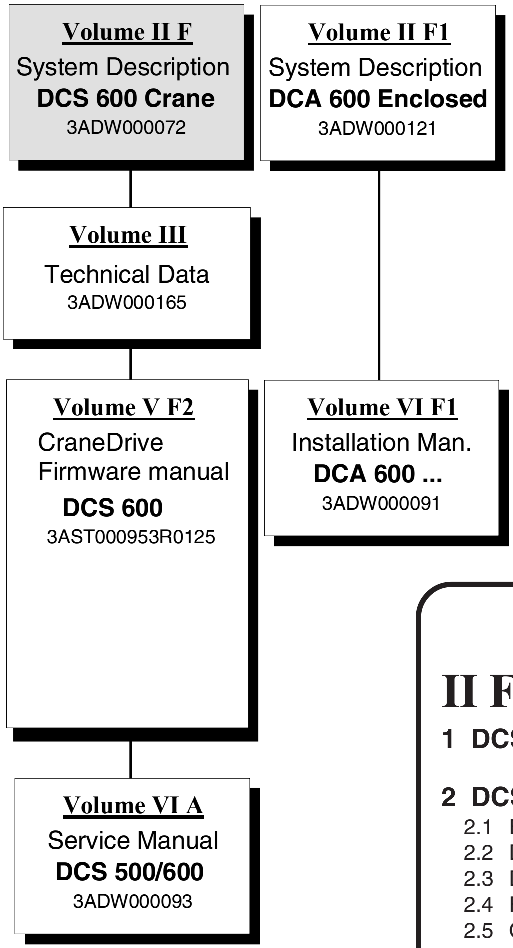
DCS Thyristor Power Converters

for DC Drive Systems

25 to 5150 A

System Description

DCS 600 CraneDrive



How the DCS 600 CraneDrive Documentation System works

This is to give you an overview how the system of information for DCS 600 CraneDrive converters is built up. The shaded part indicates the volume within the total system you are just now working with. In addition you see all other available documents for the same system.

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II F SYSTEM DESCRIPTION

1 DCS 600 CraneDrive - the power converter

- **state-of-the-art technology**
- **flexible design**
- **user-friendly**

ABB's long years of experience with variable-speed DC drives, plus use of the latest state-of-the-art technologies, have been combined to create this product. The DCS 600 CraneDrive contains a complete program with ratings between 25 A and 5150 A as a power converter module. It is suitable for all commonly used three-phase systems.

All our products are **CE** approved.

The DC drives factory of ABB Automation Products, Drives Division in Lampertheim has implemented and maintains a quality management system according to DIN EN **ISO 9001** and an environmental management system according to DIN EN **ISO 14001**.

DCS 600 CraneDrives are approved according to **UL** (**U**nderwriters **L**aboratory).

They also comply with the relevant EMC standards for Australia and New Zealand and are **C-Tick** marked.

DCS 600 CraneDrive converter units are suitable for standard and system drive applications.

Appropriate **PC programs** ensure that the drives are engineered for user-friendly operator control.

Unit range

The range comprises of 4 sizes, C1, C2, A5 and C4. We can deliver both modules and standard cabinets.

Basic hardware components

- Thyristor bridge(s) (from size A5 with installed branch fuses)
- Temperature monitor for the thyristor bridge(s)
- Fan
- Integrated power supply for the electronics
- Microprocessor board
- AMC (**A**pplication **M**otor **C**ontrol) board with DSP (**D**igital **S**ignal **P**rocessor) for drive control and DDCS link

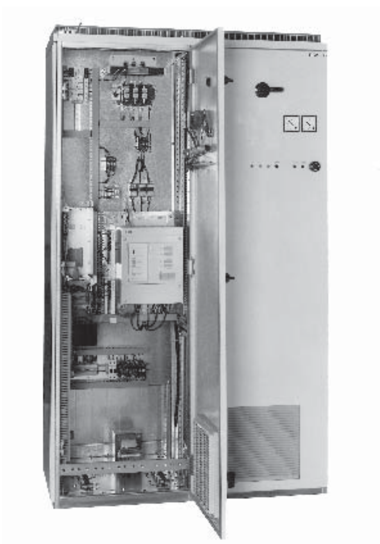
Additional components integrated in the module

- Field supply converter
  – uncontrolled full wave diode bridge, 6A or
  – half-controlled diode/thyristor bridge, 16A
- Control panel

Moreover, the accessories listed below can be used to individually customize the drive package in accordance with the application intended

- External field supply units
- Additional I/O boards (isolated)
- Interface modules for various communication protocols
- EMC filter
- PC programs


C1 - Module


Cabinet

Basic functions

All units are provided with the same digital control boards and software. The DCS 600 CraneDrive flexibility allows the user to configure functions of the drive easily, suitable for different applications. Functions of the DCS 600 CraneDrive are normally activated by parameters.

The basic software includes the following options:

- Processing the speed reference with a speed ramp generator (S-ramp capability, accel/decel ramp)
- Processing the speed feedback
- Speed controller
- Torque reference processing
- Current controller
- Field weakening
- Automatic/manual field reversal
- Autotuning of current controller
- Speed monitor
- Drive control logic
- Remote/local operation
- Electrical disconnect (category 0)
- Electronic circuits are not sensitive to line phase sequence
- Electrical and mechanical brake control
- Motor overload supervision
- Dual field
- Programmable analogue outputs
- Field supply
- Master follower via fibre optics

Controlling and operating

via **I/O's**
analogue and digital inputs and outputs

via **bus systems**
e.g.: Profibus, Modbus Plus, AF100 etc.

via **HMI** (Human Machine Interface)
Outputs:
Alarms
Faults
Status information
Parameter setting
Local control of the drive

Design and commissioning tools

DriveWindow
PC program for commissioning and maintenance under Windows® for:
Parameter setting
Fault detection
Trending
Data logger
Fault logger
Local operation (Drives Panel)

CDP 312 removable control and display panel with plain text display for:
Parameter setting
Fault detection
Parameter uploading and downloading
Local operation

Monitoring functions

Self-test
Non-volatile fault memory
Motor protection
In the event of:

- Speed feedback error
- Overtemperature
- Overload
- Overspeed
- Zero speed
- Armature overcurrent
- Armature ripple
- Armature overvoltage
- Minimum field current
- Field overcurrent

Power converter protection

- Overtemperature
- Software errors (watchdog function)

Incorrect supply protection

- Mains overvoltage and undervoltage
- Auxiliary undervoltage
- Incorrect mains phase sequence (only inform.)

The cost effective crane drive with safety and performance already built in.

DCS 600 CraneDrive

ABB's dedicated crane drive offers a standard range of functions, which ensure safer and faster crane operations for both I/O stand-alone and fieldbus controlled drives.

This is enabled by DCS 600 family benefits and a proven standard crane software.

Available both for DCS 600 converter modules and DCA 600 enclosed converter and line-ups.

DCS 600 CraneDrive benefits:

- Wide power range.
- Ready-to-use with proven modular crane functionality.
- Easy installation and start-up reduces the total project costs.
- Smooth crane operation keeps the cost of damaged goods low.
- Accurate torque response increases the operational productivity.
- Small size and weight of the converter.
- Small size and weight of the DC motor.
- Low inertia of the DC motor.
- Cost advantage for revamping of existing DC motor installation.
- Common control and monitoring structure with ACS 600 CraneDrive.
- Skilled local support people available in many countries worldwide.

Flexible User Interface

Joystick Interface. For control from a driver's cabin with step or continuous speed reference.

Pendant Control. For low speed cranes controlled from the floor with step button or motor potentiometer reference.

Radio Control. For cranes controlled from the floor with step or continuous speed reference.

Fieldbus Communication. Interface for several fieldbus modules when a PLC is used for controlling the crane drive.

Limit Switch Supervision. Interfacing of pre and end limits to ensure the crane works within a safe envelope.

Other Crane products

- Grab control
- Sway control

These crane products are supporting DCS 600 CraneDrive

CraneDrive functions

- Mechanical brake control
- Fast stop
- Torque proving
- Speed monitor
- Torque monitor
- Joystick interface
- Limit switch supervision

2 DCS 600 CraneDrive Components Overview

DCS 600 Armature converter

The DCS 600 CraneDrive power converter range is a system of components and complete standard cabinets to control DC motors. It consists of individual components, based on the DCS 600 power converter modules. This chapter provides a brief description of the DCS 600 CraneDrive components available for matching the drive with the conditions on site.

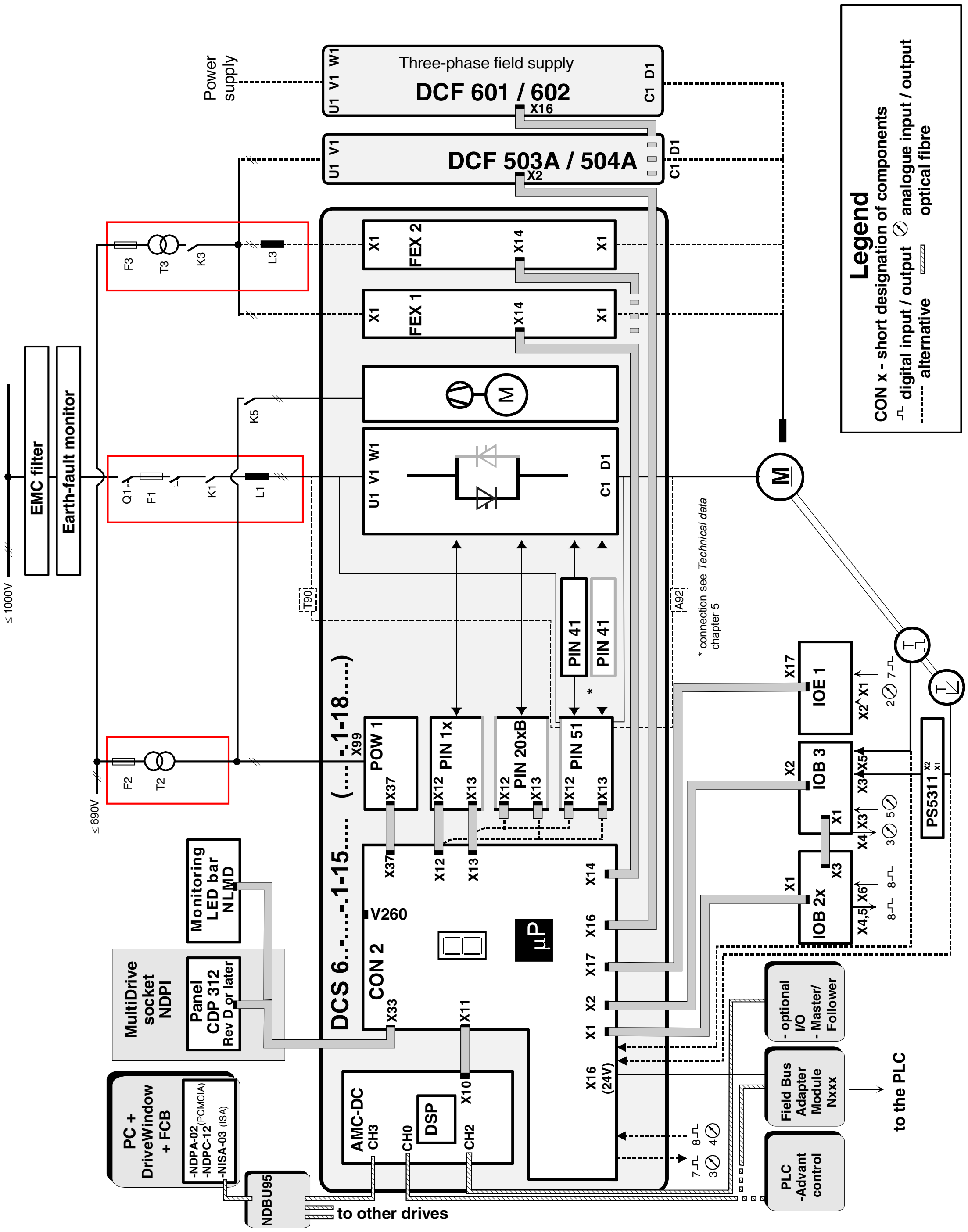


Fig. 2/1: DCS 600 CraneDrive Components overview for **armature converters**

This overview has been designed to help you to familiarize yourself with the system; its main components are shown in the diagram above. The system's heart is the DCS 600 converter module.

DCF 600 Field supply converter

The DCF 600 field supply converter range is a system of components and complete standard cabinets to control the field supply of DC motors. It consists of individual components, based on the DCS 600 power converter modules. The difference to the armature converter is only the modified power interface board SDCS-PIN-1x (if used) and the reduced range of current and voltage types (see table 2.2/2). The function for field supply will be selected by software parameters.

Note: Armature and field converters use the same firmware.

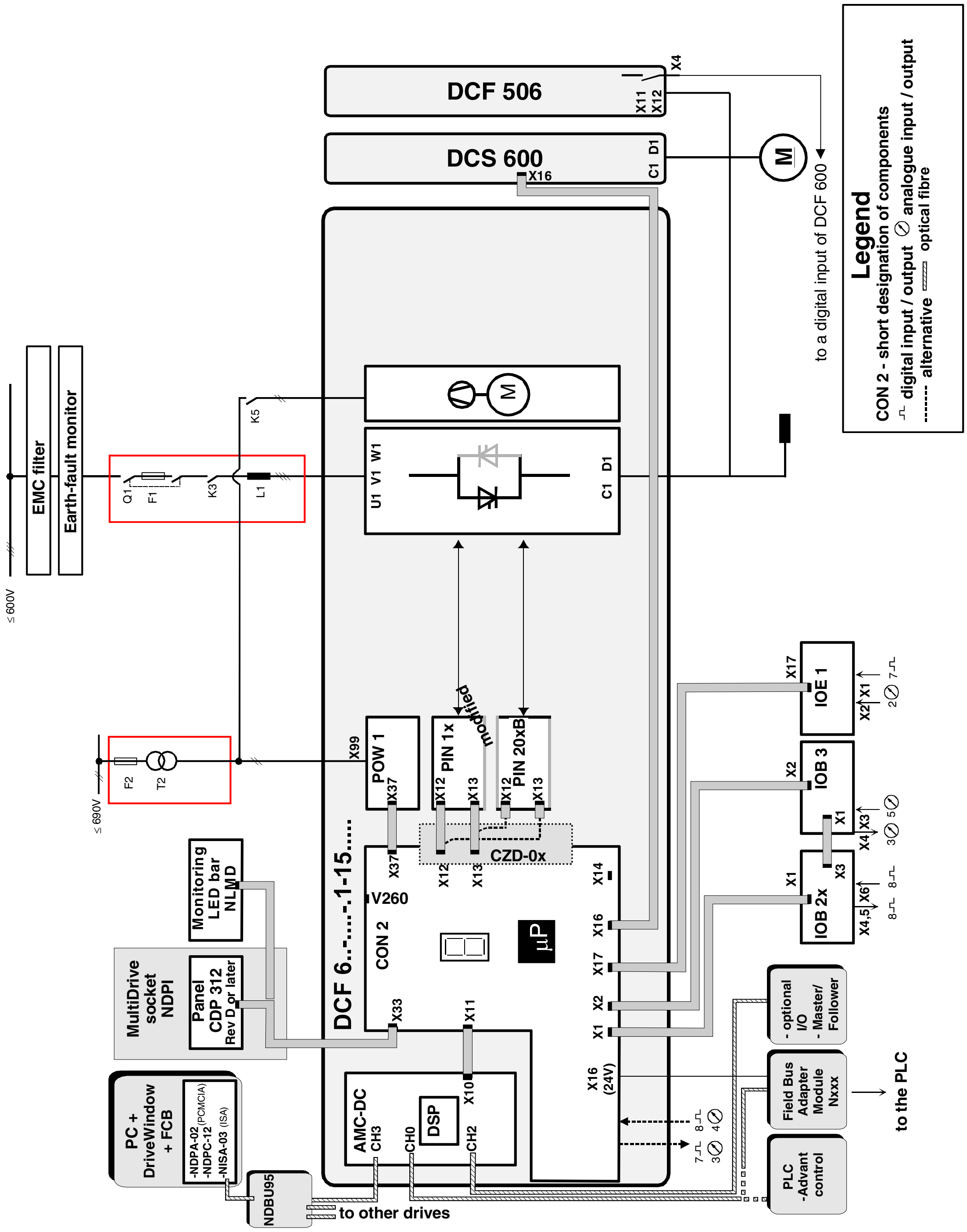


Fig. 2/2: DCS 600 CraneDrive Components overview for **field supply converters**

This overview has been designed to help you to familiarize yourself with the system; its main components are shown in the diagram above. The system's heart is the DCF 600 field supply converter module.

2.1 Environmental Conditions

System connection

Voltage, 3-phase:	230 to 1000 V according to IEC 38
Voltage deviation:	±10% continuous; ±15% short-time *
Rated frequency:	50 Hz or 60 Hz
Static frequency deviation:	50 Hz ±2 %; 60 Hz ±2 %
Dynamic: frequency range:	50 Hz: ±5 Hz; 60 Hz: ± 5 Hz
df/dt:	17 % / s

* = 0.5 to 30 cycles.
Please note: Special consideration must be taken for voltage deviation in regenerative mode.

Degree of protection

Converter Module and accessories (line chokes, fuse holder, field supply unit, etc.):	IP 00
Enclosed converters:	IP 20/21/31/41

Paint finish

Converter module:	NCS 170 4 Y015R
Enclosed converter:	light grey RAL 7035

Environmental limit values

Permissible ambient temp. with rated I_{DC}:	0 to +40°C
Relative humidity (at 5...+40°C):	5 to 95%, no condensation
Relative humidity (at 0...+5°C):	5 to 50%, no condensation
Ambient temp. converter module:	+40°C to 55°C; s. Fig. 2.1/2
Change of the ambient temp.:	< 0.5°C / minute
Storage temperature:	-40 to +55°C
Transport temperature:	-40 to +70°C
Pollution degree:	Grade 2

Site elevation:

<1000 m above M.S.L.:	100%, without current reduction
>1000 m above M.S.L.:	with current reduct., see Fig. 2.1/1

Vibration converter module: 0.5 g, 5 Hz to 55 Hz

Sound pressure level (1 m distance): Size	as module L_P	in the ABB standard cabinet L_P
C1	59 dBA	57 dBA
C2	71 dBA	64 dBA
A5	75 dBA	73 dBA
C4	83 dBA	76 dBA

Current reduction to (%)

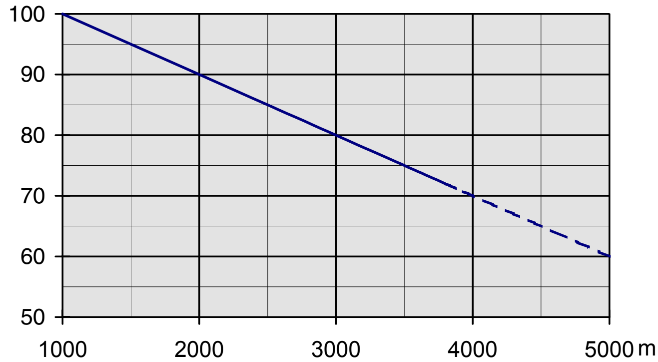


Fig. 2.1/1: Effect of the site elevation above sea level on the converter's load capacity.

