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SIPROTEC 5 – Point on Wave Adjustment during Commissioning (APN-084)

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SIPROTEC Application

SIPROTEC 5 – Point on Wave: Adjustment during Commissioning

APN-084, Edition 1

Content

1 SIPROTEC 5 – Point on Wave: Adjustment during Commissioning

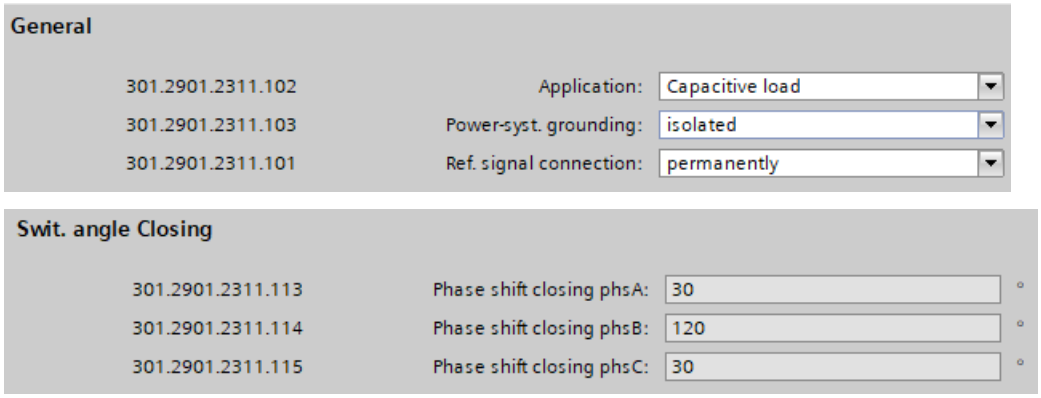
1.1 Introduction

Based on the Point on Wave (PoW) function in SIPROTEC 5, applied for closing of a capacitor bank, the checks and adjustments required during commission are described here. Only the fundamental aspects of the PoW are considered here, the influence on closing time from e.g. supply voltage or temperature are not considered. These must be checked separately.

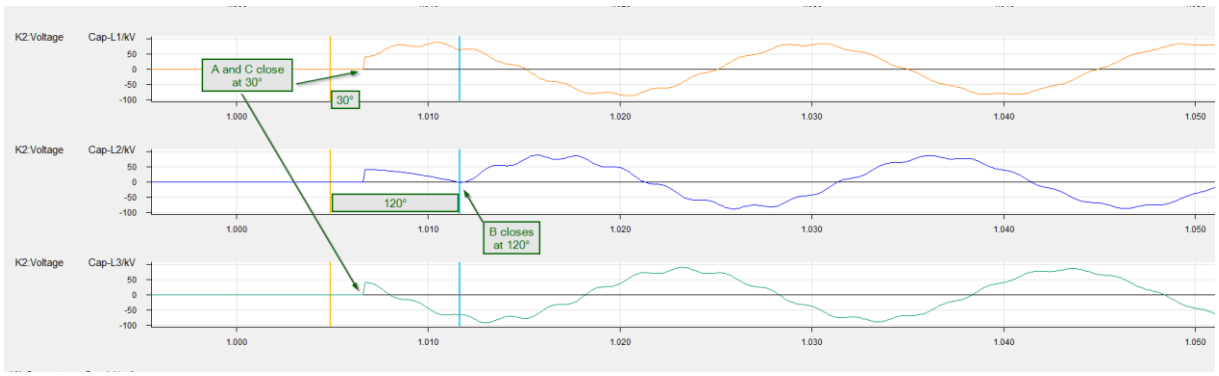
The principle source of data for the adjustments described here will be the fault log that is triggered during the closing process. The recorded waveforms and binary traces can be used to support and check the data and adjusted settings.

