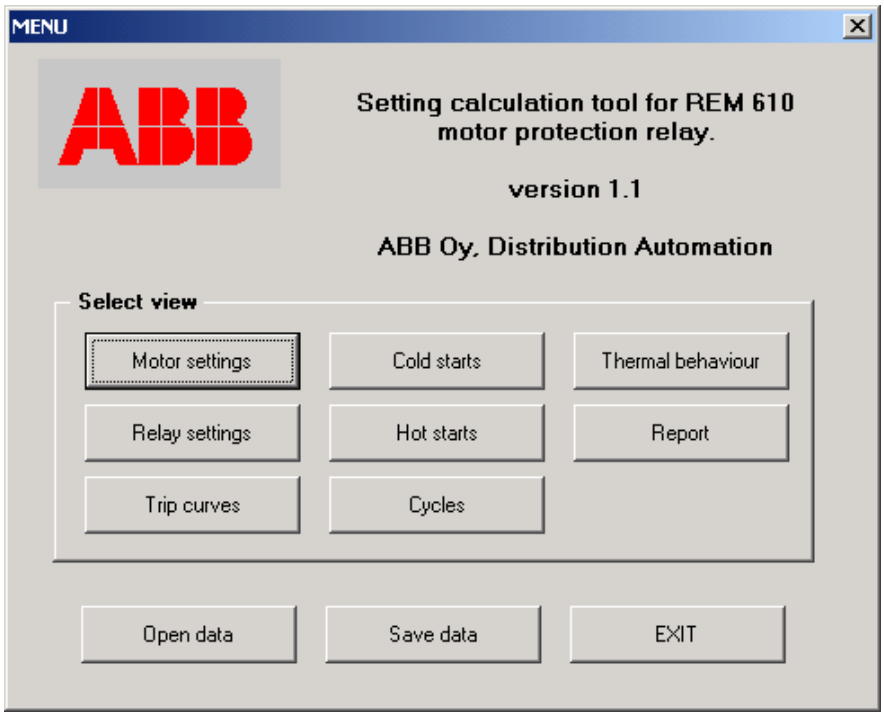
REM 610
Motor Protection Relay

Setting calculation tool,
Instructions for use



menu_1

Contents:

1. Program implementation

1.1. Program installation

The program can be used directly from the CD or installed on the PC hard disk. To install the program, copy the REM 610.xls file to the desired directory on the hard disk. The program does not write in Windows registry, so you can easily uninstall it by moving it to the Trash can.

1.2. Packed program

If the program is delivered packed, the installation is easy: double-click the REM program icon using the left mouse button to open the installation window. In the installation window, select the installation directory and click the Unzip button. The program is unzipped in the selected directory where it can be started.

1.3. Starting the program

The program works in Microsoft Excel 97 and Office 2000 environments. It requires one of these programs to work.

To open the program, double-click the program icon using the left mouse button. Alternatively, you can start Excel and select the Open command to start the REM program from the installation directory.

As the program starts, Excel displays a warning about macros that may contain dangerous computer viruses. However, not all the macros are viruses or dangerous. The macros contained in the program are designed to perform calculations. If the macros have not been modified, they are not dangerous.

⚠	The program contains several macros. The entire operation of the program is based on these macros, so they must be enabled for the program to run.

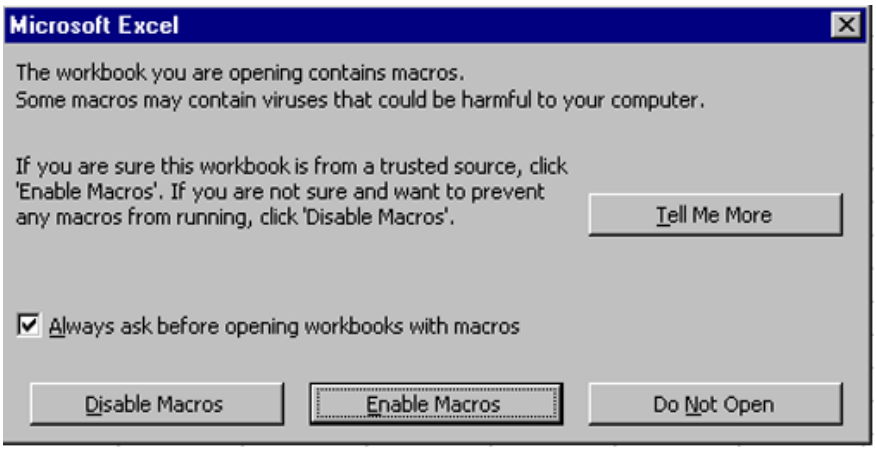
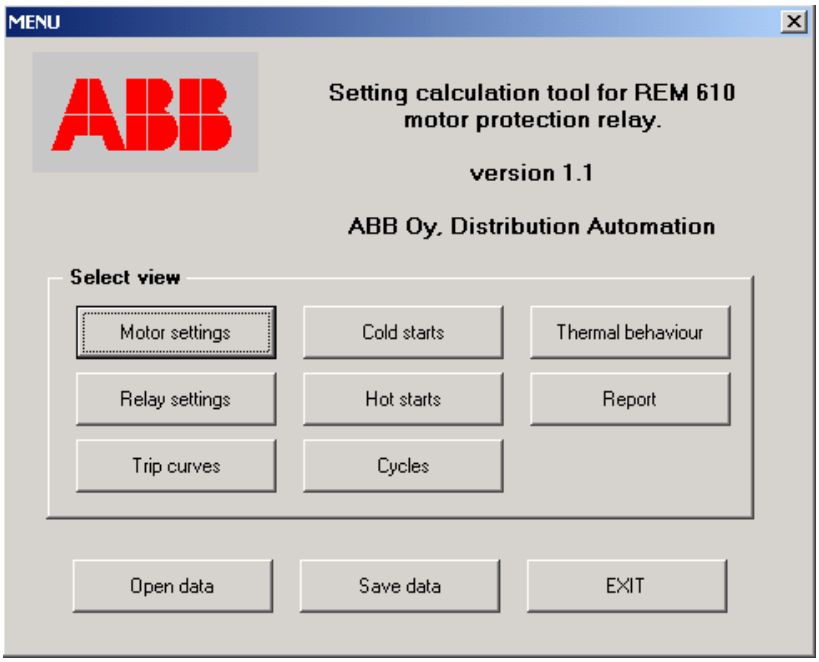


Fig. 1.3.-1 Macro warning

2. Main menu

The main menu opens when the program is started. The menu facilitates moving between the different parts of the program. To return to the menu from another page, click the MENU button at the bottom of a page.



menu_1

Fig. 2.-1 Main menu.

2.1. Functions

To move between the different parts of the program, use the main menu buttons in the following way:

Motor settings	motor setting table
Relay settings	relay setting table
Trip curves	trip curve display
Cold starts	setting table for cold starts
Hot starts	setting table for hot starts
Cycles	setting table for varying load
Thermal behaviour	thermal behaviour plot display
Report	reports on calculation results

2.2. Saving data

To save all the changes for later use, click the Save data button. To retrieve the saved data, click the Open data button.

2.3. Closing the program

When the Exit button is clicked, the program warns that closing the program will delete all unsaved data and asks if you really want to close the program. Click Yes to close the program or No to return to the program.

3. Calculating the settings

1. Enter the values for the motor and current transformers (Motor settings).
2. Set the ambient temperature (Set ambient temp.).
3. Set the scaling factor (Relay settings/p.u. scaling factor).
4. Set the weighting factor for the thermal protection (Weighting factor).
5. Specify the hot and cold starts (Hot/Cold starts).
6. Calculate the motor stall time (Stall time, t6x).
7. Check the thermal behaviour (Thermal behaviour).
8. Set/calculate the remaining relay settings (Relay settings).
9. Check the trip curves (Trip curves).
10. Check the report and print it (Report).