Current reduction to (%)

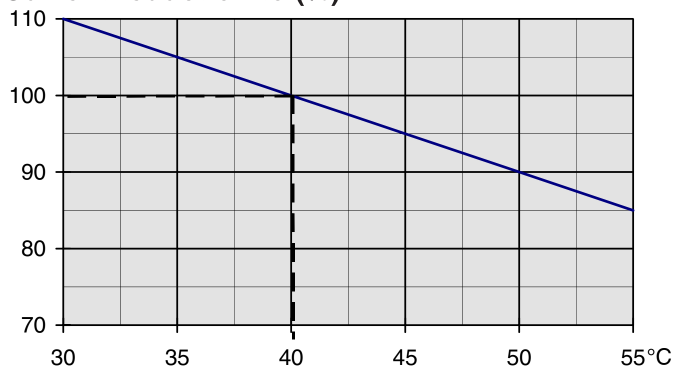


Fig. 2.1/2: Effect of the ambient temperature on the converter module load capacity.

Regulatory Compliance

The converter module and enclosed converter components are designed for use in industrial environments. In EEA countries, the components fulfil the requirements of the EU directives, see table below.

European Union Directive	Manufacturer's Assurance	Harmonized Standards: Converter module	Harmonized Standards: Enclosed converter
Machinery Directive 89/392/EEC 93/68/EEC	Declaration of Incorporation	EN 60204-1 [IEC 204-1]	EN 60204-1 [IEC 204-1]
Low Voltage Directive 73/23/EEC 93/68/EEC	Declaration of Conformity	EN 60146-1-1 [IEC 146-1-1] EN 50178 [IEC --] see additional IEC 664	EN 60204-1 [IEC 204-1] EN 60439-1 [IEC 439-1]
EMC Directive 89/336/EEC 93/68/EEC	Declaration of Conformity Provided that all installation instructions concerning cable selection, cabling and EMC filters or dedicated transformer are followed.	EN 61800-3 ① [IEC 1800-3]	EN 61800-3 ① [IEC 1800-3]
		were limits are under consideration EN 50081-2 / EN 50082-2 has been supplied	
		① in accordance with 3ADW 000 032	① in accordance with 3ADW 000 032/ 3ADW 000 091
		The Technical Construction File to which this declaration relates has been assessed by Report and Certificate from ABB EMC Certification AB being the competent Body according to EMC Directive.	

North American Standards

In North America the system components fulfil the requirements of the table below.

Safety for Power conversion Equipment ≤ 600 V	**Standard for module UL 508 C**; available for converter modules (including internal field exciter units) sizes C1, C2; under preparation for sizes A5 and C4
Industrial control Equipment: industrial products ≤ 600 V	**CSA C 22.2. No.1495**; available for sizes C1, C2, C4; under preparation for size A5

Note:
Only for Converter Modules

The power converter modules are modular in construction. They are based on the housing, which contains the power section with the RC snubber circuit. There are 4 different sizes, depending on current and voltage. All units are forced cooled.

The power section is controlled by the unit’s electronic system, which is identical for the entire product range. Parts of the unit’s electronic system can be installed in the unit, depending on the particular application involved, e.g. a field supply for the motor, or an interface board to connect the converter to an overriding control system. A control/display panel is available for the operator. It can be mounted to the power converter module or installed in the cabinet's door by means of a mounting kit.

Accessories such as external fuses, line reactors and the like are available, for putting together a complete drive system.

Reference variables

The voltage characteristics are shown in Table 2.2/1. The DC voltage characteristics have been calculated using the following assumptions:

- U_{VN} = rated mains voltage, 3-phase
- Voltage tolerance ±10 %
- Internal voltage drop approx. 1%
- If a deviation or a voltage drop has to be taken into consideration in compliance with IEC and VDE standards, the output voltage or the output current must be reduced by the actual factor according to table 2.2/1.

Mains voltage U_v	DC voltage (max. Motor voltage) U_d 2-Q ①	4-Q	Ideal DC voltage without load U_{di0}	Recommended DCS 600 Voltage class y=
230	265	240	310	4
380	440	395	510	4
400	465	415	540	4
415	480	430	560	4
440	510	455	590	5
460	530	480	620	5
480	555	500	640	5
500	580	520	670	5
525	610	545	700	6
575	670	600	770	6
600	700	625	810	6
660	765	685	890	7
690	800	720	930	7
790	915	820	1060	8
1000	1160	1040	1350	9
1190	1380	1235	1590	1

① in case of a 2-Q converter, which is used in regenerative mode, 4-Q voltage values have to be used.

Table 2.2/1: DCS 600 max. DC voltages achievable with a given mains voltage.

Converter type ➔		y →		y=4 (400 V)		y=5 (500 V)		y=6 (600 V)		y=7 (690 V)	
➔ x=1 → 2-Q	I_{DC} [A]		I_{AC} [A]		P [kW]		P [kW]		P [kW]		P [kW]	
x=2 → 4-Q	4Q	2Q	4Q	2Q	4Q	2Q	4Q	2Q	4Q	2Q	4Q	2Q
DCS60x-0025-y1	25	25	20	20	10	12	13	15				
DCS60x-0050-y1	50	50	41	41	21	23	26	29				
DCS60x-0050-61	50	50	41	41					31	35		
DCS60x-0075-y1	75	75	61	61	31	35	39	44				
DCS60x-0100-y1	100	100	82	82	42	47	52	58				
DCS60x-0110-61	110	100	90	82					69	70		
DCS60x-0140-y1	140	125	114	102	58	58	73	73				
DCS60x-0200-y1	200	180	163	147	83	84	104	104				
DCS60x-0250-y1	250	225	204	184	104	105	130	131				
DCS60x-0270-61	270	245	220	200					169	172		
DCS60x-0350-y1	350	315	286	257	145	146	182	183				
DCS60x-0450-y1	450	405	367	330	187	188	234	235	281	284		
DCS60x-0520-y1	520	470	424	384	216	219	270	273				
DCS60x-0680-y1	680	610	555	500	282	284	354	354				
DCS60x-0820-y1	820	740	670	605	340	344	426	429				
DCS60x-1000-y1	1000	900	820	738	415	418	520	522				
DCS60x-0903-y1	900	900	734	734					563	630	648	720
DCS60x-1203-y1	1200	1200	979	979	498	558	624	696				
DCS60x-1503-y1	1500	1500	1224	1224	623	698	780	870	938	1050	1080	1200
DCS60x-2003-y1	2000	2000	1632	1632	830	930	1040	1160		1400		1600
DCF60x-0025-y1	25	25	20	20	10	12	13	15				
DCF60x-0050-y1	50	50	41	41	21	23	26	29				
DCF60x-0075-y1	75	75	61	61	31	35	39	44				
DCF60x-0100-y1	100	100	82	82	42	47	52	58				
DCF60x-0200-y1	200	180	163	147	83	84	104	104				
DCF60x-0350-y1	350	315	286	257	145	146	182	183				
DCF60x-0450-y1	450	405	367	330	187	188	234	235				
DCF60x-0520-y1	520	470	424	384	216	219	270	273				

Table 2.2/2: Table of DCS 600 / DCF 600 units - construction types C1, C2, A5

Converter type ➔		y →	y=4 (400 V)	y=5 (500 V)	y=6 (600 V)	y=7 (690 V)	y=8 (790 V)	y=9 (1000V)	y=1 (1190V)
	I_{DC} [A]	I_{AC} [A]	P [kW]	P [kW]	P [kW]	P [kW]	P [kW]	P [kW]	① P [kW]
2-Q converters									
DCS601-2050-y1	2050	1673			1435	1640	1876	2378	
DCS601-2500-y1	2500	2040	1163	1450	1750	2000			
DCS601-2650-y1	2650	2162						3074	3658
DCS601-3200-y1	3200	2611					2928	3712	4417
DCS601-3300-y1	3300	2693	1535	1914	2310	2640			
DCS601-4000-y1	4000	3264	1860	2320	2800	3200	3660	4640	5520
DCS601-4750-y1	4750	3876			3325	3800	4346		
DCS601-5150-y1	5150	4202	2395	2987					
4-Q converters									
DCS602-2050-y1	2050	1673			1281	1476	1681	2132	
DCS602-2500-y1	2500	2040	1038	1300	1563	1800			
DCS602-2650-y1	2650	2162						2756	3280
DCS602-3200-y1	3200	2611					2624	3328	3960
DCS602-3300-y1	3300	2693	1370	1716	2063	2376			
DCS602-4000-y1	4000	3264	1660	2080	2500	2880	3280	4160	4950
DCS602-4750-y1	4750	3876			2969	3420	3895		
DCS602-5150-y1	5150	4202	2137	2678					

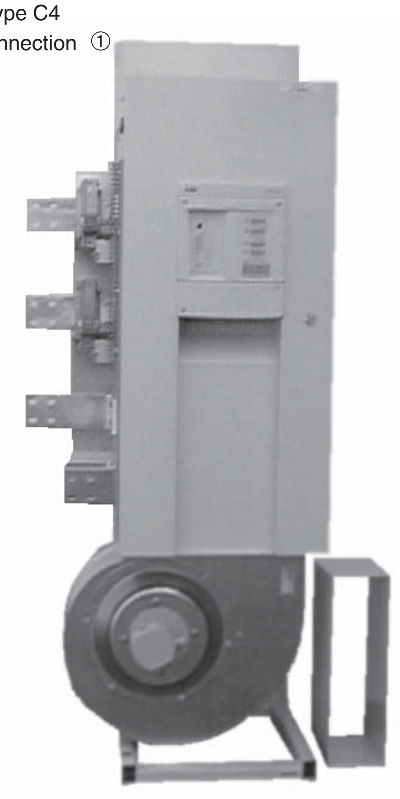
① These converters are equipped with additional components. More information on request

Table 2.2/3: Table of DCS 600 units - construction type C4

Construction type C1

Construction type C2

Construction type A5



Construction type C4
Left busbar connection ①

Converter type ③	Dimensions H x W x D [mm]	Weight [kg]	Clearances top/bottom/side [mm]	Construct. type	Power loss at 500V P_V [kW]	Fan connection	Semiconductor Fuses
DCS60x-0025-y1	420x273x195	7.1	150x100x5	C1	< 0.2	230 V/1 ph	external
DCS60x-0050-y1	420x273x195	7.2	150x100x5	C1	< 0.2	230 V/1 ph	external
DCS60x-0050-61	420x273x195	7.6	150x100x5	C1	-	230 V/1 ph	external
DCS60x-0075-y1	420x273x195	7.6	150x100x5	C1	< 0.3	230 V/1 ph	external
DCS60x-0100-y1	469x273x228	11.5	250x150x5	C1	< 0.5	230 V/1 ph	external
DCS60x-0110-61	469x273x228	11.5	250x150x5	C1	-	230 V/1 ph	external
DCS60x-0140-y1	469x273x228	11.5	250x150x5	C1	< 0.6	230 V/1 ph	external
DCS60x-0200-y1	505x273x361	22.3	250x150x5	C2	< 0.8	230 V/1 ph	external
DCS60x-0250-y1	505x273x361	22.3	250x150x5	C2	< 1.0	230 V/1 ph	external
DCS60x-0270-61	505x273x361	22.8	250x150x5	C2	-	230 V/1 ph	external
DCS60x-0350-y1	505x273x361	22.8	250x150x5	C2	< 1.3	230 V/1 ph	external
DCS60x-0450-y1	505x273x361	28.9	250x150x10	C2	< 1.5	230 V/1 ph	external
DCS60x-0520-y1	505x273x361	28.9	250x150x10	C2	< 1.8	230 V/1 ph	external
DCS60x-0680-y1	652x273x384	42	250x150x10	C2b	< 1.6	230 V/1 ph	external
DCS60x-0820-y1	652x273x384	42	250x150x10	C2b	< 2.0	230 V/1 ph	external
DCS60x-1000-y1	652x273x384	42	250x150x10	C2b	< 2.5	230 V/1 ph	external
DCS60x-0903-y1	1050x510x410	110	300x100x20	A5	-	230 V/1-ph	internal
DCS60x-1203-y1	1050x510x410	110	300x100x20	A5	< 5.2	230 V/1-ph	internal
DCS60x-1503-y1	1050x510x410	110	300x100x20	A5	< 5.5	230 V/1-ph	internal
DCS60x-2003-y1	1050x510x410	110	300x100x20	A5	< 6.6	230 V/1-ph	internal
DCS60x-2050-y1	2330x820x624 ① ②	350	to be installed in cabinet	C4	-	400/690 V/3-ph④	internal
DCS60x-2500-y1	2330x820x624 ①	350		C4	< 12	400/690 V/3-ph④	internal
DCS60x-2650-y1	2330x820x624 ① ②	350		C4	-	400/690 V/3-ph④	internal
DCS60x-3200-y1	2330x820x624 ① ②	350		C4	-	400/690 V/3-ph④	internal
DCS60x-3300-y1	2330x820x624 ①	350		C4	< 15	400/690 V/3-ph④	internal
DCS60x-4000-y1	2330x820x624 ① ②	350		C4	< 16	400/690 V/3-ph④	internal
DCS60x-4750-y1	2330x820x624 ①	350		C4	-	400/690 V/3-ph④	internal
DCS60x-5150-y1	2330x820x624 ①	350		C4	< 20	400/690 V/3-ph④	internal

① The dimensions for modules with busbar connection on the right side are 2330x800x624 mm (Busbar connection on the right side is optional)
Example for the type designation: connection left DCS60x-2050-y1**L**; connection right DCS60x-2050-**y**1**R**
② The depth of 1000 V / 1190 V units is 654 mm
③ **x=1** → 2-Q; **x=2** → 4-Q; **y=4...9/1** → 400...1000 V/1190 V supply voltage
④ Supply voltages up to 400 V in delta connection; 415 V or higher in star connection

(grey box) Also available as field supply converter DCF60x- (for 500 V units see table 2.2/2). Data are the same as the armature current converter DCS60x

Table 2.2/4: Table of DCS 600 units

2.3 DCS 600 Overload Capability

To match a drive system as efficiently as possible with the driven machine's load profile, the armature power converters DCS 600 can be dimensioned by means of the load cycle. Load cycles for driven machines have been defined in the IEC 146 or IEEE specifications.

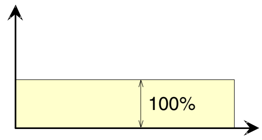
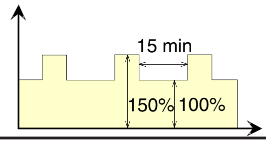
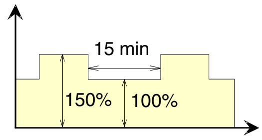
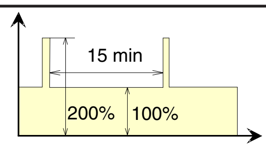
The currents for the DC I to DC IV types of load (see table 2.3/2) for the power converter modules are listed in the table below.

Unit type	$I_{DC\ I}$	$I_{DC\ II}$		$I_{DC\ III}$		$I_{DC\ IV}$	
	contin-uous	100 % 15 min	150 % 60 s	100 % 15 min	150 % 120 s	100 % 15 min	200 % 10 s
400 V / 500 V	[A]	[A]		[A]		[A]	
DCS60x-0025-41/51	25	24	36	23	35	24	48
DCS60x-0050-41/51	50	44	66	42	63	40	80
DCS60x-0075-41/51	75	60	90	56	84	56	112
DCS60x-0100-41/51	100	71	107	69	104	68	136
DCS601-0140-41/51	125	94	141	91	137	90	180
DCS602-0140-41/51	140	106	159	101	152	101	202
DCS601-0200-41/51	180	133	200	111	198	110	220
DCS602-0200-41/51	200	149	224	124	219	124	248
DCS601-0250-41/51	225	158	237	132	233	130	260
DCS602-0250-41/51	250	177	266	147	260	147	294
DCS601-0350-41/51	315	240	360	233	350	210	420
DCS602-0350-41/51	350	267	401	258	387	233	466
DCS601-0450-41/51	405	317	476	306	459	283	566
DCS602-0450-41/51	450	352	528	340	510	315	630
DCS601-0520-41/51	470	359	539	347	521	321	642
DCS602-0520-41/51	520	398	597	385	578	356	712
DCS601-0680-41/51	610	490	735	482	732	454	908
DCS602-0680-41/51	680	544	816	538	807	492	984
DCS601-0820-41/51	740	596	894	578	867	538	1076
DCS602-0820-41/51	820	664	996	648	972	598	1196
DCS601-1000-41/51	900	700	1050	670	1005	620	1240
DCS602-1000-41/51	1000	766	1149	736	1104	675	1350
DCS60x-1203-41/51	1200	888	1332	872	1308	764	1528
DCS60x-1503-41/51	1500	1200	1800	1156	1734	1104	2208
DCS60x-2003-41/51	2000	1479	2219	1421	2132	1361	2722
DCS60x-2500-41/51	2500	1830	2745	1740	2610	1725	3450
DCS60x-3300-41/51	3300	2416	3624	2300	3450	2277	4554
DCS60x-4000-41/51	4000	2977	4466	2855	4283	2795	5590
DCS60x-5150-41/51	5150	3800	5700	3669	5504	3733	7466
600 V / 690 V							
DCS60x-0050-61	50	44	66	43	65	40	80
DCS601-0110-61	100	79	119	76	114	75	150
DCS602-0110-61	110	87	130	83	125	82	165
DCS601-0270-61	245	193	290	187	281	169	338
DCS602-0270-61	270	213	320	207	311	187	374
DCS601-0450-61	405	316	474	306	459	282	564
DCS602-0450-61	450	352	528	340	510	313	626
DCS60x-0903-61/71	900	684	1026	670	1005	594	1188
DCS60x-1503-61/71	1500	1200	1800	1104	1656	1104	2208
DCS601-2003-61/71	2000	1479	2219	1421	2132	1361	2722
DCS60x-2050-61/71	2050	1502	2253	1426	2139	1484	2968
DCS60x-2500-61/71	2500	1830	2745	1740	2610	1725	3450
DCS60x-3300-61/71	3300	2416	3624	2300	3450	2277	4554
DCS60x-4000-61/71	4000	3036	4554	2900	4350	2950	5900
DCV60x-4750-61/71	4750	3734	5601	3608	5412	3700	7400
790 V							
DCS60x-2050-81	2050	1502	2253	1426	2139	1484	2968
DCS60x-3200-81	3200	2655	3983	2540	3810	2485	4970
DCS60x-4000-81	4000	3036	4554	2889	4334	2933	5866
DCS60x-4750-81	4750	3734	5601	3608	5412	3673	7346
1000 V							
DCS60x-2050-91	2050	1577	2366	1500	2250	1471	2942
DCS60x-2650-91	2650	2000	3000	1900	2850	1922	3844
DCS60x-3200-91	3200	2551	3827	2428	3642	2458	4916
DCS60x-4000-91	4000	2975	4463	2878	4317	2918	5836
1190 V							
Data on request							

x=1 → 2-Q; **x=2** → 4-Q

Table 2.3/1: Power converter module currents during corresponding load cycles.
The characteristics are based on an ambient temperature of max. 40°C and an elevation of max. 1000 m.

Types of load

Load cycle	Load for converter	Typical applications	Load cycle
DC I	$I_{DC\ I}$ continuous (I_{dN})	pumps, fans	
DC II	$I_{DC\ II}$ for 15 min and 1,5 * $I_{DC\ II}$ for 60 s	extruders, conveyor belts	
DC III *	$I_{DC\ III}$ for 15 min and 1,5 * $I_{DC\ III}$ for 120 s	extruders, conveyor belts	
DC IV *	$I_{DC\ IV}$ for 15 min and 2 * $I_{DC\ IV}$ for 10 s		

* Load cycle is **not** identical with menu item *Duty cycle* in DCSize !
Table 2.3/2: Definition of the load cycles

If the driven machine's load cycle does not correspond to one of the examples listed, you can determine the necessary power converter using the DCSize software program.

