) Min. Response Time (minre-sptime)	
	TCC1GMRTA	Ground TCC1,Ground TCC2 Ground TCC3,Ground TCC4	Min. Response Time (minre-sptime) Min. Response Time (minre-sptime)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
	TCC2GMRTA	Ground TCC1,Ground TCC2 Ground TCC3,Ground TCC4	Min. Response Time (minre-sptime) Min. Response Time (minre-sptime)	
	TCC1QMRTA	Q TCC1, Q TCC2 Q TCC3, Q TCC4	Min. Response Time (minre-sptime) Min. Response Time (minre-sptime)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2QAMRTA	Q TCC1, Q TCC2 Q TCC3, Q TCC4	Min. Response Time (minre-sptime) Min. Response Time (minre-sptime)	
	TCC1 Phase Reset Coefficient	Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Reset Delay (ResetT) Reset Delay (ResetT)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2 Phase Reset Coefficient	Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Reset Delay (ResetT) Reset Delay (ResetT)	
	TCC1 Ground Re-set Coefficient	Ground TCC1, Ground TCC2 Ground TCC3, Ground TCC4	Reset Delay (ResetT) Reset Delay (ResetT)	Set accordingly with the <i>Operation Sequence Ground Sequence</i> relay setting
	TCC2 Ground Re-set Coefficient	Ground TCC1, Ground TCC2 Ground TCC3, Ground TCC4	Reset Delay (ResetT) Reset Delay (ResetT)	
	TCC1 Negative Sequence Reset Co-efficient	Q TCC1, Q TCC2 Q TCC3, Q TCC4	Reset Delay (ResetT) Reset Delay (ResetT)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2 Negative Sequence Reset Co-efficient	Q TCC1, Q TCC2 Q TCC3, Q TCC4	Reset Delay (ResetT) Reset Delay (ResetT)	
	TCC1 Phase Disk Reset	Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Reset Characteristic (resetdis) Reset Characteristic (resetdis)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2 Phase Disk Reset	Phase TCC1, Phase TCC2 Phase TCC3, Phase TCC4	Reset Characteristic (resetdis) Reset Characteristic (resetdis)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	TCC1 Ground Disk Reset	Ground TCC2	Reset Characteristic (resetdis)	Set accordingly with the <i>Operation Sequence Ground Sequence</i> relay setting
		Ground TCC3, Ground TCC4	Reset Characteristic (resetdis)	
	TCC2 Ground Disk Reset	Ground TCC1, Ground TCC2	Reset Characteristic (resetdis)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Ground TCC3, Ground TCC4	Reset Characteristic (resetdis)	
	TCC1 Negative Sequence Disk Reset	Q TCC1, Q TCC2	Reset Characteristic (resetdis)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q TCC3, Q TCC4	Reset Characteristic (resetdis)	
	TCC2 Negative Sequence Disk Reset	Q TCC1, Q TCC2	Reset Characteristic (resetdis)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q TCC3, Q TCC4	Reset Characteristic (resetdis)	
	TCC1PHCTEn	Phase HC 1, Phase HC 2	Out of service (outserv)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase HC 3, Phase HC 4	Out of service (outserv)	
	TCC2PHCTEn	Phase HC 1, Phase HC 2	Out of service (outserv)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
		Phase HC 3, Phase HC 4	Out of service (outserv)	
	TCC1GHCTEn	Ground HC 1, Ground HC 2	Out of service (outserv)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Ground HC 3, Ground HC 4	Out of service (outserv)	
	TCC2GHCTEn	Ground HC 1, Ground HC 2	Out of service (outserv)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Ground HC 3, Ground HC 4	Out of service (outserv)	
