Motor Protection
Calculation Tool
for SPAM 150 C

User’s manual and
Technical description
Motor Protection Calculation Tool for SPAM 150 C

Data subject to change without notice

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General

The SPAM 150C setting program has been designed as an aid for defining the setting values for the SPAM 150 C motor protection relay.

The program is a calculation tool, allowing the user to simulate various motor operation situations and to observe the behaviour of the thermal unit of the motor protection relay in these situations. The calculation program is suitable for testing the setting values for motor protection.

The setting parameters defined by the program cannot be transferred on-line to the relay via a PC. The program does not know the load capacity of the motor to be protected, nor whether the values entered are right or wrong. This means that the program user will be responsible for the motor protection relay settings.

Technical requirements:

- PC with at least 80386 processor
- RAM at least 4 MB
- Microsoft Windows version 3.1 or later
- Microsoft Excel 5.0 or later

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Installation

The program (SPAM150.XLS) is based on Excel 5.0 and it has been saved on a disk as SPAM.EXE. This file can be copied and unloaded on a PC hard disk as follows:

1. Insert the disk in drive A
2. Write COPY A:SPAM.EXE C:EXCEL
3. Go to root C:EXCEL
4. Write spam and press ENTER
5. Now you will find the SPAM150.XLS file on your hard disk C

You can delete the SPAM.EXE file from the root C:EXCEL, or save it as a back-up copy.
1.1 Program start-up

Start Excel 5.0 on your PC.
Choose: File => Open => spam150.xls => Press OK

Figure 1. Program start-up.

When the program has been started, the main menu window will automatically appear on the screen.

Figure 2. Selection menu
Explanation of push-buttons:

<table>
<thead>
<tr>
<th>Push-button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor settings</td>
<td>motor setting table</td>
</tr>
<tr>
<td>Relay settings</td>
<td>relay setting table</td>
</tr>
<tr>
<td>Trip curves</td>
<td>coordination curves</td>
</tr>
<tr>
<td>Cold starts</td>
<td>setting table for cold starts</td>
</tr>
<tr>
<td>Hot starts</td>
<td>setting table for hot starts</td>
</tr>
<tr>
<td>Cycles</td>
<td>setting table for various loads</td>
</tr>
<tr>
<td>Thermal Behaviour</td>
<td>thermal characteristics of thermal unit</td>
</tr>
<tr>
<td>Report</td>
<td>report pages</td>
</tr>
<tr>
<td>Open data</td>
<td>opens data of previous simulation.</td>
</tr>
<tr>
<td>Save data</td>
<td>saves simulation data</td>
</tr>
<tr>
<td>EXIT</td>
<td>closes simulation and Excel 5.0</td>
</tr>
</tbody>
</table>

2. Motor setting values

Open the motor setting table by pressing **Motor settings** in the menu window, fig. 2.

<table>
<thead>
<tr>
<th>Motor name: XXX-XXX</th>
</tr>
</thead>
</table>

**Motor data:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power, $P_{NM}$</td>
<td>2800 kW</td>
</tr>
<tr>
<td>Rated voltage, $U_{NM}$</td>
<td>11 kV</td>
</tr>
<tr>
<td>Rated current, $I_{NM}$</td>
<td>166 A</td>
</tr>
<tr>
<td>Starting current, $I_S$</td>
<td>5 x In</td>
</tr>
<tr>
<td>Starting time, $t_S$</td>
<td>2.5 s</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>40 °C</td>
</tr>
</tbody>
</table>

**CT data:**

<table>
<thead>
<tr>
<th>Primary:</th>
<th>200 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary:</td>
<td>1 A</td>
</tr>
</tbody>
</table>

Figure 3. Motor setting table with present setting values.

To define the settings of a motor protection relay at least the following motor data must be known:

- Rated power, $P_M$
- Rated voltage, $U_n$
- Rated current, $I_{NM}$
- Start current, $I_S$
- Start time, $t_S$
- Maximum stall time for cold and hot motor
- Possible start-ups from cold and hot condition

Note: The rated current to be used is the current in the measuring point, which means that the influence of components limiting or increasing the current must be taken into account in the rated current, e.g. the influence of transformers and capacitor banks.
E.g.:

Motor rated current $I_{nM} = 80$ A
Current on the 10 kV side is:
$$I_{nM} = \frac{6kV}{10kV} \times 80A = 48A$$

The current to be used in the program is 48 A.

