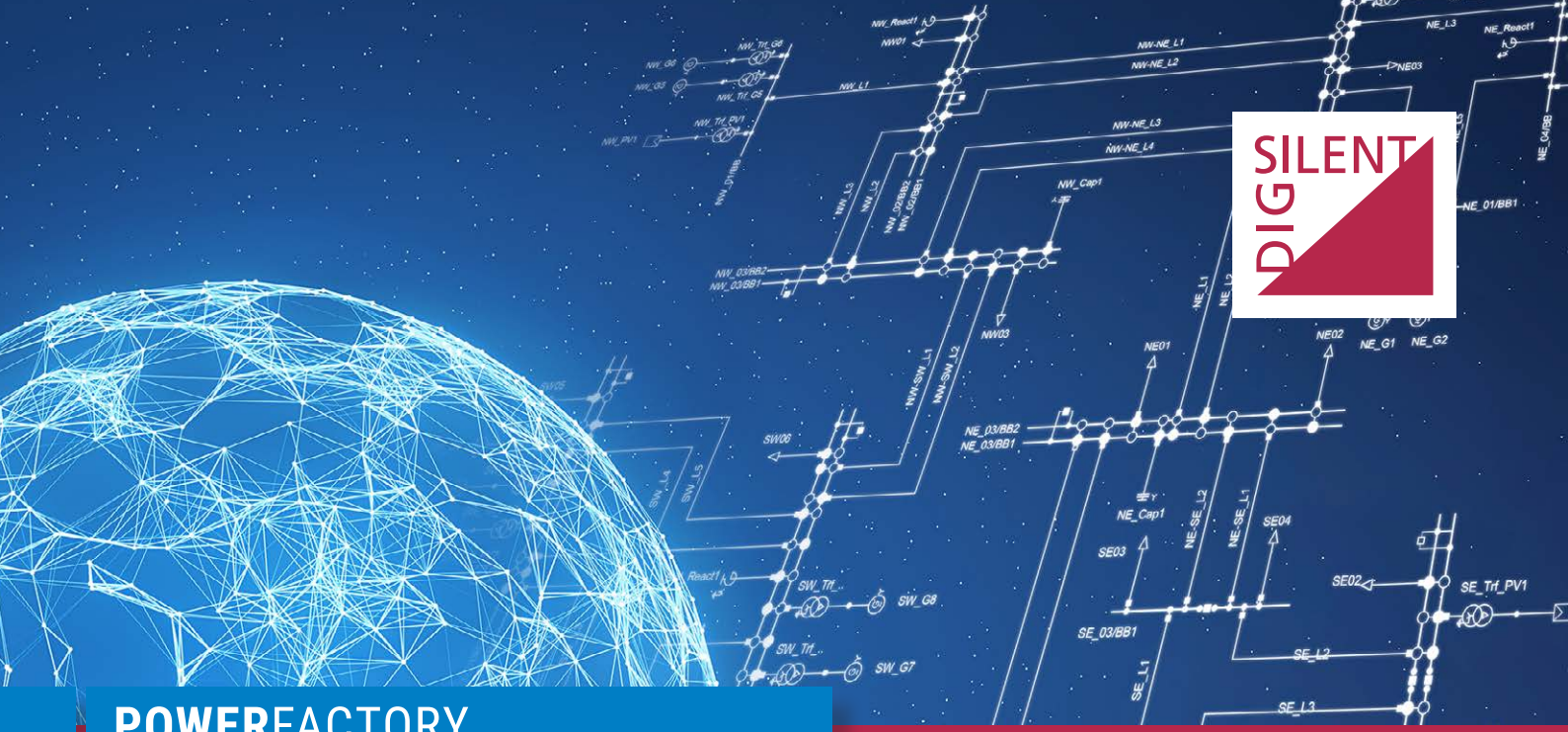

POWERFACTORY

PowerFactory 2021

Technical Reference

Areva P220

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

Publisher:
DIgSILENT GmbH
Heinrich-Hertz-Straße 9
72810 Gomaringen / Germany
Tel.: +49 (0) 7072-9168-0
Fax: +49 (0) 7072-9168-88
info@digsilent.de

Please visit our homepage at:
https://www.digsilent.de

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Contents

1 Model information

Manufacturer Areva

Model P220

Variants The Areva P220 PowerFactory relay model can be used to simulate the different firmware versions of Areva P220 relays. The relay firmware version used to implement the model is Areva P220 V6.D .