It is recommended you follow the above mentioned sequence to avoid problems.

4. Motor data

To enter motor data, click the Motor settings button in the main menu to open the motor setting page. To change the motor data, click the Set New Data button. A dialog opens and you can enter the new data. The data is updated on the Motor settings page immediately after you click the OK button in the dialog.

The entered data must be numeric or the program will not accept it.

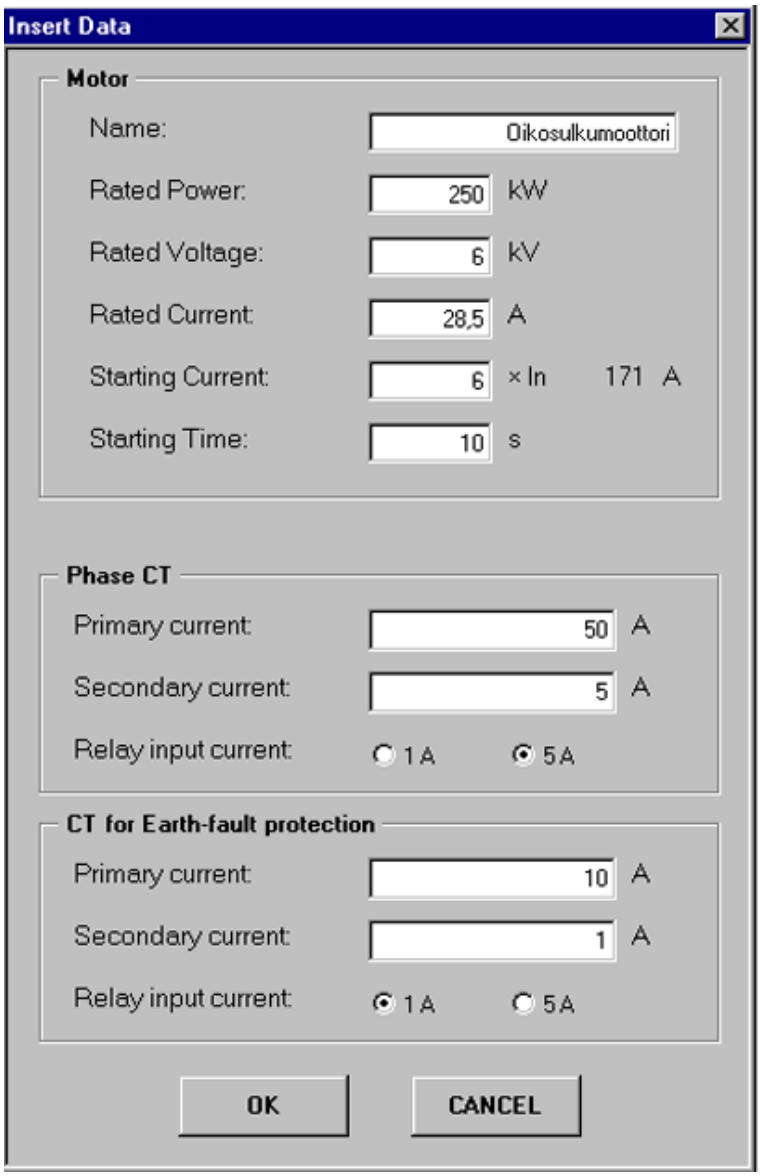
4.1. Basic data

The basic motor data (Insert Data window) can be displayed and modified as described above, see figure 4.1-1. The basic data includes the following:

- Name — name of the protected motor or object
- Rated Power — (Pn)
- Rated Voltage — (Un)
- Rated Current — (In)
- Starting Current — (Is)
- Starting Time — (ts)

The rated currents of the primary and secondary windings of the phase current transformer and the relay input currents can be set in the Phase CT area.

The I_0 current transformer data can be entered in the CT for Earth-fault protection area.

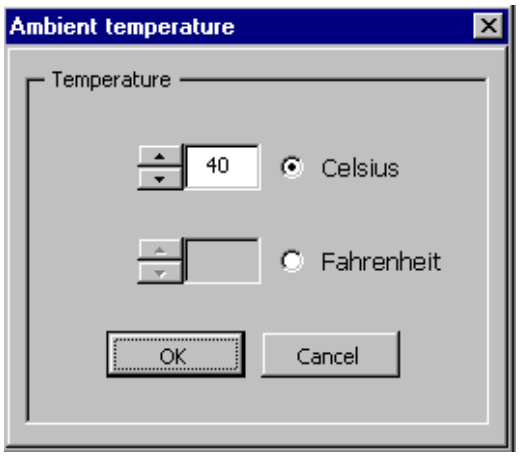


insertdata_5

Fig. 4.1.-1 Motor data dialog

4.2. Entering the ambient temperature

To enter the ambient temperature, click the Set ambient temp. button on the Motor Settings, Cold Starts, Hot Starts, Cycles or Trip curves page. Enter the temperature in the opening dialog in degrees Celsius or Fahrenheit. The temperature can be 0 to 70°C or 32 to 158°F. After confirmation the entered temperature value is displayed on the Motor Settings page.



ambtemp_6

Fig. 4.2.-1 Ambient temperature dialog

5. Calculating the relay set values

Click the Relay settings button in the main menu to open the relay setting page. To return to the main menu, click MENU.

There are two ways of calculating the relay settings: quick setting or normal setting. See the descriptions of both methods in the following chapters.

5.1. Quick setting

To start the quick setting procedure, click the Quick setting button on the relay setting page. In quick setting, approxinate numbers are calculated prior to calculating the actual values. The method leaves some data uncalculated. When calculating the final relay settings, all the settings must be gone through.

The quick setting window has the following fields (see figure 5.1-1):

- Hot starts: can the motor be started hot once or twice
- Short-circuit protection (High-set): is current doubling enabled (Enabled) or disabled (Disabled)
- Start-up supervision:
  - definite time principle (Definite time)
  - thermal stress principle (Thermal stress)
- Start-up time counter: 2 or 3 start-ups per hour

	Note the warning in the dialog! The quick setting procedure does not calculate the earth-fault protection and undercurrent protection settings. It is recommended that all the relay settings are also calculated after quick setting according the instructions in the following chapter.