To change motor data press **Settings** (Fig. 3).
To return to the selection menu (Fig. 2) press **Menu**.

---

### 3. Relay setting

The relay setting table is used for calculating the relay settings.

Press **Relay settings** in the selection menu, fig. 2.

The relay setting table shows the present settings. To change the settings press **Settings**.

To close the relay setting window, press **OK**.
(At the bottom of Figure 5).
3.1 Setting of thermal overload unit

The settings for the thermal overload unit are found in the Thermal overload section in the relay setting window. The settings include:

- Full load current $I_0$: $0.5 \ldots 1.5 \times I_n$
- Safe stall time $t_{6x}$ on current $6 \times I_0$: $2.0 \ldots 120$ s
- Weighting factor $p$: $20 \ldots 100$ %
- Prior alarm level $\theta_0$: $50 \ldots 100$ % $\times \theta_t$
- Restart inhibit level $\theta_i$: $20 \ldots 80$ % $\times \theta_t$
- Cooling time multiplier: $1 \ldots 64 \times \tau_{heat}$

3.1.1 Setting of load current $I_0$

Press Full load current (Fig. 5) to set the load current $I_0$.

---

Figure 5. Relay setting window.

Figure 6. Proposal for load current $I_0$. 

Calculated value is $0.83 \times I_n$. 

Do you want to use it?

Yes  No
The program proposes a calculated value for the load current setting. If you accept the calculated value press Yes, if not, press No.

The calculated value is obtained using the formula:

\[ I_0 = \frac{(k \times I_{nM} \times I_2)}{(I_1 \times I_{relay})} \]

\[ k = \text{variable dependent on the ambient temperature,} \]
\[ (\theta_{amp} = 40°C, k = 1; \theta_{amp} < 40°C, k \geq 1.05) \]
\[ I_{nM} = \text{motor rated current} \]
\[ I_1 = \text{rated primary current of current transformer} \]
\[ I_2 = \text{rated secondary current of current transformer} \]
\[ I_{relay} = \text{relay current input (1 A or 5 A)} \]

If you answer No (Fig. 6), the program will request the desired setting:

![Thermal overload unit](image1.png)

Figure 7. Setting of load current \( I_0 \).

3.1.2 Setting of stall time \( t_{6x} \)

When calculating this setting you have to notice that the program calculates the setting on the basis of the hot starts i.e. the hot starts and the preload level have to be set in order to obtain the correct value. If you change the hot starts or the preload level, the setting has to be calculated again.

Press Safe stall time (Fig. 5).

![Calculating](image2.png)

Figure 8. Desired thermal level.

First the desired thermal level is requested. This value has to be between 50 and 100%. Then the PC calculates the stall time suitable for the motor drive in question (Fig. 9).
Figure 9. Calculated stall time $t_{6x}$.

The window shows:
- weighting factor $p$ (50%)
- calculated stall time value $t_{6x}$ (7.0 s)
- thermal capacity used by the motor's fastest warming parts during last start-up (94.23 %)
- thermal capacity used by the motor's fastest warming parts at the end of operation (80.23%)
- thermal capacity used by the motor's more slowly warming parts at the end of operation (80.23 %)

If you want to use the calculated stall time value, press Yes, if you want to enter another value, press No (Fig. 9).

3.1.3 Setting of weighting factor $p$

For a normal squirrel-cage motor the weighting factor must be set at 50%. Should the object to be protected be a slip-ring motor, cable, or transformer, the weighting factor must be set at 100%.

Press Weighting factor (Fig. 5).

Figure 10. Info window for setting the weighting factor $p$.

Press OK in the info window (Fig. 10).
3.1.4 Setting of thermal prior alarm level $\theta_a$

The program calculates this setting on the basis of the present hot starts, so if you change the startups, the setting value proposed by the program will change as well.

Press Prior alarm level in the relay setting window (Fig. 5).

3.1.5 Setting of thermal restart inhibit level $\theta_i$

Press Restart inhibit level in the relay setting window (Fig. 5).

The program calculates this setting on the basis of the present hot starts, so if you change the startups, the restart inhibit level setting value proposed by the program will be changed as well.

