

This manual includes

- Safety
- Commissioning of the Supply Section with ISU
- Functional Description
- Parameters
- Fault Tracing
- Technical Data

ACA 635 IGBT Supply Sections
260 to 4728 kVA
ACS 800-17 Line-side Converter
120 to 1385 kVA



ACS 600 MultiDrive Manuals *(Air-cooled Units, English Originals)*

GENERAL MANUALS

*Safety and Product Information EN 63982229

- Complete general Safety Instructions
- Technical data for DSU and TSU supplies and Drive Sections: ratings, power losses, dimensions, weights, fuses etc.

*System Description EN 63700151

- General description of ACS 600 MultiDrive

*Hardware Manual EN 63700118

- General Safety Instructions
- Hardware description of the Drive Section
- Cable selection
- ACS 600 MultiDrive mechanical and electrical installation
- Hardware commissioning of the Drive Section
- Preventive maintenance of ACS 600 MultiDrive

ACS 600 MultiDrive Control Electronics LED Indicators

EN 64289721

- LED descriptions

**Modules Product Catalogue EN 64104268

- Supply Unit components
- Drive Unit components
- Dynamic Braking Units
- DriveWare information
- Dimensional drawings
- Single line diagrams
- Auxiliary power consumption
- Master component tables

**Modules Installation Manual EN 64119010

- Cabinet assembly
- Wiring

**Grounding and Cabling of the Drive System EN 61201998

- Grounding and cabling principles of a variable speed drive system

**EMC Compliant Installation and Configuration for a Power Drive System EN 61348280

- * Included with cabinet-assembled systems only
- ** Included in Modules deliveries only

SUPPLY SECTION MANUALS (depending on the supply type one of these manuals is included in the delivery)

Diode Supply Sections User's Manual (DSU) EN 61451544

- DSU specific Safety Instructions
- DSU hardware and software descriptions
- DSU commissioning
- Earth fault protection options

Thyristor Supply Sections User's Manual (TSU) EN 64170597

- TSU operation basics
- TSU firmware description
- TSU program parameters
- TSU commissioning

IGBT Supply Sections User's Manual EN 64013700

- ISU specific Safety Instructions
- Main components of ISU
- ISU ratings
- ISU power losses
- ISU dimensions and weights
- ISU fuses
- ISU program parameters
- Earth fault protection options

FIRMWARE MANUALS FOR DRIVE APPLICATION PROGRAMS

(appropriate manual is included in the delivery)

System EN 63700177

- Commissioning of the System Application Program
- Control Panel use
- Software description
- Parameters of the System Application Program
- Fault tracing
- Terms

Application Program Template EN 63700185

- Commissioning of the Drive Section
- Control Panel use
- Software description
- Parameters
- Fault tracing
- Terms

Standard EN 61201441

- Control Panel use
- Standard application macros with external control connection diagrams
- Parameters of the Standard Application Program
- Fault tracing
- Fieldbus control

Note: a separate Start-up Guide is attached

Crane Drive EN 3BSE 011179

- Commissioning of the Crane Drive Application Program
- Control Panel use
- Crane program description
- Parameters of the Crane Drive Application Program
- Fault tracing

CONTROL SECTION MANUALS (delivered with optional Control Section)

Advant Controller 80 User's Manual EN 64116487

- AC 80 hardware and connections
- AC 80 software
- Programming
- Diagnostics

Advant Controller 80 Reference Manual PC Elements EN 64021737

- Description of PC and DB elements

Advant Controller 80 Reference Manual TC Elements EN 64331868

- Description of TC elements

BRAKING SECTION MANUAL (delivered with optional Braking Section)

ACA 621/622 Braking Sections User's Manual EN 64243811

- Installation, Start-up, Fault tracing, Technical data
- Dimensional drawings

MANUALS FOR OPTIONAL EQUIPMENT (delivered with optional equipment)

Fieldbus Adapters, I/O Extension Modules, Braking Choppers etc.

- Installation
- Programming
- Fault tracing
- Technical data

ACA 635 IGBT Supply Sections
260 to 4728 kVA
ACS 800-17 Line-side Converter
120 to 1385 kVA

User's Manual

This manual concerns the ACS 600 MultiDrive supply sections (ACA 635) equipped with an IGBT Supply Unit and ACS 800-17 drives.

3BFE 64013700 REV D
EN
EFFECTIVE: 07.07.2003

Safety Instructions

Overview

The complete safety instructions for the ACA 6xx in *Safety and Product Information* (EN code: 63982229) and for the ACS800-17 in *Hardware Manual* (EN code: 64638505) must be followed when installing, operating and servicing the drives. Study the complete safety instructions carefully.

Installation and Maintenance Safety

These safety instructions are intended for all who work on the ACA 6xx or the ACS 800-17. Ignoring these instructions can cause physical injury or death.



WARNING! All electrical installation and maintenance work on the drive should be carried out by qualified electricians.

Any installation work must be done with power off, and power is not to be reconnected unless the installation work is complete. Dangerous residual voltages remain in the capacitors when the disconnecting device is opened. Wait for 5 minutes after switching off the supply before starting work. Always ensure by measuring that the voltage between the terminals UDC+ and UDC- and the frame is close to 0 V and that the supply has been switched off before performing any work on the equipment or making main circuit connections.

If the main circuit of the inverter unit is live, the motor terminals are also live even if the motor is not running!

Open switch fuses of all parallel connected inverters before doing installation or maintenance work on any of them. These switch fuses are not included in the the ACS 800-17.

When joining shipping splits, check the cable connections at the shipping split joints before switching on the supply voltage.

If the auxiliary voltage circuit of the drive is powered from an external power supply, opening the disconnecting device does not remove all voltages. Control voltages of 115/230 VAC may be present in the digital inputs or outputs even though the inverter unit is not powered. Before starting work, check which circuits remain live after opening of the disconnecting device by referring to the circuit diagrams for your particular delivery. Ensure by measuring that the part of the cabinet you are working on is not live.

The control boards of the converter unit may be at the main circuit potential. Dangerous voltages may be present between the control boards and the frame of the converter unit, when the main circuit voltage is on. It is critical that the measuring instruments, such as an oscilloscope, are used with caution and safety as a high priority. The fault tracing instructions give special mention of cases in which measurements may be performed on the control boards, also indicating the measuring method to be used.

Live parts on the inside of doors are protected against direct contact. Special safety attention shall be paid when handling shrouds made of sheet metal.

Do not make any voltage withstand tests on any part of the unit while the unit is connected. Disconnect motor cables before making any measurements on motors or motor cables.



WARNING! Close switch fuses of all parallel connected inverters before starting the drive.

Do not open the drive section switch fuses when the inverter is running.

Do not use Prevention of Unexpected Start for stopping the drive when the inverter is running. Give a Stop command instead.

CAUTION! Fans may continue to rotate for a while after the disconnection of the electrical supply.

CAUTION! Some parts like heatsinks of power semiconductors and toroidal cores on motor cables inside the cabinet remain hot for a while after the disconnection of the electrical supply.

