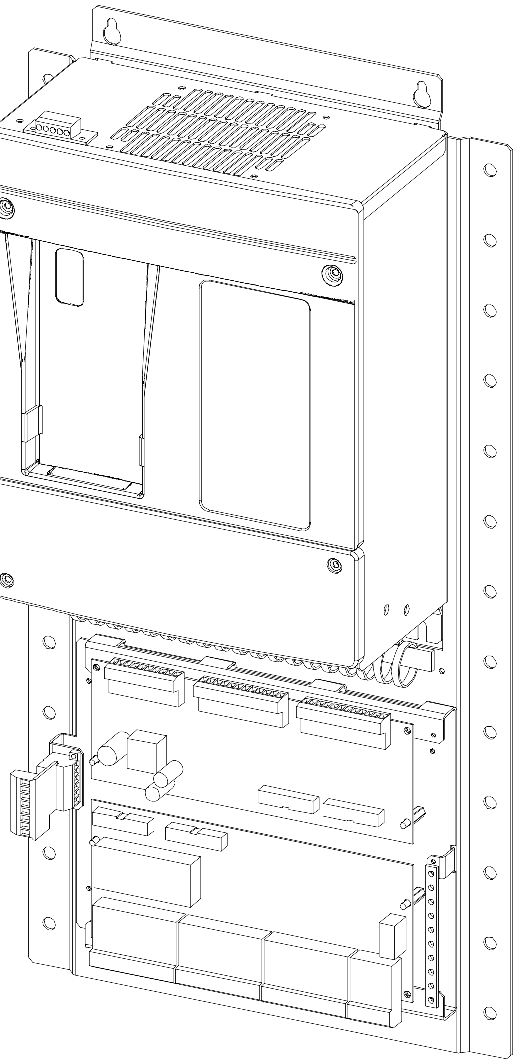
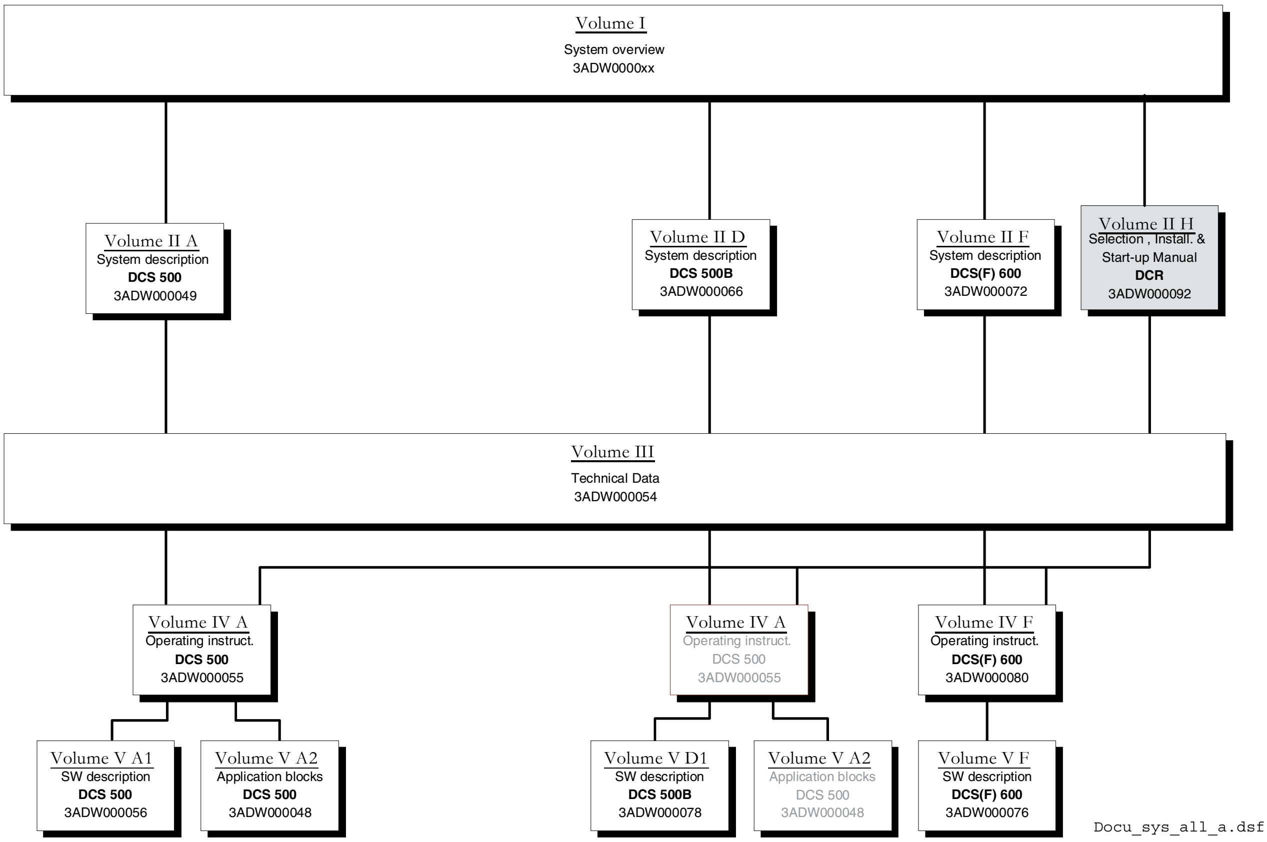
Thyristor Power Converters
for DC Drive Systems

Selection, Installation and Start-Up Manual for Rebuild Kits



How the DCS Documentation System works

The overview below shows how the documentation system for the DCS/DCR range is built up.
This brochure is valid for all units of type DCR; the shaded part indicates the position of this brochure within the total documentation system. In addition the overview informs about all other available documents for the same system.



Thyristor Power Converters

Series

DCR 500B
DCR 600

Selection, Installation and Start-Up Manual for Rebuild Kits

Code: 3ADW 000 092 R0301 Rev C

IND/AME: DCR_S_E_C.DOC

EFFECTIVE: April. 7th, 2004
SUPERSEDES:Rev B June. 6th, 2001

©2004 ABB Automation Products GmbH. All rights reserved.

Contents

II H SELECTION, INSTALLATION AND START-UP MANUAL

Chapter 1 - Introduction

How to use this manual

The purpose of this manual is to provide you with the information necessary to select the right rebuild kit with all the necessary or available options, to install it, do the start-up and operate it as a DC drive system. Depending on the hardware and software (which can be downloaded to the microprocessor board), different functionality and different options concerning the user interface are available. Because of this there are different subsets of the DC Rebuild Kit existing. They will slightly differ in their names. As long as the general Rebuild Kit needs to be named, DCR kit or similar will be used without any more detailed specification.

Contents of this manual

Chapter 1 – Introduction describes how to use this manual and the boundary conditions applying.

Chapter 2 – Basic Selection provides the information about the types of the DCR kits, their type designations and options.

Chapter 3 – Hardware description provides the information about the boards and components

Chapter 4 – DCR Interfacing the Electronics and Thyristors provides the information about the configurations and functions of drives and examples of the whole circuit diagram.

Chapter 5 – Installation provides the information about required ambient conditions, space requirements, cabling and wiring and how to install a rebuild system.

Chapter 6 – Start-up gives some general guidelines and cross references how to commission and start up a DC drive system using a DCR kit.

Chapter 7 – Ordering gives information about ordering a DCR kit.

Chapter 8 – Special Accessories lists components not needed in every case. They are quite helpful in case an additional function like cooling condition monitoring has to be realized.

This manual is designed to help those responsible for planning, in stalling, starting up and servicing the thyristor power converter.

Associated publications

Associated publications see *Chapter 2*: DCR xxx type

Chapter 2 – Basic Selection

Technical preconditions and limits

If an electrical drive is in operation for several years, most often discussions will be started about items like
- better factory automation based on latest technology
- decrease of standstill time of production
- availability of spare parts
- increase of productivity; perhaps an enlargement of the whole installation using both types of drives, DC and AC drives
- and other arguments

These wishes can be turned into real life by:
- upgrade the drive itself completely
- upgrade only the converter, which had controlled the DC motor
- upgrade the converter´s electronics only
- upgrade a part of the converter´s electronics.

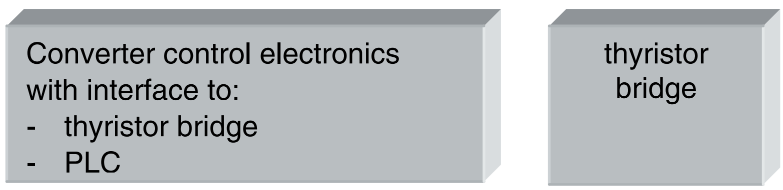
For a final solution, all the **benefits** described by:

• higher production • more accurate control
• design of state of the art • others

will be compared with the **disadvantages** of revamping described by:

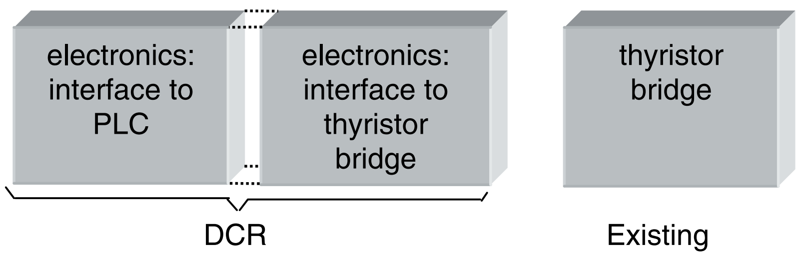
• standstill time of production • hardware cost • training etc.

If this comparison is based on an upgrade of the converter´s electronics the DCR kit, which is described within this document, may be a solution. Before the final decision is made to use the DCR kit the configuration of the existing drive needs to be checked more in detail to make sure the DCR kit fulfills all demands.
The next picture shows the basic structure of a converter, used for controlling a DC motor.



Selecting the suitable DCR kit

The electronics of the existing converter indicated by the left box above is splitted into 2 boxes at the DCR kit.



The DCR kit can be used for armature bridges in non-regenerative or regenerative mode with maximum 4 thyristors in parallel. In case there are more than 4 thyristors in parallel per current direction there is no standard DCR kit prepared; please contact your local ABB organization.

Selecting a DCR kit at first the *HARDWARE CONDITIONS* must be checked to become aware of critical limitations. If this is not a problem the *DRIVE´S DESIGN CONDITIONS* will give some guidelines for the overall design. After that a decision must be made for the functionality of the interface between the kit and the Programmable Logic Controller. Depending on that the DCR kit´s name can be fixed by using the 2 type designations listed on the next pages. Afterwards please check, if all conditions are fulfilled, mentioned at *CONDITIONS, CAUSED BY THE APPLICATION*.

Hardware conditions

If a DCR kit is really taken into consideration, the next items list some conditions that the DCR kit should be used or better a converter module / enclosed converter.

- Before an existing DC power part is upgraded by the DCR kit, it should be checked, if a brand new module may be the easier and more reliable solution.
- The existing power bridge should be build up by max. 4 thyristors in parallel (solution for more thyristors in parallel on request).
- The mains voltage on line supply, used at the existing thyristor bridge has to be lower than 1200 V because of the devices, used to interface the electronics to the thyristors (higher mains voltages on request).
- The thyristors should be of a disk type and one single thyristor bridge should be capable of running around 1000 A or more, if the converter is build up by more than one bridge in parallel; if a single bridge cannot give this current a brand new converter is probably the more economical solution
- The ratio between reverse / forward blocking voltage of the thyristors and the nominal line voltage should be factor 3 or higher; the blocking voltage has to be measured on a thyristor test stand; if the actual blocking voltage gives a lower ratio the thyristor(s) need to be replaced; in such a case, please check, if a complete new converter may be more economic.

Drive´s design conditions

It is intended to install the kit into the existing drive cabinet. The following drive equipment will be reused and should therefore be in good condition:

- Check all parts in the AC supply like main disconnecting switch with fuses or main contactor or similar for good condition.
- Check the thyristor bridge itself (fixing devices; press clamps for thyristor mounting, etc.) with cooling equipment for good condition.

- If a DCR kit is used for the armature supply the existing field supply can be reused or upgraded too.
  - If the field supply will be upgraded one of these can be used:

SDCS-FEX-1 or FEX-2	(build in)
DCF 503 or 4	(external; 2 phase)
DCF501/502 or DCF 601/602	(external; 3 phase)

  - If the old field supply will be reused check the overall strategy concerning monitoring, fault tracing and overall control and performance of the drive. Either a binary or an analogue signal should be available indicating “field supply equipment o.k.”. In case this signal is not available galvanic isolated then it should be made potentially free for safety reasons. If the drive should also be used in the field weakening range, an analogue signal, representing the actual field current, is highly recommended. It will be used for monitoring and fault indications generated within the DCR kit´s software.
- Depending on the old control structure an analogue tacho generator can be reused. A pulse generator can only be (re)used, if it generates a pulse train as an output signal (see software description).
- The DCR kit expects an armature current feedback signal for the current control loop. This signal normally is taken from two current transformers on the a.c. side of the thyristor bridge. The current transformers shall give 0.5 - 0.85 A, which corresponds to the nominal current of the thyristor bridge (other solutions on request).
- A 230 V a.c. supply for the DCR kit´s electronics is needed.

Conditions, caused by the application

In addition to that it has to be checked, if the selected DCR kit type can handle the application of the existing drive. As long as the existing one was used in a 6 pulse bridge configuration, there is no limitation.

- If the existing bridge has been used in a 12-pulse configuration, additional engineering is needed. Please make sure that the selected DCR kit is prepared for that type of system.
- There are drives used in the past in a configuration sometimes named MASTER - FOLLOWER or MASTER - SLAVE or similar. In all these applications, one drive had generated references or commands for the second, third etc. All 2 types of the DCR kit are prepared for those configurations; the final wiring may be different. For more details, please refer to the documentation.
- If the existing converter has been used in a non motor application most often a prepared solution is not available, but most often an engineered solution can be found. Please contact your local ABB engineering organization.

Mechanical design

There is only one principle of mechanical construction. The four type designations differ in the software code and in the mechanical options, which can be selected.

The first kit named DCS 500 and the last one, named DCS 500/11 are no longer available. They are equipped with a SDCS-CON-1 controller board, which is no longer used as a standard part. Nevertheless the block diagrams will be kept within this manual for information only.

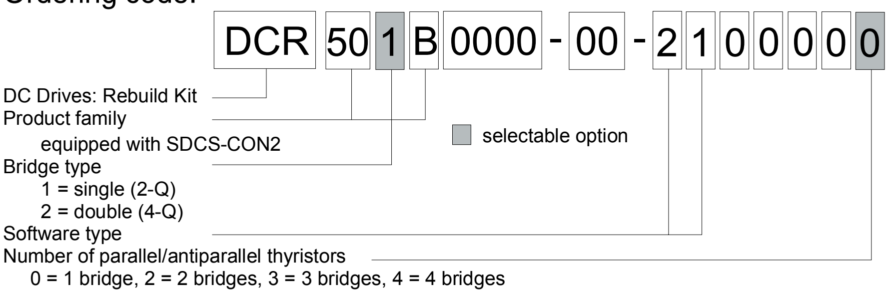
Types of DCR kits

DCR 500B

The documentation belonging to DCS 500B is used together with this description. One common feature is the software, which can be identified by the designation S 21.xxx.

- **DCS 500 / DCS 500B System Description** describes more in detail the overview, shown on the next page.
- **Technical Data** describes all the external connections and settings of the circuit boards.
- **DCS 500 / DCS 500B Operating Instruction**
- **DCS 500 Software Description**
- **DCS 500 Application Function Blocks** describes in detail all the additional function blocks, like AND, OR, ADD, MULTIPLY etc.. to generate application specific functions.

Ordering code:



Applications:

- 12 pulse parallel	available
- 12 pulse serial	-------------
- MASTER – FOLLOWER	available; hardware data exchange

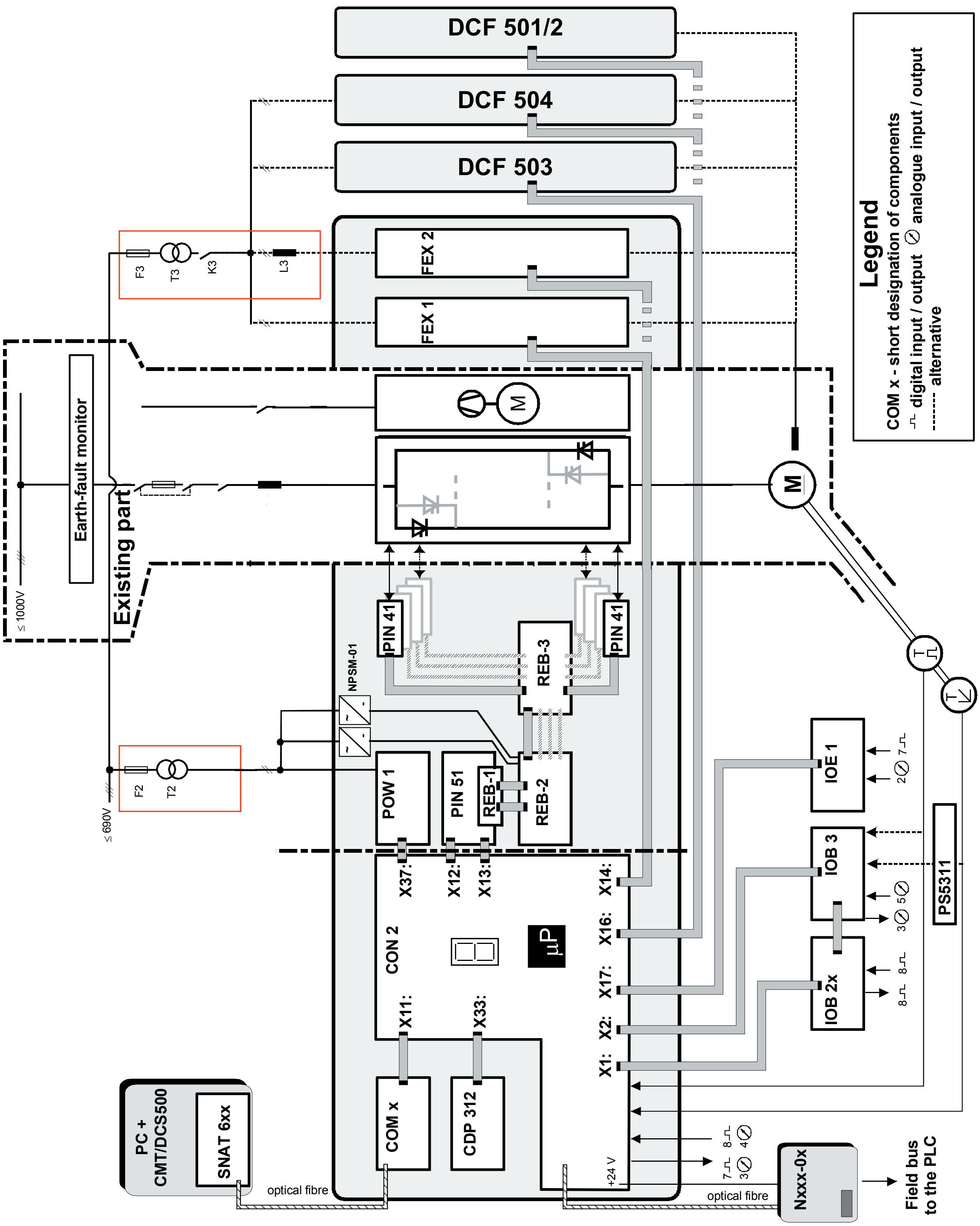


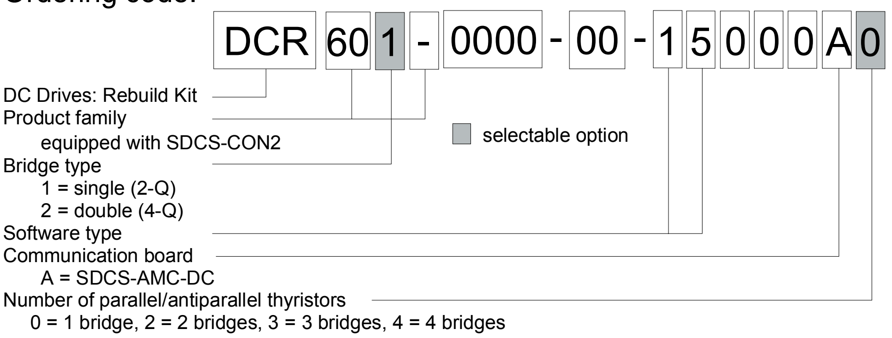
*Figure 2 - 1 Overview of **DCR 500B** System*

DCR 600

The documentation belonging to DCS 600 is used together with this description. One common feature is the software, which can be identified by the designation S 15.xxx.

- **DCS 600 System Description** describes more in detail the overview, shown on the next page.
- **Technical Data** describes all the external connections and settings of the circuit boards.
- **DCS 600 Operating Instruction**
- **DCS 600 Software Description**

Ordering code:



Applications:

-	12 pulse parallel	available
-	12 pulse serial	available
-	MASTER - FOLLOWER	available; serial data exchange

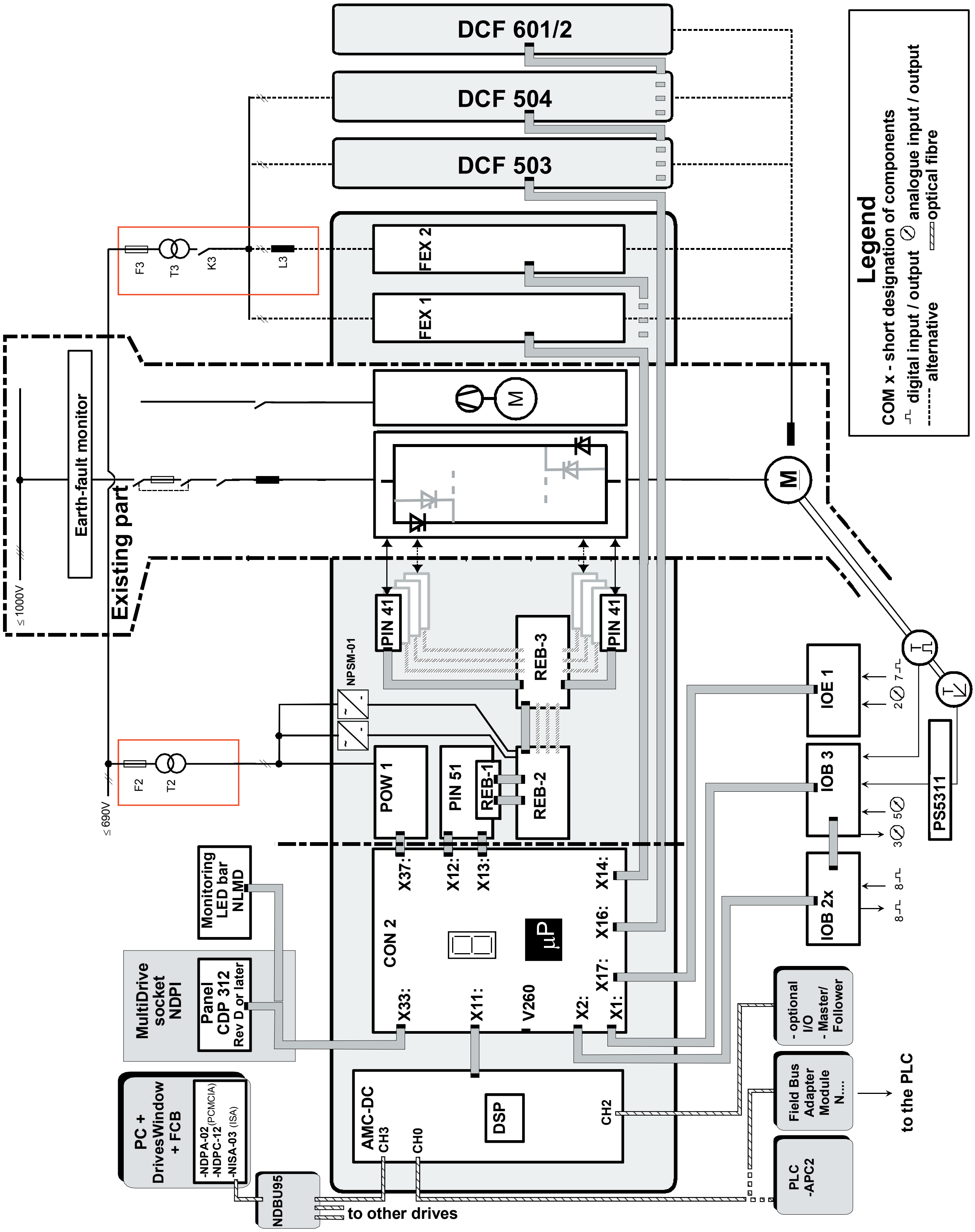


Figure 2 - 2 Overview of ***DCR 600*** System

Dimensions

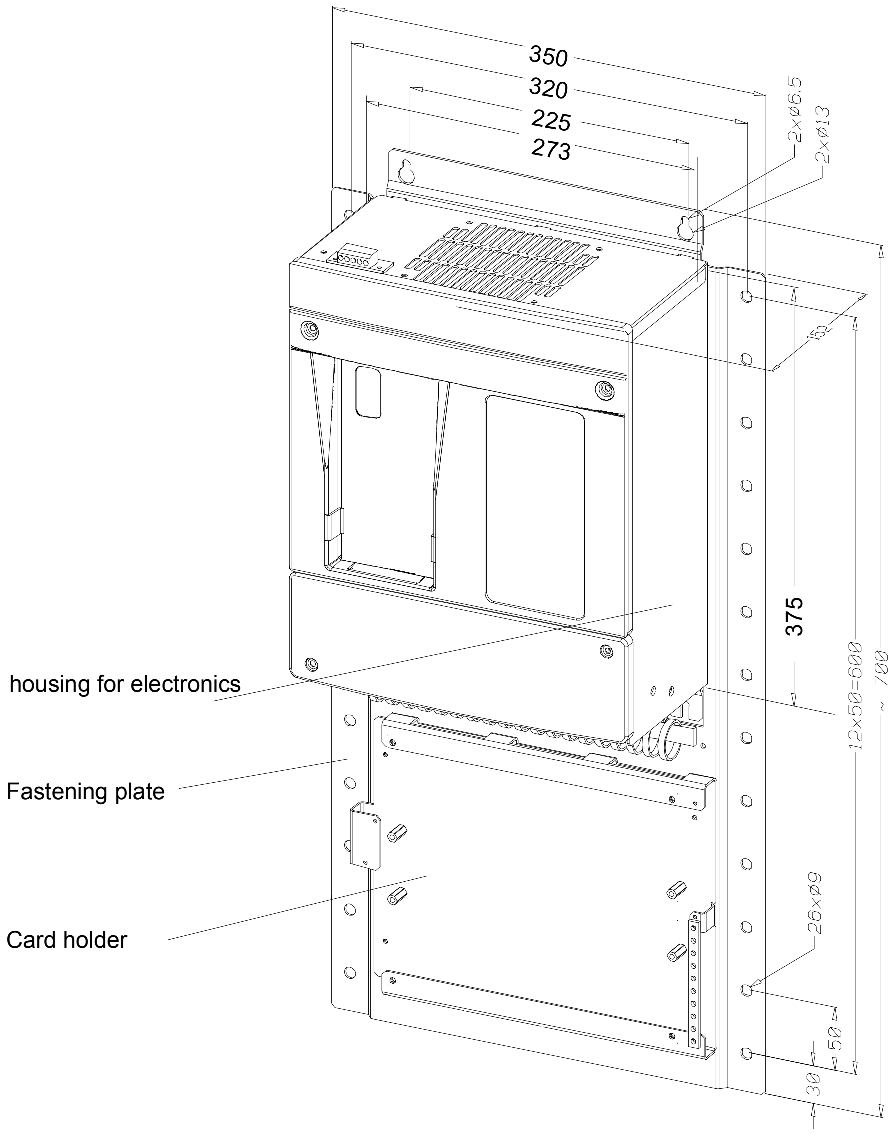


Figure 3 - 1 Dimension of the DCR kit´s main electronics

Environmental conditions of the DCR kit

- For environmental conditions, please see documentation:
  System Description
- The electronics housing is equipped with a cooling fan, which takes the air from the bottom and blows it out at the top; the route of the air flow has to be free.
- Fan data or further information, please see documentation:
  Technical Data

Basic components of the DCR kit

The DCR kit is ordered according to the type designation at chapter 2. The delivery can be subdevided into 3 parts:
- DCR kit´s main electronics already pre-assembled
- electronic boards and cables to measure signals at the power part and control the existing thyristors; this will come as loose parts
- the interface towards the PLC can be done via inputs / outputs; in this case optional parts are added

Pre-assembled part

These parts are pre-assembled:
- Fastening plate with housing (including fan and electronics)
- Control board SDCS-CON-2 built in (at a DCR 600 the communication board SDCS-AMC-DC is built in too)
- Electronic power supply SDCS-POW1 built in (including flat cable to SDCS-CON-2)

Hint: at older DCR versions (e.g. DCS 500 or DCS 500/11) the SDCS-CON-1 MOD1 had been used instead of CON-2.

One of the communication boards (SDCS-COM-1 or COM-5 for a DCR 500B) and one of the field supplies (SDCS-FEX-1 or 2) can be mounted inside the housing of the electronics, if ordered separately and as an option.

Loose parts

The kit is available as a 2-Q or 4-Q version. Both of them are available for power parts with one up to four thyristors in parallel. Because of the different versions some components will be part of the delivery in every case like the SDCS-PIN51 and SDCS-REB1 board, others depend on the configuration:

DCR501B DCR601-	....-..-......0 (1 Bridge)	....-..-......2 (2 Bridges)	....-..-......3 (3 Bridges)	....-..-......4 (4 Bridges)
(2-Q)	1x PIN41A - - - - - - - - - - - -	2x PIN41A 2x NPSM01 1x REB2 - - - -	3x PIN41A 2x NPSM01 1x REB2 1x REB3	4x PIN41A 2x NPSM01 1x REB2 1x REB3
DCR502B DCR602-	....-..-......0 (1 Bridge)	....-..-......2 (2 Bridges)	....-..-......3 (3 Bridges)	....-..-......4 (4 Bridges)
(4-Q)	2x PIN41A - - - - - - - - - - - -	4x PIN41A 2x NPSM01 1x REB2 - - - -	6x PIN41A 2x NPSM01 1x REB2 1x REB3	8x PIN41A 2x NPSM01 1x REB2 1x REB3

The boards serve for different purposes:

- **SDCS-PIN41A:**
  Pulse transformer board is mounted on a card holder. For the interconnections 6 firing leads (twisted pair; system plug on one end) and a shielded flat cable (round; 20 pole) will come with the kit. For cable length, please refer to chapter 5.
- **SDCS-PIN51:**
  Measuring board is mounted on a card holder. For the interconnections 5 leads for the AC and DC voltage measurement (single core; 6,3mm faston on one end), 2 leads for the current measurement (twisted pair; system plug on one end), 2 shielded flat cable (round; 16 pole) and a plugable resistor for X22 will come with the kit. For cable length, please refer to chapter 5.
- **SDCS-REB-1:** (Interface board)
- **NPSM-01:** (Power supply)
- **SDCS-REB2:**
  Pulse amplification board is mounted on a card holder. For the interconnections 2 flat cable (20 pole) will come with the kit. For cable length, please refer to chapter 5.
- **SDCS-REB-3:**
  Firing pulse routing board is mounted on a card holder. For the interconnections 2 flat cable (20 pole) will come with the kit. For cable length, please refer to chapter 5.

Optional parts

If the subassembly **SDCS-IOB-2x/IOB3** has been ordered as:

- **build-in**, the two boards and the PS 5311 will be mounted on a card holder, which is shown on fig. 3-1; this card holder will be mounted already on the fastening plate; the flat cables between the boards and between the micro-processor board will be plugged-in; the length of the flat cables is according to the mechanics.

- **not build-in/separate**, the two boards and the PS 5311 will be mounted on a card holder, which is shown on fig. 3-1. Three flat cables will be delivered as separate parts; two of them will have a length of 4 m, one of 0.26 m.

Pulse transformer board SDCS-PIN-41

This board is always required in a DCR kit.
Normally one SDCS-PIN-41 board per 6 thyristors, if the board can be placed close (gate wires <1 m) to all 6 thyristors.

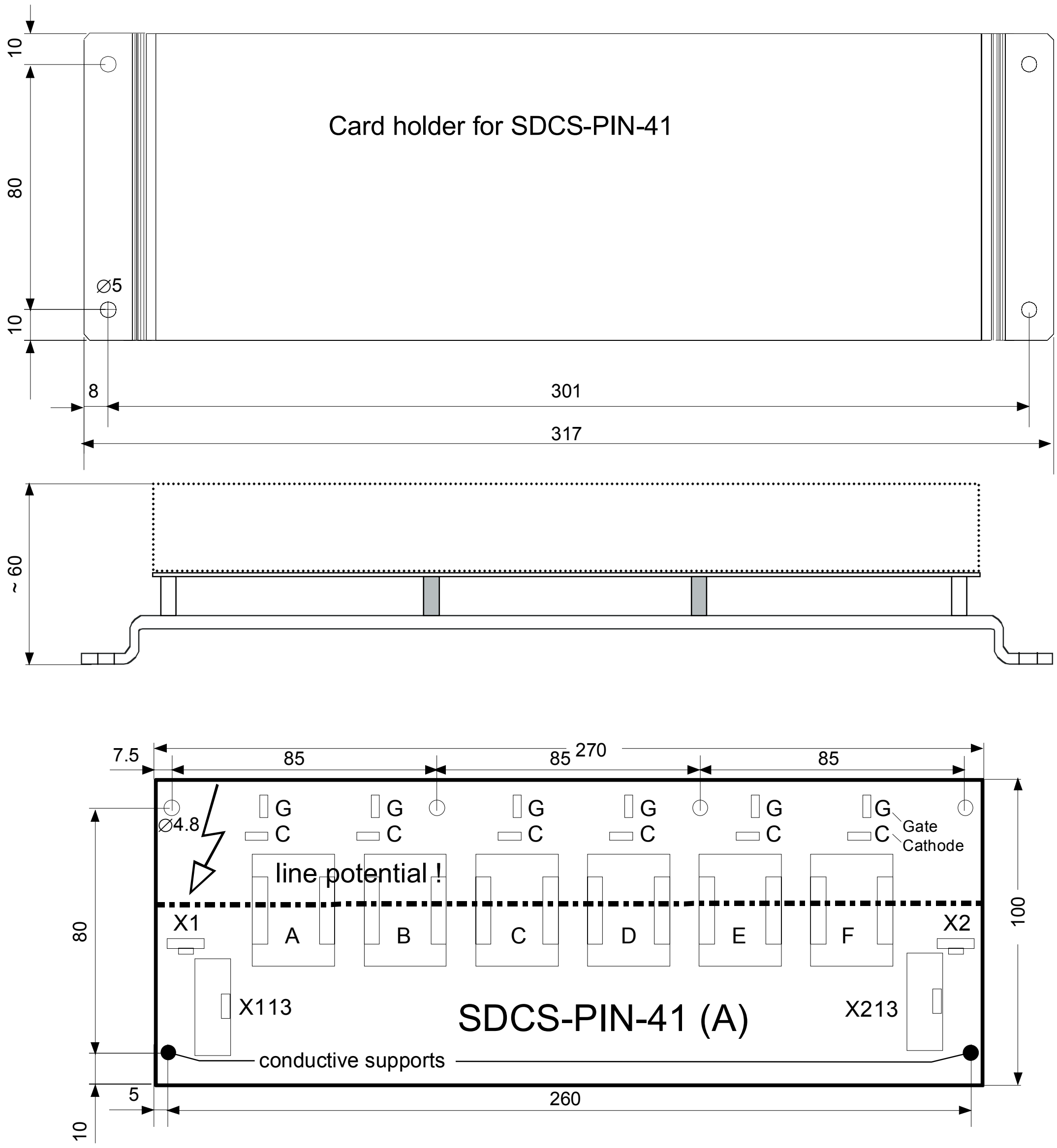


Figure 3 - 2   SDCS-PIN-41 board and card holder

Wiring

The gate-cathode wires, which are a part of the DCR kit delivery, have to be handled in this way:

- One end is equipped with a coded plug, which fits the C and G pins on the SDCS-PIN-41(A)
- The cable length in the delivery condition is 2 m. The cable routing should be done, to end up with a cable length as short as possible; the max. cable length is 1 m. The cables have to be shortened and have to be equipped with the plug connector, demanded by the thyristor type in use.

Measurement board SDCS-PIN-51

This board is always required in a DCR kit.
One SDCS-PIN-51 board per DCR kit.

General

The SDCS-PIN-51 board contains following functions:

- Connection to pulse transformer board / boards
- Interface for heat sink temperature measurement with a PTC resistor
- Measurement and scaling of AC and DC voltage via high ohmic resistors
- Measurement of the armature current and scaling with burden resistors to 1.5 V for rated current; burden resistors for zero current detection
- Selection of 2-Q / 4-Q-operation

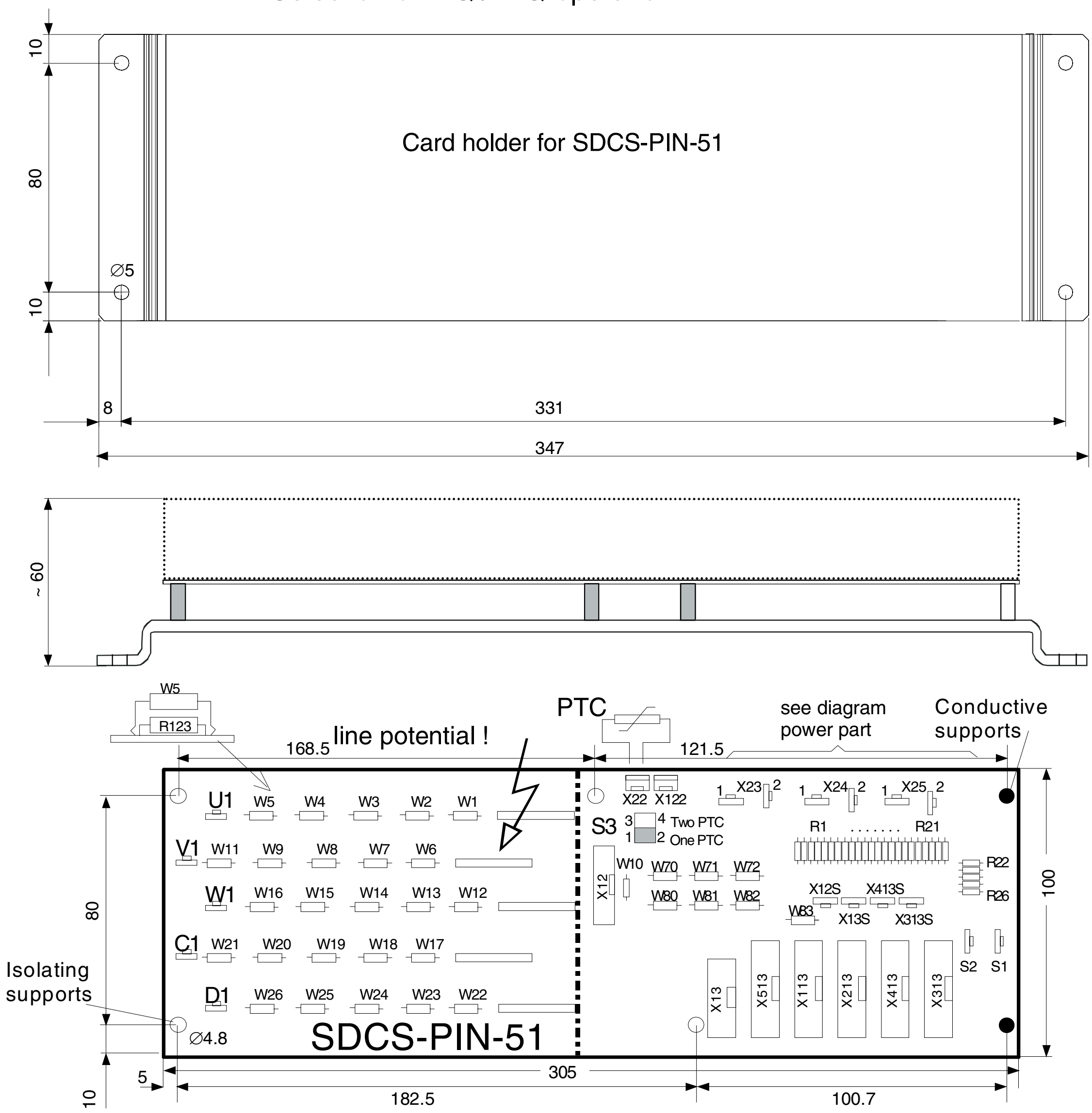


Figure 3 - 3 SDCS-PIN-51 board and card holder

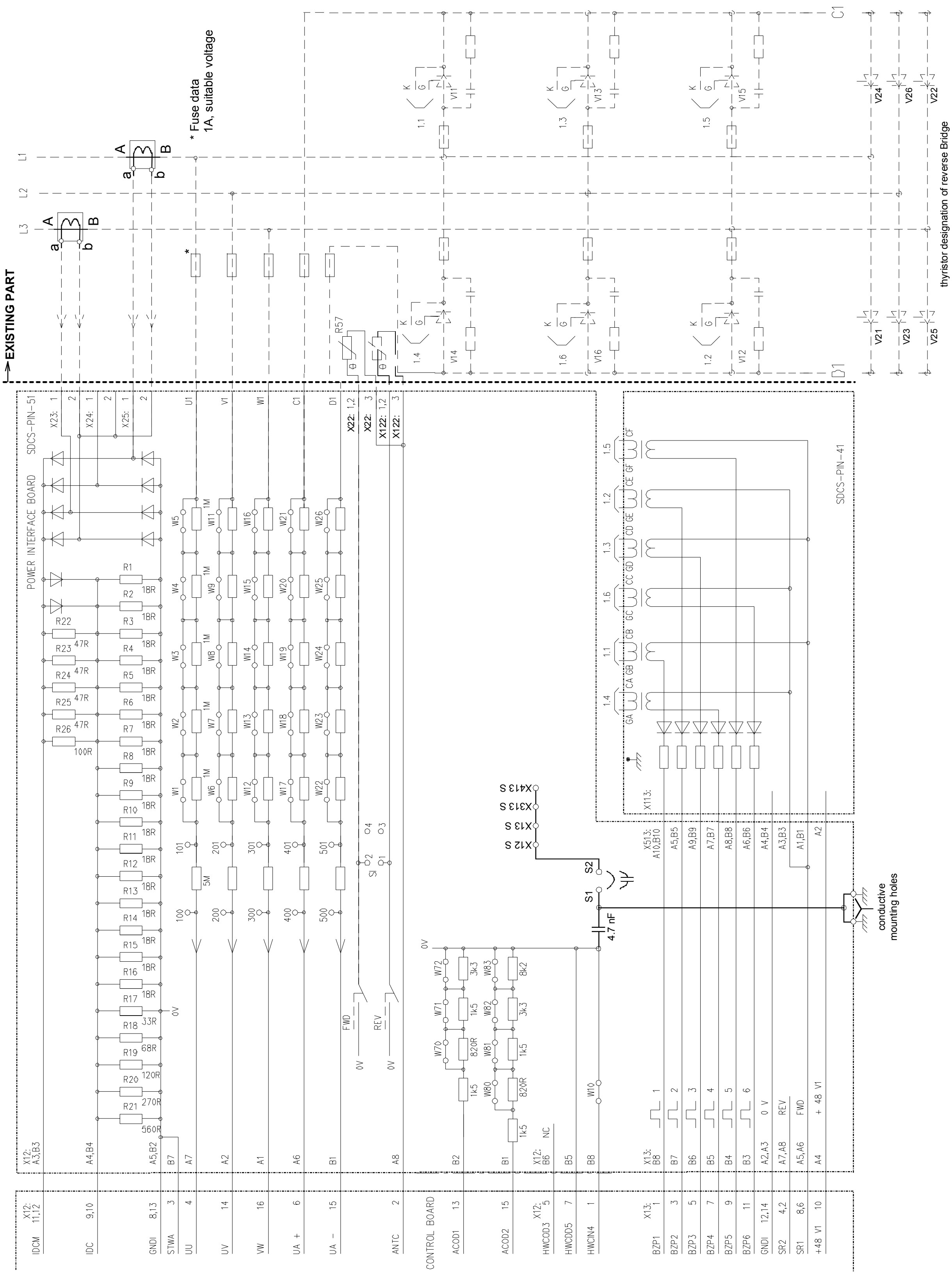


Figure 3 - 4 Typical rebuild connection with DCR kit, SDCS-PIN-41 and SDCS-PIN-51 boards

Wiring

If the distance between the terminals C1, D1, U1, V1, W1 and the power terminals of the existing power part exceeds 1 m, an additional fuse has to be used per wire (see fig. 3-4).

PTC temperature sensor

Normally there is no temperature sensor in existing converters; in this case, a separate resistor (2.21 kohm; 0.5 W; 1%; 50 ppm; delivered with the kit) must be connected between terminals X22:1 and X22:3 on SDCS-PIN-51; jumper S3 on the same board must be on position 1-2. Because of this, the temperature measurement reads a fixed value and is out of operation.
Some kind of power part monitoring can be designed by using optional devices. For more information see *chapter 8.*

HW type coding

- All jumpers W70 to W72 and W80 to W83 build in
- The quadrant type should be set with jumper W10.

Voltage coding

Use settings for C4 modules, depending on the line voltage.
Note:
At existing power parts with high supply voltage the option **galvanic isolation** should be taken into consideration because of personal and functionallity safety reasons.

Nominal current scaling

At first make sure, that the current transformers are mounted and wired according to figure 3-4.
In addition to that two other definitions are important:

- **the nominal current I_{dN} is equivalent to 1.5 V across the nominal current burden resistors**
- **the current measurement is designed to handle peak currents up to two-times of I_{dN}**

Most often the current I_{dN} is the thermal current of the existing power part; the peak current may be the highest current running through the motor.

- **If the peak current is higher than two-times I_{dN} the nominal current needs to be redefined.**

  The value $I_{dNDCR} = 0.5 * I_{peak}$ has to be used instead of I_{dN} at all the next equations!

- The scaling for nominal current will be done by the resistors R1 to R21, which are connected in parallel.
- The scaling for the zero current detection will be done by the resistors R22 to R26, which are connected in parallel too.

If the ratio of the current transformer is ***either*** *2500:1 or 4000:1*

please use the complete table (R1 to R26) related to the converter modules, equipped with SDCS-PIN-51 board (see *Technical data, section Power Interface SDCS-PIN-41/SDCS-PIN-5x*).

If the ratio of the current transformer is ***different to*** *2500:1 or 4000:1*

Calculate the total burden resistance R_{br}:

$$R_{br} = \frac{1{,}5V}{I_{dN}} * roct$$

with: I_{dN} = nominal current of power part
$roct$ = ratio of current transformer

Calculate the resistors to be cut off within R1 to R21 according to the next formula. The resulting resistance R_r should be as close as possible to the burden resistance R_{br}. If the resulting resistance R_r is smaller than R_{br}, the nominal current $I_{dN}(R_r)$ will be higher than the current the calculation was based on (keep that value and use the one at the parameter SET_I_CONV_A):

$$\frac{1}{R_{br}} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + ... + \frac{1}{Rn}$$

Calculate the total burden resistance R_{bz} for zero current detection:

$$R_{bz} = R_{br} * f$$

with: $f = 9$

Calculate the resistors to be cut off within R22 to R26 according to the next formula:

$$\frac{1}{R_{bz}} = \frac{1}{R22} + \frac{1}{R23} + ... + \frac{1}{R_n}$$

Because of the resistors available and their values a selection of resistors resulting very close to f = 9 is seldom. As long as f is within 8 to 10 the selection can be kept.

Additional settings

The following settings will be done by software parameters:
- nominal current of the converter by SET_I_CONV_A
- nominal voltage of the converter by SET_U_CONV_V
- set parameter SET_CONVERTER_TYPE to 4
- set parameter SET_MAX_BRIDGE_TEMP to 60 degrees
- set parameter SET_QUADRANT_TYPE to:
  1 at a one quadrant power part
  4 at a four quadrant power part

Fastening

The boards SDCS-PIN-41 and SDCS-PIN-51 have six M4 mounting holes. The figures 3-2 and 3-3 show which of the holes have to be grounded and which have to be isolated. 15 to 20 mm long metal stand-offs and insulation stand-offs have to be used. The insulation clearance must be rated to 1200 V AC working voltage.

Interface board SDCS-REB-1

Using SDCS-REB-1 plugged to SDCS-PIN-51 the firing commands are arranged in such a manner, that one SDCS-PIN-41 gives firing pulses to the six forward bridge thyristors and another one to the six reverse bridge thyristors.

If the REB-1 is plugged on SDCS-PIN-51 board connectors X513, X113 and X213, the board routes the firing pulse so that the pulse transformer board for the forward bridge is connected to X613 and the pulse transformer board for the reverse bridge is connected to X713.

Thyristors in old bridges are often differently positioned on the heat sink than in the bigger converter modules. At the bigger standard DCS500B/DCS600 modules firing commands are arranged on the pulse transformer board SDCS-PIN-41.
In this way three channels are used for forward bridge and three channels for reverse bridge. This solution keeps the gate leads as short as possible (see chapter 4).

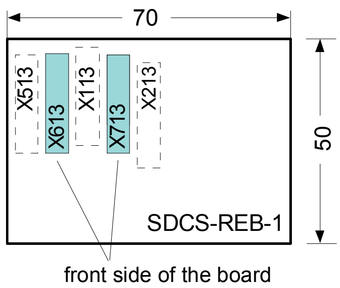


Figure 3 - 5 Layout of the SDCS-REB-1 board

Interface board SDCS-REB-2

This board is used to provide the power to fire the thyristors for a drive equipped with 2 to 4 parallel connected thyristors. In such a configuration the SDCS-REB-2 board is used together with 2 external +24V power supplies and the SDCS-REB-1 to have all the firing pulses available per bridge on one SDCS-PIN-41 board. The SDCS-REB-2 contains optocoupler isolation for firing pulse commands to open ground loops between the different boards, drivers for max. 4 forward bridge and max. 4 reverse bridge pulse transformer boards, connector for external +24 V and +48 V power supply and one isolated transistor output for monitoring of the external supply voltage.

Power supply

The power supply can be made with two +24V power supplies, wired up in series. For this connection suitable power supply is NPSM-01; rated +24V / 2A.

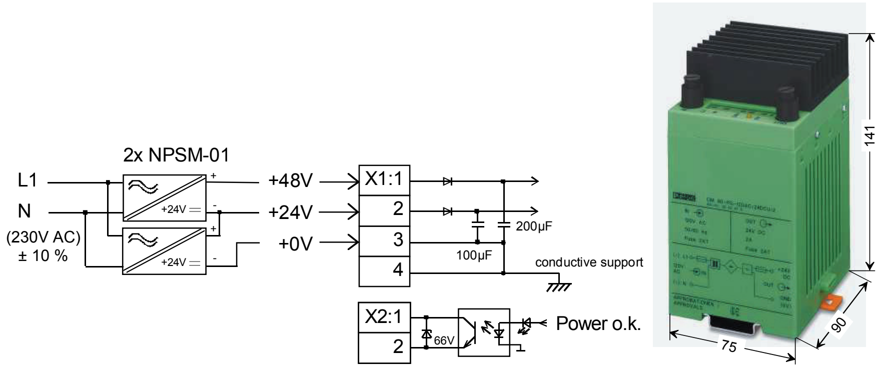


Figure 3 - 6 NPSM-01 connection and dimensions

Monitoring of the external power supply by the SDCS-REB-2:

- +48 V and +24 V are monitored
- if +48 V is under +41 V and +24 V under +19.5 V then firing pulses are suppressed, the green led V58 is not lit and the transistor switch connected to X2 is open. Normally V58 should be lit and the transistor switch is closed.
- the transistor output rating is 60 V DC/ max. 50 mA; the output is isolated; see figure above.

Hint:

The above mentioned monitoring signal should be read by the PLC (programmable logic controller) to handle the COASTING function of the converter. If the supply voltage is o.k. the converter can be released by the PLC. If the supply voltage drops below the threshold, the signal level changes at X2:1 /2. The COASTING function should be activated, which will block the controllers of the converter and force the current to zero as fast as possible for safety reasons. To avoid a blocking and unblocking condition the “power ok” signal should be latched off.
The PLC should release the system depending on other starting conditions.

Functionality

Electrical characteristics of the SDCS-REB-2

- Current requirement for +24 V is 100 mA
- Current requirement for +48 V is 0.4 A for each parallel connected thyristor; if there are 4 parallel thyristors the requirement is 1.6 A
- The power supply should contain sufficient amount of capacitance so that ± 10 % secondary voltage tolerance is not exceeded due to voltage ripple; 0V terminal of the electronics on SDCS-REB-2 is connected to the six mounting holes on the board. Therefore it is grounded.

At the input plug connectors X613 and X713, firing pulse signals 1 to 6 are received, and the current-direction signals SR1 and SR2 as well. The board amplifies these signals and distributes them to 8 plug connectors named X11 to X42. The current direction signal SR1 is assigned to plug connectors Xx1, and current direction signal SR2 to plug connectors Xx2.

Fastening

The SDCS-REB-2 board has six M4 mounting holes. All of them must be grounded using metal stand-offs (see figure 3-8).

Diagram

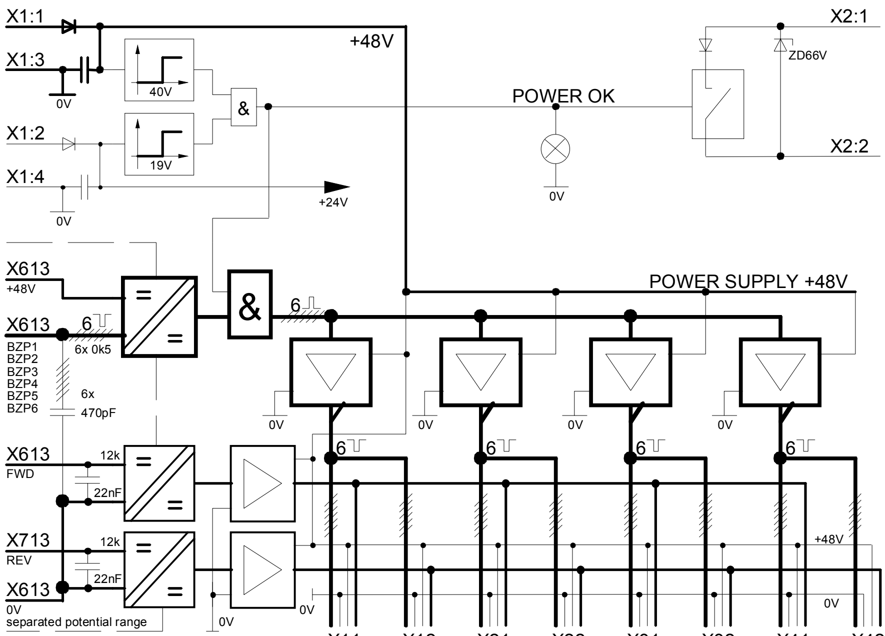


Figure 3 - 7   Diagram of the SDCS-REB-2 board

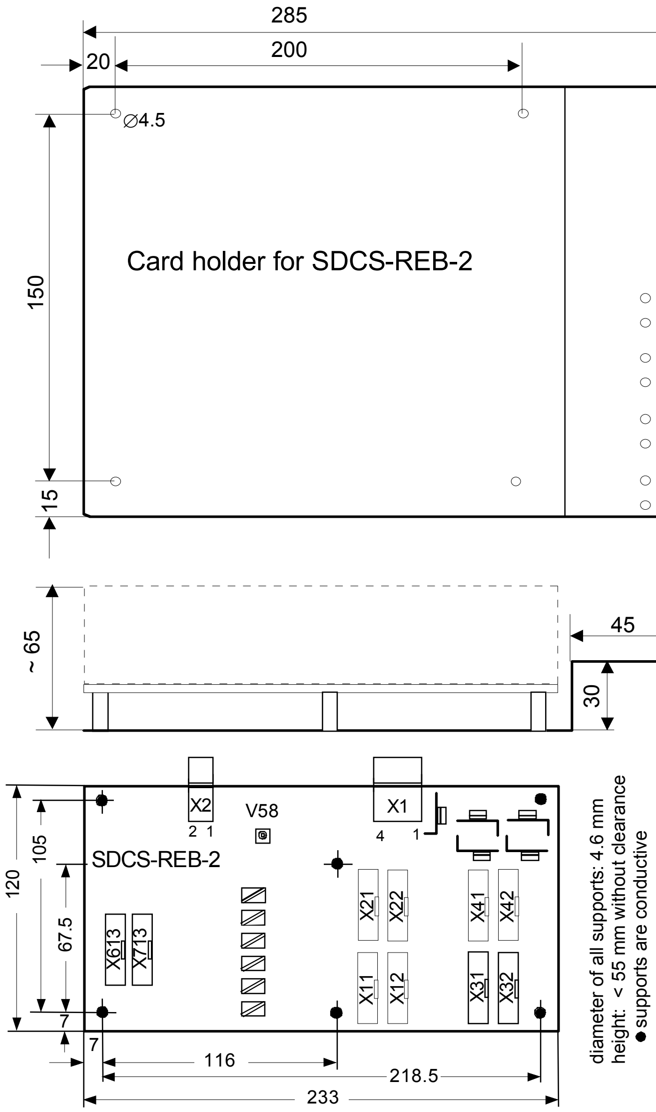


Figure 3 - 8 Layout of the SDCS-REB-2 board

Interface board SDCS-REB-3

In a single thyristor bridge the distance between the 6 thyristors and the pulse transformer board is often quite short. The length of these cables, which is limited to 1 meter, is sufficiently long. In big thyristor stages with parallel thyristors the distance can be longer than 1 meter.
In addition to that, there is another reason, which becomes more critical at big thyristor stages. The wiring of the SDCS-PIN-51, SDCD-REB1 and SDCS-REB-2 is designed, that firing pulses for one complete thyristor bridge will be available at SDCS-PIN-41.
To get flexible routing of the firing pulses, the SDCS-REB-3 board comes into use. This board enables the firing pulses to be assigned to the pulse transformers and therefore to the thyristors as well.
If the SDCS-REB-3 board is used, it must be installed between the SDCS-REB-2 and the pulse transformer board SDCS-PIN-41. This board represents a matrix which is used for assigning the current direction signals and the firing pulses received at plugs X11: to X:42 to the output plugs X113: to X813:. If possible try to avoid connecting thyristors of different bridges to the same SDCS-PIN-41. Commissioning and testing will become easier.

At a power part with parallel thyristors each thyristor gets a three digit number. Every digit has the meaning (see fig. 4-1):
- thyristors named 1xx, 2xx, 3xx or 4xx belong to the first, second, third or fourth bridge
- thyristors named x1x belong to the forward bridge, which is activated by the current direction signals SR_1ACE and SR_1BDF
- thyristors named x2x belong to the reverse bridge, which is activated by the current direction signals SR_2ACE and SR_2BDF
- thyristors named xx1, xx2, up to xx6 indicate the normal firing sequence by their number

Firing pulses

The pulse transformer board SDCS-PIN-41 contains 6 channels numbered A to F. These are in turn subdivided into 2 groups, one with the channels A, C, E and one with the channels B, D, F. These are controlled by two current direction signals. The next figure shows the routing of the firing pulses and the activation of the two groups for three different configurations, used with the bigger standard DCS500B/DCS600 modules.

Signal flow and Thyristor designation

Signal flow of firing pulses and doubling of current direction signals is shown based on the figures 4-2, 4-4 to 4-7. That results in the thristor designation.

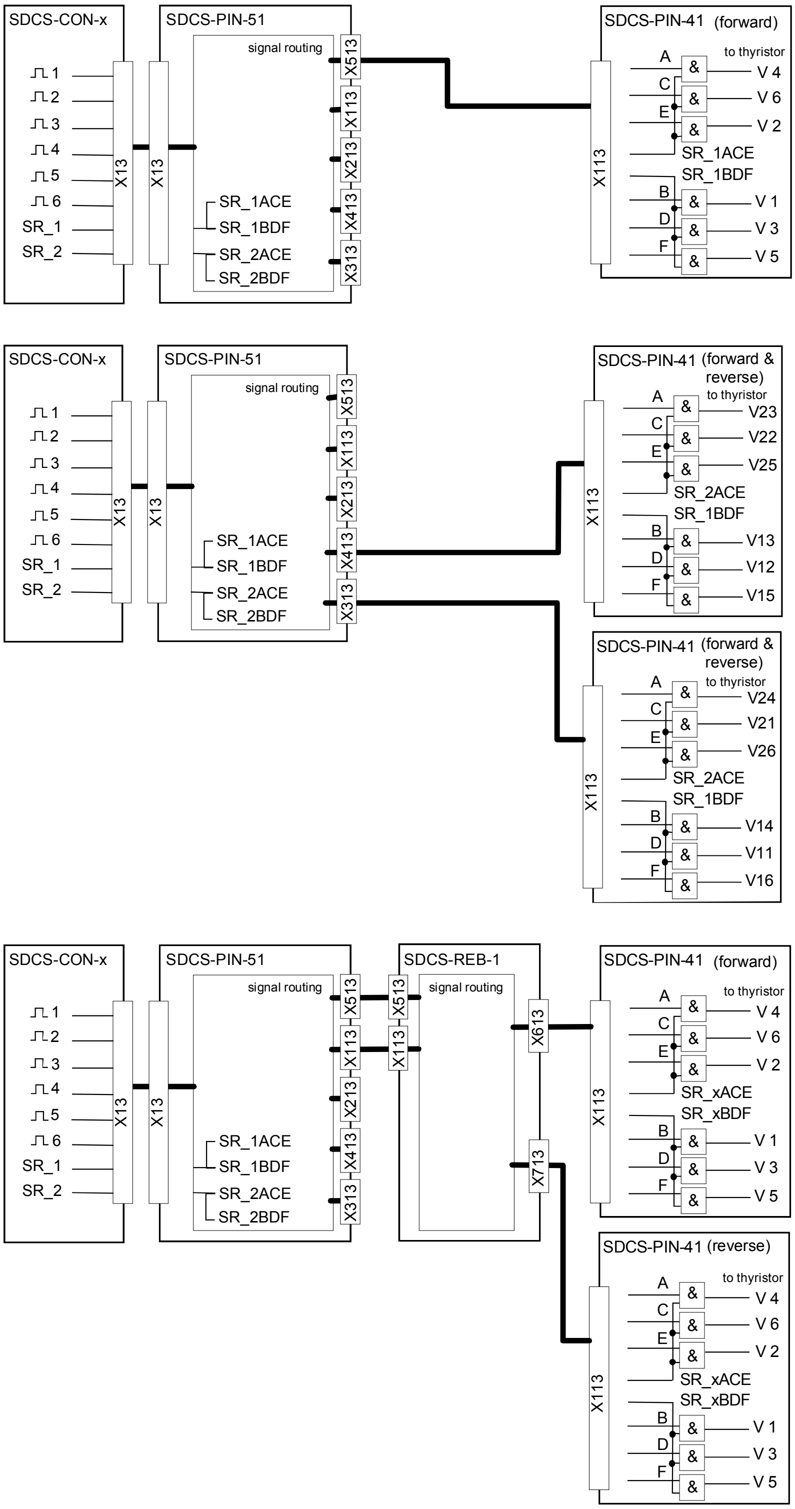


Figure 3 - 9 Signal flow of firing pulses and thyristor designation

The following results from this configuration:
- A thyristor receives firing pulses when it has been addressed by one of the signals A to F and by one of the current direction signals SR_Xxxx.
- All members of one group have always to be assigned to the same current direction but not necessarily to the same bridge.

There are four horizontal groups of rows assigned to the input terminals, and eight vertical rows assigned to the output terminals. There is one column for the SR_1 and another one for the SR_2 signal, and eight pair of rows for the outgoing SR_ACE and SR_BDF signals. Penetrations are located in the intersections of these signals, vertical to horizontal. If a wire is inserted in these penetrations and soldered on both sides, an input-to-output connection has thus been established.
The multilayer construction used for this board enables this method to be employed.

Design hints

- Name the AC terminals of the existing power part.
- Name all thyristors according to the list above.
- Look for a place, where the SDCS-PIN-41 board can be mounted and make sure, that the distance to the gates of the thyristors does not exceed one meter; the best noise immunity can be achieved with the shortest gate leads.
- Assign the thyristors to a firing channel, bearing in mind the group assignments.

Signal handling

The handling of the signals, controlling a thyristor is presented by an example:

- *Stipulation*
  - *Thyristor* Vx26 is to be controlled via plug X32: to plug X813: and via channel D of SDCS-PIN-41 board
- *Evaluation*
  - Thyristor Vx26 has been assigned to signal 6
  - Thyristor Vx26 belongs to current direction 2 (SR_2)
  - Channel D has been assigned to group SR_BDF
  - Channels B and F are then likewise assigned to current direction 2

- *Implementation*
  - Solder in pin: row to X813: - intersection SR_2 - SR_BDF
  - Solder in pin: field 3/8 - intersection 6 – D
    (Pins have to be soldered in by inserting the pin, solder it on both sides of the board and shorten the pin)

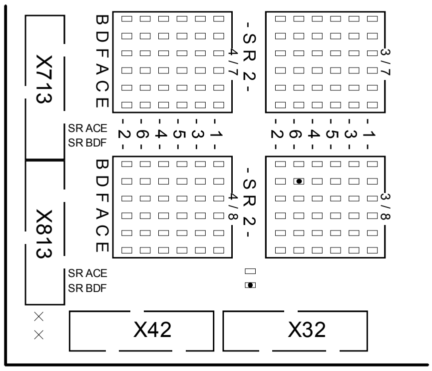


Figure 3 - 10 Signal handling of SDCS-REB-3

- *Check the configuration*
  - A firing pulse amplifier of the SDCS-REB-2 via plug connectors X11, X21, X32 and X42 may operate only one firing pulse transformer per current direction.
  - There is only one connecting point allowed per column at a 2-Q system.
  - There are only two connecting points allowed per column at a 4-Q system.
  - There is only one connection allowed per row.
  - Precisely one matrix field with six connections should be assigned per outgoing plug connector (X113..X813).
  - The SR_ACE or SR_BDF outputs of plug connectors X113 to X813 must always be assigned to only one current direction signal, either to SR1 or to SR2.

- Assign SDCS-PIN-41 to SDCS-REB-3 board connections.
- Configure the SDCS-REB-3 board, complying with the information given by the example
- Inspect visually for clean solder points and remove undesired tin bridges
- Check firing pulses

Plug connectors X1113: and X2113: These plug connectors are only used in simple applications aiming solely at a redistribution of the firing pulses as compared to and deviating from the standard distribution in modular design. In this variant, REB-1 and REB-2 are dispensed with, with the result that only two anti-parallel thyristor bridges can be controlled.

Fastening The SDCS-REB-3 has nine fixing holes. All of them must be grounded.

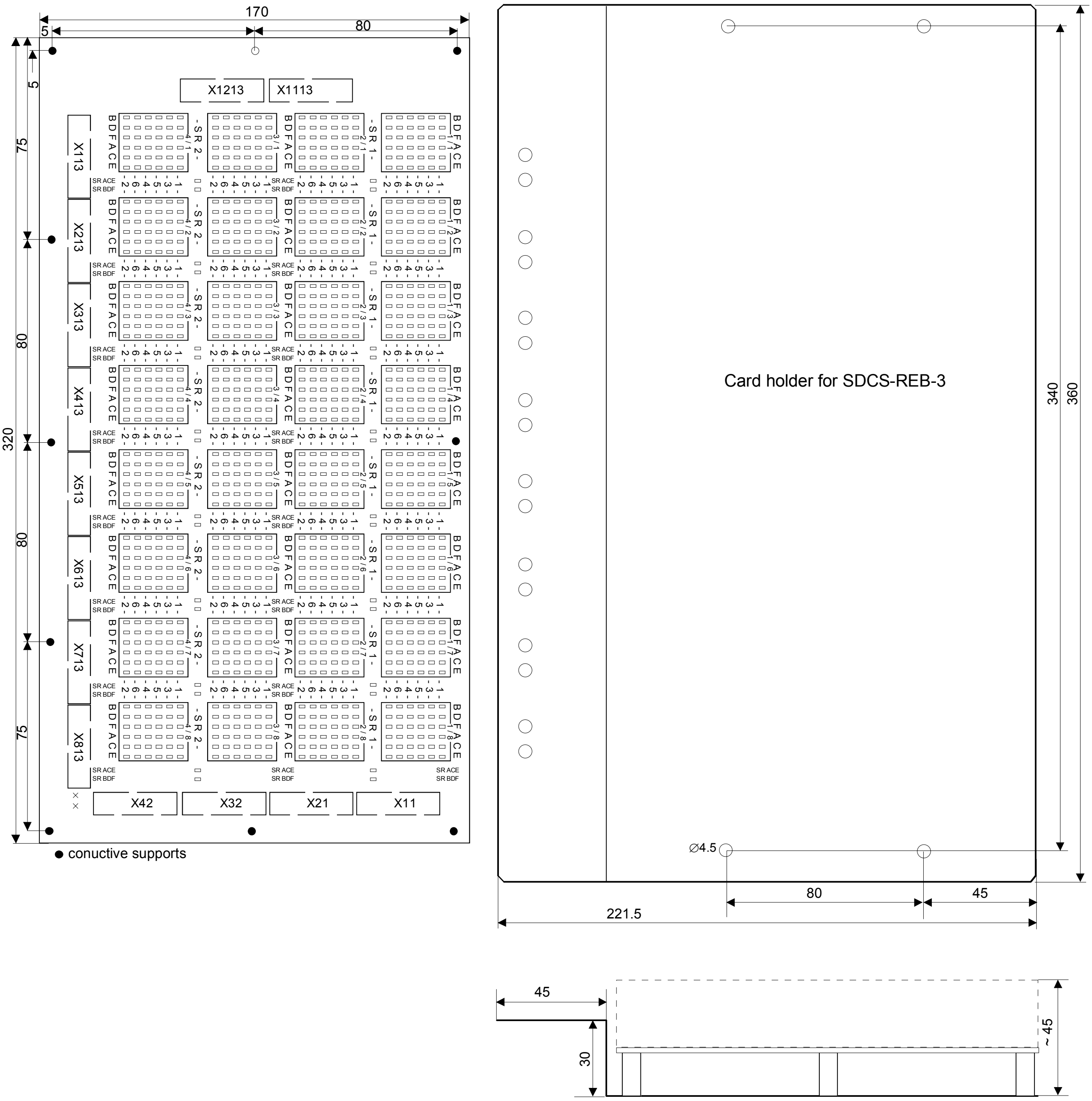


Figure 3 - 11 Layout of the SDCS-REB-3 board

Chapter 4 - Interfacing the Electronics and Thyristors

General

There are several ways to connect the firing commands from the measurement board to the pulse transformer board(s). The assignment of power section, mains connection and wiring to the SDCS-PIN-51 board is mandatory, since the computer board uses this assignment as the basis for computing the pulse sequence. With existing systems, we recommend following our configuration when numbering the semiconductor valves so as to preclude any errors. The arrangement of the thyristors in an anti parallel bridge is presented in the figure below. Thyristors for forward bridge (current direction 1; SR1) are numbered V11, V12,..., V16 and thyristors for reverse bridge (current direction 2; SR2) are numbered V21, V22,..., V26.

In two quadrant applications only the forward bridge is existing.

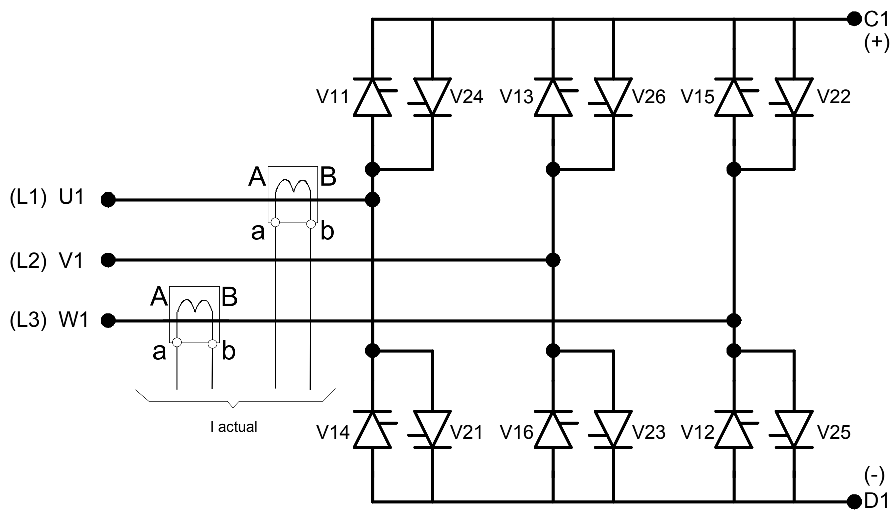


Figure 4 - 1 Arrangement of thyristors in an anti parallel bridge

Connection for 2-quadrant application – No parallel Thyristors

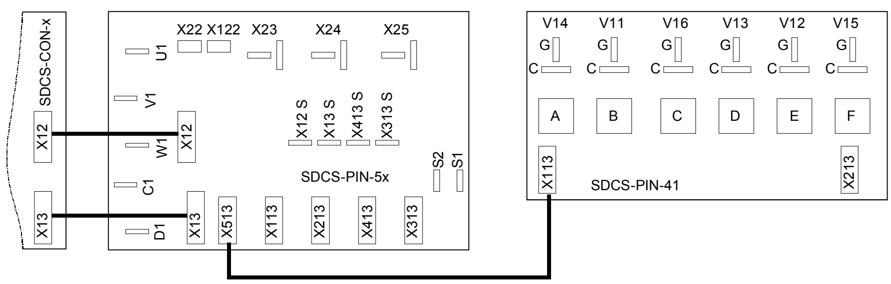


Figure 4 - 2 2-quadrant application, no parallel connected thyristors

Connection for 4-quadrant application – No parallel Thyristors

There are three ways shown on Figure 4-3 to 4-5, how to connect the thyristors, the pulse transformer board(s) and the measuring board to each other.

At figure 4-3 the flat cables are connected between

SDCS-PIN-51 X113 to SDCS-PIN-41 X113 and
SDCS-PIN-51 X213 to SDCS-PIN-41 X213,

which gives the result, that

- one SDCS-PIN-41 board transfers all the firing pulses for the thyristors, connected to D1 (see figure 4-1)
- the other SDCS-PIN-41 board transfers all the firing pulses for the thyristors, connected to C1 (see figure 4-1)

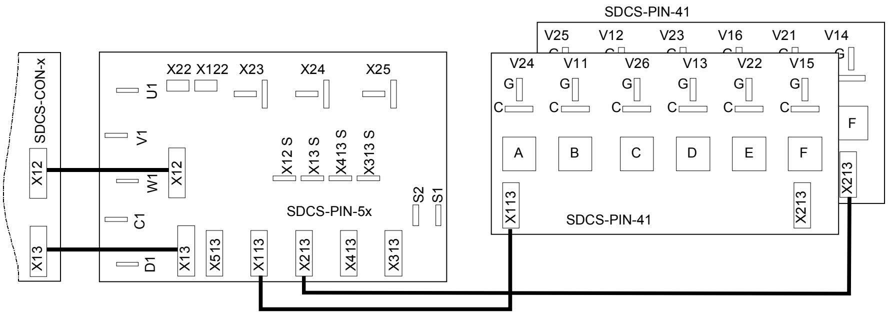


Figure 4 - 3 Firing pulse assignment

At figure 4-4 the flat cables are connected between

SDCS-PIN-51 X413 to SDCS-PIN-41 X113 and
SDCS-PIN-51 X313 to SDCS-PIN-41 X113,

which gives the result, that

- one SDCS-PIN-41 board transfers all the firing pulses for the thyristors, connected to phase L1 and half of the thyristors, connected to phase L2 (see figure 4-1)
- the other SDCS-PIN-41 board transfers all the firing pulses for the rest of the thyristors, connected to phase L2 and for the thyristors, connected to phase L3 (see figure 4-1)

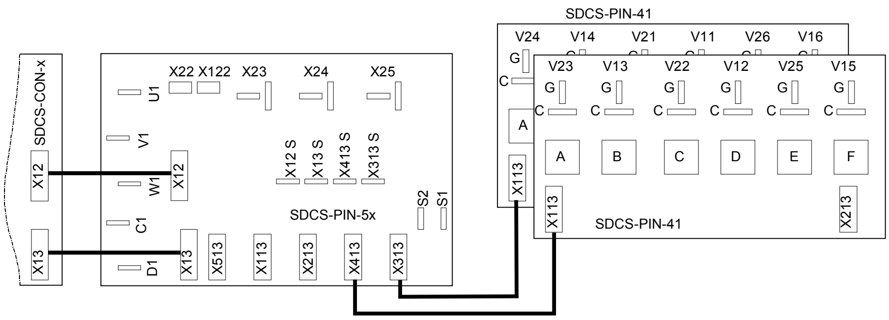


Figure 4 - 4 Firing pulse assignment

The connection shown below is used normally when the anti parallel bridge is built by connecting two mechanically separate bridges in an anti parallel configuration. Then gate wiring is most simple and short when all six thyristors of a bridge are connected to one pulse transformer board.

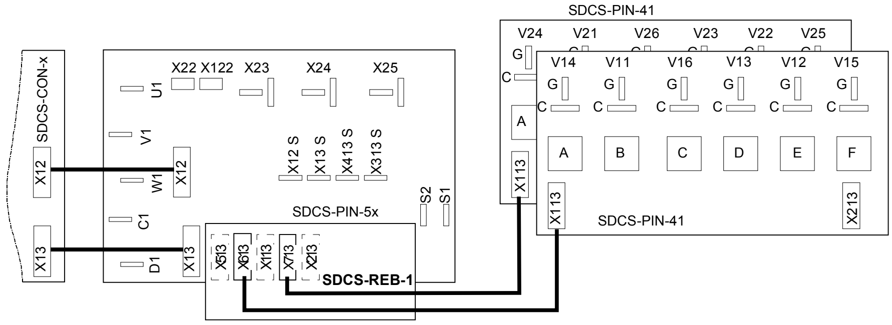


Figure 4 - 5   4-quadrant application, no parallel thyristors

Connection for 4-quadrant application - parallel thyristors

With parallel connected thyristors, both additional boards SDCS-REB-1 and SDCS-REB-2 are needed. Because of the REB-2 board external +24V and +48V are needed. The power supply SDCS-POW-1 is not able to give enough power for parallel connected thyristors.

The figure below shows the configuration for a 4-quadrant bridge with 4 parallel connected thyristors.

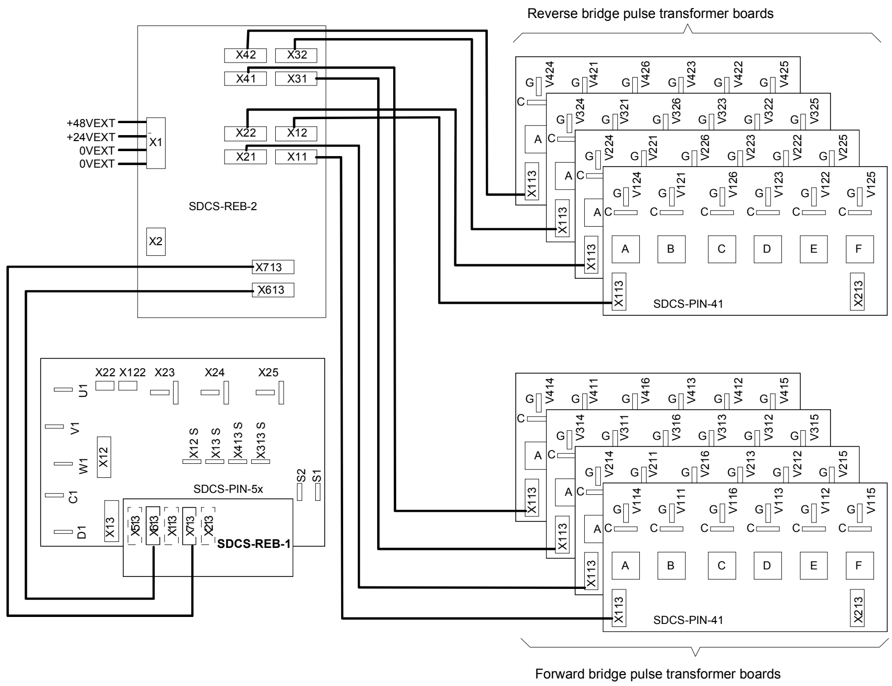


Figure 4 - 6   4-quadrant application, parallel thyristors.

Connection for 2-quadrant application - parallel thyristors

With parallel connected thyristors, the additional board SDCS-REB-2 is needed. Because of the REB-2 board external +24V and +48V are needed. The power supply SDCS-POW-1 is not able to give enough power for parallel connected thyristors.

The additional board SDCS-REB-1 can be used, but has not be used. Depending on the final decision the flat cable from X613 (SDCS-REB-2) has to be connected to either X613 (SDCS-REB-1) or X513 (SDCS-PIN-51 with SDCS-REB-1 removed).

The figure below shows the configuration for a 2-quadrant bridge with 4 parallel connected thyristors.

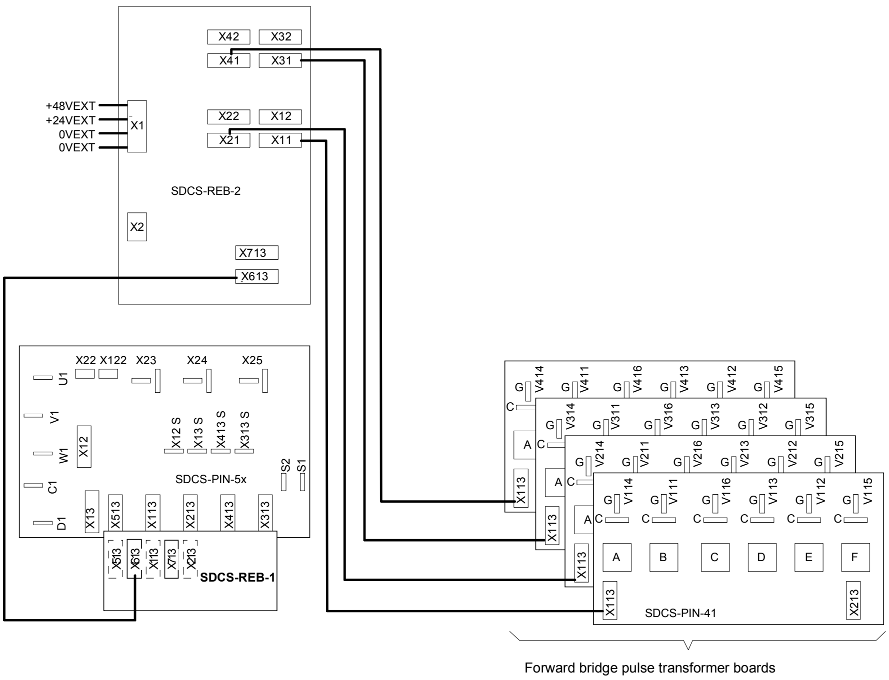


Figure 4 - 7   2-quadrant application, parallel thyristors.

Chapter 5 - Installation

General

The information given within this chapter shall help the installation personnel to select a place for the different components of the DCR kit, to mount them and do the interconnections between the boards and the existing hardware.

Background for the figures of this chapter

The figures within this chapter show the different electrical configurations of the kit and give some suggestions for mechanical mounting. On the electrical figures a 4-Q version is drawn. In case a 2-Q version is in use, the SDCS-PIN-41 boards plus cables for the reverse bridge will not be delivered with the kit. Pleasae ignore that part of the figures. The figures 5-3 and 5-4 differ from that strategy. There the SDCS-REB-3 board is not shown to indicate, that this board does not need to be used in every case as long as the mechanics allow gate cable length lower than 1m!
Parts which are common for the different configurations are always drawn at the same position. So the parts not needed or not used in the one or the other situation can easily be recognised.

The installation of the DCR kit can be subdivided into 3 parts. Figure 5-2 is taken as an example and will have these 3 parts marked (read the other pictures in a similar way):

- The first part consists of the SDCS-PIN-41 boards, which have to be mounted as close as possible to the thyristors.
- The second part covers the SDCS-PIN-51 and the SDCS-REB-2 boards with their accessories. The components within this part may be different depending on the final configuration needed for the existing power part. The cable connections within these boards are quite short; so the boards have to be mounted close to each other, but can be mounted quite far away from the boards used for part 1 or 3. Figure 5-5 gives a suggestion how the components can be mounted on a metal plate. In case the configuration according to figure 5-6 or 5-7 is used figure 5-8 and the following ones will show the mechanical possibilities.
- The third part shows the main DCR electronics with the electronic power supply SDCS-POW-1 and the microprocessor system SDCS-CON-2. All other options which can be connected to the controller boards are left out for easier reading. They are indicated on the diagrams at chapter 2 showing the overall configuration. The detailed description of these options are to be found within the manual *Technical Data*. All components belonging to the third part should be mounted close to each other with or without fastening plate in the existing drive cabinet (see dimension drawing).

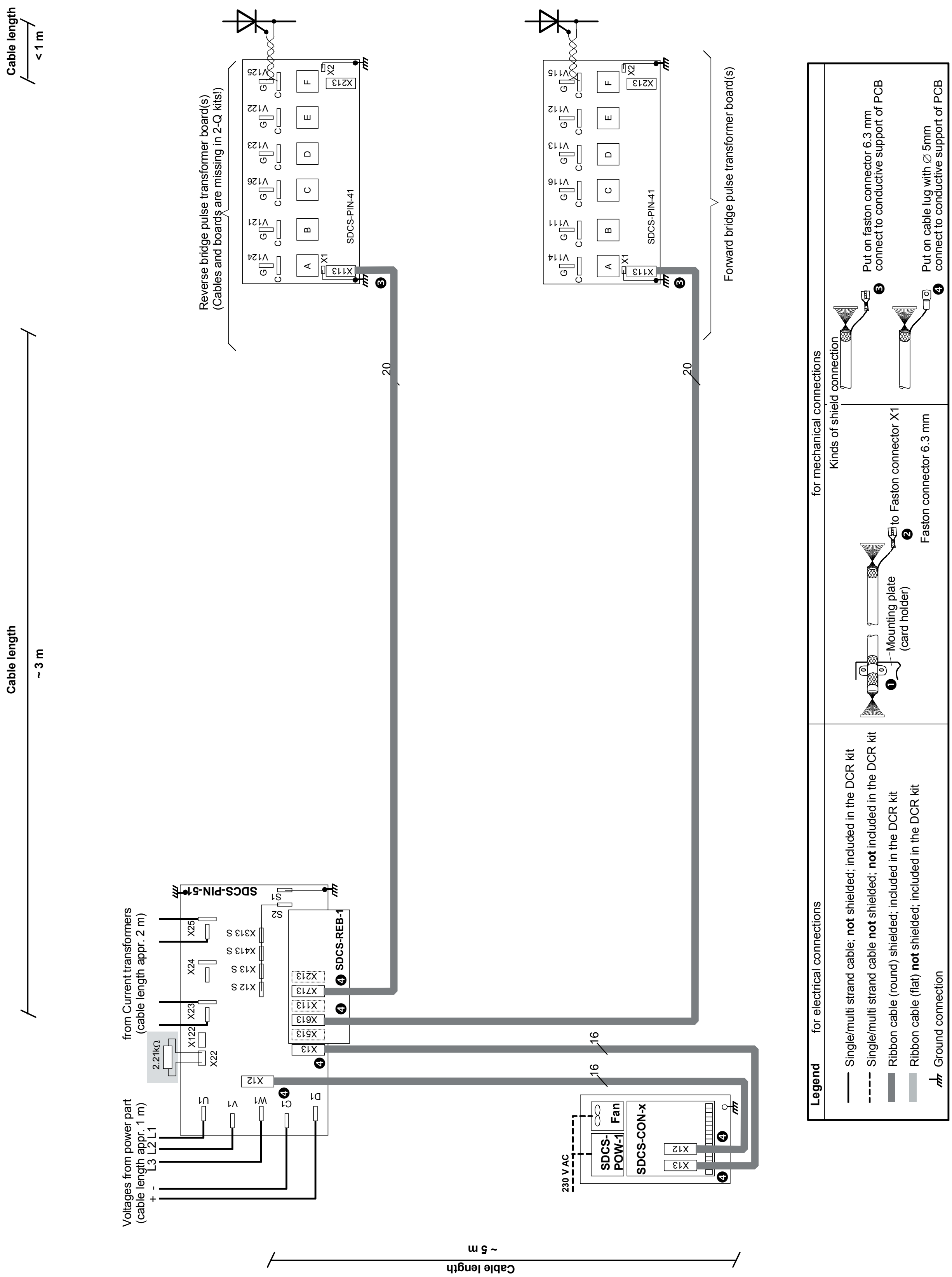


Figure 5 - 1 Electrical drawing: 1 thyristor stage

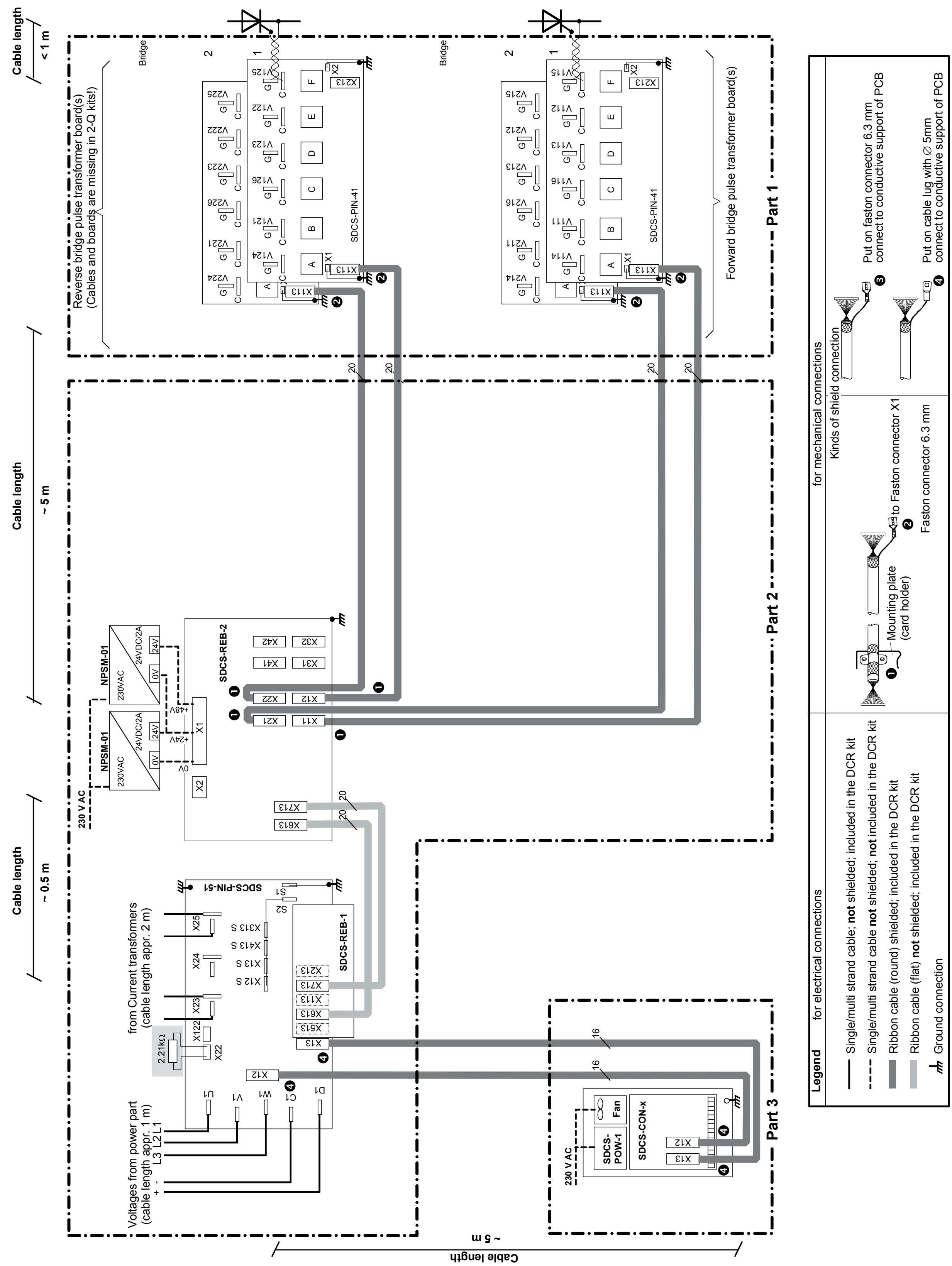


Figure 5 - 2 Electrical drawing: 2 Thyristor stages in parallel

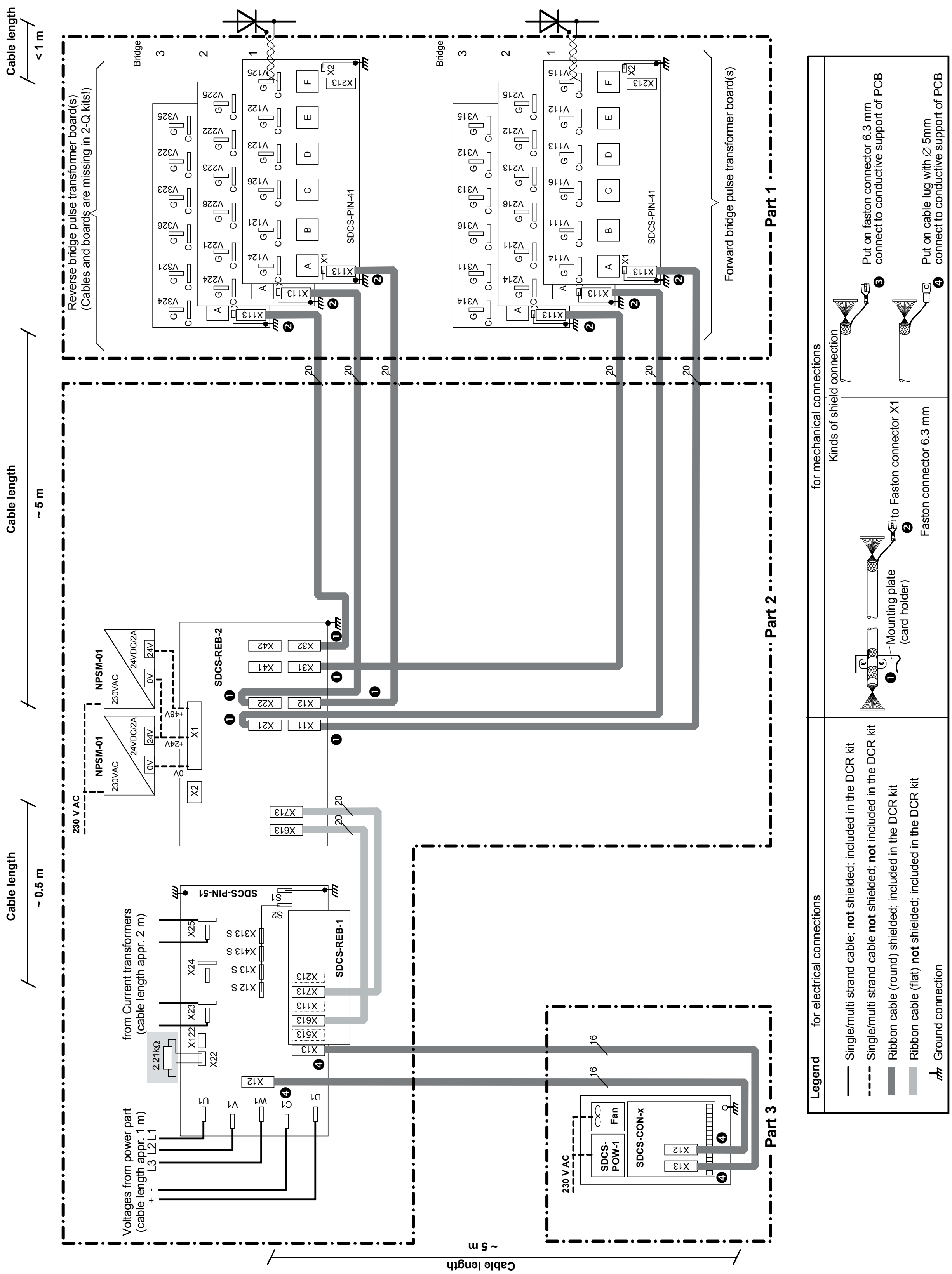


Figure 5 - 3 Electrical drawing: 3 Thyristor stages in parallel

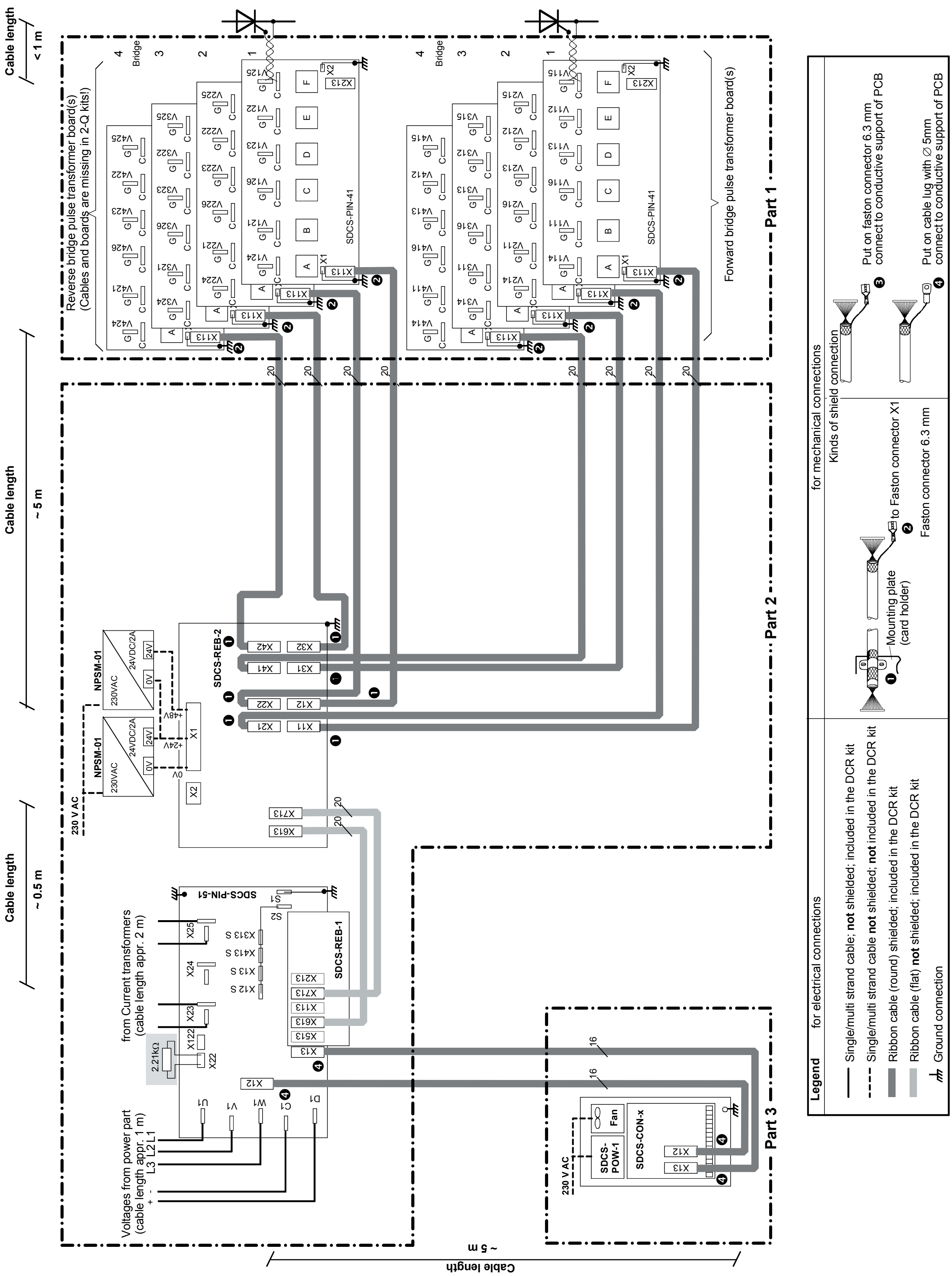


Figure 5 - 4 Electrical drawing: 4 Thyristor stages in parallel

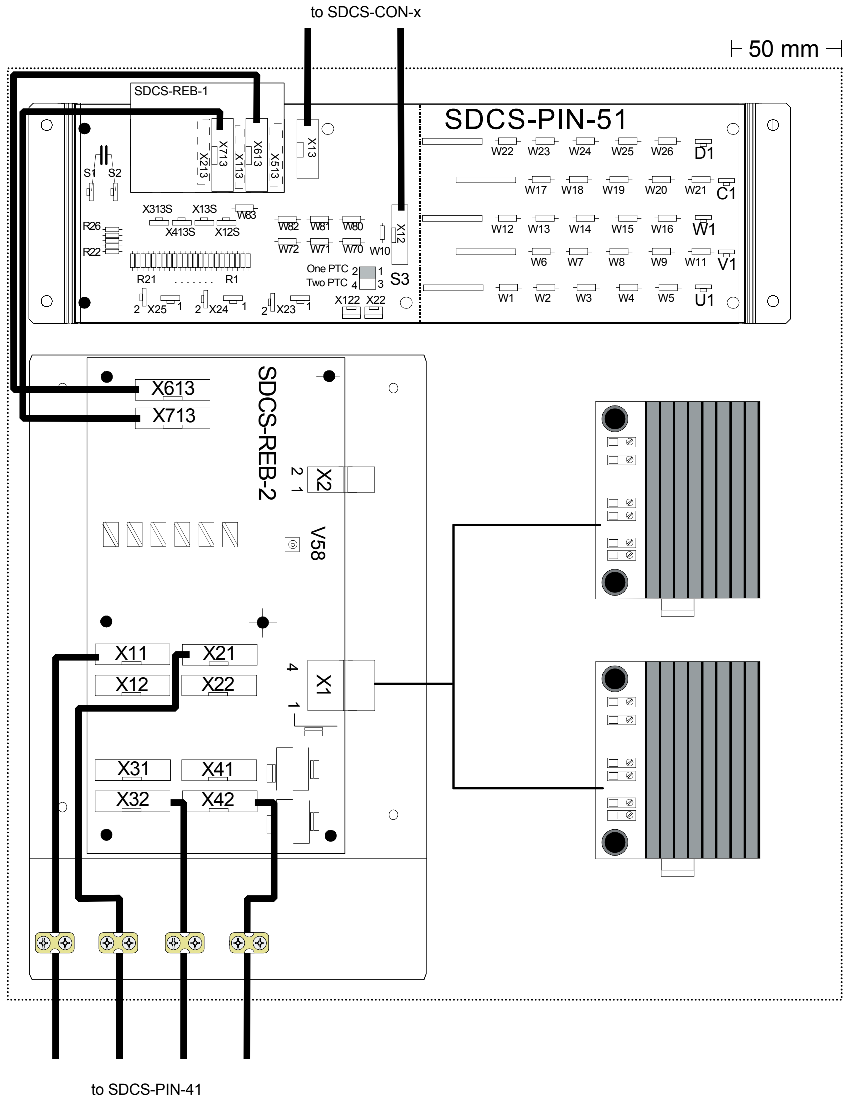


Figure 5 - 5 Mechanical suggestion Part 2 without SDCS-REB-3

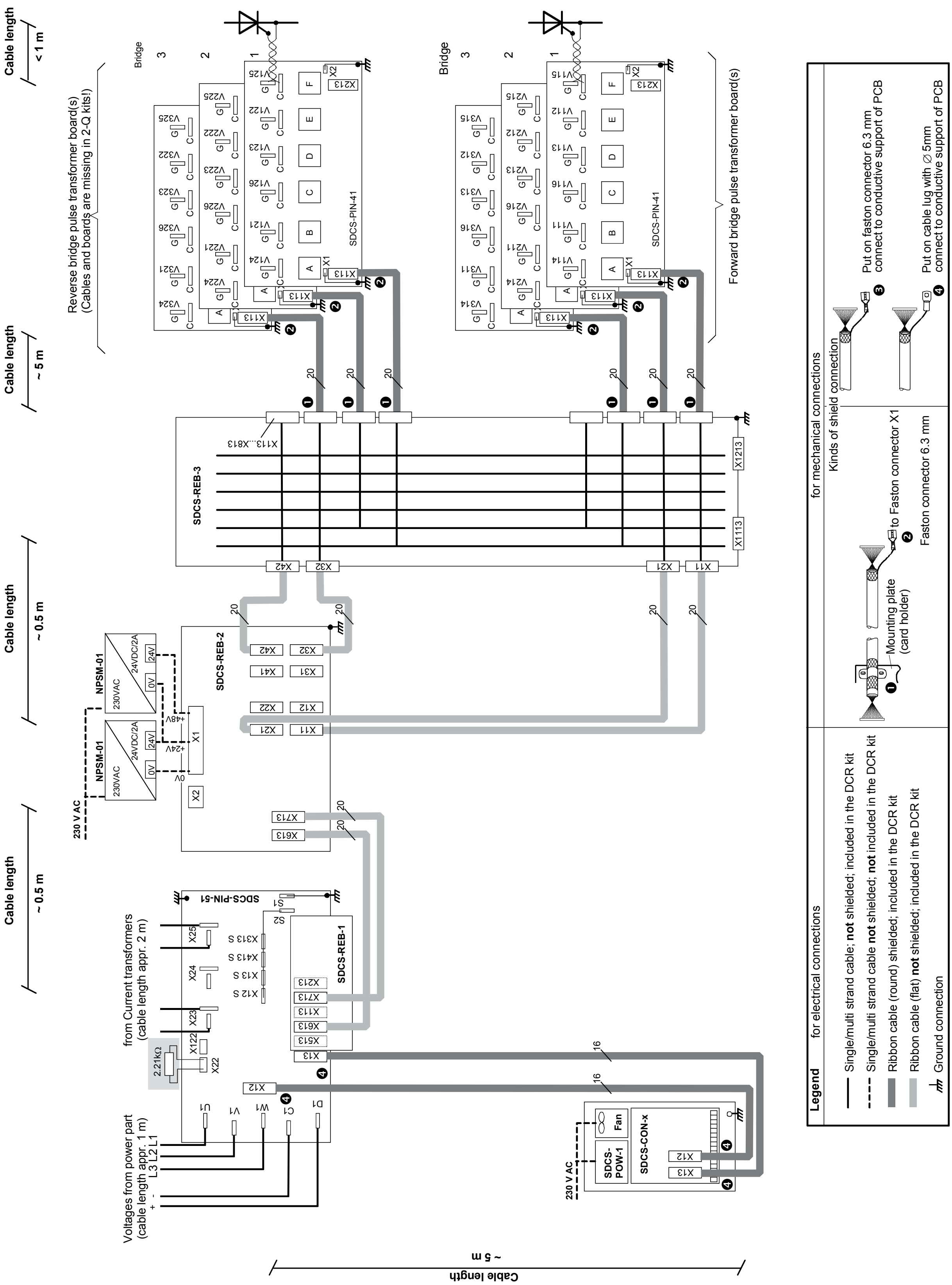


Figure 5 - 6   Electr. drawing: 3 Thyr. stages in parallel w. REB-3

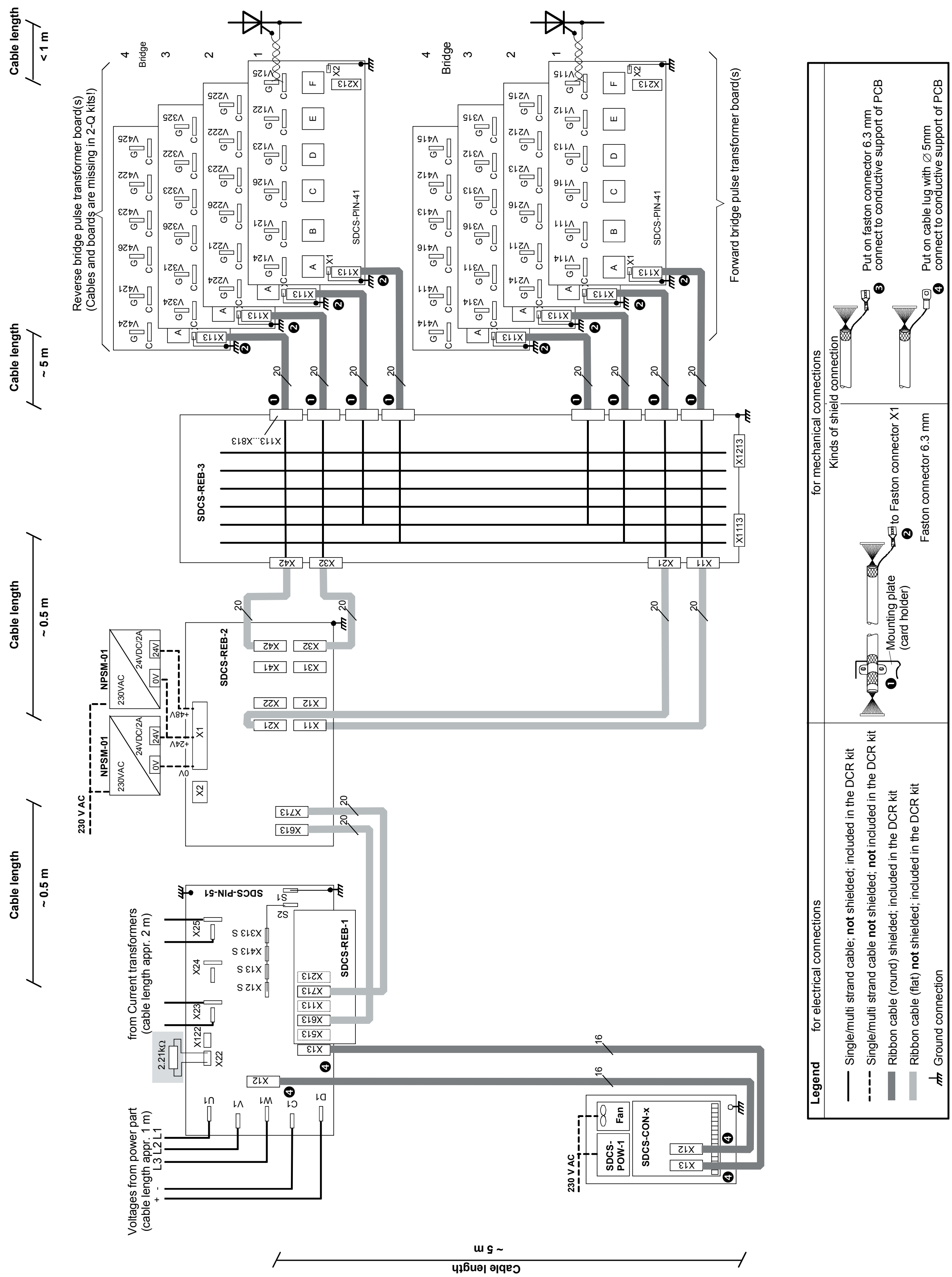


Figure 5 - 7 Electr. drawing: 4 Thyr. stages in parallel w. REB-3

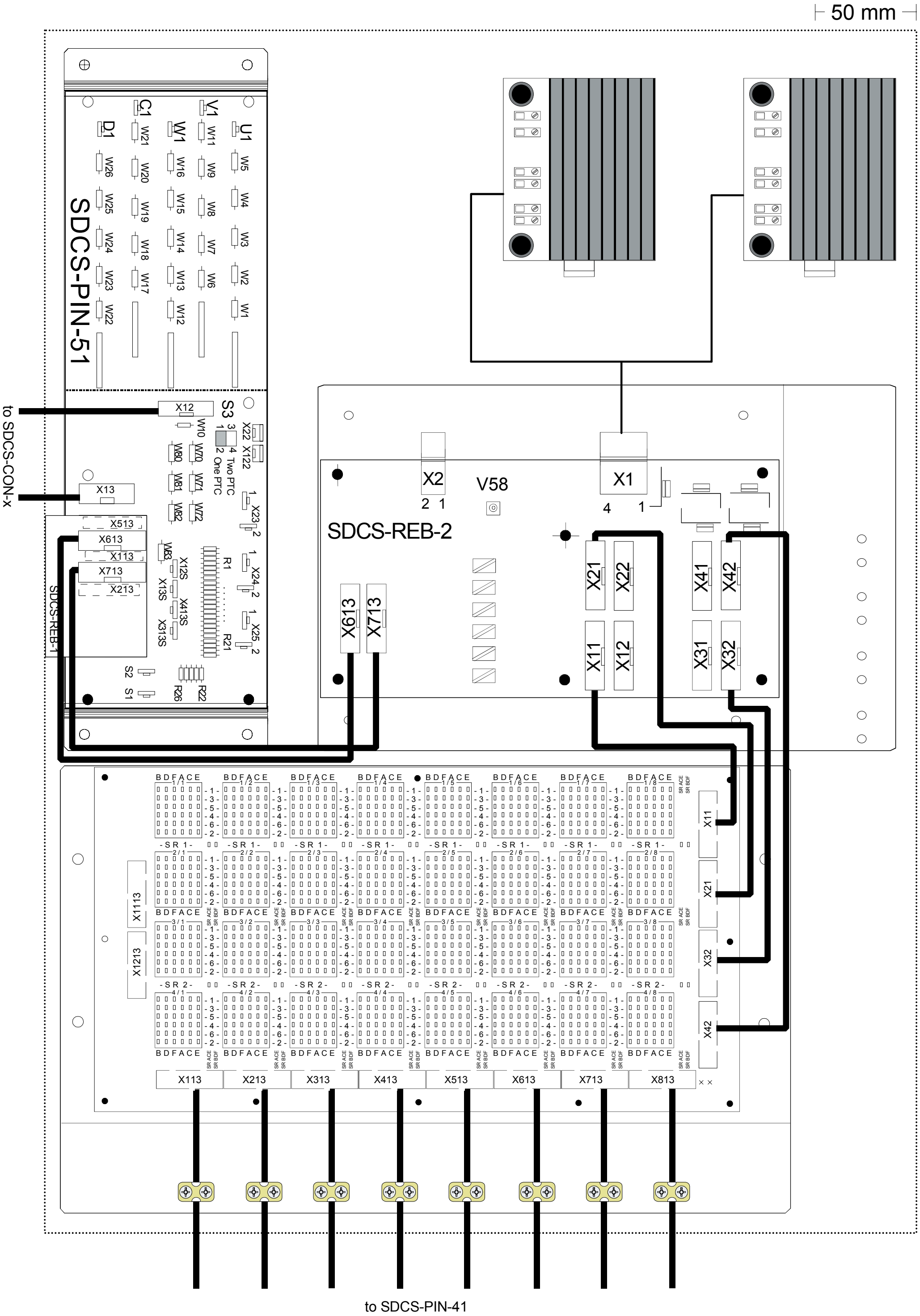


Figure 5 - 8 Mechanical suggestion 1 for Part 2 with REB-3

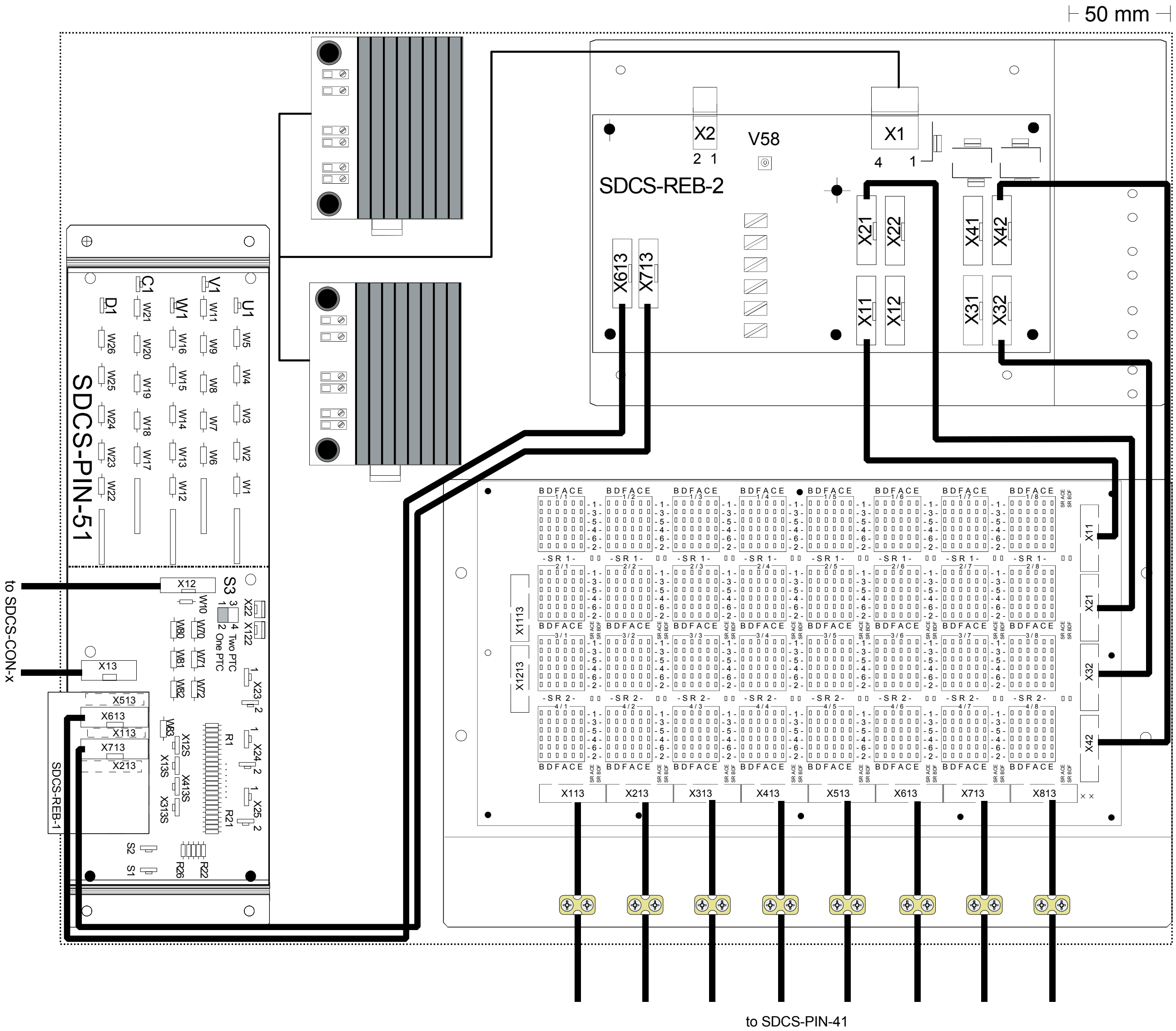


Figure 5 - 9 Mechanical suggestion 2 for Part 2 with REB-3

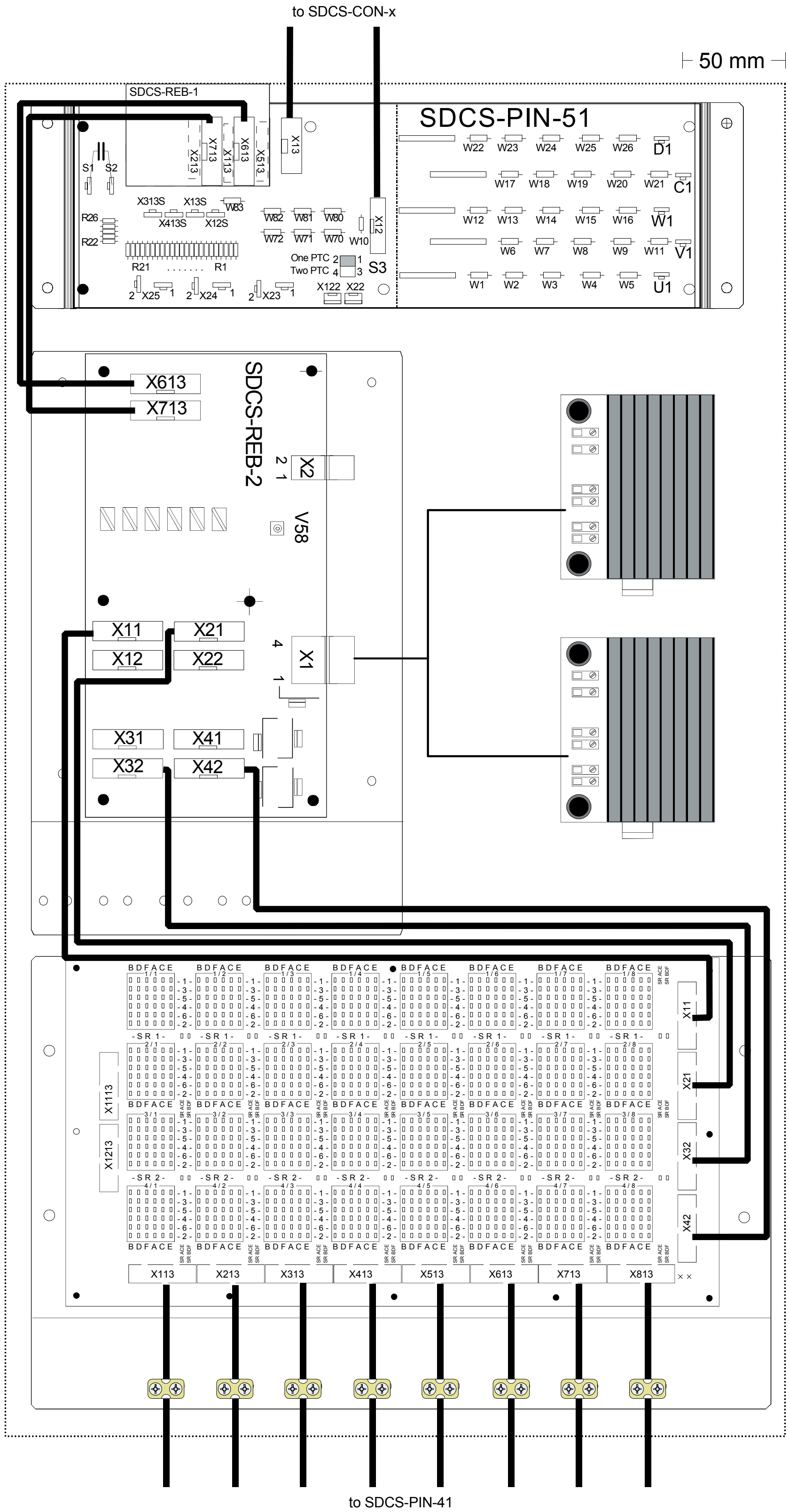


Figure 5 - 10   Mechanical suggestion 3 for Part 2 with REB-3

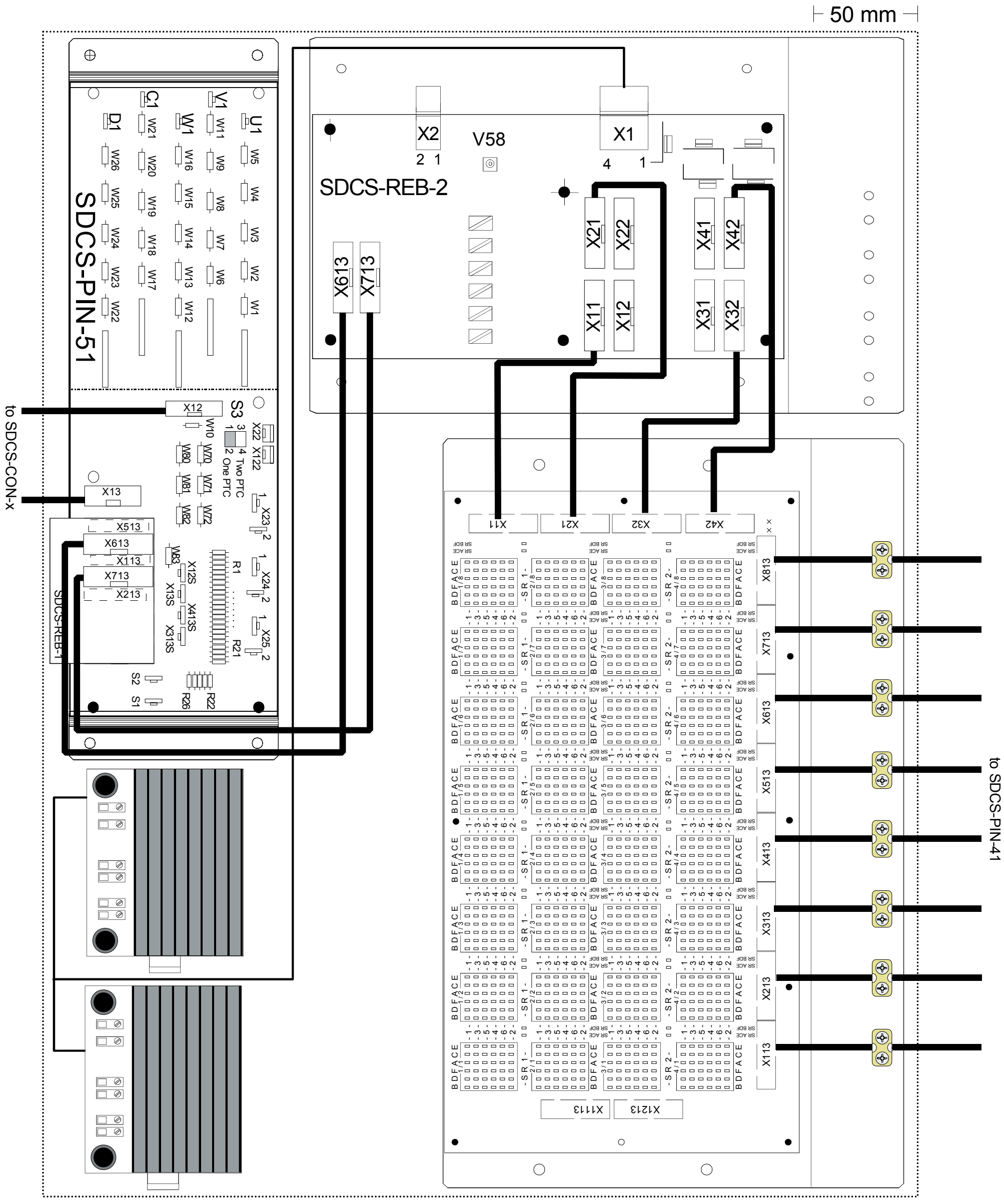


Figure 5 - 11   Mechanical suggestion 4 for Part 2 with REB-3

Hints for Cabling

Each DCR kit will be delivered already with most of the cables needed to do the complete wiring. The next table lists the different types. Together with figure 5-12 they can be identified to use the right cable for any of the connections. In case there is more than one connection between two or more boards (e.g. connection made by cable B2) all the cables will have the same marking.

Marking at fig. 5-12	*Order number*	*Remark*
A	GNT 6093768R9	2 cables per kit; 5 m long
B1	3ADT 693230P1	1 cable per bridge; 3 m long
B2	3ADT 693217P1	2...8 cables per kit; 5 m long
C	GNT 6093268R6	2..6 cables per kit; 0.5 m long
D	DCA 0020531P1	1x Resistor 2.21 kΩ
E		if needed use cable type: AWG20, UL10203,T
F	DCA 0021154R0001	Adapters for different gate connections

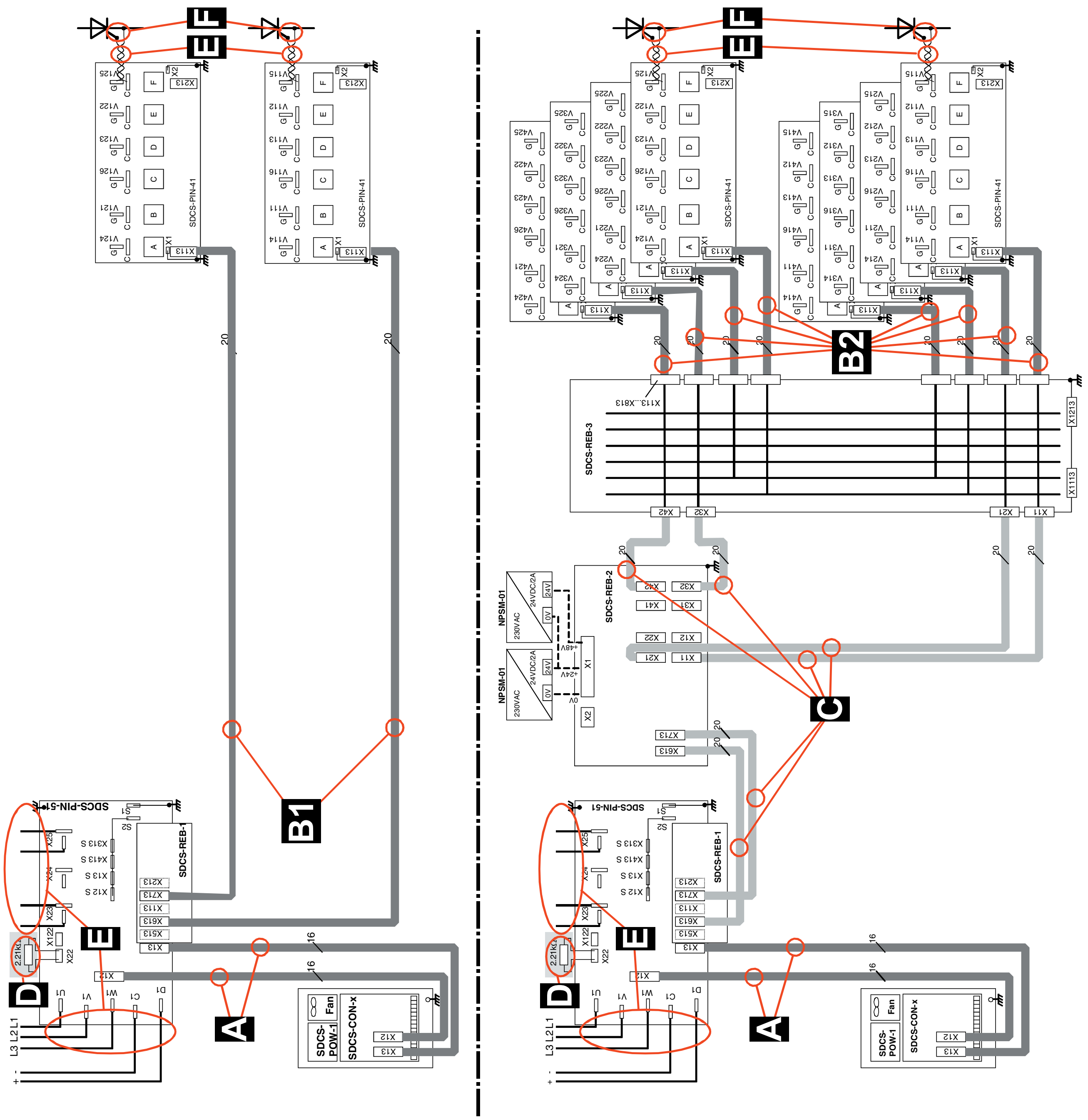


Figure 5 - 12   Principles of cabling

Chapter 6 – Start-up

General

This chapter describes the commissioning procedure for a DCR kit. This is done based on the procedure used for DCS converters. Only the actions and steps, which are different are listed here.

Related documents

see *Chapter 2*

Safety Instructions

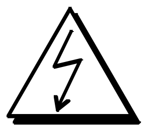
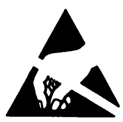
This part is a subset of the very first part of the manual *Operating Instruction* and explains the symbols used within this chapter.

It is absolutely necessary to read this chapter, the complete manual *Operating Instruction* and the related documents before opening the door of any cabinet.

The symbols are used to indicate:

DANGER: High Voltage
GENERAL WARNING (mostly non electrical)
Warning of electrostatic discharge

Symbols

	**Danger: High Voltage!** This symbol warns you of high voltages, which may result in injuries to persons and/or damage to equipment. Where appropriate, the text printed adjacent to this symbol describes how risks of this kind may be avoided.
	**General warning:** this symbol warns you of non-electrical risks and dangers, which may result in serious or even fatal injury to persons, and/or in damage to equipment. Where appropriate, the text printed adjacent to this symbol describes how risks of this kind may be avoided.
	**Warning of electrostatic discharge:** this symbol warns you against electrostatic discharges, which may damage the unit. Where appropriate, the text printed next to this symbol describes how a risk of this kind may be avoided.

Points to be observed because of the situation

All relevant safety regulations must be observed in the installation, commissioning and maintenance work.

Because the DCR kit enclosure class is IP00, it´s main and auxiliary connections and other electrical parts can be reached without any protection.

After the supply voltage is disconnected by the main switch, always ensure by measuring that no part of the system has voltage or the system is protected with sufficient touching cover before any work is started.

There might be live terminals inside the drive cabinet even after the supply voltage has been disconnected by the DCR kit main switch, e.g. incoming busbars of the main switch itself or external auxiliary power supplies.

Avoid unnecessary voltage withstand tests on any part of the unit.

Maintenance work

All maintenance of the DCS / DCR must be carried out by a competent electrician, who shall also have custody of keys to the doors, unless the system is located in switch gear.

All points within this chapter must be observed before any work is begun.

Tools

In addition to the tools needed to maintain electrical parts some special tools are recommended:
- Oscilloscope either with galvanically isolating transformer or isolating amplifier for safe measurements
- Clamp on current probe; an AC type is sufficient for gate firing pulse measurements; in case the scaling of the DC load current needs to be checked, a DC type is needed
- Voltmeter

Make sure, all equipment in use is suitable for that voltage level applied to the power part!

General hint

In addition to the work specific for the installation of the pure DCR kit hardware attention should be paid to features related to drives in general. There is the engineering and the interface to other components in general, the selection of control cables and their routing, earthing and grounding, screening and other points which need further considerations. The manual *Technical Guide* gives some help within the chapter *EMC Compliant Installation and Configuration for a Power Drive System*. This chapter gives information specific to fullfill the needs necessary for the CE marking. Most often CE marking is not the most important target for a system upgraded by a DCR kit. Nevertheless using some of the ideas will make the complete system more safe.

Measurements with the "old" equipment still working

Some measurements should be carried out before the existing installion is switched off and dismantled. They serve to document the existing performance and get the definition of some signals or terminals of the existing hardware:

- record the actual signals of
  - the speed
  - the armature and the field current
  - line, armature and field voltage
  - other application related signals
- record line and armature voltage to determine the name of the single line phase and the position of the + and – terminal; this will be an alternaty to disassemble the thyristor stack to check the orientation of the thyristors
- at power parts with more than one thyristor in parallel, record the firing pulse and the thyristor current of each thyristor to be sure, all of them are conducting

Mounting the DCR Kit

When starting the installation work make sure the equipment is disconnected from the power supply and checked for safe condition! The figures within chapter 5 show all the components needed for the different configurations possible. Use this drawing as a basic guideline which fits the best to the actual power part depending on the number of parallel thyristors and the configuration (with / without SDCS-REB-3). Mounting the boards can be subdivided into 3 steps:

- Select a place for the SDCS-PIN-41 board(s) as close as possible beside the thyristors. When fixing the board at the selected place make sure it´s conductive supports / card holder have good metal contact to the cubicle´s frame. This frame by itself has to be grounded.
- Select a place for the SDCS-PIN-51 (and all the other components shown within "part 2"). Take care for the cable length towards the SDCS-PIN-41 board(s) and towards the SDCS-CON-2 board. All components of this part 2 have to be mounted on a metal plate to ensure good contact between conductive supports / card holder and the cubicle´s frame. This frame by itself has to be grounded. Make sure the shields of the shielded cables follow the guidelines given in chapter 5 (grounding on large areas by means of clamps).
- Select a place for the DCR kit housing and mount it with or without fastening plate. Take care for the cable length towards the SDCS-PIN-51. Take the same grounding guidelines as before.

Wiring the DCR Kit

The system still has to be in a safe condition! The drawing used for the mechanical work should now be used for the electrical wiring too. For single thyristor bridges figures 4-2 to 4-5 show flat cable connections (without parallel thyristors; antiparallel configuration) which can be used instead of figure 5-1. Before the wiring work is started do the following preparations:

- Check, if there are labels / indications on the existing power part naming the thyristors and / or phases according to figure 4-1. In case labels are existing, check, if they are correct and fit to each other.
- If there are no labels existing or they are incorrect, start in this way:
  - look for the phase U1 (L1) and mark; it do the same with V1 (L2) and W1 (L3)
  - look for thyristor V11 and mark it; the next statements may be of help in case problems may arise
    - use the measurements done before
    - if not, follow the busbar U1; the thyristor connected to that busbar is either V11 or V24
    - the cathode of V11 (or the heatsink) has electrical contact to the C1 / + power part terminal
    - at disk type thyristors the orientation can easily be recognised by the smaller distance between cathode and gate compared to the bigger distance between gate and anode
    - if the place of V11/V24 is found, but the orientation is not clear and the thyristor is not visible take one pair of pulse firing leads (one of them is the auxiliary cathode) and check them for electrical contact to C1 / + power part terminal by means of an Ω-meter
  - look for the other thyristors and mark them
  - if there are parallel connected thyristor bridges do the same marking as for the first
- do the electrical connections according to the drawing for:
  - all the flat cable connections within and between the 3 parts
  - the 3 AC and the 2 DC voltage measurements
  - the 2 current transformers
  - for the power part monitoring (klixon, fan monitoring, others)
  - the auxiliary voltage
  - make sure a 2,2 Kohm resistor or something similar is plugged on terminal X22: at SDCS-PIN-51 board
  - **don´t connect any of the gate leads!**

Commissioning the DCR Kit

The complete commissioning of a DC drive consisting of the motor and the thyristorized power part equipped with a DCR kit is based on the manual Operating Instruction used for the converter type DCS 500B or DCS 600. Only a few additional steps are recommended and will be listed afterwards.

Start with the manual *Operating Instructions* at the very beginning:

- Safety Instructions
- Introduction
- Start-Up Instructions; only the parts:
  - General,
  - Preparatory work
  - Scaling intra-unit signals

can be taken as listed there; please keep in mind that the DCR kit has to be treated like converters above 2000A!

In contrast with the normal commissioning procedure additional precautions should be made to avoid damage to components of the drive system in case of wrong wiring or unknown data.

- Connect the gate leads to thyristor V11, V13 and V15.
- Set the parameter for the bridge changeover to a remarkable value.
- Before the drive is released the first time, the parameter for the minimum firing angle should be set to values higher than 90 degrees. Allow the system some moments to adapt to the new value. This limits the output voltage of the drive and gives a safe operation, even with a fault in the current feedback circuit. Precautions should be made do avoid to get EMF at the DC circuit (disable field current or block the motor), if the drive will be released and will generate current.
- Switch on the drive using the ON/OFF command. The RUN command has to remain in logic “0” level. This action causes the pulse firing logic to work and to generate single firing pulses at inverter limit position. No current should flow. Record the thyristor voltage (connection U1 – C1) and the firing pulse (by means of a current probe or of SDCS-MP-1) and check the firing pulse position being at 150°el.
- Switch off the drive.
- Connect the gate leads to thyristor V14, 16 and 12.
- Switch on the drive using the ON/OFF command.
- No current should flow! Record the thyristor voltage and the firing pulse as before.
- Switch off the drive.
- Switch on the drive using the ON/OFF command. Set the RUN command to logic “1” level. Generate small current references within zero and limit discontinuous / continuous current. Everything is o.k., if the current can be varied and does not hit the limit set by the parameter above or inverter limit position.
- Switch off the drive.

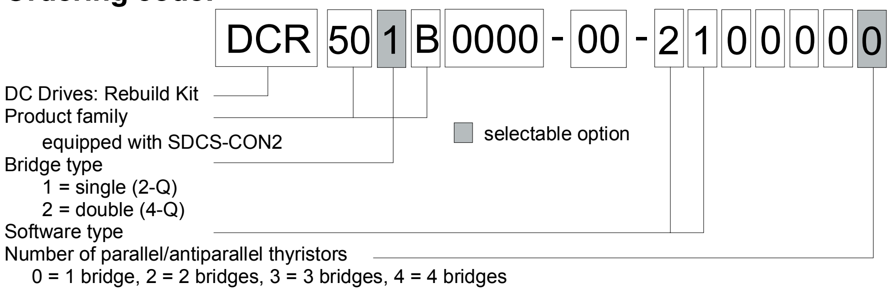
- In case of trouble check the wiring for open loop or wrong connections. Do the check once again.
- In case the current can be varied by the reference and the power part consists of a reverse bridge go on with the same procedure used for the forward bridge. Keep the value of the parameter for minimum firing angle position. Check for correct connections.

If current is flowing in forward and reverse direction in a controlled manner set the parameter for the minimum firing angle back to default. Check for the correct value for the parameter of the bridge changeover time.

In case the power part consists of parallel bridges do the gate interconnections bridge per bridge and check for correct assignment. When the gate connections are done and current is flowing in a controlled manner go on with the other chapters listed with the manual *Operating Instructions.*

DCR 500B

Ordering code:



All parts, which are mentioned on figure 2-1 and which cannot be coded by the type designation above, have to be ordered separate, like:

Control panel
- CDP 312 (can be mount on electronic housing)

Field supply
- SDCS-FEX-1 or
- SDCS-FEX-2 (the one or the other can be build in in electronic housing; please do not use the ordering code for the board, being used as a spare part!)
- external field supply DCF 503 or DCF 504 or 3 phase version

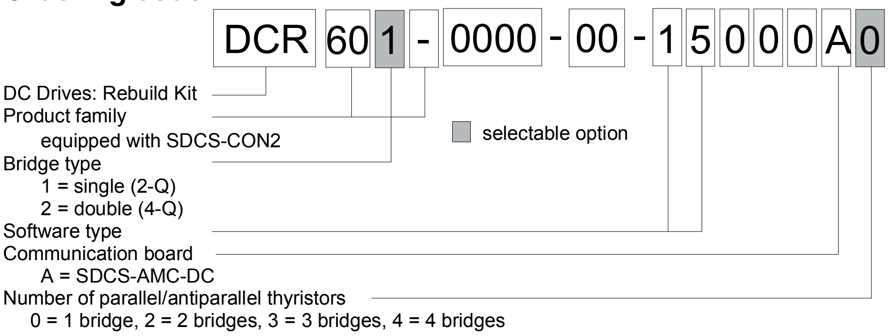
I/O configuration
- Subassembly SDCS-IOB-2x / IOB-3
  (order it **build in** or **not build in / separate**; please see chapter 3 for more detailed information)

Communication board
- SDCS-COM-5 (can be build in in electronic housing; is only needed for connecting the CMT tool)

All other additional parts
- field bus modules
- electronics transformer
- field supply matching transformer
- 12-pulse parallel kit
- etc.

DCR 600

Ordering code:



All parts, which are mentioned on figure 2-2 and which cannot be coded by the type designation above, have to be ordered separate, like:

Control panel
- CDP 312 (can be mount on electronic housing)

Field supply
- SDCS-FEX-1 or
- SDCS-FEX-2 (the one or the other can be build in in electronic housing; please do not use the ordering code for the board, being used as a spare part!)
- external field supply DCF 503 or DCF 504 or 3 phase version

I/O configuration
- Subassembly SDCS-IOB-2x / IOB-3 (order it **build in** or **not build in / separate**; please see chapter 3 for more detailed information)

All other additional parts
- field bus modules
- electronics transformer
- field supply matching transformer
- 12-pulse parallel kit
- 12-pulse serial kit
- etc.

Chapter 8 – Special Accessories

General

All the items described within this chapter serve as an option not absolutely necessary for the current / speed control functionality of the DCR kit. Depending on the condition of the existing power part (thyristors, heat sinks and others) and it´s measuring or monitoring devices it may be necessary to exchange some of them or build up a new function. In addition to that some background information is given too:

- possibilities to check the correct cooling condition for the power part
- current transformer, in case the old power part has not got such a device to measure the current or they cannot be used any more because of their data or age

Monitoring cooling conditions

Monitoring the existing power part for the correct cooling condition is an important measure to protect the system. The cooling condition of power parts can be checked with different devices. There is a list of possibilities which had been used in the past:

Klixon temperature switch

Most often one had been used per power part; very seldom several of them. If the power part consists of more than one heat sink it is very important to mount the Klixon at the right one. This monitoring principle still can be used, if the Klixon signal (potential free) is wired in series with the resistor plugged on X22 at SDCS-PIN-51.

PT100, PTC or NTC

There is a similar problem than before, if the power part consists of more than one heat sink. In case a PTC or NTC is used linearization is necessary. This type of sensor is a quite accurate way to protect the power part of overheating, but in case of a rebuild project, the threshold has to be known and parts of the old design criteria. Because of the linearization and the hardware interface for temperature measurement on the SDCS-PIN-51 board that principle can only be used, if the threshold is known and the existing sensor can be exchanged to the one used at a DCS converter. When intending to do so these limit have to be applied:

- the sensor mounted at an A6/A7 (C4) converter has to be used; see comments further on)
- isolation voltage according to max 500V AC; make sure, there is no higher voltage to ground (e.g. floating network, 12 pulse serial connection, etc)!

PT100, PTC or NTC to monitor the cooling air temperature

In this case the sensor should be exchanged towards a PTC used at a DCS converter. There is no problem with the threshold. A survey has to be made if all cases for faulty condition result in an error message and the power part is protected as demanded.

Airflow or pressure switch

They had been used quite often to check the motor cooling condition. Basically this principle can be used for the converters too. When intending to use them the advantages have to be compared with the disadvantages, because they are sensitive agains dust, have mechanical parts which can break a.s.o. This principle can be used in the future by using the same solution presented for the Klixon.

PTC for ambient temperature plus pressure switch

That´s the monitoring principle used at the A& and A/ (C4) converters. In case this principle will be used for the existing power part use the same components for the supervision as utilized for the converter modules DCS. For more details please see manual *Technical Data*, Power section cooling.

Monitoring the cooling fan´s motor current

In case there was no monitoring function at all or the monitoring function used in the past cannot be used together with the new hardware - monitoring the motor current of the cooling fan maybe an option. When trying to establish this monitoring principle the fan current needs to be checked being within limits. In case the fan current is too low or there is no fan current at all or it is too high, the drive needs to be switched off. The fan current may be too low because:

- the fan may not be switched on or
- any protection device within the fan supply has acted or
- a wire is broken or
- the propeller became loose or something similar

The fan current may be too high because:

- the fan may be blocked mechanically or
- there is a short circuit in the fan winding or something similar

Depending on the protection level monitoring the status of an overcurrent relay may cause at least a reaction of short circuits, perhaps for a blocked fan too.

Current transformer

Detailed technical data and mechanical dimensions are given for the current transformers used at A5, A6 and A7 type converters. The information helps,

- if a current transformer needs to be changed in an A5, A6 or A7 type DCS converter or
- to engineer rebuild jobs, where the electronic part of an existing thyristor bridge will be exchanged to a new digital control electronic using the DCR Kit. Reasons to use one of these CTs:
    - if there was no current measurement at all or
    - if the current was measured by a shunt on the DC side
- the existing current transformers will not be used in the future because of their physical condition

Current measurement

The control electronics of the DCS converter range is based on either 2 or 3 normal current transformers located on the AC side of the bridge to measure and control the armature current. At A5, A6 and A7 type converters two current transformers are used. At rebuild jobs using the DCR Kit to upgrade the control electronics 2 current transformers are needed too. The A5 and A6 type converters use the same type of current transformer, which is electrically and mechanically totally different to the one used at A7 types.

Wiring

The wiring of the current transformers is basically identical for A5, A6 and A7 converter types. The standard drawing for the one or the other converter type is different and is shown at Fig. 8-1

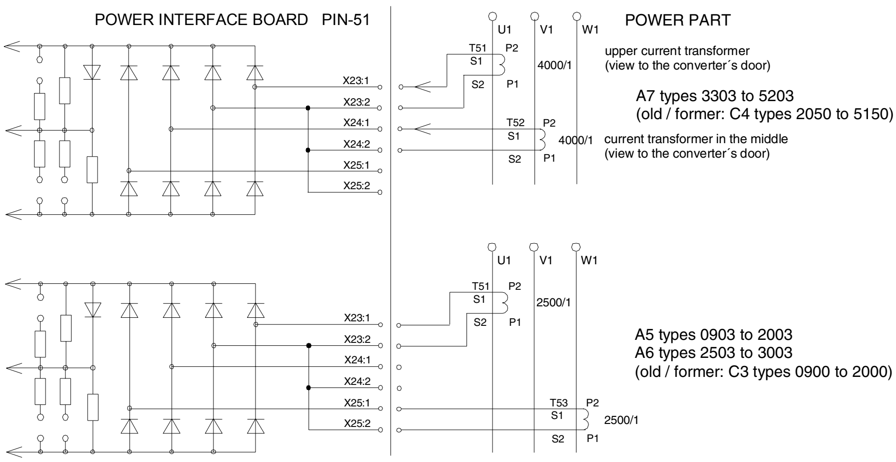


Figure 8 - 1 Wiring of current transformer

In case of service / engineering DCR kit

If one of the current transformer should be installed together with a DCR kit in an existing power part or if a current transformer fails or needs to be repaired at one of the A5 to A7 types, the following procedure has to be applied:

- It is important, that **both** current transformers are orientated and mounted in the same way on the bus bar. Fix them at the bus bar as recommended.
- Check the wiring of the old current transformers according to figure 8-1. It is important, that **both** current transformers are wired in the same way; take additional care in case the connection is not done by coded twisted pair cables.
- In case of service exchange the CTs; use the figures as a help; connect the wires to the terminals and check for correct wiring

Basic procedure to exchange current transformers

Independent of the converter type make sure the system is in a safe condition before any work is started. Make sure all voltage is switched off and all other safety regulations are fulfilled!

At converters type A5:

- to get access to the current transformer(s) the top panel of the converter´s body needs to be removed
- the old CT(s) then can be removed; put the new one(s) on; no extra mechanical fastening is needed; take care for the electrical connection; put the top panel back; connect the AC wires / bus bars

At converters type A6:

- the current transformers are hold in place by 3 copper bolts instead of a bus bar; they serve as a bus bar connecting the one for the AC power connection on the left with one end of the AC fuses located inside via 3 screws; to get access to the copper bolts either remove the AC bus bar on the left side of the converter or remove the fuses; make sure the CT will not fall down when removing the copper bolts
- mount the new CT by following the procedure in the opposite sequence

At converters type A7, (C4):

- remove the screw fastening the current transformer to the bus bar; remove the CT, put the new one on and fasten it; take care for the electrical connection
  (Some of the C4 type required a mounting screw to secure the CT to the bus bar. When drilling the hole for the mounting screw, proper care must be taken, so that no copper shavings remain in the drive.)

Environmental condition

The transformers withstand at rated current continuously an ambient temperature up to 55° C at a temperature of 90° C on the primary conductor simultaneously.

A5 and A6 type converters

All A5 and A6 type converters have been delivered up to now with the same type of current transformers. The type of current transformer used and its position within the converter is shown in *figures 8-2* and *8-4*.

- At A5 converters the AC bus bar and at A6 converters 3 copper bolts instead of a bus bar are feed through the current transformer. The transformer is kept in place by its mounting principle and needs no further fixation.
- The electrical connection to the electronics is done by a twisted pair cable with coded plugs on both ends.

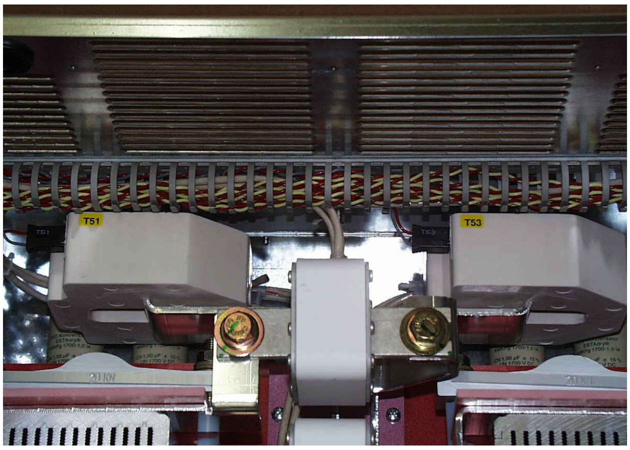


Figure 8 - 2 Converter type A5

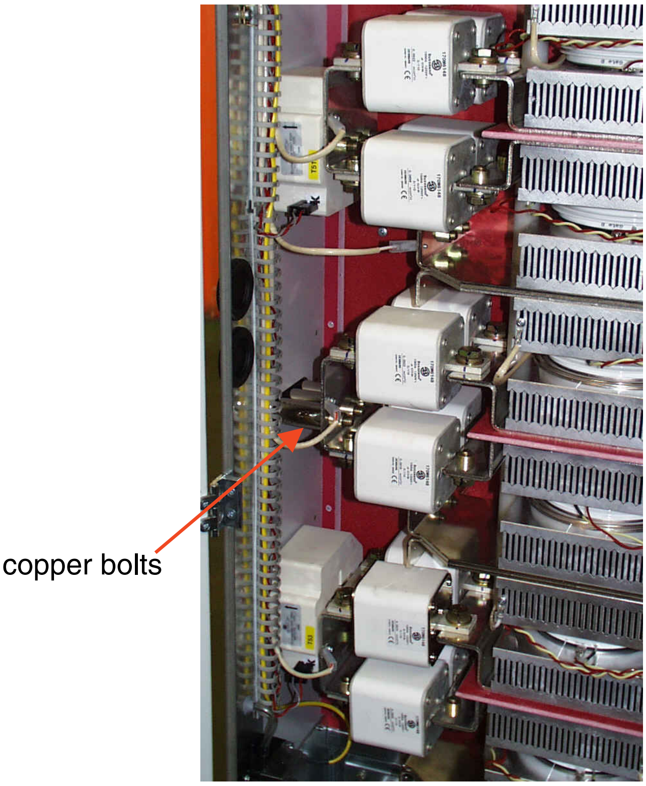


Figure 8 - 3 Converter type A6

Electrical data

Rated primary current:	3000 A AC
Rated secondary current:	1.2 A AC
Ratio:	2500 : 1
Short time magnetic overload capacity:	3
Max. rated voltage:	1500 V AC
Max. test voltage:	5000 V AC for less than 3 sec.

Mechanical data

Dimensions: in mm; see *figure 8-4*
Weight: 1.7 kg

Ordering information	Type:	LT 2032
	Ordering number:	3 ADT 751 010 P 0001

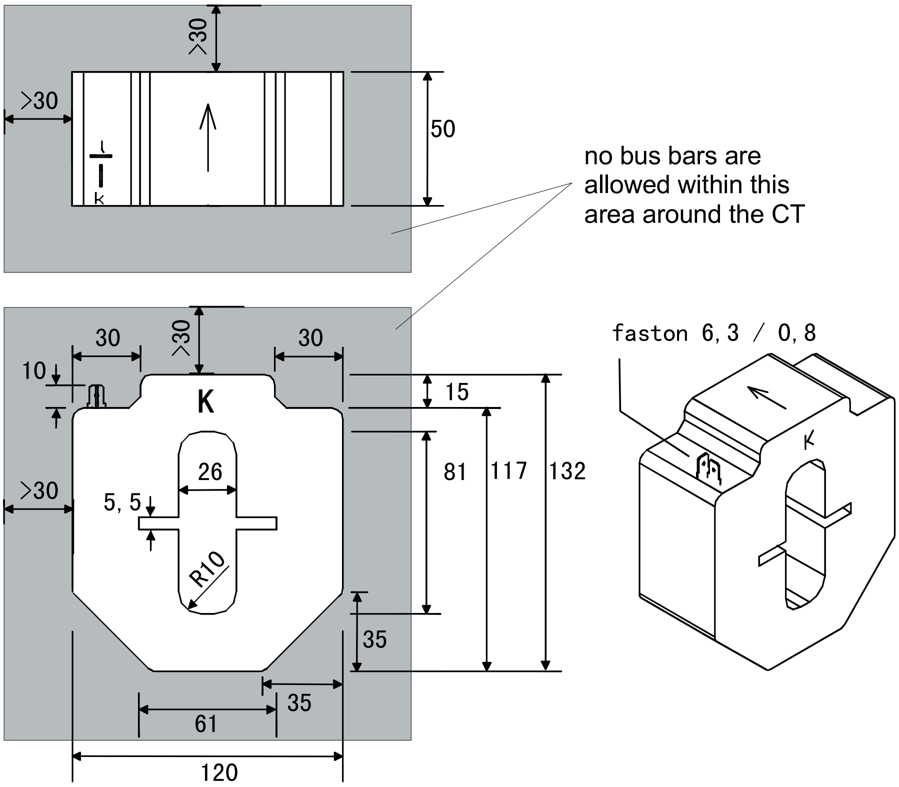


Figure 8 - 4 Dimension drawing current transformer for converters type A5 and A6

A7 (C4) type converters

For all A7 type converters the type of current transformer used is shown in figures *8-5 to 8-7*.
- The current transformers are fixed on the bus bar with the help of a screw.
- They will be connected to the electronics via coded plugs.

(For all C4 type converters, **delivered since middle of September 1998 up to now**, the same type of current transformer is used.)

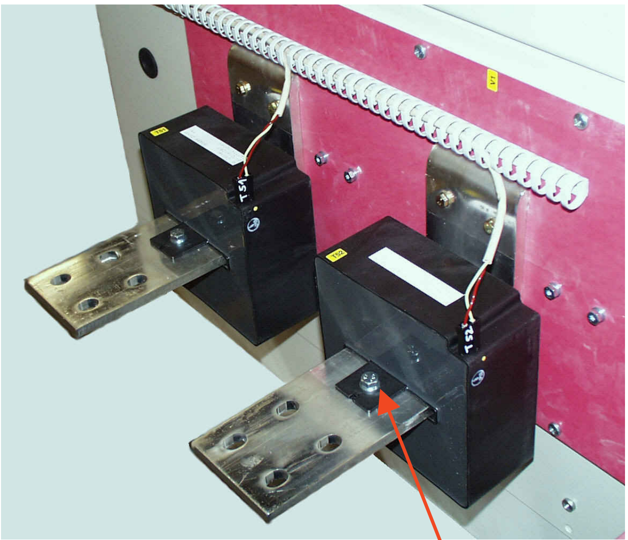


Figure 8 – 5 Converter type C4

Figure 8 – 6 Converter type A7

Electrical data

Rated primary current:	5000 A AC
Rated secondary current:	1.25 A AC
Ratio:	4000 : 1
Short time magnetic overload capacity:	3
Max. rated voltage:	1200 V AC
Max. test voltage:	4000 V AC for less than 1 min.

The mechanical dimensions are shown in *figure 8-7*.

Ordering information

Ordering number: 3 ADT 751 007 P1

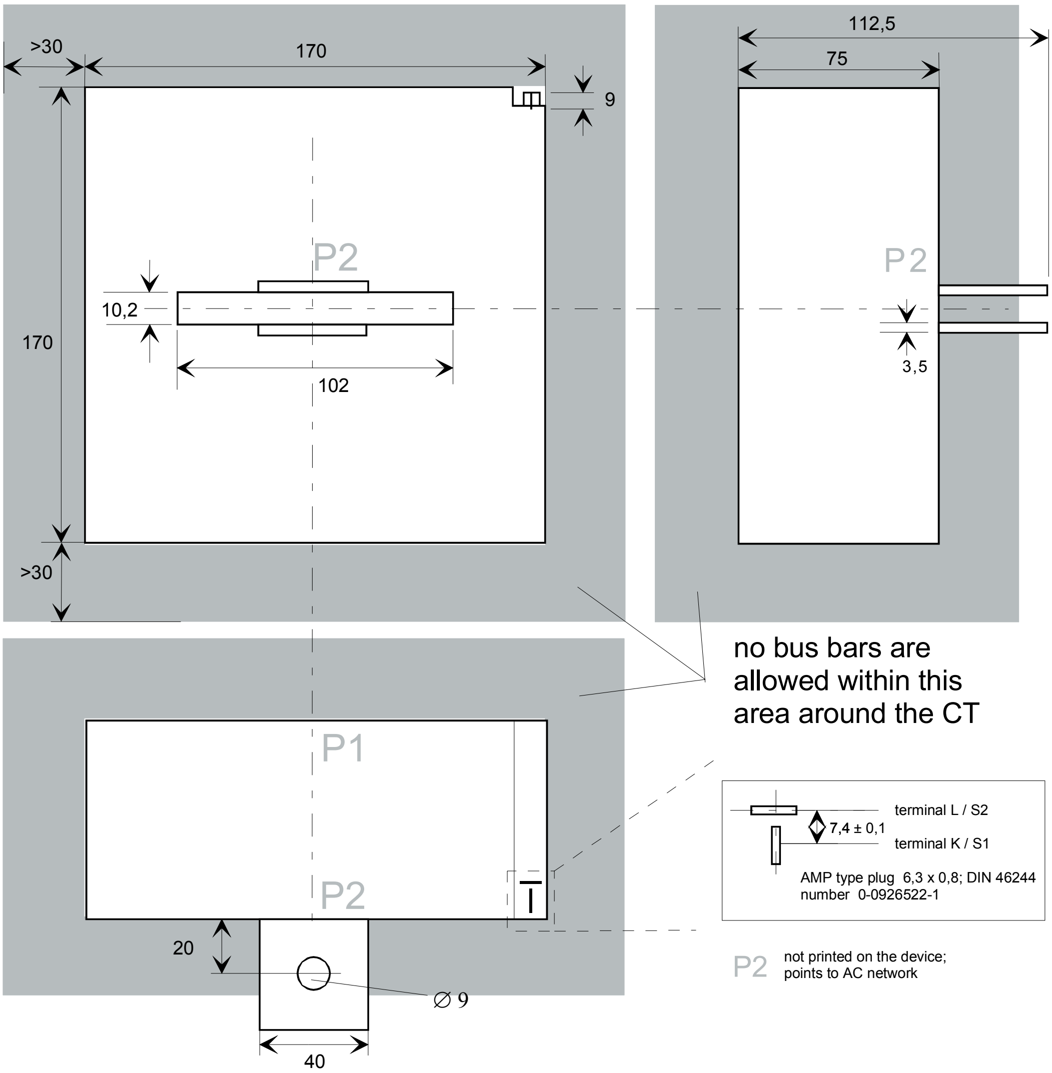


Figure 8 – 7 Converter type A7

Appendix A – Guideline for starting rebuild projects

General

In rebuild projects commercial and technical points have to be taken into consideration. The points within this technical questionnaire are subdivided into 3 parts. They are related to the motor, the converter and the control system. If all the information is properly collected, it will help you, to decide, whether a DCR Kit, a converter module or an enclosed converter should be used for this project and it will enable us to support you as best as possible.

Technical items, related to the motor

These items intend to collect information about the motor. They are used to check, if there are critical points, which result in a different control philosophy compared to the one in use. This information is absolutly necessary to decide wether the existing power stack can be used or should rather be replaced by a new one.

Motor data

Nominal armature current:	A
Nominal armature voltage:	V
Maximum armature current in operation (appr.):	A
Nominal / minimum field current:	A
Nominal field voltage:	V
Speed range:	min^{-1}
Speed measuring device:	
Type + number of temperature sensor(s):	

Specialities:

Technical items, related to the converter and the application

These items intend to collect information about the converter and the application. They are used to check, if the DCR Kit can be used in general. Some of the information is used for statistics, other to make sure, that the easiest way of engineering is used and up to which level we can support. Every line filled in with an information will enable us to give more detailed support.

Converter / Application data

Wiring of the thyristors		**Remark**
6-pulse bridge configuration	☐	
12-pulse serial configuration	☐	
12-pulse parallel configuration	☐	
sequencial control	☐	
3-pulse star or double star	☐	
circulating current control principle	☐	
other	☐	
Control		
analogue	☐	
digital	☐	

Nominal voltage (existing converter):	V
Nominal current (existing converter):	A
Nominal line voltage:	V

Specialities:

Hardware conditions for DCR Kit solution

If a DCR kit is really taken into consideration, the next items list some conditions when the DCR kit should be used or better a converter module / enclosed converter.

- Before an existing DC power part is upgraded by the DCR kit, it should be checked, if a brand new module may be the easier and more reliable solution.
- The existing power bridge should be build up by max. 4 thyristors in parallel (solution for more thyristors in parallel on request).
- The mains voltage on line supply, used at the existing thyristor bridge has to be lower than 1200 V because of the devices, used to interface the electronics to the thyristors (higher mains voltages on request).
- The thyristors should be of a disk type and one single thyristor bridge should be capable of running around 1000 A or more, if the converter is build up by **more than one** bridge in parallel; if a single bridge cannot give this current a brand new converter is probably the more economical solution
- The ratio between reverse / forward blocking voltage of the thyristors and the nominal line voltage should be factor 3 or higher; the blocking voltage has to be measured on a thyristor test stand; if the actual blocking voltage gives a lower ratio the thyristor(s) need to be replaced; in such a case, please check, if a complete new converter may be more economic.

Manufacturer of the existing converter:	
Type of thyristor:	
Manufacturer of thyristor:	
Number of parallel thyristors forward:	
Number of parallel thyristors reverse:	
Amount of overcurrent:	
Ratio of the current transformers:	
Type of overtemperature protection / sensor:	
Application:	
Photo(s) of the converter for more detailed checks	
If possible, a copy of the manufacturer´s documentation	
Instead of a picture mechanical drawing with basic dimensions and the position of each thyristor bridge	

Drive´s wear conditions

In case a DCR kit or a converter module will be used, a part of the existing equipment has to be used or will be used. Components which should be reused should be in a good condition. Please observe the following technical circumstances:

- Check all parts in the AC supply like main disconnecting switch with fuses or main contactor or similar for good condition.
- Check the thyristor bridge itself (fixing devices; press clamps for thyristor mounting, etc.) with cooling equipment for good condition.
- If a DCR kit is used for the armature supply, any of the field supply units SDCS-FEX-1 / FEX-2 / DCF 503 or 4 / DCF501 or 2 can be used!
  If the old field supply equipment should be reused; the reuse of this equipment depends on the overall strategy concerning monitoring, fault tracing and overall control and performance of the drive. If the existing equipment is reused either a binary or an analogue signal should be available indicating "field supply equipment o.k.". In case this signal is not available galvanic isolated then it should be made potentially free for safety reasons.
  If the drive should also be used in the field weakening range, an analogue signal, representing the actual field current, is highly recommended. It will be used for monitoring and fault indications generated within the DCR kit´s software.
- Depending on the old control structure an analogue tacho generator can be reused. A pulse generator can only be (re)used, if it generates a pulse train as an output signal (see software description).
- The DCR kit expects an armature current feedback signal for the current control loop. This signal normally is taken from two current transformers on the a.c. side of the thyristor bridge. The current transformers shall give 0.5...0.85 A, which corresponds to the nominal current of the thyristor bridge (other solutions on request).
- A 230 V a.c. supply for the DCR kit´s electronics is needed.

Items, related to the control system

These items try to cover information about the control system and the control principle. They are used to share the responsibility between the different departments involved. This information is helpful to get a feeling about the complete project.

Control system data

Brand / type of the existing overriding control system:	
Does the overriding control system have to be re-used:	
Which overriding control system will be used in future?	
Is the converter controlled by analogue / digital signals:	
Should a field bus be used and which type:	

Specialities:

Appendix B – Obsolete Kits

DCR 500

The documentation belonging to DCS 500 and 500B is used together with this description. One common feature is the software, which can be identified by the designation S 21.xxx.

- **DCS 500 / DCS 500B System Description** describes more in detail the overview, shown on the next page.
- **Technical Data** describes all the external connections and settings of the circuit boards.
- **DCS 500 / DCS 500B Operating Instruction**
- **DCS 500 Software Description**
- **DCS 500 Application Function Blocks** describes in detail all the additional function blocks, like AND, OR, ADD, MULTIPLY etc. to generate application specific functions.

Ordering code:

DCR 501 - 0000 - 00 - 2 1 0 0 0 0 0

DC Drives: Rebuild Kit
Product family
equipped with SDCS-CON1
Bridge type
1 = single (2-Q)
2 = double (4-Q)
Software type
Number of parallel/antiparallel thyristors
0 = 1 bridge, 2 = 2 bridges, 3 = 3 bridges, 4 = 4 bridges

selectable option

Applications:

- 12 pulse parallel	available
- 12 pulse serial	-------------
- MASTER - FOLLOWER	available; hardware data exchange

TECHNICAL INFORMATION!
NOT FOR NEW DESIGN!

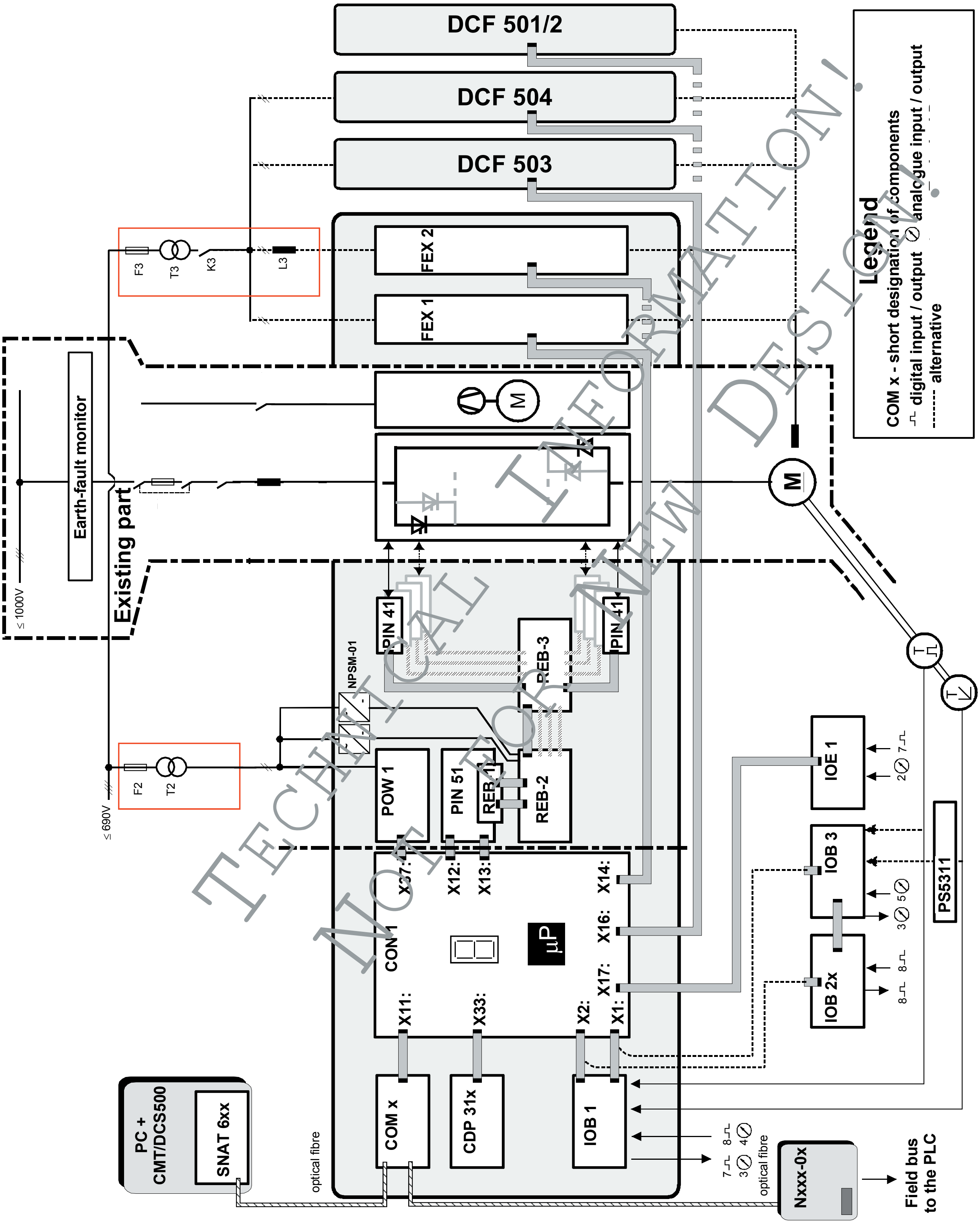


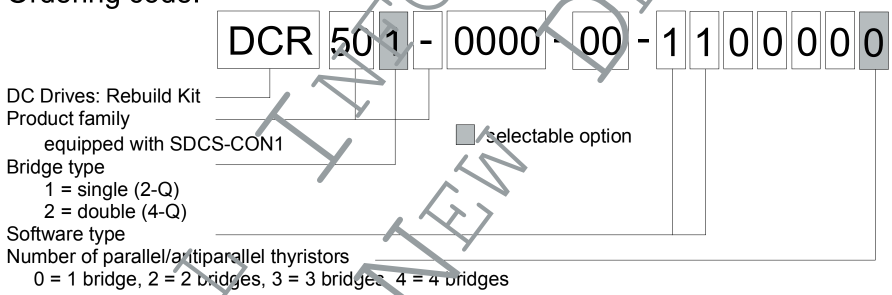
Figure B - 1 Overview of ***DCR 500*** *System*

DCR 500 /11

This type is designed only for DCV 700 functionality.
The documentation belonging to DCV 700 is used together with this description. One common feature is the software, which can be identified by the designation S 11.xxx.

- **DCV 700 Software Description**
- **DCV 700 Commissioning Manual**
- **Technical Data**
- **DCV 700 Service Manual** is for fault tracing and maintenance.
- **DCV 700 Parameter and Signal description**
- **DCV 700 Program diagram**

Ordering code:



Applications:
- 12 pulse parallel — available
- 12 pulse serial — available
- MASTER – FOLLOWER — available; serial data exchange

TECHNICAL INFORMATION!
NOT FOR NEW DESIGN!

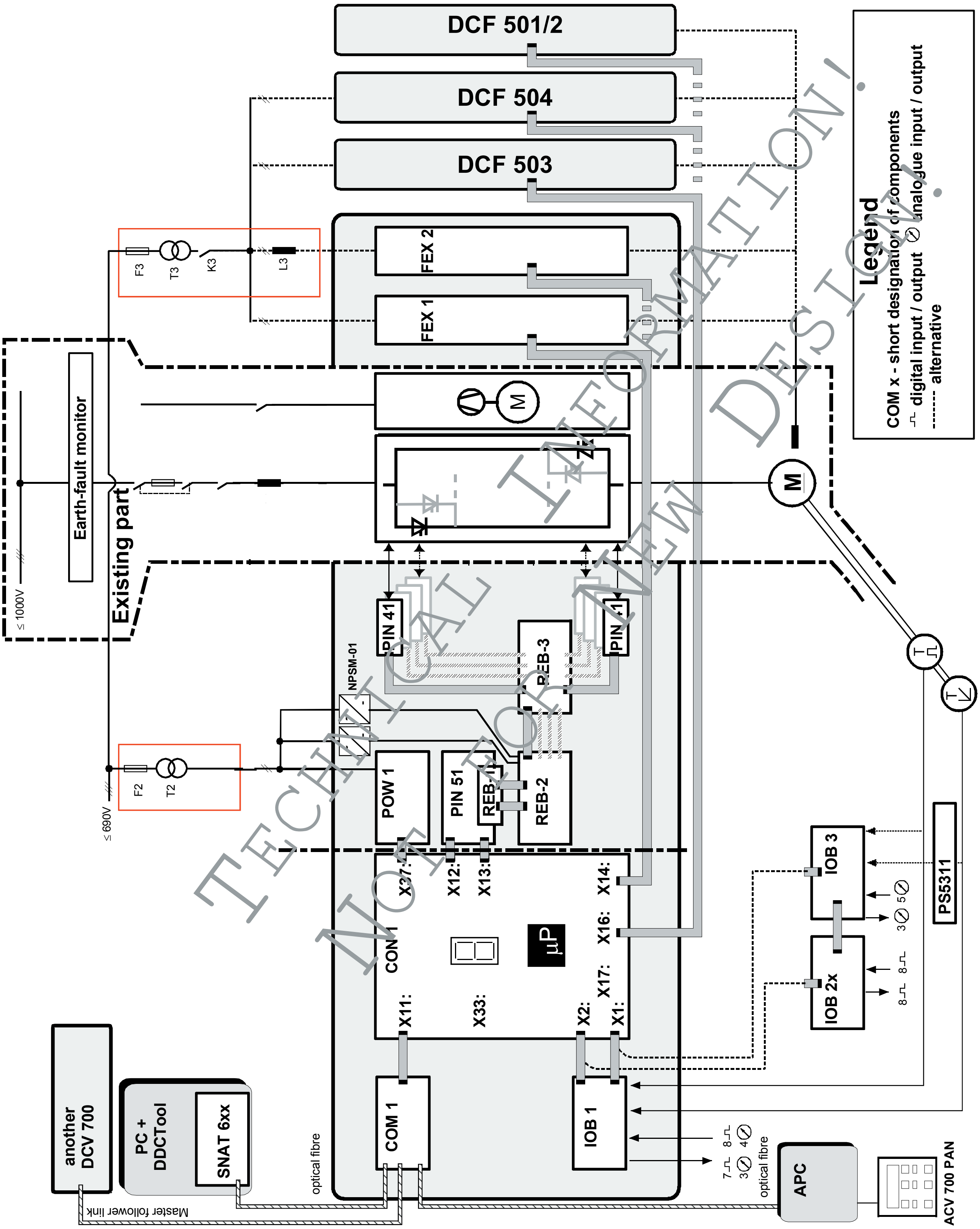
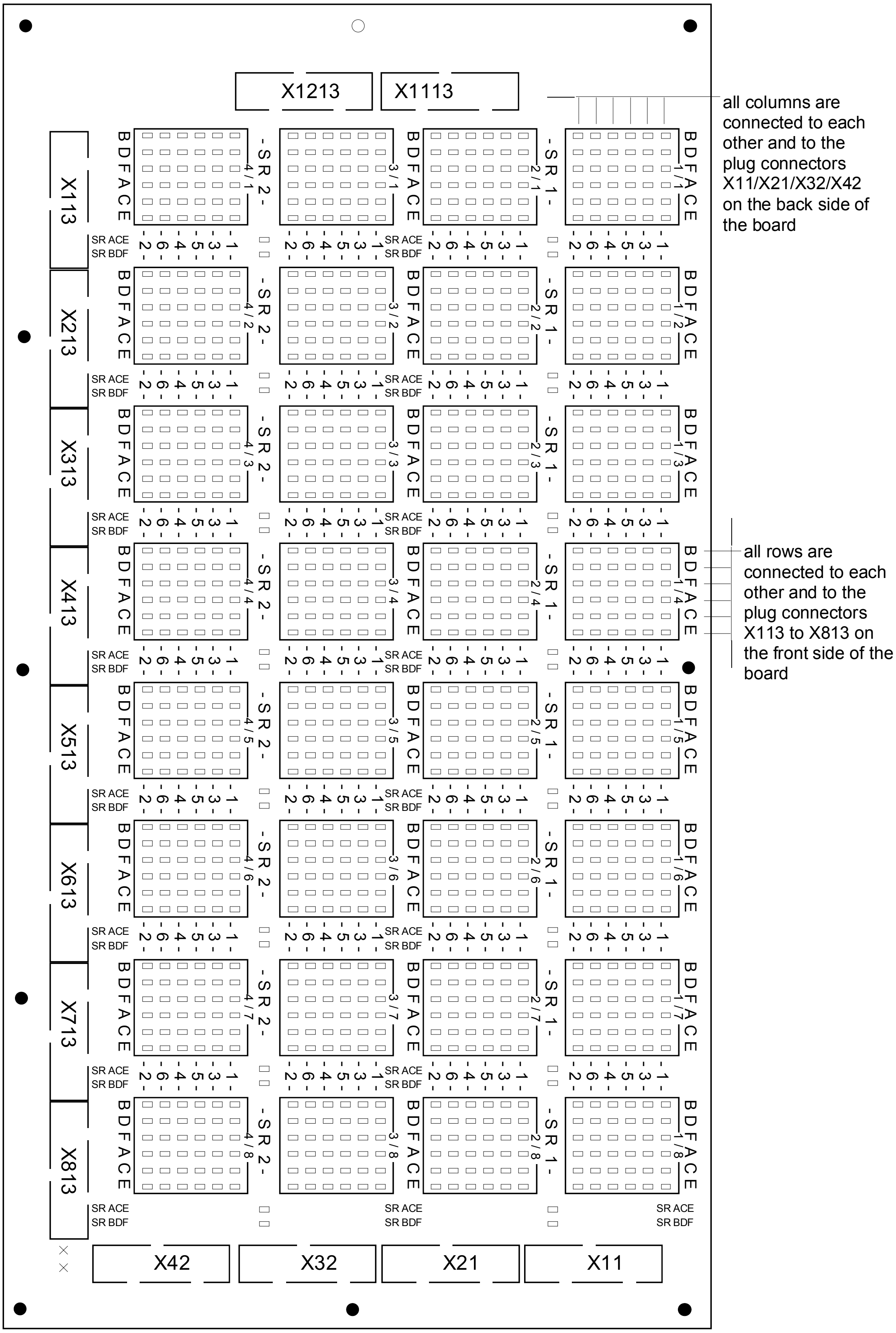
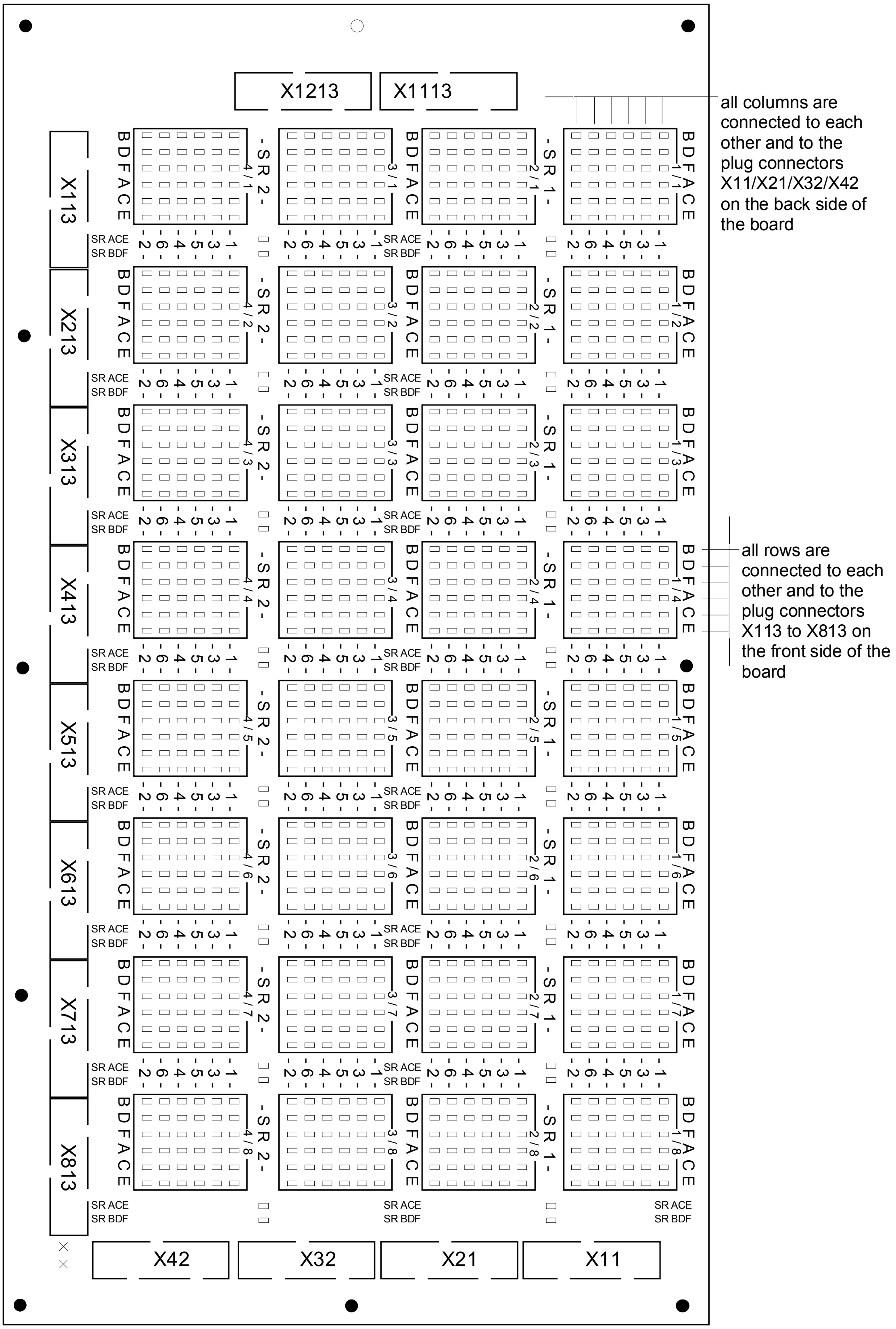


*Figure B - 2 Overview of **DCR 500 /11** System*

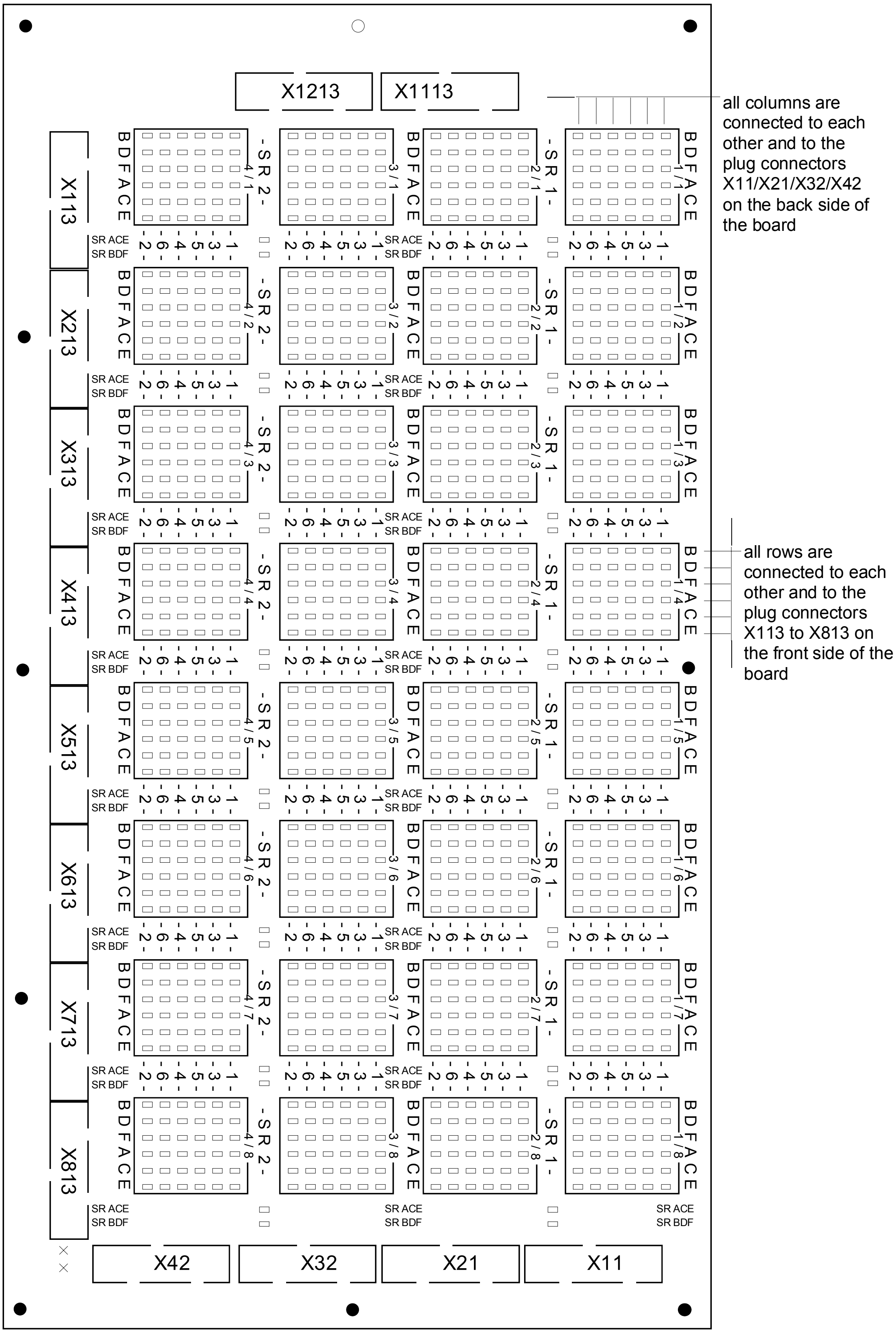
Appendix C – REB-3 Layout for detailed design



For planning the connections (make copies for try-outs)



For planning the connections



For planning the connections

ABB Automation Products GmbH
Postfach 1180
D-68619 Lampertheim
Tel: +49 (0) 62 06-5 03-0
Fax:+49 (0) 62 06-5 03-6 09
www.abb.com/dc

Ident. No.: 3ADW 000 092 R0301 Rev C
04_2004

092R0301A4150000