If you want to use a restart inhibit level value other than that proposed by the program, press No (Fig. 13).
3.1.6 Setting of cooling time multiplier $k_c$

Press Cooling time multiplier (Fig. 5).

Figure 14. Info-window for setting the cooling time multiplier $k_c$.

For a normal surface-cooled motor the cooling time multiplier is 4-6. Should the motor protected be equipped with a separate cooler, the cooling time multiplier is 1-3.

E.g. 

Motor heat-up time constant $\tau_{\text{heat}} = 40$ min

Motor cooling time constant $\tau_{\text{cool}} = 240$ min

$k_c = \frac{\tau_{\text{cool}}}{\tau_{\text{heat}}} = \frac{240}{40} = 6$

Press OK (Fig. 14).

3.2. Setting of start-up supervision unit

The settings for the start-up supervision unit are found in the Start-up supervision unit section in the relay setting window (Fig. 5). The settings include: start-up current $I_s$ and start-up time $t_s$.

Two operation modes are available: the definite time mode ($I_s \times t_s$) or the $I_s^2 \times t_s$ mode.

3.2.1 Definite time principle

First select the definite time operation mode. Then set the overcurrent unit ($I_s >$). Press Start-up current. (Fig. 5)

Figure 16. Proposed setting for overcurrent stage.
The setting proposed for the overcurrent unit is 50% of the motor start-up current.

E.g. 
Motor rated current $I_{nM} = 166$ A
Motor start-up current $I_s = 5 \times I_{nM}$
Current transformer 200 A / 1 A

Setting proposed $= 50\% \times 5 \times 166/200 = 2.08 \times I_n$

If you want to use the calculated value press Yes, if you want to enter another value, press No (Fig. 16).

Then press Start-up time (Fig. 5) to set the operate time ($t_s$).

![Start-up time](image)

**Figure 17.** Setting operate time ($t_s$).

If you accept the calculated operate time value, press Yes, if you want to use another value, press No (figure 17).

The coordination curves show this setting as follows:

![Coordination curves](image)

**Figure 18.** Coordination curves

Relay settings in Fig. 18:

$I_q = 0.83 \times I_n$, $I_s = 2.08 \times I_n$, $t_s = 3.00$ s
Select the $I_s^2 \times t_s$ principle operation mode. Then press Start-up current. (Fig. 5)

**Figure 19. Current setting for start-up supervision.**

The current setting proposed is equal to the motor start-up current.

*E.g.*

Motor rated current $I_{nM} = 166$ A  
Motor start-up current $I_s = 5 \times I_{nM}$  
Current transformer 200 A / 1 A  
Proposed setting = $5 \times \frac{166}{200} = 4.15 \times I_n$  

If you accept the calculated value, press Yes, if you want to enter another value, press No (Fig. 19). Then press Start-up time (Fig. 5) to set the operate time ($t_s$).

**Figure 20. Setting of operate time ($t_s$) for start-up supervision unit.**

The operate time setting proposed is 15% longer than the start-up time.

*E.g.*

Motor start-up time $t_s = 2.5$ s  
Proposed setting = $2.5$ s + 15% = 2.88 s  

If you accept the calculated value, press Yes, if you want to use another value, press No (Fig. 20).
On the coordination curves the $I^2_t$ -principle is shown as follows:

Figure 21. Coordination curves.

[Image]

Relay settings in Fig. 21:  
$I_0 = 0.83 \times I_n$  
$I_s = 4.15 \times I_n$  
$t_s = 2.88 \text{ s}$

### 3.3 Setting of high-set overcurrent (short-circuit) unit

The settings for the high-set overcurrent unit are found in the High-set overcurrent unit section in the relay setting window (Fig. 5). The settings include:

- **Start current $I_{>>}$**: $0.5...20 \times I_n$
- **Operate time $t_{>>}$**: $0.04...30 \text{ s}$

A doubling function can be used in the setting of this current unit. This means that when the motor is started up, the setting value is doubled and thus equal to the setting value during normal operation.

### 3.3.1 Setting of start current $I_{>>}$

First choose whether you want to use the doubling function during start-up or not. Then press **Start current $I_{>>}$**. (Fig. 5)
Figure 22. Calculated start current value (I>>) when the doubling function is used.