Automatic Resets

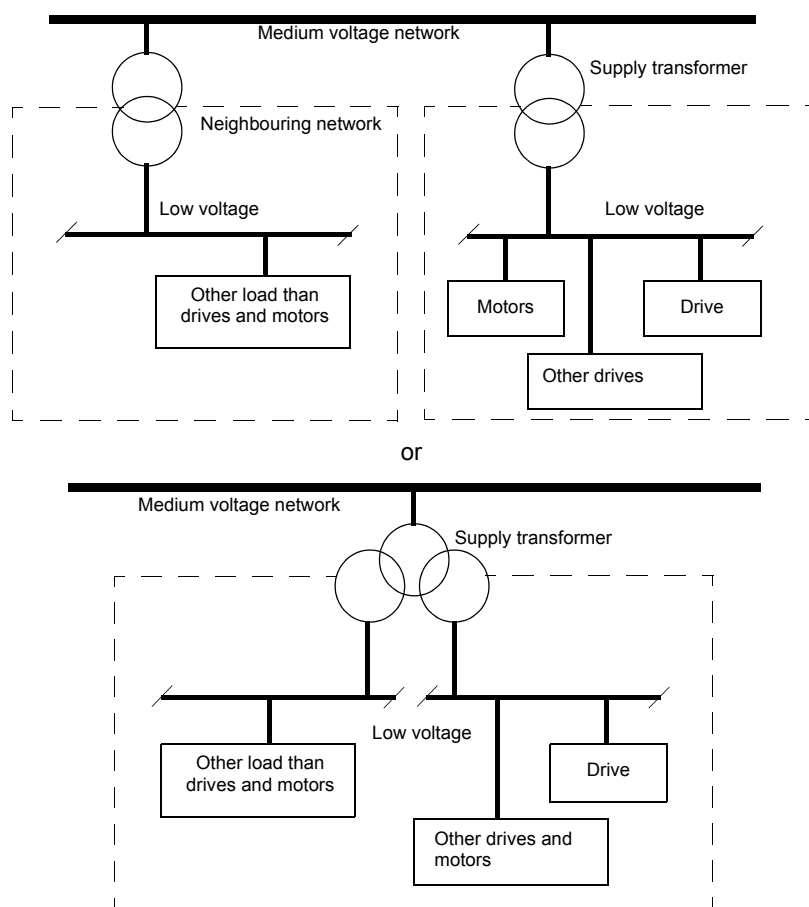


WARNING! If an external source for start command is selected and it is ON, the drive will start immediately after fault reset.

Dedicated Transformer



WARNING! Frame size R11i and above must be supplied with a transformer dedicated to drives and motors or equipment of equal or higher power, or with a transformer equipped with two secondary windings, one of which is dedicated to drives and motors. Resonances might occur if there is capacitive load (e.g. lighting, PC, PLC, small power factor compensation capacitors) in the same network with the drive. The resonance current might damage some unit in the network.



Safety Instructions

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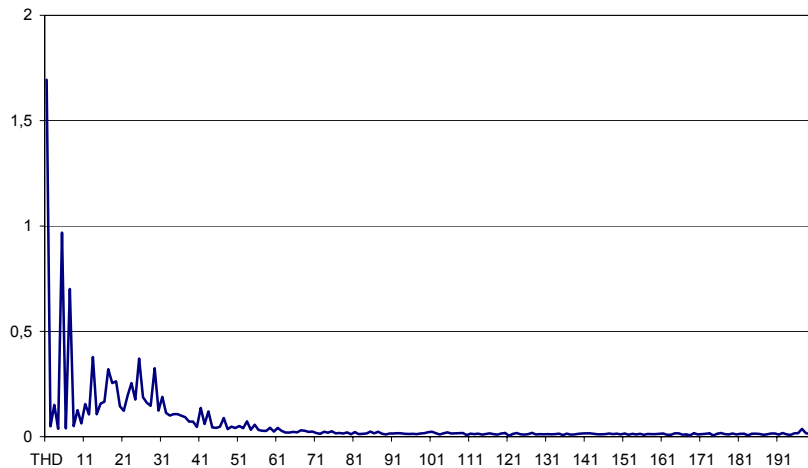
The notice concerns	The translation (DE revision C) of the ACA 635 IGBT Supply Sections 260 to 4728 kVA, ACS 800-17 Line-side Converter 120 to 1385 kVA User's Manual: code 3BFE 64495062
The notice is in use	from 28.07.2003
The notice contains	Updates to the REV C translation.

ACS 800-17 Line-side Converter **CHANGED:** ACS/ACC 617 line-side converter has been replaced by the ACS 800-17 line-side converter.

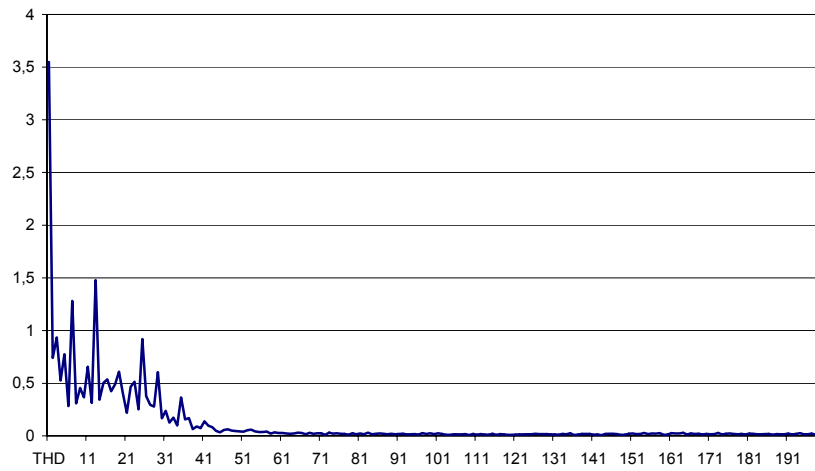
Chapter 1 - About this Manual Page 1-2, User Interface **CHANGED:** The user interface of the IGBT Supply Unit is a CDP 312 Control Panel or a PC, which is equipped with a DDCS board and DriveWindow.

Chapter 2 - Operation Basics Page 2-3 **CHANGED:** Voltage and current distortion