	TCC1QHCTEn	Q HC 1, Q HC 2	Out of service (outserv)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q HC 3, Q HC 4	Out of service (outserv)	
	TCC2QHCTEn	Q HC 1, Q HC 2	Out of service (outserv)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q HC 3, Q HC 4	Out of service (outserv)	
	TCC1PHCT Mul	Phase HC 1, Phase HC 2	Pickup Current (Ipset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase HC 3, Phase HC 4	Pickup Current (Ipset)	
	TCC2PHCT Mul	Phase HC 1, Phase HC 2	Pickup Current (Ipset)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
		Phase HC 3, Phase HC 4	Pickup Current (Ipset)	
	TCC1GHCT Mul	Ground HC 1, Ground HC 2	Pickup Current (Ipset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Ground HC 3, Ground HC 4	Pickup Current (Ipset)	
	TCC2GHCT Mul	Ground HC 1, Ground HC 2	Pickup Current (Ipset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Ground HC 3, Ground HC 4	Pickup Current (Ipset)	
	TCC1QHCT Mul	Q HC 1, Q HC 2	Pickup Current (Ipset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q HC 3, Q HC 4	Pickup Current (Ipset)	
	TCC2QHCT Mul	Q HC 1, Q HC 2	Pickup Current (Ipset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Q HC 3, Q HC 4	Pickup Current (Ipset)	
	TCC1PHCTDly	Phase HC 1, Phase HC 2	Time Setting (cTset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase HC 3, Phase HC 4	Time Setting (cTset)	
	TCC2PHCTDly	Phase HC 1, Phase HC 2	Time Setting (cTset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
		Phase HC 3, Phase HC 4	Time Setting (cTset)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	TCC1GHCTDly	Ground HC 1,Ground HC 2	Time Setting (cTset)	Set accordingly with the <i>Operation Sequence Ground</i> relay setting
	TCC2GHCTDly	Ground HC 3,Ground HC 4 Ground HC 1,Ground HC 2	Time Setting (cTset) Time Setting (cTset)	
	TCC1QHCTDly	Ground HC 3,Ground HC 4 Q HC 1, Q HC 2	Time Setting (cTset) Time Setting (cTset)	Set accordingly with the <i>Operation Sequence-Phase /Negative Sequence</i> relay setting
	TCC2QHCTDly	Q HC 3, Q HC 4 Q HC 1, Q HC 2 Q HC 3, Q HC 4	Time Setting (cTset) Time Setting (cTset) Time Setting (cTset)	
	Fault Directional Phase	Dir phase	Tripping Direction (idir)	
		Phase TCC1, Phase TCC2	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Phase TCC3, Phase TCC4	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Phase HC 1, Phase HC 2	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
	Fault Directional Negative Sequence	Phase HC 3, Phase HC 4	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Dir phase	Tripping Direction (idir)	
		Q TCC1, Q TCC2	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Q TCC3, Q TCC4	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
	Fault Directional Ground	Q HC 1, Q HC 2	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Q HC 3, Q HC 4	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Dir Ground	Tripping Direction (idir)	
		Ground TCC1,Ground TCC2	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
	Maximum Torque Angle - Fault	Ground TCC3,Ground TCC4	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Ground HC 1,Ground HC 2	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Ground HC 3,Ground HC 4	Tripping Direction (idir)	Set <i>None</i> for a not directional trip
		Dir Ground	Max. Torque Angle (mtau)	In the "Voltage Polarizing" tab page
		Dir phase	Max. Torque Angle (mtau)	In the "Voltage Polarizing" tab page

