

9 Function descriptions

NOTE

The available scope of converter functions is shown in the function diagrams (block diagrams) in Section 8.

Section 9 does not attempt to provide a complete description of all these functions, but to explain in further detail certain individual features, which cannot be adequately illustrated in graphic form, and provide examples of their application.

9.1 General explanations of terms and functionality

Function blocks

Although the illustrated function blocks have been implemented in digital form (as software modules), the function diagrams can be "read" in a similar way to the circuit diagrams of analog equipment.

Configurability

The converter is characterized by the optional configurability of the function blocks provided. "Optional configurability" means that the connections between individual function blocks can be selected by means of parameters.

Connectors

All output variables and important computation quantities within the function blocks are available in the form of "connectors" (e.g. for further processing as input signals to other function blocks). The quantities accessed via connectors correspond to output signals or measuring points in an analog circuit and are identified by their "connector number" (e.g. K0003 = connector 3).

Special cases: K0000 to K0008 are fixed values with signal levels corresponding to 0, 100, 200, -100, -200, 50, 150, -50 and -150%.

K0009 is assigned to different signal quantities. Which signal quantity it actually refers to is dependent on the selector switch (parameter) at which connector number 9 is set. A description can be found under the relevant parameter number in the Parameter List. If the Parameter List or block diagram does not contain any reference to a special function in relation to selection of connector K0009, then the selector switch (parameter) concerned must not be set to "9".

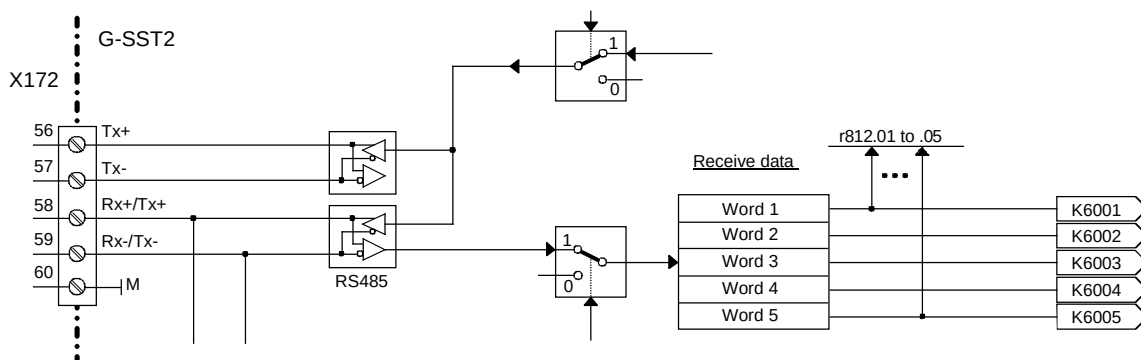
The internal numerical representation of connectors in the software is generally as follows:

100% corresponds to 4000 hexadecimal = 16384 decimal. The resolution is 0.006% (step change).

Connectors have a value range of -200% to +199.99%.

For a list of available connectors, please refer to Section 12.

Example: The data received via peer-to-peer 2 are available at connectors K6001 to K6005 (Section 8, Sheet G173)



Binectors

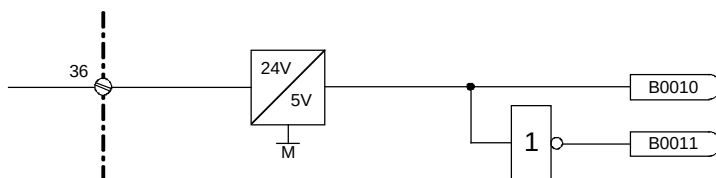
All binary output quantities and important binary output signals of the function blocks are available as "Binectors" (connectors for binary signals). Binectors can assume states log. "0" and log. "1". The quantities accessed via binectors correspond to output signals or measuring points in a digital circuit and are identified by their "Binector number" (e. g. B0003 = binector 3).

Special cases: B0000 = Fixed value log. "0"

B0001 = Fixed value log. "1"

A list of available binectors can be found in Section 12.

Example: The status of terminal 36 is available at B0010 and, in inverted form, at binector B0011 (Section 8, Sheet G110)

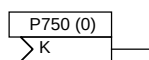


Selection switches, connections

(see also Section "Data sets")

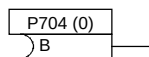
The inputs of function blocks are defined at "selection switches" by setting the appropriate selection parameters. The input is defined by entering the number of the connector or binector to be applied as the input quantity in the parameter for the relevant selection switch.

Representation in function diagrams (examples):



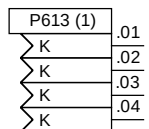
Selection of a connector

Parameter number = P750, factory setting = 0 (i. e. fixed value 0%)



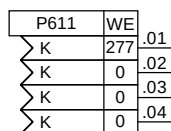
Selection of a binector

Parameter number = P704, factory setting = 0 (i. e. fixed value 0)



Selection of connectors ("indexed" parameter with 4 indices)

Parameter number = P613, factor setting = 1 (i. e. fixed value 100%; this factory setting applies to all the indices of P613)

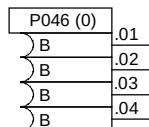


Selection of connectors ("indexed" parameter with 4 indices)

Parameter number = P611

Factory setting for index .01 = 277 (i. e. connection with connector K0277)

Factory setting for indices .02 to .04 = 0 (i. e. fixed value 0%)



Selection of binectors ("indexed" parameter with 4 indices)

Parameter number = P046, factory setting = 0 (i. e. fixed value 0, this factory setting applies to all the indices of P046)

The selected setting can be entered in the empty field (fields). The value in brackets next to the parameter number is the factory setting of the selection parameter.

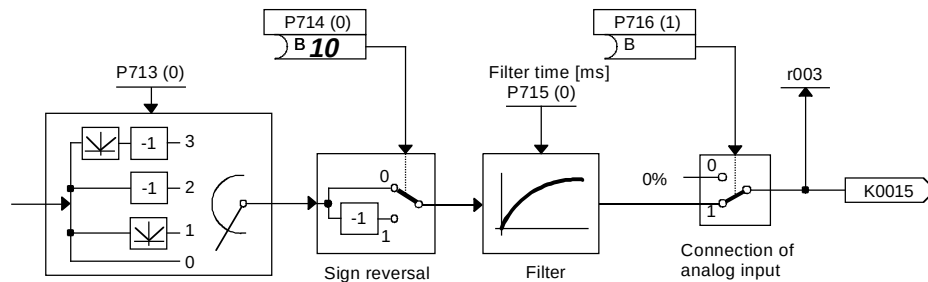
Examples: Some examples of how to handle connectors and binectors are given below.

Example 1: As a function of the status of terminal 36 (B0010 - see Section 8, Sheet G110), analog selectable input 1 (terminals 6 and 7) must be made available, either with the correct sign or inverted sign, at the function block output (= connector K0015). This output value must then be injected as an additional setpoint and output simultaneously at analog output terminal 14.

The following settings need to be made to create the correct links:

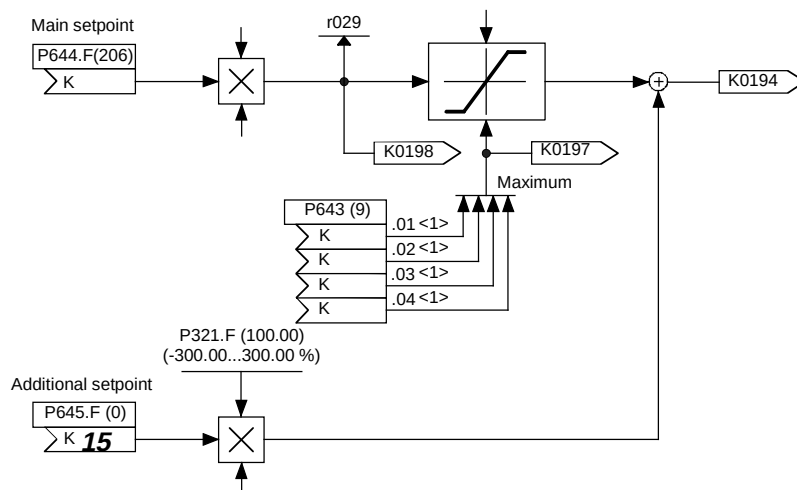
1. P714 = 10: Selects binector B0010 (status of terminal 36) as the control signal for sign reversal. Parameter P716 remains set at 1 (= fixed value 1, delivery state), thereby ensuring that the analog input is switched in continuously.

Section 8, Sheet G113:



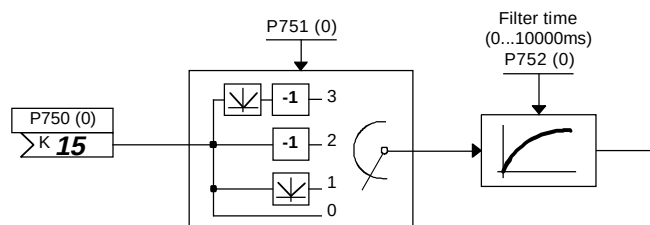
2. P645 = 15: Applies connector K0015 to the additional setpoint input when the setpoint is processed

Section 8, Sheet G135:



3. P750 = 15: Applies connector K0015 to the input of the function block for the analog output terminal 14. This example of K0015 illustrates how it is possible to apply a connector as an input signal to any number of function blocks.

Section 8, Sheet G115:



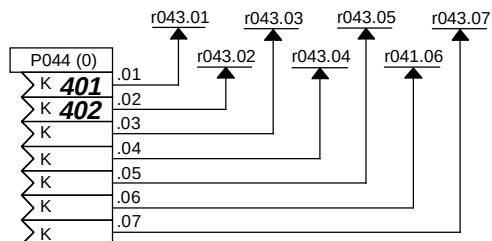
Example 2: The contents of connectors K0401 and K0402 must be output on the connector displays (parameter r043)

The following settings need to be made to create the correct links:

P044.index01 = 401: Links connector K0401 to the 1st connector display

P044.index02 = 402: Links connector K0402 to the 2nd connector display

Section 8, Sheet G120:



The following values are now displayed in parameter r043:

r043.index01: Contents of connector K0401

r043.index02: Contents of connector K0402

r043.index03

to

r043.index07: Parameter P044.index.03 to 07 remain at the works setting (0) (value in brackets next to parameter number) in this example, i. e. the contents of connector K0000 (=fixed value 0) are displayed on r043.index.03 to .07.

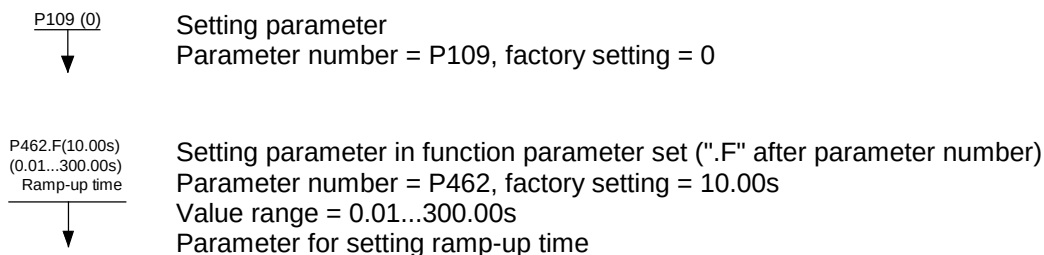
Setting parameters

(see also Section "Data sets")

In addition to the parameters that are used to select a signal (connector, binector), there are also parameters which define an operating mode or the parameter value of some function.

Representation in function diagrams:

Apart from parameter numbers, the function diagrams may also contain the factory setting, function and value range of parameters as supplementary information.



Examples: P700 in Section 8, Sheet G113 defines the signal type of the analog input (voltage input $\pm 10V$, current input 0...20mA, current input 4...20mA).

P705 in Section 8, Sheet G113 defines the filter time for the analog input (adjustable in ms).

Parameters P520 to P530 in Section 8, Sheet G153 determine the shape of the friction characteristic.

P465 in Section 8, Sheet G126 determine whether the time settings must be multiplied by a factor of 1 or 60.

Data sets

See also Section "Switch over parameter sets"

Switch over function parameters (function data sets):

4 different sets of some parameters (function parameters) are available and can be selected by means of the "Switch over function parameters" function. The switchover operation is controlled by control word 2 (bits 16 and 17, see Section 8, Sheets G181 and G175). Index .01, .02, .03 or .04 of these parameters is operative depending on the status of the control bit.

The parameters of this parameter set are identified by an ".F" next to the parameter number in the function diagrams and by "FDS" under the parameter number in the tabulated parameter list.

The parameters belonging to the function parameter set must not be confused with other parameters which, by chance, also have 4 indices. The latter parameters are not affected by the "Switch over function parameters" function.

Switch over binector and connector parameters (Bico data sets):

2 different sets of some selection switches are available and can be selected by means of the "Switch over binector and connector parameters" function. The switchover function is controlled by control word 2 (bit 30, see Section 8, Sheets G181 and G175). The status of the control bit determines whether index.01 or index .02 of the parameter is operative.

The parameters of the Bico data set are identified by a ".B" next to the parameter number in the function diagrams and by "BDS" under the parameter number in the tabulated parameter list.

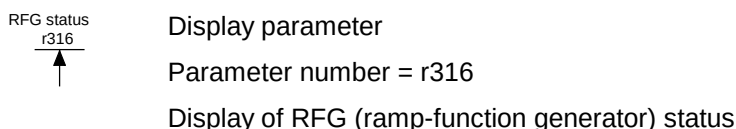
The parameters belonging to the Bico data set must not be confused with other parameters which, by chance, also have 2 indices. The latter parameters are not affected by the "Switch over binector and connector parameters" function.

Display parameters

The values of certain signals can be output using display parameters (r parameters, n parameters). Connector displays (Section 8, Sheet G120) can be used to link all connectors with display parameters so that they can be displayed.

Representation in function diagrams:

Apart from the parameter number, the function diagrams may also include a function description for the parameter as supplementary information.



9.2 Computation cycles, time delay

Functions associated with analog inputs, analog outputs, binary inputs, binary outputs and interfaces, as well as function blocks associated with the motorized potentiometer, setpoint generation, ramp-function generator and closed-loop speed and armature current controls, are called up and calculated in synchronism with the armature firing pulses (i.e. every 3.333 ms at a line frequency of 50 Hz).

Function blocks associated with the closed-loop EMF and field current controls (shown in Section 8, Sheets G165 and G166) are called and calculated in synchronism with the field firing pulses (i.e. every 10 ms at a line frequency of 50 Hz).

The parameter settings are processed in a further computation cycle with a cycle time of 20 ms. The execution of optimization runs is also controlled from this cycle.

With regard to the transfer of parameter values via interfaces, it is important to remember that some transferred parameters must be converted to this 20 ms cycle before they can be applied, for example, in the armature firing pulse cycle.

9.3 Switch-on, shutdown, enabling

9.3.1 OFF2 (voltage disconnection) - control word 1, bit 1

The OFF2 signal is low active (log."0" state = voltage disconnection).

The following operating modes are possible:

P648 = 9: The control bits in control word 1 are input bit-serially. OFF2 is generated from the AND operation between the binectors selected with P655, P656 and P657 (see Section 8, Sheet G180).

P648 ≠ 9: The connector selected via P648 is used as control word 1. Bit 1 of this word then controls the OFF2 function.

Sequence of operations for "Disconnect voltage":

1. Input "Disconnect voltage" command
2. Disable technology controller, ramp-function generator, n and I controllers
3. $I_{\text{set}} = 0$ is applied
4. The pulses are disabled when $I = 0$
5. Output signal "Close operating brake" (binector B0250 = 0, when P080 = 2)
6. Converter reaches operating state o10.0 or higher
7. An "older" actual field current value (K0265) is input as the field current setpoint upper limit (function is "released" in operating states of ≤o5)
8. The "Line contactor closed" relay drops out
9. Drive coasts to a standstill (or is braked by the operating brake)
10. Parameterizable delay time (P258) runs down
11. The field is reduced to a parameterizable value (P257)
12. When $n < n_{\text{min}}$ (P370, P371) has been reached, the "Close holding brake" signal is output (binector B0250 = 0, when P080 = 1)

9.3.2 OFF3 (Fast stop) - control word 1, bit 2

The OFF3 signal is LOW active (log."0" state = fast stop).

The following operating modes are possible:

P648 = 9: The control bits in control word 1 are input bit-serially. OFF3 is generated from the AND operation between the binectors selected with P658, P659 and P660 (see Section 8, Sheet G180).

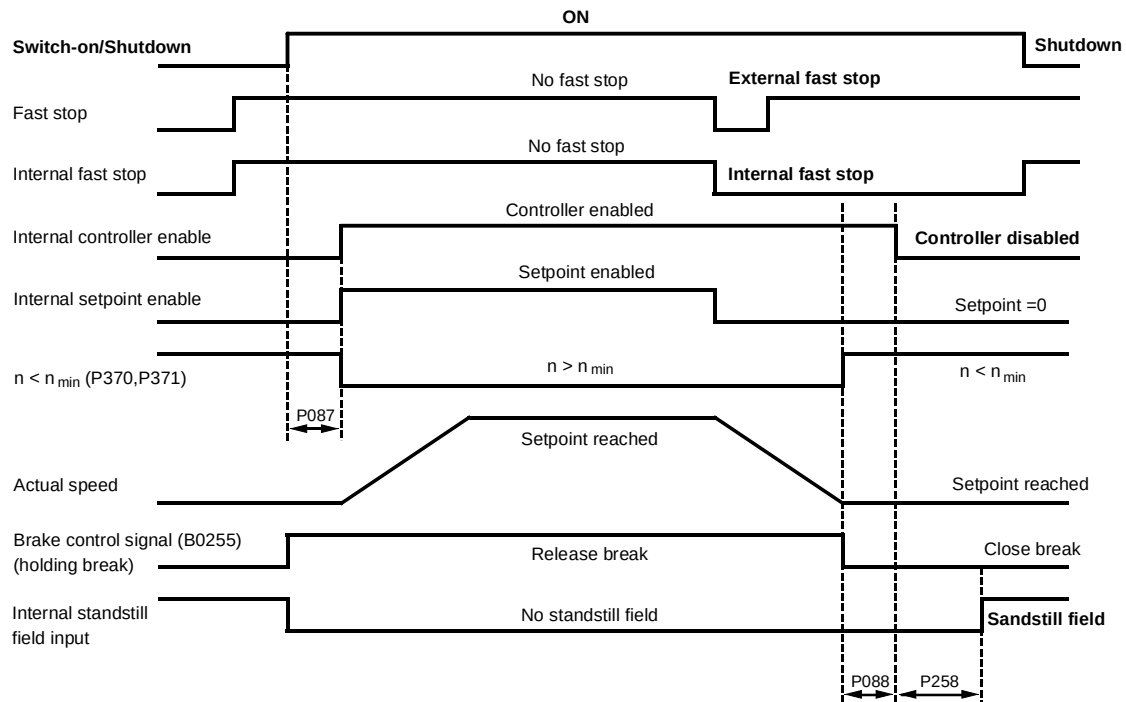
P648 ≠ 9: The connector selected via P648 is used as control word 1. Bit 2 of this word then controls the OFF3 function.

Sequence of operations for "Fast stop":

1. Input "Fast stop" command (e.g. binary input wired up to "Fast stop")
2. Technology controller and ramp-function generator are disabled
3. Enter $n_{\text{set}} = 0$
4. Decelerate along current limit
5. Wait until $n < n_{\text{min}}$ (P370, P371)
6. Output signal "Close operating or holding brake" (binector B0250 = 0)
7. Wait for brake closing time (P088) to run down
8. Enter $I_{\text{set}} = 0$
9. Ramp-function generator and n controller are disabled
10. The pulses are disabled when $I = 0$
11. The "Line contactor closed" relay drops out
12. Converter reaches operating state o9.0 or higher
13. Delay time for field current reduction (P087) runs down
14. The field is reduced to a parameterizable value in P257

Sequence of operations for cancellation of "Fast stop":

1. Stop applying "Fast stop" command
2. Enter "Standstill" command (e.g. via "Switch-on/shutdown" terminal)
3. Converter exits operating state o8



P087 Brake release time (positive in this example)

P088 Brake closing time

P258 Delay for automatic field current reduction

- The "Fast stop" command need only be applied as a short pulse (> 10 ms). It is then stored internally. The memory can be reset only by applying the "Shutdown" command.
- All "Fast stop" commands are ANDed by the SIMOREG converter, i.e. all commands must be set to "No fast stop" before the function can be deactivated.
- When $n < n_{\min}$ (P370, P371) is reached for the first time, an internal interlock is activated which prevents the drive from attempting to brake again if the motor is turned by external forces. The $n < n_{\min}$ signal then disappears again.

9.3.3 Switch-on / shutdown (ON / OFF) terminal 37 - control word 1, bit 0

The "Switch-on / shutdown" (ON / OFF) function is controlled via the "Switch-on command of ON / OFF1" (= ANDing between signal from terminal 37 and binector selected in parameter P654, level- or edge-triggered, see below) and bit 0 of connector selected as the control word in P648.

The following operating modes are possible:

- P648 = 9: The control bits in control word 1 are input bit-serially. "ON / OFF" is controlled via the "Switch-on command of ON / OFF1".
- P648 $\neq$ 9: The connector selected in P648 is used as control word 1. Bit 0 of the control word is ANDed with the "Switch-on command of ON / OFF1" to produce the "ON / OFF" command (ON only if both signals are log. "1").
- P445 = 0: The "Switch-on command of ON / OFF1" is generated as an AND operation between the signal from terminal 37 and the binector selected in P654 (level-triggered, 0 = shutdown, 1 = switch-on).

P445 = 1: Edge triggering of "Switch-on command of ON / OFF1":
 The switch-on command is stored on the 0 → 1 transition (see Section 8, Sheet G130).
 The binector selected in P444 must be in the log. "1" state. The memory is reset when this binector switches to the log. "0" state.

In the following example circuit, the ON key (NO contact) is connected to terminal 37 and the shutdown key (NC contact) to terminal 36. Connector 3003 (= word 3 of DPRAM interface on board in slot 2) is used as control word 1.

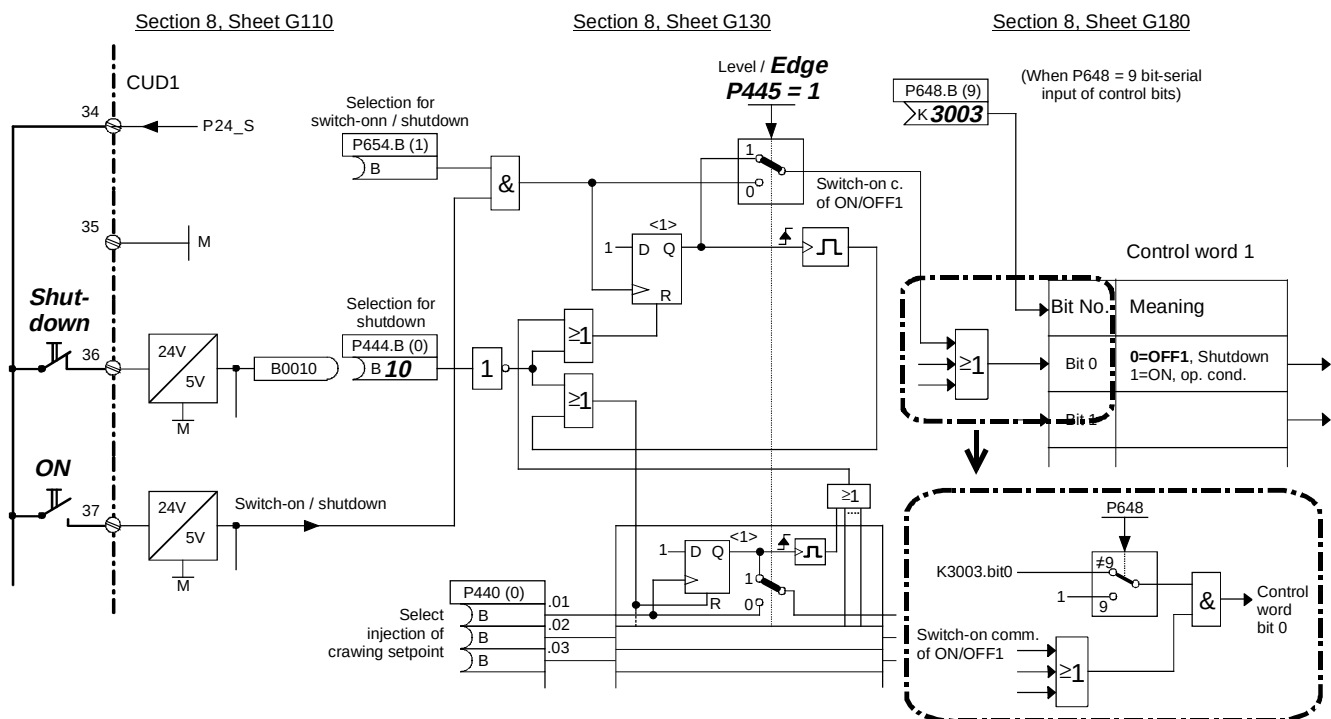
The following parameter values must be set:

P444=10 Connects binector 10 (= status of terminal 36) to the reset input of the memory for the ON signal (and to the reset input of the memory for the CRAWL command)

P445=1 Selects edge triggering of "Switch-on command of ON / OFF1" (and injection of the crawling setpoint)

P648=3003 Connector K3003 is assigned status of control word 1.

The combination of the control bit for ON/OFF from the DPRAM control word (K3003.bit0 in this example) and the switch-on command from the converter terminal is shown in the boxes with dot-dash line borders.



Sequence of operations for switching on drive:

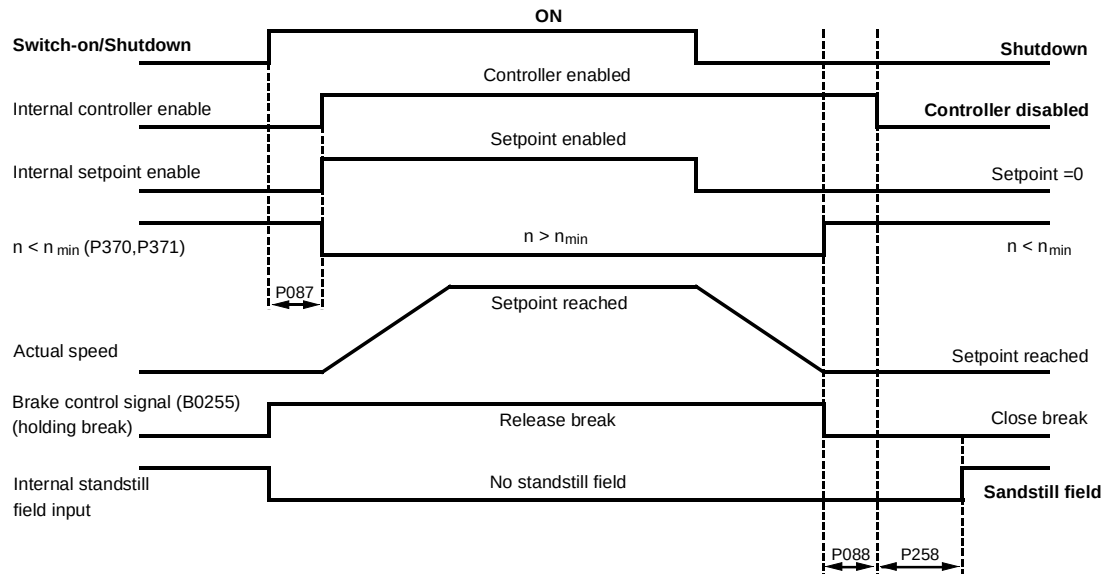
1. Enter the "Switch-on" command (e.g. via terminal "Switch-on/shutdown")
2. The converter exits operating state 07
3. The "Line contactor closed" relay picks up
4. The field current reduction command is cancelled

If "Enable operation" signal is applied:

5. With a positive brake release time (P087), output signal "Release holding or operating brake" (binector B0250 = 1) and wait for P087 in operating state 01.0, with a negative brake release time (P087 negative), go to step 6 immediately, brake remains closed (binector B0250 = 0)
6. Technology controller, ramp-function generator, n controller and I controller are enabled
7. When a negative brake release time (P087) has run down, output signal "Release holding or operating brake" (binector B0250 = 1).

Sequence of operations for shutting down drive:

1. Enter the "Shutdown" command (e.g. via terminal "Switch-on / shutdown")
2. Decelerate along ramp-function generator ramp
3. Wait until $n < n_{\min}$ (P370, P371)
4. Output signal "Close holding or operating brake" (binector B0250 = 0)
5. Wait for brake closing time (P088) to run down
6. Input $i_{\text{set}} = 0$
7. Technology controller, ramp-function generator and n controller are disabled
8. The pulses are disabled when $I = 0$
9. The "Line contactor closed" relay drops out
10. The converter reaches operating state o7.0 or higher
11. Delay for field current reduction (P258) runs down
12. The field is reduced to a parameterizable value (P257)



P087 Brake release time (positive in this example)

P088 Brake closing time

P258 Delay for automatic field current reduction

- When $n < n_{\min}$ (P370, P371) is reached for the first time, an internal interlock is activated which prevents the drive from attempting to brake again if the motor is turned by external forces. The $n < n_{\min}$ signal then disappears again.
- Changing the parameter setting between level and edge triggering affects the "Switch-on", "Shutdown" and "Crawl" commands.
- The "Switch-on" and "Crawl" commands are applied alternately when edge triggering is selected, i.e. a "Switch-on" edge at terminal 37 cancels a "Crawl" function triggered beforehand, and a "Crawl" edge at a binector selected in P440 cancels an active "Switch-on" edge.
- The converter cannot be restarted automatically after a brief failure of the electronics power supply when edge triggering is selected.
- In order to ensure that "Shutdown" still works after "rewiring of parameters", if lower current or torque limits are applied or when additional setpoints are injected, certain functions are automatically deactivated when the "Shutdown" command is entered. All torque limits are made inoperative while the drive brakes down to $n < n_{\min}$. Of all the current limits, only the system current limit (P171 and P172), the speed-dependent current limit and the limit derived from I^2t monitoring of the power section remain operative.

9.3.4 Operating enable (enable) terminal 38 - control word 1, bit 3

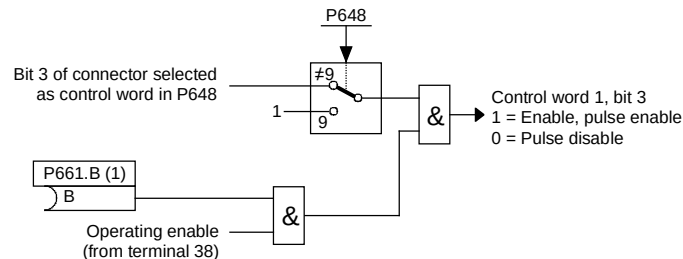
The Enable signal is HIGH active (log."1" state = Enable).

The following operating modes are possible:

P648 = 9: The control bits in control word 1 are input bit-serially. The operating enable command is generated from the AND operation between the enable signal from terminal 38 and the binector selected in P661 (see Section 8, Sheet G180).

P648 ≠ 9: The connector selected in P648 is used as control word 1. Bit 3 of this connector is ANDed with the signal that is generated as for P648=9 to produce the operating enable signal.

To ensure that the "Operating enable" function can be activated, the conditions defined in the following diagram must be fulfilled:



Sequence of operations for enabling operation (if a switch-on command is applied):

1. Enter the "Enable operation" command
2. With a positive brake release time (P087), output a "Release holding or operating brake" signal (binector B0250 = 1) and wait for P087 to run down in operating state o1.0, with a negative brake release time (P087 negative), go to step 3 immediately, brake remains closed (binector B0250 = 0)
3. Technology controller, ramp-function generator, n and I controllers are enabled
4. Converter reaches operating state I, II or —
5. When a negative brake release time (P087) has run down, output signal "Release holding or operating brake" (binector B0250 = 1).

Sequence of operations for cancellation of operating enable:

1. Cancel "Enable operation" command
2. Disable technology controller, ramp-function generator, n and I controllers
3. Enter $I_{\text{set}} = 0$
4. The pulses are disabled when I = 0
5. Output signal "Close operating brake" (binector B0250 = 0, when P080 = 2)
6. The converter reaches operating state 0.10 or higher
7. Drive coasts to a standstill (or is braked by the operating brake)
8. When $n < n_{\text{min}}$ (P370, P371) is reached, the signal "Close holding brake" is output (binector B0250, when P080 = 1)

9.4 Ramp-function generator

See also Section 8, Sheet G136

NOTE

The following conditions must be fulfilled for the ramp-function generator to work:

- Ramp-function generator enable = 1 (control word 1.bit 4 = 1)
- Enable setpoint = 1 (control word 1.bit 6 = 1)

9.4.1 Definitions

Ramp-up = Acceleration from low, positive to high, positive speeds (e.g. from 10% to 90%) or from low, negative to high, negative speeds (e.g. from -10% to -90%)

Ramp-down = Deceleration from high, positive to low, positive speeds (e.g. from 90% to 10%) or from high, negative to low, negative speeds (e.g. from -90% to -10%)

On transition from negative to positive speeds, e.g. -10% to +50%:

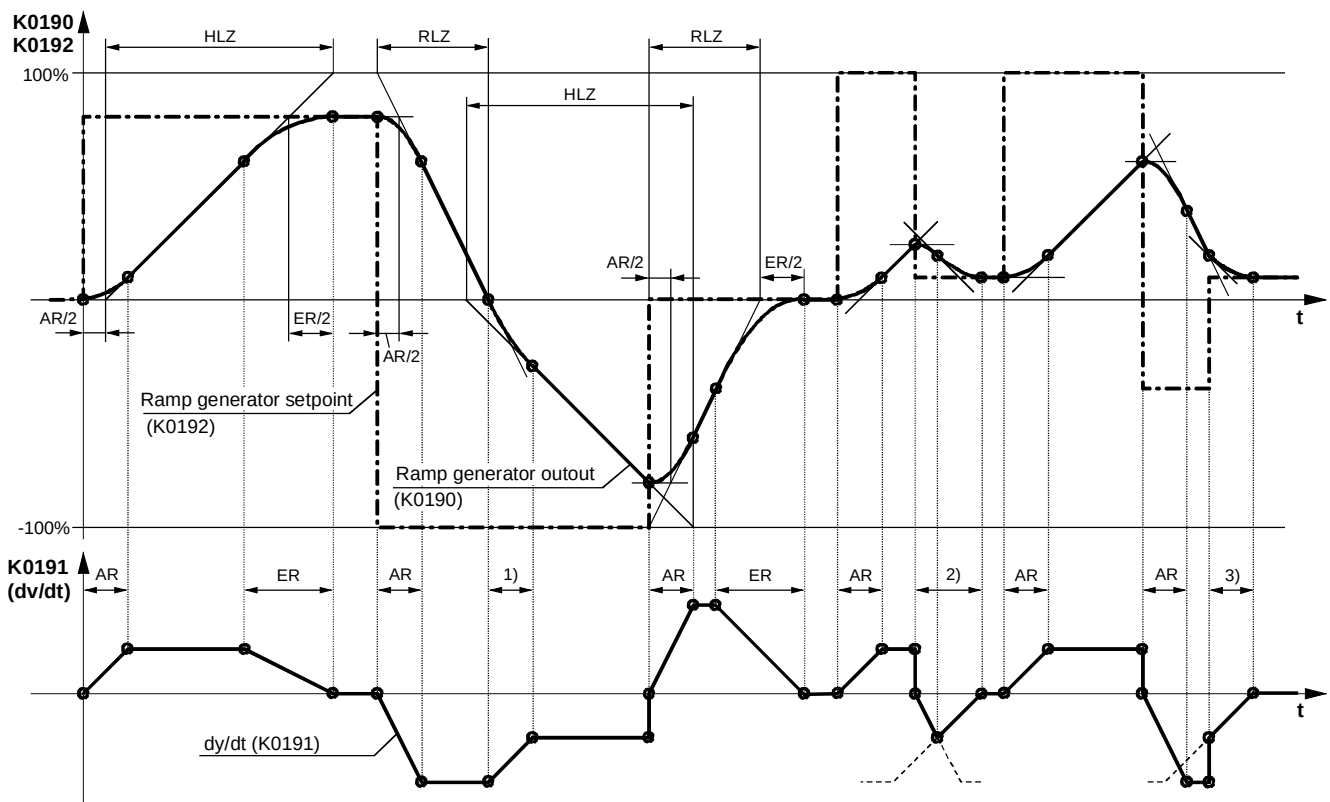
From -10% to 0 = ramp-down and

From 0 to +50% = ramp-up and vice versa

Ramp-up time refers to the time required by the ramp-function generator to reach the 100% output value, with a lower and upper transition rounding of 0 and a step change in the input quantity from 0 to 100% or from 0 to -100%. The rate of rise at the output is the same in response to smaller step changes in the input quantity.

Ramp-down time refers to the time required by the ramp-function generator to reach the 100% output value, with a lower and upper transition rounding of 0 and a step change in the input quantity from 100% to 0 or from -100% to 0. The rate of rise at the output is the same in response to smaller step changes in the input quantity.

9.4.2 Operating principle of ramp-function generator



HLZ ... Ramp-up time (H303, H307, H311),

RLZ ... Ramp-down time (H304, H308, H312)

AR ... Lower transition rounding (H305, H309, H313), ER ... Upper transition rounding (H306, H310, H314)

- 1) Transition from ramp-down gradient to ramp-up gradient
- 2) The lower rounding switches to the upper rounding before the maximum ramp-down gradient is reached
- 3) Due to the input step change, only the last part of the upper transition rounding is executed here

9.4.3 Control signals for ramp-function generator

The ramp-function generator operating mode can be preset by the following control signals:

Ramp-function generator start (control word 1.bit 5):

- 1 = Setpoint is injected at ramp-function generator input
- 0 = Ramp-function generator is stopped at current value (generator output is injected as generator input).