Spectrum of the Voltage Distortion



Spectrum of the Current Distortion

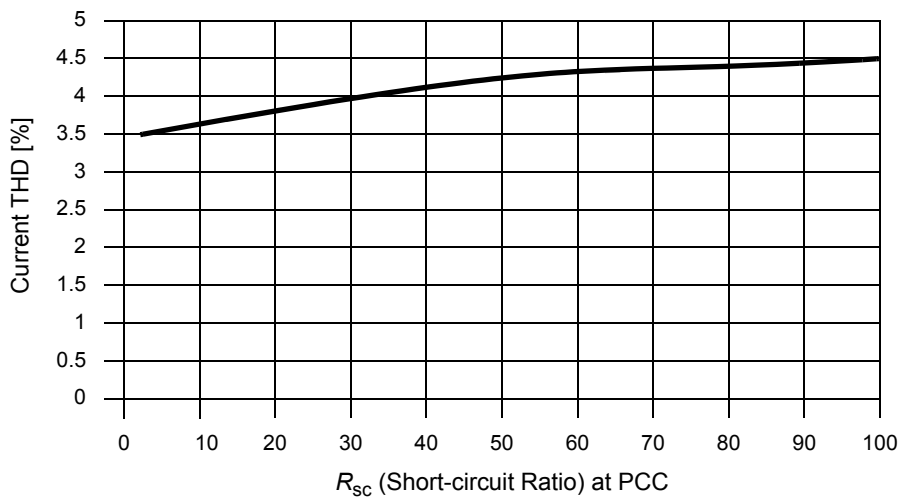


Chapter 3 - Hardware Description

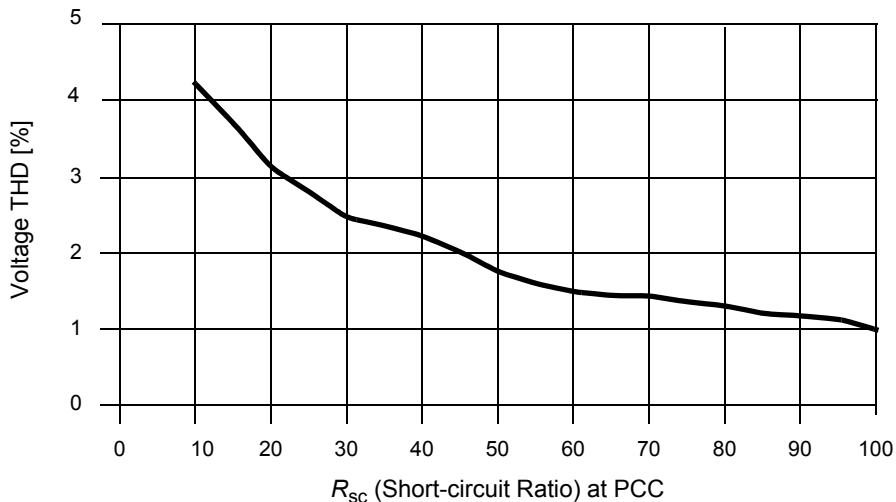
Page 3-2, Incoming Unit **CHANGED: Frames R6i to R9i:** switch fuse (including AC fuses) and main contactor. **Frames R11i and above:** air circuit breaker.

Page 3-3 **CHANGED:** Current and voltage distortion

Current Distortion (up to 200th) Generated by the Supply Unit at PCC (Point of Common Coupling)

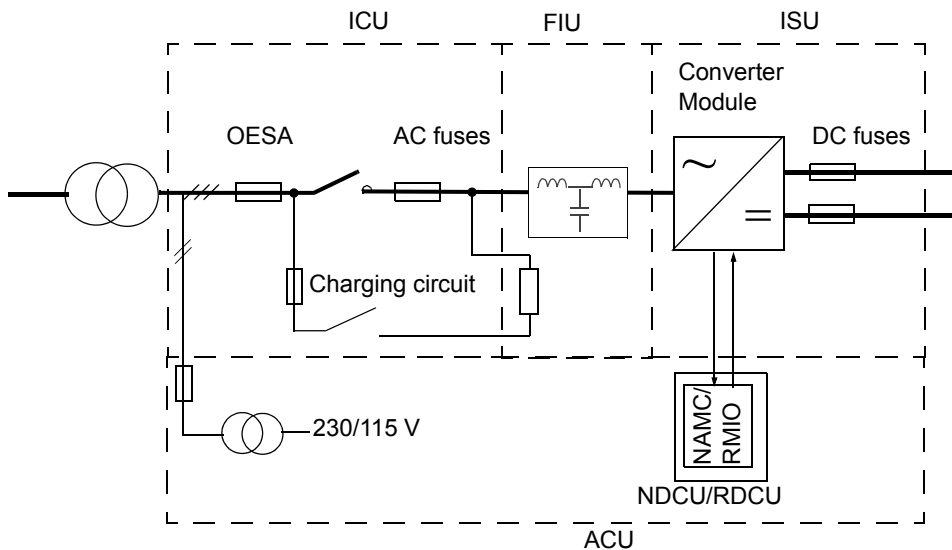


Voltage Distortion (up to 200th) Generated by the Supply Unit at PCC (Point of Common Coupling)



Page 3-5 Basic Configuration **CHANGED:**

The hardware of the IGBT supply unit is similar to the hardware of the ACS 600 MultiDrive inverter. One NAMC/RMIO board controls the converter module. It is located inside the Drive Control Unit (NDCU/RDCU) box. The supply section is equipped with an LCL filter, DC fuses and AC fuses/switch fuse OESA. AC fuses are used with a breaker and a switch fuse is used with a contactor.



Chapter 8 - Parameters Page 8-2 **CHANGED:**

Code	Parameter	Range/Unit	Description	Integer Scaling
1	ACTUAL SIGNALS			
1.19	AI1 [V]	0...10	Non-scaled value of analogue input AI1. See Par. 13.01 AI1 HIGH VALUE and 13.02 AI1 LOW VALUE.	10000 = 10 V or 20 mA

Page 8-4 **CHANGED:**

The software version (Parameters 4.01 and 4.03) is expressed as follows:

Character	Example	Meaning
no		
1	I	I = Input bridge software
2	X	Product: X= ISU
3	X	Software type: A = application software (Parameter 4.03)
4	G	Control board: G = NAMC-51, R = RMIO
5 to 8	6000	Software version number: 6000 = NAMC-51, 7000 = RMIO

Page 8-9 **ADDED:**

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
13	ANALOGUE INPUTS					
13.12	MINIMUM AI1	I	0 V	(1) 0 V (2) -10 V	This value corresponds to the minimum reference from analogue input AI1.	

Page 8-22 **CHANGED:**

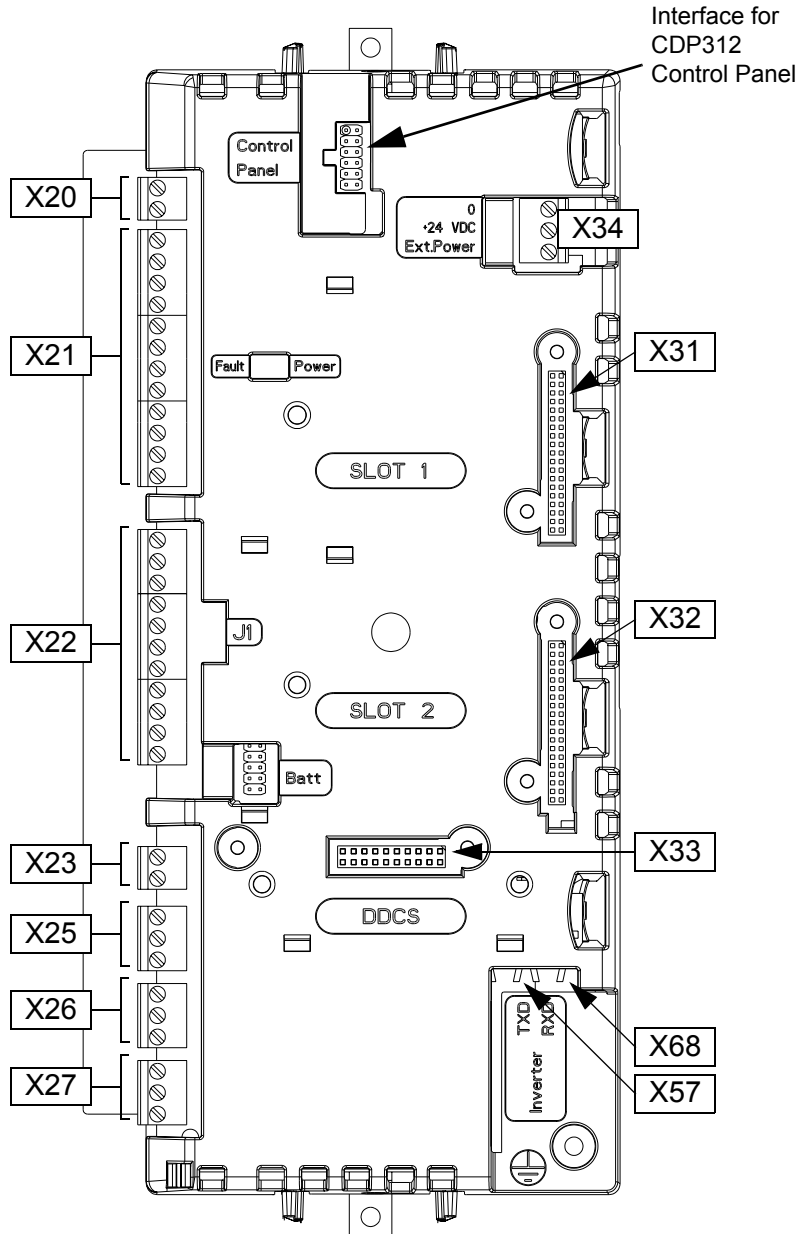
Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
70	DDCS CONTROL					
70.20	CH3 HW CONNECTION	B	STAR		This parameter is used for enabling or disabling regeneration of channel CH3 optical transmitter. In regeneration mode any message received by the channel is echoed back.	1=1
				(0) RING	Regeneration enabled. Select RING if the CH3 channels on the NAMC boards / RDCO modules are connected to a ring configuration.	
				(1) STAR	Regeneration disabled. Select STAR with a star configuration such as DriveWindow (PC) – NDBU-95 optical branching unit(s) – NAMC board / RDCO module (RMIO board).	