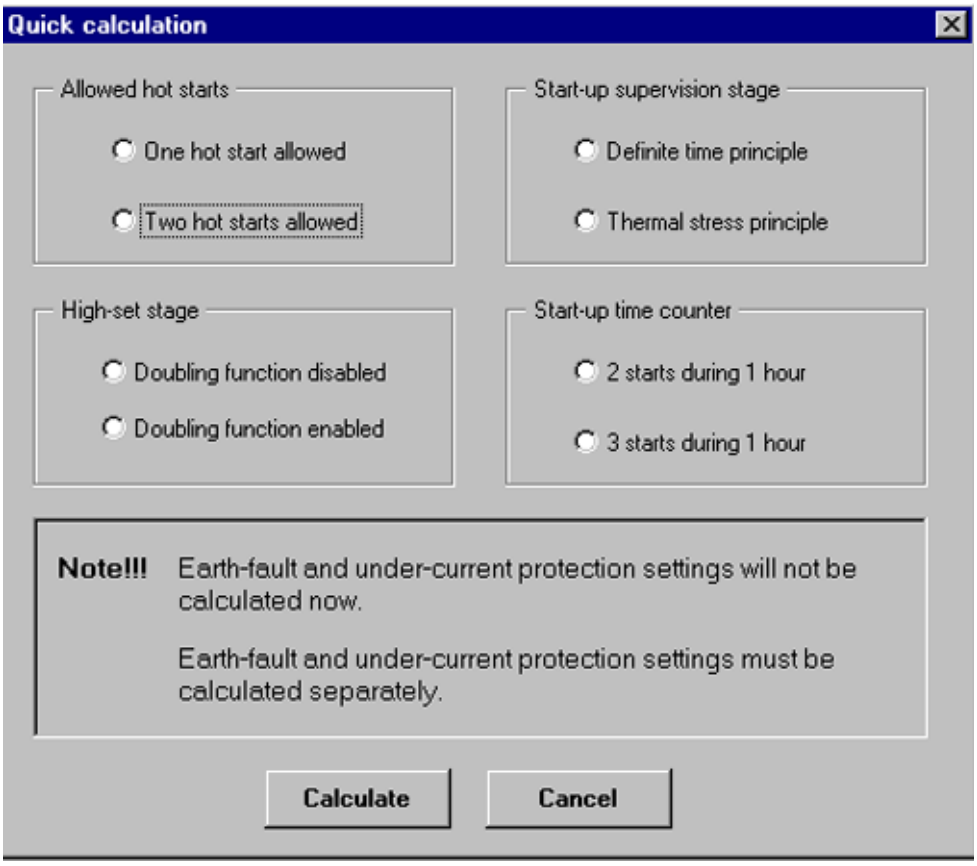
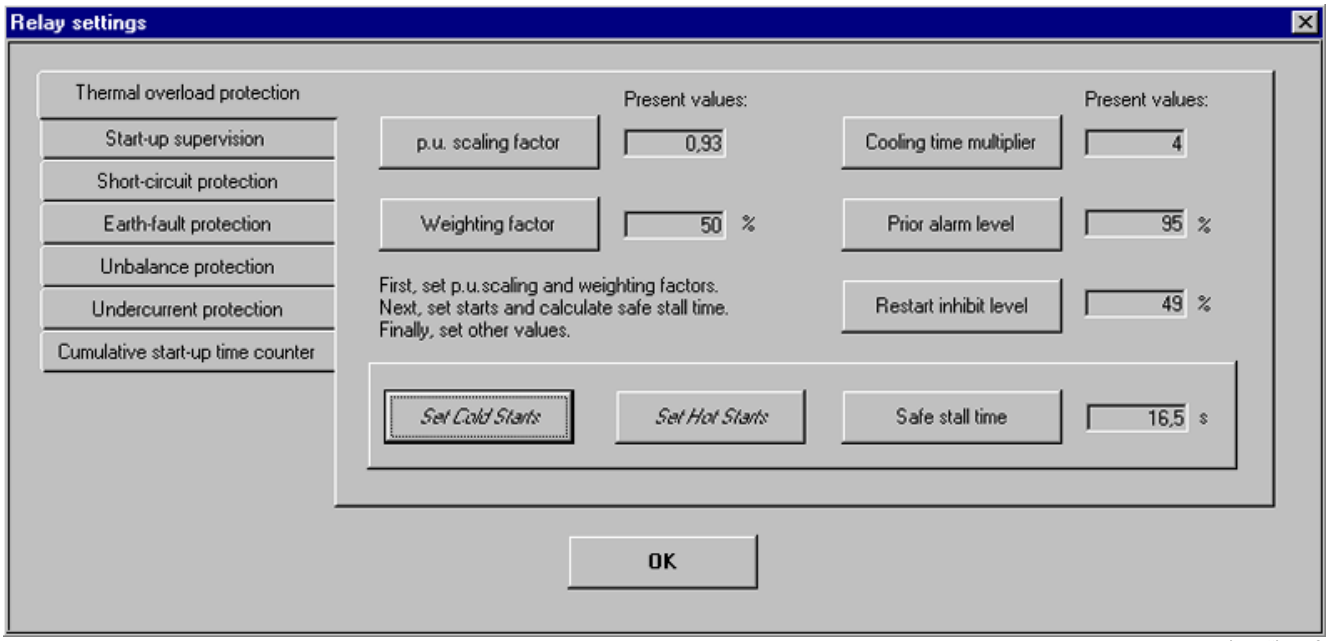


Fig. 5.1.-1 Relay quick setting window.

5.2. Normal setting

To view the relay settings, you can click the Relay settings button in the main menu. A window opens showing the current relay settings. To modify the settings, click the Relay settings button to open the relay setting window. Click the buttons in the window to calculate the value of the setting and prompt for a confirmation. If you do not want to use the value suggested by the program you can enter a value using the keyboard.



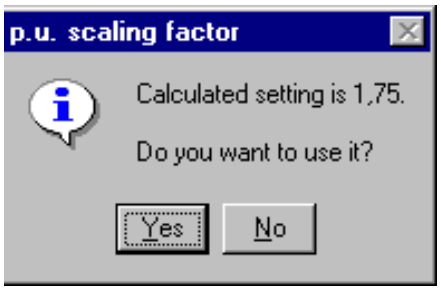
relaysettings_8

Fig. 5.2.-1 Relay setting window.

5.2.1. Thermal overload protection

5.2.1.1. Rated current scaling factor

The settings for the relay thermal overload protection are calculated in the dialog shown in the figure above. The first value calculated is the rated current scaling factor (p.u. scaling factor), which the program uses in current calculations for a full motor load. When you click the button, the program suggests a calculated value. To change the value, click No. The program will prompt for a value.



p_u_scalfact_9

Fig. 5.2.1.1.-1 To accept the calculated value, click Yes. To change the value, click No.

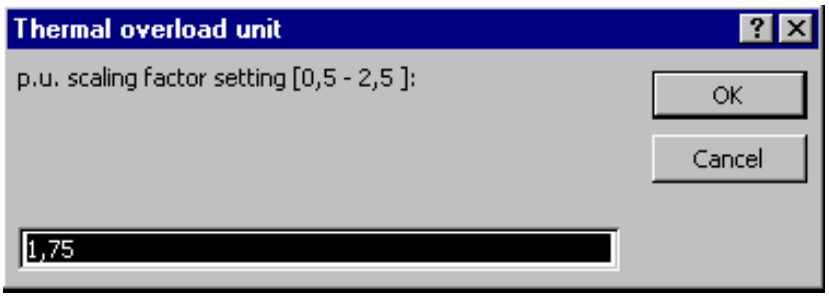


Fig. 5.2.1.1.-2 Entering a value (0.5 to 2.5) for the scaling factor.

5.2.1.2. Weighting factor

The weighting factor for motors is 50%, except for objects with no local thermal overload during start-up or use. These cases include e.g. cables and not-direct-on-line started motors, for which a 100% setting is used.

5.2.1.3. Permitted motor stall time

When calculating t_{6x}, safe stall time, make sure that the data for hot starts and prior load has been entered earlier, as the program uses this data to calculate the stall time. Of course the stall time must be re-calculated if hot start or prior load data is changed.

When you click the Safe stall time button, the program asks you to give the maximum value for thermal capacity (figure 5.2.1.3.-1). When you click the OK button, the program calculates the permitted stall time. To change the calculated time, click No in the dialog shown in figure 5.2.1.3.-2. You can now enter a stall time (2-120 s).