Enable setpoint (control word 1.bit 6):

- 1 = Setpoint enabled at ramp-function generator input
- 0 = Ramp-function generator setting 1 is activated and 0 applied at the input (generator output is reduced to 0)

Set ramp-function generator:

- 1 = The ramp-function generator output is set to the setting value (selected in P639)

Enable ramp-function generator (control word 1.bit 4):

- 0 = Ramp generator disabled, generator output is set to 0
- 1 = Ramp-function generator enabled

Ramp-up integrator operation (parameter P302):

See below and Section 11, Parameter List, parameter P302

Enable switchover of ramp-up integrator (select via P646):

See below

Ramp-function generator settings 2 and 3

See below

Ramp-function generator tracking ON (parameter P317):

See below and Section 11, Parameter List, parameter P317

Set ramp-function generator on shutdown (parameter P318):

See Section 11, Parameter List, parameter P318

Bypass ramp-function generator:

- 1 = Ramp-function generator operates with ramp-up/ramp-down time of 0

The function is controlled via the binector selected in P641.

The ramp generator can also be bypassed in INCHING, CRAWLING and INJECTION OF FIXED SETPOINT modes.

9.4.4 Ramp-function generator settings 1, 2 and 3

Selection via binectors selected in parameters P637 and P638

Status of binector Selected via parameter		R-F generator setting	Effective ramp-up time	Effective ramp- down time	Effective lower rounding	Effective upper rounding
P637	P638					
0	0	1	P303	P304	P305	P306
1	0	2	P307	P308	P309	P310
0	1	3	P311	P312	P313	P314
1	1	Not permitted, activates fault message F041 (selection not clear)				

The ramp-function generator settings preset via the binectors selected in P637 and P638 have priority over the generator setting specified via the ramp-up integrator.

9.4.5 Ramp-up integrator

The ramp-up integrator is activated by setting P302 = 1, 2 or 3. After an "ON" command ("Switch-on", "Inching", "Crawling"), ramp-function generator setting 1 (P303 to P306) is applied until the ramp-function generator output reaches the required setpoint for the first time.

The remaining sequence of operations is controlled by the "Enable switchover of ramp-up integrator" function (binector selected in P646).

Enable switchover of ramp-up integrator = 1:

As soon as the ramp-function generator output reaches the required setpoint for the first time after the "ON" command, the ramp generator setting selected in P302 is activated automatically.

Enable switchover of ramp-up integrator = 0:

Ramp-function generator setting 1 (P303 to P306) remains active after the generator output has reached its setpoint until the "Enable switchover of ramp-up integrator" function is switched to 1. The ramp-function generator setting selected in P302 is then activated.

When the enable signal for ramp-up integrator switchover is cancelled ($\rightarrow 0$), ramp-function generator setting 1 is activated again and, with a new enable command ($\rightarrow 1$), this setting continues to remain active until the generator output has reached its setpoint again. The ramp generator setting selected in P302 is then activated again.

When a "Shutdown" command is given, the drive is shut down according to setting 1.

Note:

Activation of "Ramp-function generator setting 2" (P307 to P310, selected in P637), or "Ramp-function generator setting 3" (P311 to P314, selected in P368), has priority over the generator setting selected by means of the "Ramp-up integrator" function.

9.4.6 Ramp-function generator tracking

The ramp-function generator output (K0190) is limited to the following values when ramp-function generator tracking is activated:

$$\frac{-M_{\text{grenz}} * 1,25}{K_p} + n_{\text{ist}} < HLG - \text{Ausgang} < \frac{+M_{\text{grenz}} * 1,25}{K_p} + n_{\text{ist}}$$

When P170 = 1 (torque control), the following equation applies:

$$\frac{-I_{A, \text{grenz}} * \Phi_{\text{Motor}} * 1,25}{K_p} + n_{\text{ist}} < HLG - \text{Ausgang} < \frac{+I_{A, \text{grenz}} * \Phi_{\text{Motor}} * 1,25}{K_p} + n_{\text{ist}}$$

When P170 = 0 (current control), the following equation applies:

$$\frac{-I_{A, \text{grenz}} * 1,25}{K_p} + n_{\text{ist}} < HLG - \text{Ausgang} < \frac{+I_{A, \text{grenz}} * 1,25}{K_p} + n_{\text{ist}}$$

Φ_{motor}	Normalized motor flux (1 at rated field current)
n_{act}	Actual speed value (K0167)
$+M_{\text{limit}}$	Lowest positive torque limit (K0143)
$-M_{\text{limit}}$	Lower negative torque limit (K0144)
$+I_{A, \text{limit}}$	Lowest positive current limit (K0131)
$-I_{A, \text{limit}}$	Lowest negative current limit (K0132)
K_p	Effective speed controller gain

However, if the value added to n_{act} were to correspond to less than 1%, then +1% or -1% would be added.

The purpose of the "Ramp-function generator tracking" function is to ensure that the ramp generator value cannot deviate excessively from the actual speed value once the torque or current limit has been reached.

Note:

When ramp-function generator tracking is selected, the filter time for the speed setpoint should be set to a low value in P228 (preferably to 0).

9.4.7 Limitation after ramp-function generator

Since the input signal can be freely selected, this limiter stage can be used completely independently of the ramp-function generator.

A special feature of this limiter is that the lower limit can also be set to positive values and the upper limit to negative values (see P300 and P301). This type of limit setting then acts as a lower limit (minimum value) for the ramp generator output signal in the other sign direction.

Example: P632.01-04 = 1 (= 100.00%)

P300 = 100.00 (%)

P301 = 10.00 (%)

P633.01-04 = 9 (= -100.00%)

results in a limitation of the value range for K0170 to between +10.00% and +100.00%

9.4.8 Velocity signal dv/dt (K0191)

This signal specifies the change in the ramp-function generator output K0190 in the time period set in P542.

9.5 Inching

See also Section 8, Sheet G129

The INCHING function can be preset via the binectors selected with indices .01 to .08 of parameter P435 or via bits 8 and 9 of control word 1 (logic operation, see function diagram in Section 8).

When the control word option is used, the following operating modes are possible (see also Section 8, Sheet 33):

P648 = 9: The control bits in control word 1 are input bit-serially. The binectors selected in P668 and P669 determine bits 8 and 9 of control word 1 and thus the input of the INCH command.

P648 ≠ 9: The connector selected in P648 is used as control word 1. Bits 8 and 9 of this word control the input of the INCH command.

The "Inching" function can be executed only if "Shutdown" and "Operating enable" are applied.

The "Inch" command is input when one or several of the named sources (binectors, bits in control word) change to the log. "1" state. In this case, a setpoint selected in parameter P436 is assigned to each source.

An inching setpoint of 0 is applied if the inch command is input by two or more sources simultaneously.

Parameter P437 can be set to define for each possible inch command source (binector, bit in control word - logic operation, see block diagram in Section 8) whether or not the ramp-function generator must be bypassed. When the ramp generator is bypassed, it operates with ramp-up/down times of 0.

Sequence of operations for entering Inching command:

If the "Inch" command is entered, the line contactor is energized via the "Line contactor closed" relay and the inching setpoint applied via the ramp-function generator (for exact sequence, see the description of "Switch-on / Shutdown" in Section 9.2.3).

Sequence of operations for cancellation of Inching:

After the "Inch" command has been cancelled, the sequence of operations commences in the same way as for "Shutdown" (see Section 9.2.3). After $n < n_{\min}$ has been reached, the controllers are disabled and the line contactor opened after a parameterizable delay (P085) of between 0 and 60 s (operating state 07.0 or higher). The drive remains in operating state 01.3 while the parameterizable delay period (max. 60.0 s) runs down.

9.6 Crawling

See also Section 8, Sheet G130

The "Crawling" function can be activated in operating state o7 and, with "Operation enabled", in the Run state.

The "Crawl" command is entered when one or several of the binectors selected in P440 switches to the log. "1" state. A setpoint selected in parameter P441 is assigned to each binector. If the "Crawl" command is entered via several binectors, the setpoint values are added (limited to $\pm 200\%$).

Parameter P442 can be set to define for each possible crawl command source (binector) whether or not the ramp-function generator must be bypassed. When the ramp generator is bypassed, it operates with ramp-up/down times of 0.

Level / edge

P445 = 0: Level-triggered
Binector selected in P440 = 0: No crawl
Binector selected in P440 = 1: Crawl

P445 = 1: Edge-triggered
The input of "Crawl" is stored when the binector state changes from 0 → 1 (see Section 8, Sheet G130). The binector selected in P444 must be in the log. "1" state at the same time. The memory is reset when the latter binector changes state to log. "0" (see also example circuit in Section 9.2.3, Switch-on / Shutdown).

Sequence of operations for entering Crawl command:

If the "Crawl" command is entered in operating state o7, the line contactor is energized via the "Line contactor closed" relay and the crawling setpoint applied via the ramp-function generator.

If the "Crawl" command is entered in the "Run" state, the drive decelerates from the operating speed to the crawling setpoint via the ramp-function generator.

Sequence of operations for cancellation of Crawling:

With "Crawling" active, but no "Switch-on" command applied:

If all bits which activate the "Crawling" function switch to log. "0", the controllers are disabled after $n < n_{\min}$ is reached and the line contactor de-energized (operating state o7.0 or higher).

With "Crawling" active from "Run" operating state:

If all bits which activate the "Crawling" function switch to log. "0" and if the conditions for the "Run" operating state are still fulfilled, then the drive accelerates from the set crawling speed to the operating speed via the ramp-function generator.

See also Section 9.2.3 (switch-on / shutdown) with regard to edge triggering, automatic restart and the effect of the current and torque limits during braking.

9.7 Fixed setpoint

See also Section 8, Sheet G127

The "Fixed setpoint" function can be activated in the "Run" state with the "Enable controllers" signal applied.

The "Fixed setpoint" function can be input via the binectors selected via indices .01 to .08 of parameter P430 and via bits 4 and 5 of control word 2 (= bits 20 and 21 of complete control word) (see function diagram in Section 8 for logic operation).

When the control word method is used, the following operating modes are possible (see also Section 8, Sheet G181):

- P649 = 9: The control bits in control word 2 are input bit-serially. The binectors selected via P680 and P681 determine bits 4 and 5 of control word 2 (= bits 20 and 21 of complete control word), and thus input of the "Fixed setpoint" function.
- P649 ≠ 9: The connector selected via P649 is used as control word 2. Bits 4 and 5 of this word control the input of "Fixed setpoint".

The "Fixed setpoint" function is input when one or several of the named sources (binectors, bits in control word) switch to the log. "1" state. In this case, a setpoint selected in parameter P431 is assigned to each source. If "Fixed setpoint" is input via several sources simultaneously, the associated setpoints are added (limited to $\pm 200\%$).

Parameter P432 can be set to define for each possible fixed setpoint source (binector, bit in control word - logic operation, see block diagram in Section 8) whether or not the ramp-function generator must be bypassed. When the ramp generator is bypassed, it operates with ramp-up/down times of 0.

Sequence for entering Fixed Setpoint function:

The fixed setpoint is injected instead of the main setpoint.

Sequence for cancellation of Fixed Setpoint function:

When all the possible sources for injecting the fixed setpoint (binectors, bits in control word) have changed back to log. "0", the setpoint selected in parameter P433 (main setpoint) is switched through again.

9.8 Safety shutdown (E-Stop)

- **Switch operation**
(switch between terminals XS-105 and XS-106; XS-107 open; XS-108 open)
Opening this switch activates the safety shutdown operation.
- **Pushbutton operation**
(Stop pushbutton with NC contact between terminals XS-107 and XS-106; Reset pushbutton with NO contact between terminals XS-108 and XS-106; XS-105 open)
Stop pushbutton pressed: Safety shutdown is executed and stored
Reset pushbutton pressed: Storage of safety shutdown is cancelled

Sequence of operations for entering E-STOP command:

1. Enter "E-STOP" command
2. Disable ramp-function generator, n and I controllers
3. $I_{\text{set}} = 0$ is applied
4. The pulses are disabled when $I = 0$
5. Output signal "Close operating brake" (binector B0250 = 0, when P080 = 2)
6. Converter reaches operating state ≥ 10.0 or higher
7. An "older" actual field current value (K0265) is input as the field current setpoint upper limit (function is "released" in operating states of ≤ 5)
8. The "Line contactor closed" relay drops out
9. Drive coasts to a standstill (or is braked by the operating brake)
10. Parameterizable delay time (P258) runs down
11. The field is reduced to a parameterizable value (P257)
12. When $n < n_{\text{min}}$ (P370, P371) has been reached, the "Close holding brake" signal is output (binector B0250 = 0, when P080 = 1)

Note:

"E-Stop" has the same effect as "Voltage disconnection" ("OFF2"). In addition, however, the line contactor drops out (via relay K1) in response to a hardware function 15 ms after input of the command.

9.9 Activation command for holding or operating brake (low active)

The signal for controlling the brake is available at binector B0250:

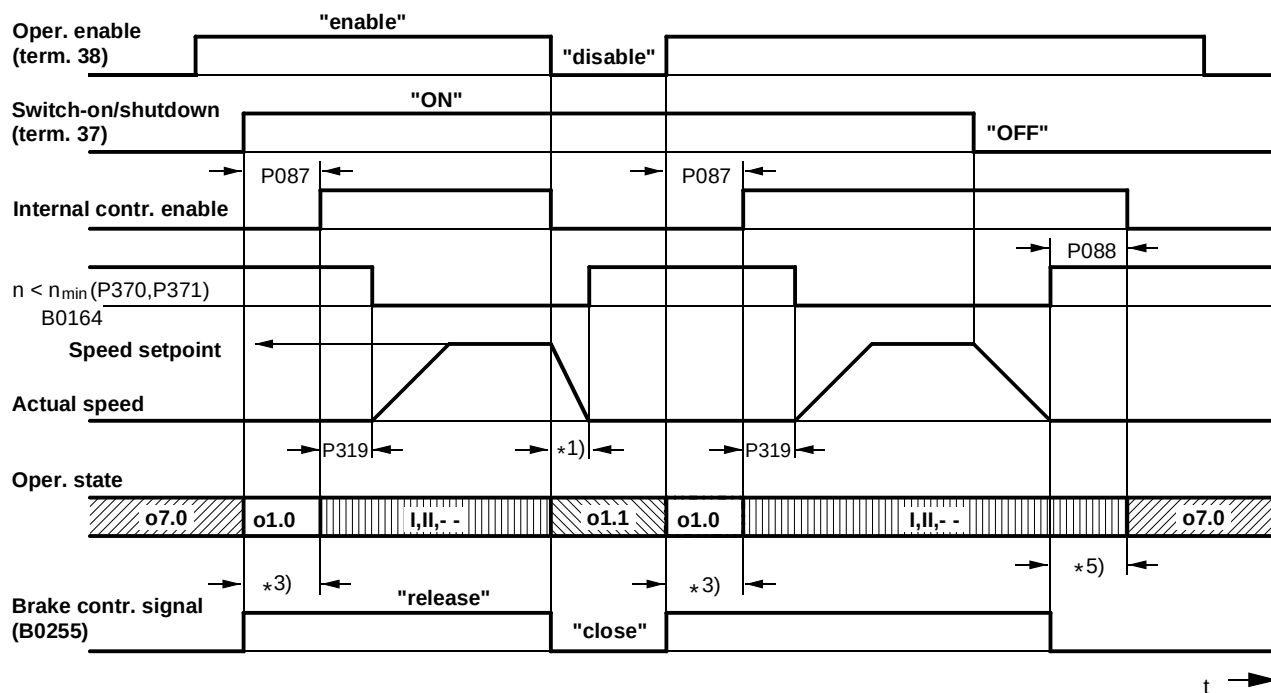
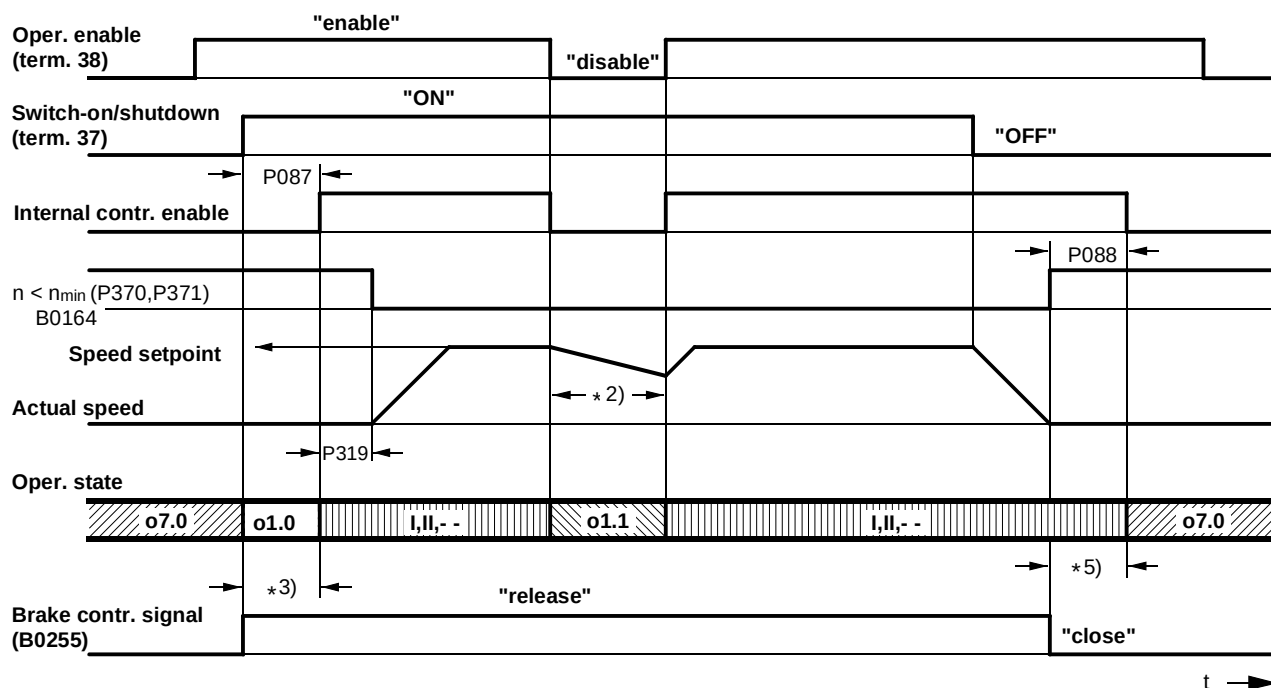
- log. "0" state = Close brake
- log. "1" state = Release brake

In order to drive a brake, this binector must be "wired up" to a binary output, e.g. by setting P771 to 250 for connection to output terminals 46 /47 (see Section 8, Sheet G112, for other possible settings).

The following parameters influence the action of the brake control signal:

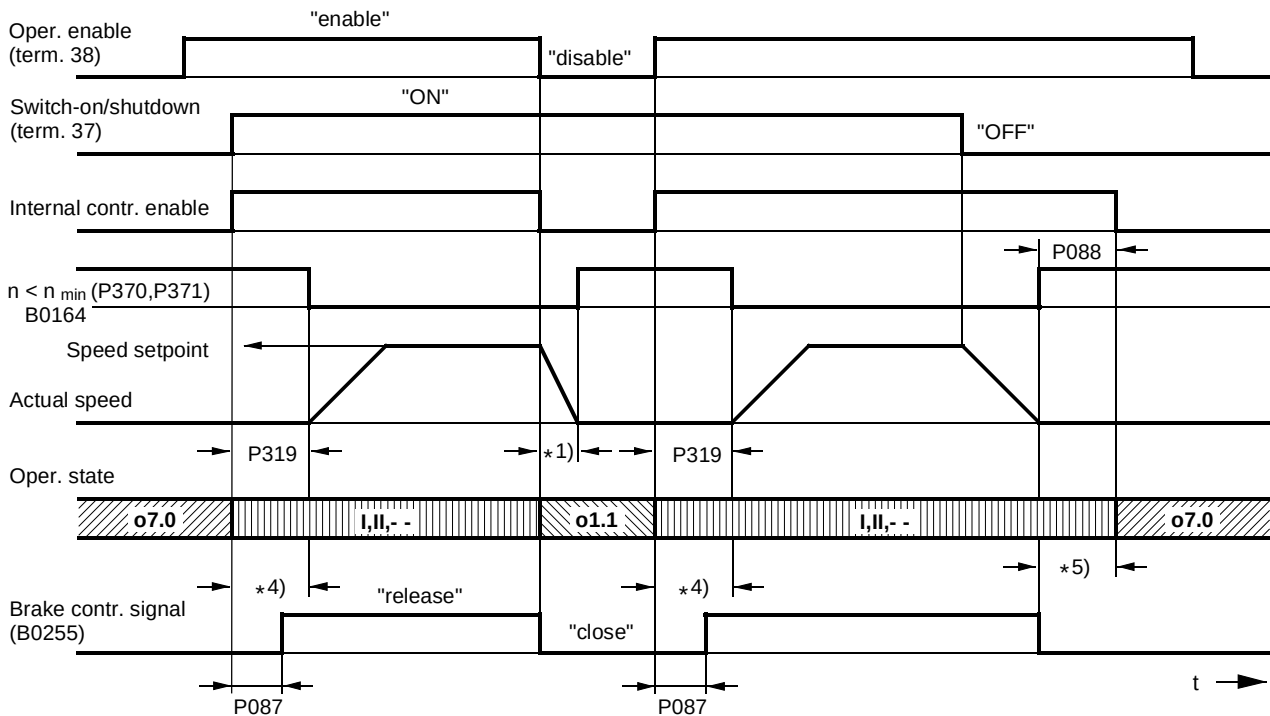
- P080 = 1 The brake is a holding brake:
"Close brake" command is entered only when $n < n_{\min}$ (P370, P371)
- P080 = 2 The brake is an operating brake:
The "Close brake" command is entered even when the motor is running
- P087 Brake release time:
A positive value prevents the motor from acting against the brake as it is released
A negative value causes the motor to act against the brake while it is still closed in order to prevent the occurrence of a brief, torque-free interval
- P088 Brake closing time:
Causes the motor to produce a torque while the brake is closing
- P319 Delay time for enabling ramp-function generator
After the controllers have been enabled, a setpoint of 0 is input for the time set here. This time should be set such that the brake has actually been released when the timer runs down. This is of particular importance when P087 is set to a negative value.

The following diagrams illustrate the chronological sequence of the brake control function with a signal level change at inputs "Switch-on / Shutdown" (e.g. terminal 37) and "Operating enable " (terminal 38). With respect to the brake control, input commands "Inching", "Crawling" or "Fast stop" have the same affect as "Switch-on / Shutdown", and input commands "Voltage disconnection" or "E-Stop" the same affect as cancelling the "Operating enable" command. The command "Close brake" is output during the optimization run for precontrol and current controller (P051 = 25).

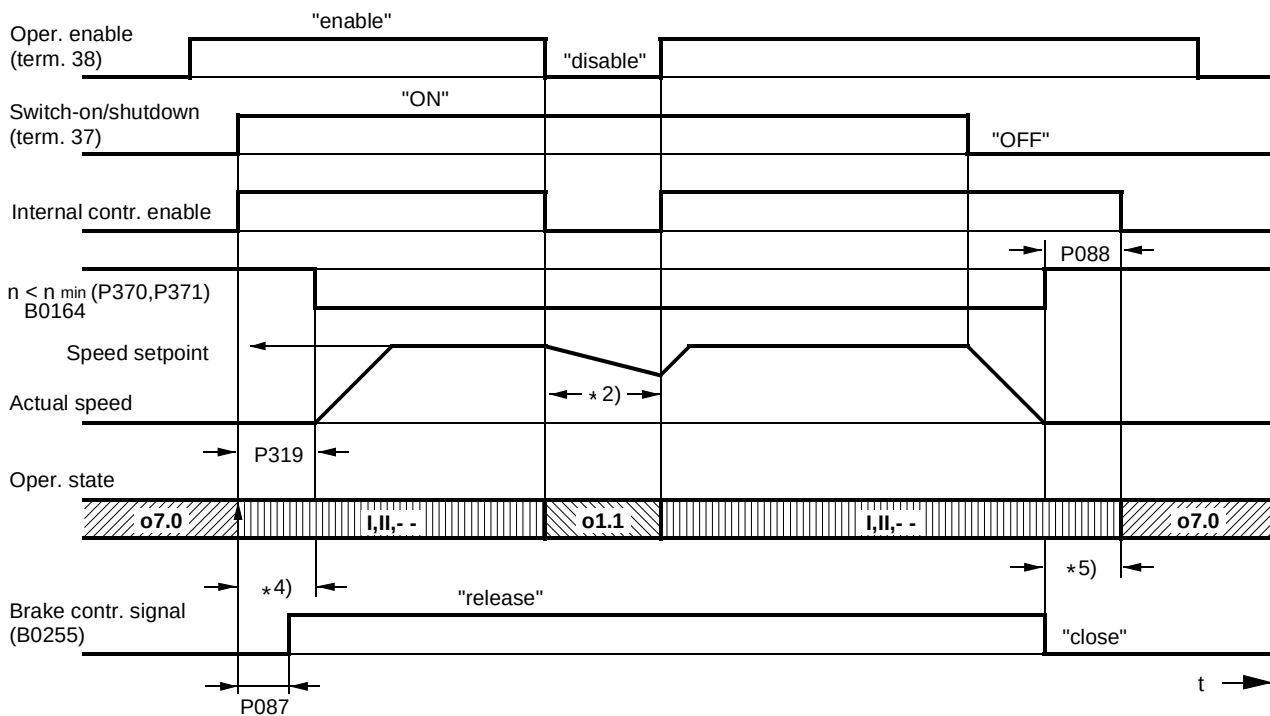
Operating brake (P080 = 2), positive brake release time (P087)**Holding brake (P080 = 1), positive brake release time (P087)**

- *1) Drive is braked mechanically by means of operating brake
- *2) Drive coasts to standstill, "Close holding brake" not output until $n < n_{\min}$
- *3) Time for the brake to open before the motor produces a torque (P087 positive)
- *5) Time for the brake to close while the motor is still producing a torque (P088)

Operating brake (P080 = 2), negative brake release time (P087)



Holding brake (P080 = 1), negative brake release time (P087)



- *1) Drive is braked mechanically by means of operating brake
- *2) Drive coasts to standstill, "Close holding brake" not output until $n < n_{\min}$
- *4) In this case, the motor is still rotating against the closed brake (P087 negative)
- *5) Time for the brake to close while the motor is still producing torque (P088)

9.10 Switch on auxiliaries

The function acts as a switch-on command for auxiliaries (e.g. motor fan).

The "Switch on auxiliaries" signal is available at binector B0251:

log. "0" state = Auxiliaries OFF
log. "1" state = Auxiliaries ON

To act as the auxiliaries drive signal, this binector must be "wired up" to a binary output, e.g. by setting P771 to 251 for connection to output terminals 46 / 47 (see Section 8, Sheet G112, for other possible settings).

The "Switch on auxiliaries" signal switches to "high" at the same time as the "Switch on" command. The converter then waits in operating state o6.0 for a parameterizable delay period (P093). The line contactor is closed on expiry of the delay.

When the "Shutdown" command is entered, the firing pulses are disabled when $n < n_{\min}$ is reached and the line contactor drops out. The "Switch on auxiliaries" signal switches to "low" after a parameterizable delay period (P094). However, if the "Switch on" command is entered again before this delay has expired, then the converter does not stay in operating state o6.0, but the line contactor is closed immediately instead.

9.11 Switch over parameter sets

See also in Section 9.1 under heading "Data sets"



WARNING



Parameter sets can be switched over while the converter is in operation (online). As a result, depending on the setting of the control bits when the motor is running, the configuration or functions may be altered in such a way as to produce dangerous operating conditions.

For this reason, we strongly recommend that a "basic" parameter set containing all basic parameter settings is created first and then copied into the other parameter sets. The intentional changes vis-à-vis the "basic" version should then be entered in each parameter set.

The "Switch over parameter sets" function affects function parameters (identified by an ".F" next to parameter number in block diagrams in Section 8) and Bico parameters (identified by a ".B" next to parameter number in block diagrams in Section 8).

The following operating modes are possible (see also Section 8, Sheet G181):

- P649 = 9: The control bits in control word 2 are input bit-serially.
The binectors selected in P676 and P677 determine bits 0 and 1 of control word 2 (= bits 16 and 17 of complete control word), and thus the input of the function data set.
The binector selected in P690 determines bit 14 of control word 2 (= bit 30 of complete control word), and thus the input of the Bico data set.
- P649 ≠ 9: The connector selected in P649 is used as control word 2.
Bits 0 and 1 of control word 2 (bits 16 and 17 of complete control word) control the input of the function data set. Bit 14 (= bit 30 of complete control word) controls the input of the Bico data set.

Control word		Active function data set (active index)
Bit 16	Bit17	
0	0	1
1	0	2
0	1	3
1	1	4

Control word Bit30	Active Bico data set (active index)
0	1
1	2

Caution:

The parameter set selection must not be changed while the optimization run is in progress. Error message F041 will otherwise be output after 0.5 s.

When the "Switch over parameter sets" function is activated, a time delay of up to 25ms may occur before the newly selected parameter set actually becomes operative.

For information about copying parameter sets, please see Section 11 (Parameter List), parameters P055 and P057.

9.12 Speed controller

See also Section 8, Sheets G151 and G152

Control signals for speed controller

The control signals for "Enable speed controller droop", "Enable speed controller" and "Switch over master/slave drive" are supplied by control word 2. The following operating modes are possible (see also Section 8, Sheet G181):

- P649 = 9: The control bits in control word 2 are input bit-serially.
The binectors selected in P684, P685 and P687 determine bits 8, 9 and 11 of control word 2 (= bits 24, 25 and 27 of complete control word), and thus the functions "Enable speed controller droop", "Enable speed controller" and "Switch over master/slave drive".
- P649 ≠ 9: The connector selected in P649 is used as control word 2.
Bits 8, 9 and 11 control the functions "Enable speed controller droop", "Enable speed controller" and "Switch over master/slave drive".

Enable speed controller:

- 0 = Disable controller, controller output (K0160) = 0, P component (K0161) = 0, I component (K0162) = value of connector selected in P631
1 = Enable controller

Enable droop:

- 0 = Droop is not active
1 = Droop is active

Switch over master/slave drive:

- 0 = Master drive
- 1 = Slave drive

When "Slave drive" is selected, the I component of the speed controller is made to "track" such that $M(\text{set}, n \text{ contr.}) = M(\text{set}, \text{limit.})$, the speed setpoint is set to equal the actual speed (K0179) (enable tracking with P229).

Set I component (selection of control signal via parameter P695):

When $0 \Rightarrow 1$ signal transition of selected binector, the I component is set to the setting value (selected in parameter P631)

Stop I component (selection of control signal via parameter P696):

- 0 = I component enabled
- 1 = Stop I component

Limitation active:

This signal is in the log. "1" state when the upper or lower torque limitation is violated, the speed limiting controller is active, the current limitation is active or when the firing angle for the armature circuit reaches the α_G -limit.
In this case, the I component of the speed controller is stopped.

Switch over to P controller:

The P controller function is activated (I component = 0) when the speed drops to below the changeover value.

D component in actual value channel or setpoint/actual value deviation channel

As a basis for selecting the correct derivative action time, it is necessary to calculate the maximum possible rate of rise at the derivative action element input, i.e. the period of time required by the input signal to change from 0 to 100% at this maximum rate of rise. The derivative action time should preferably be set to a shorter value than this period.

9.13 Serial interfaces

The SIMOREG 6RA70 converter is equipped with the following serial interfaces:

- **G-SST1** (serial interface 1)
Connector X300 on board A7005 (operator panel)
USS[®] protocol
provided for the purpose of connection the OP1S operator panel
- **G-SST2** (serial interface 2)
Terminal strip X172 (terminals 56 to 60) on board A7001
USS[®] and peer-to-peer protocol, parameterizable

Additionally if board A7006 (terminal expansion) is installed:

- **G-SST3** (serial interface 3)
Terminal strip X162 (terminals 61 to 65)
USS[®] and peer-to-peer protocol, parameterizable

Interface hardware

The hardware of G-SST1 is designed to operate in RS232 and RS485 standard / two-wire mode, and G-SST2 and G-SST3 in RS485 standard / two and four-wire mode. For connectors and terminal assignments, see Section 8, Sheets G170 to G174.

The maximum cable length for a peer-to-peer connection from the transmitter to the last receiver connected to the same transmission output is 1000 m. The same maximum cable length applies to the bus cable of a USS connection. The maximum cable length is only 500 m for both types of connection if a baud rate of 187500 bd is selected.

USS:

A maximum of 32 nodes can be connected in the bus configuration (i.e. 1 master and max. 31 slaves). The bus connector must be activated on the two bus nodes which form each end of the bus circuit.

Peer-to-peer:

Up to 31 other drives can be connected in parallel to the transmit cable of one drive. With a "parallel connection", the bus connector must be activated on the last connected drive.

9.13.1 Serial interfaces with USS® protocol

Specification for the USS® protocol: Order No. E20125-D0001-S302-A1

The SIEMENS USS® protocol is implemented in all digital converter devices supplied by SIEMENS. It can be used to provide a point-to-point or bus-type link to a master station. Any mixture of converter types can be connected up to the same bus line. The USS protocol makes it possible to access all relevant process data, diagnostic information and parameters of the SIMOREG converter.

The USS protocol is a pure master-slave protocol. In this case, a converter device can only ever function as slave. Converter devices will transmit a telegram to the master only if they have received one from it first. In other words, converters linked via the USS protocol cannot exchange data directly with one another (they can do this only via a peer-to-peer link).

Useful data which can be transferred via the USS protocol

Sheets G170 to G172 in Section 8 show how useful data can be interconnected and list the parameters relevant for configuring USS interfaces.

If parameters need to be read and/or written via the USS interface, then "Parameter data length" (P782, P792, P802) must be set to 3, 4 or 127 (select setting 4 only if double word parameters need to be transferred). If parameters do not need to be transferred, the "Parameter data length" must be set to 0.

The number of process data words to be transferred is basically identical for the transmit and receive directions and can be set in "Process data length" (P781, P791, P801). Numeric representation "100% equals 4000h = 16384d" applies to all connectors.

Numeric representation of parameter numbers and values on serial interfaces

The mode of numeric representation of a parameter value is determined by the parameter "type" assigned to each parameter in the Parameter List. The different types of parameter are explained at the beginning of the list. Parameters are always transmitted in the form specified in the "Value range" column of the Parameter List; any decimal point, however, is omitted (example: display value 123.45 → the number 12345d = 3039h is transferred via the serial interface).

Diagnostics and monitoring functions for USS interfaces

All transmitted and received useful data words can be checked (directly at the internal software transfer point from/to USS driver) by means of display parameters r810 / r811, r812 / r813 or r814 / r815.

Diagnostic parameters r789, r799 or r809 provide information about the chronological distribution of errored and error-free telegrams, as well as the nature of any communication errors that have occurred.

A watchdog can be set in P787, P797 or P807 which can initiate a shutdown on faults (F011, F012 or F013) in the case of timeout. By connecting binectors B2031, B6031 or B9031 to the fault message triggers (using P788=2031 / P798=6031 / P808=9031), it is possible to acknowledge these fault messages even if the fault is active continuously, thereby ensuring that the drive can still be operated manually after the USS interface has failed.

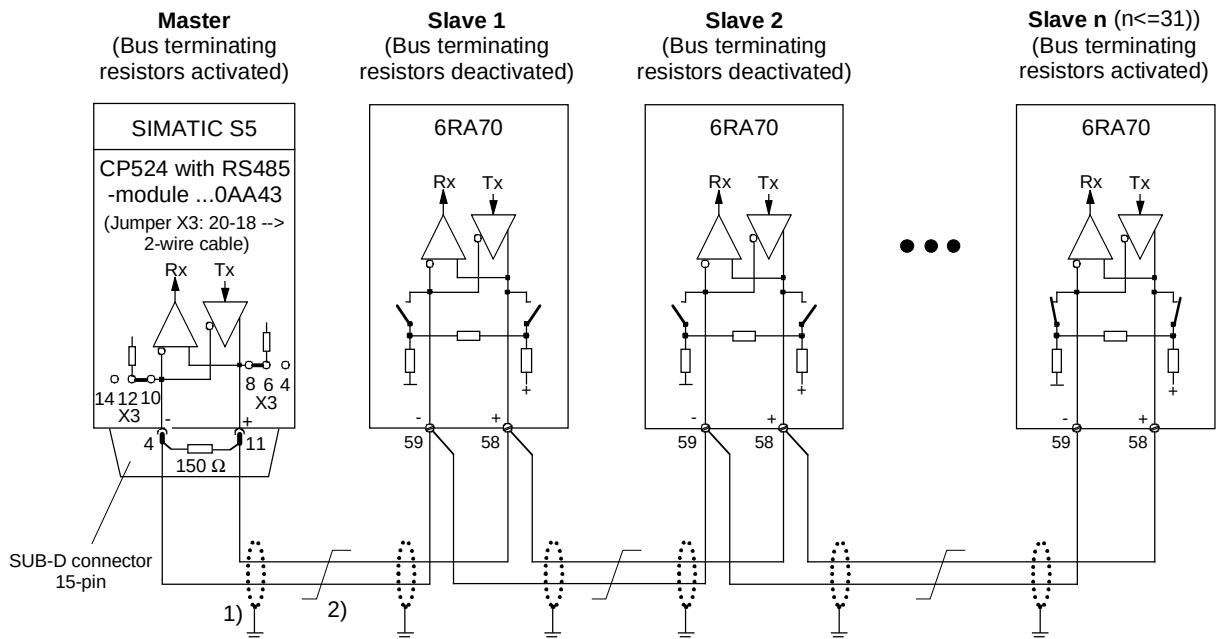
Important !