E.g.  
Motor rated current $I_{nM} = 166 \, \text{A}$  
Motor start current $I_s = 5 \times I_{nM}$  
Current transformer 200 / 1 A

When the doubling function is used, the setting is calculated as follows:

Proposed setting = $75\% \times 5 \times 166/200 = 3.11 \times I_n$

When the doubling function is not used, the setting is calculated as follows:

Proposed setting = $2 \times 75\% \times 5 \times 166/200 = 6.23 \times I_n$

The coordination curves show the setting as follows:

Figure 23. Coordination curves.
3.3.2 Setting operate time t>>
Press Operate time>> (Fig. 5).

Figure 24. Setting of operate time for high-set overcurrent unit.

3.4 Setting of earth-fault unit
The settings for the earth-fault unit are found in the Earth-fault unit section of the relay setting window:

- Start current $I_0 = 1\ldots100\% \times I_n$
- Operate time $t_0 = 0.05\ldots30$ s

3.4.1 Setting of start current $I_0$
As shown in Figure 5 some data about the network, to which the motor is connected, are required in order to define the setting, i.e. the primary and secondary current (A) of the measuring current transformer, the maximum earth-fault current of the network (A) and the protection sensitivity (%) determined by the operator.

E.g.
- Current transformer: $100 \text{ /} 1$ A
- Maximum earth-fault current = 30 A
- Desired sensitivity = 10 \%

According to the requirements the earth-fault unit has to detect an earth fault when the current is 10\% of the maximum earth-fault current:

$$10\% \times 30 \text{ A} = 3.0 \text{ A}$$

Relay setting:

$$I_0 = 3.0 \text{ A} \times \left(1 \div 100\right) \text{ A} = 3.0\% \times 1 \text{ A}$$

Press Start Current $I_0$ (Fig. 5) after having selected the required values.

Figure 25. Calculated current setting value .
If you accept the calculated value, press Yes, if you want to enter another value, press No (Fig. 25).
3.4.2 Setting of operate time t₀

Press Operate time $t_0$ (Fig. 5).

![Image showing Earth-fault unit settings](image)

Figure 26. Setting of operate time.

3.5 Setting of phase unbalance unit

The settings for the phase unbalance unit are found in the Phase unbalance unit section in the relay setting window (Fig. 5). The settings are:

- Start current $\Delta I = 10\ldots40\% \times I_L$
- Operate time $t_A = 20\ldots120$ s

Press Start current $\Delta I$ (Fig. 5).

![Image showing Start current, DI settings](image)

Figure 27. Setting of phase unbalance unit.

Figure 27 shows the following settings proposed by the program:

- Sensitivity = 15% as negative phase sequence of the current
- Start current $\Delta I = 26\% \times \sqrt{3} \times 15\% = 26\%$
- Operate time $t_A = 20$ s

These settings allow a negative phase sequence of 15% during start-up. The operate time has been set at its minimum but, when the start-up time is longer, also the setting of the operate time will increase.

If you accept the settings proposed by the program, press Yes, if you want to use another value, press No (Fig. 27).

You can also set the operate time separately by pressing Operate time $t_A$ (Fig. 5).
3.6 Setting of undercurrent unit

The undercurrent unit protects the motor, and the object it operates, at a sudden loss of load. The undercurrent unit is used in applications where a sudden load loss indicates a fault situation, for instance, in conveyor applications.

The program does not propose any setting values for the undercurrent unit. If required, the values can be entered manually. The setting values given are shown on the report sheets (see Appendix 1). The settings for the undercurrent unit include:

- Start current \( I < 30\ldots80\% \times I_o \), or out of operation
- Operate time \( t < 2\ldots600 \text{ s} \)

If you want to make the undercurrent unit inoperative, press **Not in use** in the Undercurrent unit section of the relay setting window (Fig. 5).

3.7 Setting of start time counter

The settings for the start time counter are found in the Cumulative start-up time counter section in the relay setting window. These settings include:

- Restart inhibit start time count setting \( \Sigma t_{si} \) \( 5\ldots500 \text{ s} \)
- Countdown rate of start time counter \( \Delta \Sigma t / \Delta t \) \( 2\ldots250 \text{ s/h} \)

Enter the number of start-ups permitted and the time (in hours) during which these start-ups are allowed. (Fig. 5)

Then press **Calculate** (Fig. 5).

