Application Note

Basler Digital Relays offer Better Coordination for Recloser

The Cooper recloser controller offers many trip curves, many of which are difficult to coordinate with using standard relay overcurrent curves. Through use of the Type 'P' curve available in all of Basler's digital relays with overcurrent elements and carefully selecting the coefficients, it is possible to provide much better coordination than the standard curves. And when that still isn't close enough, the BE1-FLEX offers any curve with Table Curves. The settings suggested here are intended to allow a breaker in a substation to coordinate with a Cooper recloser in the circuit protected by the relay.

In some cases, the result are very good; in other cases, the shape of the recloser controller curve has features that cannot be duplicated using the standard IEEE formula behind the Type 'P' curve; and in two cases, the approximations leave much to be desired.

In all cases, the results presented are for coordination with the operation of the recloser. Starting with Cooper's published curves, the tolerances and minimum operate times are added to produce a clearing curve, and it is this clearing curve with which these suggested coefficients are selected to coordinate. The accompanying Excel workbook includes the published curves to allow the user to adjust the coefficients if desired to coordinate with the time curve.

For most Recloser Curves, the suggested Coefficients coordinate with a pickup value equal to the pickup setting of the recloser, and with the relay time dial setting at 1.0.

Adjustments

In several cases, it was necessary to adjust these to provide better coordination. Most of these adjustments require the use of a different time dial setting to match the default recloser curve placement.

In two cases, curves 121 and 122, the recloser curve is very different from the family of curves possible with the IEEE formula used for the Type 'P' relay curves. In these two cases, it was only possible to coordinate with a portion of the curve, so table curves can be used to recreate the exact requirements.

Cooper Recloser Curve #	Basler Type "P" Curve Coefficients				Notes:
	A	B	C	N	
101	0.065	0.037	0.52	2.5	
102	0.13	0.037	0.63	2.5	
103	0.201	0.035	0.5	1.97	
104	0.144	0.008	0	1.9	TD=4
105	0.195	0.011	0.25	1.4	TD=3
106	1.185	0.032	0.299	2.5	
107	0.7	0.013	0	2.5	TD=2.5
111	0.93	0.014	0.24	1.8	TD=2.5
112	2.08	0.043	0.25	1.9	
113	3.408	0.194	0.001	2.5	
114	2.4	0.016	0.4	1.7	TD=2
115	4.08	0.035	0.45	2.5	
116	6.17	0.031	0.2	2.3	
117	2.35	0.015	0.15	1.85	TD=2.5
118	5.06	0.036	0.45	2.05	
119	5.5	0.469	0.45	2.11	
120	7.76	0.112	0.31	1.92	
121	0.008	0.032	1	2.5	Pickup @ 1.5 x Recloser Pickup
122	0.006	0.032	0.8	2.5	Pickup @ 5 x Recloser Pickup
131	5.082	6.004	0.3	1.44	
132	3.5	0.01	0.493	2.2	TD=3.5
133	3.08	0.012	0.05	2.1	TD=5
134	13	0.468	0.25	2.5	
135	11.98	0.597	0.287	1.87	
136	4	0.006	0.3	2.5	TD=6
137	29	0.687	0	1.935	
138	6.2	0.035	0	1.86	TD=4
139	1.63	0.006	0.806	1.45	TD=4
140	3.08	0.012	0.05	2.1	TD=5
141	10.7	11.794	0.23	1.8	
142	65	0.048	0	2.5	
151	31	0.522	0.46	2.5	
161	3	0.025	0.98	2	TD=2
162	5.23	0.01	0.51	2.3	TD=4
163	5.23	0.032	1	2.05	
164	95	0.091	0.35	2.5	TD=0.5
165	50.67	0.05	0.8	2.36	
200	7.8	2.081	1	0.87	
201	22.7	0.438	0.99	1.3	
202	104.3	0.094	0.92	2.15	

Basler digital relays, like the BE1-FLEX shown above, offer a Type "P" Curve for better coordination.