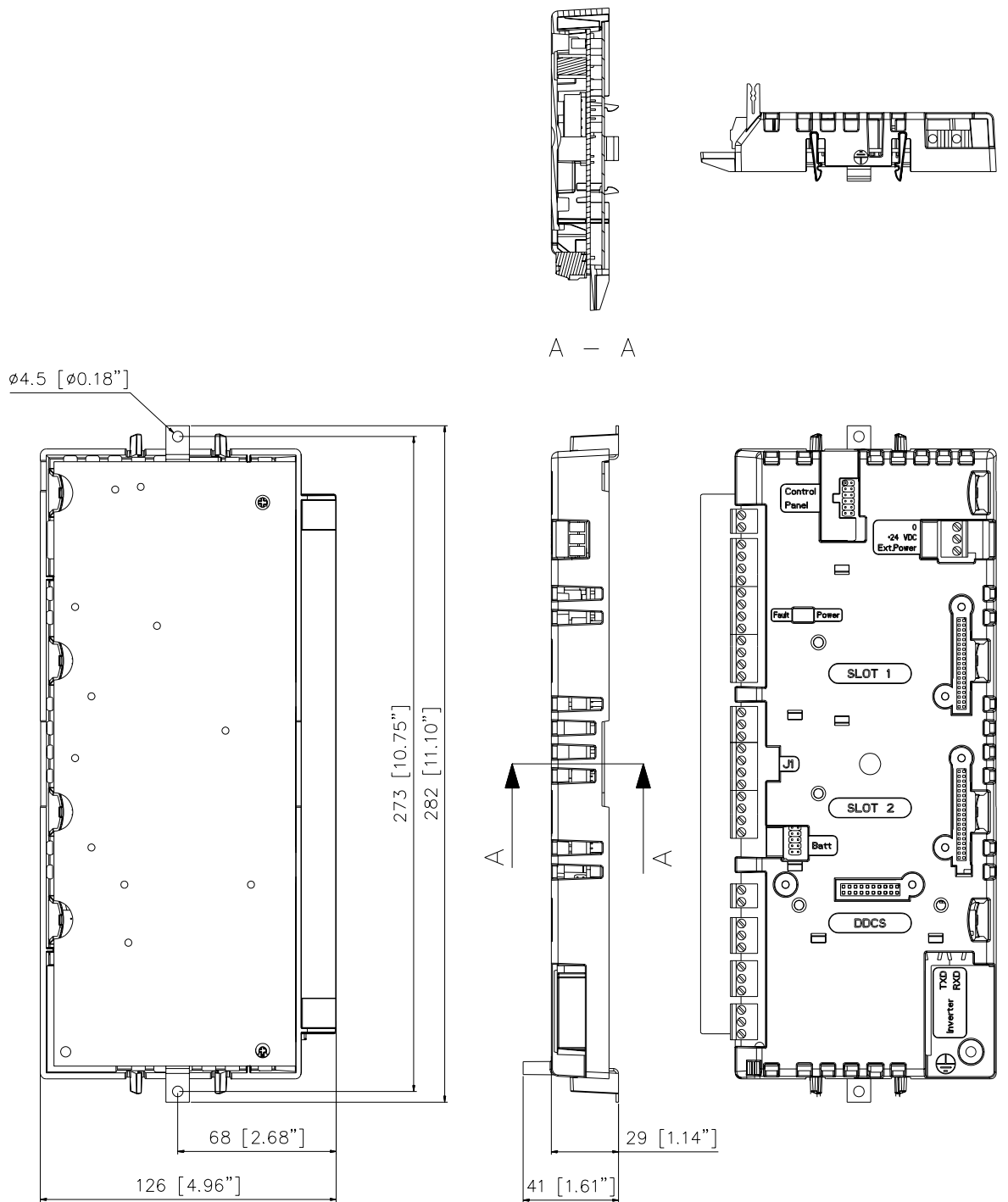
Page 8-23 **CHANGED:** D SET 10 VAL 1 denotes the receive address of data set 10 value 1.

Page 8-24 **CHANGED:** D SET 11 VAL 1 denotes the transmit address of data set 11 value 1.

**Appendix A -
Technical Data**

Page A-9 **ADDED:** Drive Control Unit RDCU has been added to the manual. The RDCU unit replaces the NDCU-51 unit. The Drive Control Unit RDCU containing an RMIO-01 board is shown in the pictures below.





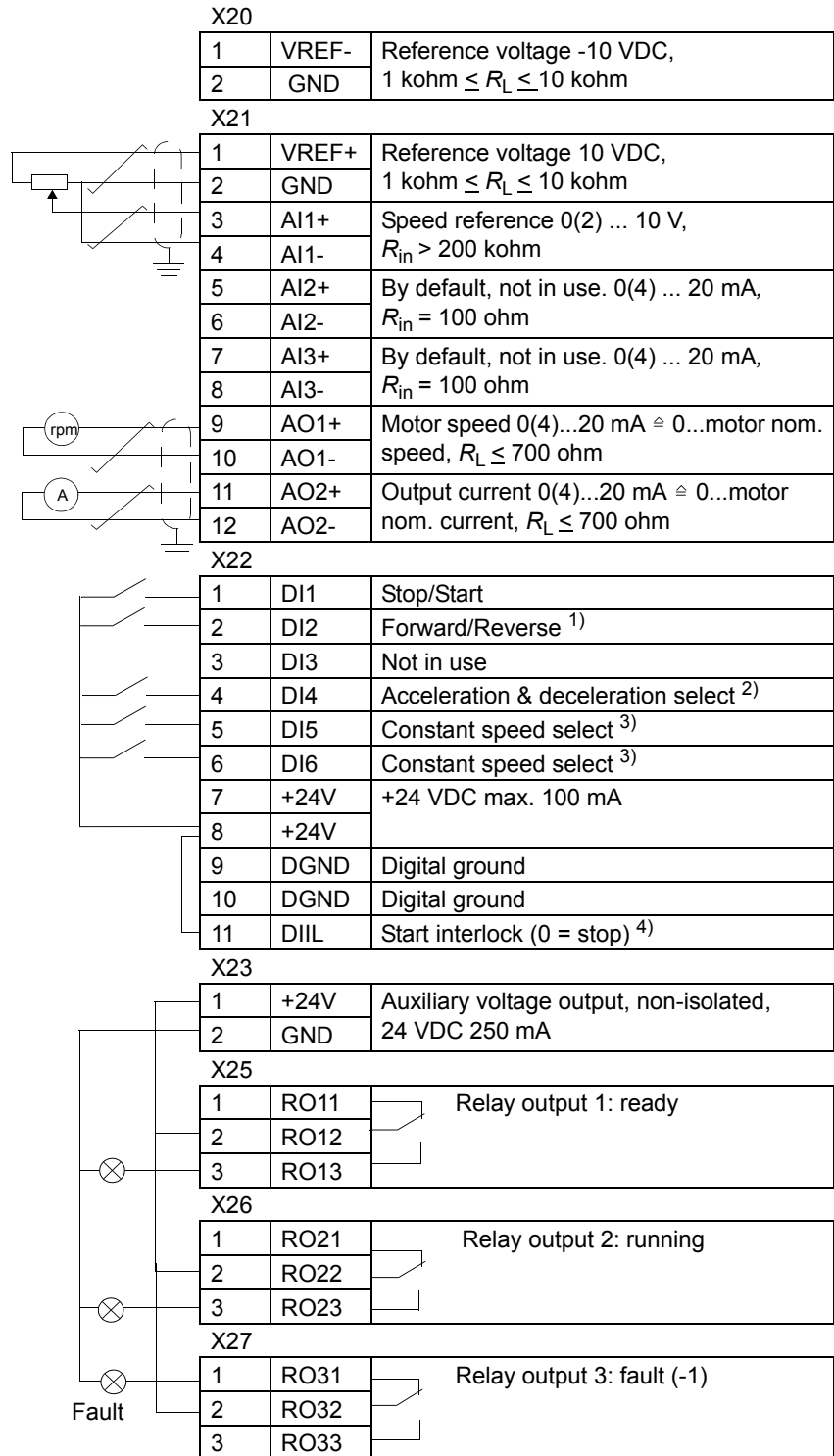
External control cable connections (**non-US**) to the RMIO board for the ACS 800 Standard Application Program (Factory Macro) are shown below. For external control connections of other application macros and programs, see the appropriate *Firmware Manual*.