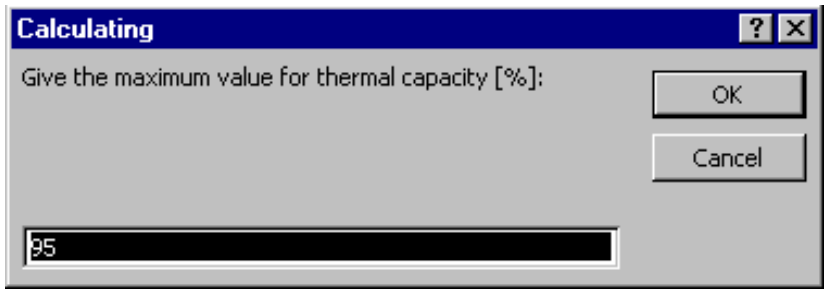
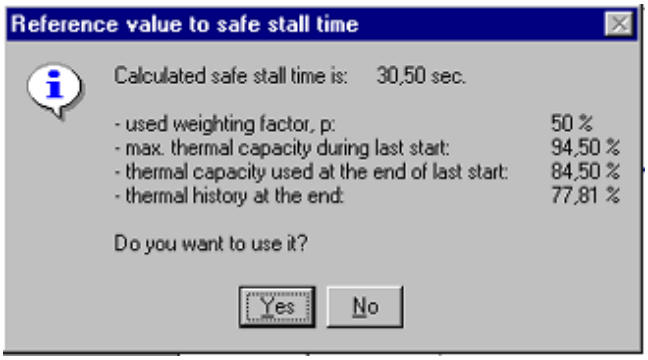


Fig. 5.2.1.3.-1 Enter a percentage value and click OK. To return to the previous window, click Cancel.

Figure 5.2.1.3.-2 shows the calculated stall time (t_{6x}) and the following values:

- weighting factor p used
- the maximum thermal capacity at the last start-up
- the used thermal capacity at the end of the last start-up
- the heating history value at the end of the start-up



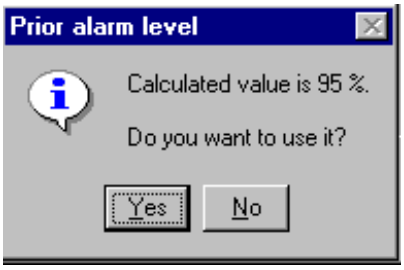
refval_stalltime_12

Fig. 5.2.1.3.-2 Permitted motor stall time. To accept the value, click Yes. To change the value, click No.

5.2.1.4. Thermal prior alarm level

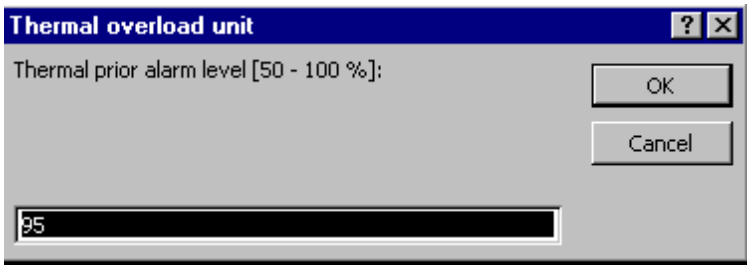
Prior alarm level (θ_a) is calculated based on the hot start settings. If the start settings are changed, the prior alarm level must be recalculated.

To accept the calculated value, click Yes. If you want to enter a different value, click No. The value is expressed as a percentage of the trip limit and used for alarms prior to tripping.



proralarmlevel_13

Fig. 5.2.1.4.-1 To accept the prior alarm level, click Yes. To change the value, click No.



th_olunit_14

Fig. 5.2.1.4.-2 The dialog opening after clicking No. Enter a value and click OK.

5.2.1.5. Restart inhibit level

Restart inhibit level (θ_i) is calculated based on the hot start settings. If the start settings are changed the restart inhibit level must be recalculated.

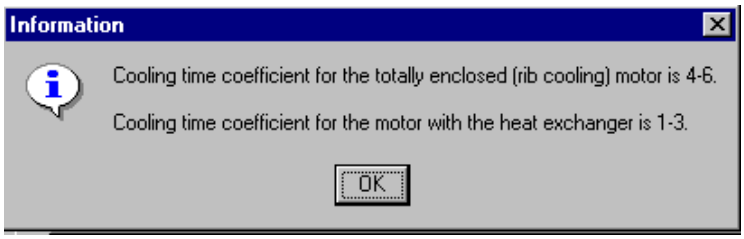
To accept the calculated level, click Yes. To change the value, click No. The inhibit level is used for determining the restart time after an overload situation. It is expressed as a percentage of the trip limit.

5.2.1.6. Cooling time multiplier

Cooling time multiplier (kc) indicates how much longer it takes for the motor to cool down after shutdown. Usually, the following applies:

- closed motors with surface cooling, k_c = 4-6 and
- motors with separate cooling, k_c = 1-3.

Click OK and enter a value from 1 to 64.

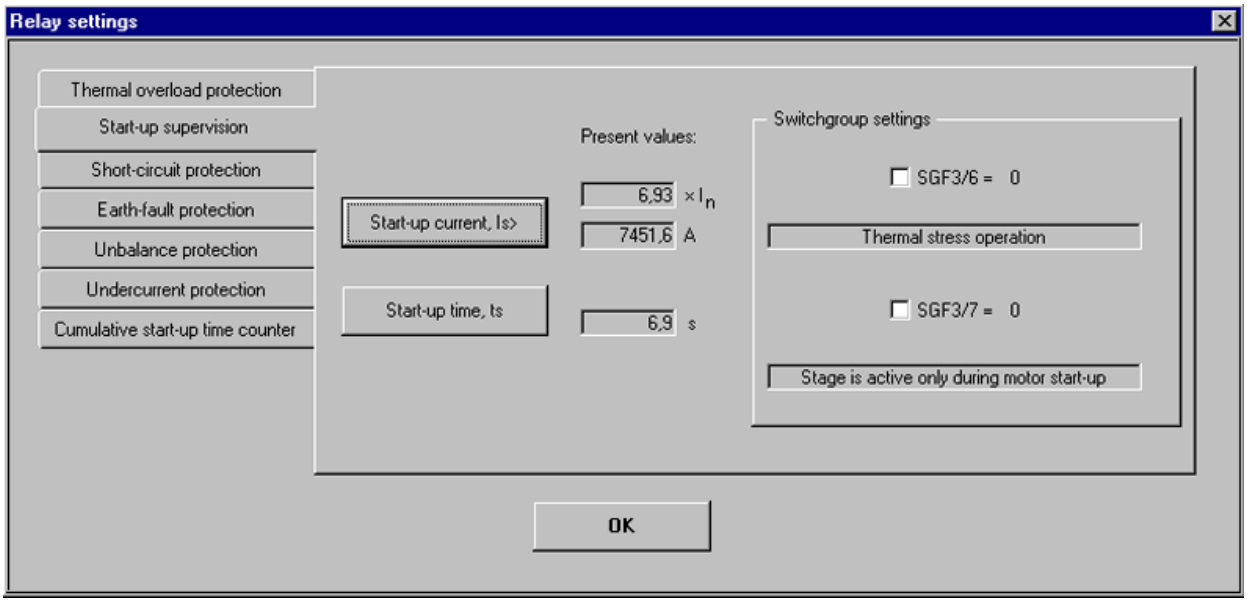


information_15

Fig. 5.2.1.6.-1 Cooling time information.

5.2.2. Start-up supervision

The start-up supervision unit (Start-up supervision) monitors the start-up situation. You can use the SGF3/6 switch to select either the definite time operation mode or the thermal stress operation mode. Use the SGF3/7 switch to select whether the protection is used in start-up only or all the time. For more information about the operation modes, see the relay operating manual. You can also use the buttons on this tab to specify the start-up current (I_S>) and the start-up time (t_S), figure 5.2.2.-1.



relaysettings_16

Fig. 5.2.2.-1 Start-up supervision

5.2.2.1. Start-up current

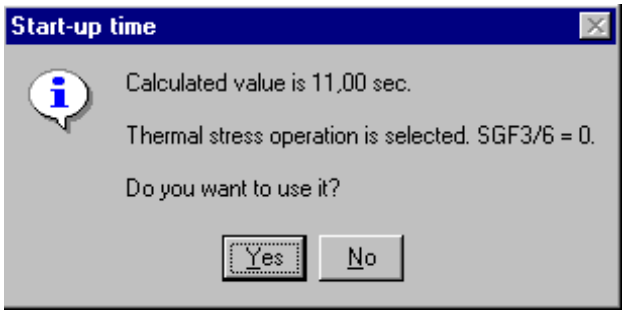
The Start-up current (I_S>) is a multiple of the rated current (I_n). You can specify it with two decimals between 1-10. The program calculates a current suggestion and displays it in a separate window. In the same window the calculation basis used is displayed (definite time or thermal stress principle).