2 General description

The MiCOM P220 protection relay is designed for motor protection applications. A complete set of protection functions is performed on the measurement of current and temperature. In addition to these basic functions, the relay carries out a large number of other functions that enable it to protect and run the motor more effectively. The MiCOM P22o protection relay is particularly adapted to Oil refinery, chemical plant, metallurgy, glass and cement manufacturing, paper mills, electrical and mechanical engineering, food production, mining etc. It is also suitable for water treatment and in pumping stations as well as in steam power plants.

The PowerFactory Areva P220 relay model consists of a main relay and the following three subrelays:

- Limitation of the number of coldstartups
- Limitation of the number of hotstart-ups
- Time between 2 start-ups

The PowerFactory Areva P220 relay model simulates most of the protective elements available in the relay. The model includes the measurement and acquisition elements, the thermal image element, the phase overcurrent/undercurrent protection elements, the unbalance elements, the ground overcurrent elements, the prolonged start protection, the motor stall protection, two separated control logics limiting the number of motor starts in the warm and in the cold motor condition, one control logic checking the time between two consecutive motor starts and the output logic.

The model implementation has been based on the information available in the relay 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 currents flowing in the power system are converted by a block simulating the 3 phase CT and by a block simulating a single phase CT measuring the earth current; the secondary currents are then measured by two elements modeling the digital sampling of the relay.

3.1.1 Available Units

- One 3 phase current transformer (”Ct-3P” block).
- One single phase current transformer (”Ct-3I0” block).
- One 3 phase measurement element (”Measure” block).
- One 3 phase measurement element providing the positive sequence current (”Measure seq” block).

The following relay input signals are available and can be used in the output block user configurable logic (see 3.6.2):

- *L1*
- *L2*
- *L3*
- *L4*
- *L5*

3.1.2 Functionality

The ”Ct-3P” and the ”Ct-3I0” block represent ideal CTs. Using the CT default configuration the current at the primary side are 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 ”Measure” block measures the currents sampling the input waves at 32 samples/cycles. The RMS values are calculated with a rectangular integration over a full cycle.

3.1.3 Data input

The CT secondary rated current (1 or 5 A) value must be set in the ”Measure” and in the ”Measure seq” block (*Nominal Current* setting).

If no core CT is available please select the 3 phases CT also in the ”Ct-3I0” slot: the earth current will be calculated assuming that an Holmgreen’s connection of the phases is used.

3.2 Main relay protective elements

The thermal image element, one definite time phase overcurrent element, one undercurrent elements, one definite time and one I^2t unbalance element, two definite time ground overcurrent elements, one too long starting and one motor stall protection are modeling the relay protective functions.

3.2.1 Available Units

- One three-phase thermal image element(”I>” and ”Ke”’ block).
- One three-phase non-directional definite time overcurrent element (”I>>” block).
- One three-phase under current element (”I<” block).
- Two earth fault non-directional definite time elements(”Io>” and ”Io>>” block).
- One negative sequence definite time overcurrent element (”Ii>” block).
- One negative sequence I^2t characteristic time overcurrent element (”Ii>>” block).
- One too long starting element (”Prolonged start/stall Current Set”, ”Prolonged start/stall Tistart”, ”Start detector”, ”Prolonged start logic” and ”Negate 1” block).
- One stall protection (”Prolonged start/stall Current Set”, ”Prolonged start/stall Tistall” and ”Prolonged stall logic” block).

3.2.2 Functionality

Overcurrent elements :

The thermal replica element (”I>” block) supports the standard IEC 60255-8 characteristic. The current input value is calculated using the positive sequence current and the negative sequence current multiplied by the *Ke* factor (”Ke” block) accordingly to the formula provided in the Areva P220 documentation.