Terminal block size:

cables 0.3 to 3.3 mm² (22 to 12 AWG)

Tightening torque:

0.2 to 0.4 Nm (2 to 4 lbf in.)



1) Only effective if par. 10.03 is set to REQUEST by the user.

2) 0 = open, 1 = closed

DI4	Ramp times according to
0	parameters 22.02 and 22.03
1	parameters 22.04 and 22.05

3) See par. group 12 CONSTANT SPEEDS.

DI5	DI6	Operation
0	0	Set speed through AI1
1	0	Constant speed 1
0	1	Constant speed 2
1	1	Constant speed 3

4) See parameter 21.09 START INTRL FUNC.

External control cable connections (**US**) to the RMIO board for the

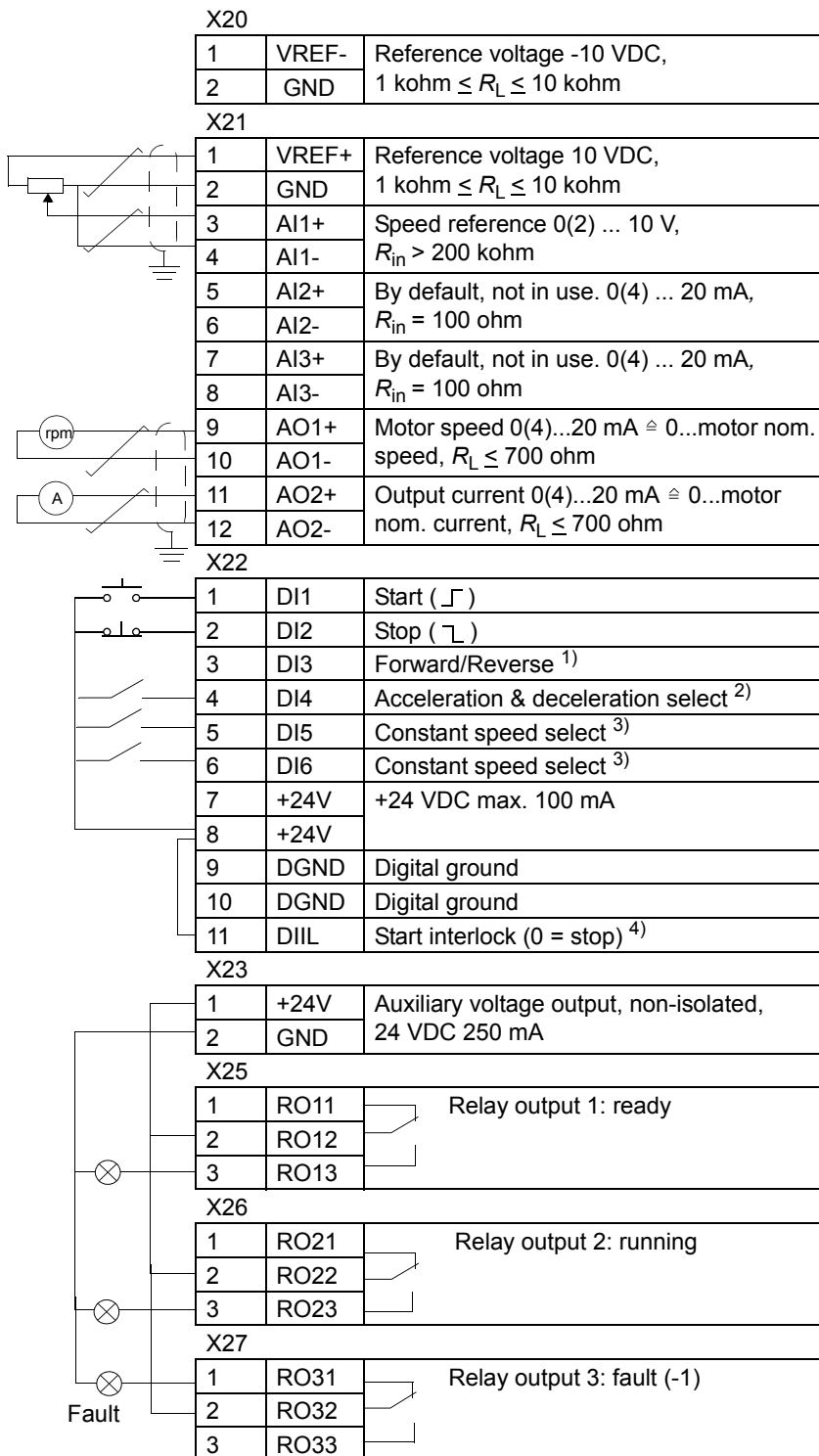
ACS800 Standard Application Program (Factory Macro US version, +N665) are shown below. For external control connections of other application macros and programs, see the appropriate *Firmware Manual*.

Terminal block size:

cables 0.3 to 3.3 mm² (22 to 12 AWG)

Tightening torque:

0.2 to 0.4 Nm (2 to 4 lbf in.)



1) Only effective if par. 10.03 is set to REQUEST by the user.

2) 0 = open, 1 = closed

DI4	Ramp times according to
0	parameters 22.02 and 22.03
1	parameters 22.04 and 22.05

3) See par. group 12 CONSTANT SPEEDS.

DI5	DI6	Operation
0	0	Set speed through AI1
1	0	Constant speed 1
0	1	Constant speed 2
1	1	Constant speed 3

4) See parameter 21.09 START INTRL FUNC.