This program can be run under Microsoft® Windows, and enables you to dimension the motor and the power converter, taking types of load (load cycle), ambient temperature, site elevation, etc. into account. The design result will be presented in tables, charts, and can be printed out as well.

To simplify the start-up as much as possible, every power converter can be adjusted to the current required by means of parameters.

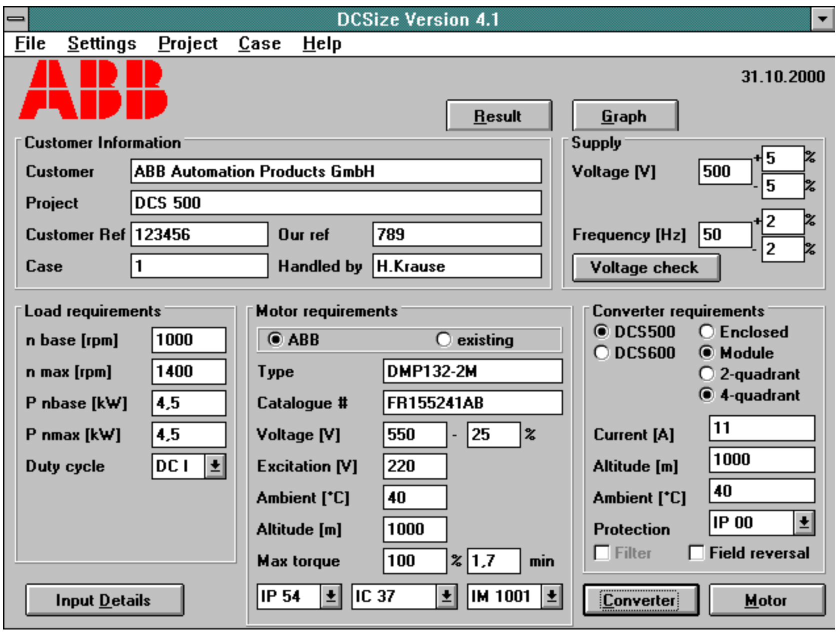


Fig. 2.3/1: Entry screen of DCSize.

Microsoft is a registered trademark. Windows is a designation of the Microsoft Corporation.

2.4 Field Supply

General data

- Currents from 6 to 520 A.
- Minimum field current monitor.
- Integrated or external field power converter or in a completely separate cabinet.
- 2-phase or 3-phase model.
- Fully digital control (except SDCS-FEX-1).

We recommend integrating an autotransformer in the field power converter's supply to adjust the AC input voltage to the field voltage, to reduce the voltage and current ripple of the field.

All field power converters (except for the SDCS-FEX-1) are controlled by the armature converter via a serial link with a speed of 62.5 kBaud. The link serves to parameterize, control and diagnose the field power converter and thus provides an exact control. Moreover, it enables you to control one internal (SDCS-FEX-2) and one external (DCF 503A/4A, DCF 601/2) or two external field supply units (2 x DCF 503A/4A, DCF 601/2). The respective software function required is available in every DC power converter.

Field converter types

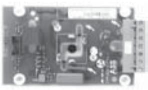
SDCS-FEX-1

- Diode bridge.
- 6 A rated current.
- Internal non adjustable minimum field current monitor.
- Construction and components have been designed for an insulation voltage of 600 V AC.
- Output voltage U_A:

$$U_A = U_V * \left(\frac{100\% + TOL}{100\%}\right) * 0.9$$

TOL = tolerance of line voltage in %
U_V = Line voltage

- Recommendation:
Field voltage ~ 0.9 * U_V



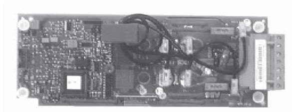
SDCS-FEX-2

- Half controlled thyristor/diode bridge (1-Q)
- Microprocessor control, with the electronic system being supplied by the armature converter.
- Construction and components have been designed for an insulation voltage of 600 V AC.
- Fast-response excitation is possible with an appropriate voltage reserve; de-excitation takes place by field time constant.
- Output voltage U_A:

$$U_A = U_V * \left(\frac{100\% + TOL}{100\%}\right) * 0.9$$

TOL = tolerance of line voltage in %
U_V = Line voltage

- Recommendation:
Field voltage 0.6 to 0.8 * U_V



DCF 503A

- Half controlled thyristor/diode bridge (1-Q).
- Microprocessor control with the control electronics being supplied separately (115...230 V/1-ph).
- Construction and components have been designed for an insulation voltage of 690 V AC.
- Output voltage U_A:

$$U_A = U_V * \left(\frac{100\% + TOL}{100\%}\right) * 0.9$$

TOL = tolerance of line voltage in %
U_V = Line voltage

- Recommendation:
  Field voltage 0.6 to 0.8 * U_V

DCF 504A

- like DCF 503A, but
- fully controlled antiparallel thyristor bridges (4-Q).
- With this unit fast response excitation / de-excitation and field reversal is possible. For fast response excitation an appropriate voltage reserve is necessary.
  In steady-state condition, the fully controlled bridge runs in half controlled mode to keep the voltage ripple as low as possible. With a fast changing field current, the bridge runs in fully controlled mode.

DCF 600

This field power converter is used mainly for armature converters with rated currents of 2050 to 5150 A. It is a modified armature circuit converter.

- Output voltage U_A respectively $U_{dmax\ 2\text{-}Q}$:
  see table 2.2/1.
- Recommendation:
  Field voltage 0.5 to 1.1 * U_V
- The three-phase field supply converters DCF 600 needs a separate active overvoltage protection unit DCF 506 for protecting the power part against too high voltages.
  The overvoltage protection unit DCF 506 is suitable for 2-Q converters DCF 601 and for 4-Q converters DCF 602.

Assignment Field supply converter to Overvoltage protection unit

Field supply converter for motor fields	Overvoltage Protection
DCF60x-0025-y1 ① ... DCF60x-0100-y1 ①	DCF506-0140-51
DCF60x-0200-y1 ① DCF60x-0350-y1 ① ... DCF60x-0520-y1 ①	DCF506-0520-51

① y = 400...500 V


DCF503A/4A


DCF601/602


DCF506-140-51, shown without cover

Unit type	Output current I_{DC} ① [A]	Supply voltage [V]	Installation site	Remarks
SDCS-FEX-1-0006 SDCS-FEX-2-0016	0.02...6 0.3...16	110V -15%...500V/1-ph +10% 110V -15%...500V/1-ph +10%	internal internal	external fuse, 6 A ⇒ I_{Frated} ext. fuse, reactor; for C1: 0.3 ... 8 A ①, **not** to be used for C4 modules!
DCF 503A-0050 DCF 504A-0050	0.3...50 0.3...50	110V -15%...500V/1-ph +10% 110V -15%...500V/1-ph +10%	external external	auxiliary supply (115...230V) if necessary via matching transformer; external fuse; Dimensions HxWxD: 370x125x342 [mm]
DCF 60x-xxxx-41/51	see table 2.2/2	200V...500V/3-ph	external	are based on the hardware of the DCS 600 and additional hardware components (DCF 506); auxiliary supply (115/230 V)

① Current reduction see also *2.1 Environmental conditions Fig.: 2.1/1 and 2.1/2*
Table 2.4/1: Data field converter units

2.5 Options for DCS 600 CraneDrive converter modules

In-/output signals

The converter can be connected in 4 different ways to a control unit via analogue/digital links. Only one of the four choices can be used at the same time. In addition to this an extension of I/O´s by SDCS-IOE 1 is possible.

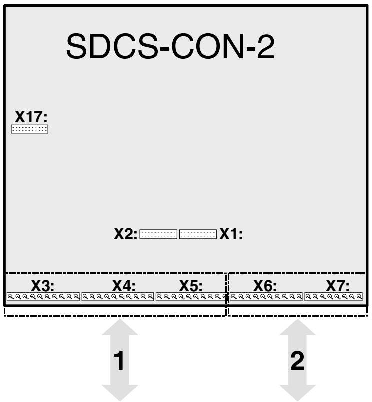


Fig. 2.5/1: I/O´s via SDCS-CON-2

Analogue I/O´s:	standard
Digital I/O´s:	not isolated
Encoder input:	not isolated

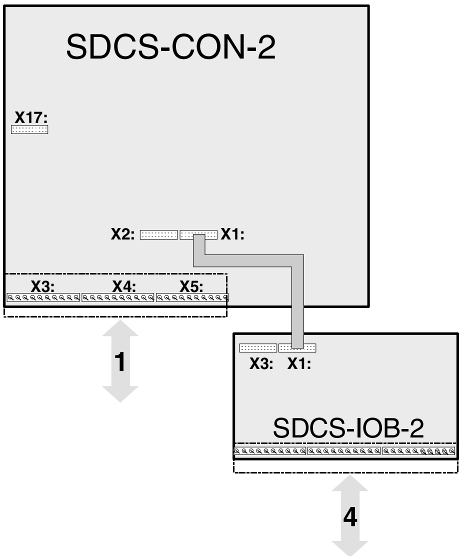


Fig. 2.5/2: I/O´s via SDCS-CON-2 and SDCS-IOB-2

Analogue I/O´s:	standard
digital I/O´s:	all isolated by means of opto-coupler/relay; the signal status is indicated by LED

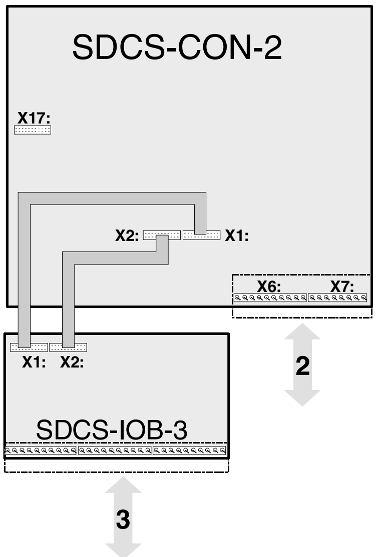


Fig. 2.5/3: I/O´s via SDCS-CON-2 and SDCS-IOB-3

Analogue I/O´s:	more input capacity
digital I/O´s:	not isolated
encoder input:	isolated
current source for:	PT100/PTC element

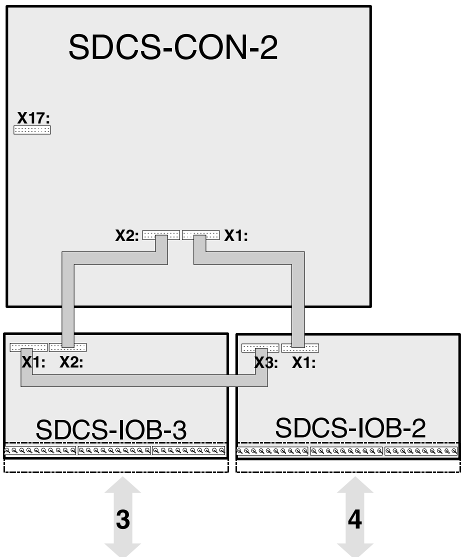


Fig. 2.5/4: I/O´s via SDCS-IOB-2 and SDCS-IOB-3

Analogue I/O´s:	more input capacity
digital I/O´s:	all isolated by means of opto-coupler/relay; the signal status is indicated by LED
current source for:	PT100/PTC element

Description of I/O signals SDCS-CON-2

Mechanical system integrated in control board

Terminals

Screw type terminals for finely stranded wires up to 2.5 mm^2

Functionality

⇨ **1 tacho input**
Resolution: 12 bit + sign; differential input; common mode range ±20 V
3 ranges from 8...30...90...270 VDC with n_{max}

⇨ **4 analogue inputs**
Range -10...0...+10 V, 4...20 mA, 0...20 mA
All as differential inputs; R_E = 200 kΩ; time constant of smoothing capacitor ≤2 ms
Input 1: Resolution: 12 bit + sign; common mode range ±20 V
Inputs 2, 3, 4: Resolution: 11 bit + sign; common mode range ±40 V

⇦ **2 outputs**
+10 V, -10 V, I_A ≤ 5 mA; sustained short-circuit-proof
voltage supply for reference potentiometer

⇦ **1 analogue output**
bipolar current actual - from power section; decoupled
IdN = ±3 V; I_A≤ 5 mA, short-circuit-proof

⇦ **2 analogue outputs**
Range -10...0...+10 V; I_A ≤ 5 mA
Output signal and scaling can be selected by means of software
Resolution: 11 bit + sign

⇨ **1 pulse generator input**
Voltage supply for 5 V/12 V/24 V pulse generators (sustained short-circuit-proof)
Output current with 5 V: I_A ≤ 0.25 A
12 V: I_A ≤ 0.2 A
24 V: I_A ≤ 0.2 A
Input range: 12 V/24 V: asymmetrical and differential
5 V: differential
Pulse generator as 13 mA current source: differential
Line termination (impedance 120Ω), if selected
max. input frequency ≤300 kHz

⇨ **8 digital inputs**
The functions can be selected by means of software.
Input voltage: 0...8 V ⇒"0 signal", 16...60 V ⇒ "1 signal"
Time constant of smoothing capacitor: 10 ms
R_E = 15 kΩ
The signal refers to the unit housing potential.
Auxiliary voltage for digital inputs: +48 V DC, ≤ 50 mA, sustained short-circuit-proof

⇦ **7+1 digital outputs**
The function can be selected by means of software.
7 outputs: relay driver with free-wheeling diode, total current limitation ≤ 160 mA; short-circuit-proof.
1 relay output - on power board SDCS-POW-1 (N.O. contact: **AC**: ≤250 V/ ≤3 A / **DC**: ≤24 V/ ≤3 A or ≤115/230 V/ ≤0.3 A) protected by VDR component.

Description of I/O signals SDCS-IOB-2x & SDCS-IOB-3

Mechanical system always external, outside the module

Terminals

Screw type terminals for finely stranded wires up to 2.5 mm^2

Functionality of SDCS-IOB-3

⇨ **1 tacho input**
Resolution: 12 bit + sign; differential input; common mode range ±20 V
Range 8 V- with n_{max}; if higher tacho voltages are in use tacho adaptation board PS 5311 is needed.

⇨ **4 analogue inputs**
All as differential inputs; time constant of smoothing capacitor ≤2 ms
Input 1: Range -10 V...0...+10 V; -20 mA...0...+20 mA; 4... 20 mA unipolar; R_E = 200 kΩ/ 500Ω/ 500Ω; Resolution: 12 bit + sign; common mode range ±20 V
Inputs 2+3: Range see input 1, in addition -1 V...0...+1 V
R_E = 200 kΩ/ 500Ω/ 500Ω/ 20kΩ; Resolution: 11 bit + sign; common mode range with -1 V...0...+1 V range ±10 V, otherwise ±40 V
Input 4: Range see input 1
R_E = 200 kΩ/ 500Ω/ 500Ω; Resolution: 11 bit + sign; common mode range ±40 V

⇨ **Fault current detection** (Earth fault) in combination with analogue input 4 (sum of phase currents ≠ 0)

⇦ **2 outputs**
+10 V, -10 V; I_A ≤ 5 mA; sustained short-circuit-proof
voltage supply for reference potentiometer

⇦ **1 analogue output**
Bipolar current actual - from power section; decoupled
IdN = ±3 V (at gain = 1); I_A≤ 5 mA; U_{Amax} = 10 V; gain can be adjusted by means of a potentiometer between 0.5 and 5; short-circuit-proof

⇦ **2 analogue outputs**
Range -10...0...+10 V; I_A ≤ 5 mA; short-circuit-proof
Output signal and scaling can be selected by means of software
Resolution: 11 bit + sign

⇦ **Current source** for PT 100 or PTC element
I_A = 5 mA / 1.5 mA

⇨ **1 pulse generator input**
Voltage supply, output current, input range: **see SDCS-CON-2**
Inputs electrically isolated from 0 V (housing) by means of optocoupler and voltage source.

Functionality of SDCS-IOB-2x

3 different designs available:

- ❍ **SDCS-IOB-21** inputs for 24...48 V DC; R_E = 4.7 kΩ
- ❍ **SDCS-IOB-22** inputs for 115 V AC; R_E = 22 kΩ
- ❍ **SDCS-IOB-23** inputs for 230 V AC; R_E = 47 kΩ

Terminals

Screw type terminals up to 4 mm^2

⇨ **8 digital inputs**
The functions can be selected by means of software.
The signal status is indicated by LED.
All isolated by means of optocouplers.
Input voltage: IOB-21:0...8 V ⇒"0 signal", 18...60 V ⇒"1 sig."
IOB-22:0...20 V ⇒"0 signal", 60...130 V ⇒"1 sig."
IOB-23:0...40 V ⇒"0 signal", 90...250 V ⇒"1 sig."
Filter time constant: 10 ms (channels 1...6); 2 ms (channels 7+8)
Auxiliary voltage for digital inputs: +48 V DC; ≤ 50 mA; sustained short-circuit-proof; referenced to the unit housing potential.

⇦ **8 digital outputs**
The functions can be selected by means of software.
The signal status is indicated by LED.
6 of them potential isolated by relay (N.O. contact: **AC**: ≤250 V/ ≤3 A / **DC**: ≤24 V/ ≤3 A or ≤115/230 V/ ≤0.3 A), protected by VDR component.
2 of them potential isolated by optocoupler, protected by zener diode (open collector) 24 V DC external, I_A ≤ 50 mA.

The digital inputs of SDCS-IOE-1 (DI 9...DI 15) can be connected to pre-defined functions (see software group 1o). This board is normally used for stand-alone mode / joystick operation.

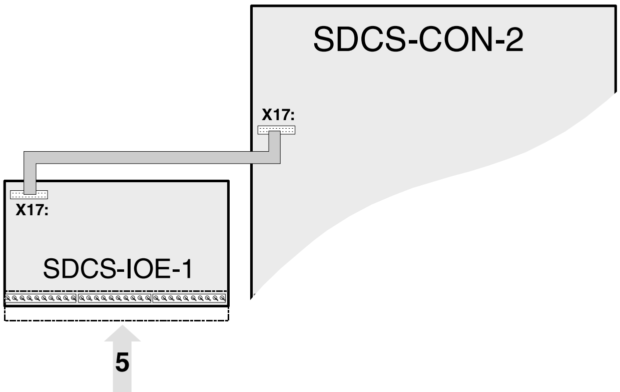


Fig. 2.5/5: Additional Inputs via SDCS-IOE1

Analogue inputs:	extended
Digital inputs:	all isolated by means of opto-coupler, the signal status is indicated by LED
current source for:	PT100/PTC element

Description of input signals **SDCS-IOE-1**

Mechanical system always external, outside the module

Terminals
Screw type terminals for finely stranded wires up to 2.5 mm²

Functionality of SDCS-IOE-1

⇨ **7 digital inputs**
The functions can be selected by means of software.
The signal status is indicated by an LED.
All isolated by means of optocouplers.
Input voltage: 0...8 V ⇒"0 signal", 16...31 V ⇒"1 signal"
Potentialwise arranged in two groups (DI 9...DI 12 and DI 13...DI 15)
Filter time constant: 2 ms

⇨ **2 analogue inputs**
No pre-defined functions

⇦ **Current source** for PT 100 or PTC element
I_A = 5 mA / 1.5 mA
The signals are referenced to the unit housing potential

Please note:

Unless otherwise stated, all signals are referenced to a 0 V potential. Within the power pack subassembly (SDCS-POW-1) and on all other PCBs, this potential is firmly connected with the unit's housing by means of plating through at the fastening points.