Reclosing :

Address	Relay Setting	Model block	Model setting	Note
	PQOper#1	Phase TCC1, Q TCC1		Set in the Phase TCC1 and in the Q TCC1 model block the trip settings present in the relay phase and Q TCC1
	PQOper#2	Phase TCC2, Q TCC2		Set in the Phase TCC2 and in the Q TCC2 model block the trip settings present in the relay phase and Q TCC2

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	PQOper#3	Phase TCC3, Q TCC3		Set in the Phase TCC3 and in the Q TCC3 model block the trip settings present in the relay phase and Q TCC3
	PQOper#4	Phase TCC4, Q TCC4		Set in the Phase TCC4 and in the Q TCC4 model block the trip settings present in the relay phase and Q TCC4
	GndOper#1	Ground TCC1		Set in the Ground TCC1 model block the trip settings present in the relay Ground TCC1
	GndOper#2	Ground TCC2		Set in the Ground TCC2 model block the trip settings present in the relay Ground TCC2
	GndOper#3	Ground TCC3		Set in the Ground TCC3 model block the trip settings present in the relay Ground TCC3
	GndOper#4	Ground TCC4		Set in the Ground TCC4 model block the trip settings present in the relay Ground TCC4
	PQOpenInt#1	Phase reclogic	Reclosing interval 1 (recltime1)	
	PQOpenInt#2	Phase reclogic	Reclosing interval 2 (recltime2)	
	PQOpenInt#3	Phase reclogic	Reclosing interval 3 (recltime3)	
	GndOpenInt#1	Ground reclogic	Reclosing interval 1 (recltime1)	
	GndOpenInt#2	Ground reclogic	Reclosing interval 2 (recltime2)	
	GndOpenInt#3	Ground reclogic	Reclosing interval 3 (recltime3)	
	Reset Time	Phase reclogic	Reset Time (resettime)	
		Ground reclogic	Reset Time (resettime)	
	Fast Trip Block	Phase reclogic	Fast Trip disabled (fasttripdisabl)	
		Ground reclogic	Fast Trip disabled (fasttripdisabl)	
	Allow sequence coordination	Phase reclogic	Sequence Coordination (seqaccesory)	
		Ground reclogic	Sequence Coordination (seqaccesory)	
	Up to	Phase reclogic	Max sequence coordination operation number (maxseqcpsno)	
		Ground reclogic	Max sequence coordination operation number (maxseqcpsno)	
	CLPU Operations to Lockout	Phase reclogic	Trips to lockout (cltripstolockout)	In the "Cold Load Pickup" tab page
		Ground reclogic	Trips to lockout (cltripstolockout)	In the "Cold Load Pickup" tab page
	CLPU Reclose Interval	Phase reclogic	Reclose Interval (clrecloseinterval)	In the "Cold Load Pickup" tab page
		Ground reclogic	Reclose Interval (clrecloseinterval)	In the "Cold Load Pickup" tab page
	Phase Enable HCL for Operation #1	Phase reclogic	HCL active on operation - 1st (hcl1active)	In the "High Current Lockout" frame
	Phase Enable HCL for Operation #2	Phase reclogic	HCL active on operation - 2nd (hcl2active)	In the "High Current Lockout" frame

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	Phase Enable HCL for Operation #3	Phase reclogic	HCL active on operation - 3rd (hcl3active)	In the "High Current Lockout" frame
	Negative Sequence Enable HCL for Operation #1	Phase reclogic	HCL active on operation - 1st (hcl1active)	In the "High Current Lockout" frame
	Negative Sequence Enable HCL for Operation #2	Phase reclogic	HCL active on operation - 2nd (hcl2active)	In the "High Current Lockout" frame
	Negative Sequence Enable HCL for Operation #3	Phase reclogic	HCL active on operation - 3rd (hcl3active)	In the "High Current Lockout" frame
	Ground Enable HCL for Operation #1	Ground reclogic	HCL active on operation - 1st (hcl1active)	In the "High Current Lockout" frame
	Ground Enable HCL for Operation #2	Ground reclogic	HCL active on operation - 2nd (hcl2active)	In the "High Current Lockout" frame
	Ground Enable HCL for Operation #3	Ground reclogic	HCL active on operation - 3rd (hcl3active)	In the "High Current Lockout" frame

Cold Load :