1.2 Application Data

In this description an ungrounded capacitor bank must be closed with PoW functionality. The corresponding setting under "General" is shown below. The closing angles are pre-configured according o the application, here 30° for the leading 2 phases and 120° for the last phase:



The first two poles (CA) close when the VCA voltage is zero (30° of reference voltage, ph A). The last pole, B, closes at 120° which is the zero crossing of the VB voltage. The diagram below shows the voltage on the capacitor with near perfect closing. The transient has only a small magnitude.



The circuit breaker data for closing is applied as follows:

CB data

301.2901.20641.105	CB closing time phsA:	62.4	ms
301.2901.20641.106	CB closing time phsB:	62.5	ms
301.2901.20641.107	CB closing time phsC:	61.1	ms
301.2901.20641.108	CB pre-arcing time phsA:	0.9	ms
301.2901.20641.109	CB pre-arcing time phsB:	0.6	ms
301.2901.20641.110	CB pre-arcing time phsC:	0.9	ms
301.2901.20641.115	CB correction time phsA:	0.00	ms
301.2901.20641.116	CB correction time phsB:	0.00	ms
301.2901.20641.117	CB correction time phsC:	0.00	ms

The closing and pre-arcing times have been set using the data provided for the circuit breaker as shown above.

1.3 Analyzing the first PoW close cycle

After the close cycle is completed the fault log should be retrieved from the device. The PoW information in the log can be checked in two steps.

1. Closing time (time until reference contact or auxiliary contact indicated CB has mechanically closed)

2. Make time (time until primary signals, current or voltage, indicate that electrical contact of the CB has been made)

1.3.1 Closing Time

In the fault log find the following entries (note: if the values are not shown in the log, check the configuration settings):

	Fault log		
1	Circuit breaker 1/3:PoW-switching:Closing	>Close CB	on
2	Recording:Fault recorder:Control	Fault number	10
3	Circuit breaker 1/3:PoW-switching:Closing	Start	on
4	Circuit breaker 1/3:Circuit break.	Close cmd. 1-pole phsA	on
5	Circuit breaker 1/3:Circuit break.	Close cmd. 1-pole phsC	on
6	Circuit breaker 1/3:Circuit break.	Close cmd. 1-pole phsB	on
7	Circuit breaker 1/3:PoW-switching:Closing	>Close CB	off
8	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsA calc.	62.400 ms
9	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsB calc.	62.500 ms
10	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsC calc.	61.100 ms
11	Circuit breaker 1/3:PoW-switching:Closing	I max. phsA	459 A
12	Circuit breaker 1/3:PoW-switching:Closing	I max. phsB	432 A
13	Circuit breaker 1/3:PoW-switching:Closing	I max. phsC	525 A
14	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsA meas.	63.364 ms
15	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsB meas.	63.666 ms
16	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsC meas.	61.964 ms
17	Circuit breaker 1/3:PoW-switching:Closing	Δ closing time phsA	0.963 ms
18	Circuit breaker 1/3:PoW-switching:Closing	Δ closing time phsB	1.166 ms
19	Circuit breaker 1/3:PoW-switching:Closing	Δ closing time phsC	0.863 ms

As there are no compensating factors via transducers in this application (e.g. closing voltage magnitude, temperature etc.) the calculated closing time equals the set closing time (e.g. 62.4 ms for phase A). The measured values (e.g. 63.364 ms for phase A) may not deviate severely so that the Δ closing time (0.963 ms for phase A) remains small (not more than approx. 3 ms, for larger values check the CB data and settings).

The measured closing time is derived from the reference contact or if this is not available from the auxiliary contact. In this example there is no reference contact, so that the following binary signals are responsible for the measured closing time:

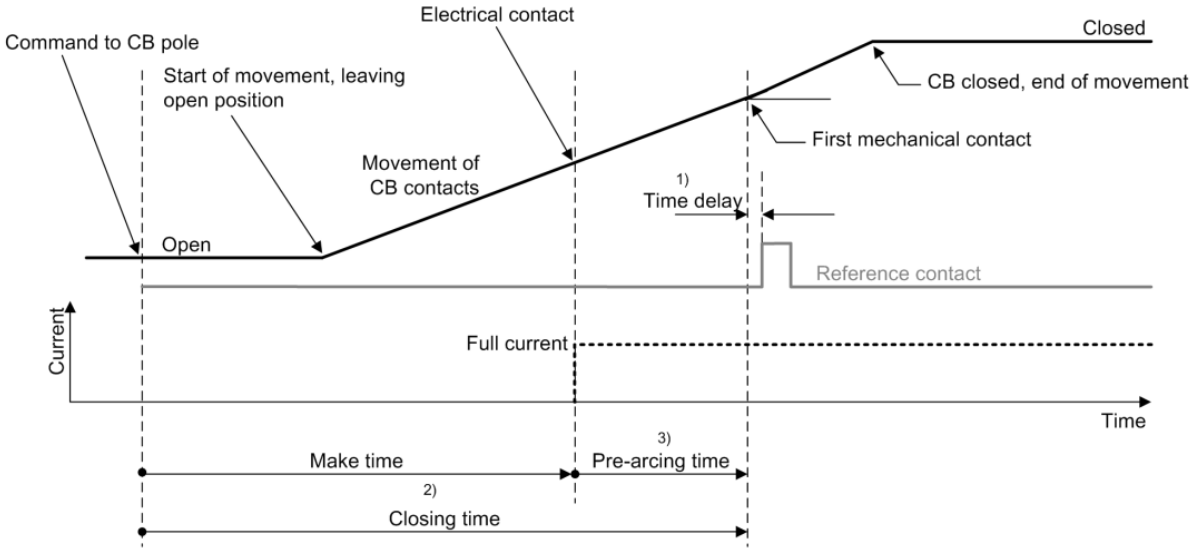
PoW-switching	301.2901		*	*	*
General	301.2901.2311		*	*	*
>CB closed phsA	301.2901.2311.500	SPS	H		
>CB closed phsB	301.2901.2311.501	SPS		H	
>CB closed phsC	301.2901.2311.502	SPS			H

The diagram below from the manual shows the closing time: start, stop and adjustment. For the adjustment of the closing time the following parameters are used:

Reference contact

301.2901.20641.118	Time delay ref. cont. phsA:	-0.852	ms
301.2901.20641.119	Time delay ref. cont. phsB:	-0.951	ms
301.2901.20641.120	Time delay ref. cont. phsC:	-0.952	ms

The "Δ closing time" measured will be subtracted from the set "Time delay ref.contact". This is the reason why settings may be negative when the "Δ closing time" was positive. See example calculation under heading "Adapting the Reference contact delay".



[dw_CB closing_except transformer, 1, en_US]

Figure 5-4 Circuit-Breaker Closing Process for Application Types Except the Transformer

(1) With the parameters **Time delay ref. cont. phs*X***, you can adapt the signal of the reference contact to the mechanical contact in an optimal way.

(2) Closing time is calculated based on the parameters **CB closing time phs*X*** and based on the parameters **CB correction time phs*X***. You can find the calculation formula in the preceding description.

1.3.2 Make Time

The Make time is most important as it determines the point in time at which current starts flowing via the circuit breaker. The extract from the fault log below shows the determined valued:

20	Circuit breaker 1/3:PoW-switching:Closing	Make time phsA calc.	61.500 ms
21	Circuit breaker 1/3:PoW-switching:Closing	Make time phsB calc.	61.900 ms
22	Circuit breaker 1/3:PoW-switching:Closing	Make time phsC calc.	60.200 ms
23	Circuit breaker 1/3:PoW-switching:Closing	Make time phsA meas.	61.665 ms
24	Circuit breaker 1/3:PoW-switching:Closing	Make time phsB meas.	62.067 ms
25	Circuit breaker 1/3:PoW-switching:Closing	Make time phsC meas.	60.365 ms
26	Circuit breaker 1/3:PoW-switching:Closing	Δ make time phsA	0.165 ms
27	Circuit breaker 1/3:PoW-switching:Closing	Δ make time phsB	0.167 ms
28	Circuit breaker 1/3:PoW-switching:Closing	Δ make time phsC	0.165 ms