The serial interfaces for the USS protocol are parameterized with the same parameters used to configure the peer-to-peer protocol, although the setting ranges are different in some cases (see Notes for relevant parameters in Parameter List, Section 11).

USS protocol: Brief start-up guide for 6RA70 converters

	G-SST1 RS232 / RS485	G-SST1 RS485 for connection of an OP1S	G-SST2 / G-SST3 RS485
Select USS protocol	P780 = 2	P780 = 2	P790 / P800 = 2
Baud rate	P783 = 1 to 13, corresponding to 300 to 187500 baud	P783 = 6 (9600 Bd) or 7 (19200 Bd) The baud rate setting must be identical for every node in bus operation	P793 / P803 = 1 to 13, corresponding to 300 to 187500 baud
No. of process data (PZD No.) (applies to Receive and Send)	P781 = 0 to 16	P781 = 2	P791 / P801 = 0 to 16
PZD assignment for control word and setpoints (received process data)	All received process data are taken to connectors and must be wired up as required	If the control bits from the OP1S are to be used: Word 1 (connector K2001): Wiring up of control bits from OP1S, see Sec. 7.2.2 Word 2 (connector K2002): Not used	All received process data are taken to connectors and must be wired up as required
No. of PKW	P782 = 0: No PKW data 3 / 4: 3 / 4 PKW data words 127: Variable data length for slave → master	P782 = 127 variable data length	P792 / P802 = 0: No PKW data 3 / 4: 3 / 4 PKW data words 127: Variable data length for slave → master
PZD assignment for actual values (transmitted process data)	Selection of transmitted values via P784	Word 1: P784.i01=32 (stat. word 1 K0032) Word 2: P784.i02=0	Selection of transmitted values via P794 / P804
Node address	P786 = 0 to 30	P786 = 0 to 30 Every node must have its own, unique address for bus operation	P796 / P806 = 0 to 30
Telegram failure time	P787 = 0.000 to 65.000s	P787 = 0.000s	P797 / P807 = 0.000 to 65.000s
Bus termination	P785 = 0: Bus term. OFF 1: Bus term. ON	P785 = 0: Bus term. OFF 1: Bus term. ON	P795 / P805 = 0: Bus term. OFF 1: Bus term. ON
Bus / point-to-point communication	RS232: Only point-to-point operation possible RS485: Bus operation possible	Bus operation possible	Bus operation possible
2-wire / 4-wire transmission via RS485 interface	2-wire operation is selected automatically	2-wire operation is selected automatically	2-wire operation is selected automatically
Cable	Connector assignments, see Sect. 6.8 or Sheet G170 in Sect. 8	See operating instructions for OP1S operator panel	Connector assignments, see Sect. 6.8 or Sheets G171, G172 in Sect. 8

Connection example for a USS bus



- 1) The interface cable shields must be connected directly on the converter with the lowest possible impedance to converter or cubicle earth (e.g. via clamp).
- 2) Twisted cable, e.g. LIYCY 2x0.5 sqmm; with longer cables, an equipotential bonding conductor must be used to ensure that the difference in frame potentials between nodes stays below 7 V.

9.13.2 Serial interfaces with peer-to-peer protocol

The term "Peer-to-peer link" refers to a "Link between partners of equal status". In contrast to the classic master/slave bus system (e.g. USS and PROFIBUS), the same converter can function as both the master (setpoint source) and the slave (setpoint receiver) in a peer-to-peer link.

Signals can be transferred in fully digital form from one converter to another via the peer-to-peer link, for example:

- **Velocity setpoints** for producing a setpoint cascade, e.g. on paper, foil and wire-drawing machines and on fiber-drawing machinery.
- **Torque setpoints** for closed-loop load distribution controls on drives that are coupled mechanically or via the material, e.g. longitudinal-shaft drives on printing presses or S-roll drives
- **Acceleration setpoints (dv/dt)** for acceleration precontrol on multi-motor drives.
- **Control commands**

Useful data which can be transferred via the peer-to-peer link

Sheets G173 and G174 in Section 8 show how useful data can be interconnected and list the parameters relevant for configuring peer-to-peer links. Any connectors can be parameterized as transmit data (numeric representation: 100% equals 4000h = 16384d).

Parameters cannot be transferred via the peer-to-peer link.

Diagnostics and monitoring functions for peer-to-peer link

All transmitted and received useful data words can be checked (directly at the internal software transfer point from/to peer driver) by means of display parameters r812 / r813 or r814 / r815. Diagnostic parameters r799 or r809 provide information about the chronological distribution of errored and error-free telegrams, as well as the nature of any communication errors that have occurred. A watchdog can be set in P797 or P807 which can initiate a shutdown on faults (F012 or F013) in the case of timeout. By connecting binectors B6031 or B9031 to the fault message triggers (using P798=6031 / P808=9031), it is possible to acknowledge these fault messages even if the fault is active continuously, thereby ensuring that the drive can still be operated manually after the peer-to-peer interface has failed.

Important !

The serial interfaces for the peer-to-peer protocol are parameterized with the same parameters used to configure the USS protocol, although the setting ranges are different in some cases (see Notes for relevant parameters in Parameter List, Section 11).

Peer-to-peer communication, 4-wire operation

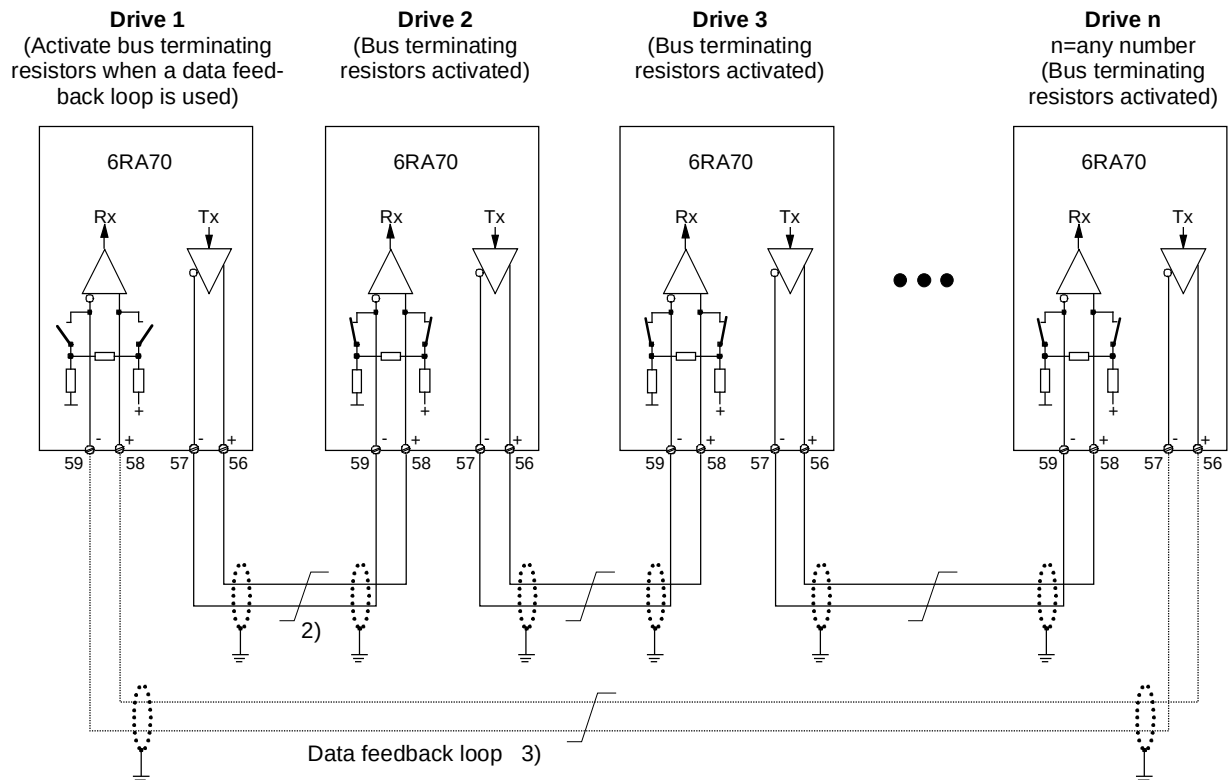
Serial linking of converter to converter (partners of equal status).

The signal flow can pass through the drives, for example, in a series connection. In this case, each drive forwards the data after processing only to the next drive (classic setpoint cascade).

Brief start-up guide for 6RA70 converters

	G-SST2 RS485	G-SST3 RS485
Select peer-to-peer protocol	P790 = 5	P800 = 5
Baud rate	P793 = 1 to 13 corresponding to 300 to 187500 baud	P803 = 1 to 13 corresponding to 300 to 187500 baud
No. of process data (PZD No.) (applies to Receive and Send)	P791 = 1 to 5	P801 = 1 to 5
PZD assignment for control word and setpoints (received process data)	All received process data are taken to connectors and must be wired up as required	All received process data are taken to connectors and must be wired up as required
No. of PKW	No parameters can be transferred	No parameters can be transferred
PZD assignment for actual values (transmitted process data)	Selection of transmitted values via P794 (indices .01 to .05)	Selection of transmitted values via P804 (indices .01 to .05)
Telegram failure time	P797 = 0.000 to 65.000s	P807 = 0.000 to 65.000s
Bus termination	P795 = 0: Bus term. OFF 1: Bus term. ON (depending on type of link)	P805 = 0: Bus term. OFF 1: Bus term. ON (depending on type of link)
2-wire / 4-wire transmission via RS485 interface	"4-wire" operation is automatically selected	"4-wire" operation is automatically selected
Cable	Terminal assignments, see Section 6.8 or Sheet G173 in Section 8	Terminal assignments, see Section 6.8 or Sheet G174 in Section 8

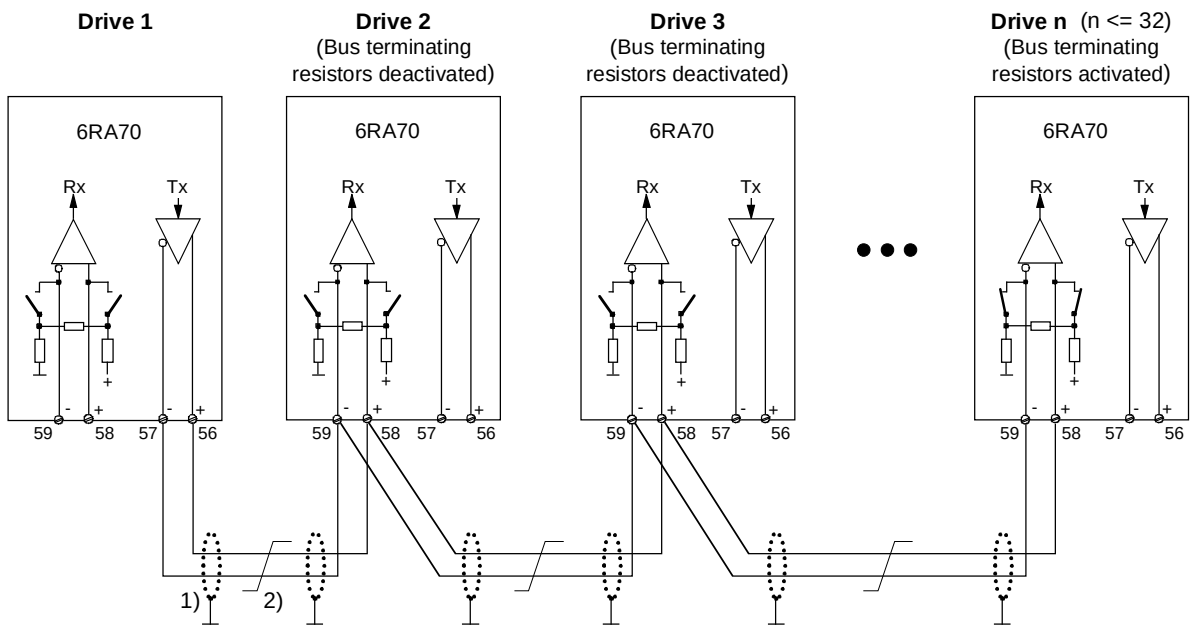
Examples of peer-to-peer links



Peer link type "Series connection"

Each drive receives its own individual setpoint from the drive connected upstream (classic setpoint cascade)

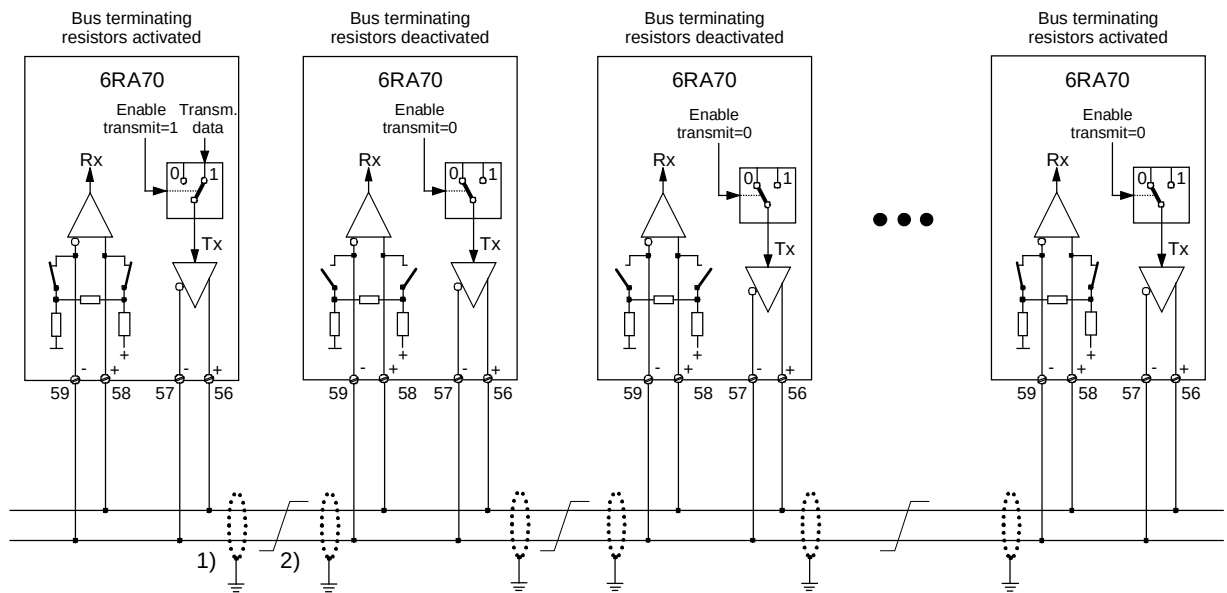
- 1) The interface cable shields must be connected directly on the converter with the lowest possible impedance to converter or cubicle earth (e.g. via a clamp).
- 2) Twisted cable, e.g. LIYCY 2x0.5 sqmm; with longer cables, an equipotential bonding conductor must be used to ensure that the difference in frame potentials between nodes stays below 7 V.
- 3) Optional data feedback loop via which drive 1 can monitor operation of the entire peer chain.



Peer link type "Parallel connection"

Up to 31 drives receive identical setpoints from drive 1

- 1) The interface cable shields must be connected directly on the converter with the lowest possible impedance to converter or cubicle earth (e.g. via a clamp).
- 2) Twisted cable, e.g. LIYCY 2x0.5 sqmm; with longer cables, an equipotential bonding conductor must be used to ensure that the difference in frame potentials between nodes stays below 7V.



Peer link type "Bus connection"

Up to 31 drives receive identical setpoints from one drive. The setpoint source drive is selected with "Enable transmit" = 1. "Enable transmit" = 0 must be preset for all other drives.

- 1) The interface cable shields must be connected directly on the converter with the lowest possible impedance to converter or or cubicle earth (e.g. via a clamp).
- 2) Twisted cable, e.g. LIYCY 2x0.5 sqmm; with longer cables, an equipotential bonding conductor must be used to ensure that the difference in frame potentials between nodes stays below 7V.

9.14 Thermal overload protection of DC motor (I²t monitoring of motor)

The I²t monitoring function is parameterized in parameters P100 and P114. If these parameters are adapted correctly, the motor is protected against overloading (not all-round motor protection).
Factory setting: monitoring is switched off by P820 i006=37.

Adaptation

P114: A time constant T_{motor} in minutes for the I²t monitoring function must be entered in parameter P114.

P100: The rated motor armature current in amperes as specified on the rating plate must be entered in parameter P100.

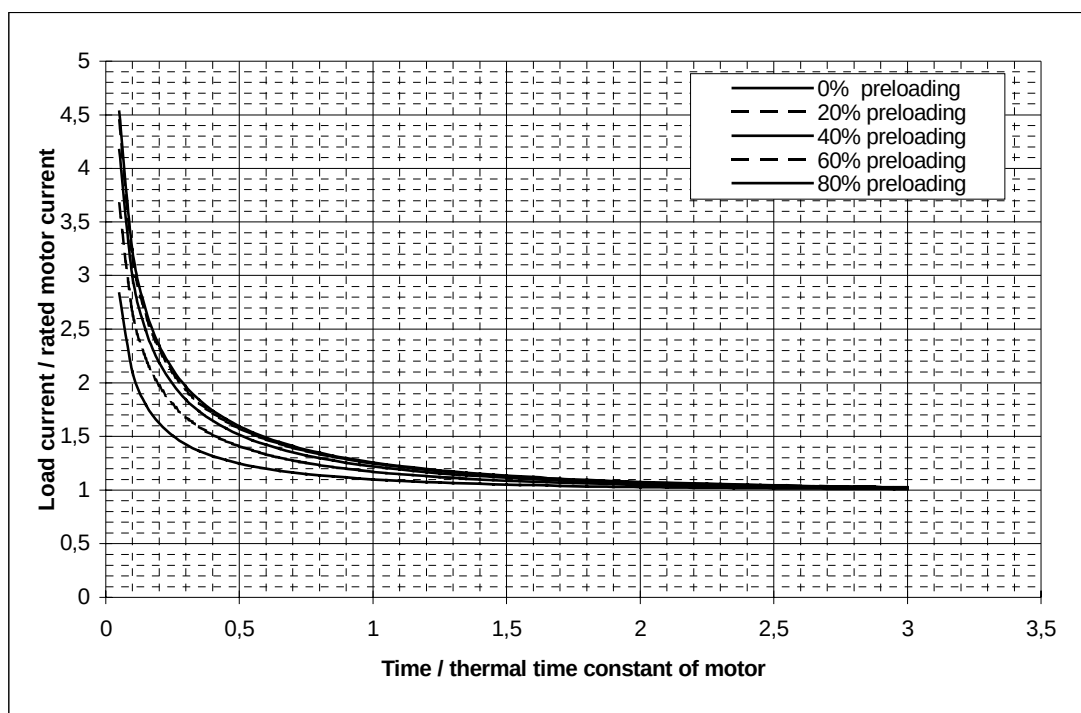
Warning characteristic / switch-off characteristic

If the motor is loaded constantly, for example, with about 125% of the rated motor DC current, then alarm A037 is triggered after a time constant (P114) has elapsed. If the load is not reduced, then the drive is shut down when the switch-off characteristic is reached and fault message F037 displayed. Warning/switch-off times for other loads can be calculated from the diagram.

Alarm message triggering by motor I²t monitoring function

This diagram shows how long it takes for an alarm message to be triggered if, after a long preloading period ($> 5 \cdot T_{\text{th}}$), a new constant load value is injected abruptly.

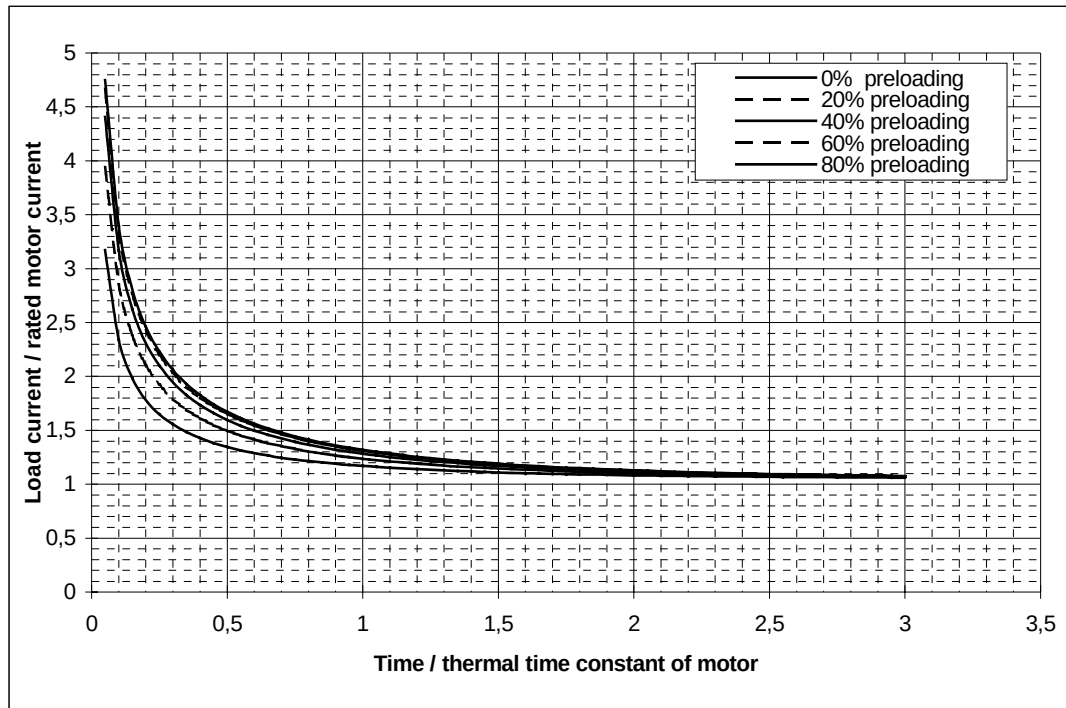
$T_{\text{th}} = P114$.. thermal time constant of motor



Fault message triggering by motor I²t monitoring function

This diagram shows how long it takes for a fault message to be triggered if, after a long preloading period ($> 5 \cdot T_{th}$), a new constant load value is injected abruptly.

T_{th} = P114 .. thermal time constant of motor



NOTE

When the electronics power supply fails for longer than 2 s, the calculated motor preloading value is lost. When the supply is reconnected, the system assumes that the connected motor has not been loaded at all!

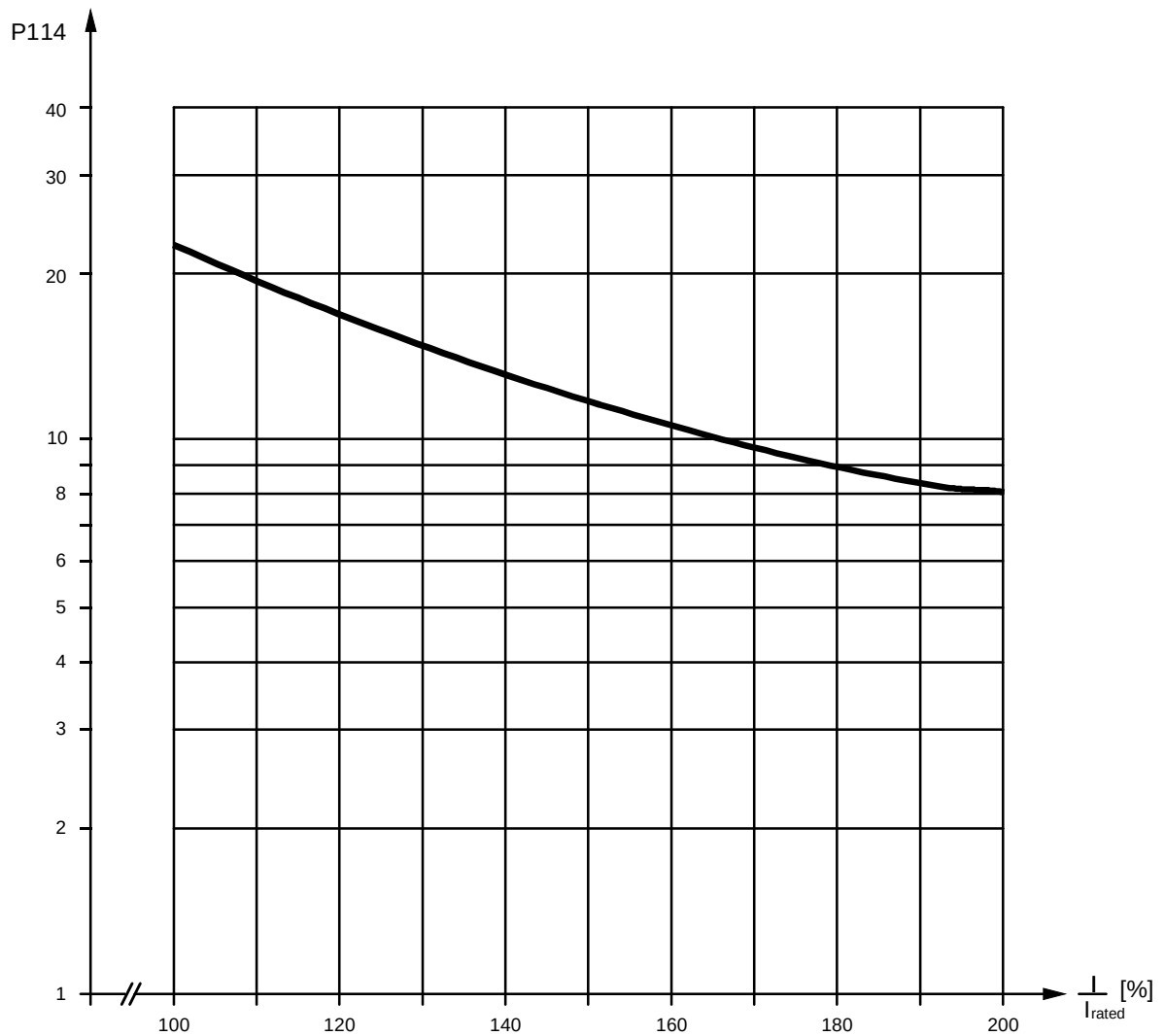
If the converter is switched on again (e.g. with "Automatic restart function") within 2 s of the electronics power supply failing, then the last calculated I²t value of the motor is applied.

The I²t monitoring function reproduces only a rough thermal image of the motor, i.e. it does not provide all-round motor protection.

If P114 (T_{motor}) is set to zero, then the I²t monitoring function is deactivated.

Calculation of thermal equivalent time constant (P114)

It must be noted that the thermal equivalent time constant is dependent on the maximum overcurrent.
Thermal equivalent time constant of 1G . 5/1H . 5 DC motors according to Catalog DA12.



I_{rated} ... Rated motor armature current (=P100)

I ... Maximum overcurrent at which motor is operated

NOTE

When other motor types are connected, the manufacturer's specifications apply.

9.15 Dynamic overload capability of power section

9.15.1 Overview of functions

The converter rated DC current specified on the rating plate (= maximum permissible continuous direct current when $P077 = 1.00$) may be exceeded in operation. The amount and permissible duration of the overload are subject to limits which are explained in more detail below.

The absolute upper limit for the absolute value of overload currents corresponds to 1.5 times the converter rated DC current * $P077$. The maximum overload period depends both on the time characteristic of the overload current and on the load history of the converter and differs depending on the installed power section.

Every overload must be preceded by an "underload" (load phase at load current $< P077 * \text{rated DC current}$). After the maximum permissible overload period has expired, the load current must be reduced to a value of at least $\leq P077 * \text{converter rated DC current}$.

The dynamic overload period is made possible by a thermal monitoring function (I^2t monitor) in the power section. This uses the time characteristic of the actual load current to calculate the time characteristic of the thyristor temperature rise over ambient temperature. When the converter is switched on, the calculation commences with the initial values that were calculated before the converter power supply was last switched off/last failed. Allowance can be made for ambient conditions (ambient temperature, installation altitude) by the setting in parameter $P077$.

In the delivery state, the ambient temperature is always set to the maximum permissible value (i.e. 45°C for naturally cooled converters and 35°C for converters with forced cooling).

The I^2t monitoring function responds when the calculated thyristor temperature rises exceeds the permissible limit. Two alternative responses to the monitor can be parameterized:

$P075 = 1$: Alarm A039 with reduction of armature current setpoint to $P077 * \text{converter rated DC current}$

$P075 = 2$: Fault F039 followed by converter shutdown

The I^2t monitoring function can be deactivated. In this case, the armature current is limited to the setting in $P077 * \text{converter rated DC current}$.

Connector K310 contains the calculated thyristor overtemperature as a % of the maximum permissible converter-specific thyristor overtemperature:

80°C on 15A to 60A converters

85°C on 90A to 140A converters

90°C on converters of $> 200\text{A}$ converter rated armature DC current.

9.15.2 Configuring for dynamic overload capability

Section 9.15.3 provides the following information for each converter model:

- Maximum overload period t_{an} for starting with cold power section and specified constant overload with an overload factor of X (i.e. loading with X times the converter rated DC current * P077) (see small table at top right)
- Maximum current interval t_{ab} (maximum cooling time) until the power section reaches the "cold" state (see below small table at top right)
- Limit characteristics fields for calculating overload capability in thermally settled, intermittent overload operation (periodic load cycles).
(In tabulated form: Top left
As curve with logarithmic y axis: Curve at bottom left
As curve with linear y axis: Curve at bottom right)

Important:

The power section is in the "cold" state when the calculated thyristor temperature corresponds to less than 5 % of its maximum permissible value. This state can be scanned via a binary selectable output.

Note:

If load cycles are started with a cold power section at least slightly within the specified load cycle limits, then the thermally settled state can be reached without tripping the I²t monitor.

If the I²t monitoring function is parameterized for a shutdown response (P075 = 2), the converter should not be allowed to operate too close to the limit characteristic when periodic load cycles are configured with a load cycle time of longer or slightly shorter or equal to 300 s.

In all other cases, and especially when parameterizing reduction of the armature current setpoint (P075 = 1) as the I²t monitoring trip response, it is possible to fully utilize the maximum overload capability defined by the limit characteristic.

Structure of limit characteristics fields for intermittent overload duty:

Each characteristics field refers to a load cycle of intermittent overload operation with a total period of 300 s.

This type of load cycle consists of two periods,

i.e. the base-load duty period (armature actual current $\leq$ P077 * converter rated DC current) and the overload period (actual armature current $\geq$ P077 * converter rated DC current).

Each limit characteristic displays the maximum permissible overload period T_p over the maximum base-load current I_g for a specific overload factor X for each converter model.

For the remainder of the load cycle, the current may not exceed the base-load current as defined by the overload factor.

If no limit characteristic is specified for a particular overload factor, then the characteristic for the next-higher overload factor must be applied.

The limit characteristics fields apply to a load cycle time of 300s.

For load cycle times of < 300s, the overload period must be reduced proportionally (load cycle/300s).

For load cycle times of > 300s, the overload period is the same as that for a cycle time of 300s, but the base-load period is correspondingly longer.

The limit characteristics fields apply for a setting of P077 = 1.00. If P077 is set to ≤ 1.00 , i.e. in the case of thermal derating, the currents which actually flow must be weighted with a factor of $1/P077$:

$$\text{Overload factor X for characteristic} = \frac{\text{Actual overload current}}{P077 * \text{converter rated DC current}}$$

$$\text{Actual maximum base-load current} = P077 * \text{max. base-load current acc. to characteristic in \% of converter rated DC current}$$

Basic tasks for configuring periodic overload operation

Terms: Base-load duty period₃₀₀ = min. base-load duty period for 300 s cycle time
 Overload period₃₀₀ = max. overload period for 300 s cycle time

Basic task 1:

Known quantities: Converter type, cycle time, overload factor, overload period

Quantities to be found: Minimum base-load duty period and maximum base-load current

Solution: Selection of limit characteristic for specified converter type and overload factor

Cycle time < 300s: Overload period₃₀₀ = (300s/cycle time) * overload period

Cycle time ≥ 300s: Overload period₃₀₀ = Overload period

If: Overload period₃₀₀ > overload period₃₀₀ for base-load current = 0

Then: Required load cycle cannot be configured,

Otherwise: Determine the maximum base-load current for overload period₃₀₀ from the limit characteristic

Example 1:

Known quantities: 30A/4Q converter; cycle time 113.2s; overload factor = 1.45; overload period = 20s

Quantities to be found: Minimum base-load period and maximum base-load current

Solution: Limit characteristic for 30A/4Q converter, overload factor 1.5

Overload period₃₀₀ = (300s/113.2s) * 20s = 53s

Base-load period₃₀₀ = 300s – 53s = 247s →

Maximum base-load current = approx. 45% of I_{rated} = 13.5A

Basic task 2:

Known quantities: Converter type, cycle time, overload factor, base-load current

Quantities to be found: Minimum base-load period and maximum overload period

Solution: Selection of limit characteristic for specified converter type and overload factor

Determine overload period₃₀₀ for base-load current from limit characteristic

Cycle time < 300s:

Max. overload period = (cycle time/300s) * overload period₃₀₀

Min. base-load period = cycle time – max. overload period

Cycle time ≥ 300s:

Max. overload period = overload period₃₀₀

Min. base-load period = cycle time – max. overload period

Example 2:

Known quantities: 30A/4Q converter; cycle time 140s; current overload factor = 1.15;

base-load current = 0.6*I_{rated} = 18A

Quantities to be found: Minimum base-load period and maximum overload period

Solution: Limit characteristic for 30A/4Q converter, overload factor 1.2

Base-load current = 60% of I_{rated} → overload period₃₀₀ = 126.35s

Max. overload period = (140s/300s) * 126.35s = approx. 58s

Min. base-load period = 140s – 58s = 82s

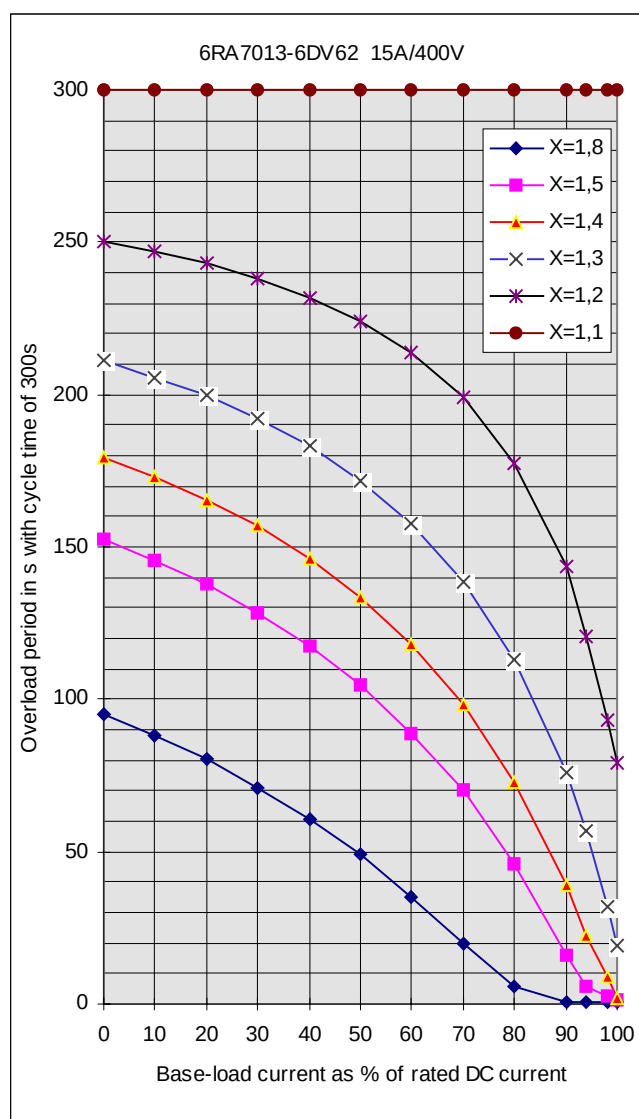
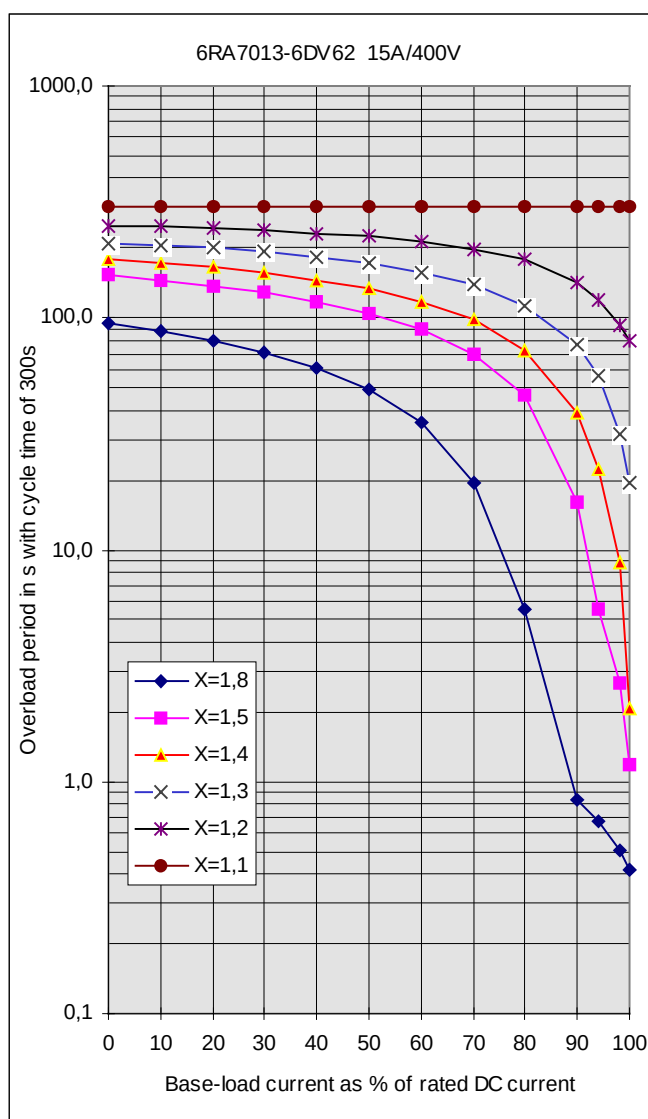
9.15.3 Characteristics for determining the dynamic overload capability for intermittent overload operation

