INSTRUCTION MANUAL

FOR

DGC-2020HD

DIGITAL GENSET CONTROLLER

Configuration

Basler Electric®

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Time Curve Characteristics

The inverse time overcurrent characteristic curves provided by the DGC-2020HD (style xxExxxxxx only) closely emulate most of the common electromechanical, induction-disk, overcurrent relays sold in North America. To further improve proper relay coordination, a selection of integrated reset or instantaneous reset characteristics are also provided.

Curve Specifications

Timing Accuracy..... Within ±500 milliseconds of indicated operating point.

Sixteen inverse time functions, one fixed time function, one 46 time function, and one programmable time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equations and comply with IEEE Std C37.112 - *IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays*.

$$T_T = \frac{AD}{(M^N - C)^Q} + BD + K$$

Equation 24

$$T_R = \frac{RD}{|M^2 - 1|}$$

Equation 25

T_T = Time to trip when $M \geq 1$

T_R = Time to reset if relay is set for integrating reset when $M < 1$. Otherwise, reset is 50 milliseconds or less

D = Time Dial setting (0.0 to 9.9) ∗

M = Multiple of Pickup setting (0 to 40)

A, B, C, N, K = Constants for the particular curve

R = Constant defining the reset time

Q = Denominator exponent

∗ Timing range is 0.0 to 7,200 seconds when the F (fixed) curve is selected.

Table 84 lists time characteristic curve constants. See the figures after the tables for graphs of the characteristics.

Table 84. 51 Time Characteristic Curve Constants

Curve Selection	Curve Name	Trip Characteristic Constants						Reset †
		A	B	C	N	K	Q	R
S1	Short Inverse	0.2663	0.03393	1	1.2969	0.028	1	0.5
S2	Short Inverse	0.0286	0.0208	1	0.9844	0.028	1	0.094
L1	Long Inverse	5.6143	2.18592	1	1	0.028	1	15.75
L2	Long Inverse	2.3955	0	1	0.3125	0.028	1	7.8001
D	Definite Time	0.4797	0.21359	1	1.5625	0.028	1	0.875
M	Moderately Inverse	0.3022	0.1284	1	0.5	0.028	1	1.75
I1	Inverse Time	8.9341	0.17966	1	2.0938	0.028	1	9
I2	Inverse Time	0.2747	0.10426	1	0.4375	0.028	1	0.8868
V1	Very Inverse	5.4678	0.10814	1	2.0469	0.028	1	5.5
V2	Very Inverse	4.4309	0.0991	1	1.9531	0.028	1	5.8231
E1	Extremely Inverse	7.7624	0.02758	1	2.0938	0.028	1	7.75
E2	Extremely Inverse	4.9883	0.0129	1	2.0469	0.028	1	4.7742
A	Standard Inverse	0.01414	0	1	0.02	0.028	1	2
B	Very Inverse (I^2t)	1.4636	0	1	1.0469	0.028	1	3.25
C	Extremely Inverse (I^2t)	8.2506	0	1	2.0469	0.028	1	8
G	Long Time Inverse (I^2t)	12.1212	0	1	1	0.028	1	29
F	Fixed Time ∗	0	1	0	0	0	1	1
46	Negative-Sequence Overcurrent	‡	0	0	2	0.028	1	100
P	User Programmable §	0 to 600	0 to 25	0 to 1	0.5 to 2.5	0.028	0.1 to 10	0 to 30

∗ Curve F has a fixed delay of one second times the Time Dial setting.

† Instantaneous or integrating reset is selected on the Overcurrent setup screen in BESTCOMS*Plus*®.

‡ Constant A is variable for the 46 curve and is determined, as necessary, based on system full-load current setting, minimum pickup, and K factor settings.

§ The programmable curve allows for four significant digits after the decimal place for every variable.

Time Overcurrent Characteristic Curve Graphs

The figures after the tables illustrate the characteristic curves of the DGC-2020HD. Table 85 cross-references each curve to existing electromechanical relay characteristics. Equivalent time dial settings were calculated at a value of five times pickup.

Table 85. Characteristic Curve Cross-Reference

Curve	Curve Name	Similar To
S1	Short Inverse	ABB CO-2
S2	Short Inverse	GE IAC-55
L1	Long Inverse	ABB CO-5
L2	Long Inverse	GE IAC-66
D	Definite Time	ABB CO-6
M	Moderately Inverse	ABB CO-7
I1	Inverse Time	ABB CO-8
I2	Inverse Time	GE IAC-51
V1	Very Inverse	ABB CO-9
V2	Very Inverse	GE IAC-53
E1	Extremely Inverse	ABB CO-11
E2	Extremely Inverse	GE IAC-77
A	Standard Inverse	Refer to BS 142
B	Very Inverse (I^2t)	Refer to BS 142
C	Extremely Inverse (I^2t)	Refer to BS 142
G	Long Time Inverse (I^2t)	Refer to BS 142
F	Fixed Time	n/a
46	K Factor	n/a
P	User Programmable	n/a

Time Dial Setting Cross-Reference

While the time characteristic curve shapes have been optimized for each relay, time dial settings of Basler Electric relays are not identical to the settings of electromechanical induction disk overcurrent relays. Table 86 helps you convert the time dial settings of induction disk relays to the equivalent setting for Basler Electric relays. Enter time dial settings using BESTCOMS*Plus*. For more information, refer to the *Protection* chapter.