Prolonged start The start condition is detected by the ”Prolonged start logic” block which get the trip signal of the ”Start detector” block, acting as under current element and the trip signal of the ”Prolonged start/stall Current Set” block which is an overcurrent element with current threshold modeling the *Prolonged start or stall Current Set* relay setting. The ”Start detector’ block has a 90 ms reset delay. To declare a start condition both the ”Start detector” and the ”Prolonged start/stall Current Set” trip signals must be on. It means that a start condition is declared if the current values jump from a value smaller than the ”Start detector” block 2% I_n current threshold to a value greater than the ”Prolonged start/stall Current Set” block current threshold in less than 90 ms. The ”Prolonged start/stall Tistart” block adds to the logic the delay represented in the relay by the *Time Delay for prolonged start* setting.

Motor stall The *Motor stall* protection is active only if the no start condition has been detected. For this reason the *Motor stall* logic is controlled by the ”Prolonged start logic” block. The *Motor stall* current threshold is shared with the *Prolonged start* logic and can be set in the ”Prolonged start/stall Current Set” block. The ”Prolonged start/stall Tistall” block adds to the logic the delay represented in the relay by the ”Time Delay for stall or locked rotor” setting.

3.2.3 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):

Overcurrent and undercurrent elements :

Address	Relay Setting	Model block	Model setting	Note
	Thermal overload function enabled ?	I>	Out of Service (outserv)	
	Thermal current threshold 1θ >	I>	Current Setting (Ipsetr)	
	Overload time-constant Te1	I>	Time Dial (Tpset)	
	Cooling time-constant Tr	I>	Reset Delay (ResetT)	In seconds in the model
	Short-circuit function enabled ?	I>>	Out of Service (outserv)	
	Threshold I>>	I>>	Pickup Current (Ipset)	
	tI>>	I>>	Time Setting (Tset)	
	Earth fault function enabled ? threshold Io>	Io>	Out of Service (outserv)	
	Threshold Io>	Io>	Pickup Current (Ipset)	
	tIo>	Io>	Time Setting (Tset)	
	Earth fault function enabled ? threshold Io>>	Io>>	Out of Service (outserv)	
	Threshold Io>>	Io>>	Pickup Current (Ipset)	
	tIo>>	Io>>	Time Setting (Tset)	
	Function Unbalance enabled ?: threshold Ii>	Ii>	Out of Service (outserv)	
	Threshold Ii>	Ii>	Pickup Current (Ipset)	
	tIi>	Ii>	Time Setting (Tset)	
	Function Unbalance enabled ?: threshold Ii>>	Ii>>	Out of Service (outserv)	
	Threshold Ii>>	Ii>>	Pickup Current (Ipset)	
	tIi>>	Ii>>	Time Setting (Tset)	

Loss of load :

Address	Relay Setting	Model block	Model setting	Note
	Loss of load function enabled ?	I<	Out of Service (outserv)	
	Threshold I<	I<	Pickup Current (Ipset)	
	tI<	I<	Time Setting (Tset)	

Prolonged start :

Address	Relay Setting	Model block	Model setting	Note
	Excess long start function enabled ?	Prolonged start/stall Tistart	Out of Service (outserv)	
	Threshold Istart	Prolonged start/stall Current Set	Pickup Current (Ipset)	Shared with *Motor stall*
	tIstart	Prolonged start/stall Tistart	Time Setting (Tdelay)	

Motor stall :

Address	Relay Setting	Model block	Model setting	Note
	Block rotor function enabled ?	Prolonged start/stall Tistall	Out of Service (outserv)	

Address	Relay Setting	Model block	Model setting	Note
	tIstall	Prolonged start/stall Tistall	Time Setting (Tdelay)	
	Threshold Istall	Prolonged start/stall Current Set	Pickup Current (Ipset)	Shared with *Prolonged start*

3.3 Limitation of the number of coldstartups subrelay

The number of motor start-ups can be limited. The Areva P220 relay can discriminate between a warm and a cold motor, making it possible to optimize the number of start-ups allocated to a particular motor over a given period of time.