6RA7013-6DV62

lg (%)	Tp (s) X=1.8	Tp (s) X=1.5	Tp (s) X=1.4	Tp (s) X=1.3	Tp (s) X=1.2	Tp (s) X=1.1
0	95.420	152.660	179.100	211.080	250.440	300.000
10	88.298	145.785	172.818	205.833	247.077	300.000
20	80.245	137.837	165.438	199.620	243.106	300.000
30	71.148	128.570	156.707	192.183	238.150	300.000
40	60.760	117.657	146.280	183.060	231.964	300.000
50	48.911	104.704	133.676	171.763	224.061	300.000
60	35.280	89.040	118.105	157.453	213.554	300.000
70	19.600	69.916	98.440	138.528	199.098	300.000
80	5.512	46.107	72.987	112.909	177.737	300.000
90	0.838	15.990	38.903	76.140	143.360	300.000
94	0.670	5.590	22.080	56.520	120.320	300.000
98	0.503	2.651	8.750	31.800	93.013	300.000
100	0.419	1.182	2.085	19.440	79.360	300.000

X	t _{an} (s)
1.1	∞
1.2	1633
1.3	1112
1.4	833
1.5	651
1.8	382

t_{ab} (s) = 2281

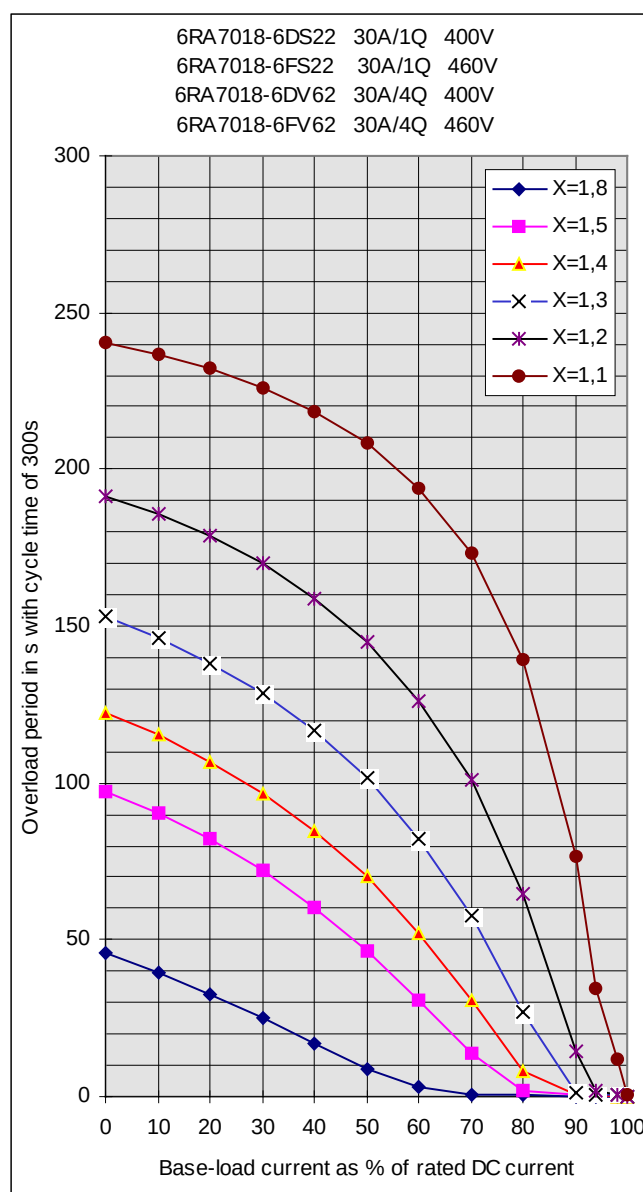
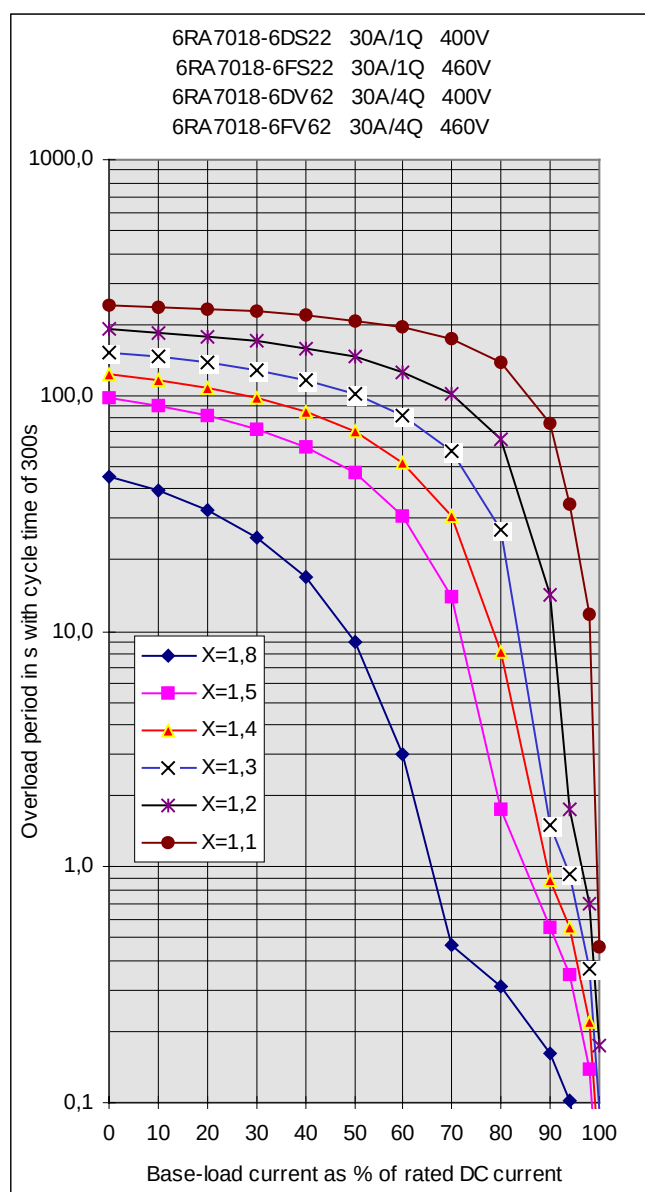


**6RA7018-6DS22 und 6RA7018-6FS22.
6RA7018-6DV62 und 6RA7018-6FV62**

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	45.520	97.480	122.400	153.020	191.300	240.300
10	39.447	90.410	115.380	146.357	185.582	236.594
20	32.616	82.061	106.977	138.295	178.589	231.970
30	25.093	72.179	96.909	128.483	169.899	226.113
40	17.093	60.500	84.768	116.423	158.923	218.466
50	9.069	46.750	70.012	101.402	144.877	208.253
60	2.993	30.889	51.992	82.375	126.350	194.047
70	0.466	13.944	30.536	57.809	101.038	173.048
80	0.314	1.750	8.127	26.755	64.820	139.207
90	0.162	0.554	0.880	1.491	14.255	76.260
94	0.101	0.346	0.550	0.932	1.758	34.440
98	0.041	0.138	0.220	0.373	0.703	11.787
100	0.010	0.035	0.055	0.093	0.176	0.460

X	t _{an} (s)
1.1	1439
1.2	906
1.3	631
1.4	456
1.5	333
1.8	123

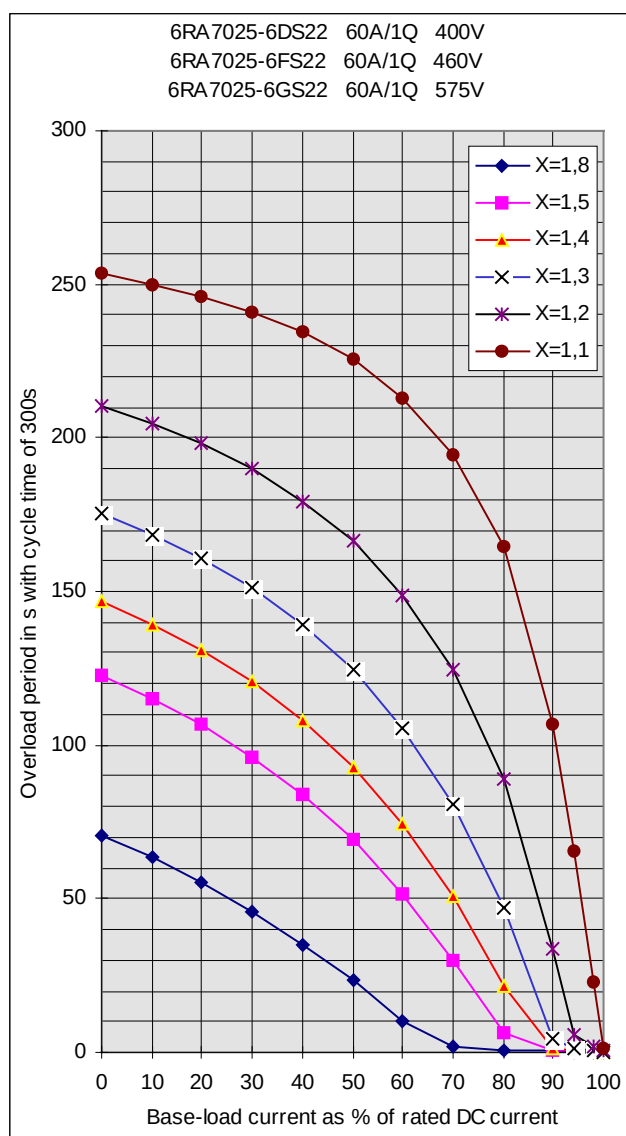
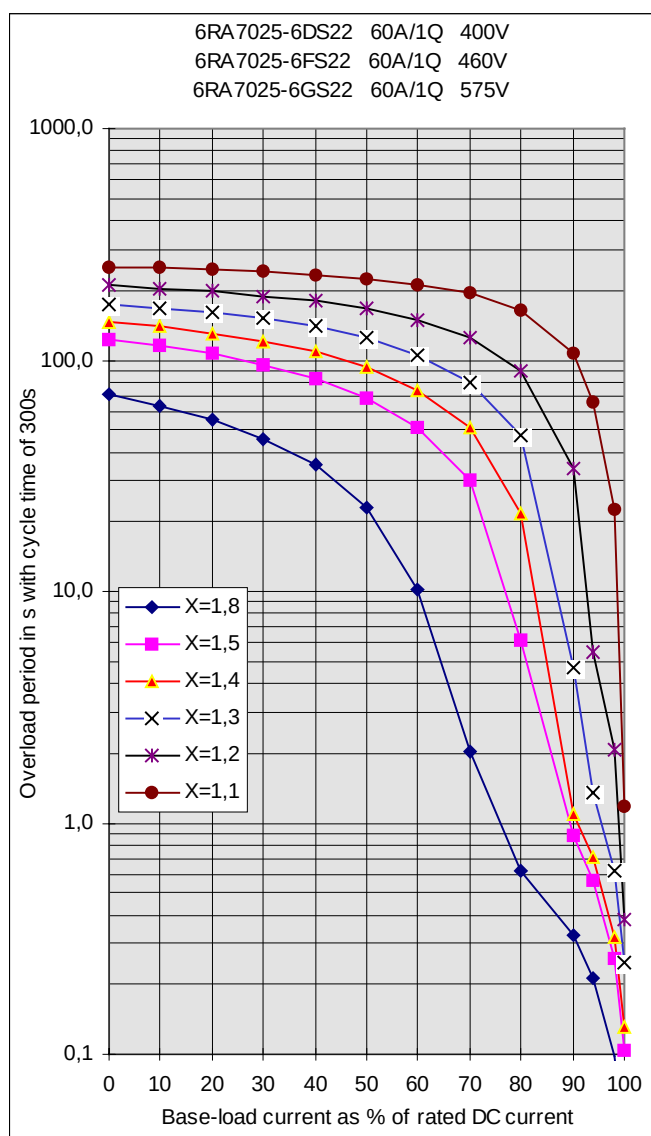
t_{ab} (s) = 2169



6RA7025-6DS22, 6RA7025-6FS22 und 6RA7025-6GS22

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	70.600	122.800	146.660	175.280	210.100	253.320
10	63.372	115.270	139.406	168.624	204.640	250.030
20	55.152	106.462	131.198	160.650	198.004	245.968
30	45.796	96.080	120.544	151.002	189.831	240.862
40	35.187	83.785	108.182	139.149	179.545	234.267
50	23.257	69.086	93.111	124.364	166.345	225.415
60	10.164	51.369	74.442	105.480	148.834	213.073
70	2.022	30.087	51.000	80.716	124.642	194.690
80	0.620	6.095	21.643	47.267	89.280	164.645
90	0.330	0.876	1.097	4.671	33.840	106.744
94	0.213	0.568	0.711	1.362	5.483	65.650
98	0.097	0.259	0.324	0.621	2.083	22.677
100	0.039	0.104	0.131	0.250	0.383	1.190

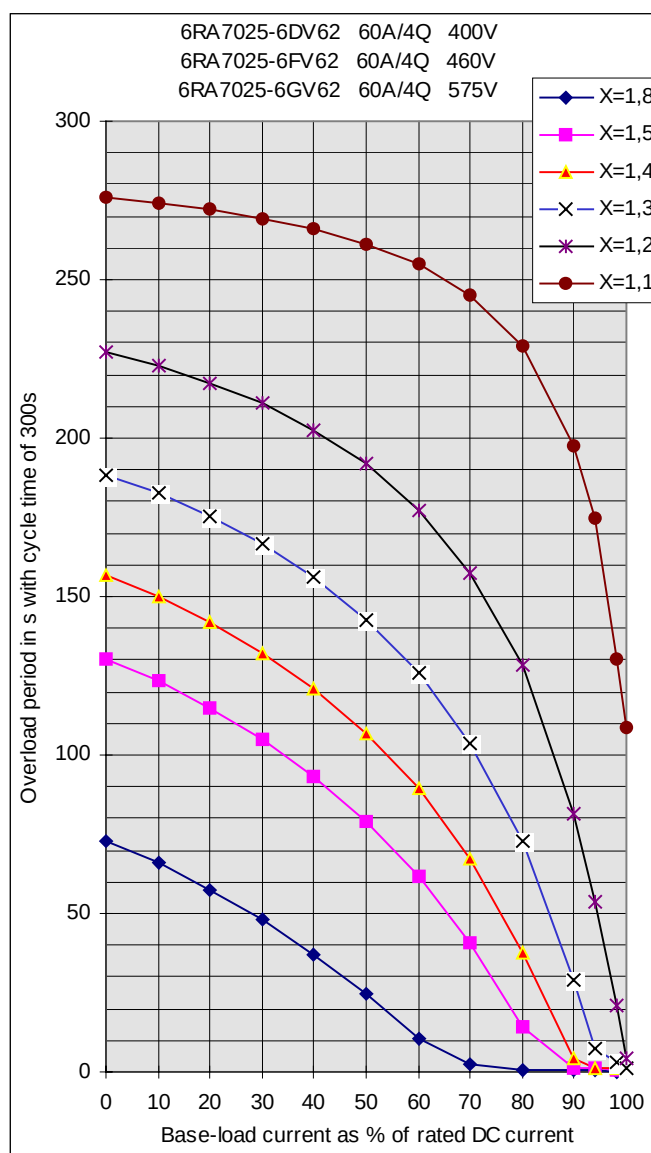
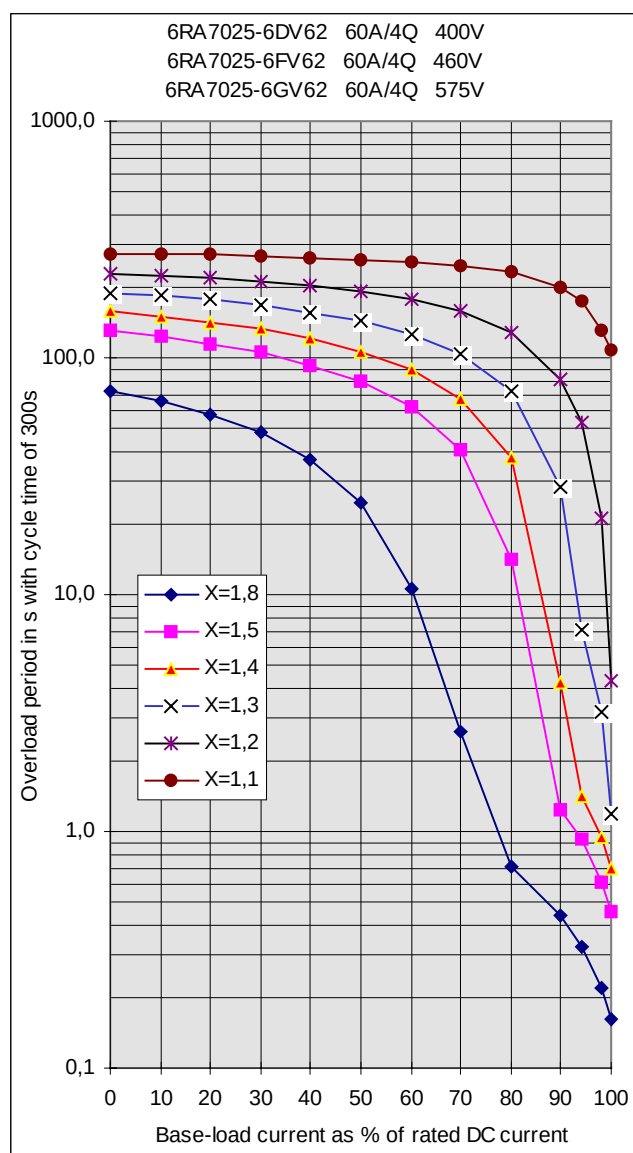
X	t _{an} (s)
1.1	2071
1.2	1352
1.3	988
1.4	756
1.5	592
1.8	296

t_{ab} (s) = 2169

6RA7025-6DV62, 6RA7025-6FV62 und 6RA7025-6GV62

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	72.980	130.400	156.740	188.460	227.300	275.940
10	65.811	123.227	149.957	182.498	222.876	274.175
20	57.585	114.814	141.930	175.350	217.469	272.034
30	48.150	104.895	132.360	166.711	210.816	269.379
40	37.259	93.130	120.832	156.101	202.443	265.933
50	24.678	79.007	106.735	142.839	191.669	261.301
60	10.683	61.827	89.233	125.906	177.370	254.787
70	2.634	40.555	66.989	103.596	157.563	245.064
80	0.716	14.001	37.903	72.993	128.433	228.970
90	0.439	1.241	4.225	28.730	81.603	197.474
94	0.328	0.927	1.420	7.154	53.876	174.472
98	0.217	0.614	0.940	3.179	20.823	130.537
100	0.162	0.457	0.700	1.191	4.296	108.570

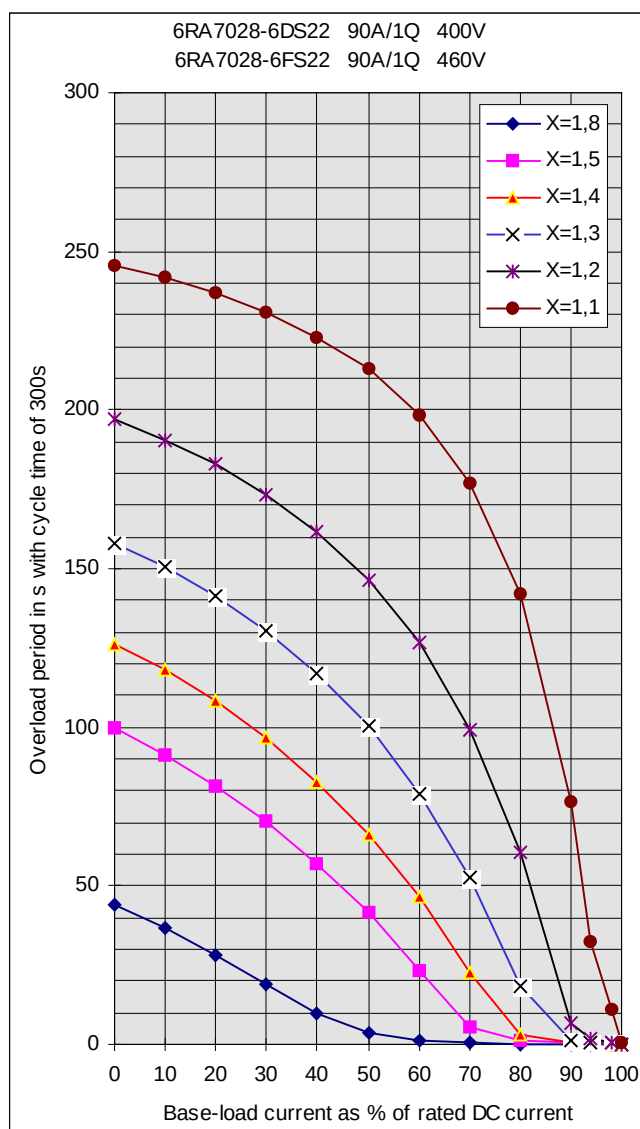
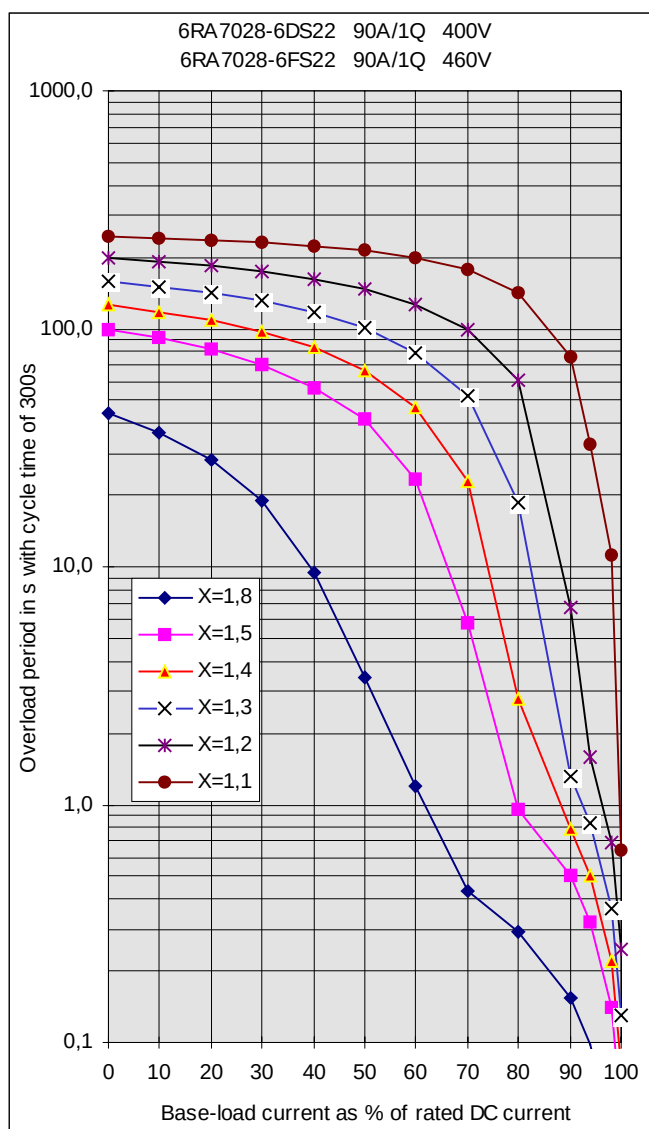
X	t _{an} (s)
1.1	2535
1.2	1446
1.3	1016
1.4	761
1.5	587
1.8	283

t_{ab} (s) = 2522

6RA7028-6DS22 und 6RA7028-6FS22

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	44.040	99.800	126.140	157.960	196.940	245.560
10	36.508	91.356	117.870	150.323	190.607	241.690
20	28.138	81.553	108.144	141.179	182.942	236.930
30	18.933	70.135	96.619	130.216	173.518	230.885
40	9.535	56.833	82.883	116.804	161.716	223.119
50	3.430	41.356	66.380	100.170	146.594	212.760
60	1.190	23.503	46.481	79.223	126.664	198.343
70	0.432	5.814	22.736	52.448	99.405	176.957
80	0.293	0.954	2.778	18.590	60.445	142.178
90	0.154	0.502	0.790	1.309	6.765	76.545
94	0.099	0.321	0.506	0.837	1.579	32.480
98	0.043	0.141	0.221	0.366	0.691	11.259
100	0.015	0.050	0.079	0.131	0.247	0.648

X	t _{an} (s)
1.1	1879
1.2	1186
1.3	831
1.4	604
1.5	443
1.8	151

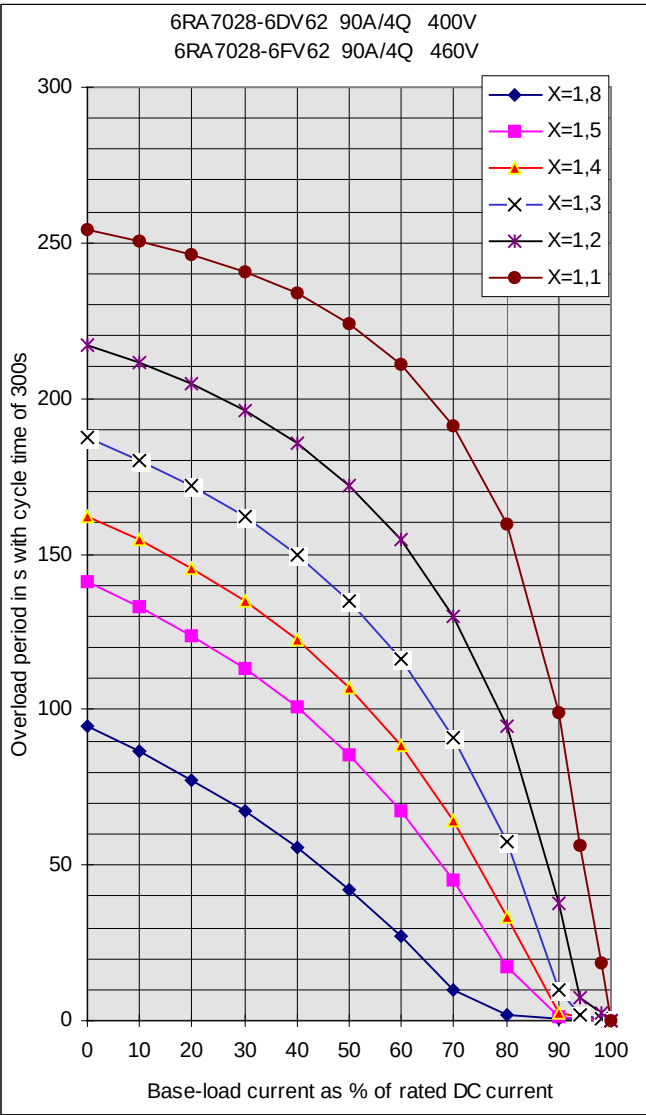
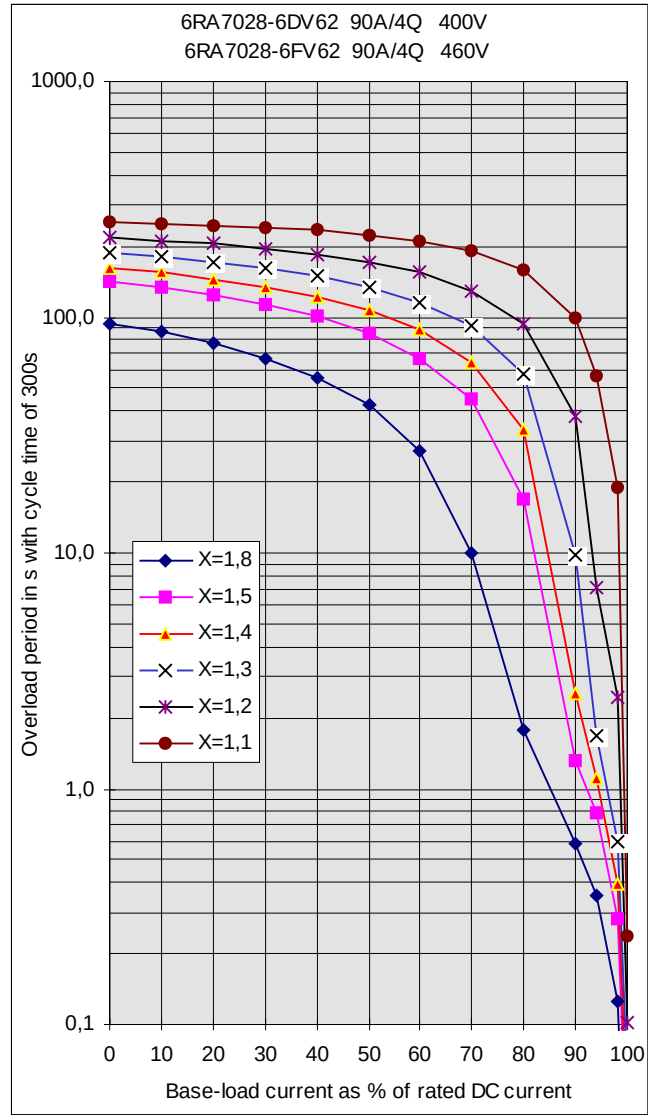
t_{ab} (s) = 2668

6RA7028-6DV62 und 6RA7028-6FV62

I _g (%)	Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	94.460	141.260	162.280	187.240	217.380	254.460						
10	86.466	133.232	154.580	180.222	211.582	250.787						
20	77.462	123.966	145.592	171.911	204.624	246.336						
30	67.269	113.195	135.009	161.976	196.128	240.743						
40	55.667	100.540	122.390	149.907	185.555	233.598						
50	42.361	85.483	107.108	134.954	172.084	224.091						
60	27.004	67.315	88.261	115.992	154.347	210.906						
70	9.972	44.985	64.499	91.200	129.983	191.381						
80	1.781	17.079	33.595	57.466	94.473	159.668						
90	0.581	1.302	2.533	9.867	37.987	99.089						
94	0.354	0.792	1.108	1.680	7.117	56.044						
98	0.126	0.283	0.396	0.600	2.441	18.841						
100	0.013	0.028	0.040	0.060	0.103	0.239						

X	t _{an} (s)
1.1	1911
1.2	1320
1.3	1007
1.4	804
1.5	659
1.8	391

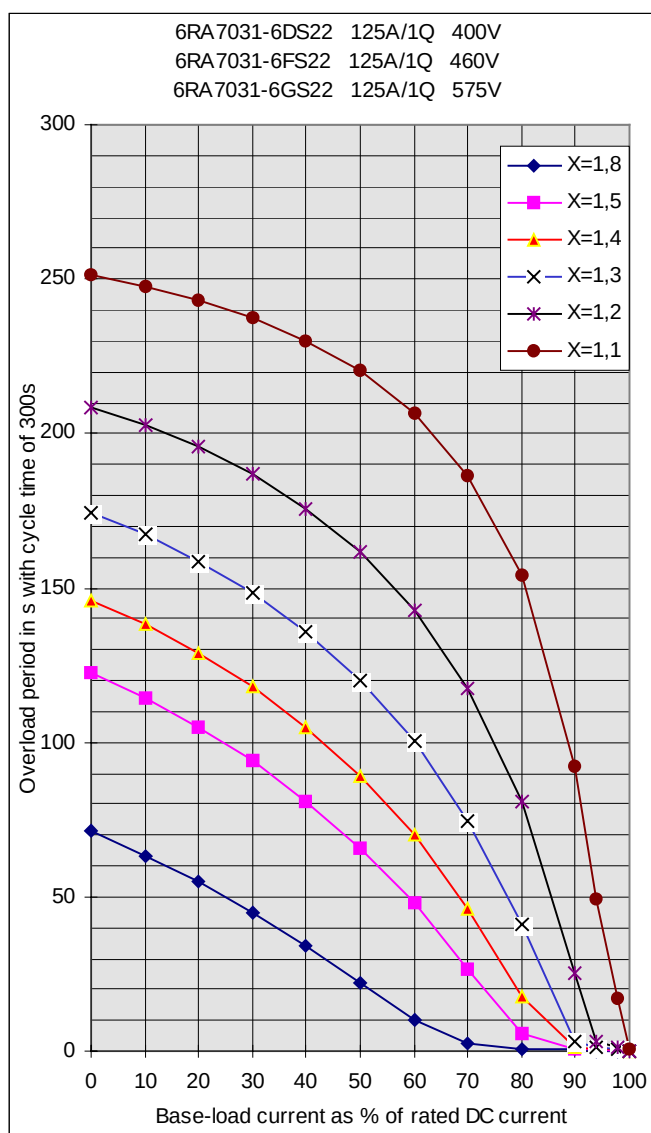
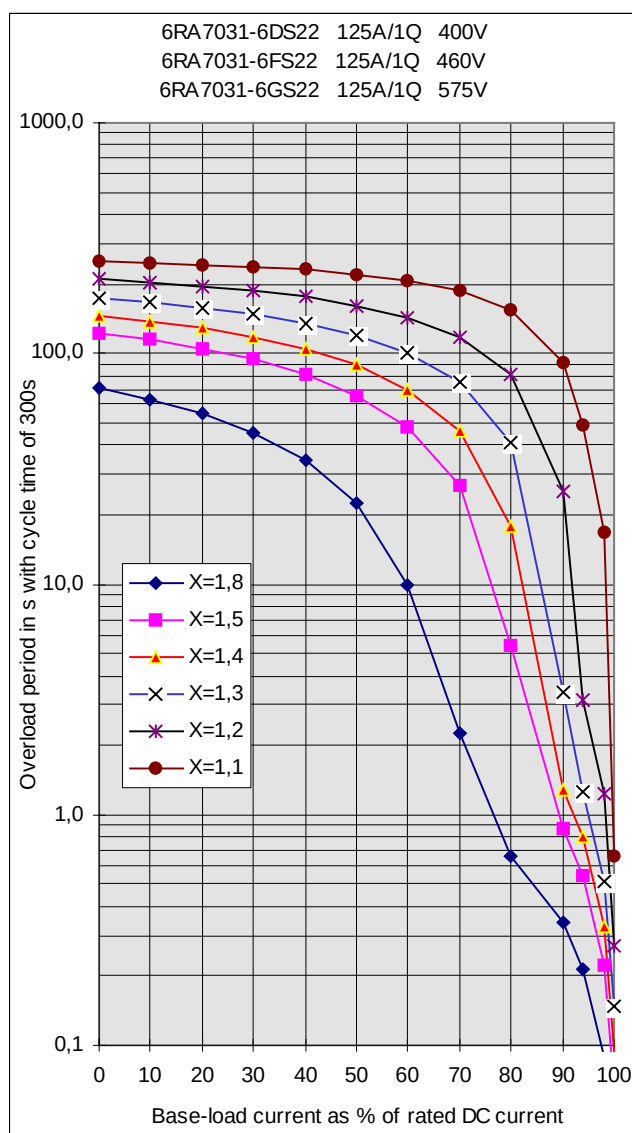
t_{ab} (s) = 2658



6RA7031-6DS22, 6RA7031-6FS22 und 6RA7031-6GS22

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	71.160	122.540	146.140	174.380	208.680	251.080
10	63.409	114.371	138.230	167.128	202.695	247.413
20	54.716	104.905	128.959	158.516	195.483	242.887
30	45.000	93.880	118.003	148.165	186.653	237.226
40	34.184	80.975	104.942	135.556	175.626	229.911
50	22.239	65.756	89.153	119.928	161.525	220.178
60	9.830	47.787	69.886	100.161	142.928	206.664
70	2.269	26.730	46.225	74.573	117.429	186.607
80	0.655	5.378	17.613	40.970	80.571	153.963
90	0.340	0.863	1.270	3.395	25.315	91.948
94	0.214	0.544	0.799	1.258	3.159	49.218
98	0.088	0.224	0.329	0.518	1.231	16.851
100	0.025	0.064	0.094	0.148	0.267	0.667