When the definite time principle is used, the suggested value is 50% of the motor starting current. The principle is straightforward, but its major weakness is the constant operation delay.

The thermal stress principle is based on the formula $I_S^2 \times t_S$. I_S is the setting value matching the actual motor starting current, and t_S is a value slightly higher than the normal motor start-up time. During start-up, the relay measures the start-up current, squares it and multiplies it by the start-up time.

5.2.2.2. Start-up time

To calculate the start-up time (t_s), click the Start-up time t_s button. To change the calculated value, click No in the confirmation dialog. You can set the start-up time with two decimals in a range of 0.20 to 80.00 s.



startuptime_17

Fig. 5.2.2.2.-1 The calculated start-up time, changes as in earlier points.

5.2.3. Short circuit protection

Short-circuit protection contains the following settings:

Start current, I>>	0.5-20.0 x I_n
Operate time, t>>	0.05-30.0 s

For start-up, an automatic start current doubling can be set using the SGF3/8 switch. The SGF3/1 switch can be used to disable the short-circuit protection.

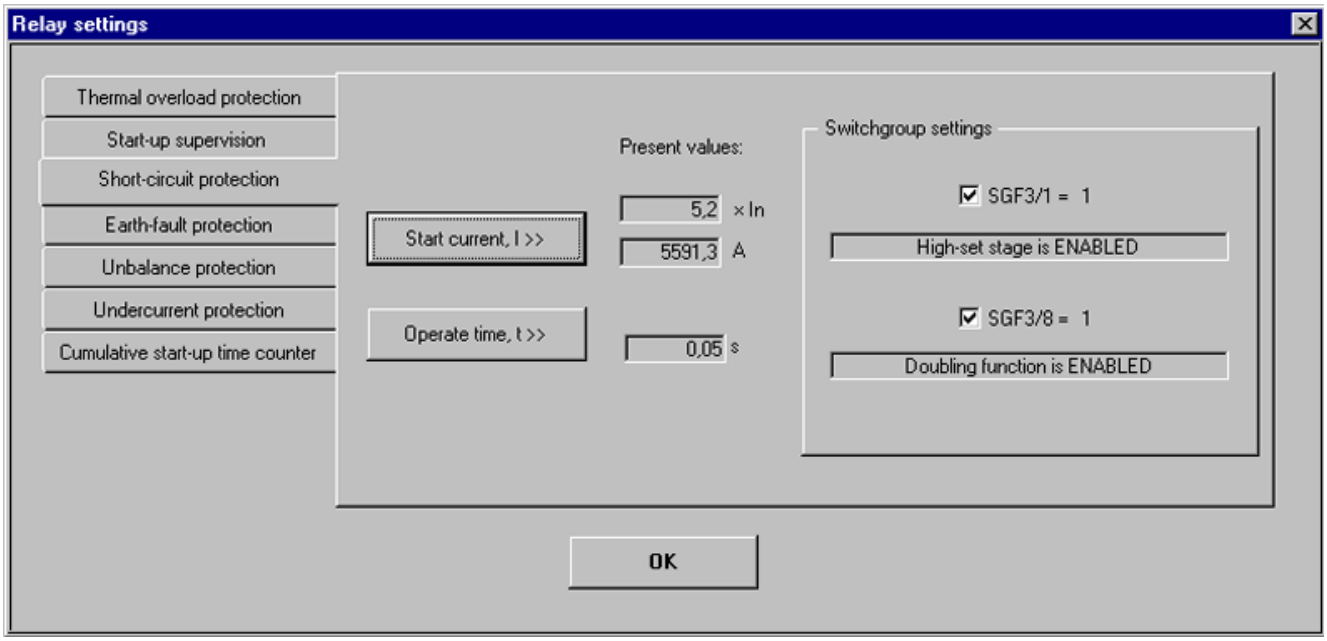


Fig. 5.2.3.-1 Short-circuit protection.

5.2.4. Earth-fault protection

Earth-fault protection is based on residual current measurement using a core-balance current transformer or three line CTs in a Holmgreen connection. The start current (I_0>) for earth-fault protection should be 1-100% x I_n and the operate time (t_0>) should be 0.05-30 seconds. First a 100% earth-fault current and the sensitivity required for the protection should be entered. The SGF3/3 switch can be used to disable the earth-fault protection. The SGF4/1 and SGF4/2 switches are for contactor use. For more information, see the relay manual.

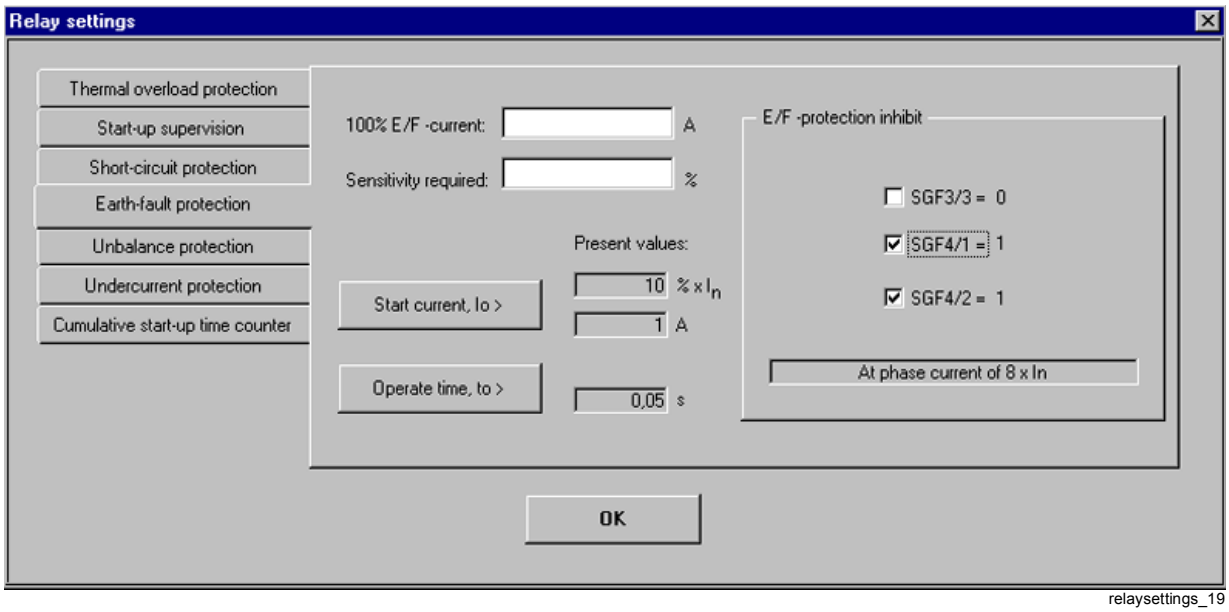


Fig. 5.2.4.-1 Earth-fault protection

5.2.5. Phase unbalance protection

The unbalance protection is used for phase discontinuity protection and unbalanced load protection for motors at network unbalance. The operation is based on current NPS measurement.

To disable the unbalance protection, use the SGF3/4 switch. The phase reversal protection monitors the sequence of the phase currents. To enable the function, use the SGF3/5 switch.