Figure 28. Setting of operate time \( t_A \).

Figure 29. Settings of the start-up time counter.

E.g.  
Motor start time = 2.5 s  
Successive start-ups allowed = 6 times /1 hour

The principle of setting the inhibit level is that the number of successive start-ups that can be made without causing damage to the motor is allowed, here 6 times. In this case the inhibit level will be activated after the fifth start-up i.e. the level will be: the time required for five start-ups + security margin (1 second).
Inhibit level = (5 x 2.5 s) + 1 s = 13.5 s
After this you have to wait for one hour until the next start-up is possible.
Countdown rate = 2.5 s / 1 hour = 2.5 s/h
If you accept the start time counter settings proposed in Fig. 29, press Yes; if you press No, the program will request these values separately.

4. Coordination curves
The coordination curves will appear on the screen when you press Trip curves (Fig. 2).

Figure 30. Coordination curves.
The coordination curves show the overcurrent settings of the relay, the motor start-up current and time, cold and hot safe stall times of the motor and the settings of the start-up supervision unit.
To print the coordination curves on the default printer press Print Chart.

4.1 Adding cold and hot safe stall time in the curves
The cold and hot safe stall time values are available from the motor manufacturer. These times indicate for how long a time the motor is allowed to be stalled in a cold or hot condition without being damaged.
Press Add stall times (in the coordination curves). Should these times have been defined earlier press Remove stall times. Then the values will be deleted and the button Add stall times will appear on the screen.
Figure 31. Setting window for stall times.

5. Setting of start-ups

The settings have to be done for both cold starts and hot starts. To select cold starts, press Cold starts and to select hot starts, press Hot starts (Fig. 2).

The setting principle is the same for both types of start-up. The only difference is that the prior load level of the motor has to be considered in the setting of hot starts and that the setting table for hot start allows the stall time $t_{6x}$ to be calculated.

The stall time $t_{6x}$ is set as described in 3.1.2.

Figure 32. Setting table for hot starts.
To set the prior load press **Set prior load** (Fig. 32). The settings include: preloading current, preloading time and possible stopping time. The preloading time includes the start time.

When specifying the prior load level, it should be noticed that the motor does not reach operating temperature until its thermal capacity stops rising, even though the preloading time is extended (Fig. 33). Not until then hot starts can be carried out.

![Thermal Behaviour of the Thermal Unit at Prior load](image1)

Figure 33. Motor preloading.

To set the hot starts, press **Set hot starts** (Fig. 32). First select the number of starts and then specify each start separately: current after start-up, running time and possible stopping time. The start time is included in the running time.

Figure 34 shows the behaviour of the thermal unit in different situations of operation. Three hot starts have been set. The start and load situations have been defined so that the temperature of the fastest heating motor parts drop to the level of the parts heating more slowly, before the next start-up takes place.

![Thermal Behaviour of the Thermal Unit at Hot starts](image2)

Figure 34. Characteristics of the thermal unit at three hot starts. The load current is shown to the right.
6. Simulation of load variations

The program also allows simulation of various load situations of the motor to be protected. Simulation of load variations is selected via Cycles in the Menu window (Fig. 2).

![Figure 35. Setting table for load changes.](image)

Set the preloading level of the motor by specifying the current after start-up and the preloading time. Then press Set prior load (Fig. 35).

Press Set cycles in order to set the load variations. First set the number of loadings (1 - 15), then specify the load current and the load time for each cycle. Figure 36 shows the result of the simulation based on the settings in Fig. 35.

![Figure 36. Thermal characteristics of load changes.](image)
To get a graphical presentation of the thermal behaviour of the thermal unit, press **Thermal behaviour** in the Menu window (Fig. 2).

The graphical presentation desired is selected by means of the push-buttons in Fig. 37:

- Cold Starts; start-up without preloading
- Prior load; related to preloading at hot starts
- Hot Starts; start-up with preloading
- Cycles; effect of short time motor load cycles

8. Others

8.1 Report

The report pages contain a summary of all the settings made. The settings can be supplemented with necessary comments. To print the report pages (three report pages), press **Print report**.

Figure 38. Print button.
8.2 Saving of data

To save data, press **Save data** in the Menu window (Fig. 2).

