



POWERFACTORY

PowerFactory 2021

Technical Reference

ABB/Westinghouse CO

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

PF2021

**SILENT
DIG**

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1 Model information

Manufacturer ABB/Westinghouse

Model CO

Variants This family of PowerFactory relay model types simulates the following overcurrent relays originally manufactured by Westinghouse and then by ABB:

- CO11
- CO2 (60Hz version)
- CO4
- CO5
- CO7
- CO8
- CO9

2 General description

The ABB/Westinghouse CO protective relays are single phase non directional ac overcurrent devices. For the user convenience the relevant PowerFactory relay models have been implemented including some 3 phase overcurrent elements which can be used to mock a set of 3 CO devices. Moreover some single phase elements are present and can be used if the model is used to simulate a single CO device. The ABB/Westinghouse CO family of PowerFactory relay models consists of models using three different schemes ("Internal schematic" [1]):

- *Toc Phase and Earth* scheme type: One inverse time characteristic element("Toc") both for phase and for ground ("Toc l> t" and "Toc l> t e" block)
- *loc Phase and Earth* scheme type: One instantaneous element("loc") both for phase and for ground ("loc l>>" and "loc l>> e" block)
- *Toc + loc Phase and Earth* scheme type: One inverse time characteristic element("Toc") and one instantaneous element("loc") both for phase and for ground ("Toc l> t", "loc l>>", "Toc l> t e" and "loc l>> e" block)

These relays have been manufactured for decades and many sub type have been delivered. The PowerFactory relay library cannot cover all subtypes manufactured during the long life of the ABB/Westinghouse CO relays but a large set of subtype is available.

The PowerFactory ABB/Westinghouse CO relay model type names have the following structure: <type name>(i.e. "CO11") + "_" + <style number> (i.e. "183A806A05")

The following PowerFactory relay model types can be found at \Library\Relays\Relays\Overcurrent Relays\ABB\Westinghouse\CO:

- CO11 Extremely Inverse

- CO11_183A806A05 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A06 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A07 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A08 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A09 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A10 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A17 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A18 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A19 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A20 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A21 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A25 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A26 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A27 (scheme type: Toc + loc Phase and Earth)
- CO11_183A806A28 (scheme type: Toc + loc Phase and Earth)
- CO11_1876257 (scheme type: Toc Phase and Earth)
- CO11_1876258 (scheme type: loc Phase and Earth)
- CO11_1876259 (scheme type: loc Phase and Earth)
- CO11_1961555 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A09 (scheme type: Toc Phase and Earth)
- CO11_289B094A10 (scheme type: Toc Phase and Earth)
- CO11_289B094A11 (scheme type: Toc Phase and Earth)
- CO11_289B094A13 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A14 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A15 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A16 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A17 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A18 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A19 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A20 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A21 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A22 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A23 (scheme type: Toc + loc Phase and Earth)
- CO11_289B094A24 (scheme type: Toc + loc Phase and Earth)

- CO2 Short (60Hz)

- CO2_183A801A05 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A06 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A07 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A08 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A09 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A10 (scheme type: Toc + loc Phase and Earth)

- CO2_183A801A17 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A18 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A19 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A20 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A21 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A25 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A26 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A27 (scheme type: Toc + loc Phase and Earth)
- CO2_183A801A28 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A09 (scheme type: Toc Phase and Earth)
- CO2_289B093A10 (scheme type: Toc Phase and Earth)
- CO2_289B093A11 (scheme type: Toc Phase and Earth)
- CO2_289B093A13 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A14 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A15 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A16 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A17 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A18 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A19 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A20 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A21 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A22 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A23 (scheme type: Toc + loc Phase and Earth)
- CO2_289B093A24 (scheme type: Toc + loc Phase and Earth)
- CO4 Long (step)
 - CO4_1876247 (scheme type: Toc + loc Phase and Earth)
 - CO4_1876247_B (scheme type: Toc + loc Phase and Earth)
- CO5 Long
 - CO5_183A802A05 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A06 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A07 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A08 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A09 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A10 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A17 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A18 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A19 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A20 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A21 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A25 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A26 (scheme type: Toc + loc Phase and Earth)
 - CO5_183A802A27 (scheme type: Toc + loc Phase and Earth)