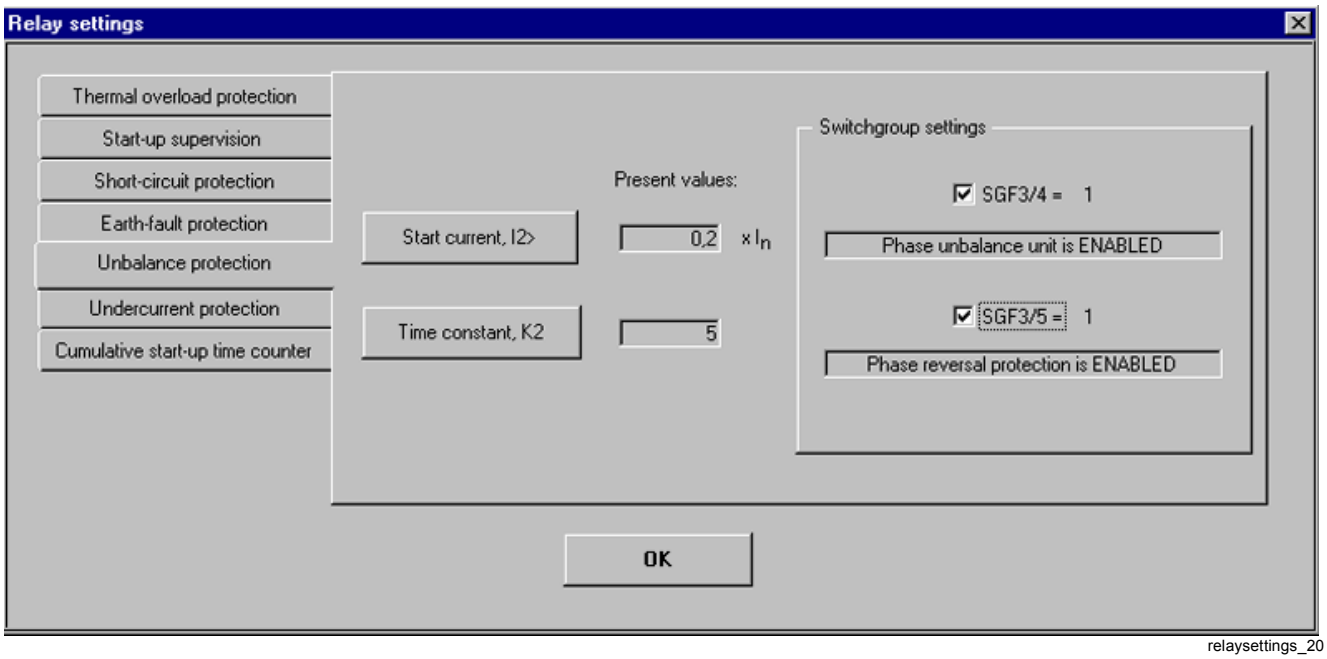


Fig. 5.2.5.-1 Phase unbalance protection

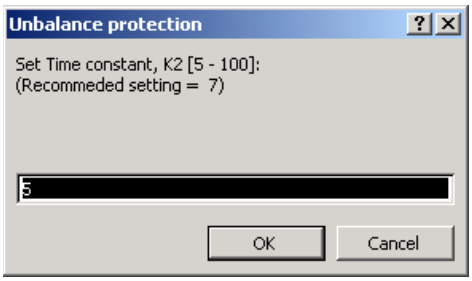
5.2.5.1. Start current

To enter the unbalance start current, click the Start current, I_2> button. The program opens a dialog where you can enter the value. The available start current range is 0.1 to 0.5 x I_n.

5.2.5.2. Calculating the operate time

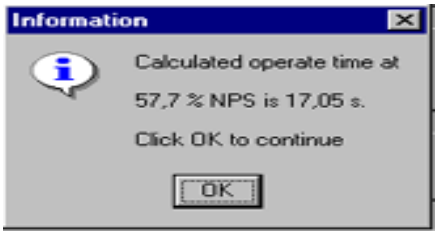
To calculate the operate time for the unbalance protection, click the Time constant, K2 button. The program prompts for the value of the machine-specific constant (Time constant). The value range is 5 to 100. When you confirm the value the program displays the calculated operate time. To continue, click OK.

⚠	To obtain an appropriate result, first enter the start current.



ph_unbalunit_21

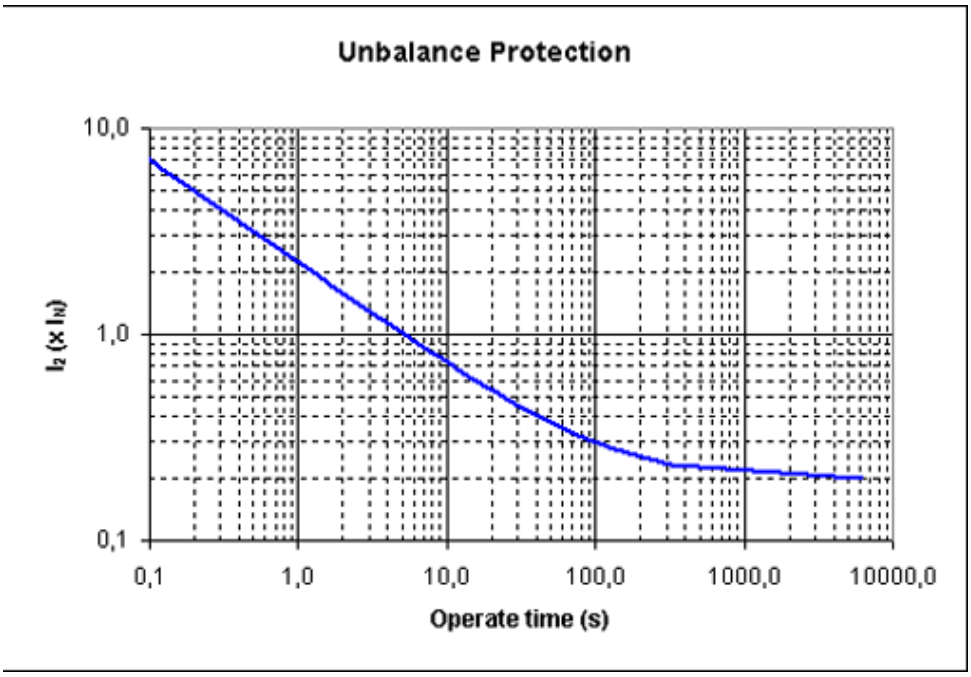
Fig. 5.2.5.2.-1 Time constant dialog.



information_22

Fig. 5.2.5.2.-2 The calculated operate time.

The phase unbalance graph is based on the start current described above, the time constant and the current NPS value. The phase unbalance graph is displayed on the second page of the report.



unbalcurve_23

Fig. 5.2.5.2.-3 Unbalance graph

5.2.6. Undercurrent protection

The undercurrent protection protects the motor during sudden load losses. To enable or disable the protection, use the SGF3/2 switch.