RMIO Board Specifications

Analogue inputs	<p>With Standard Application Program two programmable differential current inputs (0 mA / 4 mA ... 20 mA, $R_{in} = 100 \text{ ohm}$) and one programmable differential voltage input (-10 V / 0 V / 2 V ... +10 V, $R_{in} > 200 \text{ kohm}$).</p> <p>The analogue inputs are galvanically isolated as a group.</p> <p>Isolation Test voltage: 500 VAC, 1 min</p> <p>Max. common mode voltage between the channels: $\pm 15 \text{ VDC}$</p> <p>Common mode rejection ratio: $\geq 60 \text{ dB}$ at 50 Hz</p> <p>Resolution: 0.025% (12 bit) for the -10 V ... +10 V input. 0.5% (11 bit) for the 0 ... +10 V and 0 ... 20 mA inputs.</p> <p>Inaccuracy: $\pm 0.5\%$ (Full Scale Range) at 25 °C. Temperature coefficient: $\pm 100 \text{ ppm}/^\circ\text{C}$, max.</p>
Constant voltage output	<p>Voltage: +10 VDC, 0, -10 VDC $\pm 0.5\%$ (Full Scale Range) at 25 °C. Temperature coefficient: $\pm 100 \text{ ppm}/^\circ\text{C}$ ($\pm 56 \text{ ppm}/^\circ\text{F}$) max</p> <p>Maximum load: 10 mA</p> <p>Applicable potentiometer: 1 kohm to 10 kohm</p>
Auxiliary power output	<p>Voltage: 24 VDC $\pm 10\%$, short circuit proof</p> <p>Maximum current: 250 mA (without any optional modules inserted onto slots 1 and 2)</p>
Analogue outputs	<p>Two programmable current outputs: 0 (4) to 20 mA, $R_L \leq 700 \text{ ohm}$</p> <p>Resolution: 0.1% (10 bit)</p> <p>Inaccuracy: $\pm 1\%$ (Full Scale Range) at 25 °C (77 °F). Temperature coefficient: $\pm 200 \text{ ppm}/^\circ\text{C}$ ($\pm 111 \text{ ppm}/^\circ\text{F}$) max.</p>
Digital inputs	<p>With Standard Application Program six programmable digital inputs (common ground: 24 VDC, -15% to +20%) and a start interlock input. Group isolated, can be divided in two isolated groups (see Isolation and grounding diagram below).</p> <p>Thermistor input: 5 mA, $< 1.5 \text{ kohm} \hat{=} \text{"1"}$ (normal temperature), $> 4 \text{ kohm} \hat{=} \text{"0"}$ (high temperature), open circuit $\hat{=} \text{"0"}$ (high temperature).</p> <p>Internal supply for digital inputs (+24 VDC): short circuit proof. An external 24 VDC supply can be used instead of the internal supply.</p> <p>Isolation test voltage: 500 VAC, 1 min</p> <p>Logical thresholds: $< 8 \text{ VDC} \hat{=} \text{"0"}$, $> 12 \text{ VDC} \hat{=} \text{"1"}$</p> <p>Input current: DI1 to DI 5: 10 mA, DI6: 5 mA</p> <p>Filtering time constant: 1 ms</p>
Relay outputs	<p>Three programmable relay outputs</p> <p>Switching capacity: 8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC</p> <p>Minimum continuous current: 5 mA rms at 24 VDC</p> <p>Maximum continuous current: 2 A rms</p> <p>Isolation test voltage: 4 kVAC, 1 minute</p>
DDCS fibre optic link	<p>With optional communication adapter module RDCO. Protocol: DDCS (ABB Distributed Drives Communication System)</p>
<p>The RMIO board as well as the optional modules attachable to the board fulfil the Protective Extra Low Voltage (PELV) requirements stated in EN 50178.</p>	

Page A-12 **CHANGED:**

- EN 61800-3: 1996, Amendment A11: 2000 (IEC 61800-3). EMC product standard including specific test method

Page A-13, Second Environment **CHANGED:**

The ACA 635 supply sections comply with the EMC Directive in industrial low-voltage network, and IT networks (unearthed mains) with the following provisions. For ACS800-17 units, refer to ACS800-17 Hardware Manual (EN code 64638505).


1. The motor and control cables are selected as specified in the *Hardware Manual*.
2. The drive is installed according to the instructions given in the *Hardware Manual*.
3. Maximum cable length is 100 metres.

WARNING! The drive may cause radio interference if used in a residential or domestic environment. The user is required to take measures to prevent interference, in addition to the requirements for CE compliance listed above, if necessary.

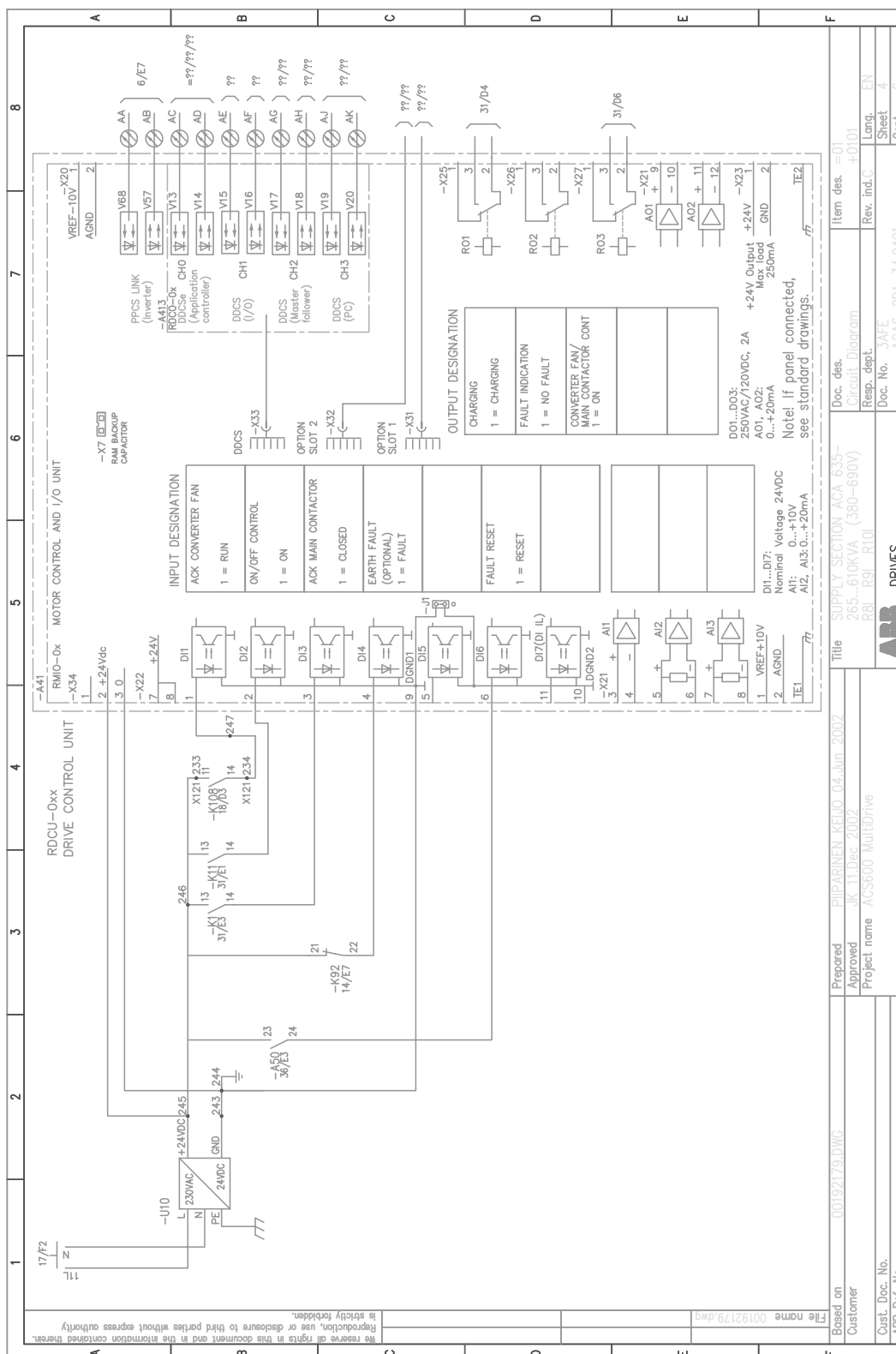
Note: It is not allowed to use EMC filters on an unearthed mains supply network, unless the filters are able to withstand the unearthed network. (EMC filters are used to minimise the RFI emission of the unit.)