Using Table 86

Cross-reference table values were obtained by inspection of published electromechanical time current characteristic curves. The time delay for a current of five times tap was entered into the time dial calculator function for each time dial setting. The equivalent Basler Electric time dial setting was then entered into the cross-reference table.

If your electromechanical relay time dial setting is between the values provided in the table, it will be necessary to estimate the correct intermediate value between the electromechanical setting and the Basler Electric setting.

The DGC-2020 has a maximum time dial setting of 9.9. When the F (fixed) curve is selected, the maximum timing range is 7,200 seconds. The Basler Electric equivalent time dial setting for the electromechanical maximum setting is provided in the cross-reference table even if it exceeds 9.9. This allows interpolation as noted above.

Basler Electric time current characteristics are determined by a linear mathematical equation. The induction disk of an electromechanical relay has a certain degree of nonlinearity due to inertial and friction effects. For this reason, even though every effort has been made to provide characteristic curves with minimum deviation from the published electromechanical curves, slight deviations can exist between them.

In applications where the time coordination between curves is extremely close, we recommend that you choose the optimal time dial setting by inspection of the coordination study. In applications where coordination is tight, it is recommended that you retrofit your circuits with Basler Electric electronic relays to ensure high timing accuracy.

Table 86. Time Dial Setting Cross-Reference

Curve	Equivalent To	Electromechanical Relay Time Dial Setting											
		0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
		Basler Electric Equivalent Time Dial Setting											
S1	ABB CO-2	0.3	0.8	1.7	2.4	3.4	4.2	5.0	5.8	6.7	7.7	8.6	9.7
L1	ABB CO-5	0.4	0.8	1.5	2.3	3.3	4.2	5.0	6.0	7.0	7.8	8.8	9.9
D	ABB CO-6	0.5	1.1	2.0	2.9	3.7	4.5	5.0	5.9	7.2	8.0	8.9	n/a
M	ABB CO-7	0.4	0.8	1.7	2.5	3.3	4.3	5.3	6.1	7.0	8.0	9.0	9.8
I1	ABB CO-8	0.3	0.7	1.5	2.3	3.2	4.0	5.0	5.8	6.8	7.6	8.7	n/a
V1	ABB CO-9	0.3	0.7	1.4	2.1	3.0	3.9	4.8	5.7	6.7	7.8	8.7	9.6
E1	ABB CO-11	0.3	0.7	1.5	2.4	3.2	4.2	5.0	5.7	6.6	7.8	8.5	n/a
I2	GE IAC-51	0.6	1.0	1.9	2.7	3.7	4.8	5.7	6.8	8.0	9.3	n/a	n/a
V2	GE IAC-53	0.4	0.8	1.6	2.4	3.4	4.3	5.1	6.3	7.2	8.4	9.6	n/a
S2	GE IAC-55	0.2	1.0	2.0	3.1	4.0	4.9	6.1	7.2	8.1	8.9	9.8	n/a
L2	GE IAC-66	0.4	0.9	1.8	2.7	3.9	4.9	6.3	7.2	8.5	9.7	n/a	n/a
E2	GE IAC-77	0.5	1.0	1.9	2.7	3.5	4.3	5.2	6.2	7.4	8.2	9.9	n/a

The 46 Curve

The 46 curve (Figure 210) is a special curve designed to emulate the $(I_2)^2t$ withstand ratings of generators using what is frequently referred to as the generator K factor.

The 46 Curve Characteristics

46 Pickup Current

Generators have a maximum continuous rating for negative sequence current. This is typically expressed as a percent of stator rating. When using the 46 curve, the user should convert the continuous I^2 rating data to actual secondary current at the relay. This value (plus some margin, if appropriate) should be entered as the pickup setting. For example, if a generator's rated full-load current is 5 amperes, a pu setting of 0.5 A would allow 10% continuous I_2.

46 Time Dial (= Generator K factor)

The amount of time that a generator can withstand a given level of unbalance is defined by Equation 26.

$$t = \frac{K}{(I_2)^2}$$

Equation 26

The K factor gives the time that a generator can withstand 1 per unit negative sequence current. For example, with a K factor of 20, since $(I_2)^2$ becomes 1 at 1 per unit of current, the generator can withstand the condition for 20 seconds. Typical values for generator K factors are in the 2 to 40 range. The relay uses the "nominal current" setting of the relay to determine what corresponds to 1 per unit current in the generator.

When curve 46 is selected, the relay changes the range of the allowed time dial to 1 to 99 (instead of the time dial range of 0.1 to 9.9 for all the other curves). The user should enter the "K" factor of the generator into the time dial field.

Relay Equation

When the 46 function is used, the relay uses the K factor (i.e., 46 time dial setting), 46 minimum pickup setting, and generator full-load current to create a constant Z (see Equation 27).

$$Z = 46\ Time\ Dial\ \left(\frac{I_{Nom\ Setting}}{46\ Pickup\ Setting}\right)^2$$

Equation 27

The time to trip equation used in the relay is:

$$T_T = \frac{Z}{M^2} + 0.028\ seconds$$

Equation 28

where:

$$M = \frac{Measured\ I_2}{46\ Pickup\ Setting}$$

Equation 29

which, when M > 1, reduces to:

$$T_T = 46\ Time\ Dial \left(\frac{I_{Nom\ Setting}}{I_2 Measured}\right)^2$$

Equation 30