The *Limitation of the number of coldstartups* subrelay implements a motor start counter with user configurable reset time and simulate the *cold motor limitation of the number of starts* relay feature. The subrelay operates when the thermal status of the *thermal overload function* (”I>” block) is smaller than 50%.

3.3.1 Available Units

- Seven timers (”Reference period 1”, ”Reference period 2”, ”Reference period 3”, ”Reference period 4”, ”Reference period 5”, ”Reference period 6” and ”Inhibition time” block).
- One logic element (”Number of Cold Starts” block).
- Six ancillary timers (”Delay 1”, ”Delay 2”, ”Delay 3”, ”Delay 4”, ”Delay 5” and ”Up delay” block).
- Six ancillary logic blocks (”Start 2 And”, ”Start 3 And”, ”Start 4 And”, ”Start 5 And”, ”Start 6 And” and ”UpDetector” block).

3.3.2 Functionality

The subrelay detects a motor start using the ”Up delay” and the ”UpDetector” block.

The *given period of time* is checked by the ”Reference period x” (with x = 1...6) timer block: after each motor starting a different timer keep on a flag signal for the *given period of time*. All flag signals are connected to a logic element (”Number of Cold Starts” block) which compares the number of flag signals with the number of allowed motor starts.
The output signal of the ”Number of Hot Starts” block is connected by default to the ”RL2” relay output contact. The logic can modified in the "Logic" tab page of the ”Trip Logic” block (see 3.6). The output signal is kept on for the *Restart inhibition time* by the ”Inhibition time” block.

The other blocks present in the subrelay are used to adapt the PowerFactory simulation engine to the feature logic and don’t contain any user configurable parameter.

3.3.3 Data input

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):

Address	Relay Setting	Model block	Model setting	Note
	Treference	Reference period 1	Time Setting (Tdelay)	In seconds in the model
		Reference period 2	Time Setting (Tdelay)	In seconds in the model
		Reference period 3	Time Setting (Tdelay)	In seconds in the model
		Reference period 4	Time Setting (Tdelay)	In seconds in the model
		Reference period 5	Time Setting (Tdelay)	In seconds in the model
		Reference period 6	Time Setting (Tdelay)	In seconds in the model
	Cold starts number	Number of Cold Starts	N_start	In the ”Logic” tab page
	Tinterdiction	Inhibition time	Time Setting (Tdelay)	In seconds in the model

3.4 Limitation of the number of hotstart-ups subrelay

The number of motor start-ups can be limited. The Areva P220 relay can discriminate between a warm and a cold motor, making it possible to optimise the number of start-ups allocated to a particular motor over a given period of time.

The *Limitation of the number of coldstartups* subrelay implements a motor start counter with user configurable reset time and simulate the *warm motor limitation of the number of starts* relay feature. The subrelay operates when the thermal status of the *thermal overload function* (”I>” block) is greater than 50%.

3.4.1 Available Units

- Seven timers (”Reference period 1”, ”Reference period 2”, ”Reference period 3”, ”Reference period 4”, ”Reference period 5”, ”Reference period 6” and ”Inhibition time” block).
- One logic element (”Number of Hot Starts” block).
- Six ancillary timers (”Delay 1”, ”Delay 2”, ”Delay 3”, ”Delay 4”, ”Delay 5” and ”Up delay” block).
- Six ancillary logic blocks (”Start 2 And”, ”Start 3 And”, ”Start 4 And”, ”Start 5 And”, ”Start 6 And” and ”UpDetector” block).

3.4.2 Functionality

The subrelay detects a motor start using the ”Up delay” and the ”UpDetector” block.

The *given period of time* is checked by the ”Reference period x” (with x = 1...6) timer block: after each motor starting a different timer keep on a flag signal for the *given period of time*. All flag signals are connected to a logic element (”Number of Cold Starts” block) which compares the number of flag signals which are on with the number of allowed motor starts.
The output signal of the ”Number of Hot Starts” block is connected by default to the ”RL2” relay output contact. The logic can modified in the "Logic" tab page of the ”Trip Logic” block (see 3.6). The output signal is kept on for the *Restart inhibition time* by the ”Inhibition time” block.