Note: With cables longer than 100 metres, the ACA 635 supply sections comply with the EMC Directive in restricted distribution mode when the installation is described in an EMC plan (a template is available from the local ABB representative).

Table A-1 The EMC cabinet option is marked in the type code as follows. 0 = No EMC cabinet, 1 = EMC cabinet (does not include RFI filters)

ACS 600 Type	Type Code	
	Character no.	Options
ACA 635	ACA635xxxxxxxxxxx... <div style="text-align: center;">  16 </div>	0,1

Appendix B Circuit Diagrams



Chapter 1 – About this Manual

What this Chapter Contains	This chapter describes the intended audience and contents of this manual. It contains a table referring to tasks described in other manuals.
Intended Audience	This manual is intended for people who plan the installation, commission, use and service the drive equipped with an IGBT supply. Read the manual before working on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.
Parameter Setting	The parameters of the IGBT Supply Unit (ISU) Program listed in this manual need not be set in a normal start-up procedure or in normal use. However, the ISU parameters can be viewed and changed using the Control Panel.
To which Products this Manual Applies	This manual applies to the ACA 635 supply sections and ACS 800-17 drives which contain the IGBT Supply Unit.
Contents	<p>The control program of the IGBT Supply Unit is described in the following chapters: Chapter 6 – Firmware Description, Chapter 7 – Fault Tracing and Chapter 8 – Parameters.</p> <p>Safety Instructions contain installation and maintenance safety instructions.</p> <p>Chapter 2 – Operation Basics describes the operation of the IGBT Supply Unit.</p> <p>Chapter 3 – Hardware Description describes the hardware of the ACA 635 supply sections including descriptions of the LCL filter and the IGBT supply unit which are parts of the ACS 800-17 as well.</p> <p>Chapter 4 – Commissioning the Supply Section with ISU describes the commissioning of a supply section that is equipped with the IGBT Supply Unit (ISU).</p> <p>Chapter 5 – Earth Fault Protection describes the earth fault protection solutions available for a drive equipped with an IGBT supply unit.</p> <p>Appendix A – Technical Data contains technical data for the ACA 635 giving information on ratings, fuses, cooling requirements, power losses etc.</p>

[Appendix B – Circuit Diagrams](#) contains some example circuit diagrams of the ACA 635.

**ISU-related
Information in Other
Manuals**

Task	See								
<p><i>Mechanical and Electrical Installation of the Drive</i> <i>Installation of Optional Modules and DriveWindow</i> <i>Preventive Maintenance</i></p>	<p><i>ACS 600 MultiDrive Hardware Manual</i> (EN code: 63700118) or <i>ACS800-17 Hardware Manual</i> (EN code: 64638505)</p>								
<p><i>Technical Data for the ACS 800-17</i></p>	<p><i>ACS800-17 Hardware Manual</i> (EN code: 64638505)</p>								
<p><i>Associating ISU with DriveWindow</i></p>	<p><i>DriveWindow Start-up Guide</i> (EN code: 36458585) When associating DriveWindow 1.3 and 1.4 with the ISU proceed as follows:</p> <table border="1" data-bbox="469 936 1393 1238"> <thead> <tr> <th data-bbox="469 936 1070 996">System Configuration Messages</th> <th data-bbox="1070 936 1393 996">What to do</th> </tr> </thead> <tbody> <tr> <td data-bbox="469 996 1070 1077"> <p>Error: Encountered target 'ISU600-xxxx-x' is unknown. Do you wish to associate it?</p> </td> <td data-bbox="1070 996 1393 1077"> <p>Click OK.</p> </td> </tr> <tr> <td data-bbox="469 1077 1070 1158"> <p>Associate 'ISU600-xxxx-x' With</p> </td> <td data-bbox="1070 1077 1393 1158"> <p>Choose ACS600 MultiDrive from the list.</p> </td> </tr> <tr> <td data-bbox="469 1158 1070 1238"> <p>Do you wish association 'ISU600-xxxx-x' = ACS600 MultiDrive be permanent?</p> </td> <td data-bbox="1070 1158 1393 1238"> <p>Click Yes.</p> </td> </tr> </tbody> </table>	System Configuration Messages	What to do	<p>Error: Encountered target 'ISU600-xxxx-x' is unknown. Do you wish to associate it?</p>	<p>Click OK.</p>	<p>Associate 'ISU600-xxxx-x' With</p>	<p>Choose ACS600 MultiDrive from the list.</p>	<p>Do you wish association 'ISU600-xxxx-x' = ACS600 MultiDrive be permanent?</p>	<p>Click Yes.</p>
System Configuration Messages	What to do								
<p>Error: Encountered target 'ISU600-xxxx-x' is unknown. Do you wish to associate it?</p>	<p>Click OK.</p>								
<p>Associate 'ISU600-xxxx-x' With</p>	<p>Choose ACS600 MultiDrive from the list.</p>								
<p>Do you wish association 'ISU600-xxxx-x' = ACS600 MultiDrive be permanent?</p>	<p>Click Yes.</p>								
<p><i>User Interface</i></p>	<p><i>Firmware Manual</i> (for System, Standard or Crane Drive Application Program) The user interface of the IGBT Supply Unit is a CDP 312 Control Panel or a PC, which is equipped with a DDCCS board and DriveWindow.</p>								