X	t _{an} (s)
1.1	1994
1.2	1318
1.3	968
1.4	743
1.5	582
1.8	289

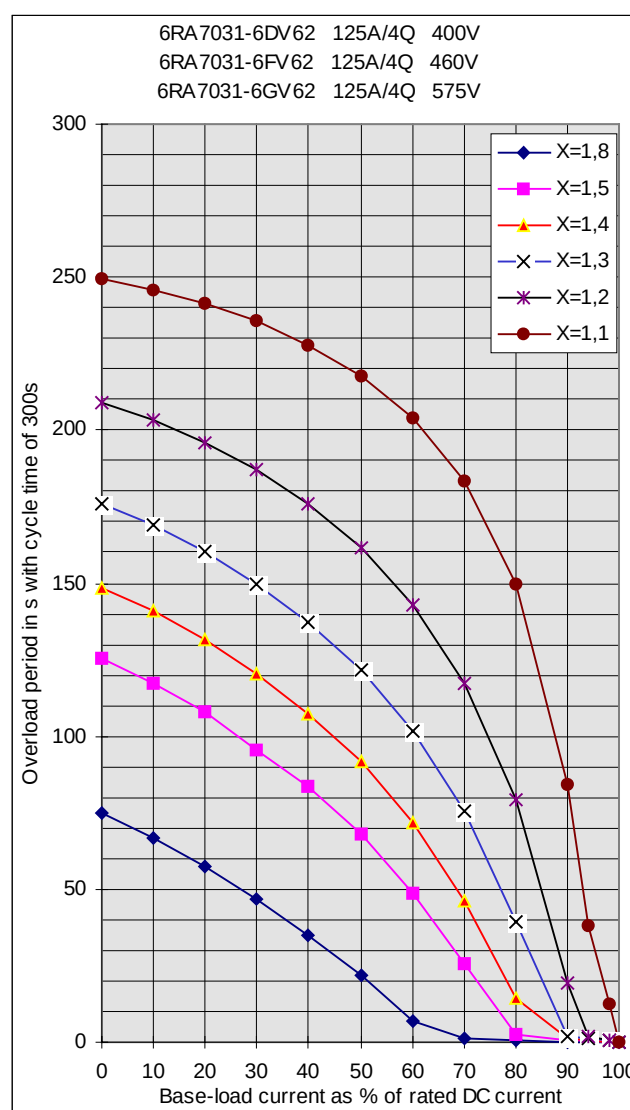
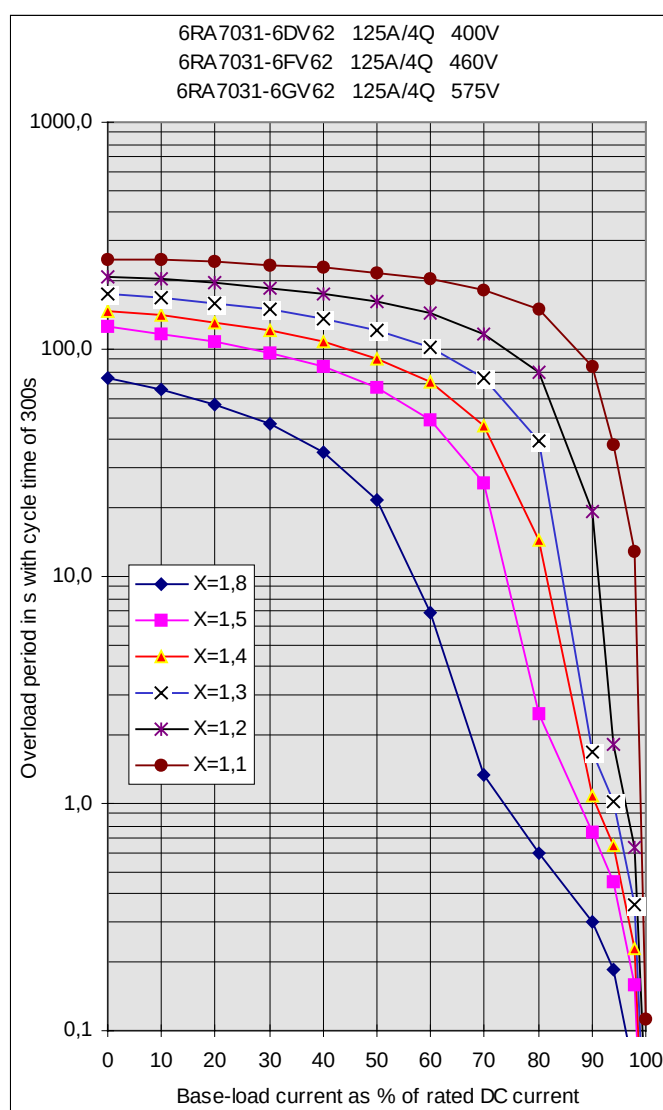
t_{ab} (s) = 3110

6RA7031-6DV62, 6RA7031-6FV62 und 6RA7031-6GV62

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	74.560	125.660	148.680	176.040	209.100	249.760
10	66.512	117.485	140.799	168.832	203.128	245.972
20	57.377	107.974	131.548	160.259	195.896	241.303
30	46.984	95.363	120.584	149.925	187.042	235.487
40	35.141	83.679	107.433	137.311	175.983	227.952
50	21.702	67.946	91.425	121.613	161.810	217.919
60	6.944	48.910	71.581	101.600	143.079	203.951
70	1.340	25.670	46.462	75.329	117.208	183.226
80	0.603	2.501	14.468	39.467	79.328	149.404
90	0.304	0.749	1.080	1.686	19.379	84.405
94	0.184	0.454	0.655	1.022	1.811	38.066
98	0.065	0.159	0.230	0.358	0.635	12.764
100	0.005	0.012	0.017	0.027	0.047	0.113

X	t _{an} (s)
1.1	2160
1.2	1453
1.3	1079
1.4	836
1.5	662
1.8	344

$$t_{ab} (s) = 3112$$

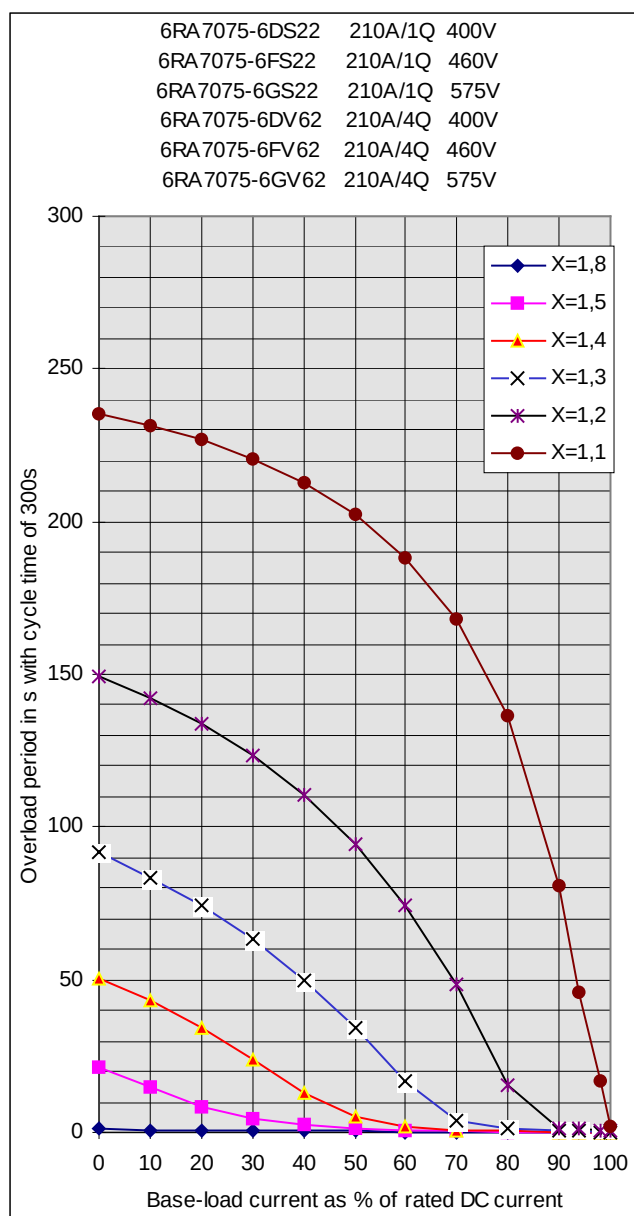
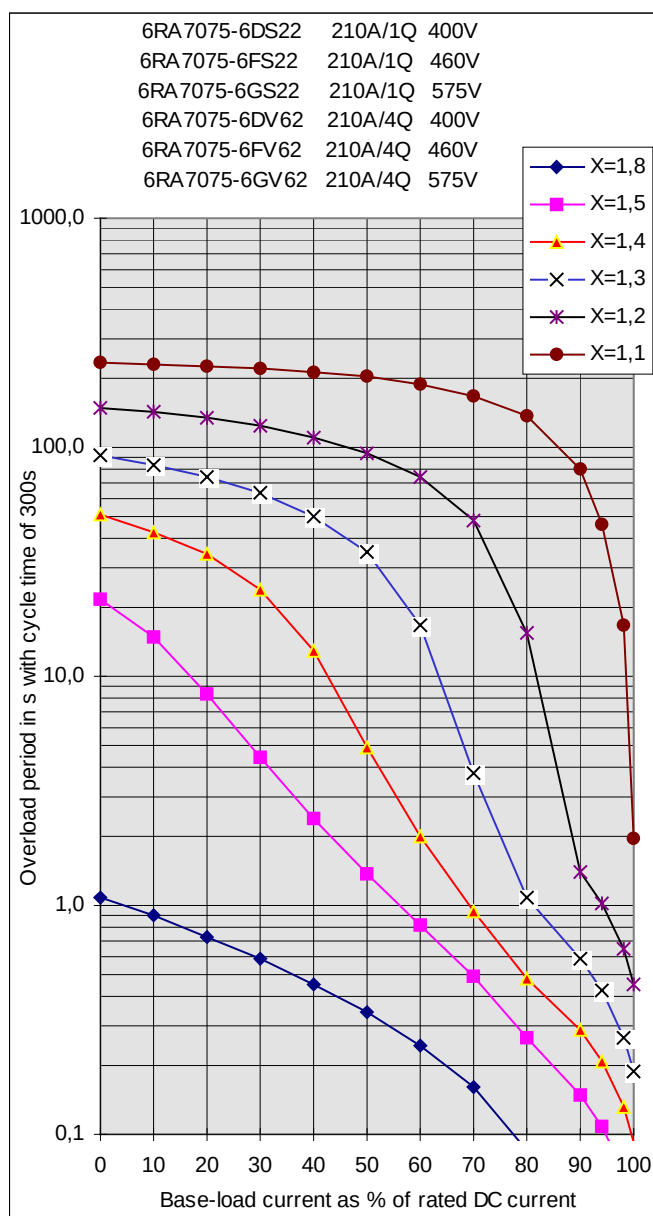


6RA7075-6DS22. 6RA7075-6FS22 und 6RA7075-6GS22
6RA7075-6DV62. 6RA7075-6FV62 und 6RA7075-6GV62

lg (%)	Tp (s) X=1.8	Tp (s) X=1.5	Tp (s) X=1.4	Tp (s) X=1.3	Tp (s) X=1.2	Tp (s) X=1.1
0	1.080	21.600	50.720	91.660	149.600	235.560
10	0.902	14.843	43.009	83.652	142.448	231.608
20	0.733	8.313	34.150	74.216	133.825	226.741
30	0.585	4.428	24.068	63.100	123.347	220.628
40	0.456	2.419	12.873	50.001	110.490	212.789
50	0.344	1.369	4.870	34.589	94.498	202.443
60	0.246	0.826	1.995	16.667	74.278	188.324
70	0.160	0.486	0.947	3.749	48.370	167.990
80	0.085	0.264	0.480	1.081	15.400	136.377
90	0.024	0.150	0.286	0.581	1.407	80.999
94	0.015	0.109	0.209	0.424	1.025	45.980
98	0.010	0.069	0.131	0.266	0.644	16.631
100	0.007	0.048	0.092	0.187	0.454	1.956

X	t _{an} (s)
1.1	680.00
1.2	318.00
1.3	167.00
1.4	78.00
1.5	25.00
1.8	0.96

t_{ab} (s) = 766

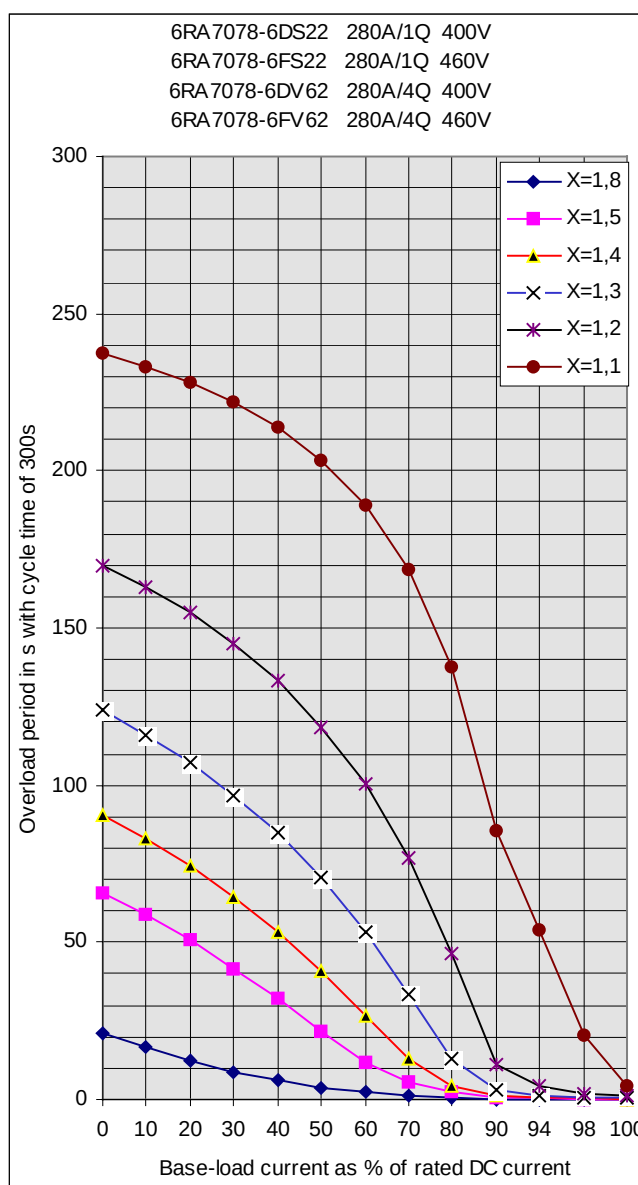
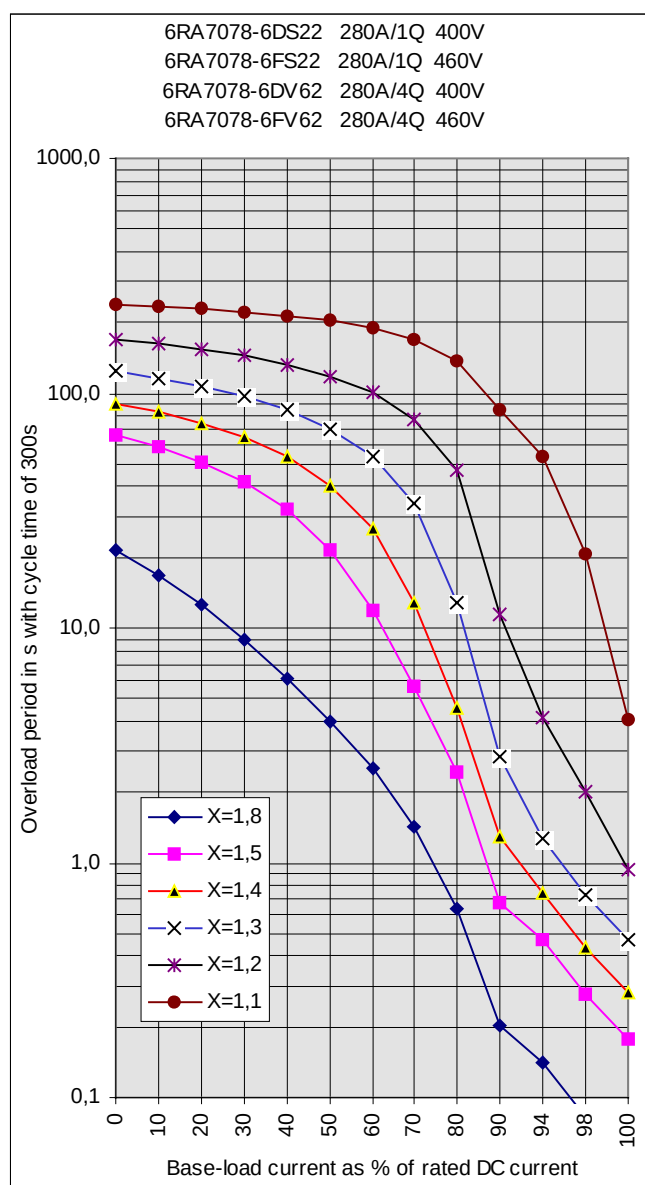


6RA7078-6DS22 und 6RA7078-6FS22
6RA7078-6DV62 und 6RA7078-6FV62

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	21.300	65.680	90.400	123.700	169.960	237.500
10	16.768	58.584	82.846	116.025	163.015	233.249
20	12.534	50.641	74.247	107.139	154.795	228.092
30	8.923	41.770	64.461	96.798	144.953	221.708
40	6.091	31.938	53.316	84.699	133.042	213.585
50	4.023	21.435	40.632	70.460	118.418	203.028
60	2.540	11.925	26.420	53.609	100.127	188.753
70	1.437	5.650	12.725	33.714	76.841	168.506
80	0.638	2.410	4.605	12.943	46.698	137.624
90	0.202	0.673	1.290	2.842	11.433	85.548
94	0.142	0.474	0.748	1.265	4.192	53.870
98	0.083	0.276	0.435	0.736	2.017	20.682
100	0.053	0.177	0.279	0.472	0.930	4.088

X	t _{an} (s)
1.1	729
1.2	381
1.3	237
1.4	155
1.5	103
1.8	24

t_{ab} (s) = 840

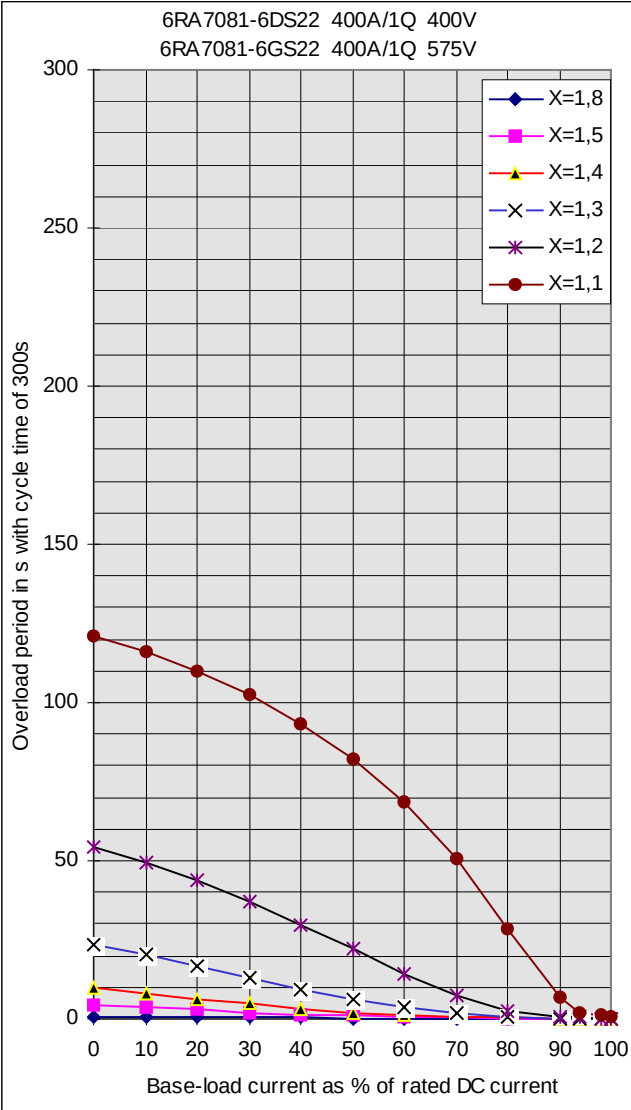
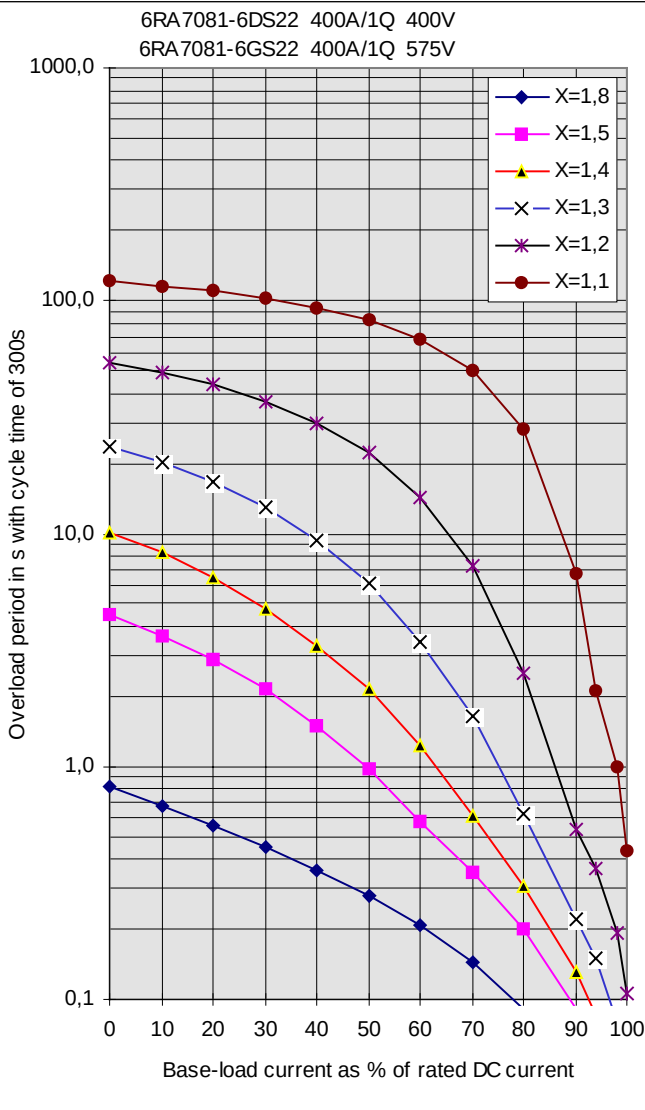


6RA7081-6DS22 und 6RA7081-6GS22

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	0.820	4.500	10.140	23.420	54.060	121.080
10	0.680	3.657	8.318	20.184	49.209	115.906
20	0.555	2.859	6.478	16.703	43.560	109.708
30	0.447	2.141	4.767	13.079	37.094	102.254
40	0.355	1.507	3.309	9.437	29.872	93.218
50	0.276	0.969	2.145	6.057	22.145	82.116
60	0.207	0.584	1.237	3.414	14.378	68.216
70	0.146	0.352	0.617	1.658	7.250	50.437
80	0.090	0.201	0.309	0.621	2.518	28.154
90	0.039	0.090	0.131	0.221	0.532	6.682
94	0.020	0.054	0.086	0.150	0.361	2.134
98	0.010	0.029	0.046	0.079	0.191	1.000
100	0.006	0.016	0.025	0.044	0.106	0.434

X	t _{an} (s)
1.1	130.40
1.2	53.90
1.3	21.70
1.4	8.90
1.5	3.80
1.8	0.72

t_{ab} (s) = 198

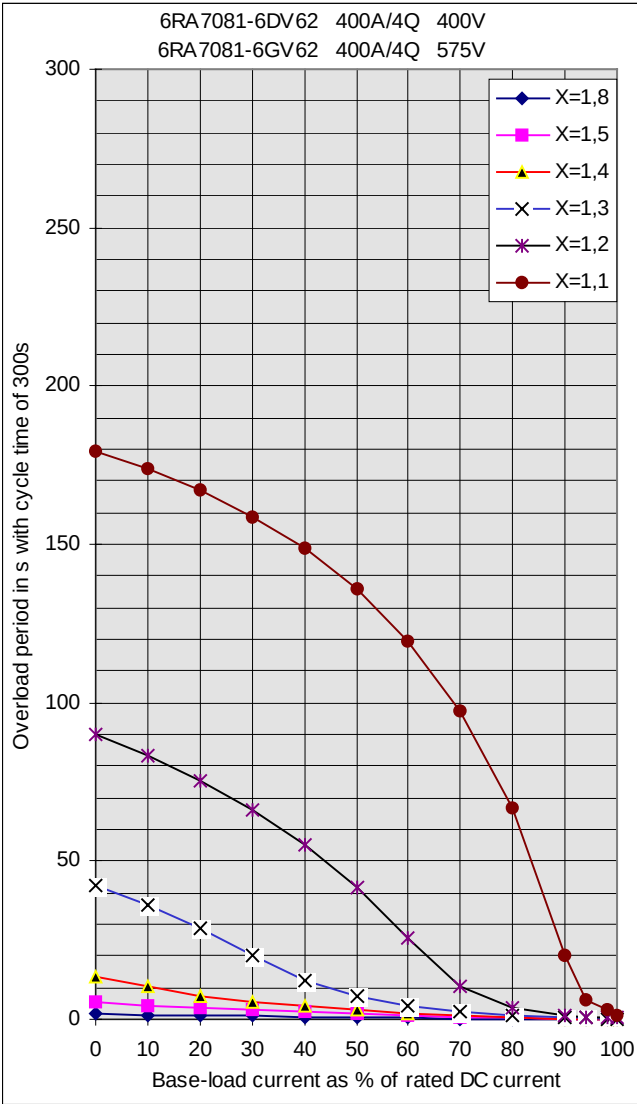
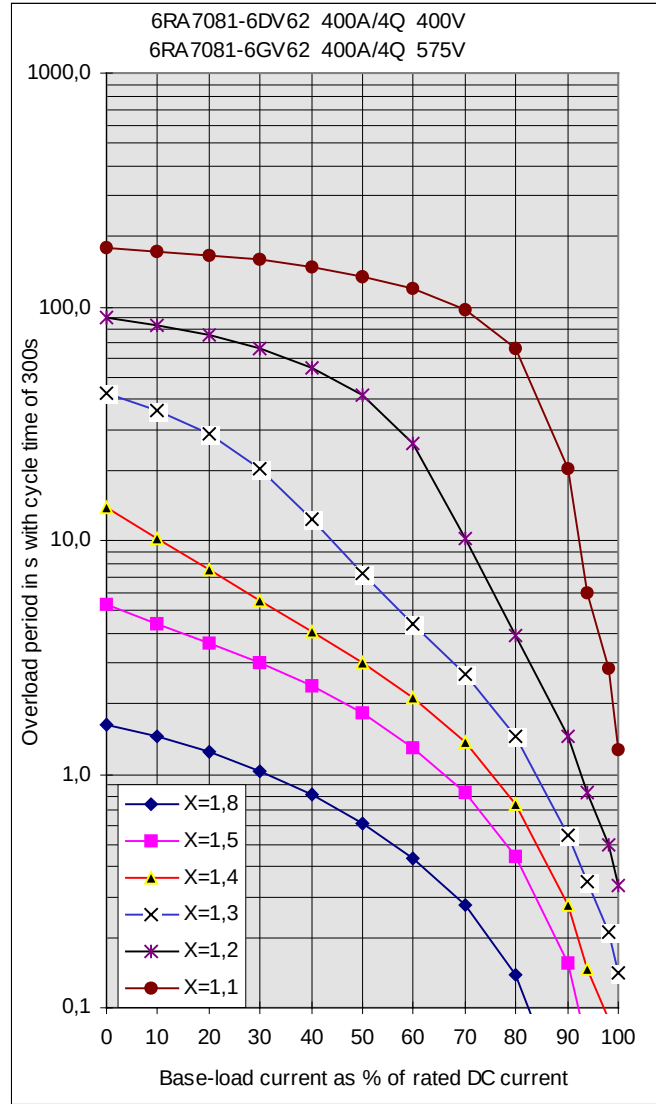


6RA7081-6DV62 und 6RA7081-6GV62

Ig (%)	Tp (s)					
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	1.640	5.320	13.720	42.460	90.020	179.460
10	1.446	4.438	10.202	36.010	83.305	173.786
20	1.235	3.666	7.483	28.596	75.421	166.961
30	1.023	2.985	5.525	20.318	66.139	158.672
40	0.814	2.372	4.105	12.433	55.130	148.477
50	0.617	1.812	3.019	7.189	41.929	135.711
60	0.437	1.296	2.136	4.358	25.980	119.321
70	0.277	0.829	1.382	2.660	10.258	97.514
80	0.137	0.443	0.743	1.449	3.915	66.912
90	0.036	0.155	0.275	0.549	1.454	20.405
94	0.018	0.068	0.148	0.349	0.832	5.925
98	0.011	0.039	0.089	0.210	0.499	2.825
100	0.007	0.025	0.059	0.140	0.333	1.276

X	t _{an} (s)
1.1	282.0
1.2	112.0
1.3	47.0
1.4	13.0
1.5	4.9
1.8	1.5

t_{ab} (s) = 338

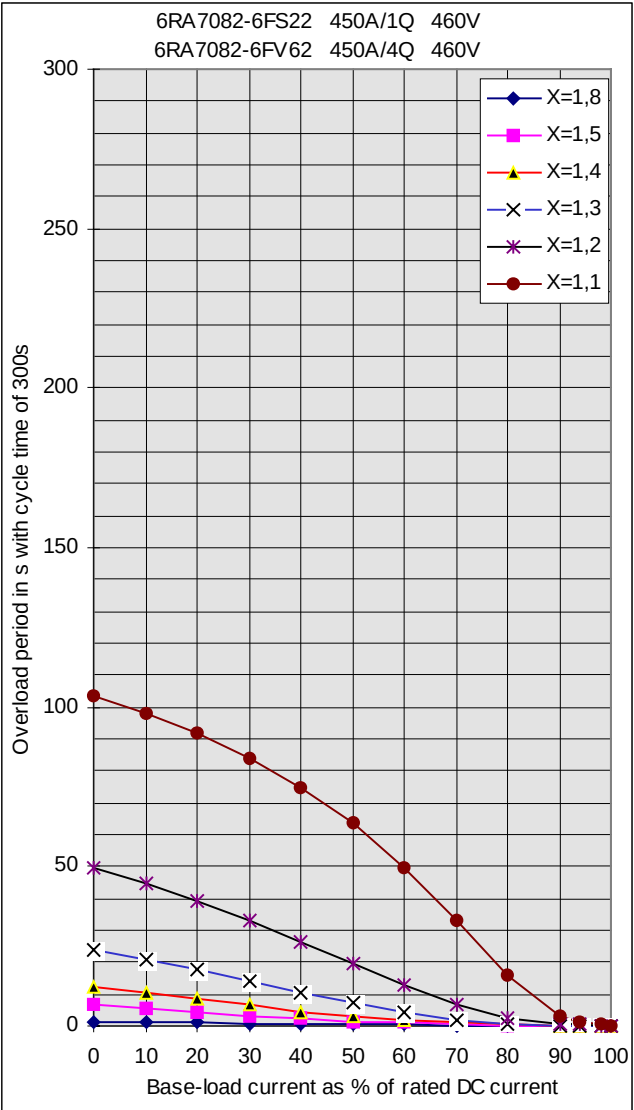
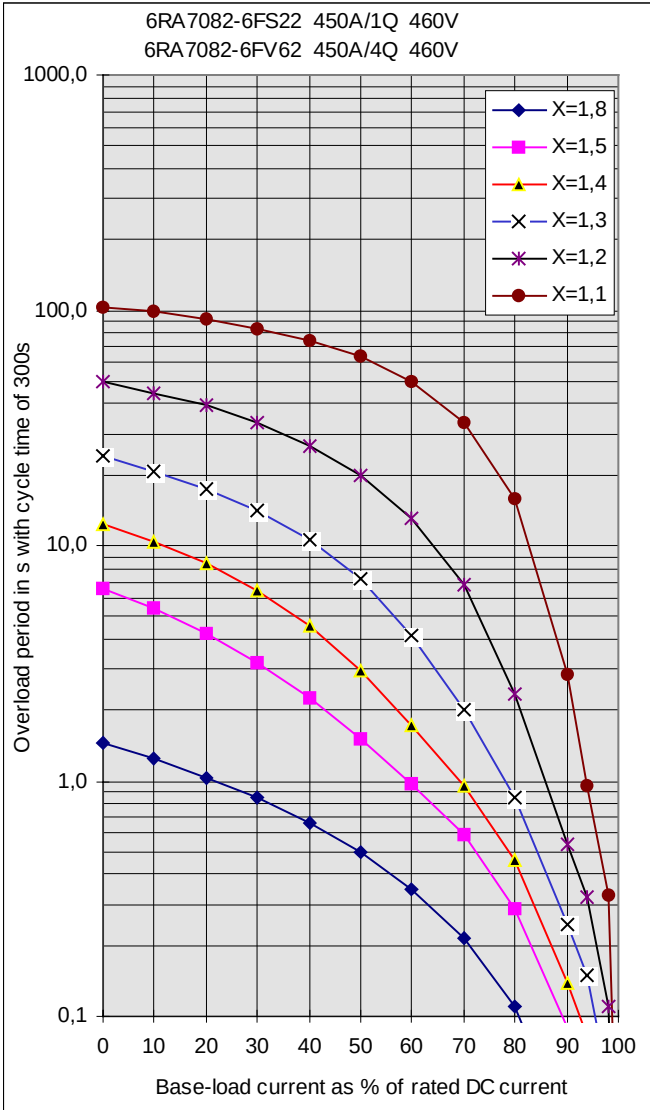


6RA7082-6FS22 und 6RA7082-6FV62

lg (%)	Tp (s) X=1.8	Tp (s) X=1.5	Tp (s) X=1.4	Tp (s) X=1.3	Tp (s) X=1.2	Tp (s) X=1.1
0	1.460	6.560	12.320	23.900	49.460	103.620
10	1.248	5.412	10.423	20.816	44.704	98.249
20	1.039	4.266	8.442	17.528	39.262	91.829
30	0.844	3.189	6.455	14.096	33.181	84.141
40	0.663	2.248	4.583	10.599	26.601	74.867
50	0.495	1.512	2.959	7.189	19.783	63.575
60	0.344	0.980	1.736	4.192	13.053	49.724
70	0.213	0.587	0.959	2.008	6.836	33.160
80	0.110	0.289	0.460	0.847	2.353	15.936
90	0.032	0.090	0.138	0.248	0.542	2.830
94	0.014	0.051	0.083	0.149	0.320	0.947
98	0.005	0.018	0.029	0.051	0.110	0.325
100	0.000	0.001	0.001	0.002	0.005	0.014

X	t _{an} (s)
1.1	109.8
1.2	49.0
1.3	22.4
1.4	11.1
1.5	5.7
1.8	1.3

t_{ab} (s) = 206

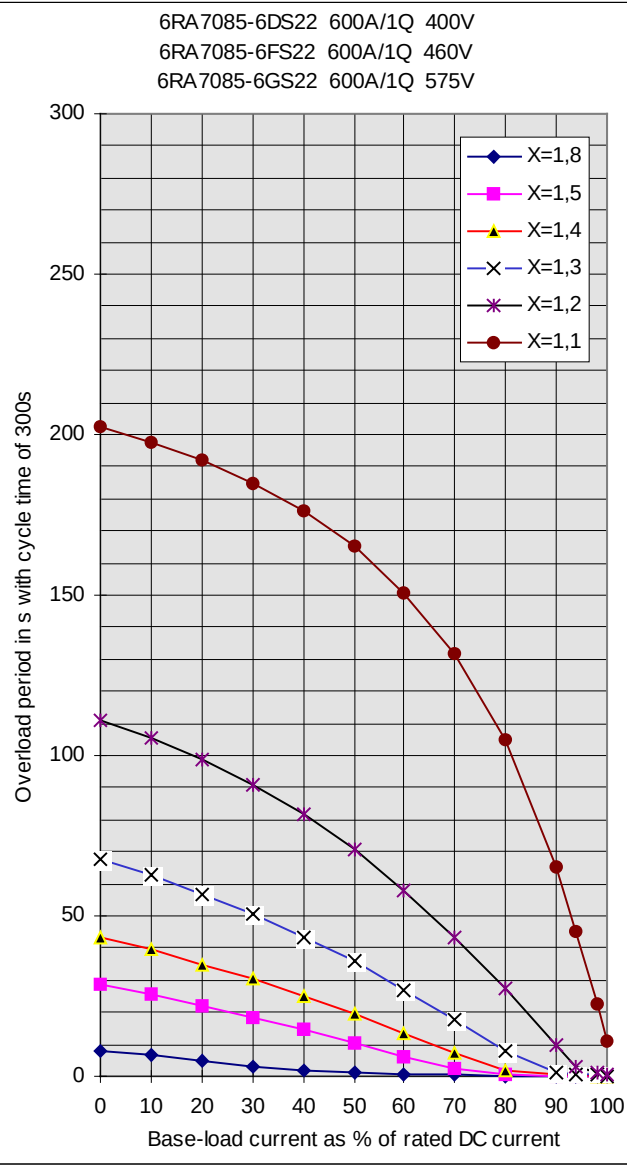
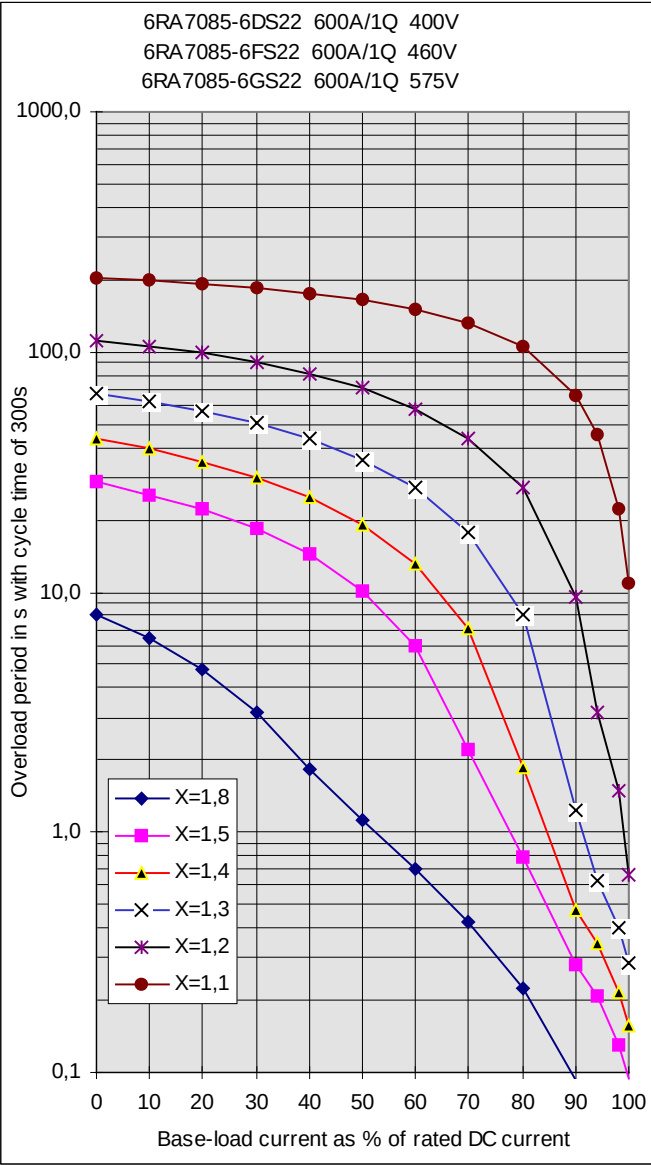