Serial interfaces

There are various serial interface options available for operation, commissioning, diagnosis and controlling. For the control and display panel CDP 312 are serial connections X33:/X34: on the SDCS-CON-2 available. Three additional serial interfaces are available on the SDCS-AMC-DC 2 board.
These interfaces use plastic or HCS optical fibres. Channel 3 is used for drive/PC interfacing. Channel 0 for fieldbus module interfacing or communication to the overriding control system. Channel 2 is used for Master-Follower link or for I/O extension. All three serial interfaces are independent from each other.

Different SDCS-AMC 2 boards are available to adapt optical cables, cable length and serial interfaces. The different SDCS-AMC 2 boards are equipped with 10 or 5 Mbaud optical transmitter and receiver devices.
A few basic rules must be considered:
- Never connect 5 Mbaud and 10 Mbaud devices.
- 5 Mbaud can handle only plastic fibre optic.
- 10 Mbaud can handle plastic or HCS cable.
- The branching unit NDBU 95 extends the maximum distance.
- The maximum distance and suitable configuration can be found in the manual *Configuration Instructions NDBU 85/95*; Doc no.: 3ADW000100.

Remark:
Fieldbus modules Nxxx (CH0) require the SDCS-AMC-DC ***Classic 2*** board - all others (FCI, AC80...) require the SDCS-AMC-DC 2 board.

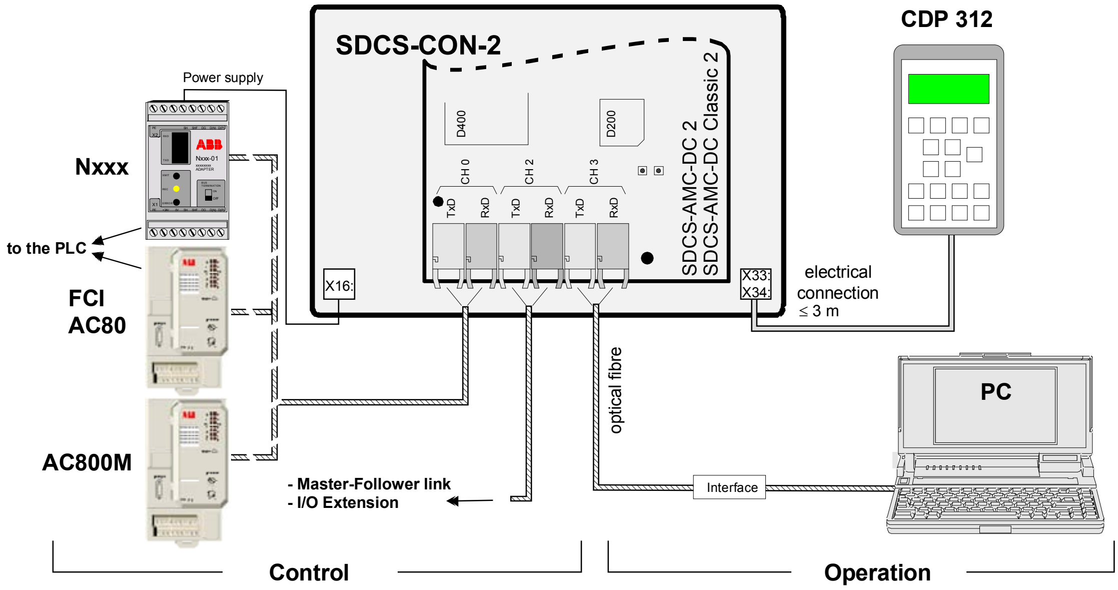


Fig. 2.5/6: Options for serial communication

Operation by panel

Panel location

There are different possibilities for mounting the panel:
- On the converter module.
- With CraneDrive door mounting kit.

LED Monitoring Display

If the CraneDrive door Mounting kit is used it is possible to insert up to three LED monitoring displays for indicating status as run, ready and fault and a selectable parameter indicator (0...150%) per drive. The display is connected to the SDCS-CON-2 board (X33:/X34:) or to the panel socket NDPI through a universal Modbus link.

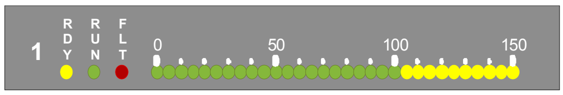


Fig. 2.5/7: LED Monitoring Display

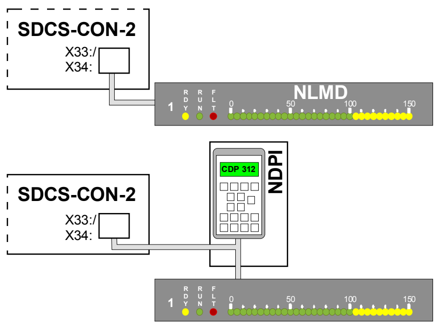


Fig. 2.5/8: Connection of the LED Monitoring Display

Panel (control and display panel)

The CDP 312 control and display panel communicates with the power converter via a serial connection in accordance with the RS 485 standard at a transmission rate of 9.6 kBaud. It is an option for the converter unit. After completion of commissioning, the panel is not necessarily required for diagnostic. The basic unit has a 7-segment display indicating errors.

Features

- 16 membrane pushbuttons in three function groups
- LCD display has four lines with 20 characters each
- Language: English
- Options for the CDP 312:
  – Cable to separate the panel from the converter.
  – Kit for mounting the panel in the cabinet door.

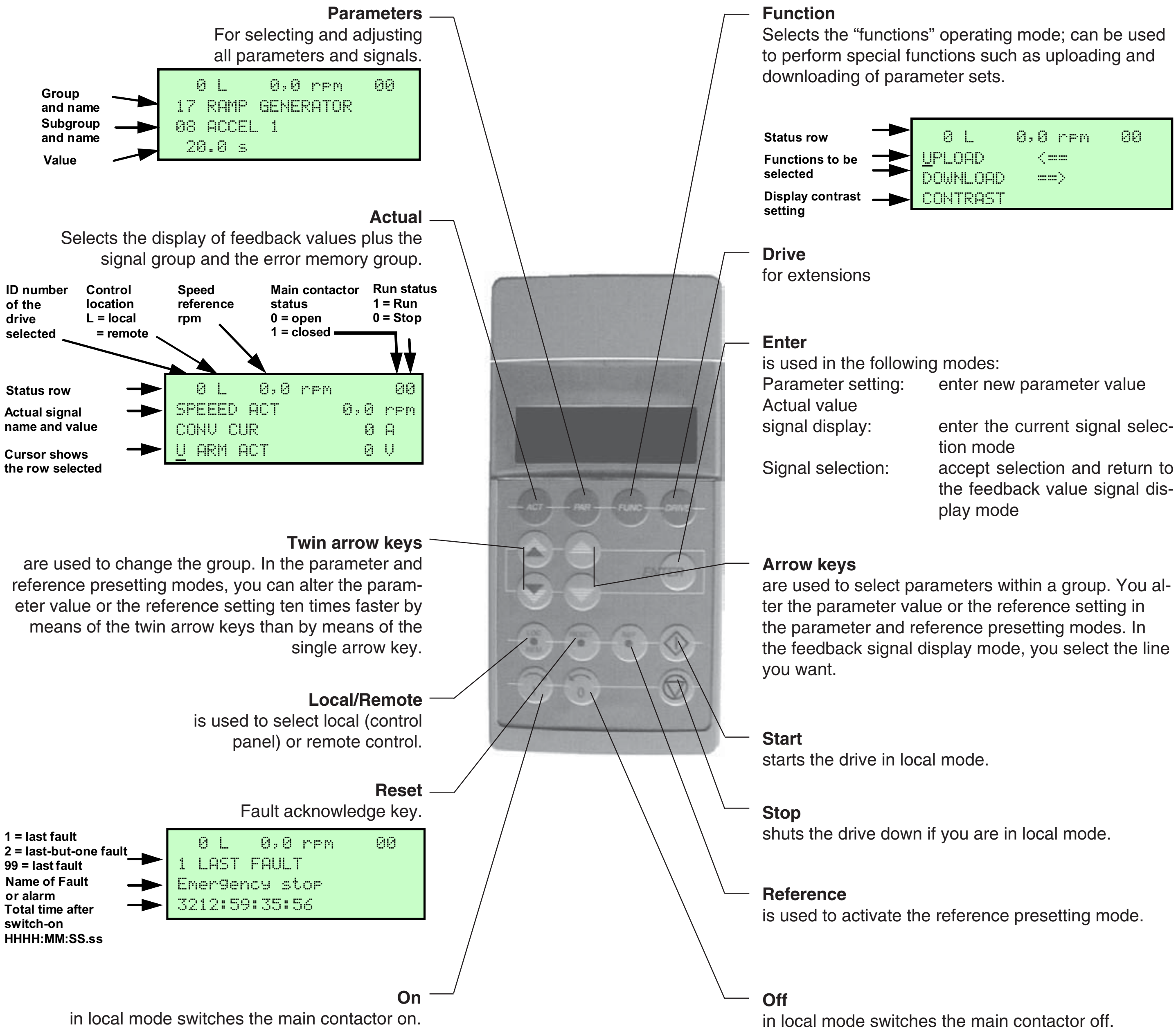


Fig. 2.5/9: Function keys and various displays on the removable control and display panel.

Operation by PC

Components required:

- Plastic optical fibre for distances up to 20 m.
- Network up to 200 drives (same as for ACS 600).
- HCS optical fibre cable up to 200 m.
  See separate manual *Configuration Instructions NDBU 85/95*; Doc no.: 3ADW000100.

Functionality:

- DriveWindow software package① for commissioning, diagnosis, maintenance and trouble shooting; structure of connections see *Technical Data*; Doc no.: 3ADW000165.

System requirements/recommendation:

- PC (IBM-compatible) with 486 processor or higher (min. 50 MHz).
- 8 MB RAM.
- DOS version 5.0 or later.
- Windows 3.1, 3.11, Windows95/98; Windows NT4.0.
- VGA monitor.
- CD-ROM drive.
- PCMCIA or ISA card slot.

In addition to the options provided by the CDP 312 control and display panel, there are further functions available, and these are described on the following page.

① For further information see the specific publications

Drive control

Components required:

- Plastic optical fibre for distances up to 15 m.
- Field bus module Nxxx-xx
- FCI (CI810)
- AC80 (PM825)
- AC800 M

Functionality:

Depends on the used module, interface e.g. to:

- PROFIBUS with NPBA-12
- MODBUS+ with NMBP-01
- AF100 with FCI (CI810)
- AC80 (PM825) or
- AC800 M
- further modules on request

You will find more detailed information on data exchange in the specific PLC or fieldbus module documentation.

Operation by PC (continued)

DriveWindow

DriveWindow is the most comprehensive commissioning and maintenance tool available for ABB products. DriveWindow is a PC tool designed for online commissioning and maintenance of ABB products. It provides several different displays to effectively and easily utilize the tool. DriveWindow is able to connect to various target devices through several different types of communication links.

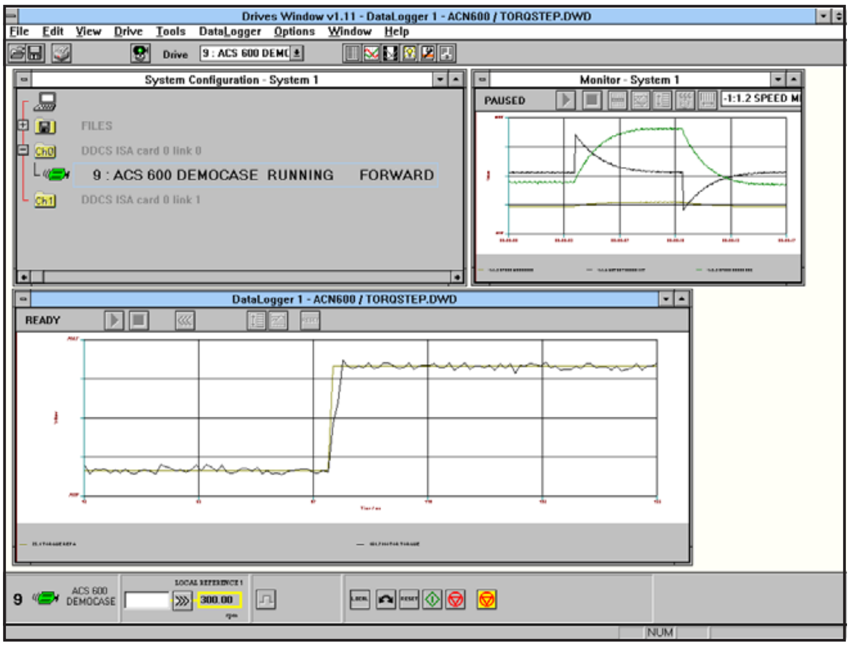


Fig. 2.5/10: Display of DriveWindow

System Configuration Display

The System Configuration Display provides an overview of the system as well as the type and status of each product connected to the communication link(s). Included in the System Configuration Display are previously saved files located on the hard drive of the computer. This display is built automatically by the DriveWindow by scanning the communication links to find the configuration of the system.

Drives Panel Display

The Drives Panel Display is used for controlling the operation of a selected drive within the system. You can control different drives by changing the target drive selection. The following commands are available with the Drives Panel:
- Start and Stop.
- Set speed reference.
- Change reference direction.
- Reset active fault.
- Change to Local/Remote control mode.

Signals and Parameters Display

The Signals and Parameters Display is used for handling signals and parameters of the target drive. The signal and parameter list is uploaded from the drive and can be viewed, saved to a file or compared to another parameter set. Previously set values can be downloaded to the active drive. You can also set the parameter values in either offline or online mode.

Monitor Display

The Monitoring Display is used for monitoring graphically the actual values of the target. The following functions are also supported:
- Zoom-in and Zoom-out
- Scaling the graphs
- Setting the sampling interval
- Setting the time window
- Triggering on specific conditions
- Signals from multiple drives can be displayed in the same view

Data Logger Display

The Data Logger Display provides facilities for viewing the contents of the data loggers in the drive. You can display the data in either graphical or numerical form as well as setting up the data logger triggering conditions.

Event Logger Display

The contents of the Event Logger can be viewed and cleared by using this display.

Fault Logger Display

The contents of the Fault Logger can be viewed and cleared by using this display.

Application Display

Application programs can be downloaded and debugged with this display.

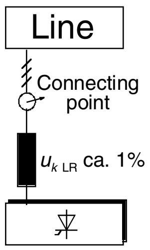
Please note:
For more information obout DriveWindow use the help function of the program.

Line reactors

For armature (DCS 600) and field (DCF 600) supply

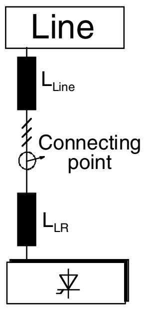
When power converters are operated with thyristors, the line voltage is short-circuited during commutation from one thyristor to the next. This operation causes voltage dips in the mains. For the connection of a power converter system to the mains, following configurations can be made:

Configuration A



When using the power converter, a minimum of 1% impedance is required to ensure proper performance of the snubber circuit. A line reactor can be used to meet this minimum impedance requirement. The value must therefore not drop below 1% u_k (relative impedance voltage). It should not exceed 10% u_k, due to considerable voltage drops.

Configuration B



If special requirements have to be met at the connecting point, different criteria must be applied for selecting a line reactor. These requirements are most often defined as a voltage dip in percent of the nominal supply voltage.
The combined impedance of Z_{Line} and Z_{LR} consists of the total series impedance of the installation. The ratio between the line impedance and the line reactor impedance determines the voltage dip at the connecting point. In such cases line reactors with an impedance of about 4% are used.

$$Voltage\,dip = \frac{Z_{Line}}{Z_{Line} + Z_{LR}} * 100\%$$

Example:
Maximum allowable voltage dip is 20% at the power converter's connecting point. Above equation used and changed to:

$$Z_{LR} = 4 * Z_{Line} \quad (1)$$

Since the line impedance is seldom known (it can be determined by means of a measurement), and the short-circuit power at the same point is more frequently available, the line reactor can be calculated by means of this value.

Assumption: The system's short-circuit power at the power converter's connecting point is 180 times the power converter's rated power.

- The system's relative impedance voltage u_k can be determined:

$$u_{k\,Line} = \frac{1}{180} * 100\% = 0.55\%$$

- In accordance with equation (1), the following applies for the line reactor:

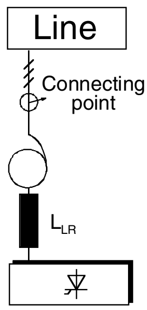
$$u_{k\,LR} = 4 * U_{K\,Line} = 2.2\%$$

- Since the line reactor has to be sized specific to the power converter, the relative variable U_k must be converted into an absolute value. For this purpose, use following equation:

$$u_k = \frac{I_{dN} * \sqrt{\frac{2}{3}} * \sqrt{3} * 2\pi * f_N * L_{LR}}{U_N}$$

I_{dN}: rated direct current of the converter
f_N: rated frequency of the system
U_N: rated line voltage
L_{LR}: line reactor inductance

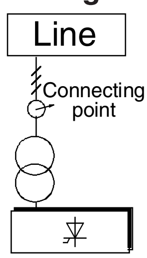
Configuration C



In the case of high power converter outputs or high currents, a power converter transformer must be used frequently to match the voltage. If an autotransformer is used for this purpose, a commutating reactor must additionally be used if special conditions must be complied with as per configuration B. The reason for this is that the u_k of commonly used autotransformers is generally too small. If you do not have special conditions of this kind, you must nevertheless check whether the u_k of the autotransformer concerned is sufficient to satisfy configuration A.

An examination of volume and costs results in the following configuration:

Configuration D



If an isolating transformer is used, it is often possible to comply with certain connecting conditions per configuration B without using an additional line reactor. The condition described in configuration A will then likewise be satisfied, since the u_k is >1 %.

With reference to the power converter:

- The line reactors listed in the table (2.6/1)
  - have been allocated to the converter's nominal current
  - are independent of converter's voltage classification; at some converter types the same line choke is used up to 690 V line voltage
  - are based on a duty cycle
  - can be used for DCS 600 as well as for DCF 600 converters
- The duty cycle taken into account varies from line choke to line choke and is between 80% and 100%. If the converter is sized on a duty cycle or is used for a drive running with high load all time like extruders do next steps to check the overall selection:
  - Calculate the I_{DCrms} based on the duty cycle and the motor current
  - Multiply the I_{rms} of the line choke by 1.2
  - In case I_{rms} is higher than I_{DCrms} the combination is okay
  - In case I_{rms} is lower than I_{DCrms} take the line choke used for the next bigger converter with the same voltage classification
- If the line choke should be used for a DCF 600 converter make sure the nominal field current doesn't exceed the thermal current of the choke. In case the field current is higher than I_{rms} of the line choke take the one used for the next bigger converter with the same voltage classification
- For units >2000 A or >690 V, we recommend using one isolating transformer per power converter as seem in configuration D.