The other blocks present in the subrelay are used to adapt the PowerFactory simulation engine to the feature logic and don’t contain any user configurable parameter.

3.4.3 Data input

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):

Address	Relay Setting	Model block	Model setting	Note
	Treference	Reference period 1	Time Setting (Tdelay)	In seconds in the model
		Reference period 2	Time Setting (Tdelay)	In seconds in the model
		Reference period 3	Time Setting (Tdelay)	In seconds in the model
		Reference period 4	Time Setting (Tdelay)	In seconds in the model
		Reference period 5	Time Setting (Tdelay)	In seconds in the model
		Reference period 6	Time Setting (Tdelay)	In seconds in the model
	Hot starts number	Number of Hot Starts	N_start	In the ”Logic” tab page
	Tinterdiction	Inhibition time	Time Setting (Tdelay)	In seconds in the model

3.5 Time between 2 start-ups subrelay

Two consecutive and very close motor start-ups could expose the motor and its start-up system to over-large resultant stresses. The protection function implemented by the *Time between 2 start-ups* subrelay makes possible to prevent two consecutive motor starts.

3.5.1 Available Units

- Two timers (”Reference period” and ”Start 1 Hold” block)
- Two ancillary logic blocks (”Start 1 neg” and ”Start 2 And” block)

3.5.2 Functionality

The ”Reference period” timer counts the time from any motor start. If a second motor start is detected when this time is smaller than the time specified in the ”Reference period” timer a relay output signal is activated. By default the ”RL2” relay output contact is operated.

The other blocks present in the subrelay are used to adapt the PowerFactory simulation engine to the feature logic and don’t contain any user configurable parameter.

3.5.3 Data input

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):

Address	Relay Setting	Model block	Model setting	Note
	Inhibition time Tbetw 2 start	Reference period	Time Setting (Tdelay)	

3.6 Output logic

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

3.6.1 Available Units

- One breaker trip element (”Trip Logic” block).
- One breaker reclosing element (”Close Circuit Breaker” block).

3.6.2 Functionality

The ”Trip Logic” block collects the trip signals coming from the protective elements and operates the ”RL1”, ”RL2”, ”RL3”, ”RL4” and ”RL5” relay output contacts.

By default ”RL1”, ”RL3”, ”RL4” and ”RL5” operate the power breaker. The ”RL2” relay output command is not operating the breaker and is controlled by the cold motor and the warm motor start number limitation function.
The trip logic assigned to the relay output contacts can be modified in the ”Logic” tab page of the ”Trip Logic” block.

The ”Close Circuit Breaker” block is driven by the ”Trip Logic” block throw the ”CloseCom” signal. The logic which controls the ”CloseCom” signal can be set by the user in the ”Logic” tab page of the ”Trip Logic” block.

3.6.3 Data input

To disable the relay model ability to open the power circuit breaker simply disable the ”Trip Logic” block.
To disable the relay model ability to close the power circuit breaker disable the ”Close Circuit Breaker” block or remove the logic controlling in the ”Trip Logic” block the ”CloseCom” signal.

4 Features not supported

The following features are not supported:

- Alarm thermal stage.
- Threshold for theta forbid start.
- Re-acceleration authorisation
- Input for PTC sensors.

5 References

[1] Areva T&D, Automation & Information Systems Business, Tour AREVA 1, place Jean Millier 92084 Paris - La Défense, 92084 France. *MiCOM P220 Motor Protection Technical Guide P220/EN/B43*, 2004.

[2] Areva T&D, Automation & Information Systems Business, Tour AREVA 1, place Jean Millier 92084 Paris - La Défense, 92084 France. *Motor Protection Relay P220 and P225 P220 VERSION V6.D P225 VERSION V6.C Technical Data Sheet P22x/EN TDS/B11*, 2004.