Address	Relay Setting	Model block	Model setting	Note
	CLPUActTime	Phase reclogic	Activation Time (clactivationt)	In the "Cold Load Pickup" tab page
		Ground reclogic	Activation Time (clactivationt)	In the "Cold Load Pickup" tab page
	CLPUBlock	Phase reclogic	Enable Cold Load Pickup (clenable)	Set the model parameter when CLPUBlock is 0
		Ground reclogic	Enable Cold Load Pickup (clenable)	Set the model parameter when CLPUBlock is 0
	CLPUPMin Trip	Phase ColdLoadTCC	Current Setting (Ipsetr)	
	CLPUPCurve	Phase ColdLoadTCC	Characteristic (pcharac)	
	CLPUPMultE	Phase ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUPMult	Phase ColdLoadTCC	Time Dial (Tpset)	
	CLPUPAddEn	Phase ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUPAdd	Phase ColdLoadTCC	Time Adder (Tadder)	
	CLPUPMRTAE	Phase ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUPMRTA	Phase ColdLoadTCC	Min.Response Time (minresp-time)	
	CLPUGMin Trip	Ground ColdLoadTCC	Current Setting (Ipsetr)	
	CLPUGCurve	Ground ColdLoadTCC	Characteristic (pcharac)	
	CLPUGMultE	Ground ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUGMult	Ground ColdLoadTCC	Time Dial (Tpset)	
	CLPUGAddEn	Ground ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUGAdd	Ground ColdLoadTCC	Time Adder (Tadder)	
	CLPUGMRTAE	Ground ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUGMRTA	Ground ColdLoadTCC	Min.Response Time (minresp-time)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	CLPUQMin Trip	Q ColdLoadTCC	Current Setting (Ipsetr)	
	CLPUQCurve	Q ColdLoadTCC	Characteristic (pcharac)	
	CLPUQMultE	Q ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUQMult	Q ColdLoadTCC	Time Dial (Tpset)	
	CLPUQAddEn	Q ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUQAdd	Q ColdLoadTCC	Time Adder (Tadder)	
	CLPUQMRTAE	Q ColdLoadTCC	Enable TCC modifiers (Mod-Frame)	
	CLPUQMRTA	Q ColdLoadTCC	Min.Response Time (minresp-time)	
	CLPUPHCTEn	Cold Load Phase HC	Out of Service (outserv)	
	CLPUPHCT Mul	Cold Load Phase HC	Pickup Current (Ipset)	
	CLPUPHCTDly	Cold Load Phase HC	Time Setting (Tset)	
	CLPUGHCTEn	Cold Load Ground HC	Out of Service (outserv)	
	CLPUGHCT Mul	Cold Load Ground HC	Pickup Current (Ipset)	
	CLPUGHCTDly	Cold Load Ground HC	Time Setting (Tset)	
	CLPUQHCTEn	Cold Load Q HC	Out of Service (outserv)	
	CLPUQHCT Mul	Cold Load Q HC	Pickup Current (Ipset)	
	CLPUQHCTDly	Cold Load Q HC	Time Setting (Tset)	

SEF :

Address	Relay Setting	Model block	Model setting	Note
	SEFBlock	Sensitive Ground	Out of Service (outserv)	
	SEFMintrip	Sensitive Ground	Pickup Current (Ipsetr)	
	SEFTime	Sensitive Ground	Time Setting (Tset)	
	SEFReclnt	SEF reclogic	Reclosing interval 1 (re-cltime1)	
		SEF reclogic	Reclosing interval 2 (re-cltime2)	
		SEF reclogic	Reclosing interval 3 (re-cltime3)	
		SEF reclogic	Reclosing interval 4 (re-cltime4)	
	SEFNumOps	SEF reclogic	Operations to lockout	
	Maximum Torque Angle - Fault	Dir Ground	Max. Torque Angle (mtau)	In the "Voltage Polarizing" tab page

Voltage :

