

SIEMENS

SIMOREG DC Master

6RA70 Series

Microprocessor-Based Converters from 6kW to 1900kW
for Variable-Speed DC Drives

Application
SIMOREG as
a field supply unit



NOTE

This application documentation does not purport to handle or take into account all of the equipment details or versions or to cover every conceivable operating situation or application. If you require more detailed information, or if special problems occur, which are not handled in enough detail in this document, please contact your local Siemens office.

The contents of this application documentation are not part of an earlier or existing agreement or legal contract and neither do they change it. The actual purchase contract represents the complete liability of the A&D Variable-Speed Drives Group of Siemens AG. The warranty conditions, specified in the contract between the two parties, is the only warranty which will be accepted by the A&D Variable-Speed Drives Group. The warranty conditions specified in the contract are neither expanded nor changed by the information provided in this application documentation.



WARNING



These converters contain hazardous electrical voltages and control rotating mechanical components (drives). Death, serious bodily injury or substantial damage to property will occur if the instructions in the relevant operating manuals are not observed.

Only qualified personnel who are thoroughly familiar with all safety notices contained in the operating instructions as well as erection, operating and maintenance instructions must be allowed to work on these devices.

Successful and safe operation of this equipment is dependent on careful transportation, proper storage and installation as well as correct operation and maintenance.

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We have checked that the contents of this publication agree with the hardware and software described herein. Nonetheless, differences might exist and therefore we cannot guarantee that they are completely identical. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. Suggestions for improvement are welcome at all times.

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1 Applications

The SIMOREG DC Master devices of the 6RA70 series are used for the armature and field supply of DC motors. The internal half-controlled bridge circuit of the field power section permits supply to motors with up to 40 A rated field current. If higher field supply currents are required, you can use a 6RA70 one-quadrant unit. In that case, the fully controlled three-phase bridge circuit normally intended for the armature supply is used for the field supply.

Here are three different applications:

- ◆ Version 1: The 6RA70 unit functions completely autonomously. A fixed internal field current setpoint is set. Field weakening is not possible.
- ◆ Version 2: The 6RA70 unit is given an external analog field current setpoint. Field weakening can have an external source with this setpoint.
- ◆ Version 3: The field supply unit (slave) functions in conjunction with a 6RA70 armature supply unit (master). Signals are exchanged via a peer-to-peer interface. The armature unit generates the current setpoint for the field supply unit and receives the current actual value and fault signals from it. Field weakening, incl. automatic optimization, is possible. Because it is necessary to activate the closed-loop control for the field current setpoint in the armature supply unit, input terminals 3U1 and 3W1 must be supplied. Otherwise, the unit fails with F005 (fault in the field circuit).

In all three cases, it is not necessary to activate option S00.