6RA7085-6DS22, 6RA7085-6FS22 und 6RA7085-6GS22

I _g (%)	T _p (s)		T _p (s)		T _p (s)		T _p (s)		T _p (s)		T _p (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	8.020	28.640	43.300	67.520	111.260	202.240						
10	6.452	25.538	39.388	62.591	105.453	197.543						
20	4.806	22.113	35.022	56.979	98.665	191.802						
30	3.158	18.383	30.202	50.655	90.734	184.774						
40	1.837	14.378	24.930	43.582	81.467	176.031						
50	1.118	10.177	19.228	35.738	70.653	164.977						
60	0.704	5.955	13.179	27.126	58.067	150.647						
70	0.422	2.214	7.058	17.825	43.557	131.462						
80	0.222	0.792	1.876	8.028	27.146	104.647						
90	0.094	0.281	0.479	1.235	9.525	65.500						
94	0.069	0.206	0.342	0.626	3.179	45.238						
98	0.044	0.131	0.218	0.398	1.504	22.342						
100	0.031	0.094	0.156	0.285	0.666	10.894						

X	t _{an} (s)
1.1	331.0
1.2	137.0
1.3	74.0
1.4	44.0
1.5	28.0
1.8	6.9

t_{ab} (s) = 381

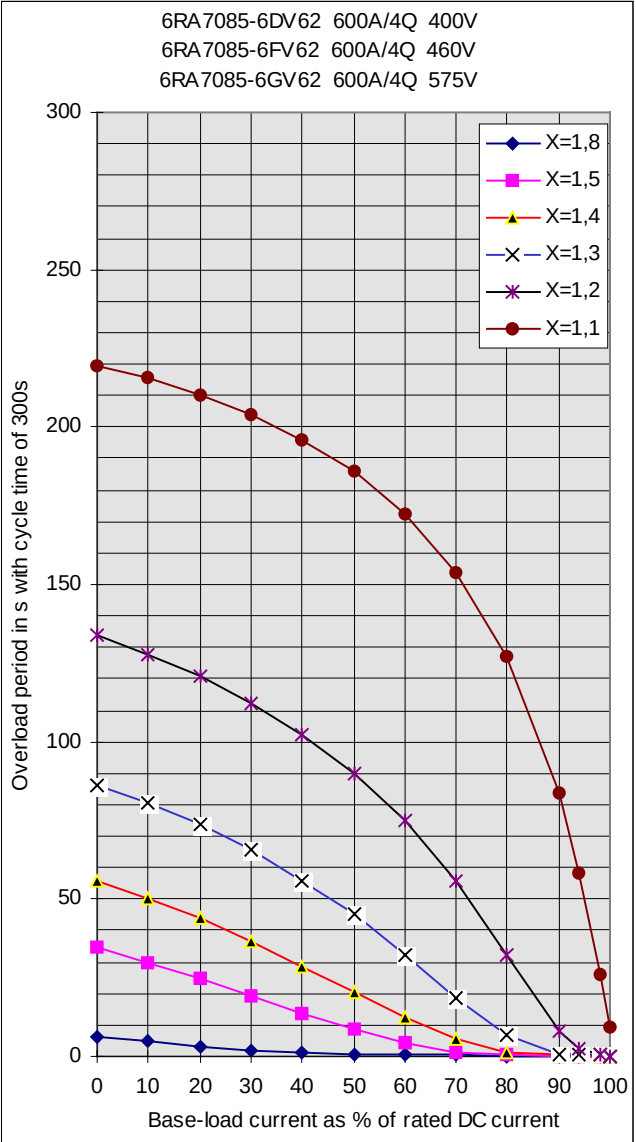
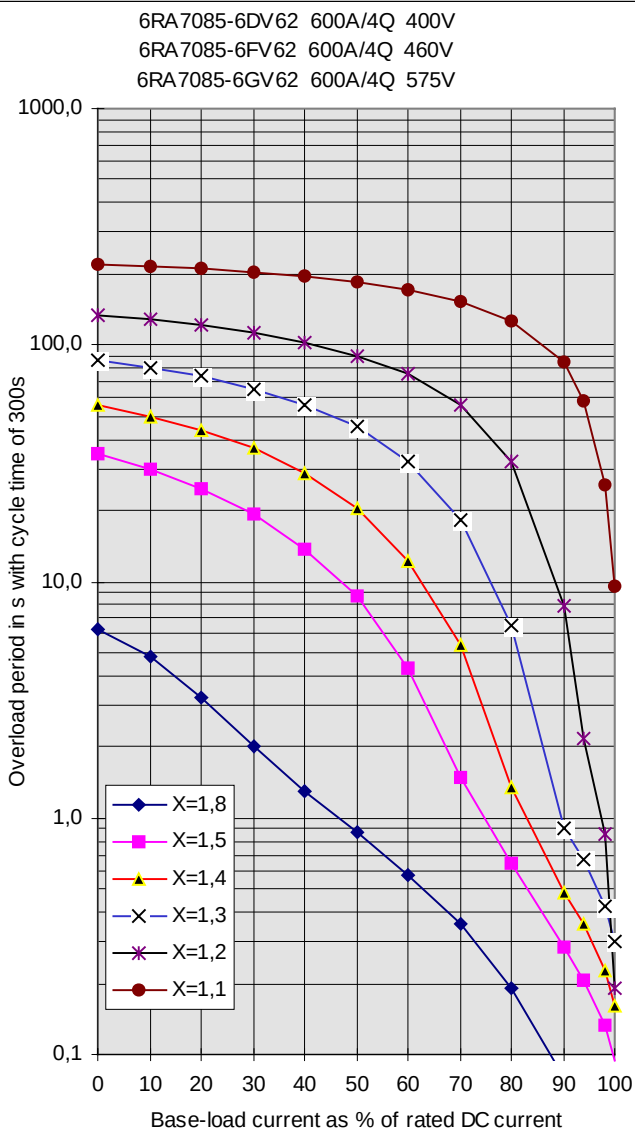


6RA7085-6DV62, 6RA7085-6FV62 und 6RA7085-6GV62

I _g (%)	Tp (s)					
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	6.320	34.420	55.620	86.300	133.680	219.660
10	4.768	29.728	50.173	80.420	127.741	215.465
20	3.249	24.577	43.899	73.524	120.691	210.355
30	2.016	19.130	36.764	65.460	112.287	203.997
40	1.293	13.684	28.809	56.012	102.199	196.025
50	0.868	8.632	20.340	44.942	89.953	185.803
60	0.575	4.294	12.167	32.342	74.877	172.318
70	0.354	1.497	5.361	18.343	55.975	153.824
80	0.192	0.645	1.347	6.565	32.161	126.914
90	0.079	0.283	0.483	0.911	7.922	83.908
94	0.058	0.208	0.355	0.662	2.177	58.269
98	0.037	0.132	0.226	0.421	0.852	25.724
100	0.026	0.094	0.161	0.301	0.190	9.452

X	t _{an} (s)
1.1	423.0
1.2	183.0
1.3	105.0
1.4	63.0
1.5	36.0
1.8	5.2

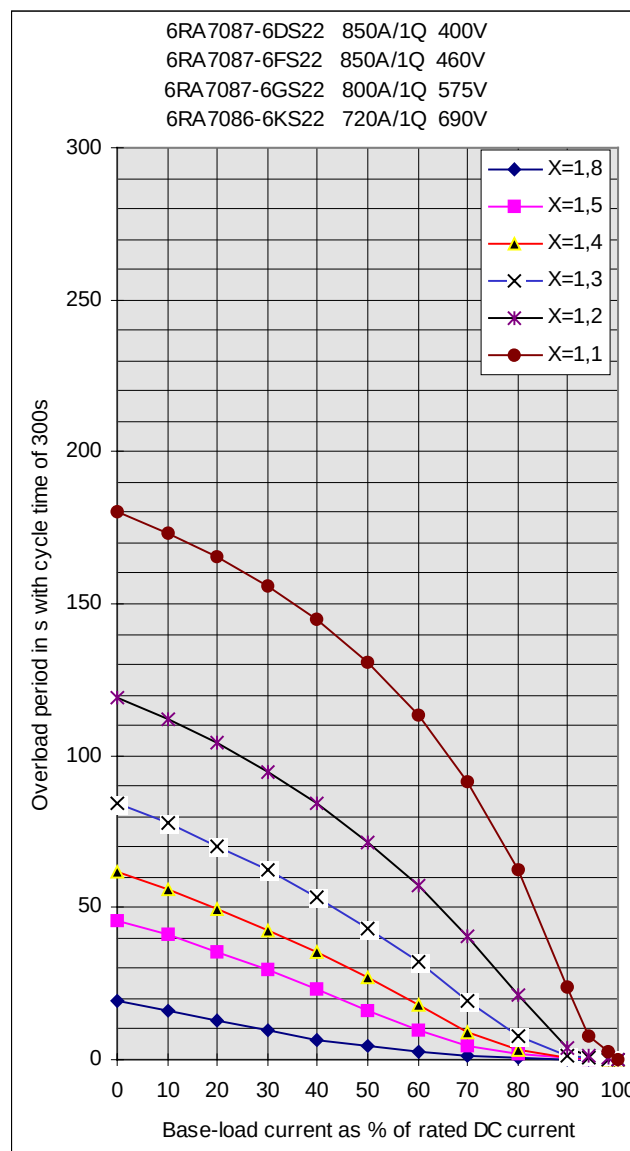
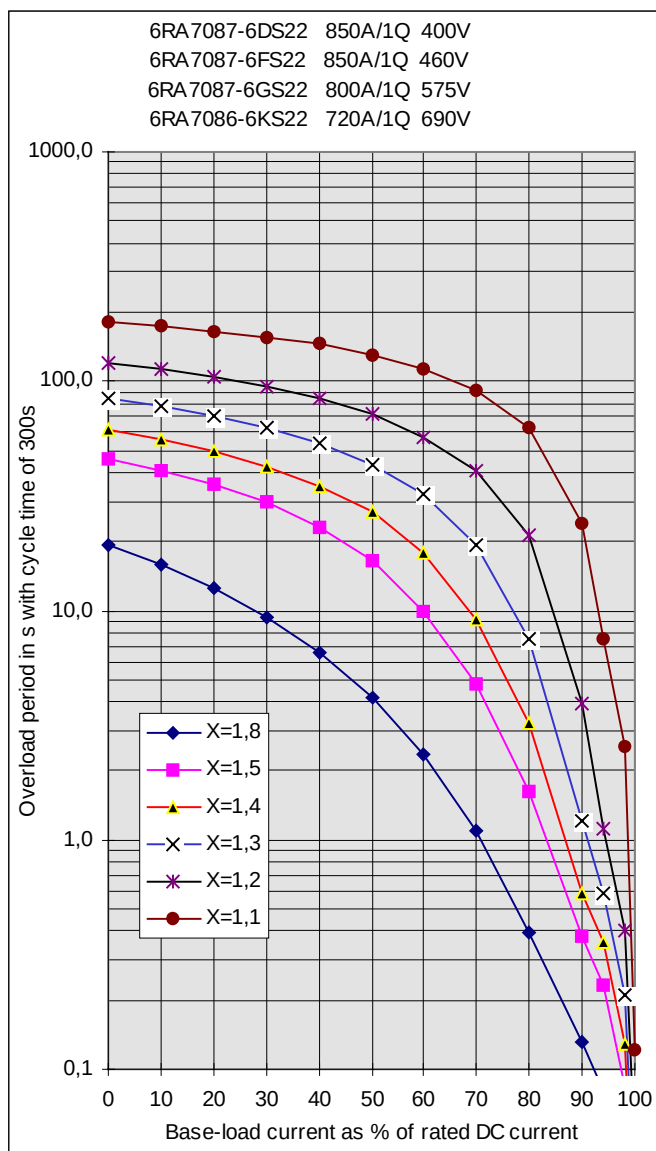
t_{ab} (s) = 452



**6RA7087-6DS22. 6RA7087-6FS22. 6RA7087-6GS22 und
6RA7086-6KS22**

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	19.240	45.900	61.540	84.160	119.400	180.060
10	15.940	40.913	55.837	77.668	112.234	173.376
20	12.583	35.472	49.571	70.427	104.059	165.491
30	9.370	29.557	42.685	62.357	94.724	156.078
40	6.534	23.164	35.118	53.350	84.017	144.712
50	4.195	16.405	26.816	43.272	71.675	130.776
60	2.356	9.869	17.861	31.981	57.378	113.369
70	1.101	4.796	9.197	19.447	40.710	91.195
80	0.392	1.619	3.225	7.482	21.279	62.331
90	0.132	0.383	0.585	1.209	3.936	23.947
94	0.080	0.234	0.357	0.586	1.125	7.453
98	0.029	0.084	0.128	0.211	0.405	2.565
100	0.003	0.009	0.014	0.023	0.045	0.122

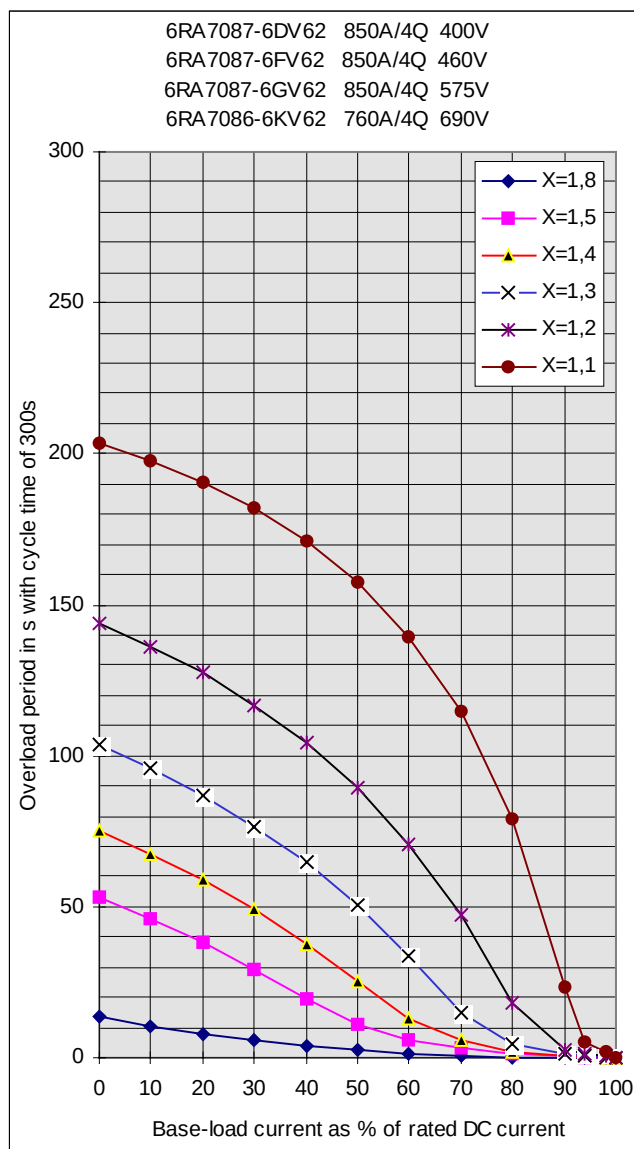
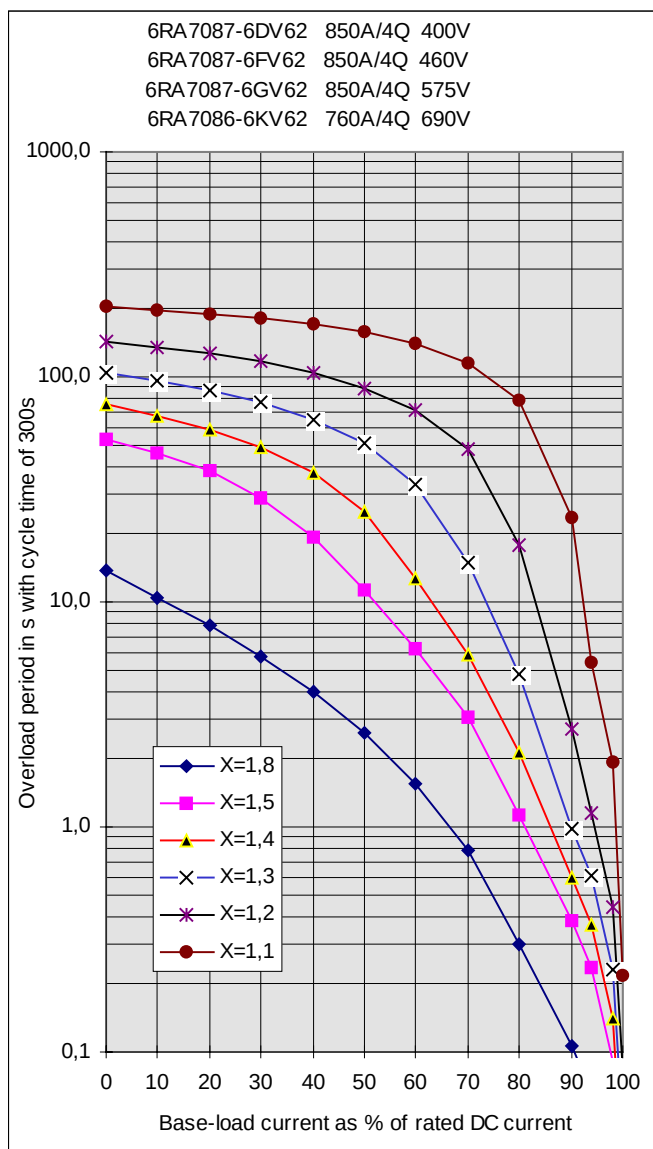
X	t _{an} (s)
1.1	296
1.2	161
1.3	102
1.4	70
1.5	50
1.8	19

 $t_{ab} (s) = 516$


**6RA7087-6DV62. 6RA7087-6FV62. 6RA7087-6GV62 und
6RA7086-6KV62**

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	13.760	53.220	74.980	103.760	143.740	203.660
10	10.426	46.039	67.417	95.971	136.188	197.687
20	7.840	37.973	58.820	87.013	127.352	190.507
30	5.681	28.968	49.019	76.651	116.928	181.775
40	4.005	19.373	37.798	64.573	104.480	170.947
50	2.631	11.176	25.080	50.350	89.409	157.197
60	1.548	6.126	12.836	33.449	70.819	139.217
70	0.787	3.058	5.774	14.946	47.335	114.694
80	0.303	1.132	2.146	4.802	17.887	79.242
90	0.106	0.382	0.596	0.981	2.723	23.486
94	0.066	0.236	0.368	0.606	1.150	5.393
98	0.025	0.090	0.141	0.232	0.439	1.942
100	0.005	0.017	0.027	0.044	0.084	0.217

X	t _{an} (s)
1.1	382.0
1.2	228.0
1.3	150.0
1.4	102.0
1.5	68.0
1.8	13.5

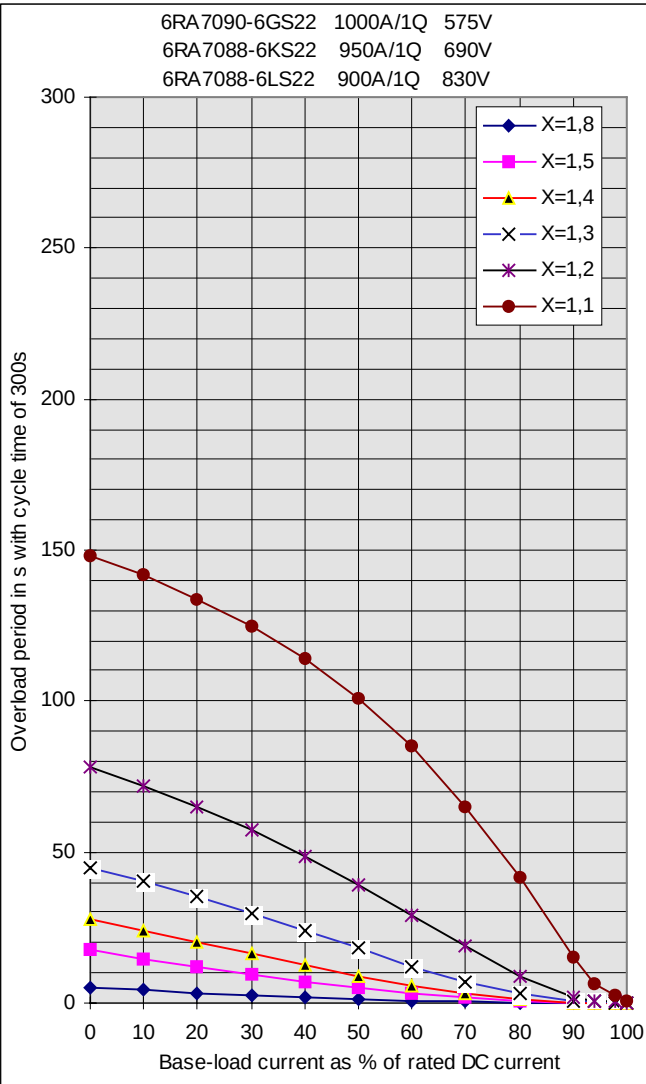
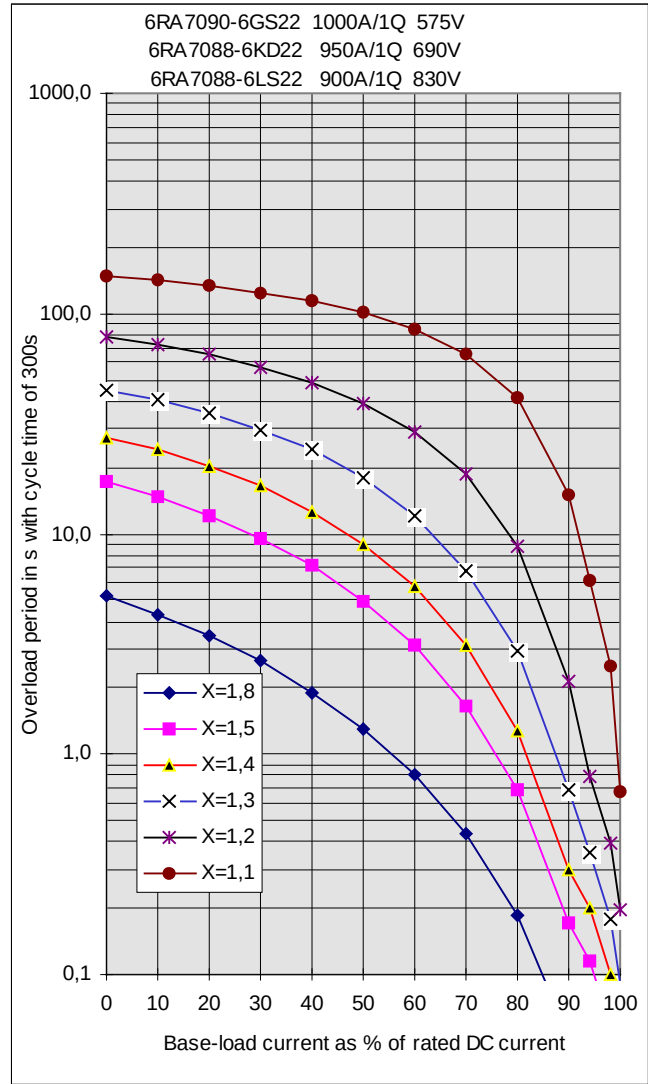
 $t_{ab} (s) = 582$


6RA7090-6GS22, 6RA7088-6KS22 und 6RA7088-6LS22

I _g (%)	Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	5.200	17.360	27.520	44.980	78.220	148.060						
10	4.317	14.787	24.058	40.280	72.007	141.537						
20	3.462	12.144	20.380	35.203	65.028	133.879						
30	2.652	9.551	16.541	29.781	57.253	124.828						
40	1.916	7.132	12.653	24.043	48.664	114.020						
50	1.296	4.984	8.952	18.058	39.296	100.938						
60	0.807	3.136	5.740	12.075	29.251	84.905						
70	0.436	1.655	3.148	6.812	18.728	65.123						
80	0.183	0.689	1.282	2.925	8.727	41.287						
90	0.052	0.173	0.301	0.692	2.145	15.025						
94	0.035	0.115	0.200	0.359	0.793	6.128						
98	0.017	0.058	0.100	0.179	0.397	2.491						
100	0.009	0.029	0.050	0.090	0.198	0.672						

X	t _{an} (s)
1.1	185.0
1.2	86.0
1.3	46.0
1.4	26.0
1.5	16.0
1.8	4.6

t_{ab} (s) = 296

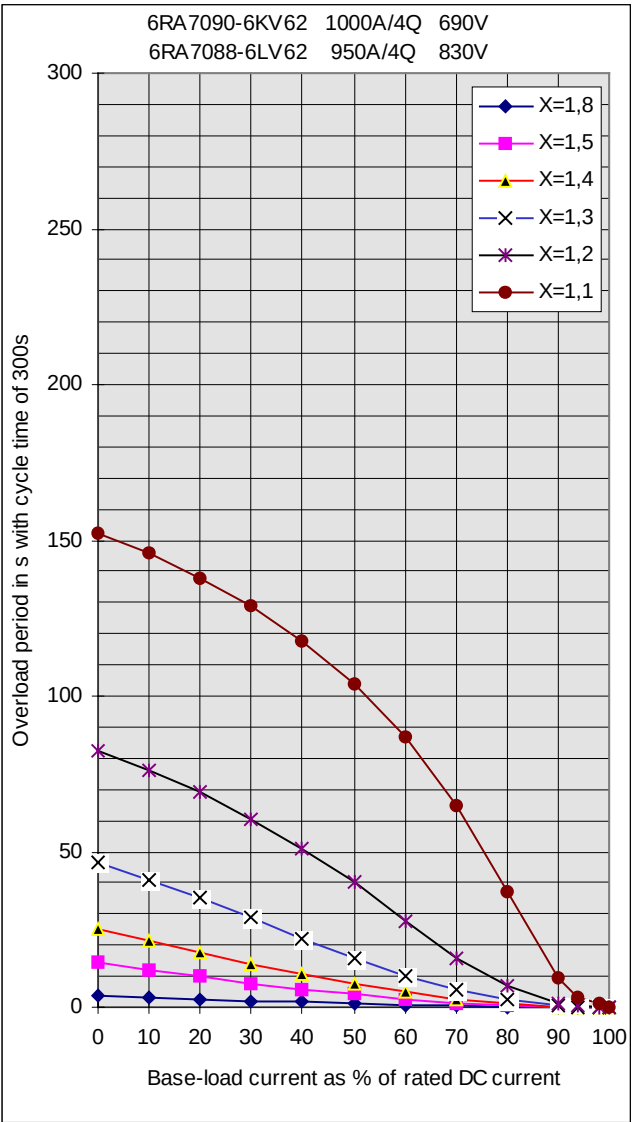
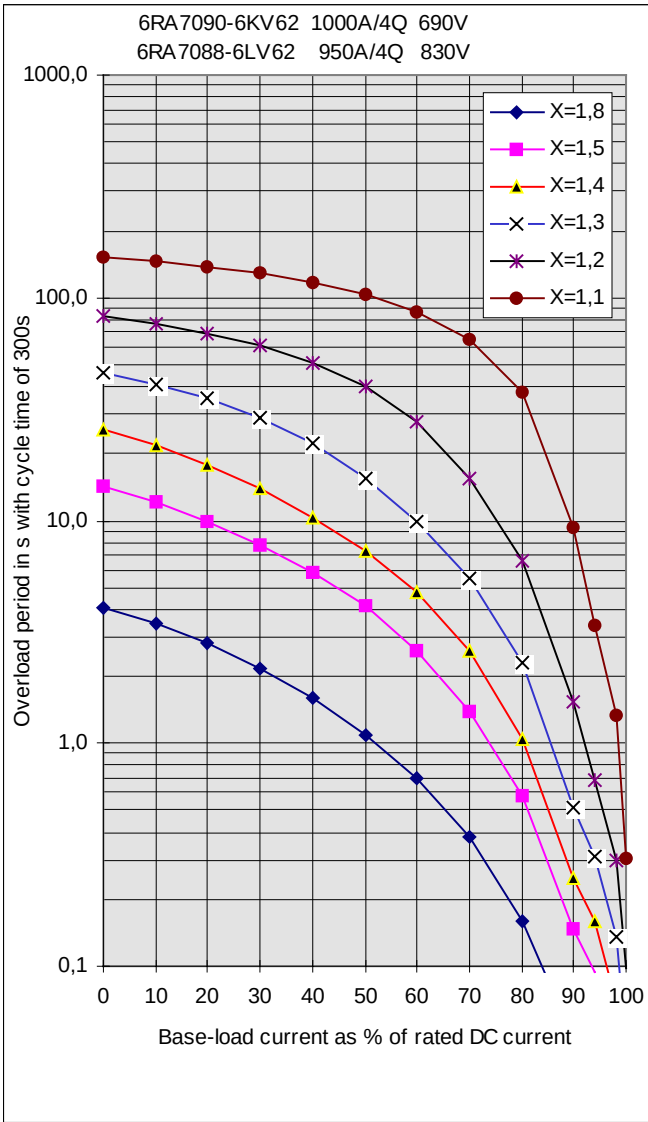


6RA7090-6KV62 und 6RA7088-6LV62

I _g (%)	Tp (s)					
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	4.080	14.280	25.460	46.360	82.600	152.260
10	3.442	12.036	21.667	41.114	76.322	145.782
20	2.794	9.811	17.755	35.237	69.058	138.048
30	2.164	7.746	13.929	28.803	60.682	128.752
40	1.586	5.854	10.403	22.049	51.032	117.487
50	1.093	4.142	7.334	15.493	39.973	103.686
60	0.693	2.616	4.748	9.849	27.665	86.554
70	0.378	1.385	2.597	5.516	15.554	64.950
80	0.160	0.581	1.049	2.324	6.650	37.418
90	0.048	0.147	0.250	0.516	1.525	9.360
94	0.030	0.093	0.159	0.313	0.690	3.399
98	0.013	0.040	0.068	0.134	0.296	1.337
100	0.004	0.013	0.023	0.045	0.099	0.305

X	t _{an} (s)
1.1	218.0
1.2	99.0
1.3	50.0
1.4	25.0
1.5	13.0
1.8	3.6

t_{ab} (s) = 373

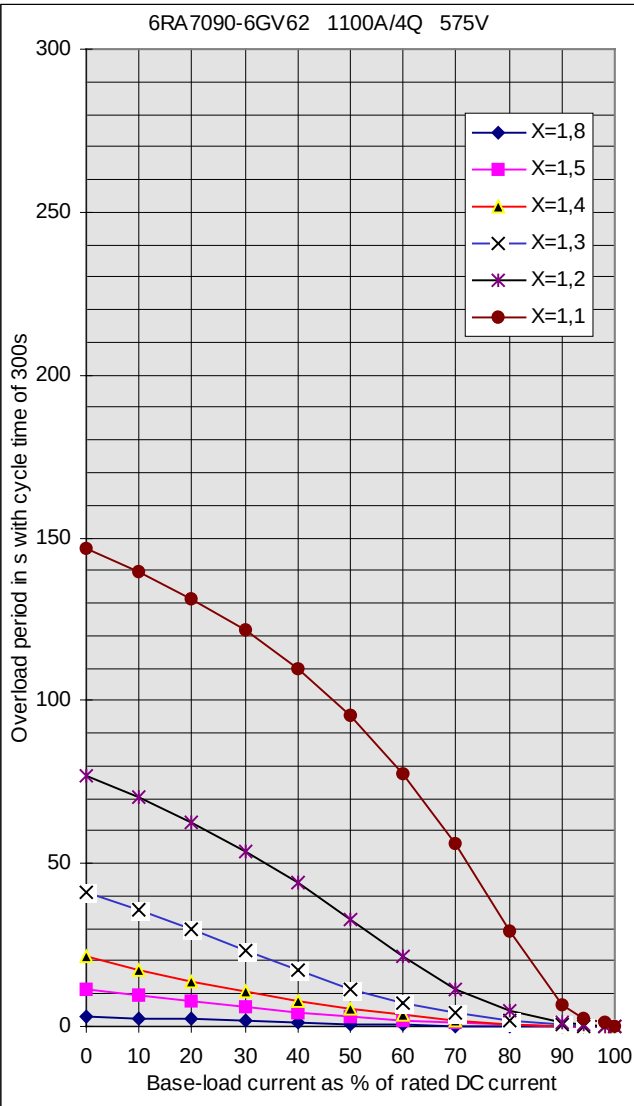
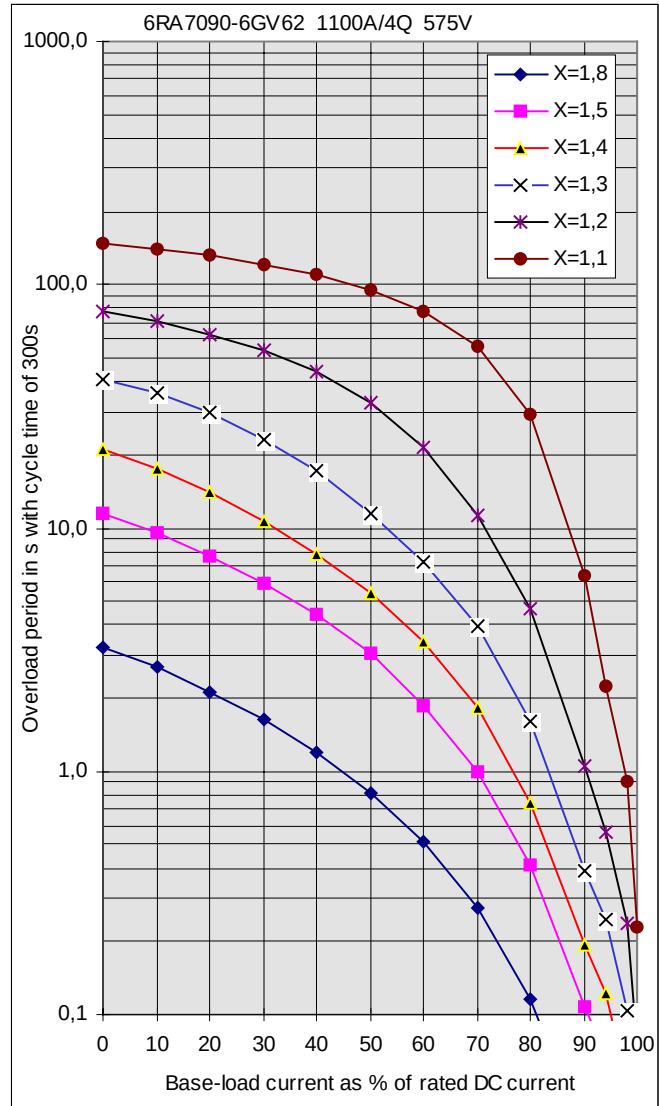


6RA7090-6GV62

Ig (%)	Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	3.220	11.460	21.200	41.120	77.020	146.840						
10	2.667	9.464	17.531	35.592	70.260	139.763						
20	2.126	7.683	13.963	29.586	62.571	131.415						
30	1.627	5.916	10.688	23.294	53.843	121.518						
40	1.190	4.393	7.839	17.098	43.959	109.666						
50	0.820	3.030	5.441	11.577	32.922	95.330						
60	0.514	1.864	3.435	7.202	21.337	77.776						
70	0.276	0.992	1.817	3.943	11.248	55.976						
80	0.116	0.412	0.746	1.595	4.679	29.109						
90	0.032	0.107	0.194	0.388	1.042	6.405						
94	0.020	0.068	0.123	0.246	0.559	2.255						
98	0.008	0.029	0.052	0.104	0.235	0.905						
100	0.003	0.009	0.016	0.032	0.074	0.230						