With the BE1-FLEX, table curves provide cut and paste curve import functionality. Simply copy the xPU and Time points of the existing curve from any two column dataset such as Excel and paste them into the BE1-FLEX settings. The graphical curve visualization supports instant confirmation that the curve shape matches the intended operation.
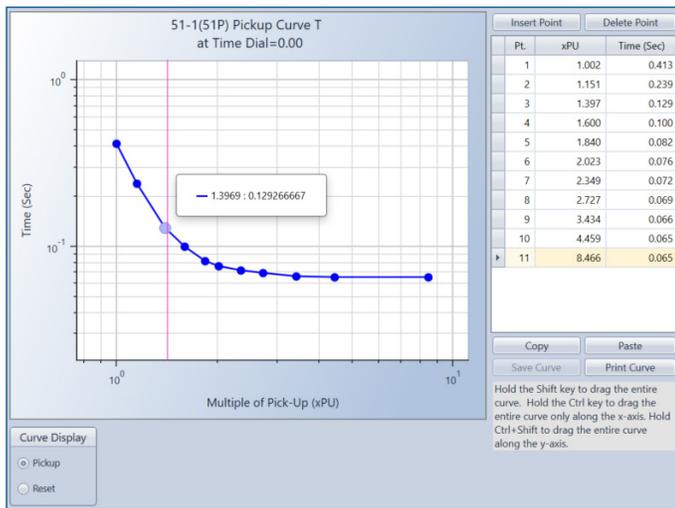
BE1-FLEX Table Curve Settings

The Excel workbook (Recloser.xls), downloadable at www.basler.com, shows the results of the suggested coefficients for each recloser curve. In addition to Cooper's published time curve, the adjusted trip curve, and the trip time of a Basler relay using the coefficients, each plot also shows the absolute error between the Cooper time and the Basler time and the per unit error.

If the recloser controller to be coordinated with is set without Time-Current Curve Modifiers, the values can be used as shown in the table. If the only modifier is the "Vertical Translation Multiplier", the relay curve can be adjusted to match through use of the time dial setting. If the "Constant Time Adder" was used in setting the recloser controller, the relay curve may need to be modified by adjusting the value of Coefficient 'B'. This adjustment may be made by dividing the added time by the time dial setting and adding the result to original value of Coefficient 'B'. For instance, if you are using curve 106 with a time dial of 2 and want to add a fixed 0.15 seconds to the resulting curve, divide the 0.15 seconds by the time dial setting of 2, resulting in 0.075. Add that to the value of 0.025 listed for Coefficient 'B' for a new value of 0.1 for Coefficient 'B'.

If the recloser controller is set with a Minimum Response Time and you want to duplicate that response with the relay, the curve does not require modification. Instead, you must use the Pickup logic of the element in use to control a PU/DO timer and then AND the output of the timer with the Trip logic of the element in use. This will not allow the trip signal beyond the AND gate until the Pickup has been present for the time set in the timer.

If the recloser controller settings include a High-Current Trip setting, a corresponding setting can be implemented in the relay through use of an Instantaneous Overcurrent element with a time delay setting set to coordinate with the recloser and included in the tripping logic of the relay.

If the recloser controller settings include the High-Current Lockout, a corresponding setting can be implemented in the relay through use of an Instantaneous Overcurrent element without time delay used in the relay logic to drive the relay reclose control to lockout.

Notes on the Excel Workbook

The current and time values used in the Excel workbook were created by digitizing Cooper's published curves; the points chosen for digitizing were those that would provide the best information for fitting the curves and are not necessarily values that would be selected if manually choosing points from the published curves. The large interval in current magnitude between the last two points for each curve is appropriate, because the final two points of each curve define a region where the recloser time curve has a definite time characteristic.

The columns "Current (x P.U.)" and "Cooper Time" are the values digitized from Cooper's published curves. The "Cooper Trip" time is the "Cooper Time" value plus a tolerance of the greater of 10% or 0.008s plus 2.5 cycles of recloser interrupting time.

The "Basler Trip" column is the result of the standard IEEE formula with the specific coefficients applied.

The "Abs Error (s)" column is the absolute value of the difference in seconds between the 'Cooper Trip' and the 'Basler Trip' times. The 'PU Error' column expresses the error in terms of the 'Cooper Trip' times.

For More Information

For information on Basler's complete range of digital relay systems, visit the download section at www.basler.com to access product documentation, Application Notes, and Technical Papers.

To discuss your application, consult Basler at +1 618.654.2341.

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