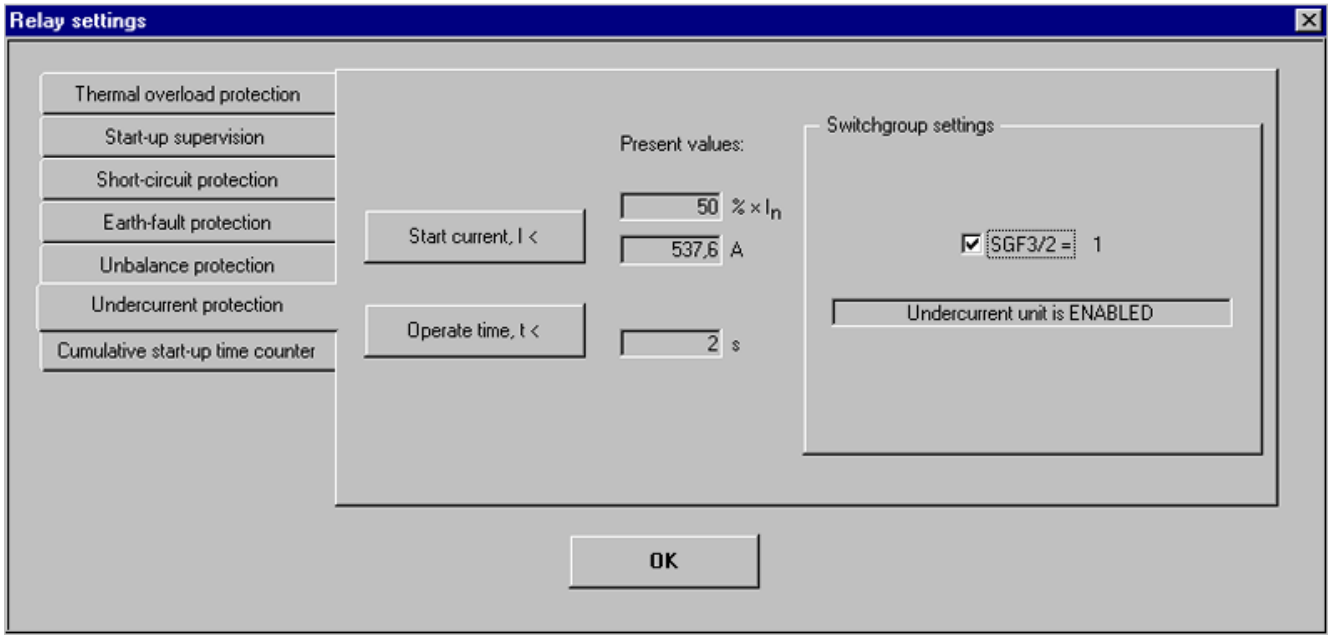


Fig. 5.2.6.-1 To enable the undercurrent protection, use the SGF3/2 switch.

5.2.6.1. Start current

To enter the undercurrent protection start current (I<), click the Start current, I< button. The available current range is 30 to 80% x $I_{n.}$ The default is 50% x I_{n}.

Operate time

To specify the operate time, click the Operate time, t< button. The permitted range is 2 to 600 seconds. The default is 2 seconds.

5.2.7. Cumulative start-up time counter

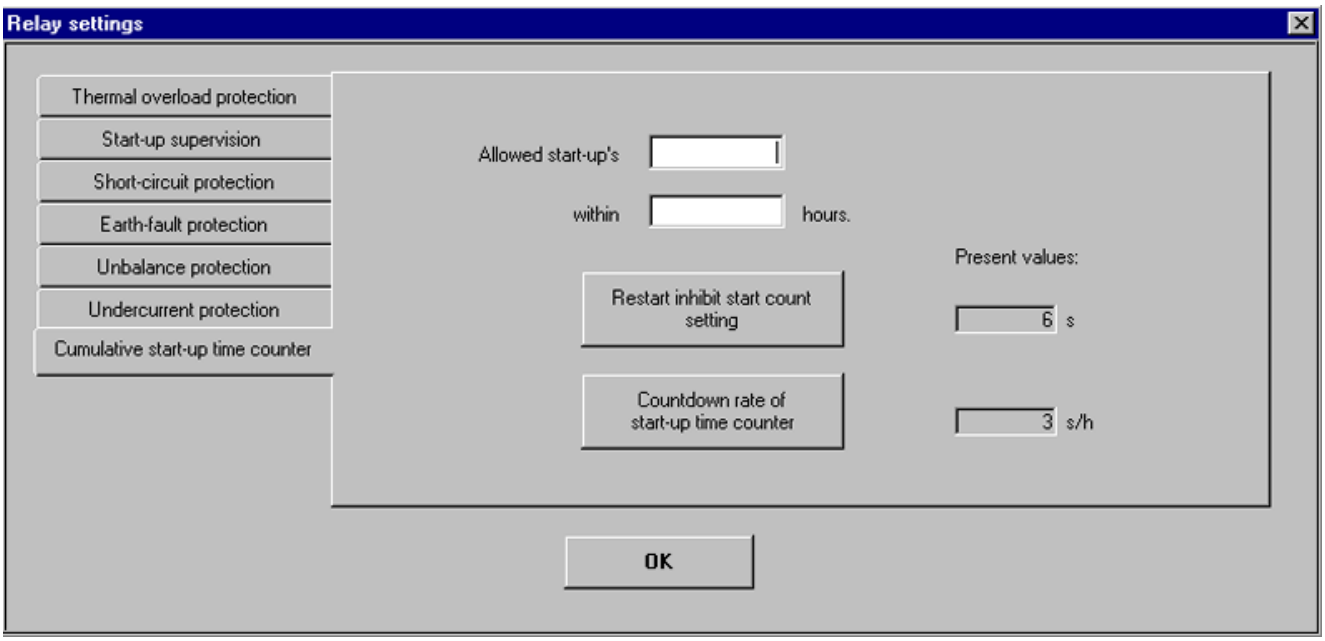


Fig. 5.2.7.-1 Start-up counter dialog.

The cumulative start-up time counter monitors the start-up time register (Σt_S) and compares it to the preset level (Σt_{Si}). If the value of the register exceeds the preset value, the counter prevents a new start-up.

5.2.7.1. Fields

Enter the number of start-ups permitted during a certain time in the fields. Enter the number of start-ups in the first field and the time (hours) in the second field.

5.2.7.2. Restart inhibit start count setting

When you click the Restart inhibit start count setting button, the program calculates the maximum start-up time. You can confirm the value or select a new value between 5 and 500 s.

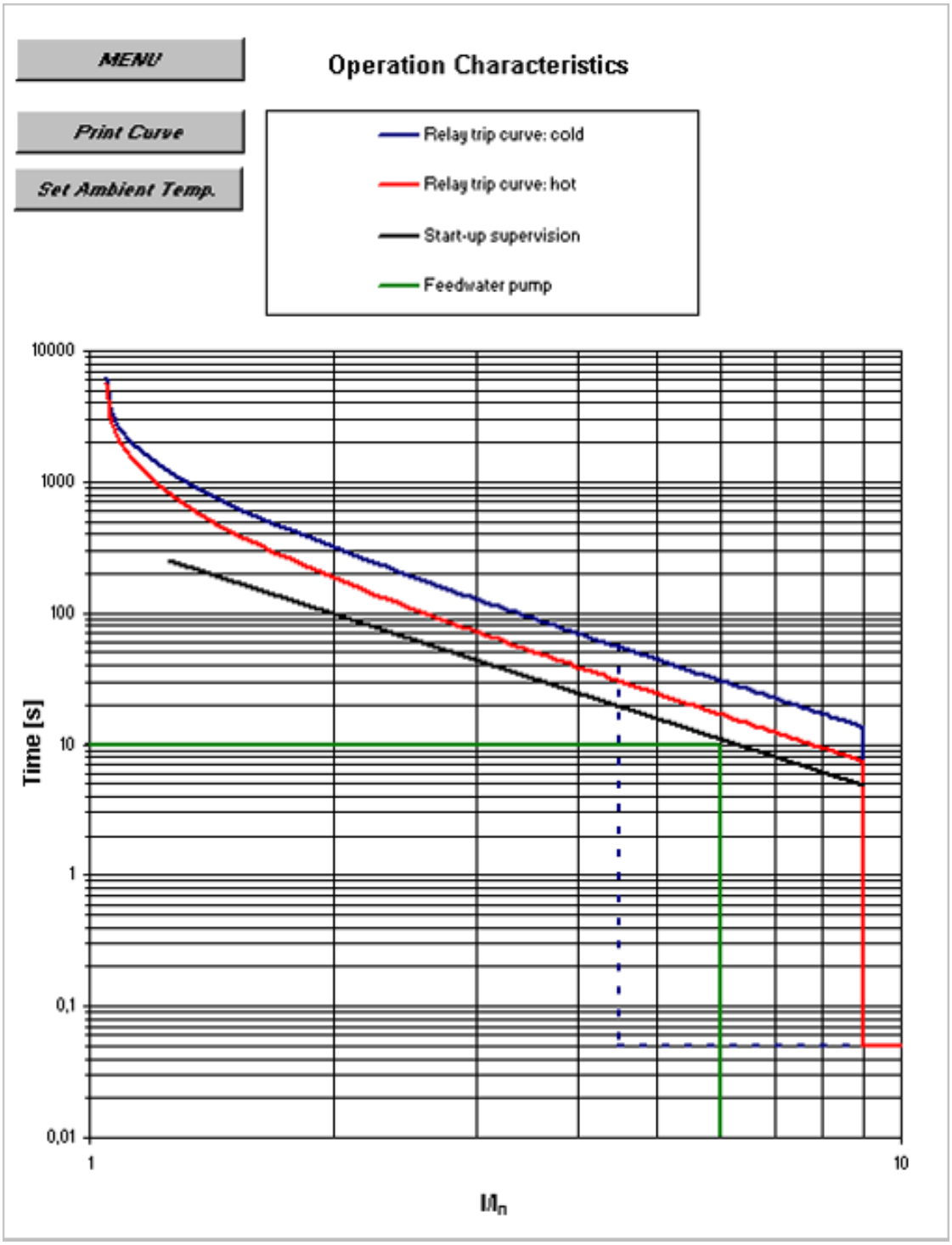
5.2.7.3. Register countdown rate

When you click the Countdown rate of start-up time counter button, the program calculates the appropriate countdown rate of the register(2 to 250 s/h).

6. Trip curves

6.1. Curves

Click the Trip curves button in the main menu to display the trip curves:



oper_char_26

Fig. 6.1.-1 Example of trip curves.

The trip curves illustrate the relay tripping functions. The curves include the motor starting current and start-up time information, the start-up supervision data and the hot and cold start curves. The X axis shows the current to motor rated current ratio, and the Y axis shows time in seconds.

6.2. Printing

To print the trip curves, click Print Curve.

7. Thermal behaviour

7.1. Cold motor

Click the Set Cold Starts button to enter data related to cold starts. Enter the number of starts, followed by the data of the first start. Enter the data in the following order:

- current after the start as a multiple of the rated current
- operation time after the start [min]
- stop time [min]

You can enter max. ten starts.

7.2. Hot motor

Click the Set Hot Starts button to enter data related to hot starts. Follow the procedure for cold motors described in the previous chapter. You should also specify the motor prior load (click the Prior load button). Enter the following data:

- motor current as a multiple of the rated current
- duration of the prior load [min]
- is the motor stopped after prior load

If the motor is stopped after prior load the stop time must also be specified.

You can use the Calculate t_{6x} button to calculate the permitted motor stall time after a hot start.

7.3. Simulating load variation

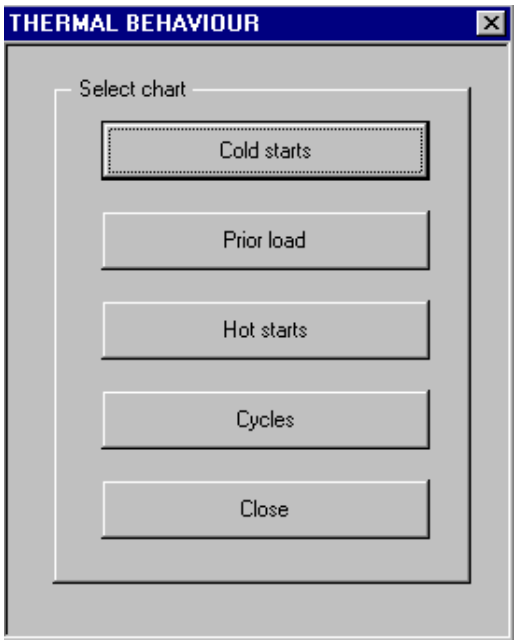
To open the load variation simulation page, click the Cycles button in the main menu.

Before entering the load variations, make sure that the prior load values are correct and change them if necessary using the Set prior load button.

You can now click the Set cycles button to enter the load variations. The maximum number of variations is 15. For each variation, enter the load current as a multiple of the rated current and the duration (in minutes).

7.4. Thermal behaviour curves

To view the thermal behaviour with the thermal functions described above, click Thermal behaviour. Clicking the Thermal behaviour button opens a window where you can select a graph for viewing. To close the menu, click Close.



thermbehav_27

Fig. 7.4.-1 Select the thermal behaviour curves in this menu.

8. Report

To open the report page of the project, click the Report button in the main menu.

8.1. Contents

The title of the report page contains the basic project data: name of the project, customer, motor, protection device, purpose of the report and the names of the persons responsible for calculations and checking.

The report contains the most important motor protection data, including motor data, relay switch positions, trip curves, thermal behaviour graphs, phase unbalance curve and comments.

Each page of the report starts with the MENU button, which opens the main menu. The first page of the report also contains the Print report and Save report buttons, whose purpose of use is described in detail in sections Printing and Saving.

8.1.1. First page

The first page displays the basic motor data entered in the Motor settings table, and the set values of the relay. In the right margin there is space for comments. Write the comments on the dotted line. Start at the left edge of the line to make sure that the comments are saved correctly. At the bottom of the page there is some space for additional comments.

8.1.2. Second page

The table on the second page lists the positions of the SGF 3 and SGF 4 switches of the relay. The left column of the table shows the switch. The second column contains a short description of the purpose of the switch. The third column contains the switch position data, and the last two columns contain the checksum. You can write any comments on switch positions on the comment lines under the columns.

In addition to the switches the second page contains the unbalance graph, for which there are separate comment lines at the bottom of the page.

8.1.3. Third page

This page contains the trip curves and the graph of the motor thermal capacity. On black and white prints it may be difficult to interpret the curves. However, the title table shows the curves in the correct sequence, which helps to interpret the graphs. There is also space for comments on the page.

8.1.4. Fourth page

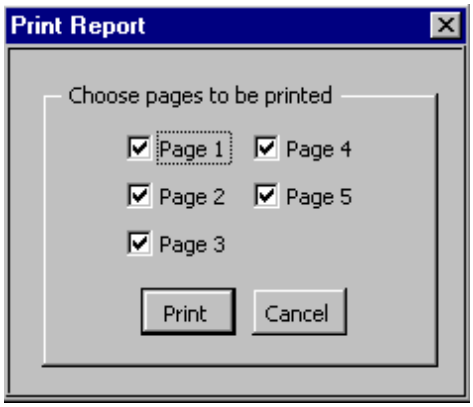
Cold and hot start graphs as well as the prior load graph are displayed. There is space for notes under each graph.

8.1.5. Fifth page

The last page of the report shows all the switchgroups of the relay and the temperature sensors with the setting ranges. Only the weighting value of each switch is printed for the switchgroups. The rest of the page is reserved for comments.

8.1.6. Printing

To print the report on paper, click the Print report button. This function is used e.g. when reports are archived or mailed. The Print report button opens a window where you can select the pages for printing. To print the selected pages, click Print.



printreport_28

Fig. 8.1.6.-1 Select the pages for printing and click Print.

The default printer is the target printer. If you want to use another printer, select the printer in the Excel File menu. Do the following: select Print in the File menu and change the printer name.

8.1.7. Saving

The report saving function makes it easier and faster to transfer the results to the recipient. Rrecipients can open the saved report in their own Excel program and read it.

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