X	t _{an} (s)
1.1	208.0
1.2	91.0
1.3	43.6
1.4	20.5
1.5	10.5
1.8	2.9

t_{ab} (s) = 366

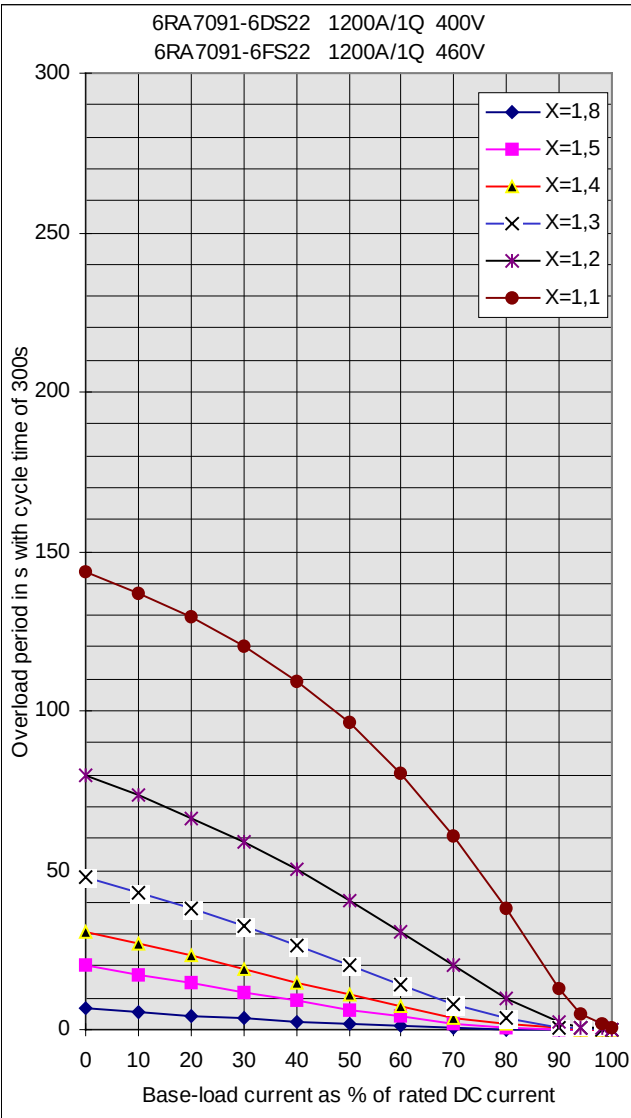
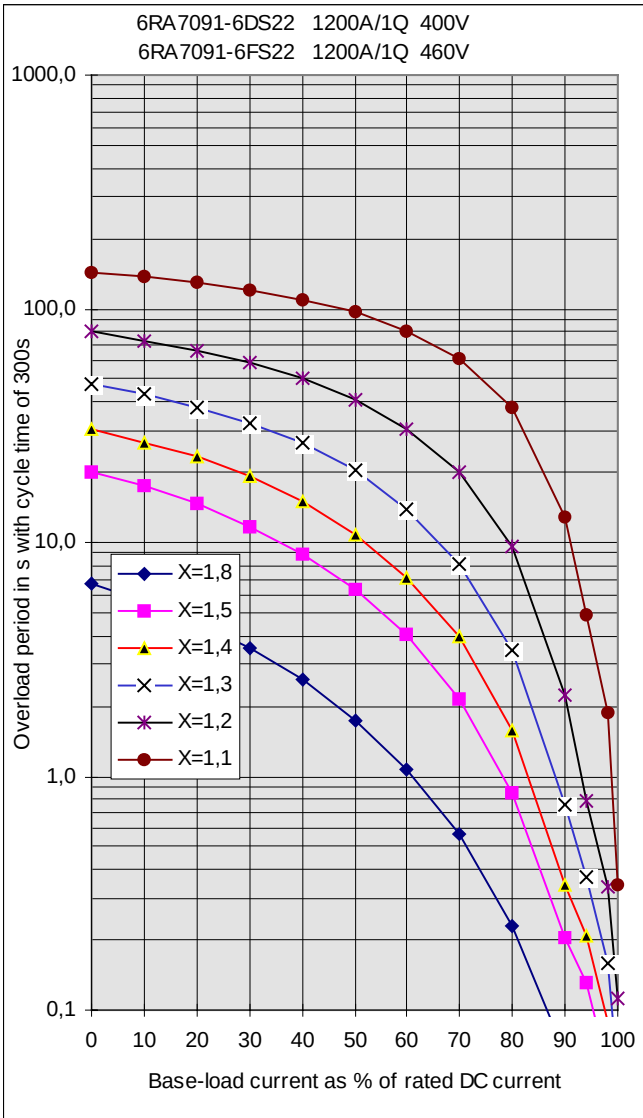


6RA7091-6DS22 und 6RA7091-6FS22

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	6.700	20.140	30.440	47.720	79.460	143.340
10	5.627	17.447	26.910	42.992	73.349	136.839
20	4.569	14.613	23.126	37.864	66.463	129.216
30	3.550	11.728	19.129	32.352	58.749	120.198
40	2.589	8.916	14.988	26.479	50.180	109.427
50	1.737	6.321	10.873	20.297	40.779	96.405
60	1.061	4.043	7.101	13.974	30.640	80.494
70	0.568	2.139	3.952	8.086	19.951	61.016
80	0.231	0.850	1.571	3.492	9.534	37.886
90	0.066	0.204	0.340	0.754	2.231	12.898
94	0.042	0.130	0.208	0.373	0.780	4.891
98	0.018	0.056	0.089	0.160	0.334	1.859
100	0.006	0.019	0.030	0.053	0.111	0.344

X	t _{an} (s)
1.1	180
1.2	88
1.3	49
1.4	30
1.5	19
1.8	6

$t_{ab} \text{ (s)} = 312$

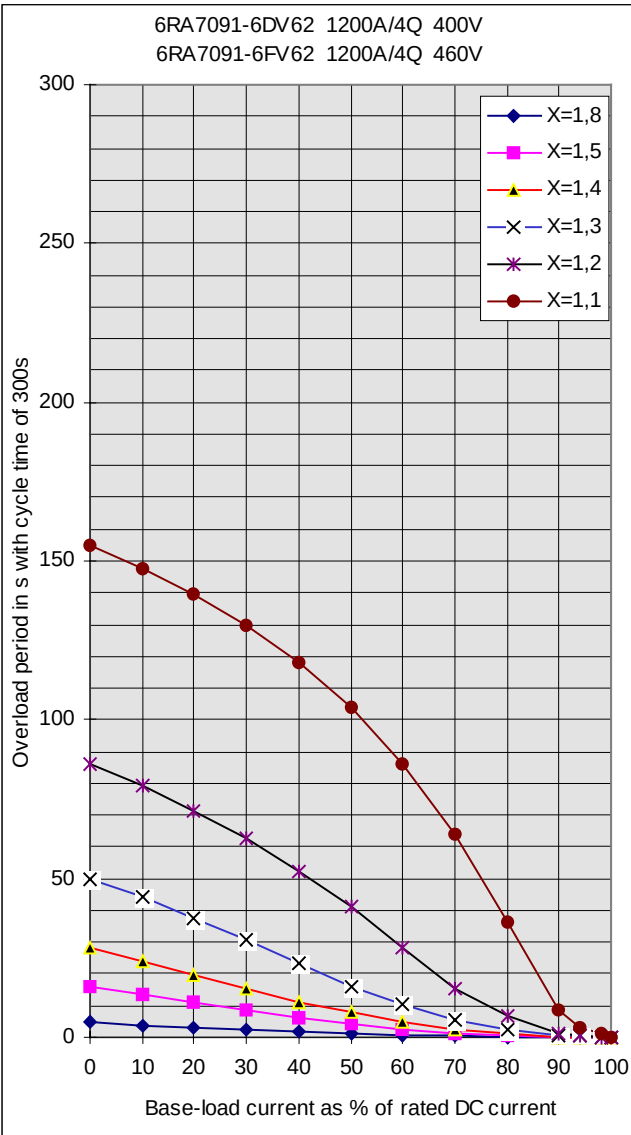
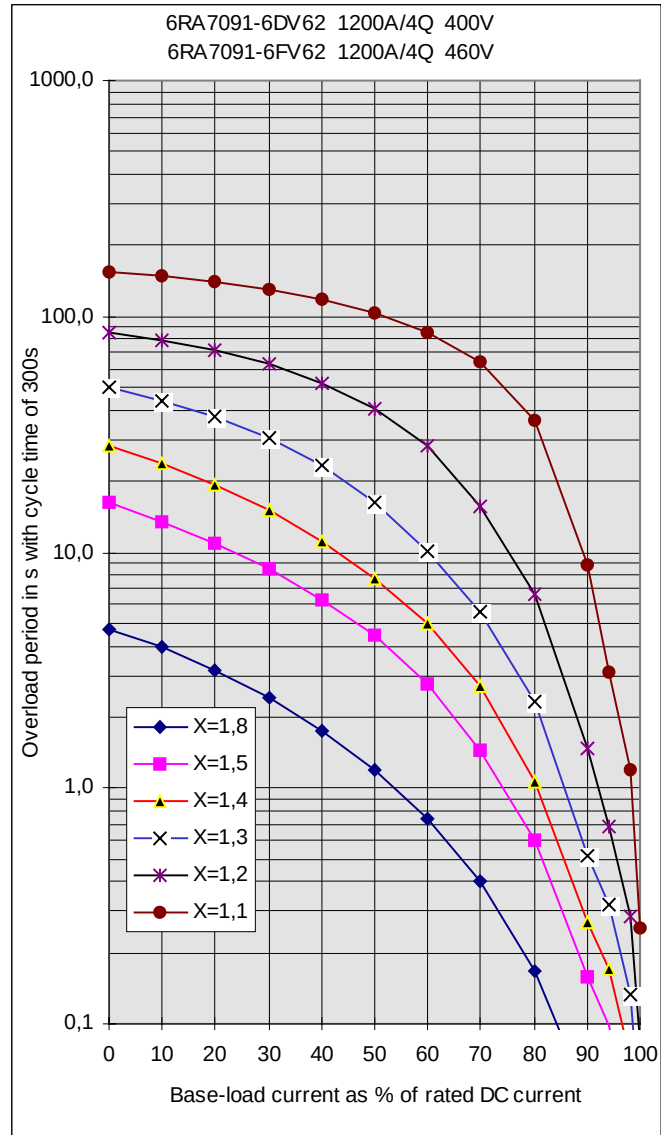


6RA7091-6DV62 und 6RA7091-6FV62

I _g (%)	Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	4.720	16.220	28.320	49.780	86.080	154.620						
10	3.939	13.465	23.936	43.976	79.248	147.678						
20	3.170	10.843	19.451	37.560	71.456	139.481						
30	2.433	8.442	15.098	30.588	62.575	129.727						
40	1.761	6.301	11.133	23.292	52.441	118.002						
50	1.194	4.415	7.745	16.227	40.916	103.748						
60	0.747	2.766	4.958	10.189	28.161	86.175						
70	0.403	1.445	2.686	5.632	15.673	64.163						
80	0.167	0.596	1.074	2.344	6.604	36.340						
90	0.048	0.157	0.270	0.511	1.482	8.816						
94	0.030	0.099	0.170	0.323	0.682	3.100						
98	0.013	0.041	0.071	0.134	0.283	1.202						
100	0.004	0.012	0.021	0.039	0.083	0.253						

X	t _{an} (s)
1.1	223
1.2	104
1.3	54
1.4	28
1.5	15
1.8	4

t_{ab} (s) = 383

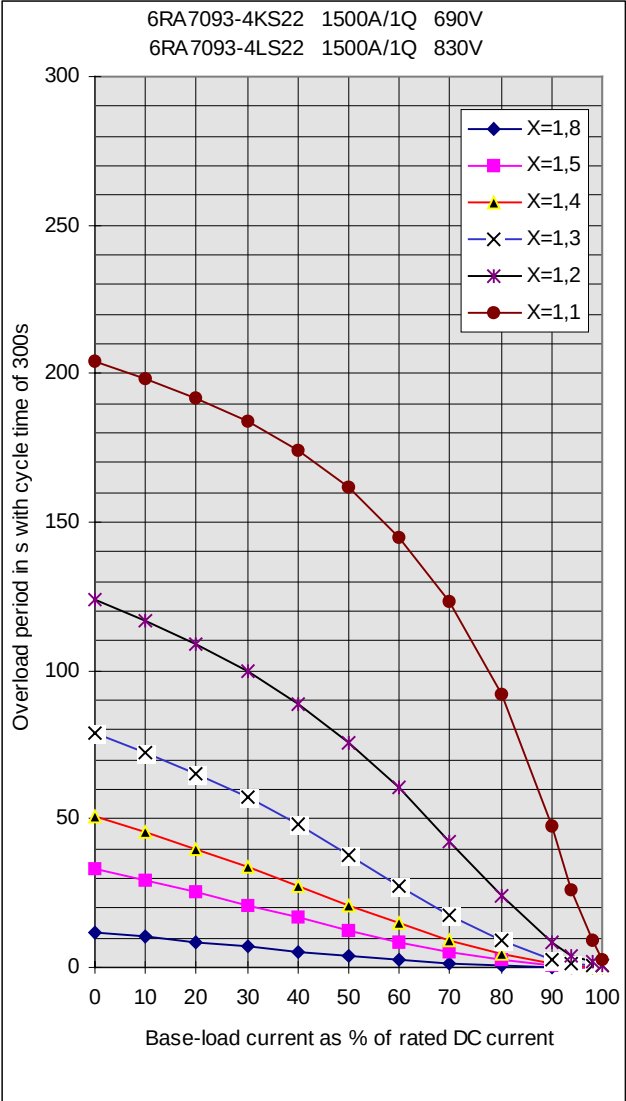
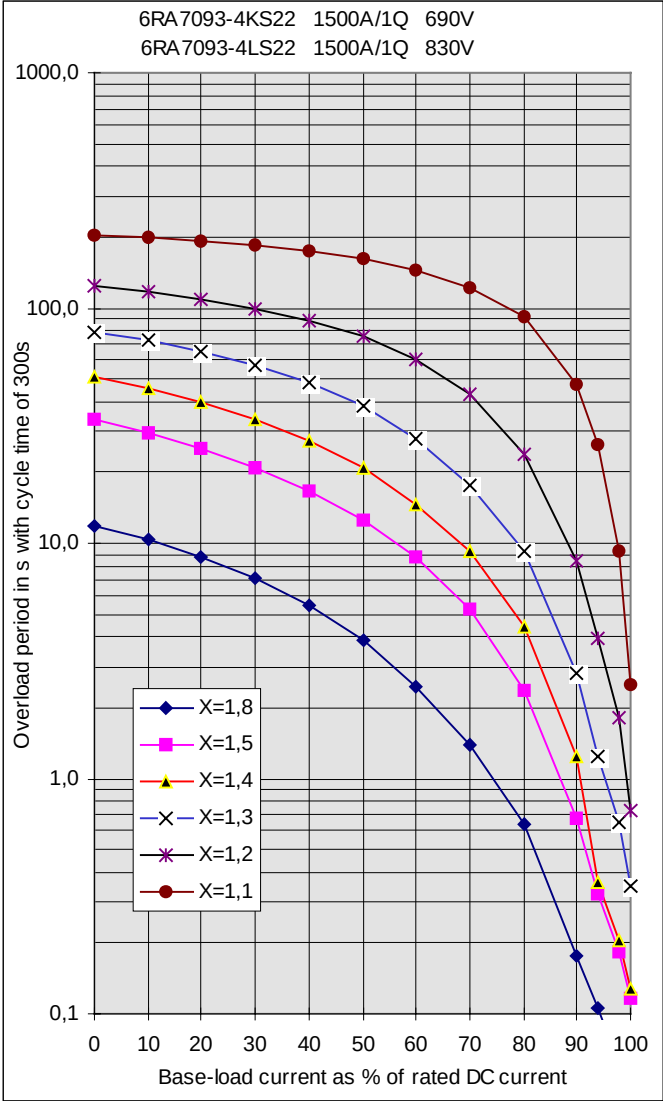


6RA7093-4KS22 und 6RA7093-4LS22

I _g (%)	Tp (s)					
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	11.960	33.580	51.120	78.920	123.920	203.840
10	10.354	29.516	45.777	72.560	117.063	198.463
20	8.711	25.272	39.920	65.342	109.063	191.954
30	7.058	20.967	33.657	57.190	99.707	183.973
40	5.420	16.716	27.174	48.056	88.721	174.045
50	3.850	12.626	20.753	38.057	75.770	161.434
60	2.466	8.783	14.690	27.663	60.472	145.020
70	1.400	5.269	9.208	17.798	42.676	122.948
80	0.640	2.374	4.467	9.313	23.903	92.099
90	0.175	0.674	1.251	2.786	8.505	47.471
94	0.107	0.324	0.360	1.251	3.933	26.380
98	0.061	0.185	0.206	0.649	1.802	9.232
100	0.038	0.116	0.128	0.347	0.736	2.516

X	t _{an} (s)
1.1	407
1.2	183
1.3	100
1.4	59
1.5	35
1.8	11

t_{ab} (s) = 565

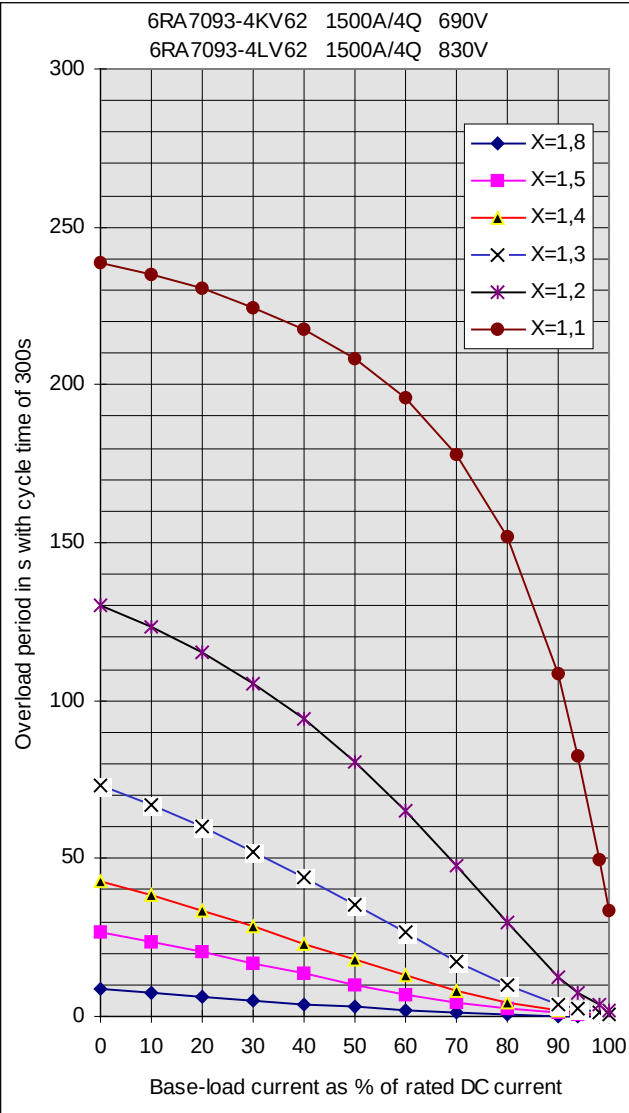
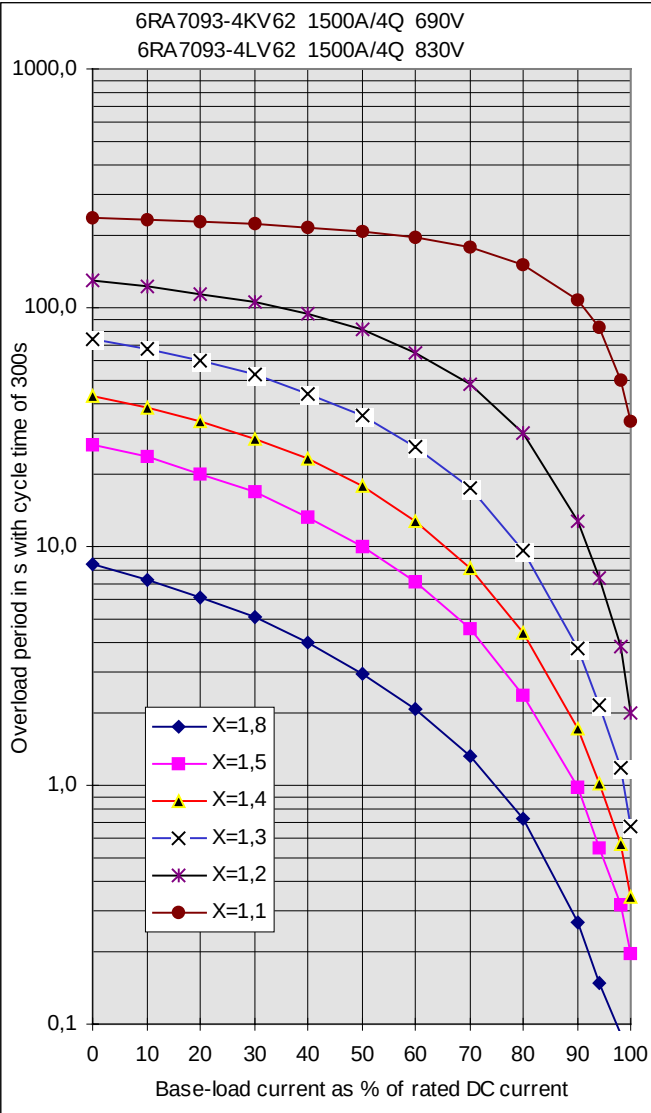


6RA7093-4KV62 und 6RA7093-4LV62

lg (%)	Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	8.440	26.800	42.880	73.260	130.180	238.580						
10	7.298	23.608	38.359	66.907	123.241	234.844						
20	6.151	20.256	33.532	59.860	115.099	230.280						
30	5.028	16.808	28.460	52.162	105.514	224.637						
40	3.954	13.363	23.204	43.906	94.199	217.465						
50	2.959	10.070	17.875	35.241	80.852	208.159						
60	2.080	7.079	12.713	26.356	65.306	196.012						
70	1.339	4.489	8.111	17.545	47.882	178.187						
80	0.729	2.403	4.373	9.623	29.713	151.885						
90	0.265	0.975	1.724	3.773	12.681	108.266						
94	0.150	0.550	1.013	2.173	7.327	82.134						
98	0.092	0.316	0.565	1.174	3.792	49.566						
100	0.063	0.198	0.341	0.675	2.025	33.283						

X	t _{an} (s)
1.1	546.0
1.2	195.0
1.3	92.0
1.4	47.0
1.5	27.0
1.8	7.8

t_{ab} (s) = 480

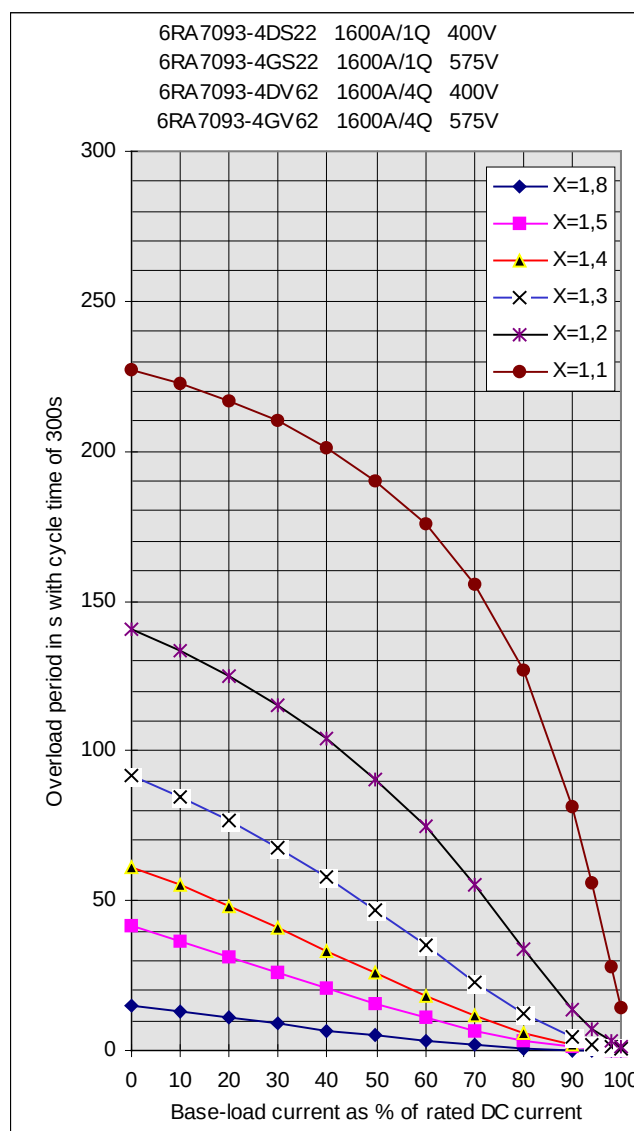
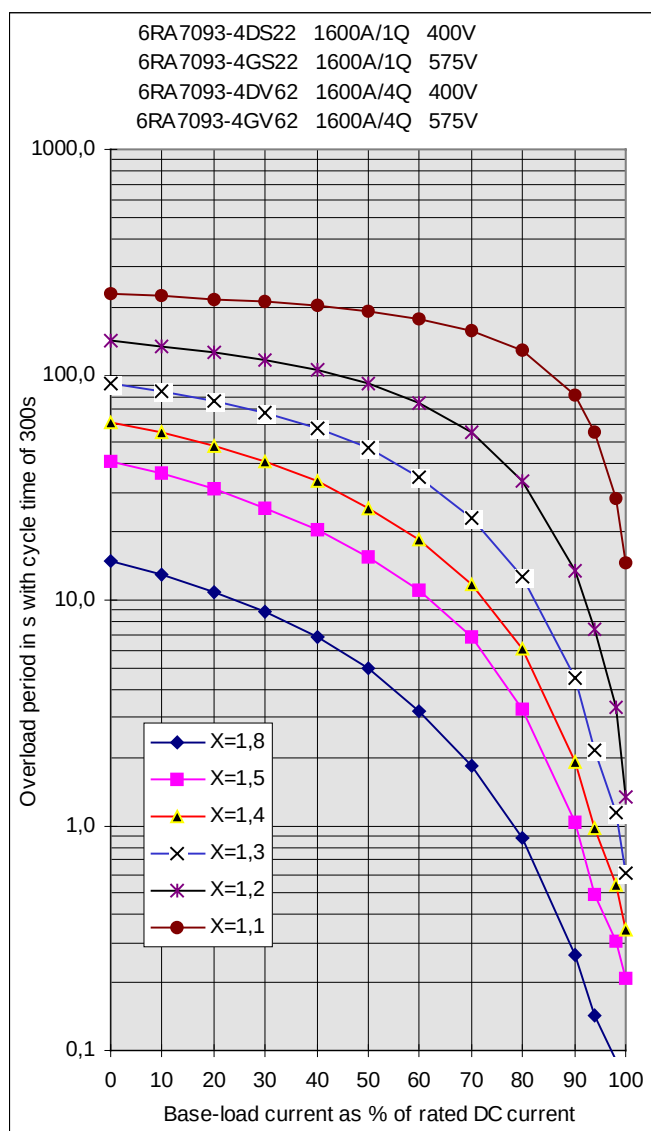


6RA7093-4DS22 und 6RA7093-4GS22
6RA7093-4DV62 und 6RA7093-4GV62

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	15.040	41.340	61.280	91.820	140.780	227.360
10	12.954	36.316	55.103	84.796	133.569	222.650
20	10.869	31.083	48.348	76.885	125.211	216.969
30	8.805	25.773	41.070	67.986	115.478	210.017
40	6.830	20.551	33.418	57.998	104.075	201.343
50	4.928	15.577	25.708	46.892	90.612	190.226
60	3.200	10.975	18.373	34.932	74.597	175.591
70	1.825	6.826	11.783	23.052	55.559	155.476
80	0.871	3.283	6.134	12.641	33.675	127.036
90	0.264	1.028	1.905	4.482	13.555	81.104
94	0.144	0.496	0.964	2.176	7.393	55.811
98	0.091	0.304	0.550	1.133	3.350	28.291
100	0.065	0.208	0.342	0.612	1.328	14.530

X	t _{an} (s)
1.1	518.0
1.2	219.0
1.3	122.0
1.4	73.0
1.5	45.0
1.8	14.5

t_{ab} (s) = 548

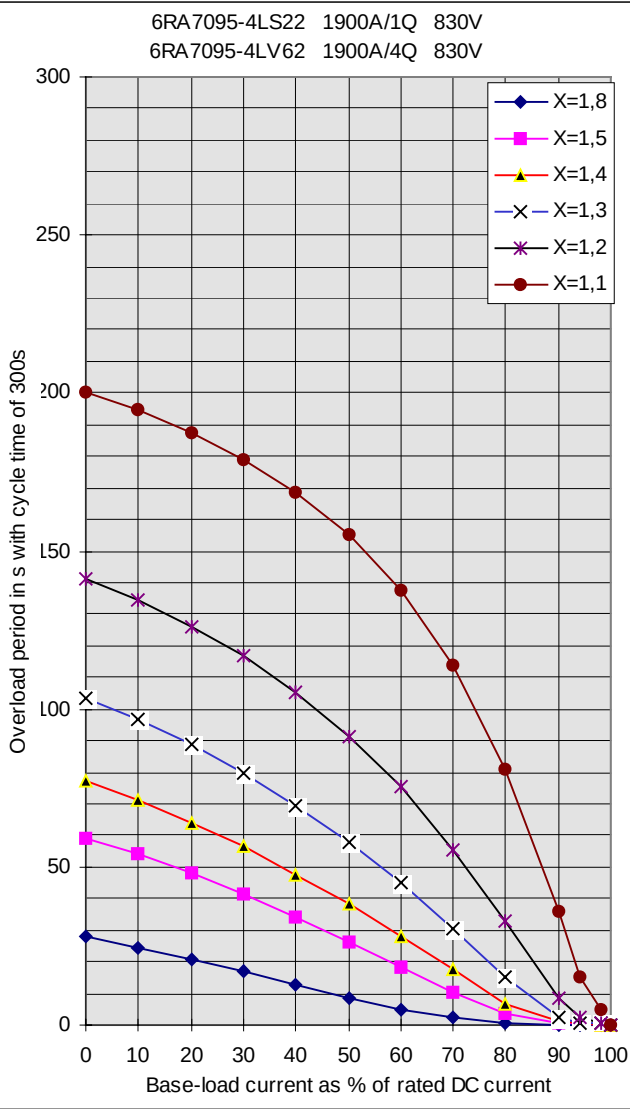
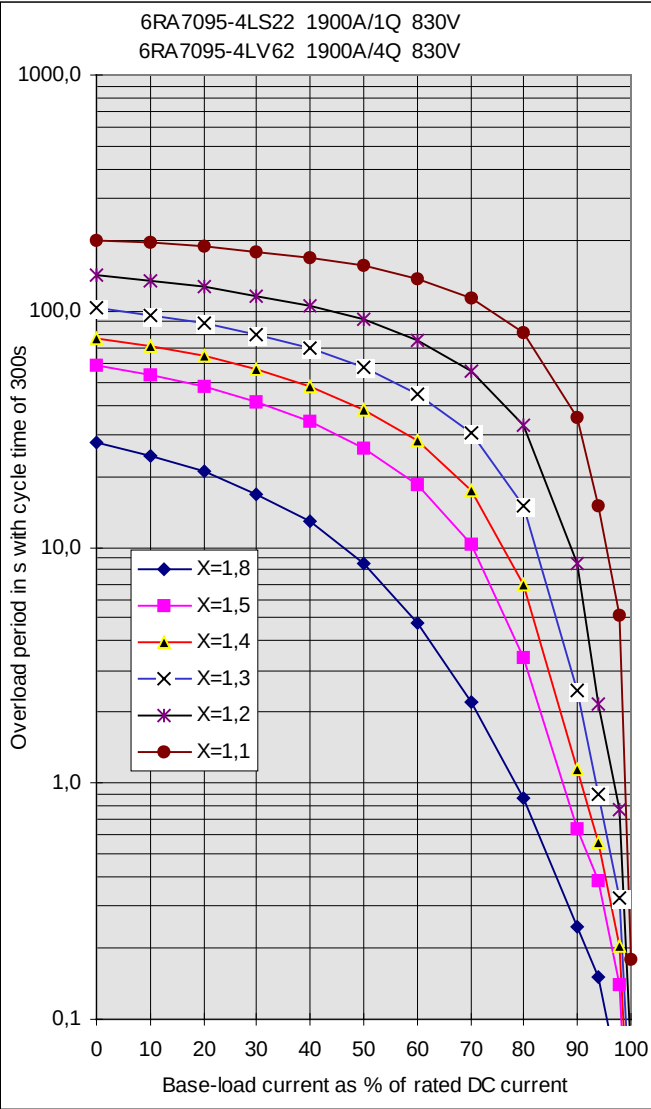


6RA7095-4LS22 und 6RA7095-4LV62

I _g (%)	Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)		Tp (s)	
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	27.940	59.320	77.240	103.320	141.420	200.360						
10	24.487	53.864	71.061	96.528	134.447	194.568						
20	20.784	47.829	64.114	88.735	126.266	187.592						
30	16.870	41.224	56.347	79.809	116.633	179.035						
40	12.774	34.075	47.728	69.588	105.208	168.391						
50	8.585	26.448	38.274	57.927	91.562	154.899						
60	4.759	18.459	28.103	44.762	75.176	137.352						
70	2.224	10.297	17.464	30.275	55.529	113.823						
80	0.866	3.403	6.908	15.091	32.654	81.138						
90	0.248	0.644	1.152	2.475	8.588	35.600						
94	0.151	0.383	0.561	0.901	2.175	14.997						
98	0.055	0.139	0.203	0.326	0.772	5.118						
100	0.006	0.016	0.024	0.038	0.070	0.179						

X	t _{an} (s)
1.1	513.0
1.2	259.0
1.3	160.0
1.4	108.0
1.5	76.0
1.8	30.8

t_{ab} (s) = 1056

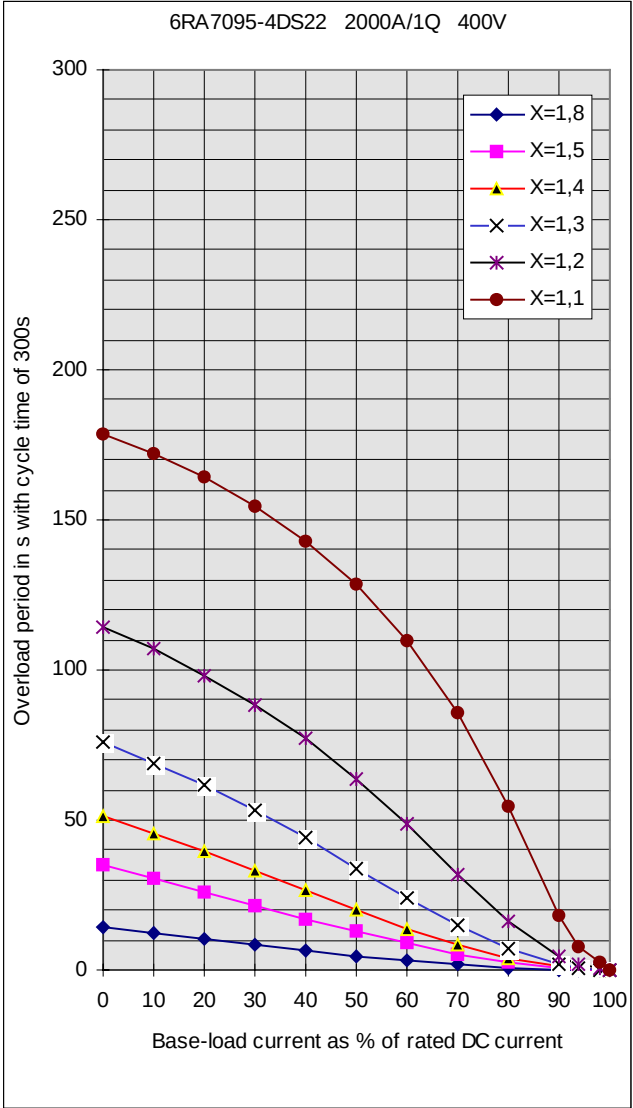
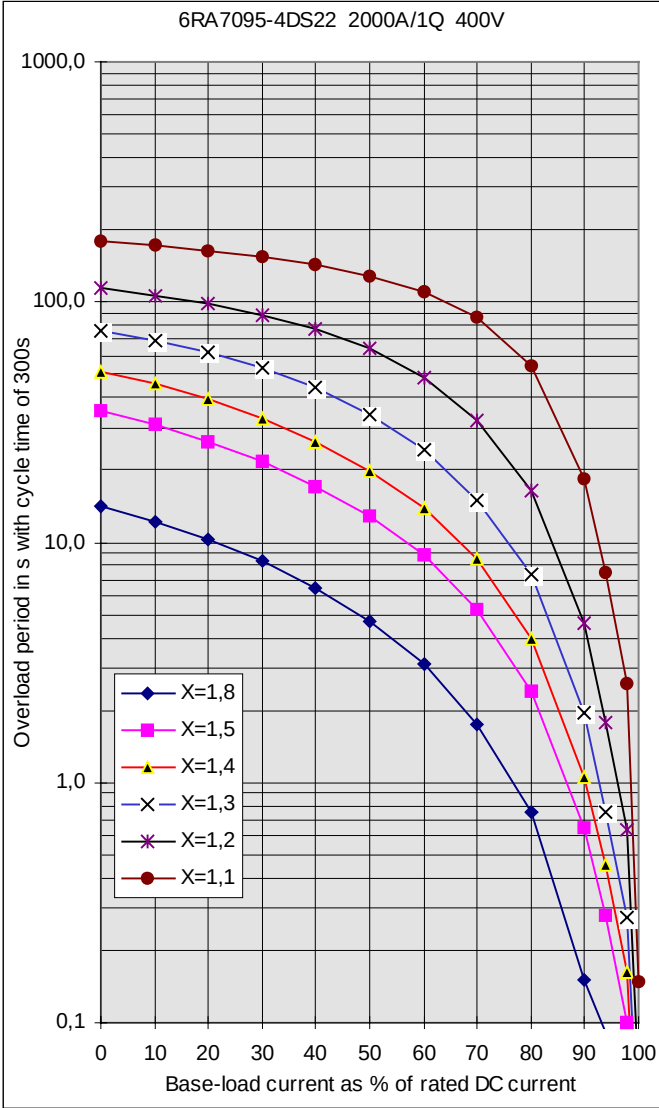


6RA7095-4DS22

I _g (%)	Tp (s)					
	X=1.8	X=1.5	X=1.4	X=1.3	X=1.2	X=1.1
0	14.080	35.260	51.320	75.880	114.220	178.880
10	12.164	30.801	45.618	69.144	106.834	172.191
20	10.242	26.203	39.457	61.597	98.330	164.219
30	8.340	21.590	32.954	53.180	88.514	154.610
40	6.490	17.086	26.323	43.913	77.142	142.861
50	4.731	12.802	19.857	34.013	63.949	128.285
60	3.124	8.827	13.843	24.086	48.749	109.844
70	1.755	5.256	8.476	15.005	32.049	86.007
80	0.750	2.411	3.965	7.384	16.379	54.679
90	0.150	0.644	1.059	1.958	4.647	18.411
94	0.091	0.280	0.455	0.758	1.781	7.489
98	0.033	0.101	0.164	0.273	0.632	2.595
100	0.004	0.011	0.018	0.030	0.057	0.148