Address	Relay Setting	Model block	Model setting	Note
	UVolt1PEna	Undervoltage 1p	Out of Service (outserv)	
		Undervoltage 3p	Out of Service (outserv)	
		Undervoltage alarm	Out of Service (outserv)	
	UVolt1PPU	Undervoltage 1p	Pickup Voltage (Usetr)	
	UFreq1PTIME	Undervoltage 1p	Time Delay (Tdel)	
	UFreq3PPU	Undervoltage 3p	Pickup Voltage (Usetr)	
	UFreq3PTIME	Undervoltage 3p	Time Delay (Tdel)	
	Undervoltage Alarm	Undervoltage alarm	Pickup Voltage (Usetr)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	Undervoltage Time Delay Alarm	Undervoltage alarm	Time Delay (Tdel)	
	OVolt1PEna	Overvoltage 1p	Out of Service (outserv)	
		Overvoltage 3p	Out of Service (outserv)	
		Overvoltage alarm	Out of Service (outserv)	
	OVolt1PPU	Overvoltage 1p	Pickup Voltage (Usetr)	
	OVolt1PTime	Overvoltage 1p	Time Delay (Tdel)	
	OVolt3PPU	Overvoltage 3p	Pickup Voltage (Usetr)	
	OVolt3PTime	Overvoltage 3p	Time Delay (Tdel)	
	Overvoltage Alarm	Overvoltage alarm	Pickup Voltage (Usetr)	
	Overvoltage Time Delay Alarm	Overvoltage alarm	Time Delay (Tdel)	

Frequency :

Address	Relay Setting	Model block	Model setting	Note
	UFreqEnabl	Underfrequency 1	Out of Service (outserv)	
		Underfrequency 2	Out of Service (outserv)	
		Underfrequency alarm	Out of Service (outserv)	
	UFreq1PU see	Underfrequency 1	Frequency (Fset)	
	UFreq1Time	Underfrequency 1	Time Delay (Tdel)	
	UFreq2PU see	Underfrequency 2	Frequency (Fset)	
	UFreq2Time	Underfrequency 2	Time Delay (Tdel)	
	Underfrequency Alarm	Underfrequency alarm	Frequency (Fset)	
	Underfrequency Time Delay Alarm	Underfrequency alarm	Time Delay (Tdel)	
	OFreqEnabl	Overfrequency 1	Out of Service (outserv)	
		Overfrequency 2	Out of Service (outserv)	
		Overfrequency alarm	Out of Service (outserv)	
	OFreq1PU see	Overfrequency 1	Frequency (Fset)	
	OFreq1Time	Overfrequency 1	Time Delay (Tdel)	
	OFreq2PU see	Overfrequency 2	Frequency (Fset)	
	OFreq2Time	Overfrequency 2	Time Delay (Tdel)	
	Overfrequency Alarm	Overfrequency alarm	Frequency (Fset)	
	Overfrequency Time Delay Alarm	Overfrequency alarm	Time Delay (Tdel)	

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:

- Phase Output Logic
- Ground Output Logic
- Negative seq Output Logic
- V&F Output Logic
- Closing Logic

3.3.2 Functionality

The "Phase Output Logic", "Ground Output Logic", "Negative seq Output Logic", and "V&F Output Logic" block have 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".

- *yout;yout_A;yout_B;yout_C* ("Phase Output Logic" block).
- *yout1* ("Ground Output Logic" block).
- *yout2* ("Negative seq Output Logic" block).
- *yout3* ("V&F Output Logic" block).

The "Phase Output Logic" block can trigger a 3 phase or a single phase trip command. The trip mode must be set in the "Operation Mode" tab page of the "Phase reclogic" block (phase reclosing logic element). For special purposes the signals enabled to trip the breaker can be set using the *Tripping signals* combo box ("sTripsig" setting) in the "Phase Output Logic" block dialog. The "Closing Logic" block controlled by the reclosing feature ("Phase reclogic", "Ground reclogic", and "SEF reclogic" block) has the purpose of generating a closing command for the power breaker when a reclosing attempt is triggered. It sets the *youtclose* relay output contact.

3.3.3 Data input

To disable the relay model ability to open the power circuit breaker disable the "Phase Output Logic", "Ground Output Logic", "Negative seq Output Logic", and "V&F 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.

3.4 Phase HC lockout subrelay

3.4.1 Available Units

- Three instantaneous 3 phase overcurrent elements ("Phase HC Lockout 1", "Phase HC Lockout 2", "Phase HC Lockout 3" block).
- One output logic block ("Logic" block).