![Image of Save dialog box]

**Figure 39. Saving of data.**

The program places motor data, relay settings and start-up data in a table which can be stored under the desired name (max. 8 characters). The values will be saved according to specific commands allowing just data saved using this button to be opened by means of the **Open data** button (Fig. 2).

8.3 Opening of data

Press **Open Data** in the Menu window (Fig. 2).

Select the file previously saved with this simulation program and press **OK** (see Fig. 40).

![Image of Open dialog box]

**Figure 40. Opening of data.**

8.4 Closing of program

Press **EXIT** (Fig. 2) to close the simulation program and the Excel spreadsheet program.
To avoid functional problems and minimize faulty settings the following order of procedure is recommended:

1. Setting of motor and current transformer values.
2. Setting of relay load current (Full load current).
3. Setting of relay weighting factor.
4. Setting of cold and hot starts.
5. Setting of stall time $t_{st}$
6. Thermal behaviour. If the operation fails or you want to change some load current or load time settings, repeat points 4, 5 and 6.
7. Define the rest of the relay settings.
8. Add the cold and hot safe stall times to the coordination curves.
9. Check the settings in the coordination curves. When required, you can print the curves.
10. Check the report pages. Delete old comments and add new ones. Print the report.
## Motor Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Unit(s)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>P&lt;sub&gt;AM&lt;/sub&gt; =</td>
<td>kW</td>
<td></td>
</tr>
<tr>
<td>Rated voltage</td>
<td>U&lt;sub&gt;AM&lt;/sub&gt; =</td>
<td>kV</td>
<td></td>
</tr>
<tr>
<td>Rated current</td>
<td>I&lt;sub&gt;AM&lt;/sub&gt; =</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Starting current</td>
<td>I&lt;sub&gt;S&lt;/sub&gt; =</td>
<td>A</td>
<td>I&lt;sub&gt;AM&lt;/sub&gt; ×</td>
</tr>
<tr>
<td>Starting time</td>
<td>t&lt;sub&gt;S&lt;/sub&gt; =</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
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<td>°C</td>
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## CT data:

<table>
<thead>
<tr>
<th>Type</th>
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<th>Unit(s)</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Primary</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

## Relay settings:

<table>
<thead>
<tr>
<th>Setting range</th>
<th>Formula</th>
<th>Unit(s)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal overload unit:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full load current</td>
<td>I&lt;sub&gt;f&lt;/sub&gt; =</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Safe stall time</td>
<td>t&lt;sub&gt;f&lt;/sub&gt; =</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Weighting factor</td>
<td>p =</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Prior alarm level</td>
<td>θ&lt;sub&gt;p&lt;/sub&gt; =</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Restart inhibit level</td>
<td>θ&lt;sub&gt;r&lt;/sub&gt; =</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Cooling time constant</td>
<td>k&lt;sub&gt;c&lt;/sub&gt; =</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Start-up supervision unit: | | | |
| Start current | I<sub>S</sub> = | A | | |
| Start-up time | t<sub>S</sub> = | s | | |

| High-set overcurrent unit: | | | |
| Start current | I<sub>H</sub> = | A | | |
| Operate time | t<sub>H</sub> = | s | | |

| Earth-fault unit: | | | |
| Start current | I<sub>E</sub> = | A | | |
| Operate time | t<sub>E</sub> = | s | | |

| Phase unbalance unit: | | | |
| Start current | ΔI = | A | | |
| Operate time | t<sub>ΔI</sub> = | s | | |

| Undercurrent unit: | | | |
| Start current | I<sub>UC</sub> = | A | | |
| Operate time | t<sub>UC</sub> = | s | | |