Line reactors L1

DCS Type 400V-690V 50/60 Hz	Line choke type for **configur. A**	Fig.	Line choke type for **configur. B**	Design Fig.
DCS60x-0025-41/51	ND01	1	ND401	4
DCS60x-0050-41/51	ND02	1	ND402	4
DCS60x-0050-61	ND03	1	on request	-
DCS60x-0075-41/51	ND04	1	ND403	5
DCS60x-0100-41/51	ND06	1	ND404	5
DCS60x-0110-61	ND05	1	on request	-
DCS60x-0140-41/51	ND06	1	ND405	5
DCS60x-0200-41/51	ND07	2	ND406	5
DCS60x-0250-41/51	ND07	2	ND407	5
DCS60x-0270-61	ND08	2	on request	-
DCS60x-0350-41/51	ND09	2	ND408	5
DCS60x-0450-41/51	ND10	2	ND409	5
DCS60x-0450-61	ND11	2	on request	-
DCS60x-0520-41/51	ND10	2	ND410	5
DCS60x-0680-41/51	ND12	2	ND411	5
DCS601-0820-41/51	ND12	2	ND412	5
DCS602-0820-41/51	ND13	3	ND412	5
DCS60x-1000-41/51	ND13	3	ND413	5
DCS60x-0903-61/71	ND13	3	ND413	5
DCS60x-1203-41/51	ND14	3	on request	-
DCS60x-1503-41/51/61/71	ND15	3	on request	-
DCS60x-2003-41/51	ND16	3	on request	-
DCS601-2003-61/71	ND16 *	3	on request	-

* with forced cooling

Table 2.6/1: Line reactors (for more information see publication *Technical Data)*

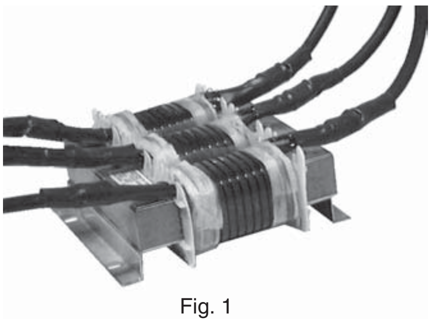


Fig. 1

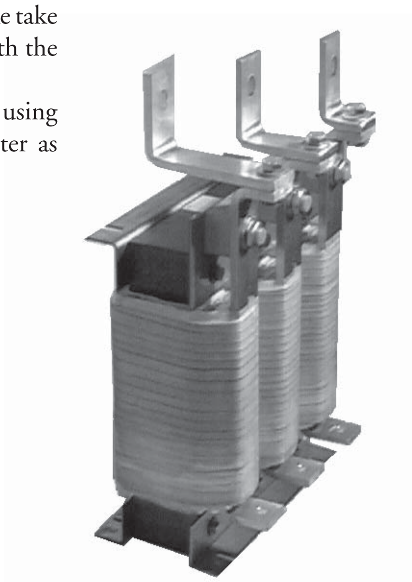


Fig. 3

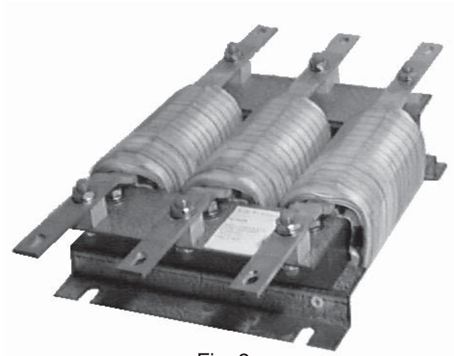


Fig. 2

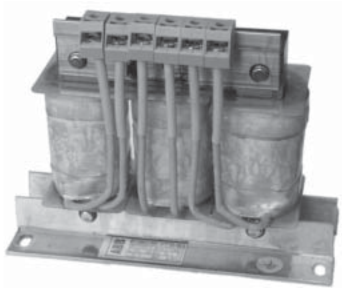


Fig. 4

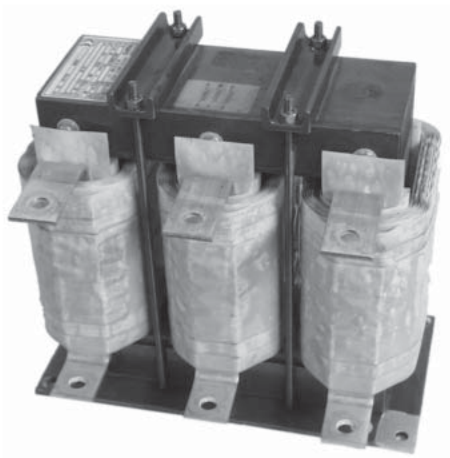


Fig. 5

General

Unit configuration

Protection elements such as fuses or overcurrent trips are used whenever overcurrents cannot entirely be ruled out. In some configurations, this will entail the following questions: firstly, at what point should which protective element be incorporated? And secondly, in the event of what faults will the element in question provide protection against damage?
Possible sources of faults are:

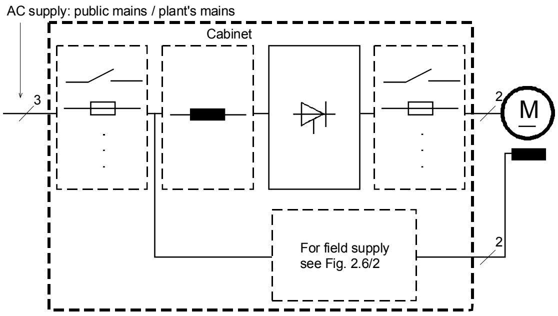


Fig. 2.6/1 Arrangement of the switch off elements in the armature circuit converter

Faults within the unit electronics

- Usually the coverter will limit the current. The maximum current corresponds to the set current limit. If this limitation or one of its components fails, then the current will often rise sharply.
  Output current $I >> I_{RATED}$; Fault: **1**
- If one or more false firing pulses are generated, e.g. due to component failures or other factors, then the current will likewise rise sharply.
  Output current $I >> I_{RATED}$; Fault: **2**
- If in 4-Q units thyristors of both bridges become conductive, circulating current is the consequence. The cause may be component defects or other factors. The current on the three-phase side will rise sharply.
  $I_{AC} >> I_{RATED}$; Fault: **3**

Defective system conditions leading to commutation failure

- In the case of regeneration, the ratio of motor voltage to line voltage rises above 1.05, which is followed by a situation called "shoot-through". The current rises substantially.
  Output current $I >> I_{RATED}$; Fault: 4
  Possible causes:
  - Network problems (line undervoltage).
  - Overspeed (load accelerates motor) or control error.
  - Field supply generates a field current larger than IF_{RATED} or control error in the field weakening range.

Faults caused by components

- Semiconductor faults can be, that a thyristor no longer fires (5a), or in that it is permanently conductive (5b). Depending on the system condition (4-Q operation, regeneration, etc.), these two cases will then show similar symptoms like cases 3 and 4.
  Faults: **5a, 5b**
- Insulation faults may occur within the cabling of the mains supply, the power converter and the motor. These can be subdivided into faults finally resulting in a short-circuit and those leading to an earth fault.
  - In the event of a short-circuit, the following generally applies: $I >> I_{RATED}$
  - In the event of an earth fault, depending on where the fault has occurred, the current may range between $I = I_{RATED}$ and $I >> I_{RATED}$.
  Fault: **6**

Fusing of the armature-circuit supply

The table below shows the fault cases in which semiconductor fuses (super fast) can protect the drive system consisting of motor and converter. Those cases marked (X) would protect the motor only, and not the converter.

Fault	Semiconductor fuses on the **AC** side	Semiconductor fuses on the **DC** side
1	X	(X)
2	X	(X)
3	X	
4		X
5a ⇒ 3	X	
5b ⇒ 4		X
6	X	X

Before deciding whether fuses are going to be used on the DC side, you must first check in which working points the drive is used and how often (proportion of time compared to the overall duration of operation).

Following general rule applies:
- Analogue systems are more sensitive and more vulnerable to malfunctions than digital systems.
- Digital systems are able to detect critical situations much easier and have features to prevent the equipment from being shut down.

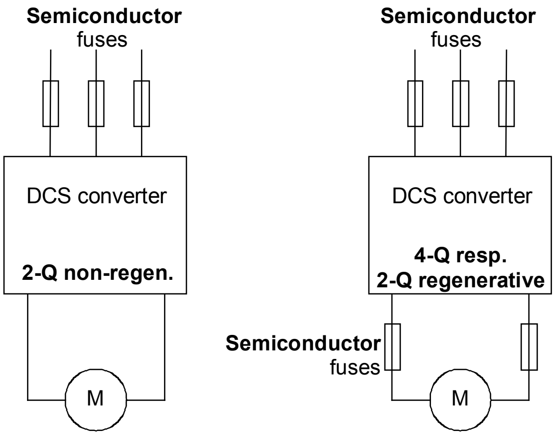
Conclusion for the armature supply

Due to cost saving standard fuses are used instead of the more expensive semiconductor fuses at some applications. Under normal and stable operating conditions, this is understandable and comprehensible, as long as cartain **fault scenarios can be ruled out**.

In the **event of a fault** , however, the saving may cause very high consequential costs. Exploding power semiconductors may not only destroy the power converter, but also **cause fires**.

Adequate protection against **short-circuit** and **earth fault**, as laid down in the **EN50178** standard, is possible only with **appropriate semiconductor fuses**.

ABB's recommendations



Complies with Basic Principles on:

1 – Explosion hazard	yes
2 – Earth fault	yes
3 – “Hard“ networks	yes
4 – Spark quenching gap	yes
5 – Short-circuit	yes
6 – 2-Q regenerative	yes

Fusing of the field supply

Basically similar conditions apply to both field supply and armature circuit supply. Depending on the power converter used (diode bridge, half-controlled bridge, fully controlled 4-Q bridge), some of the fault sources may not always be applicable. Due to special system conditions, such as supply via an autotransformer or an isolating transformer, new protection conditions have to be added.

In opposite to the armature circuit supply, fuses are **never** used on the DC side for the field supply, since a fuse trip might under certain circumstances lead to greater damage than the cause tripping the fuse in the first place (small, but long lasting overcurrent; fuse ageing; contact problems; etc.).

Fault 4 can also occur in the case of field supply units, but will not cause such a rapid and substantial current rise as encountered with the armature circuit supply. This is due to the significantly higher inductance of the field winding.

If conditions similar to those for armature circuit supply are to apply, like for example protection of the field supply unit and the field winding, then semiconductor fuses (super fast F3.1) must be used.

The following configurations are relatively frequent used:

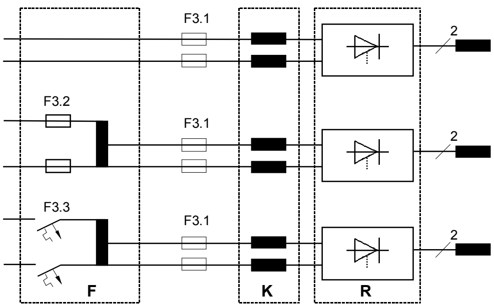


Fig 2.6/2 Configurations for field supplies

R Possible field supply units:
- SDCS-FEX-1: uncontrolled diode bridge; Fault: **5a, 6**
- SDCS-FEX-2: half-controlled bridge, 1-Q; Fault: **1, 5a, 6**
- DCF 503A: half-controlled bridge, 1-Q; Fault: **1, 5a, 6**
- DCF 504A: fully controlled bridge, 4-Q; Fault: **1, 3, 4, 6**

The faults listed here are described under “Aspects of fusing for armature circuits and field supplies”.

Note: in the case of 1, 4, and 6, the current is limited to relatively small overcurrents due to the ohmic content of the field winding, so that the fuses may not trip.

K See section *Line reactors*

F The F3.2 and F3.3 fuse types serve as line protectors and **cannot protect the field supply** unit. Only pure HRC fuses or miniature circuit breakers may be used. Semiconductor fuses would be destroyed by the inrush current.

Fuses F1 and fuse holders for armature and 3-phase field supply (DCS 600 - DCF 600)

The converter units are subdivided into two groups:

– Unit sizes C1 and C2/C2b with rated currents up to 1000 A require external fuses.
– In unit sizes A5 and C4 with rated currents up to 5150 A, the semiconductor fuses are installed internally (no additional external semiconductor fuses are needed).

The semiconductor fuses for C1 and C2/C2b unit sizes are blade fuses except 170M6166. The relevant data is listed in table 2.6/2.

The fuses' type of construction requires special fuse holders.

Type of converter	Manufacturer / Type	Fuse holder
DCS60x-0025-41/51	Bussman 170M 1564	OFAX 00 S3L
DCS60x-0050-41/51	Bussman 170M 1566	OFAX 00 S3L
DCS60x-0050-61	Bussman 170M 1566	OFAX 00 S3L
DCS60x-0075-41/51	Bussman 170M 1568	OFAX 00 S3L
DCS60x-0100-51	Bussman 170M 3815	OFAX 1 S3
DCS60x-0110-61	Bussman 170M 3815	OFAX 1 S3
DCS60x-0140-41/51	Bussman 170M 3815	OFAX 1 S3
DCS60x-0200-41/51	Bussman 170M 3816	OFAX 1 S3
DCS60x-0250-41/51	Bussman 170M 3817	OFAX 1 S3
DCS60x-0270-61	Bussman 170M 3819	OFAX 1 S3
DCS60x-0350-41/51	Bussman 170M 5810	OFAX 2 S3
DCS60x-0450-41/51/61	Bussman 170M 6811	OFAS B 3
DCS60x-0520-41/51	Bussman 170M 6811	OFAS B 3
DCS60x-0680-41/51	Bussman 170M 6813	OFAS B 3
DCS60x-0820-41/51	Bussman 170M 6813	OFAS B 3
DCS60x-1000-41/51	Bussman 170M 6166	3x 170H 3006

Table 2.6/2: Fuses and fuse holders (details see *Technical Data)*

Fuses F3.x and fuse holders for 2-phase field supply

Depending on the protection strategy different types of fuses are to be used. The fuses are sized according to the nominal current of the field supply. If the field supply is connected to two phases of the network, two fuses should be used. In case the unit is connected to one phase and neutral only the fuse in the phase can be used. Table 2.6/3 lists the fuses currents with respect to Fig. 2.6/2.

The fuses can be sized according to the maximum field current of the motor. In this case take the fuse, which fits to the field current levels of the motor.

Field conv.	Field current	F3.2	F 3.3
SDCS-FEX-1 SDCS-FEX-2	$I_F \leq 6$ A	OFAA 00 H10	10 A
SDCS-FEX-2	$I_F \leq 12$ A	OFAA 00 H16	16 A
SDCS-FEX-2 DCF 503A DCF 504A	$I_F \leq 16$ A	OFAA 00 H25	25 A
DCF 503A DCF 504A	$I_F \leq 30$ A	OFAA 00 H50	50 A
DCF 503A DCF 504A	$I_F \leq 50$ A	OFAA 00 H63	63 A
Type of protection elements		LV HRC type for 690 V; fuse hold. OFAX 00	circuit breaker for 500 V or 690 V

Table 2.6/3: Fuses and fuse holders for 2-phase field supply

Transformer T3 for field supply to match voltage levels

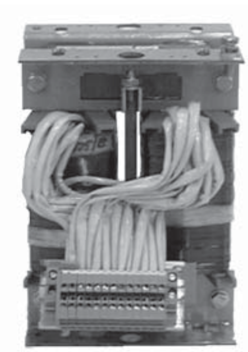


Fig. 2.6/3: T3 autotransformer

The field supply units' insulation voltage is higher than the rated operating voltage (see chapter *Field supply*). This provides the option in systems with more than 500 V to supply the armature of the converter directly from the mains. An autotransformer is used to match the field supply to its rated voltage. Moreover, you can use the autotransformer to adjust the field voltage (SDCS-FEX-1 diode bridge) or to reduce the voltage ripple. Different types (primary voltages of 400...500 V and of 525...690 V) with different rated currents are available.

Field converter type ≤500 V; 50/60 Hz	for field current I_F	Transformer type 50/60 Hz
		U_{prim} **≤500 V**
SDCS-FEX-1	≤6 A	T 3.01
SDCS-FEX-2	≤12 A	T 3.02
SDCS-FEX-2	≤16 A	T 3.03
DCF503A/4A-0050	≤30 A	T 3.04
DCF503A/4A-0050	≤50 A	T 3.05
		U_{prim} **≤600 V**
SDCS-FEX-1	≤6 A	T 3.11
SDCS-FEX-2	≤12 A	T 3.12
SDCS-FEX-2	≤16 A	T 3.13
		U_{prim} **≤690 V**
DCF503A/4A-0050	≤30 A	T 3.14
DCF503A/4A-0050	≤50 A	T 3.15

Table 2.6/4: Autotransformer data (details see *Technical Data)*

Line reactor

When using the SDCS-FEX-2 field power converter, you should additionally use a line reactor because of EMC considerations. A line reactor is not necessary for the SDCS-FEX-1 (diode bridge). In DCF 503A/504A field power converters a line reactor is already installed.

Converter ≤500 V; 50/60 Hz	**Reactor**
SDCS-FEX-2	ND 30

Table 2.6/5: Line reactor (details see *Technical Data)*

Electronic system / fan supply

The converter unit requires various auxiliary voltages. E.g. the unit's electronics require 115 V/1-ph or 230 V/1-ph. The unit fans require 230 V/1-ph or 400 V/690 V/3-ph, according to their size. The T2 auxiliary transformer is available to supply the unit's electronic system and the single-phase fans.

Auxiliary transformer T2

Input voltage: 380...690 V/1-ph; 50/60 Hz
Output voltage: 115/230 V/1-ph

Fig. 2.6/4: T2 auxiliary transformer

Earth fault monitor

An earth fault monitor is provided by the standard software. If needed, the analogue input AI4 has to be activated. A current signal of the three phase currents should be supplied to AI4 by a current transformer. If the addition of the three current signal is different from zero, a fault is generated (details see *Technical Data).*

EMC filters

The paragraphs below describe selection of the electrical components in conformity with the EMC Guideline.

The aim of the EMC Guideline is, as the name implies, to achieve electromagnetic compatibility with other products and systems. The guideline ensures that the emissions from the product concerned are so low that they do not impair another product's interference immunity.

In the context of the EMC Guideline, two aspects have to be considered:

- the product's **interference immunity**
- the product's actual **emissions**

The EMC Guideline expects EMC to be taken into account when a product is being developed. However, EMC cannot be designed in, it can only be quantitatively measured.

Note on EMC conformity

The conformity procedure is the responsibility of both the power converter's supplier and the manufacturer of the machine or system concerned, in proportion to their share in expanding the electrical equipment involved.