3.4.2 Functionality

The subrelay contains three phase overcurrent stages which can stop the reclosing procedure if any phase current is greater than a given, user configurable threshold. Each overcurrent stage is associated to a different reclosing attempt and can be enabled or disabled. Please notice that the relevant relay current threshold setting is unique so all elements must be set with the same value.

3.4.3 Data input

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

Address	Relay Setting	Model block	Model setting	Note
	Phase HCL Pickup	Phase HC Lockout 1	Pickup Current (Ipsetr)	
		Phase HC Lockout 2	Pickup Current (Ipsetr)	
		Phase HC Lockout 3	Pickup Current (Ipsetr)	
	Enable HCL for Operation #1	Phase HC Lockout 1	Out of Service (outserv)	
	Enable HCL for Operation #2	Phase HC Lockout 2	Out of Service (outserv)	
	Enable HCL for Operation #3	Phase HC Lockout 3	Out of Service (outserv)	

3.5 Ground HC lockout subrelay

3.5.1 Available Units

- Three instantaneous ground overcurrent elements ("Ground HC Lockout 1", "Ground HC Lockout 2", "Ground HC Lockout 3" block).
- One output logic block ("Logic" block).

3.5.2 Functionality

The subrelay contains three ground overcurrent stages which can stop the reclosing procedure if the ground current is greater than a given, user configurable threshold. Each overcurrent stage is associated to a different reclosing attempt and can be enabled or disabled. Please notice that the relevant relay current threshold setting is unique so all elements must be set with the same value.

3.5.3 Data input

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

Address	Relay Setting	Model block	Model setting	Note
	Ground HCL Pickup	Ground HC Lockout 1	Pickup Current (Ipsetr)	
		Ground HC Lockout 2	Pickup Current (Ipsetr)	
		Ground HC Lockout 3	Pickup Current (Ipsetr)	
	Enable HCL for Operation #1	Ground HC Lockout 1	Out of Service (outserv)	
	Enable HCL for Operation #2	Ground HC Lockout 2	Out of Service (outserv)	
	Enable HCL for Operation #3	Ground HC Lockout 3	Out of Service (outserv)	

3.6 Q HC lockout subrelay

3.6.1 Available Units

- Three instantaneous negative sequence overcurrent elements ("Q HC Lockout 1", "Q HC Lockout 2", "Q HC Lockout 3" block).
- One output logic block ("Logic" block).

3.6.2 Functionality

The subrelay contains three negative sequence overcurrent stages which can stop the reclosing procedure if the negative sequence current is greater than a given, user configurable threshold. Each overcurrent stage is associated to a different reclosing attempt and can be enabled or disabled. Please notice that the relevant relay current threshold setting is unique so all elements must be set with the same value.

3.6.3 Data input

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

Address	Relay Setting	Model block	Model setting	Note
	Negative Sequence HCL Pickup	Q HC Lockout 1	Pickup Current (Ipsetr)	
		Q HC Lockout 2	Pickup Current (Ipsetr)	
		Q HC Lockout 3	Pickup Current (Ipsetr)	
	Enable HCL for Operation #1	Q HC Lockout 1	Out of Service (outserv)	
	Enable HCL for Operation #2	Q HC Lockout 2	Out of Service (outserv)	
	Enable HCL for Operation #3	Q HC Lockout 3	Out of Service (outserv)	

4 Features not supported

- Overcurrent alarm.
- Breaker fail (LBB).
- Low set overcurrent protection.
- Incipient Cable Splice Fault.
- Hot line tag.
- Fault location distance.
- Sync check.
- Under frequency restoration.

5 References

- [1] Cooper Power Systems, 1045 Hickory Street, Pewaukee, WI 53072 USA. *Kyle Form 6 Microprocessor-Based Recloser Control Programming Guide S280-70-4 KA2048-544 Rev. 5*, 2004.