The calculated make time is the set closing time minus the pre-arc time. The pre-arc time depends on the voltage across the CB contacts as the breaker is closing. As the PoW always closes at the same point on wave this is approximately the same every time. The pre-arc time is therefore **not** used to compensate the measured make time. The parameters used to adjust the make time are the following:

CB data

301.2901.20641.105	CB closing time phsA:	62.4	ms
301.2901.20641.106	CB closing time phsB:	62.5	ms
301.2901.20641.107	CB closing time phsC:	61.1	ms
301.2901.20641.108	CB pre-arcing time phsA:	0.9	ms
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301.2901.20641.115	CB correction time phsA:	0.00	ms
301.2901.20641.116	CB correction time phsB:	0.00	ms
301.2901.20641.117	CB correction time phsC:	0.00	ms

The "CB correction time" is used to adapt the PoW response (make time). The applied correction time is added to the closing time. A positive setting will therefore result in an earlier close command (longer closing time). The positive Δ make time in the fault log above indicates that the measured make time was longer than expected. The values from the fault log (green box) are therefore added to the old setting (in this case the old settings are zero, so the Δ make time can be set directly as follows (only 2 decimal places):

CB correction time phsA:	0.16	ms
CB correction time phsB:	0.17	ms
CB correction time phsC:	0.16	ms

The next closing operation will include these settings in the calculated close time (longer) and the make time should now have a very small delta (exactly zero is generally not possible).

1.3.3 Adapting the Reference contact delay

Note: the reference contact adjustment should be done after the correction time adjustment as shown above. From the **new** fault log after adjusting the correction time, the delta closing times are used to adapt the time delay reference contact setting as follows:

	"X"		"Y"		X-Y
Phase	Old setting		Measured		New setting
	Time del ref		delta Close		Time del ref
A	-0,852		0,963		-1,815
B	-0,951		1,166		-2,117
C	-0,952		0,863		-1,815

Reference contact

301.2901.20641.118	Time delay ref. cont. phsA:	-0.852	ms
301.2901.20641.119	Time delay ref. cont. phsB:	-0.951	ms
301.2901.20641.120	Time delay ref. cont. phsC:	-0.952	ms

Δ closing time phsA	0.963 ms
Δ closing time phsB	1.166 ms
Δ closing time phsC	0.863 ms

Time delay ref. cont. phsA:	-1.815
Time delay ref. cont. phsB:	-2.117
Time delay ref. cont. phsC:	-1.815

By subtracting the delta closing in the fault log from the "old setting" of "Time delay ref. cont." in each phase the make time is adjusted. The next close should show significantly smaller Δ closing time values:

	7	Circuit breaker 1/3:PoW-switching:Closing	>Close CB	off
	8	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsA calc.	62.400 ms
	9	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsB calc.	62.500 ms
	10	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsC calc.	61.100 ms
	11	Circuit breaker 1/3:PoW-switching:Closing	I max. phsA	459 A
	12	Circuit breaker 1/3:PoW-switching:Closing	I max. phsB	432 A
	13	Circuit breaker 1/3:PoW-switching:Closing	I max. phsC	525 A
	14	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsA meas.	62.401 ms
	15	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsB meas.	62.500 ms
	16	Circuit breaker 1/3:PoW-switching:Closing	Clos. time phsC meas.	61.101 ms
	17	Circuit breaker 1/3:PoW-switching:Closing	Δ closing time phsA	0 ms
	18	Circuit breaker 1/3:PoW-switching:Closing	Δ closing time phsB	0 ms
	19	Circuit breaker 1/3:PoW-switching:Closing	Δ closing time phsC	0 ms

In this test case the modified settings produce a perfect result with 0 ms deviation in all phases.

1.4 Conclusion

The PoW function can be adapted with the relevant settings using the information recorded in the fault log. After adjustment the correct response can be checked with a new closure of the plant. In the above example a shunt capacitor with ungrounded neutral was used, but the basic principles of the adjustment apply to all types of plant.

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