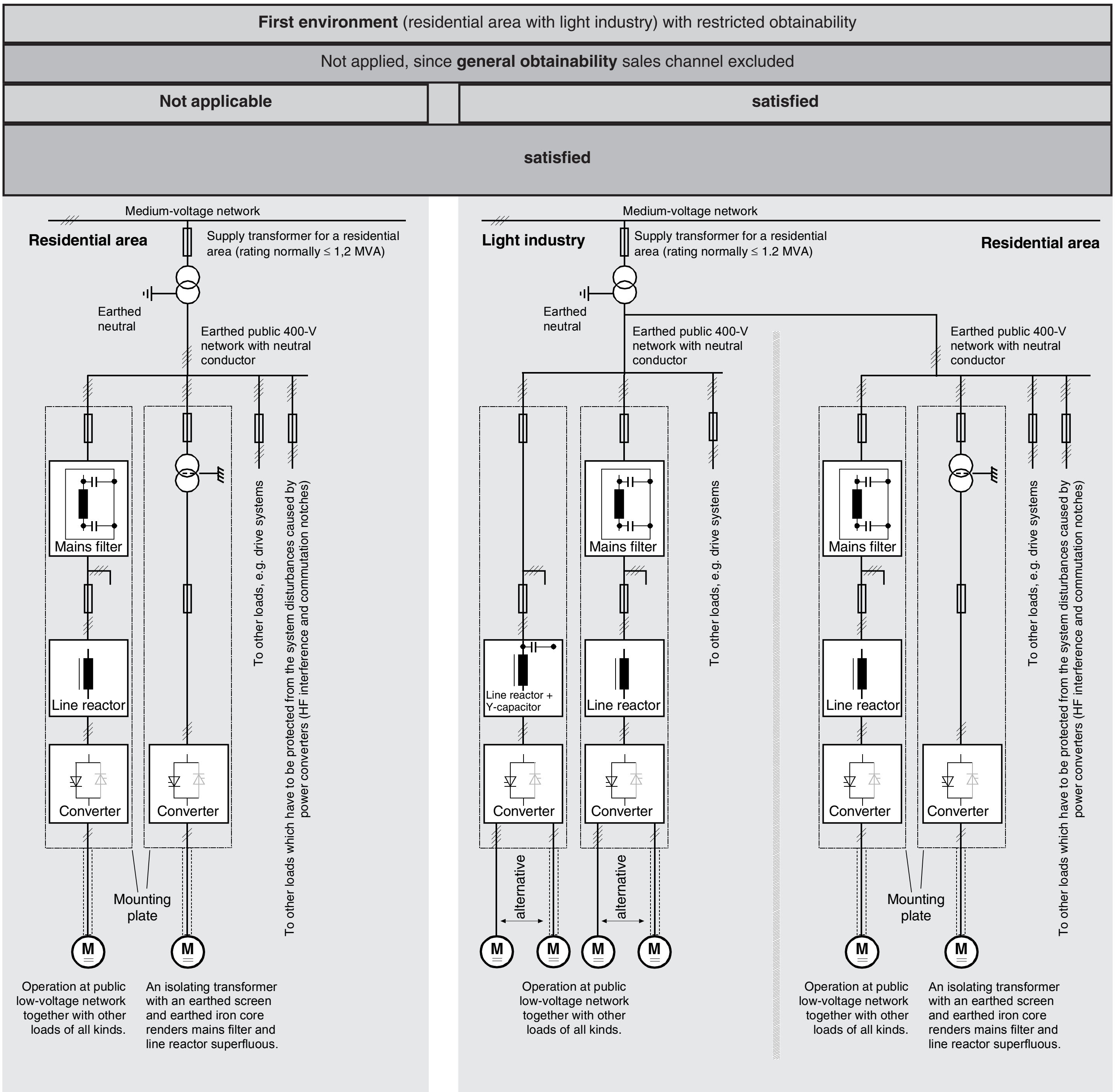


Fig. 2.6/5: Classification

For compliance with the protection objectives of the German EMC Act (EMVG) in systems and machines, the following EMC standards must be satisfied:

Product Standard EN 61800-3

EMC standard for drive systems (**P**ower**D**rive**S**ystem), interference immunity and emissions in residential areas, enterprise zones with light industry and in industrial facilities.

This standard must be complied with in the EU for satisfying the EMC requirements for systems and machines!

In cases where the product standard is not applied, the generic standards EN 50081 and EN 50082 are sometimes adduced.

For emitted interference, the following apply:

EN 50081-1 Specialised basic standard for emissions in **light industry** can be satisfied with special features (mains filters, screened power cables) in the lower rating range.

EN 50081-2 Specialised basic standard for emissions in **industry**

For emitted interference, the following apply:

EN 50082-1 Specialised basic standard for interference immunity in **residential areas**

EN 50082-2 Specialised basic standard for interference immunity in **industry**. The EN 61000-6-2 standard replaces EN 50082-2. If this standard is satisfied, then the EN 50082-1 standard is automatically satisfied as well.

Classification

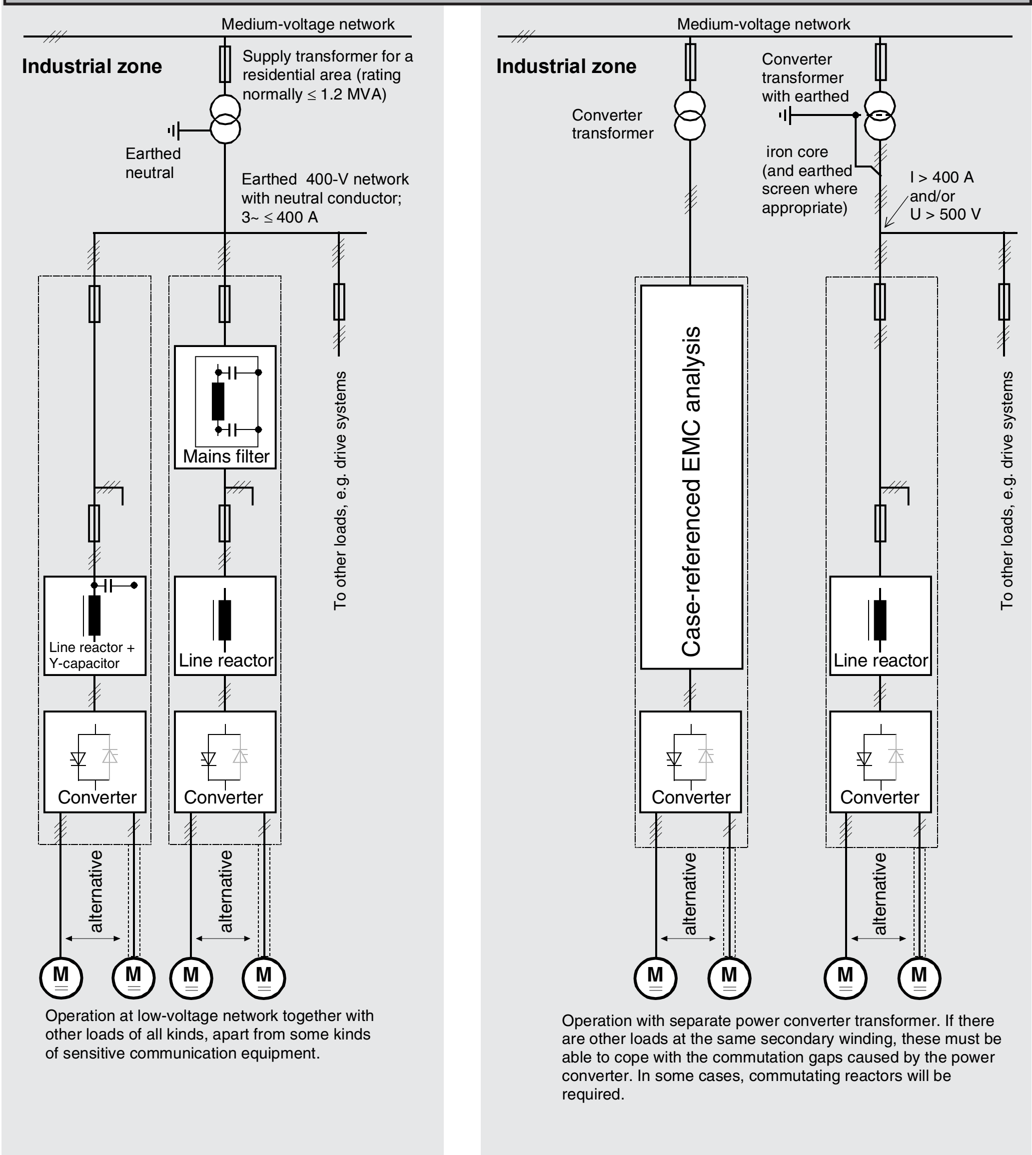
The following overview utilises the terminology and indicates the action required in accordance with Product Standard EN 61800-3

For the DCS 600 series, the limit values for emitted interference are complied with, provided the action indicated is carried out. This action is based on the term ***Restricted Obtainability*** used in the standard (meaning a sales channel in which the products concerned can be placed in the stream of commerce only by suppliers, customers or users which individually or jointly possess technical EMC expertise).

For power converters without additional components, the following warning applies:

This is a product with restricted obtainability under IEC 61800-3. This product may cause radio interference in residential areas; in this case, it may be necessary for the operator to take appropriate action (see adjacent diagrams).

			Standards
Second environment (industry) with restricted obtainability			**EN 61800-3**
Not applicable			**EN 50081-1**
satisfied	**on customer's request**	**satisfied**	**EN 50081-2**
satisfied			**EN 50082-2** EN 61000-6-2 **EN 50082-1**

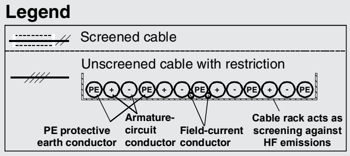


Operation at low-voltage network together with other loads of all kinds, apart from some kinds of sensitive communication equipment.

Operation with separate power converter transformer. If there are other loads at the same secondary winding, these must be able to cope with the commutation gaps caused by the power converter. In some cases, commutating reactors will be required.

The field supply is not depicted in this overview diagram. For the field current cables, the same rules apply as for the armature-circuit cables.

Legend



Filter in a grounded line (earthed TN or TT network)

The filters are suitable for grounded networks only, for example in public European 400 V networks. According to EN 61800-3 filters are not needed in insulated industrial networks with own supply transformers. Furthermore they could cause safety risks in floating networks (IT networks).

Three - phase filters

EMC filters are necessary to fulfill EN 50081 if a converter shall run at a public low voltage networks, in Europe for example with 400 V between the phases. Such networks have a directly earthed conductor. ABB offers suitable three-phase filters for 400 V and 25 A....600 A and 500 V filters for 440 V networks outside Europe.

Networks with 500 V to 1000 V are not public. They are local networks inside factories, and they do not supply sensitive electronics. Therefore converters do not need EMC filters if they run with 500 V and more.

Converter type	Rated DC current [A]	Filter type ❶ xxx = Voltage
DCS60x-0025-x1	25	NF3-xxx-25
DCS60x-0050-x1	50	NF3-xxx-50
DCS60x-0075-x1	75	NF3-xxx-64
DCS60x-0100-x1	100	NF3-xxx-80
DCS60x-0140-x1	140	NF3-xxx-110
DCS60x-0200-x1	200	NF3-xxx-320
DCS60x-0250-x1	250	NF3-xxx-320
DCS60x-0350-x1	350	NF3-xxx-320
DCS60x-0450-x1	450	NF3-xxx-600
DCS60x-0520-x1	520	NF3-xxx-600
DCS60x-0680-x1	610	NF3-500-600
DCS601-0820-x1	740	NF3-500-600
DCS602-0820-x1	820	NF3-690-1000
DCS60x-1000-x1	900	NF3-690-1000
DCS60x-0900-x1	900	NF3-xxx-1000
DCS60x-1200-x1	1200	NF3-xxx-1000
DCS60x-1500-x1	1500	NF3-xxx-1600
DCS60x-2000-x1	2000	NF3-xxx-1600
DCS60x-2500-x1	2500	NF3-xxx-2500

Filters 25... 2500 A are available for 440 V and 500 V.
Filters 600...2500 A are available for 690 V as well.

❶ The filters can be optimized for the real motor currents: $I_{Filter} = 0.8 \bullet I_{MOT\ max}$; the factor 0.8 takes the current ripple into account.

Table 2.6/6: Three-phase filters

Single-phase filters for field supply

Many field supply units are single-phase converters for up to 50 A excitation current. They can be supplied by two of the three input phases of the armature converter. In that case a field supply unit does not need its own filter.

If one phase voltage to neutral is taken (230 V in a 400 V network) then a separate filter is necessary. ABB offers such filters for 250 V and 6...30 A.

Converter type of field supply unit	DC current [A]	Filter type ❶ U_{max} = 250 V
SDCS-FEX-1	6	NF1-250-8
SDCS-FEX-2	8	NF1-250-8
SDCS-FEX-2	16	NF1-250-20
DCF 503A-0050	50	NF1-250-55
DCF 504A-0050	50	NF1-250-55
further filters for	12	NF1-250-12
	30	NF1-250-30

❶ The filters can be optimized for the real field currents: $I_{Filter} = I_{Field}$

Table 2.6/7: Single-phase filters

Commutation and line reactors

(see also Section ***Line reactors*** in this chapter)

Due to the maximum power of public 400 V transformers (P_{MAX} = 1.2 MVA ⇒ I_{MAX} = 1732 A) and due to their relative voltage drop of 6% or 4% the maximum AC current which is available for a converter is 346 A or 520 A ($I_{DC} \leq$ 422 A or 633 A).

Isolating transformers

An isolating transformer makes line chokes unnecessary because of its leakage inductance, and a grounded screen between its windings saves an EMC filter. The screen and the iron core must be well connected with the mounting plate of the converter.

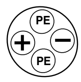
Converter transformers

A converter transformer transfers a high power directly from a medium voltage network to a single large converter or to a local low voltage network for several converters. Furthermore it acts as isolating transformer.

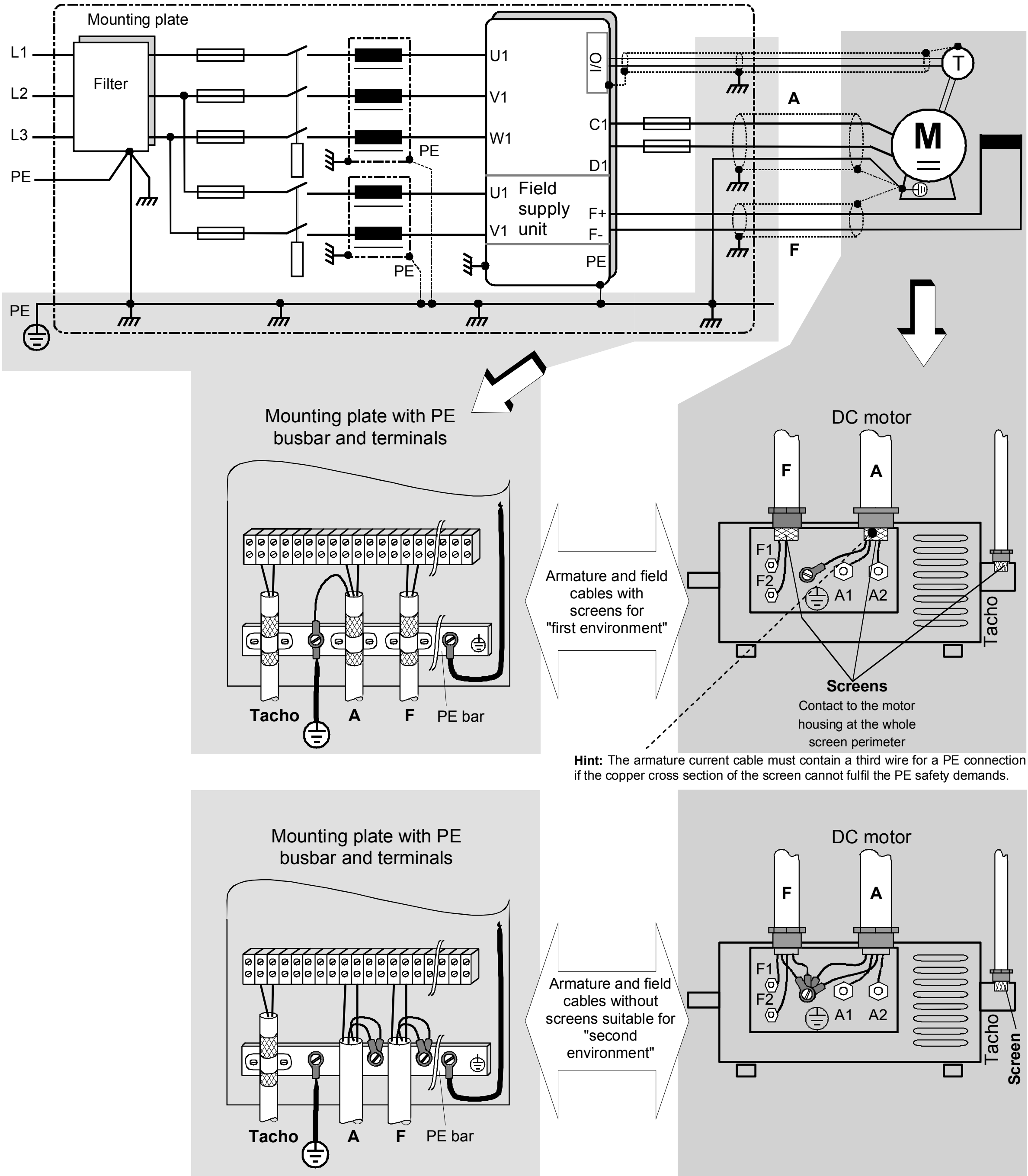
If such a converter transformer has no screen the EMC demands are nevertheless fulfilled in most cases, because the RF interference can hardly get via the medium-voltage network and the transformer of the public network to the loads which must be protected against disturbances.

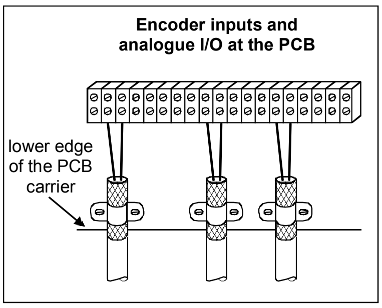
Installation hints

- All metal cabinets available on the market can be used.
- The mounting plate must be made from steel with zinc coating and without any painting. It must be connected with the PE busbar by several bolts/ cables.
- The converter, the line reactors, fuses, contactors and the EMC filter are to be placed on the mounting plate so that the connections are as short as possible, especially those from the converter via the line choke to the filter.
- The cables for digital signals which are longer than 3m and all cables for analogue signals must be screened. Each screen must be connected at **both** ends by metal clamps or comparable means directly on clean metal surfaces. In the converter cubicle this kind of connection must be made directly on the sheet metal close to the terminals.
- The necessity of a screen for power cables depends on the length of the cable and on the environmental demands. If a screen is necessary then it must be pressed by a well conducting metal clamp directly against the mounting plate or the PE busbar of the converter cabinet.
- Screened cables to the armature and to the excitation winding cause the lowest noise level. The armature current cable must contain a wire for a PE connection if the copper cross section of the screen cannot fulfil the safety demands.
- If a screen is not necessary the armature current cable must be a four-wire cable. Two wires are needed as PE to discharge the parasitic RF currents from the motor to the EMC filter in the cabinet.



Connection example in accordance with EMC





Important hint:
The example shows the principle structure of a DC drive and its connections. It is a not binding recommendation, and it cannot take all conditions of a plant into account. Therefore each drive must be considered individually and with respect due to its special application. Additionally the general installation and safety rules must be taken into account.

Fig. 2.6/6: Connection example in accordance with EMC

3 Overview of crane software

3.1 Basic structure of DCS 600 CraneDrive

The control hardware of DCS 600 CraneDrive consists of 2 parts:

- converter control board SDCS-CON-2
- drive control board SDCS-AMC-DC 2
  (AMC = **A**pplication **M**otor **C**ontrol)

Accordingly, the software is split into 2 parts:

- All control functions superimposed to the torque reference are done inside the AMC board. In addition, all HMI (Human Machine Interface) and communication functions are part of the AMC board's software. Also the Start/Stop functions ('Drive Logic') are realized by the AMC board's software. All parameters and signals of the drive are accessed via an AMC board residing data structure called 'AMC-table'.

- All converter related functions and the handling of standard I/O are done by the SDCS-CON-2 software:
  • Armature current control
  • Field weakening
  • Motor protection
  • I/O handling

In general, the software functions are distributed between the SDCS-CON-2 board and the SDCS-AMC-DC 2 board according to the following diagram:

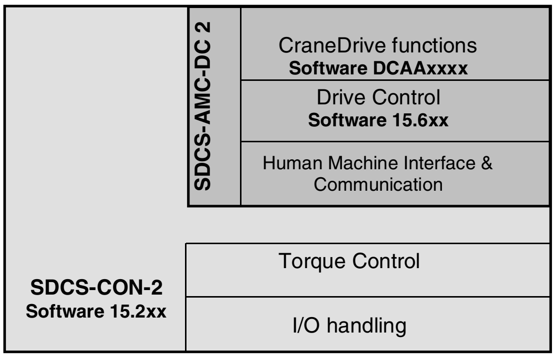


Fig. 3.1/1: Distribution of software functions

3.2 Control modes

The Control mode selects the source of control word and references.