WARNING

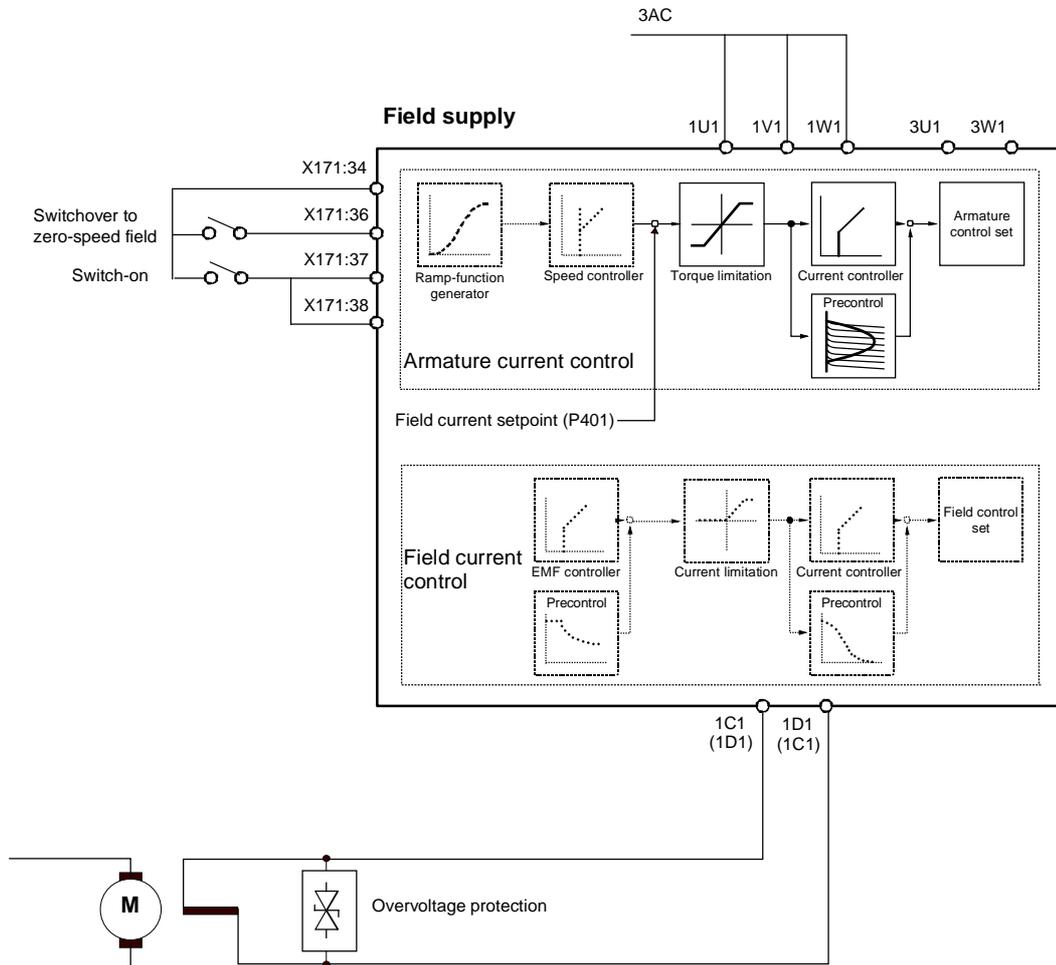


If the armature power section is used for the field supply, always include overvoltage protection to protect the converter valves because if the input voltage fails the energy in the field circuit cannot be reduced.

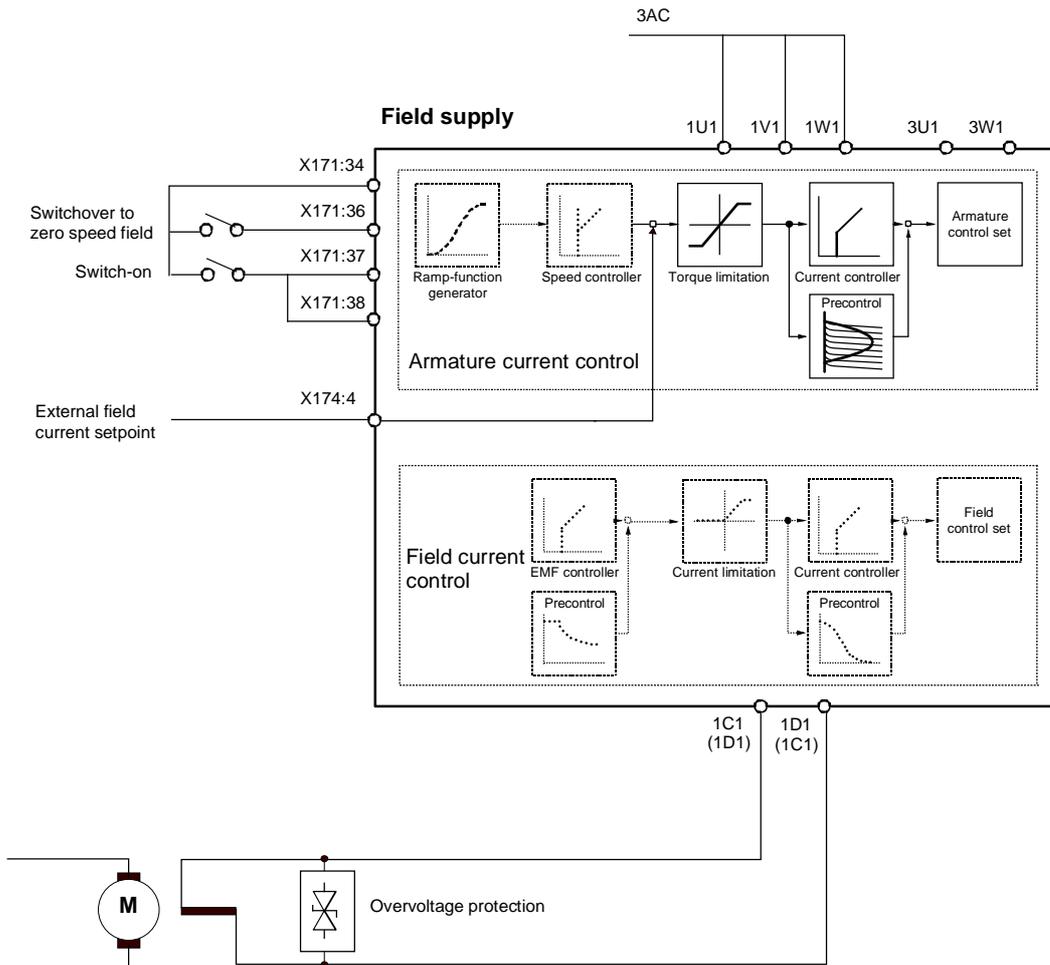
So as not to load the overvoltage protection unnecessarily, ensure that the field current is already 0 when setting the pulse inhibit, e.g. by activating the zero-speed excitation because otherwise the residual energy of the field has to be eliminated via the overvoltage protection.

2 Block Diagrams

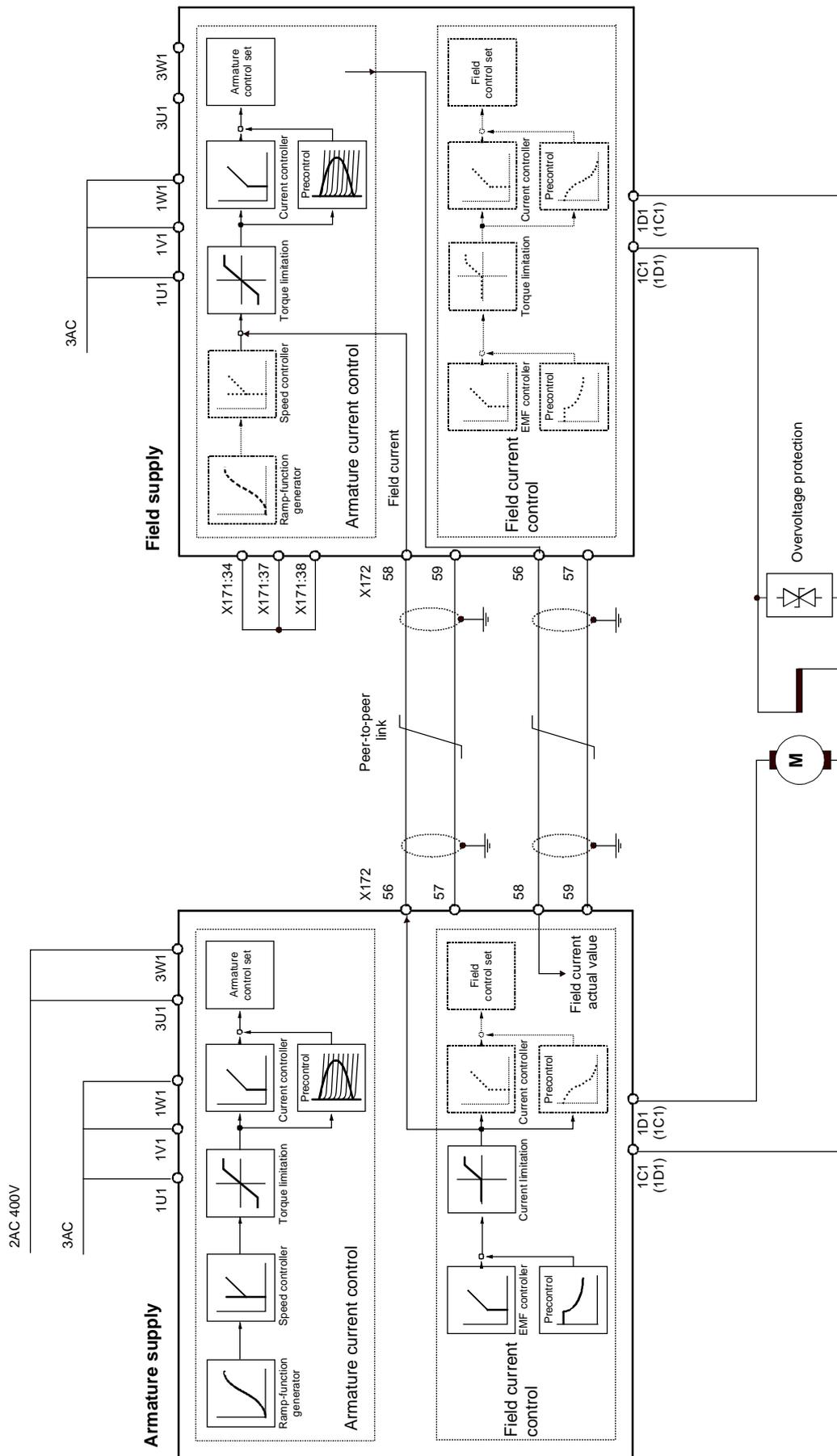
2.1 Version 1: Field supply with an internal setpoint



2.2 Version 2: Field supply with an external setpoint



2.3 Version 3: Field supply + armature supply



3 Parameter Lists

3.1 Version 1: Field supply with an internal setpoint

Field supply unit	
P076.001	Adaptation device rated DC armature. = Normalization of the actual field current
P076.002	Adaptation device rated DC field. Setting irrelevant because not used.
P079 1	Enable long pulses armature trigger set Required with field supply from the armature terminals
P082 0	Internal field not used
P083 4	Speed actual value freely interconnectable
P084 2	Current-controlled operation
P100	Rated armature current = In that case, the exciter current of the motor
P102	Setting irrelevant because not used
P153 3	Required with large inductances at the armature terminals
P161 >0	Additional alpha W pulses (approx. 3.....7) Depending on the magnitude of the inductance.
P401	Setpoint operating field 100% = Nominal device current of the armature circuit
P402	Setpoint zero-speed field 100% = Nominal device current of the armature circuit
P430.001 B0010	Injection zero-speed field via binary input Term.X171: 36 1..... zero-speed field
P431.001 K0402	Routing setpoint zero-speed field
P433 K0401	Routing setpoint operating field
P601.003 K0209	Routing field current setpoint
P609 K0000	Source speed actual value
P820.007 42	Masking of fault message "Tacho fault"

3.2 Version 2: Field supply with an external setpoint

Field supply unit	
P076.001	Adaptation device rated DC armature. = Normalization of the actual field current
P076.002	Adaptation device rated DC field. Setting irrelevant because not used.
P079 1	Enable long pulses armature trigger set Required with field supply from the armature terminals
P082 0	Internal field not used
P083 4	Speed actual value freely interconnectable
P084 2	Current-controlled operation
P100	Rated armature current = In that case, the exciter current of the motor
P102	Setting irrelevant because not used
P153 3	Required with large inductances at the armature terminals
P161 >0	Additional alpha W pulses (approx. 3.....7) Depending on the magnitude of the inductance.
P402	Current setpoint for zero-speed field 100% = Nominal device current of the armature circuit
P430.001 B0010	Injection zero-speed field via binary input Term.X171: 36 1..... zero-speed field
P431.001 K0402	Routing setpoint zero-speed field
P433 K0011	Routing setpoint operating field Analog setpoint from Term.X174: 4
P601.003 K0209	Routing field current setpoint
P609 K0000	Source speed actual value
P820.007 42	Masking of fault message "Tacho fault"

3.3 Version 3: Armature supply + field supply

Armature supply unit	Field supply unit
P076.001 Adaptation device rated DC armature	P076.001 Adaptation device rated DC armature. = Normalization of the actual field current
P076.002 Adaptation device rated DC field CAUTION! Do not change factory setting!	P076.002 Adaptation device rated DC field. Setting irrelevant because not used.
	P079 1 Enable long pulses armature trigger set. Required with field supply form the armature terminals
P082 2 or 3 These settings are required to be able to use a field current setpoint(K0268).	P082 0 Internal field not used
	P083 4 Speed actual value freely interconnectable
P084 1 Speed-controlled operation	P084 2 Current-controlled operation
P094 OFF delay of the auxiliaries The time set here must be longer than the time entered in P258 for the field current reduction.	
P100 Rated armature current	P100 Rated armature current(=field current)
P102 Rated field current The set value for P102 is calculated by the following formula: $P102 [A] = \frac{I_{F_{mot}}^{[A]} * r073.002 (armature_supply_unit)}{r072.002 (field_supply_unit)}$ $I_{F_{mot}}^{[A]}$Nominal field current of the motor	P102 Setting irrelevant because not used
	P153 3 Required with large inductances at the armature terminals
	P161 >0 Additional alpha W pulses (approx. 3.....7) Depending on the magnitude of the inductance.
P257 Zero-speed field The value should be left as WE=0.0 because no energy then has to be eliminated via the overvoltage protection when the field supply unit is switched off.	
P258 Delay time with aut. field current reduction The time set here must be shorter than the time entered in P094 for the OFF delay of the auxiliaries.	
	P601.003 K6001 Field current setpoint
	P609 K0000 Source speed actual value
	P654 B6200 ON command
	P661 B6200 Pulse enable
P675 B6201 Trigger "Ext. Fault 1" with fault of the field supply unit	
P790 5 Peer-to-peer selection	P790 5 Peer-to-peer selection
P791 2 Number of words transmitted	P791 2 Number of words transmitted
P793 8 Recommended baudrate	P793 8 Recommended baudrate
P795 1 Bus termination ON	P795 1 Bus termination ON
P794.001 K0268 Field current setpoint	P794.001 K0114 Field current actual value
P794.002 K6020 Routing auxiliaries "ON"	P794.002 K6020 Routing fault bit
P797 0.3-0.5s Telegram failure time. If a fault occurs when the electronics supply is switched on during initialization → Set a longer time	P797 0.3-0.5s Telegram failure time. If a fault occurs when the electronics supply is switched on during initialization → Set a longer time
U117.001 K0251 Auxiliaries "ON"	U117.001 B0107. Routing fault bit
P820.007 5 Masking of fault message "Fault in the field circuit"	P820.007 42 Masking of fault message "Tacho fault"

NOTICE

If a fault occurs on the field supply unit, the armature supply unit is switched off with F021 (external fault 1).
It is then necessary to acknowledge first the fault on the field supply unit and then F021 on the armature supply unit.

4 Startup, Optimization

NOTE

If, during optimization for feedforward control and closed-loop current control, the value range of P110 (armature circuit resistance > 32.767Ω) or of P111 (armature circuit inductance > 327.67mH) is exceeded, the maximum possible value is entered in the relevant parameter and output at the end of optimization F050.

You can then read the details in the monitoring parameter r047 (display of the fault diagnostic memory). P155 (armature controller P-gain) and P156 (armature controller reset time) are always correctly set despite that.

Optimization should be repeated with a warm field winding because the resistance of the field circuit largely depends on the operating temperature.

4.1 Version 1: Field supply with an internal setpoint

- ◆ Setting of the parameters acc. to the list from Section 3.1
- ◆ Perform optimization for feedforward control and current controller (P051=25)
For procedure to follow, see Section 7.5 of the instruction manual of the 6RA70.

4.2 Version 2: Field supply with an external setpoint

Procedure as in Section 4.1

4.3 Version 3: Armature supply + field supply

4.3.1 Setting of the parameters acc. to the list from Section 3.2

Please keep to the following sequence when performing automatic optimization:

4.3.2 Field supply unit

Procedure:

- ◆ Start optimization for feedforward control and current controller, i.e.
set **P051=25**
- ◆ Set commands "switch on" and "operating enable", preferably by setting
P654=B0001 and **P661=B0001** (this avoids having to activate the armature supply unit)
- ◆ Wait for the end of the optimization run.

4.3.3 Armature supply unit

Procedure:

- ◆ **P082=0** Set for the duration of the optimization run P051=25 because the internal field is not used and cannot therefore be optimized.
- ◆ Secure the field control unit against switch-on, e.g. by setting **P654/P661=B0000**.
- ◆ **P051=25** Perform optimization run for feedforward control and current controller (armature).
- ◆ **P082** Set back to the original value.
- ◆ **P654/P661** of the field control unit to be set to **B0001** (permanent enable of the field control unit).
- ◆ **P051=26,27,28** Perform optimization runs for speed controller, field weakening, and friction or inertia compensation, as required (see the instruction manual for 6RA70 Section). 7.5)
- ◆ **P654/P661** of the field control unit to be set back to **B6200**.
- ◆

5 Overvoltage Protection

5.1 General information



WARNING



Overvoltage protection is absolutely necessary in this application because, for example, in the event of a power failure the thyristors block and an overvoltage arises due to the energy contained in the field (switch-off of an inductor). That can cause destruction of the thyristors in the SIMOREG unit.

The overvoltage protection therefore has the task of limiting the voltage to a defined value and to eliminate the energy contained in the field.

Because this application can only realistically be applied to motors with large field currents and therefore also large inductances with the corresponding energy content, the following suppressor networks are available:

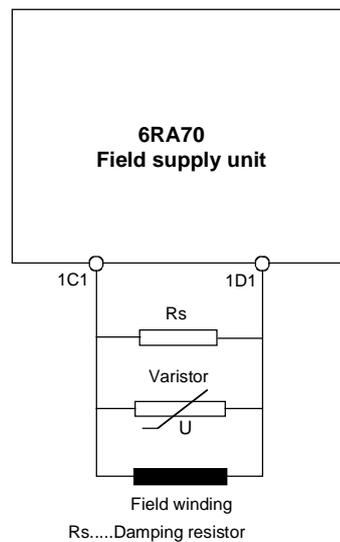
- ◆ Silicon carbide varistors
- ◆ Thyristor modules

NOTICE

SIOV block varistors are a problem because of their low load capability and short life. They are not therefore dealt with here.

It is also necessary to use a damping resistor R_s which has the purpose of damping the overvoltages that arise with a small direct current due to the intermittent current chopping, oscillation, or undershooting of the protection thyristor holding current.

5.2 Protection using silicon carbide varistors



These can be obtained, for example, from Conradty/Nuremberg, Germany.

Silicon carbide varistors (e.g. of type series 820SB) are disk-shaped and can be connected in series or parallel depending on the voltage and current requirement. There are no standard types. Dimensioning is a service offered by Conradty and requires the following data:

- ◆ Application
- ◆ Type of converter circuit (B6C)
- ◆ Network voltage (nominal value + tolerance)
- ◆ Mean value of the output direct voltage
- ◆ Rated field current/voltage
- ◆ Field energy

$$W = \frac{I_{\text{fieldnom}}^2 * L}{2}$$

W.....energy content of the field winding of the motor

I_{fieldnom} rated field current of the motor [A]

L.....inductance of the field winding of the motor [H]

- ◆ Maximum permissible limitation voltage - depending on the motor, converter
Choose the smaller value

Values for converters:

Input voltage 3AC	Limitation voltage DC
400V	1.300V
460V, 575V	1.500V
690V	1700V
830V	2100V

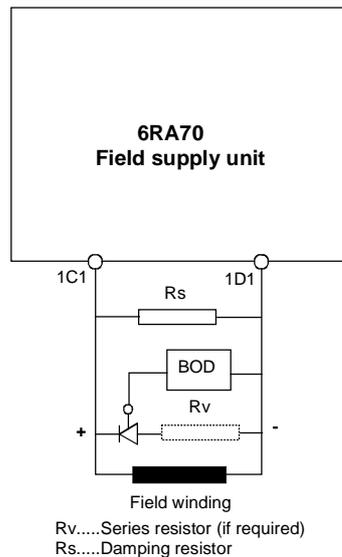
Values for motors:

To be found under SIEMENS Motors in Catalog DA12 1995/96 Section 1/29 "Suppressor network of the field winding".

- ◆ Frequency of operating cycles
- ◆ Operating duration
- ◆ Ambient temperature

Source: **C. Conradt**
Nürnberg GmbH & Co.KG
 Postfach 1263
 90549 Röthenbach
 Federal Republic of Germany
 Phone: +49 (0)911 5708-0
 Fax: +49 (0)911 5708-211
 (Info dated August 2000)

5.3 Protection using thyristor modules



Thyristor protection modules are used in fields with an energy content > 400Ws and field currents up to approx. 500A. They are only suitable for protection in the event of a fault. If an overvoltage arises, the thyristor is fired via a BOD element (breakover diode) and remains conductive until the field energy has been eliminated and the holding current of the thyristor is exceeded.

The following values are required to dimension the suppressor network:

- ◆ Largest operating load current
- ◆ Time constant τ of the free-wheeling circuit

$$\tau = \frac{L}{R}$$

L..... Inductance of the field winding of the motor [H]

R.....Summated resistance field winding + supply leads + series resistance (if required) [Ω] τ Time constant [s]

The magnitude of current and duration of current flow together determine the thermal load of the protection thyristor.

For the permissible currents depending on the time constant and information for rating a series resistance, see the instruction manual for the overvoltage protection module E89110.

Documentation can be obtained from:

SIEMENS ERL F98
 ATD TD 6 FP
 Phone: +49 (0)9131 18 82329
 Fax: +49 (0)9131 18 84445
 (info dated August 2000)

5.4 Damping resistors R_S

Dimensioning for B6C circuit:

$$R_S[\Omega] \leq \frac{1.35 * U_L [V]}{0.5 [A]}$$

$$P_V[W] = 2...3 * \frac{U_{FN}^2 [V]}{R_S[\Omega]}$$

U_LPhase voltage

P_VPower loss of R_S

U_{FN}Nominal field voltage