X	t _{an} (s)
1.1	321.0
1.2	164.0
1.3	96.0
1.4	59.0
1.5	38.0
1.8	13.7

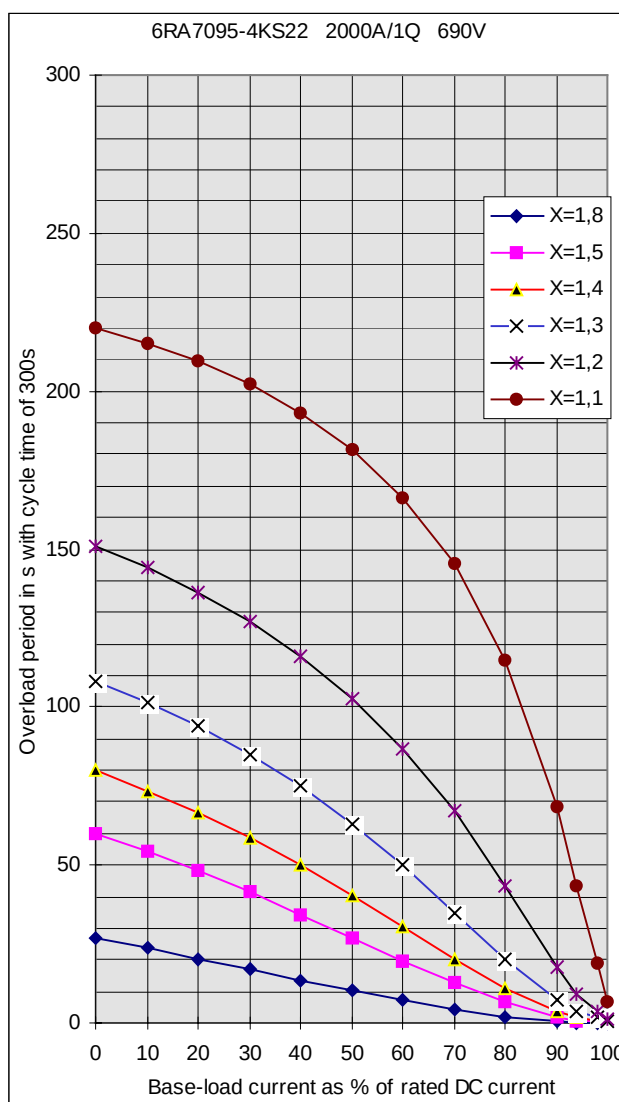
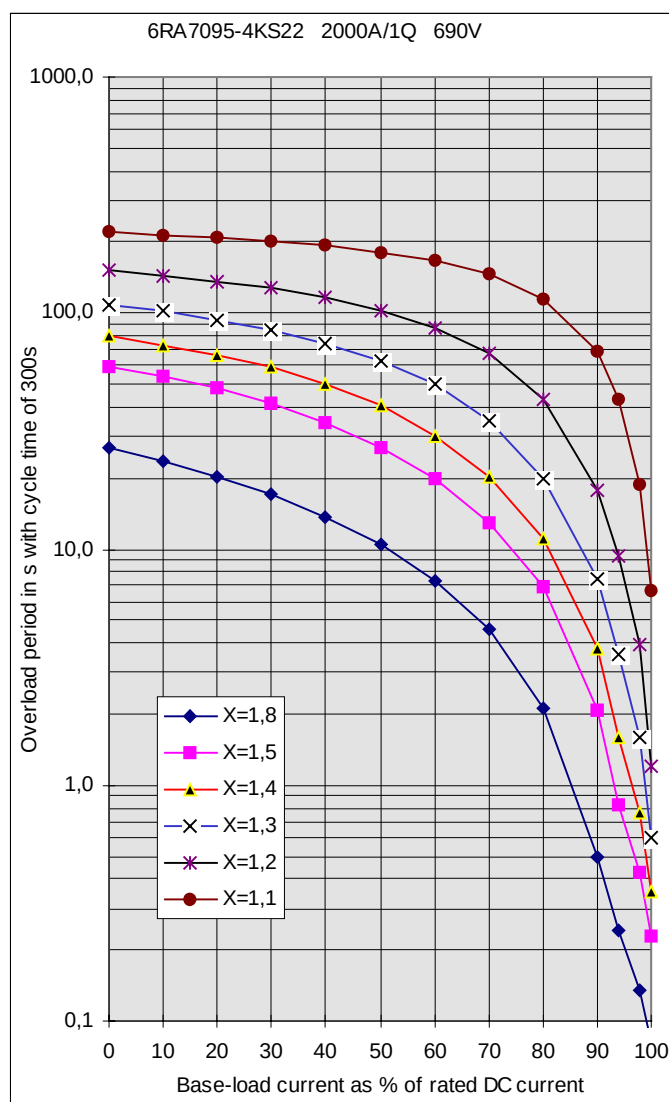
t_{ab} (s) = 600



6RA7095-4KS22

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	26.880	59.700	79.780	108.360	151.120	220.200
10	23.649	54.174	73.569	101.610	144.367	215.318
20	20.327	48.089	66.581	93.882	136.463	209.406
30	16.978	41.460	58.758	85.031	127.152	202.144
40	13.665	34.367	50.050	74.872	116.097	193.067
50	10.445	27.004	40.484	63.200	102.850	181.458
60	7.380	19.715	30.318	49.860	86.799	166.159
70	4.552	12.906	20.226	35.021	67.180	145.210
80	2.097	6.899	11.149	20.032	43.331	114.998
90	0.496	2.090	3.812	7.485	17.833	68.545
94	0.243	0.828	1.607	3.608	9.406	43.196
98	0.135	0.427	0.770	1.602	3.935	18.871
100	0.081	0.227	0.351	0.599	1.200	6.709

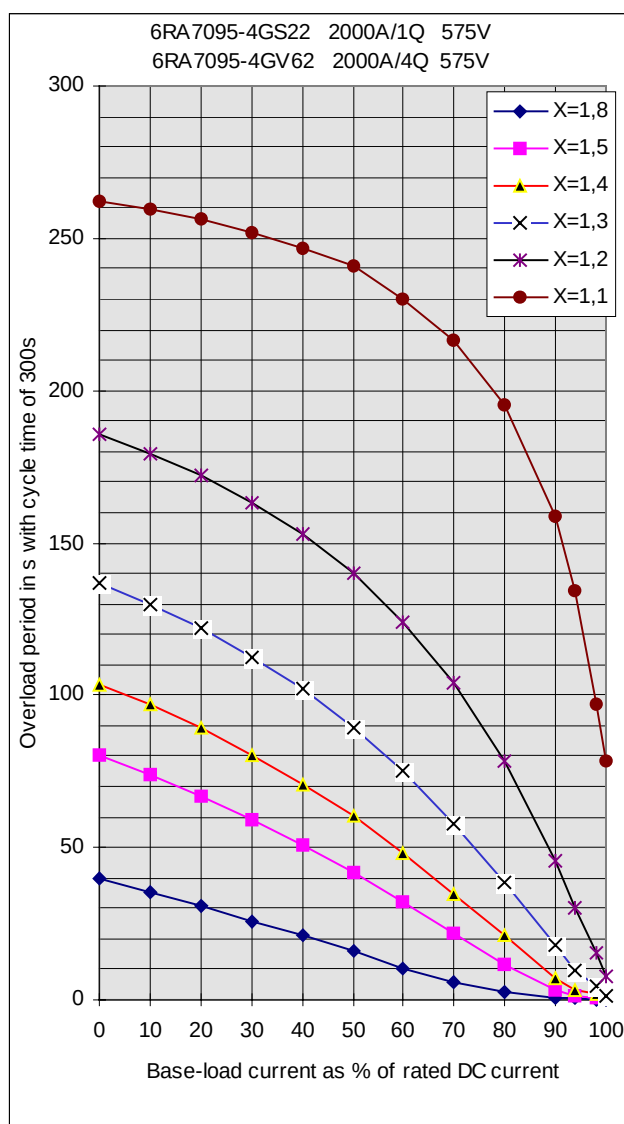
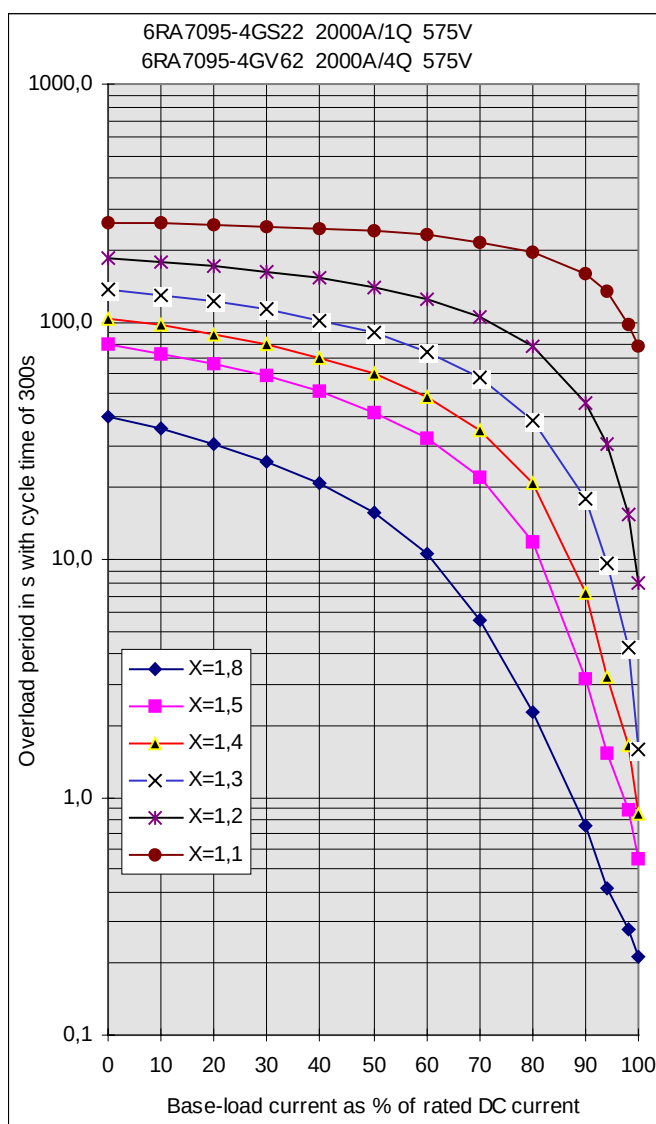
X	t _{an} (s)
1.1	479.7
1.2	248.5
1.3	155.7
1.4	104.8
1.5	73.4
1.8	28.7

t_{ab} (s) = 663

6RA7095-4GS22 und 6RA7095-4GV62

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	39.720	80.060	103.680	136.840	185.580	262.160
10	35.381	73.782	96.869	129.838	179.331	259.402
20	30.789	66.849	89.218	121.817	171.987	256.043
30	25.968	59.224	80.620	112.580	163.277	251.935
40	20.951	50.876	70.958	101.897	152.798	246.641
50	15.779	41.819	60.123	89.469	140.037	241.189
60	10.524	32.135	48.069	74.951	124.224	230.257
70	5.568	22.016	34.904	58.026	104.256	216.666
80	2.295	11.757	21.027	38.670	78.552	195.547
90	0.753	3.171	7.298	17.853	45.497	158.419
94	0.411	1.542	3.225	9.642	30.440	134.458
98	0.280	0.883	1.640	4.265	15.415	96.988
100	0.214	0.553	0.848	1.576	7.902	78.254

X	t _{an} (s)
1.1	1247.5
1.2	421.2
1.3	241.9
1.4	159.2
1.5	111.9
1.8	46.6

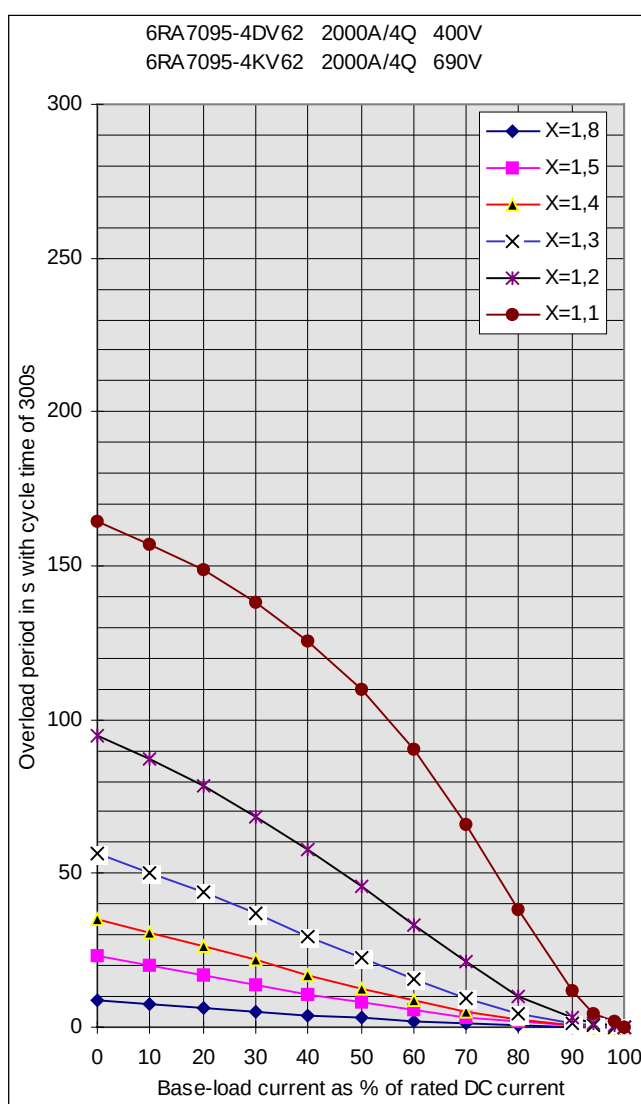
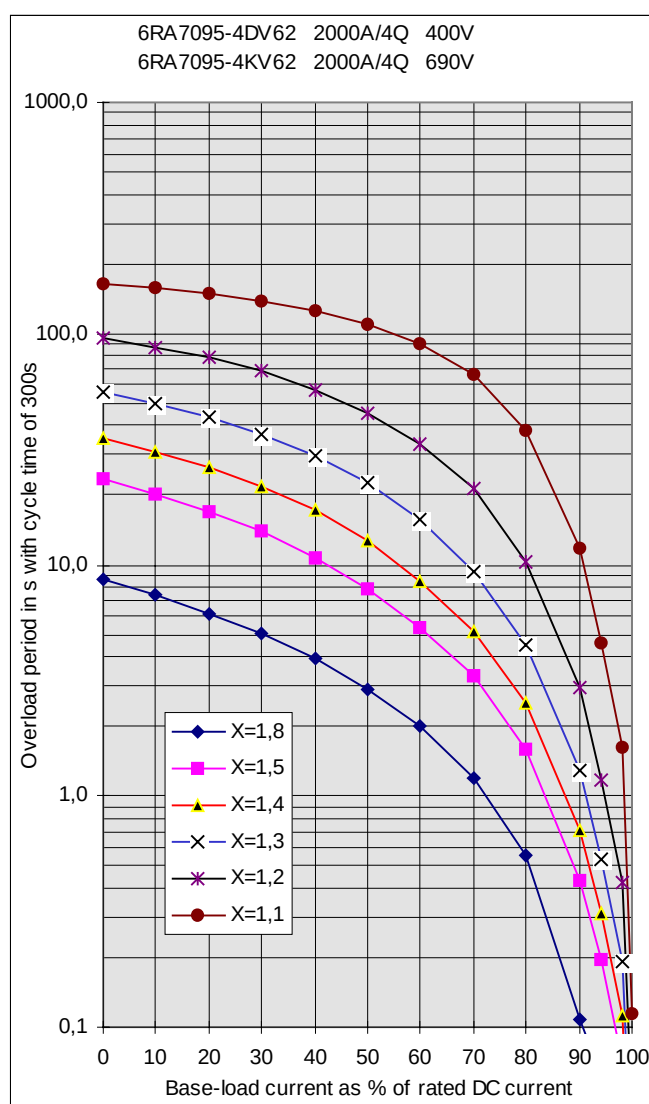
t_{ab} (s) = 1064

6RA7095-4DV62 und 6RA7095-4KV62

I _g (%)	T _p (s) X=1.8	T _p (s) X=1.5	T _p (s) X=1.4	T _p (s) X=1.3	T _p (s) X=1.2	T _p (s) X=1.1
0	8.620	23.520	35.400	56.300	94.920	164.420
10	7.378	20.361	31.064	50.189	87.161	157.186
20	6.169	17.114	26.540	43.681	78.348	148.563
30	5.012	13.871	21.887	36.852	68.439	138.188
40	3.922	10.752	17.198	29.797	57.475	125.541
50	2.910	7.889	12.663	22.639	45.671	109.901
60	1.992	5.385	8.571	15.623	33.425	90.316
70	1.197	3.281	5.173	9.344	21.245	65.970
80	0.559	1.596	2.535	4.520	10.275	38.038
90	0.107	0.428	0.709	1.302	2.929	11.665
94	0.062	0.195	0.311	0.533	1.179	4.610
98	0.022	0.070	0.112	0.192	0.421	1.613
100	0.002	0.008	0.012	0.021	0.043	0.115

X	t _{an} (s)
1.1	274
1.2	128
1.3	65
1.4	37
1.5	23
1.8	8

$$t_{ab} (s) = 493$$



9.16 Speed-dependent current limitation

The speed-dependent current limitation protects the commutator and brushes of the DC motor at high speeds.

The necessary parameter settings (P104 to P107) can be taken from the motor rating plate.

The maximum operating speed of the motor (P108) must also be entered. This must be the same as the actual maximum operating speed.

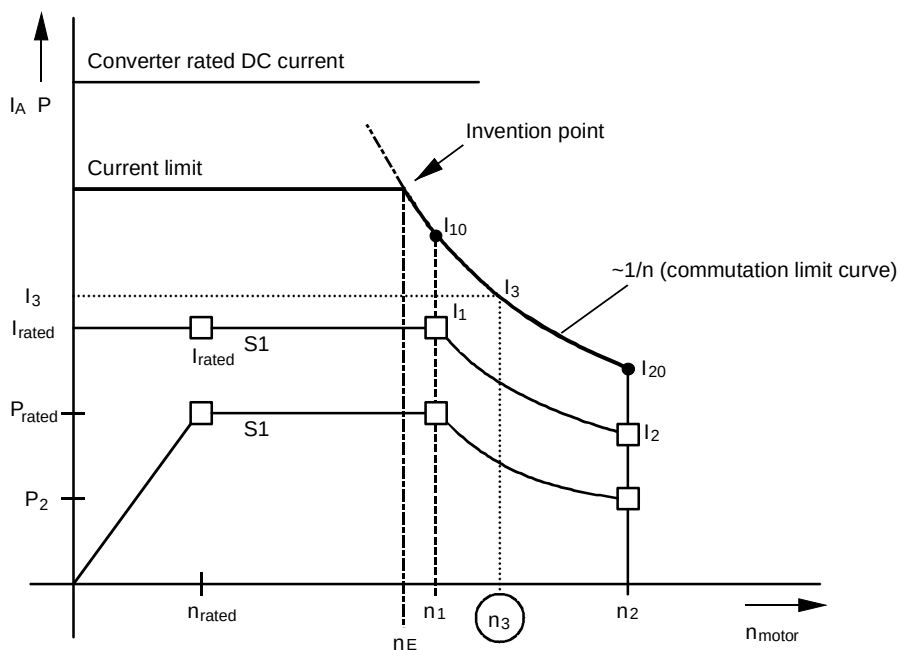
The actual maximum operating speed is determined by:

- P143 with actual speed supplied by a pulse encoder,
- P741 with actual speed supplied by an analog tacho,
- P115 in operation without a tachometer.

Furthermore, the speed-dependent current limitation must be activated by setting P109 = 1!

NOTE
Setting the speed-dependent current limitation function to the wrong value may cause excessive loading of the commutator and brushes, resulting in a drastic reduction in brush life!

9.16.1 Setting the speed-dependent current limitation for motors with commutation transition

☐ Motor rating plate data

n_E = Point at which speed-dependent current limitation intervenes

- Permissible limit values

$$n_3 = \text{Maximum operating speed}$$

$$I_{10} = 1.4 * I_1$$

$$I_{20} = 1.2 * I_2$$

The current limitation curve is determined by n_1 , I_{10} , n_2 and I_{20} .

Parameters:

$$P_{104} = n_1$$

P105 = I_1 (used by unit to calculate I_{10})

$$P106 = n_2$$

P107 = I_2 (used by unit to calculate I_{20})

P108 = n_3 (defines speed normalization)

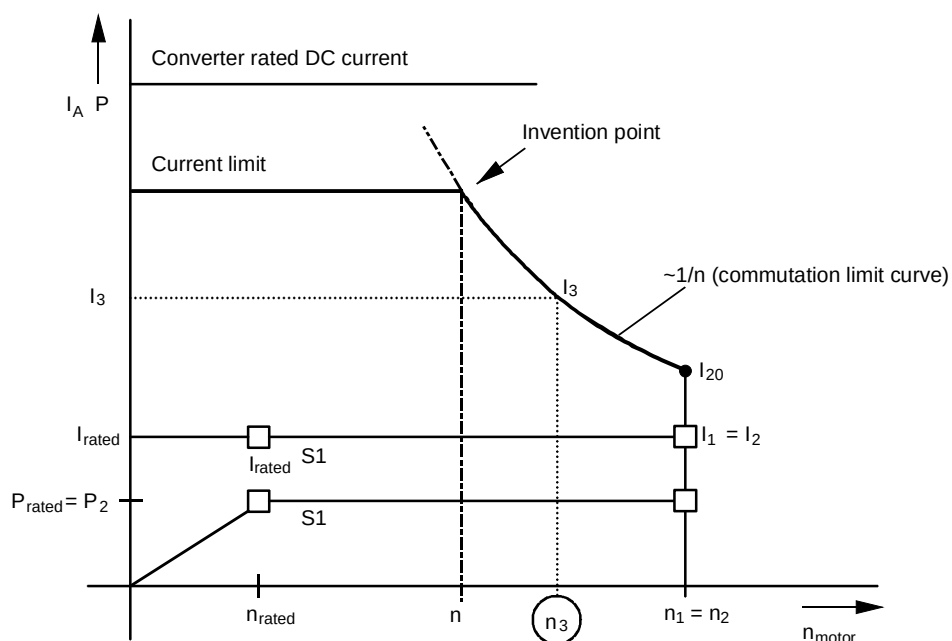
P109 = 0 ... speed-dependent current limitation deactivated

1 ... speed-dependent current limitation activated

Example of a motor rating plate:

* NEBENSCHL.-MOT.		1GG5162-0GG4 -6HU7	
IEC160	NR.E	VDE0530	
V	1/MIN	A	KW
46-380	50-1490	78.0-78.5	0.880-26.0
380	<u>3400</u> / <u>4500</u>	REG. <u>80.0</u> / <u>58.0</u>	26.0 / 19.0
ERR.	V	THYR.: B6C	LV= 0MH 380V/ 50HZ
FREMD	310	IP23	BAUF.
	77/51		I.CL.F
Z:A11 G18 K01 K20			
FREMDKUEHLUNG SCHWINGSTAERKESTUFE R			

9.16.2 Setting of speed-dependent current limitation for motors without commutation transition



□ Motor rating plate data

n_E = Point at which speed-dependent current limitation intervenes

• Permissible limit values

⊙ n_3 = Maximum operating speed

$$I_{20} = 1.2 \cdot I_2$$

Example of a motor rating plate:

* NEBENSCHL.-MOT.		1GG5116-0FH4 -6HU7	
IEC160	NR.E	VDE0530	
V	$n_2 = n_1$	1/MIN	A
46-380	50-2300	36.0-37.5	0.265-12.0
380	6000	38.5	12.0
ERR.	V	A	THYR.: B6C LV=
FREMD	310	1.45	0MH 380V/ 50HZ
	54	0.32	BAUF.
			I.CL.F
Z:A11 G18 K01 K20			
FREMDKUEHLUNG SCHWINGSTAERKESTUFE R			

9.17 Automatic restart

The "Automatic restart" function is controlled by the setting in parameter P086:

P086 = 0 No automatic restart
 P086 = 0.1s to 2.0s "Automatic restart" in seconds

The purpose of the "Automatic restart" function is to prevent the SIMOREG converter from switching immediately to the "FAULT" state, but allow it to return to the "Run" state after the elimination of certain fault conditions such as brief failures in supply voltages, brief undervoltage or overvoltage, very high or very low line frequencies or in the case of an excessive deviation between the field current actual value and setpoint.

The appropriate fault message is output only if one of the following fault conditions prevails continuously for longer than the "Automatic restart time" set in P086 (maximum time delay within which fault condition must be eliminated for "Automatic restart"):

- F001 Failure of electronics supply in operation (5U1, 5W1)
- F004 Armature supply phase failure (1U1, 1V1, 1W1)
- F005 Fault in field circuit (field supply phase failure (3U1, 3W1) or
 $I_{\text{field act}} < 50\% I_{\text{field set}}$)
- F006 Undervoltage (armature or field supply)
- F007 Overvoltage (armature or field supply)
- F008 Line frequency (armature or field supply) less than 45Hz
- F009 Line frequency (armature or field supply) greater than 65 Hz

When one of the fault conditions associated with faults F003 to F006, F008, F009 is active and the automatic restart time delay is still running, the converter dwells in operating state 04.0 (with armature line voltage faults) or 05.0 (with field line voltage or field current faults).

Failures in the electronics supply lasting up to several 100 ms are bridged by the back-up power supply. With longer failures, the failure time is measured by measuring the voltage across one "discharge capacitor" and, if the failure has not lasted as long as the "Restart time" set in P086, the converter restarted again immediately provided that the corresponding control signals (e.g. "Switch-on", "Operating enable") are still applied.

When the "Switch-on", "Shutdown" and "Crawl" functions are edge-triggered (see P445 = 1), the converter cannot be restarted automatically after the power supply backup has been used.

9.18 Field reversal (also refer to Section 8 "Function diagrams" Sheet G200)

By reversing the current polarity in the field winding of the DC motor (i.e. through field reversal), a drive which incorporates a 6RA70 single-quadrant converter (with only a single armature conduction direction) will be able to operate in other quadrants of the speed/torque characteristic (reversal of rotational direction and braking). Two contactors in the field circuit (1, 2) are required to reverse the polarity of the field voltage.

The signal level of binectors B0260 ("Close field contactor 1") and B0261 ("Close field contactor 2") are defined in an internal operating sequence involving functions "Direction of rotation reversal using field reversal" and "Braking with field reversal". These binectors are used to control the two reversing contactors for changing the field polarity. A snubber circuit must be installed in the field circuit.

- Level of **B0260**: 0 No contactor control
 1 Control for one contactor for switching through positive field direction.
- Level of **B0261**: 0 No contactor control
 1 Control for one contactor for switching through negative field direction.

9.18.1 Direction of rotation reversal using field reversal

This function is controlled by the binector selected in P580.

The "Direction of rotation reversal using field reversal" has a switch function and defines the field direction and, if a positive speed setpoint is applied, also the direction of rotation.

Level:	0	Positive field direction is selected ("Close field contactor 1" (B0260) = 1, "Close field contactor 2" (B0261) = 0)
	1	Negative field direction is selected ("Close field contactor 1" (B0260) = 0, "Close field contactor 2" (B0261) = 1)

Changing the logic level of the binector controlling the "Direction of rotation reversal using field reversal" function initiates an internal sequence which brakes the motor and accelerates it in the opposite direction.

While the field reversal process is in progress, the logic level of the controlling binector is irrelevant, i.e. once the function has commenced, it is completed without interruption. Only on completion is another check made to establish whether the logic level of the controlling binector actually coincides with the currently selected field direction.

Note:

Only positive speed setpoints are meaningful.

Sequence of control operations when "Direction of rotation reversal using field reversal" is applied:

1. Drive is rotating in rotational direction 1 (or is at standstill)
2. Logic level of binector controlling the "Direction of rotation reversal using field reversal" changes
3. Internal field reversal process takes place (only if a braking operation has not already been activated by pushbutton function "Braking with field reversal"):
 - 3.1 Wait for armature current $I_A = 0$ and then armature pulse disable (drive then dwells in operating state $\geq o1.4$)
 - 3.2 Disable field firing pulses (also causes K0268=0)
 - 3.3 Wait for $I_{field} (K0265) < I_{field\ min} (P394)$
 - 3.4 Waiting time according to P092.i001 (0.0 to 10.0 s, factory setting 3.0 s)
 - 3.5 Open current field contactor (B0260 = 0 or B0261 = 0)
 - 3.6 Waiting time according to P092.i002 (0.0 to 10.0 s, factory setting 0.2 s)
 - 3.7 Close new field contactor (B0261 = 1 or B0260 = 1)
 - 3.8 Reverse polarity of actual speed value (except when P083 = 3 ... EMF as actual speed value)
 - 3.9 Waiting time according to P092.i003 (0.0 to 10.0 s, factory setting 0.1 s)
 - 3.10 Enable field firing pulses
 - 3.11 Wait for $I_{field} (K0265) > I_{field\ set} (K0268) \cdot P398 / 100\%$
 - 3.12 Waiting time according to P092.i004 (0.0 to 10.0 s, factory setting 3.0 s)
 - 3.13 Enable armature firing pulses (It is possible to exit operating mode o1.4)
4. Drive brakes and then accelerates in rotational direction 2 (or remains at standstill)

Note:

If the actual speed value polarity is reversed internally as a result of field reversal, P083 (but not P083=3) is supplied with inverted signal values (see Section 8, Sheet G152). When the ramp-function generator is in use, it is advisable to set P228=0 (no speed controller setpoint filtering). Otherwise, initial braking along the current limit may occur in connection with the actual speed value polarity reversal and setting of the ramp-function generator output (to (reversed) actual speed value (or to value set in P639) in operating state o1.4).

9.18.2 Braking with field reversal

This function is controlled by the binector selected in P581.

"Braking with field reversal" has a pushbutton function.

If the logic level of the binector controlling the "Braking with field reversal" function = 1 (for at least 30 ms) and the converter is in an operating state $\leq o5$ (line contactor closed), an internal process is activated for braking the drive down to $n < n_{min}$. The original field direction is then selected.

The motor cannot accelerate again in the original rotational direction until the braking command has been cancelled (binector level = 0) and an acknowledgement given with "Shutdown" and "Switch-on".

Sequence of control operations when "Braking with field reversal" is applied:

1. Drive rotates in direction 1
2. The binector controlling the "Braking with field reversal" function = 1 for more than 30 ms
3. Internal field reversal process takes place (only if the line contactor is closed (in operating state of $\leq o5$) and the drive is not already in braking mode. Braking is detected by a negative internal actual speed (resulting from reversal of the real actual speed polarity in the negative field direction):
 - 3.1 Wait for armature current $I_A = 0$ and then armature pulse disable (drive then dwells in operating state $\geq o1.4$)
 - 3.2 Disable field firing pulses (also causes K0268=0)
 - 3.3 Wait for $I_{field} (K0265) < I_{field min} (P394)$
 - 3.4 Waiting time according to P092.i001 (0,0 to 10,0 s, factory setting 3,0 s)
 - 3.5 Open current field contactor (B0260 = 0 or B0261 = 0)
 - 3.6 Waiting time according to P092.i002 (0,0 to 10,0 s, factory setting 0,2 s)
 - 3.7 Close new field contactor (B0261 = 1 or B0260 = 1)
 - 3.8 Reverse polarity of actual speed value (except when P083 = 3 ... EMF as actual speed value)
 - 3.9 Waiting time according to P092.i003 (0,0 to 10,0 s, factory setting 0,1 s)
 - 3.10 Enable field firing pulses
 - 3.11 Wait for $I_{field} (K0265) > I_{field set} (K0268) * P398 / 100\%$
 - 3.12 Waiting time according to P092.i004 (0,0 to 10,0 s, factory setting 3,0 s)
 - 3.13 Enable armature firing pulses (It is possible to exit operating mode o1.4)
4. Internal sequence for braking the drive:
 - 4.1 Internal setting of $n_{set} = 0$ at the ramp function generator input, the drive brakes
 - 4.2 Wait for $n < n_{min} (P370)$
 - 4.3 Wait for armature current $I_A = 0$ and thus armature pulse disable (drive then switches to operating state o7.2)
 - 4.4 Wait for cancellation of braking command through binector level = 0 (as long as level = 1, drive is held in operating state o7.2)
5. Internal sequence for switching over to original field direction (only if the current field direction is not the same as the direction requested by the "Direction of rotation reversal using field reversal" function):
 - 5.1 Wait for armature current $I_A = 0$ and then armature pulse disable (drive then dwells in operating state $\geq o1.4$)
 - 5.2 Disable field firing pulses (also causes K0268=0)
 - 5.3 Wait for $I_{field} (K0265) < I_{field min} (P394)$
 - 5.4 Waiting time according to P092.i001 (0,0 to 10,0 s, factory setting 3,0 s)
 - 5.5 Open current field contactor (B0260 = 0 or B0261 = 0)
 - 5.6 Waiting time according to P092.i002 (0,0 to 10,0 s, factory setting 0,2 s)
 - 5.7 Close new field contactor (B0261 = 1 or B0260 = 1)
 - 5.8 Reverse polarity of actual speed value (except when P083 = 3 ... EMF as actual speed value)
 - 5.9 Waiting time according to P092.i003 (0,0 to 10,0 s, factory setting 0,1 s)
 - 5.10 Enable field firing pulses
 - 5.11 Wait for $I_{field} (K0265) > I_{field set} (K0268) * P398 / 100\%$
 - 5.12 Waiting time according to P092.i004 (0,0 to 10,0 s, factory setting 3,0 s)
 - 5.13 Armature firing pulses are possible again

6. Drive is in operating state o7.2
 Drive can be accelerated in original rotational direction after acknowledgement by an external "Shutdown" and "Switch-on" command.

Please also read the Note at the end of the section 9.18.1.

Delay times for field reversal (parameter P092)

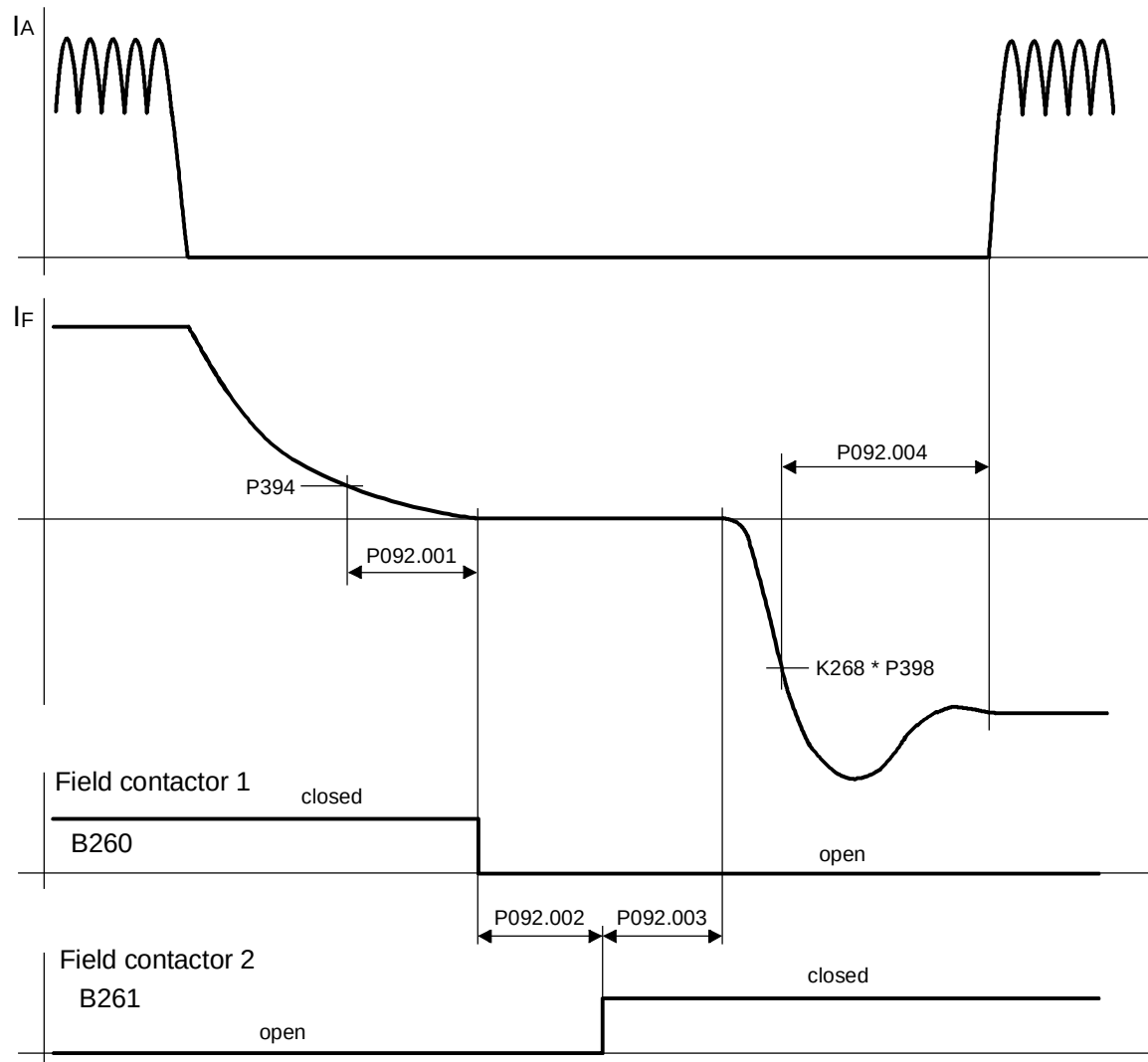


Bild 9.18.1

9.19 Status description of some bits of status word ZSW1