Local Mode

Commissioning tool DriveWindow is connected to DDCS channel 3 of the AMC board and can use local mode.
Local mode is also available on the panel CDP 312.

Fieldbus Mode

Reference and control word are supplied by an overriding control system, Advant controller or a fieldbus adapter connected to the DDCS channel 0. This control mode enables also the functionality of shared motion control bit (two motors controlled by one converter).

Stand-alone Mode

Reference and control signals are supplied by hardware signals.

Master/Follower Mode

Reference and control word are supplied to the follower drive by the master drive via DDCS channel 2.

3.3 Start, Stop and Fault Reactions

Power up

When the electronics power supply is switched on the drive remains in the ON_INHIBIT state until electrical disconnect input (DI4) is closed. In case of a fault the drive remains in the FAULT state.

Normal start

Status bit RDY_FOR_ON = 1 signals that no faults are pending and that the device is ready to close the main, fan and field contactor.
The command DRIVE ON = 1 closes fan, field and main contactor and activates the field control.
In stand-alone control mode the ON command is generated internally by the first rising edge of the RUN command (direction + reference).
Status bit RDY_FOR_RUN = 1 indicates that the field converter is active and that the drive is ready to generate torque.
The command START OVR = 1 activates speed and torque control.
Status bit RUNNING = 1 indicates that the drive is in normal operation.

Normal stop

START OVR = 0 sets the speed reference to zero and the drive decelerates by ramp.
After the actual speed has reached zero the status bit RUNNING is reset, the armature converter sets the firing angle to maximum. The state RDY_FOR_RUN is entered, when the current has reached zero.
ON = 0 sets RDY_FOR_RUN = 0 and the field current reference to zero. The field converter sets the firing angle to maximum. The contactors open, when the current has reached zero.
ON = 0 internally forces RUN = 0.

Electrical Disconnect (Stop category 0)

Field and armature current are removed as fast as possible. After the current has reached $I_{DC} = 0$ the contactors are opened. The normal DRIVE ON command is accepted when ELEC DISC-N = 1.

Fault reaction

Depending on the actual fault the armature current and/or field current is reduced to zero as fast as possible with single pulses and maximum firing angle. Contactors are opened when the current has reached zero.
The state TRIPPED is entered and after a successful reset the state ON_INHIBIT.

3.4 Crane functions

Optimal Operational Safety

Mechanical Brake: Controls and supervises the opening and closing of the brake.

Fast Stop: Stops the drive as fast as possible. When stopped, movement in the opposite direction to the fault is possible e.g. external detection for overload or slack rope.

Torque Proving: Ensures that the motor is able to produce torque before brake is lifted.

Speed Monitor: Supervises actual motor speed to be within given limits. It also detects overspeeds and zero speed for control interlocks.

Torque Monitor: Supervises the correlation between requested speed & actual motor speed and direction.

Fault Handling: Monitors internal faults, identifies possible causes and presents fault history.

Outstanding Crane Drive Performance

Start and Stop: Supervising and control logic for starting and stopping the drive, including torque proving.

Speed Reference: Individual settings of acceleration and deceleration ramp times. For smooth load handling and reduction of 'shock' loading.

Speed and Torque: Ensures a minimum variation of speed independently of the load.

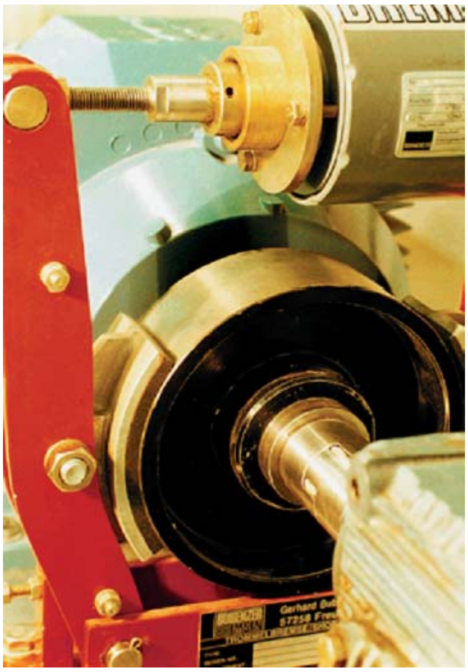
Torque Memory: Presetting of torque when starting the hoist with suspended load. The risk of load drop is thereby minimized.

Power Optimization: Automatic field weakening of hoist drive. Ensures maximum hoist speed relative to the load and thus optimizes cycle times.

Master Follower: Facilitates load sharing of two motors on the same shaft. Can also be used when dual-redundancy is required.

Speed Correction: Coordination of two drives from an external control system. Input for correction of speed error when used in synchronized operations.

Shared Motion: One DCS 600 CraneDrive is able to handle two different motors (of two different motions) including the different field windings and brakes.



3.5 Speed Control

The speed controller is located in the AMC board software.

Speed reference

The source of the reference is depending on the operating mode.

Overriding control system, fieldbus adapters	➔ remote mode, DDCS via AMC board
DriveWindow	➔ local mode, DDCS via AMC board
Panel CDP312	➔ local mode, connector on CON-2
Analogue inputs	➔ local I/O

Speed reference features

- Speed reference limiter
- Variable slope rate
- Speed correction

Speed measurement

The actual speed may be calculated from:

- Armature voltage
- Analogue tachometer
- Pulse encoder

Controller features

- PID controller
- Window control
- Acceleration compensation
- Speed and torque adaptation
- Droop
- Additional torque references
- Torque limitation and gear backlash function (the integral part of the controller is set to a suitable value on limitation)
- Oscillation damping (band rejection filter for speed error)

The diagram Fig. 3.9/2 shows the functionality of the speed reference chain as well as of the speed controller.

3.6 Torque Control

Flux and Torque Calculation

The torque control is in general an open loop control. The flux is adjusted by the field current. The reference of the field current is generated by the superimposed armature voltage control.
The torque is adjusted by the armature current. The conversion from torque to current reference is done by means of the calculated flux (based on the field current and saturation characteristic).

Torque reference features

- Torque reference A with 1st order filter and load share
- Torque reference B with torque ramp
- Torque reference limiter
- Torque step

A good behaviour in the field weakening requires speed measurement by tachometer or encoder.

A simplified scheme of the torque reference chain is given in diagram fig. 3.9/2.

3.7 HMI (Human Machine Interface)

The HMI is performed by CDP 312 control panel or by DriveWindow.
Both tools contain:

- Display of drive signals
- Setting of drive parameters
- Display fault and alarm messages
- Control the drive in local operation

3.8 Torque Generation

Interface between SDCS-AMC-DC 2 board and DC control board SDCS-CON-2

The major signals exchanged each 2 ms between CON-2 and AMC-DC 2 are:

SPEED_ACTUAL	speed actual value from CON-2
TORQ_USED_REF	active torque reference to CON-2

In addition, the calculated torque limits are read from the CON-2 each 8 ms:

TC_TORQMAX
TC_TORQMIN

Armature voltage Control

This controller enables operation in the field weakening range. It generates the field current reference. At low speeds the field current is constant and armature voltage is roughly proportional to the speed. At higher speeds (≥ base speed) the field current reference is reduced so that the armature voltage doesn't exceed its reference.

Field Current Control

Two field exciters can be operated simultaneously for two different motors.
The first field exciter can be operated with fixed current reference, in field weakening or with a reduced reference for field heating.
The second field exciter has a fixed current reference (no field weakening possible). However, it may be reduced for field heating purposes.
A field reversal control is available for the first field exciter.
Optitorque is a special control method where the flux is reduced at small torque reference. This is available for drives with and without field reversal.

Armature Current Control

The armature current reference is calculated from torque reference and flux. Then it is processed by a ramp, limitation and speed dependent limitation.
The actual value of the armature current is the measured mean value between two firing pulses.
The armature voltage reference is generated by a PI controller.
The firing angle is calculated from this voltage reference depending on the actual line voltage and the conduction time (adaptation between continuous and discontinuous state of the converter current).

A simplified scheme of the armature current control is given in diagram fig. 3.9/3.

3.9 Software diagrams

Introduction

The designation of parameters and signals consist of a group and an index.

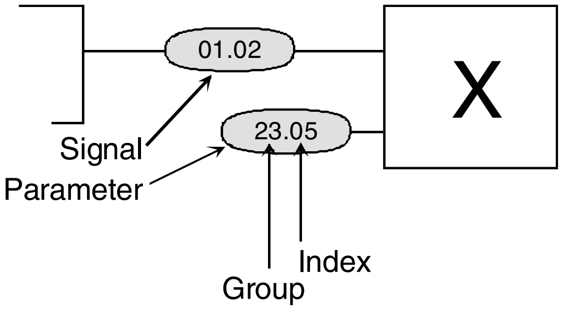
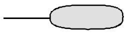


Fig. 3.9/1: Parameter/signal designation

An empty box  means: This signal does not exist or can not be displayed by the CraneDrive software.

The structure of the software is given. Changes of the functions or pointers are realized through setting parameters.

This can be done via panel, DriveWindow (PC utility), fieldbus or overriding control system.

Changed parameters or pointers are stored immediately in the non-volatile flash PROM.

All parameters can be transferred to the PC and be stored on a data medium by using the PC program DriveWindow.

On the following pages the simplified software structure is shown.

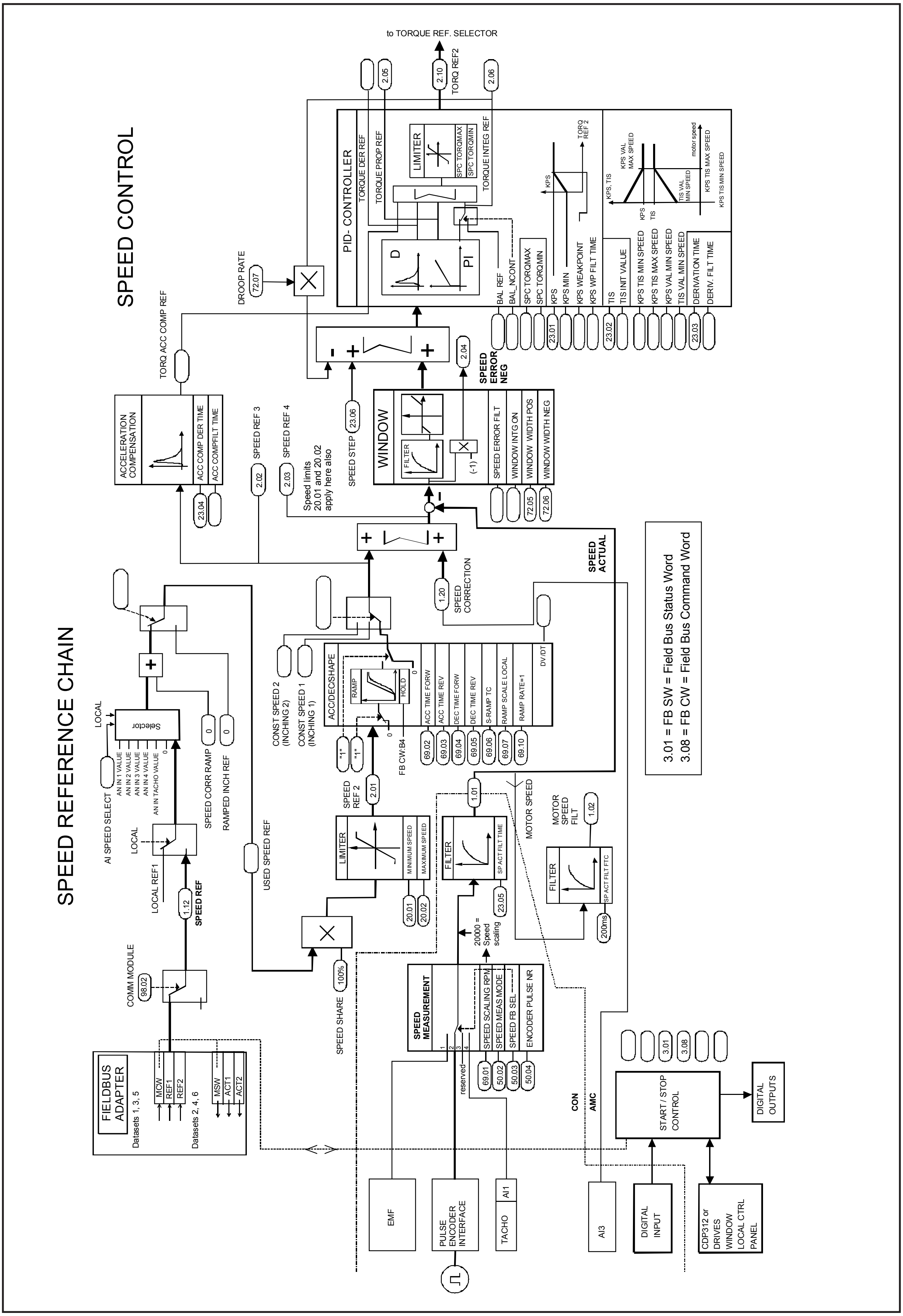


Fig. 3.9/2: Speed reference chain

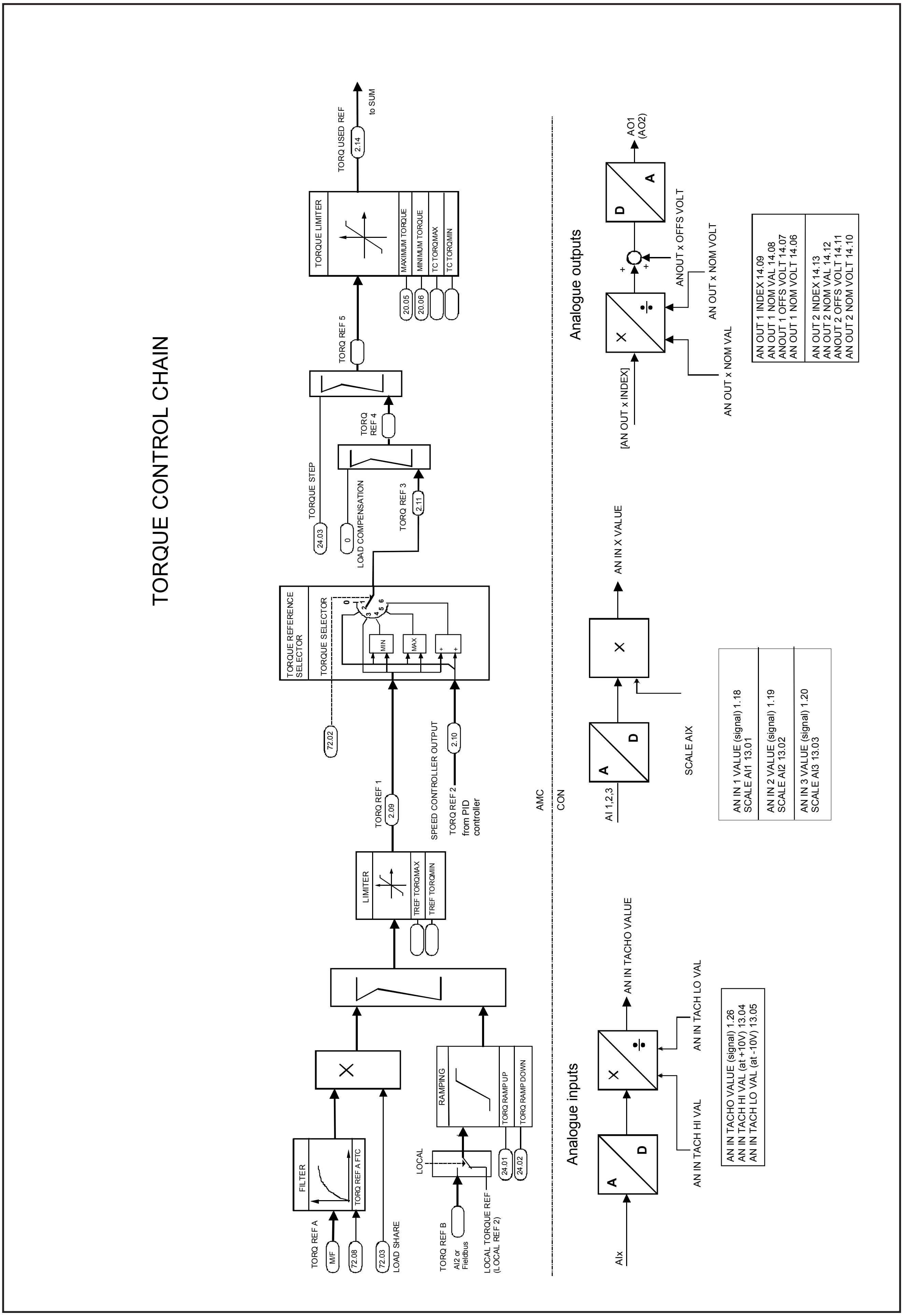


Fig. 3.9/3: Torque control chain

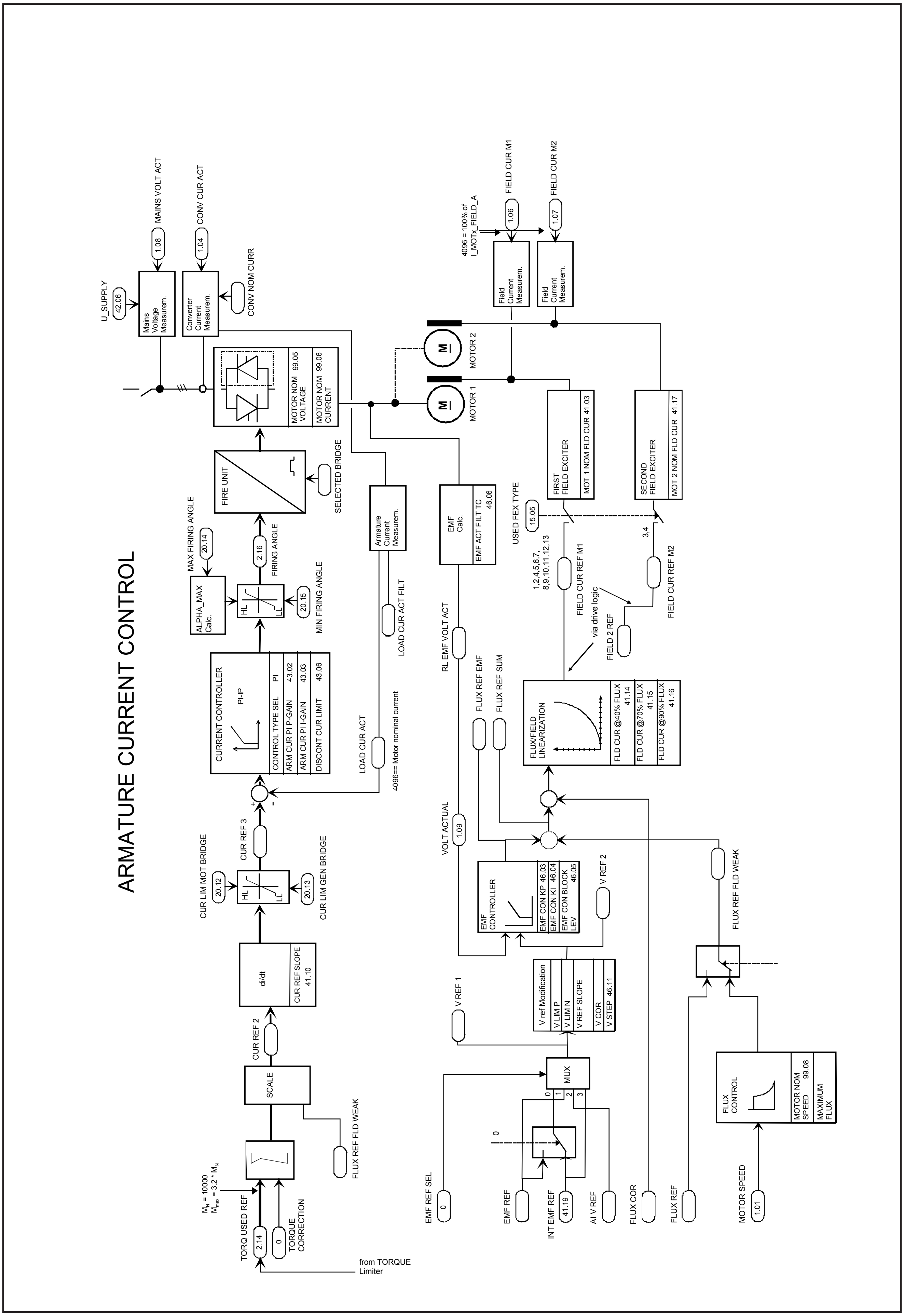


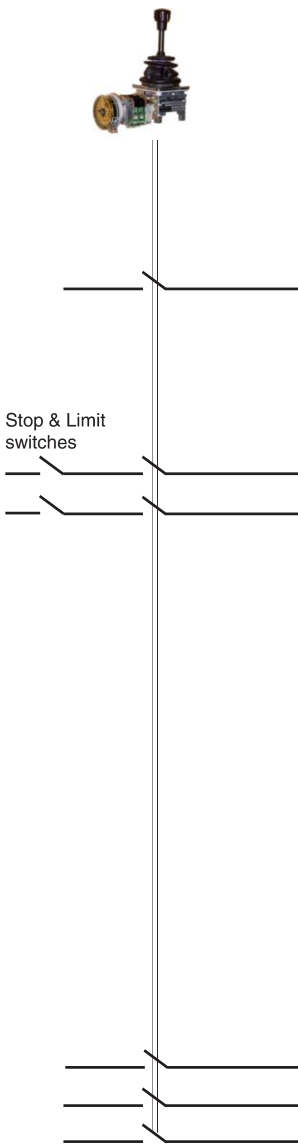
Fig. 3.9/4: Armature current control

4 Connection examples

4.1 Control connections

I/O configuration example for step joystick operation

64.1 ⇨ Stand-alone
64.10 ⇨ Step Joystick



Inputs/outputs

Depending on the drive modes there are different possibilities for inputs and outputs.

Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-CON-2			
DI 1	ACK_C_FAN	fix	Converter fan acknowledge
DI 2	DI 2	configurable	Zero position
DI 3	ACK_M_CONT	fix	Main contactor acknowledge
DI 4	DI 4	fix	Electrical disconnect
DI 5	DI 5	fix	Funct. depends on SW rel.
DI 6	DI 6	configurable	Brake acknowledge
DI 7	DI 7	fix	Start Direction A
DI 8	DI 8	fix	Start Direction b

Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-IOE-1			
DI 9	DI 9	configurable	Fast STOP N Overload Slow down N ..... see Group 10
DI 10	DI 10		
DI 11	DI 11		
DI 12	DI 12		
DI 13	DI 13		Step ref 1
DI 14	DI 14		Step ref 2
DI 15	DI 15		Step ref 3

Digital Outputs			
Output	**Signal**	**use**	**Description**
DO 1	FANS_ON	fix	Command fan contactor ON
DO 2	FIELD_EX_ON	fix	Comm. Field exciter cont. ON
DO 3	MAIN_CONT_ON	fix	Comm. Main contactor ON
DO 4	DIG_OUT 4	default	Brake lift
DO 5	DIG_OUT 5	default	Watchdog N
DO 6	DIG_OUT 6	configurable	Ready Running Fault ... see Group 14
DO 7	DIG_OUT 7		
DO 8	DIG_OUT 8		

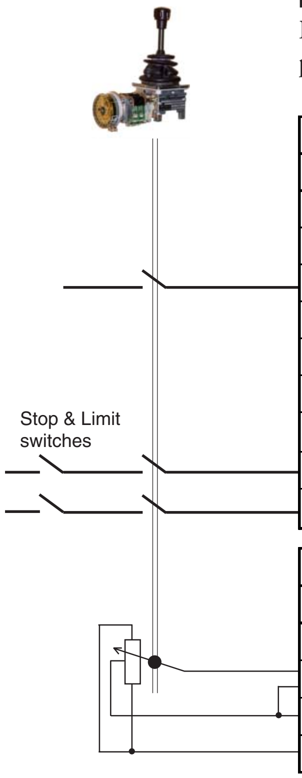
Table 4.1/1: I/O configuration step joystick

I/O configuration example for pot joystick operation

64.1 ⇨ Stand-alone
64.10 ⇨ Joystick

Inputs/outputs

Depending on the drive modes there are different possibilities for inputs and outputs.



Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-CON-2			
DI 1	ACK_C_FAN	fix	Converter fan acknowledge
DI 2	DI 2	configurable	Zero position
DI 3	ACK_M_CONT	fix	Main contactor acknowledge
DI 4	DI 4	fix	Electrical disconnect
DI 5	DI 5	fix	Funct. depends on SW rel.
DI 6	DI 6	configurable	Brake acknowledge
DI 7	DI 7	fix	Start Direction A
DI 8	DI 8	fix	Start Direction b

Analogue Inputs			
Input	**Signal**	**use**	**Description**
SDCS-CON-2			
AI 1	SPEED_REF	fix	Speed reference
0 V			
+10 V			

Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-IOE-1			
DI 9	DI 9		
DI 10	DI 10		
DI 11	DI 11		
DI 12	DI 12	configurable	Fast STOP N Overload Slow down N ..... see Group 10
DI 13	DI 13		
DI 14	DI 14		
DI 15	DI 15		

Digital Outputs			
Output	**Signal**	**use**	**Description**
DO 1	FANS_ON	fix	Command fan contactor ON
DO 2	FIELD_EX_ON	fix	Comm. Field exciter cont. ON
DO 3	MAIN_CONT_ON	fix	Comm. Main contactor ON
DO 4	DIG_OUT 4	default	Brake lift
DO 5	DIG_OUT 5	default	Watchdog N
DO 6	DIG_OUT 6		
DO 7	DIG_OUT 7	configurable	Ready Running Fault ... see Group 14
DO 8	DIG_OUT 8		

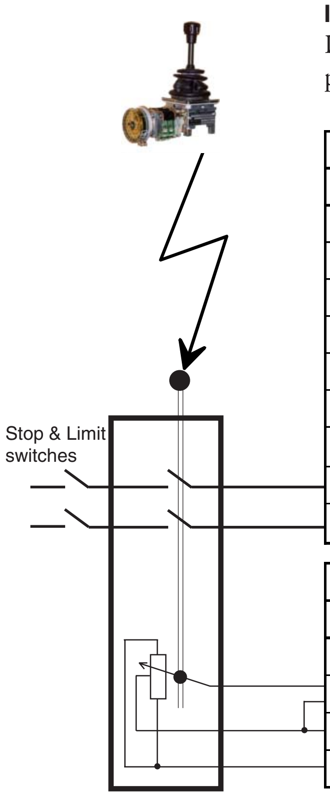
Table 4.1/2: I/O configuration pot joystick

I/O configuration example for radio control operation

64.1 ⇨ Stand-alone
64.10 ⇨ Radio Joystick

Inputs/outputs

Depending on the drive modes there are different possibilities for inputs and outputs.



Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-CON-2			
DI 1	ACK_C_FAN	fix	Converter fan acknowledge
DI 2	DI 2	configurable	
DI 3	ACK_M_CONT	fix	Main contactor acknowledge
DI 4	DI 4	fix	Electrical disconnect
DI 5	DI 5	fix	Funct. depends on SW rel.
DI 6	DI 6	configurable	Brake acknowledge
DI 7	DI 7	fix	Start Direction A
DI 8	DI 8	fix	Start Direction b

Analogue Inputs			
Input	**Signal**	**use**	**Description**
SDCS-CON-2			
AI 1	SPEED_REF	fix	Speed reference
0 V			
+10 V			

Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-IOE-1			
DI 9	DI 9	configurable	Fast STOP N Overload Slow down N ..... see Group 10
DI 10	DI 10		
DI 11	DI 11		
DI 12	DI 12		
DI 13	DI 13		
DI 14	DI 14		
DI 15	DI 15		

Digital Outputs			
Output	**Signal**	**use**	**Description**
DO 1	FANS_ON	fix	Command fan contactor ON
DO 2	FIELD_EX_ON	fix	Comm. Field exciter cont. ON
DO 3	MAIN_CONT_ON	fix	Comm. Main contactor ON
DO 4	DIG_OUT 4	default	Brake lift
DO 5	DIG_OUT 5	default	Watchdog N
DO 6	DIG_OUT 6	configurable	Ready Running Fault ... see Group 14
DO 7	DIG_OUT 7		
DO 8	DIG_OUT 8		

Table 4.1/3: I/O configuration radio joystick

I/O configuration example for fieldbus operation (Fieldbus Mode)

64.1 ⇨ Not Stand-alone
98.2 ⇨ Fieldbus or overriding control system

Inputs/outputs

Depending on the drive modes there are different possibilities for inputs and outputs.

PLC

Command Word
Data set 1 word 1

Bit number	Signal	Description
0 = Bit 0, LSB	COMTEST REC	Comtest receive bit
1	DRIVE ON	Drive ON from overriding control
2	HIGH SPEED	High speed select
3	START OVR	Start from overriding control
4	RAMP HOLD	Ramp holding signal
5	SEPARATE	Separate ctrl select signal (M/F ctrl)
6	TORQ CTRL	Torquecontrol select signal
7	LOAD MEAS SEL	Load measurement select (enable LOAD MEAS REF)
8	RESET OVR	Reset from overriding control
9	FAST STOP 1	Fast stop 1
10	FAST STOP 11	Fast stop 11 type select
11	PGM SYNC	Program synchronization of pos meas.
12	HW SYNC	Hardware synchronization inhibit
13	RESET SYNC READY	Reset synchronization ready
14	USER MACRO CHANGE	Shared motion Motor1/Motor2 change request
15 = Bit 15, MSB	not used	

Speed reference
Data set 1 word 2

Fiedbus

Digital Inputs			
Input	**Signal**	**use**	**Description**
SDCS-CON-2			
DI 1	ACK_C_FAN	fix	Converter fan acknowledge
DI 2	DI 2	configurable	
DI 3	ACK_M_CONT	fix	Main contactor acknowledge
DI 4	DI 4	fix	Electrical disconnect
DI 5	DI 5	fix	Funct. depends on SW rel.
DI 6	DI 6	configurable	Brake acknowledge Motor 1
DI 7	DI 7	configurable	
DI 8	DI 8	configurable	Brake Acknowledge Motor 2 *

Status Word
Data set 2 word 1

Bit number	Signal	Description
0 = Bit 0, LSB	RDY FOR ON	Ready for on
1	ELEC DISC-N	Electrical disconnect, DI4
2	RDY FOR RUN	Ready for run
3	RUNNING	Running
4	ZERO SPEED	Zero speed
5	REM LOC	Remote / local (1=Remote)
6	TORQ PROV OK	Torque proving OK
7	USER 1 OR 2	Motor 1 or 2 active
8	FAULT	Fault
9	WARNING	Warning
10	LIMIT	Drive in torque limit
11	SYNC	Sync input (e.g. DI7)
12	SYNC RDY	Synchronization ready
13	BRAKE LONG FTIME	Brake long falling time indication
14	COMTEST TRA	Communication test transmit bit
15 = Bit 15, MSB	SNAG LOAD	Snag load indication

Actual Speed
Data set 2 word 2

Digital Outputs			
Output	**Signal**	**use**	**Description**
DO 1	FANS_ON	fix	Command fan contactor ON
DO 2	FIELD_EX_ON	fix	Comm. Field exciter cont. ON
DO 3	MAIN_CONT_ON	fix	Comm. Main contactor ON
DO 4	DIG_OUT 4	default	Brake lift Motor 1
DO 5	DIG_OUT 5	default	Watchdog N
DO 6	DIG_OUT 6	configurable	Brake lift Motor 2 * Ready Running Fault ... see Group 14
DO 7	DIG_OUT 7		
DO 8	DIG_OUT 8		

Table 4.1/4: I/O configuration fieldbus or overriding control system

* for shared motion application

Master/Follower

Master/Follower is normally a load sharing application. It is designed for applications running two DCS 600 CraneDrives being coupled by a motor shaft via gears, rails, etc.

The Master/Follower application is controlling the load distribution between the two drives. The Master is sending control signals and references (e.g. speed or torque) through the Master/Follower link to the Follower. The Master is also reading back status information from the Follower to ensure a safe operation.

The Master/Follower application can be used for both hoist and travel motions, as well as in fieldbus mode and stand-alone mode.

The Master is speed controlled and the Follower is normally torque controlled.

This feature is useful for:

- Hoist drive - operation on one drum
  - ⇨ use Follower torque controlled
- Travel drive - weak mechanical connection
  - ⇨ use Follower window controlled
- Redundancy purpose
  - ⇨ use emergency parameter set handled by user macro

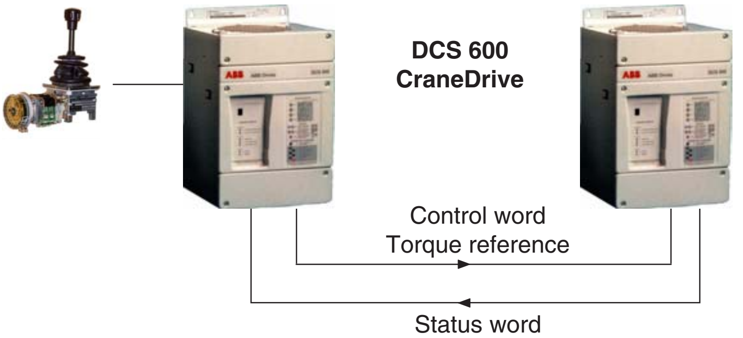


Fig 4.1/1: Master Follower

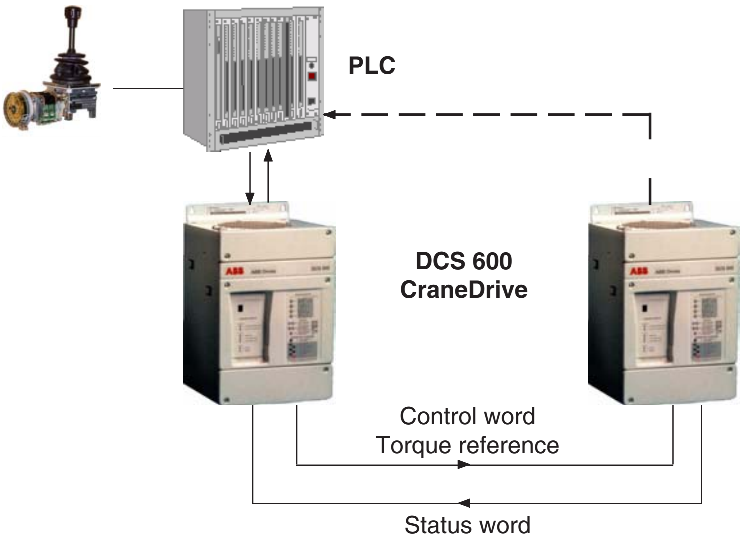


Fig 4.1/2: Master Follower with PLC control

4.2 Wiring diagram

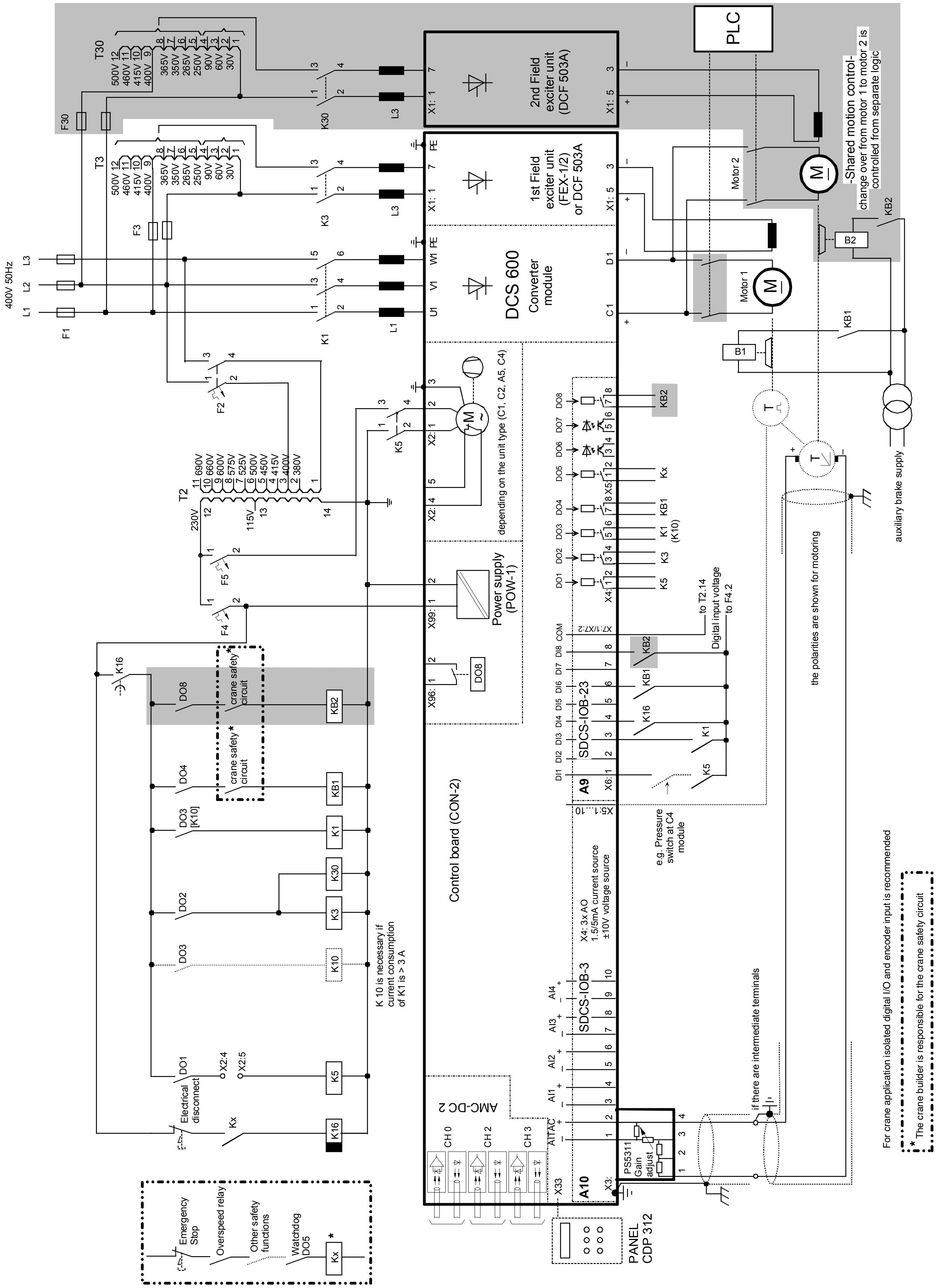


Fig. 4.2/1: DCS 600 CraneDrive wiring diagram

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Since we aim to always meet the latest state-of-the-art standards with our products, we are sure you will understand when we reserve the right to alter particulars of design, figures, sizes, weights, etc. for our equipment as specified in this brochure.

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