- CO5_183A802A28 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A09 (scheme type: Toc Phase and Earth)
- CO5_289B432A10 (scheme type: Toc Phase and Earth)
- CO5_289B432A12 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A13 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A14 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A15 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A16 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A17 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A18 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A19 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A21 (scheme type: Toc Phase and Earth)
- CO5_289B432A22 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A23 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A24 (scheme type: Toc + loc Phase and Earth)
- CO5_289B432A25 (scheme type: Toc + loc Phase and Earth)
- CO7 Moderately Inverse
 - CO7_183A804A05 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A06 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A07 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A08 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A09 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A10 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A17 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A18 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A19 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A20 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A21 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A25 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A26 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A27 (scheme type: Toc + loc Phase and Earth)
 - CO7_183A804A28 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A09 (scheme type: Toc Phase and Earth)
 - CO7_288B716A10 (scheme type: Toc Phase and Earth)
 - CO7_288B716A11 (scheme type: Toc Phase and Earth)
 - CO7_288B716A13 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A14 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A15 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A16 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A17 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A18 (scheme type: Toc + loc Phase and Earth)
 - CO7_288B716A19 (scheme type: Toc + loc Phase and Earth)

- CO7_288B716A20 (scheme type: Toc + loc Phase and Earth)
- CO7_288B716A21 (scheme type: Toc + loc Phase and Earth)
- CO7_288B716A22 (scheme type: Toc + loc Phase and Earth)
- CO7_288B716A23 (scheme type: Toc + loc Phase and Earth)
- CO7_288B716A24 (scheme type: Toc + loc Phase and Earth)
- CO8 Inverse
 - CO8_184A8004A05 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A06 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A07 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A08 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A09 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A10 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A17 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A18 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A19 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A20 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A21 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A25 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A26 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A27 (scheme type: Toc + loc Phase and Earth)
 - CO8_184A8004A28 (scheme type: Toc + loc Phase and Earth)
 - CO8_1876251 (scheme type: Toc Phase and Earth)
 - CO8_1876252 (scheme type: loc Phase and Earth)
 - CO8_1876253 (scheme type: loc Phase and Earth)
 - CO8_288B717A09 (scheme type: Toc Phase and Earth)
 - CO8_288B717A10 (scheme type: Toc Phase and Earth)
 - CO8_288B717A11 (scheme type: Toc Phase and Earth)
 - CO8_288B717A13 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A14 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A15 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A16 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A17 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A18 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A19 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A20 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A21 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A22 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A23 (scheme type: Toc + loc Phase and Earth)
 - CO8_288B717A24 (scheme type: Toc + loc Phase and Earth)
- CO9 Very Inverse
 - CO9_183A805A05 (scheme type: Toc + loc Phase and Earth)
 - CO9_183A805A06 (scheme type: Toc + loc Phase and Earth)

- CO9_183A805A07 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A08 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A09 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A10 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A17 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A18 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A19 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A20 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A21 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A25 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A26 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A27 (scheme type: Toc + loc Phase and Earth)
- CO9_183A805A28 (scheme type: Toc + loc Phase and Earth)
- CO9_1876254 (scheme type: Toc Phase and Earth)
- CO9_1876255 (scheme type: loc Phase and Earth)
- CO9_1876256 (scheme type: loc Phase and Earth)
- CO9_288B718A09 (scheme type: Toc Phase and Earth)
- CO9_288B718A10 (scheme type: Toc Phase and Earth)
- CO9_288B718A11 (scheme type: Toc Phase and Earth)
- CO9_288B718A13 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A14 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A15 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A16 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A17 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A18 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A19 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A20 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A21 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A22 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A23 (scheme type: Toc + loc Phase and Earth)
- CO9_288B718A24 (scheme type: Toc + loc Phase and Earth)

Please notice that different relay models using the same scheme type (i.e. "CO9_1876254" and "CO9_1876255") have the same protective elements with different setting ranges.

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

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 an element simulating a 3 phase CT or a single phase CT.

3.1.1 Available Units

- one 3ph current transformer ("Ct" block in the "Toc Phase and Earth" or in the "Ioc Phase and Earth" scheme, "Ct-3P/3xI0" block in the "Toc + Ioc Phase and Earth" scheme)
- one phase measurement element ("Measure" block)

3.1.2 Functionality

The "Ct" and the "Ct-3P/3xI0" block represent an ideal CT. 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 measurement block simulate a second order low pass analog filter with DC component filter; its time constant is 1 ms.

3.1.3 Data input

No user input is required

3.2 Protective elements

A set of inverse time and instantaneous overcurrent elements is modeling the relay protective functions. The inverse characteristics available in the relays are available as well in the inverse time model blocks.

3.2.1 Available Units

- *Toc Phase and Earth* scheme type
 - one 3 phase inverse time overcurrent element("Toc I> t" block)
 - one zero sequence inverse time overcurrent element("Toc I> t e" block)
- *Ioc Phase and Earth* scheme type
 - one 3 phase instantaneous overcurrent element("Ioc I>>" block)
 - one zero sequence instantaneous overcurrent element("Ioc I>> e" block)
- *Toc + Ioc Phase and Earth* scheme type
 - one 3 phase inverse time overcurrent element("Toc I> t" block)
 - one zero sequence inverse time overcurrent element("Toc I> t e" block)
 - one 3 phase instantaneous overcurrent element("Ioc I>>" block)
 - one zero sequence instantaneous overcurrent element("Ioc I>> e" block)

3.2.2 Functionality

Each protective relay of the ABB/Westinghouse CO family support an unique tripping characteristics. The following tripping characteristics are available in the PowerFactory relay model types:

- Extremely Inverse ("CO11" model types)
- Short time ("CO2" 60Hz model types)
- Long time ("CO4" model types)
- Long time ("CO5" model types)
- Moderately Inverse ("CO7" model types)
- Inverse ("CO8" model types)
- Very Inverse ("CO9" model types)

3.2.3 Data input

The relationships between the relay settings and the model parameters can be found in the following tables.

Toc Phase and Earth scheme type:

Address	Relay Setting	Model block	Model setting	Note
	Pickup	Toc I> t	Current Setting	
		Toc I> t e	Current Setting	
	Time Dial	Toc I> t	Time Dial	
		Toc I> t e	Time Dial	

loc Phase and Earth scheme type:

Address	Relay Setting	Model block	Model setting	Note
	Instantaneous Pickup	loc I>>	Pickup Current	
		loc I>> e	Pickup Current	

Toc + loc Phase and Earth scheme type:

Address	Relay Setting	Model block	Model setting	Note
	Pickup	Toc I> t	Current Setting	
		Toc I> t e	Current Setting	
	Time Dial	Toc I> t	Time Dial	
		Toc I> t e	Time Dial	
	Instantaneous Pickup	loc I>>	Pickup Current	
		loc I>> e	Pickup Current	

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

- one output logic element ("Logic Type" block)

3.3.2 Functionality

The "Logic Type" block is collecting the trip signals coming from the protective elements and is operating the relay output contact. The output contact is named "yout".

3.3.3 Data input

No user input is required. To disable the relay model ability to open the power circuit breaker simply disable the "Trip Logic" block.

4 Features not supported

The following features are not supported:

- Delayed reset time of the inverse time characteristic

5 References

- [1] ABB Power T&D Company Inc Relay Division, Coral Springs, FL 33065 USA. *Type CO Overcurrent Relay Descriptive Bulletin 41-101E, September 1990*, 1990.
- [2] ABB Power T&D Company Inc Relay Division, Coral Springs, FL 33065 USA. *Type CO Overcurrent Relay Instruction Leaflet 41-101U, January 1992*, 1992.