<p>| Cumulative start time counter unit: | | | |
| Restart inhibiting | Σt&lt;sub&gt;st&lt;/sub&gt; = | s | | |
| Countdown rate of start-up time counter | ΔΣt/Δt = | s/h | | |</p>
<table>
<thead>
<tr>
<th>Switch</th>
<th>Function</th>
<th>Setting</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGF1</td>
<td>High-set overcurrent unit inhibited or in use</td>
<td>0 = high-set stage inhibited, 1 = high-set stage in use</td>
<td>x1</td>
</tr>
<tr>
<td>SGF2</td>
<td>Setting of high-set overcurrent stage doubled during a motor start-up</td>
<td>0 = no doubling, 1 = doubling feature active</td>
<td>x2</td>
</tr>
<tr>
<td>SGF3</td>
<td>Earth-fault trips inhibited on overcurrents higher than a selected multiple of the motor full load current</td>
<td>PLC as follows:</td>
<td>x4</td>
</tr>
<tr>
<td>SGF4</td>
<td>Selection or deselection of phase unbalance protection</td>
<td>SGF5 = D, SGF3 = 1</td>
<td>x8</td>
</tr>
<tr>
<td>SGF5</td>
<td>Selection or deselection of phase unbalance protection</td>
<td>0 = not in use (setting displayed &quot;---&quot;, 1 = operative</td>
<td>x16</td>
</tr>
<tr>
<td>SGF6</td>
<td>Inverted phase sequence protection inhibited or in use</td>
<td>0 = not in use, 1 = operative</td>
<td>x32</td>
</tr>
<tr>
<td>SGF7</td>
<td>Stall protection based on the thermal stress supervision</td>
<td>l_2^2 = l_1, 0 = definite time overcurrent, 1 = thermal stress monitoring</td>
<td>x64</td>
</tr>
<tr>
<td>SGF8</td>
<td>Selection or deselection of the undervoltage protection</td>
<td>0 = not in use (setting displayed &quot;---&quot;, 1 = operative</td>
<td>x128</td>
</tr>
<tr>
<td>SGB1</td>
<td>Stall information to relay from speed switch on motor (1)</td>
<td>x1</td>
<td></td>
</tr>
<tr>
<td>SGB2</td>
<td>Restart of the motor inhibited by external command (1)</td>
<td>x2</td>
<td></td>
</tr>
<tr>
<td>SGB3</td>
<td>When SGB3 = 1, the phase unbalance unit is blocked by the input signal BS.</td>
<td>x4</td>
<td></td>
</tr>
<tr>
<td>SGB4</td>
<td>When SGB4 = 1, the earth-fault unit is blocked by the input signal BS.</td>
<td>x8</td>
<td></td>
</tr>
<tr>
<td>SGB5</td>
<td>External trip command carried out to output relay A (1)</td>
<td>x16</td>
<td></td>
</tr>
<tr>
<td>SGB6</td>
<td>External relay reset (1) makes it possible to have a manual reset button outside the relay.</td>
<td>x32</td>
<td></td>
</tr>
<tr>
<td>SGB7</td>
<td>Latching of output relay for short-circuit, earth-fault unbalance trip. When SGB7 = 0, the tripping signal returns to its initial state. When SGB7 = 1, the tripping signal remains on.</td>
<td>x64</td>
<td></td>
</tr>
<tr>
<td>SGB8</td>
<td>Latching (1) of output relay for any tripping, independent of the cause. When SGB8 = 0, the tripping signal returns to its initial state. When SGB8 = 1, the tripping signal remains on.</td>
<td>x128</td>
<td></td>
</tr>
<tr>
<td>SGF11</td>
<td>The thermal prior alarm linked to</td>
<td>SS2, TS2</td>
<td>x1</td>
</tr>
<tr>
<td>SGF12</td>
<td>The thermal trip signal linked to</td>
<td>0 = it, 1 = it</td>
<td>x2</td>
</tr>
<tr>
<td>SGF13</td>
<td>The signal from stall protection linked to</td>
<td>0 = it, 1 = it</td>
<td>x4</td>
</tr>
<tr>
<td>SGF14</td>
<td>The signal for high-set overcurrent linked to</td>
<td>0 = it, 1 = it</td>
<td>x8</td>
</tr>
<tr>
<td>SGF15</td>
<td>The signal for current unbalance linked to</td>
<td>0 = it, 1 = it</td>
<td>x16</td>
</tr>
<tr>
<td>SGF16</td>
<td>The signal for earth-fault linked to</td>
<td>0 = it, 1 = it</td>
<td>x32</td>
</tr>
<tr>
<td>SGF17</td>
<td>The signal for undervoltage linked to</td>
<td>0 = it, 1 = it</td>
<td>x64</td>
</tr>
<tr>
<td>SGF18</td>
<td>The earth-fault unit linked to</td>
<td>0 = it, 1 = it</td>
<td>x128</td>
</tr>
</tbody>
</table>

Remarks: