

## Matching CO and COM Protection Functions in Relion® Relays

### Objective and Scope

This application note can be used whenever replacing legacy ABB CO (and COM) electro-mechanical relays with Relion® micro-processor based relays that have the programmable curve feature (i.e., REF615 ANSI). It describes the process for translating all over-current settings for each type of CO relay to Relion® within its specified ranges. For the CO relays this consists of the tap (pickup), time dial, indicating instantaneous trip (IIT) and high dropout instantaneous (ITH) unit settings (COM relay). The Relion® settings include nominal CT *Secondary current*, *Curve parameters*, *Pickup value*, *Time multiplier*, *Trip delay time*, and *Operating curve type* (always 'programmable'). The values for the Relion® programmable curve parameters are based on characteristics defined in the test object library of Omicron® Test Universe 3.00 [3]. The only exception being the CO-5 relay since curve parameter 'B' was out of range in the Relion® relay. In this case the curve parameters were determined using the Curvegen tool in the ABB WinECP setting software.

To fine tune curves, request graphical curve comparisons, or determine parameters for inverse reset curves (upstream relays with no immediate reset capability, typically electro-mechanical relays) contact customer support team.

### Matching the Curve Type and Time Dial

The inverse time over-current curve characteristics for each type of CO relay was closely approximated using the 'Programmable' *Operating curve type* selectable setting in the 51P-1 function of the REF615 relay. The *Curve parameters* setting values (A, B, C and E) in Table 1 define the characteristics of the programmable curves in accordance with the following equation:

$$t[s] = \left( \frac{A}{\left(\frac{I}{I_{set}}\right)^c - E} + B \right) \cdot k \quad (1)$$

- I> Measured current
- I set Pickup value
- k set Time multiplier

The time dial settings of the CO relays can be matched directly in the REF615 by substituting the values into the *Time Multiplier* setting 'k' of equation (1).

Table 1: REF615 ANSI curve parameters for CO/COM type relays

Relay Type	Curve Parameters			
	A	B	C	E
CO/COM-2	0.1052	0.0262	0.80	1.0
CO/COM-5	1.32	0.5672	0.31	1.0
CO/COM-6	0.3164	0.1934	1.40	1.0
CO/COM-7	0.0094	0.0366	0.02	1.0
CO/COM-8	5.8480	0.1654	2.00	1.0
CO/COM-9	4.1200	0.0958	2.00	1.0
CO/COM-11	5.5700	0.0280	2.00	1.0

## Matching the Tap and Instantaneous Trip

A relay tap setting value equal to or greater than 0.25 can be divided by the nominal CT *Secondary current* setting (1 or 5 A) to match the *Pickup value* of the 51P-1 function in the REF615 (equation 2). For tap values less than 0.25A the *Secondary current* setting must be 1A. In this case the tap value would be equal to the *Pickup value*.

The low and high set instantaneous unit trip setting values (ITH/IT, ITT) can also be divided by the nominal CT *Secondary current* to match the *Pickup value* of the 50P-1/2/3 functions in the REF615 (equation 3). However, if the *Secondary current* setting is 1A then the maximum instantaneous unit trip setting value that can be matched is 40A.

$$Pickup\ value_{REF615} = \frac{Tap\ setting}{I_n} \quad (2)$$

$$Pickup\ value_{REF615} = \frac{Inst\ trip\ unit\ setting}{I_n} \quad (3)$$

where,

$$I_n = Secondary\ current\ setting\ (1\ or\ 5\ A)_{REF615}$$

$$I_n = 1A ; Tap\ setting < 0.25A$$

$$I_n = 5A ; Tap\ setting \geq 0.25A\ (typical)$$

## Example (Typical)

For this example, the protection functions of a CO-6 relay (Time Dial = 8) will be matched in a REF615 ANSI relay. Curve data was derived empirically from Instruction Leaflet 41-101U. The CO-6 curve points were plotted on a semi-log graph making the times values (linear axis) easier to read. The tap setting and instantaneous trip unit settings were chosen at 4A and 40A respectively allowing a typical nominal CT *Secondary current* setting of 5A. The REF615 settings (figures 1, 2 &3) are determined as follows:

### Operating Curve type and parameters:

*Operating curve type* = Programmable

From Table 1 (for CO-6 relay) the *Curve parameter* setting values are:

$$Curve\ parameter\ A = 0.3164$$

$$Curve\ parameter\ B = 0.1934$$

$$Curve\ parameter\ C = 1.40$$

$$Curve\ parameter\ E = 1.0$$

Refer to figure 4 and 5 for graphical comparison and percent deviation between REF615 and CO-6 curve.

### Secondary current and Pickup value (Inverse time over-current):

From equation 2:

$$I_n = 5A ; Tap\ setting \geq 0.25A\ (Tap\ setting = 4A)$$

$$Pickup\ value_{REF615} = \frac{Tap\ setting}{I_n} = \frac{4A}{5A} = 0.80$$

**Time Multiplier:**

Time multiplier setting = Time Dial = 8.00

**Pickup value (Instantaneous):**

From equation 3:

$$Pickup\ value_{REF615} = \frac{Inst\ trip\ unit\ setting}{I_n} = \frac{40A}{5A} = 8.00$$

Trip delay time = 20 ms (minimum setting)

Current (3I,CT)(Current (IA,IB,IC,CT))					
Current (IA,IB,IC,CT)					
Secondary current	(In)	5A			
Primary current		600.0	A	1.0	6000.0

Figure 1 – Analog input current (CT) settings.

PHLPTOC1(51P-1): 1					
51P-1					
Operation		enable			
Num of pickup phases		1 out of 3			
Minimum trip time		20	ms	20	60000
Reset delay time		20	ms	0	60000
Measurement mode		DFT			
Curve parameter A		0.3164		0.0086	120.0000
Curve parameter B	Table 1	0.1934		0.0000	0.7120
Curve parameter C		1.40		0.02	2.00
Curve parameter D		29.10		0.46	30.00
Curve parameter E		1.0		0.0	1.0
Setting Group 1				<input checked="" type="checkbox"/>	
Pickup value	(Equation 2)	0.80	xIn	0.05	5.00
Pickup value mult		1.0		0.8	10.0
Time multiplier	(time dial)	8.00		0.05	15.00
Trip delay time		40	ms	40	200000
Operating curve type		Programmable			
Type of reset curve		Immediate			

Figure 2 – 51P-1 function protection settings (Inverse time over-current).

PHIPTOC1(50P-3): 1					
50P-3					
Operation	enable				
Num of pickup phases	1 out of 3				
Reset delay time	20	ms	0	60000	
Setting Group 1			<input checked="" type="checkbox"/>		
Pickup value	(Equation 3)	8.00	xln	1.00	40.00
Pickup value mult		1.0		0.8	10.0
✓ Trip delay time	(Inst trip time)	20	ms	20	200000

Figure 3 – 50P-3 function protection settings (Instantaneous over-current).

CO(M) Curve	Time Dial (D)	REF615 Programmable Curve Coefficients -CO(M)			
		A	B	C	E
CO(M)-6	8	0.3164	0.1934	1.40	1.0

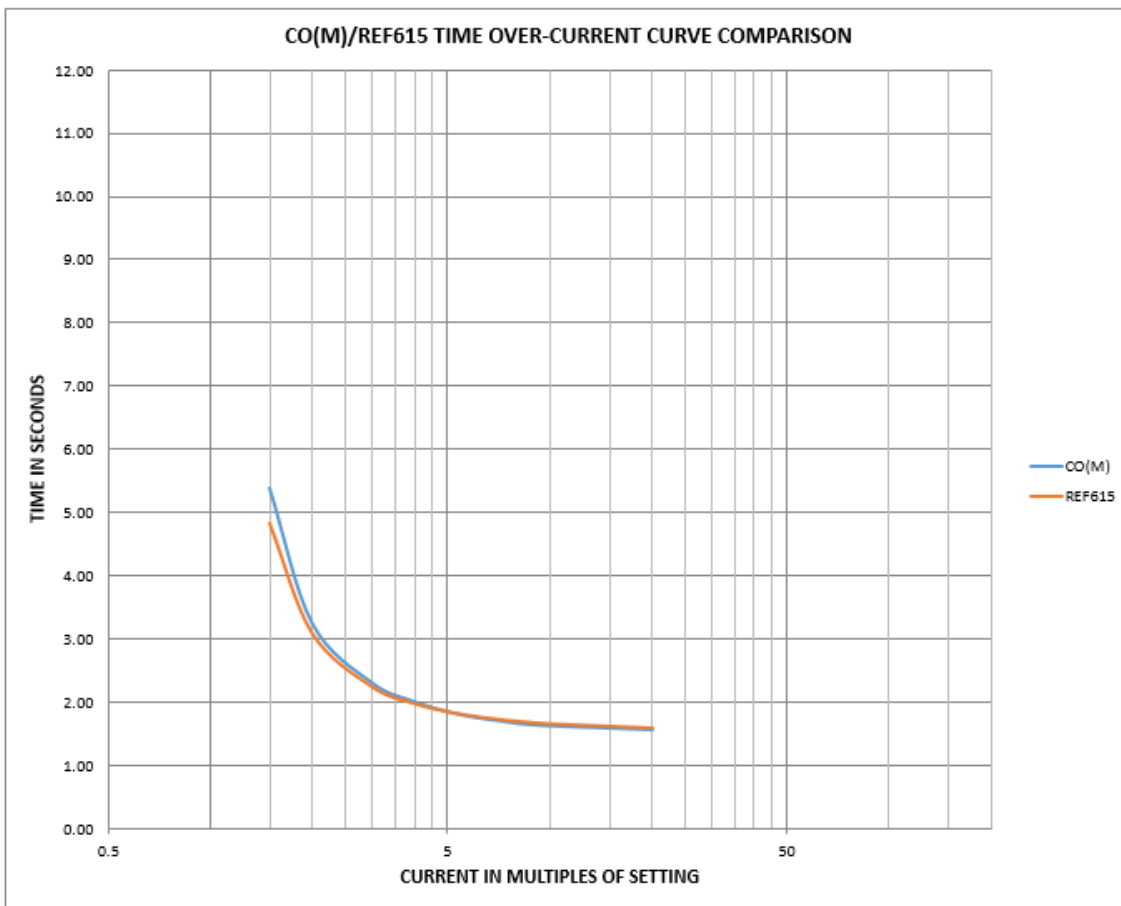


Figure 4 – Graphical comparison between CO-6 (Time Dial = 8) and REF615 programmable curve.

**PERCENT DEVIATION**

CO(M) CURVE VS. EQUIVALENT REF615 PROGRAMMABLE CURVE

Multiples of Pickup	CO(M)	REF615	$\Delta$
	Time (Seconds)		%
1.5	5.40	4.8263	10.62%
2	3.25	3.0842	5.10%
3	2.30	2.2382	2.69%
4	2.00	1.9710	1.45%
5	1.84	1.8441	-0.22%
6	1.75	1.7713	-1.22%
7	1.70	1.7248	-1.46%
8	1.65	1.6928	-2.38%
9	1.63	1.6696	-2.33%
10	1.62	1.6521	-2.29%
20	1.55	1.5860	-2.04%
40	1.53	1.5618	-1.83%

*Figure 5 – Percent deviation between CO-6 (Time Dial = 8) and REF615 programmable curve.*

## Reference list

- /1/ Type CO Overcurrent Relay Instruction Leaflet 41-101U
- /2/ Type COM Overcurrent Relay Instruction Leaflet 41-102F
- /3/ Omicron® Test Universe Software 3.00 - Test Object Library: CO and COM curve parameters

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