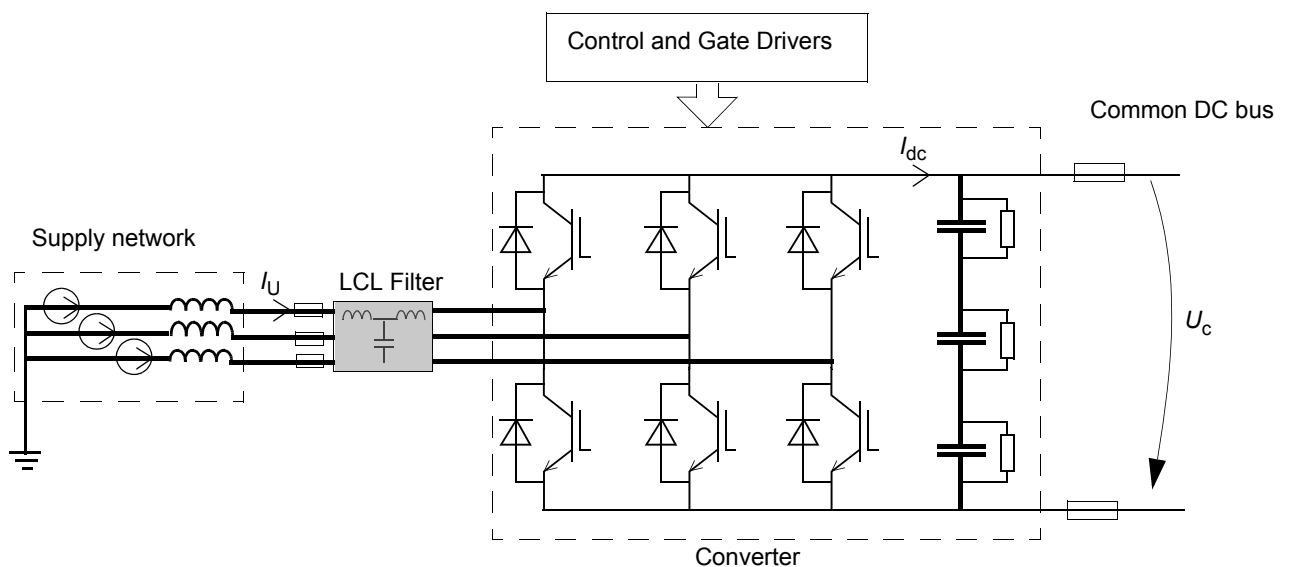
Chapter 2 – Operation Basics

Operation of ISU

The ISU is a four-quadrant switching-mode converter, i.e., the power flow through the converter is reversible. The AC current of the ISU is sinusoidal at a unity power factor. As a default, the ISU controls the DC link voltage to the peak value of the line-to-line voltage. The DC voltage reference can be set also higher by a parameter.

Main Circuit Diagram

A diagram of the main circuit of the IGBT supply is shown below.



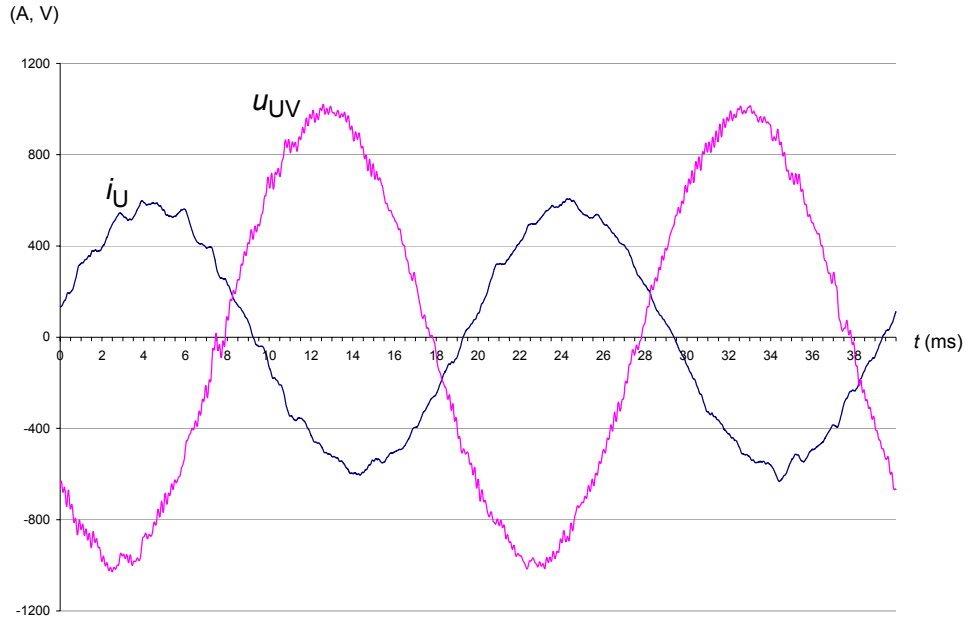
Control

The control and modulation is based on the Direct Torque Control (DTC) method typically used in ACS 600 motor control. Two line currents and DC link voltage are measured and used for the control. The control boards are similar to the boards of the inverter.

Voltage and Current Waveforms

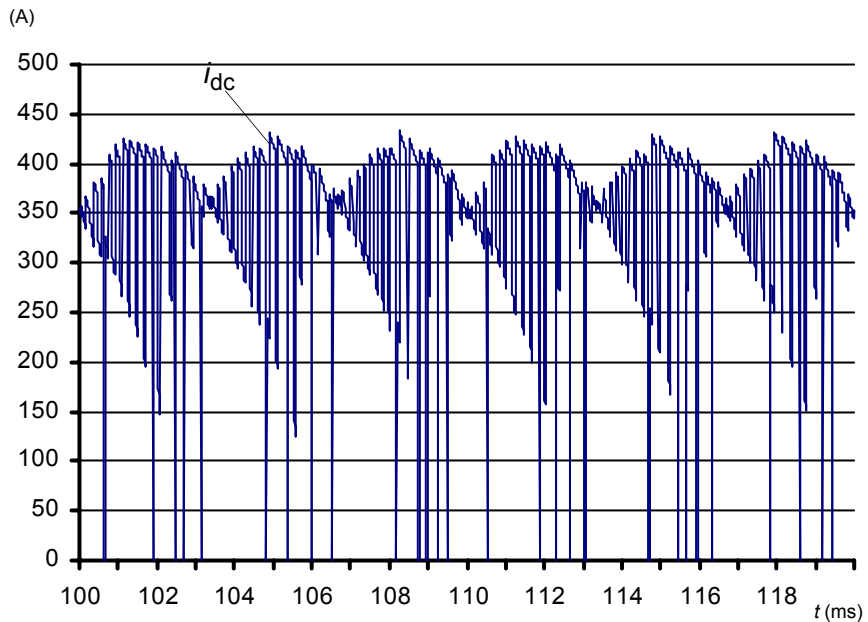
The high frequency switching and high du/dt slightly distorts the voltage waveform at the input of the converter. The depth of the voltage notches depends on the ratio of network inductance to total line inductance (network + LCL filter inductance).

Typical line current (i_U) and voltage (u_{UV}) waveforms are shown below.



DC Current

A typical DC current (i_{dc}) waveform is shown below.

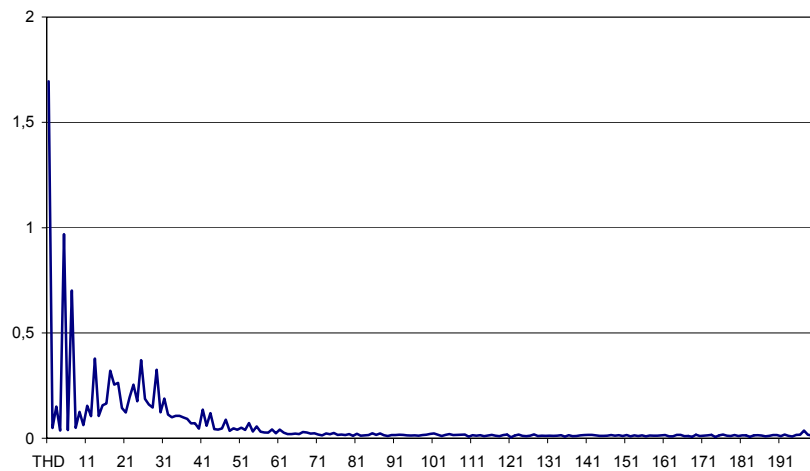


Distortion

IGBT supply unit does not generate characteristic current/voltage overtones like a traditional 6- or 12-pulse bridge does, because of the sinusoidal waveform of the line current. The Total Harmonic Distortion (THD) in voltage depends slightly on the Short Circuit Ratio in the Point of Common Coupling (PCC), refer to [Appendix A – Technical Data](#).

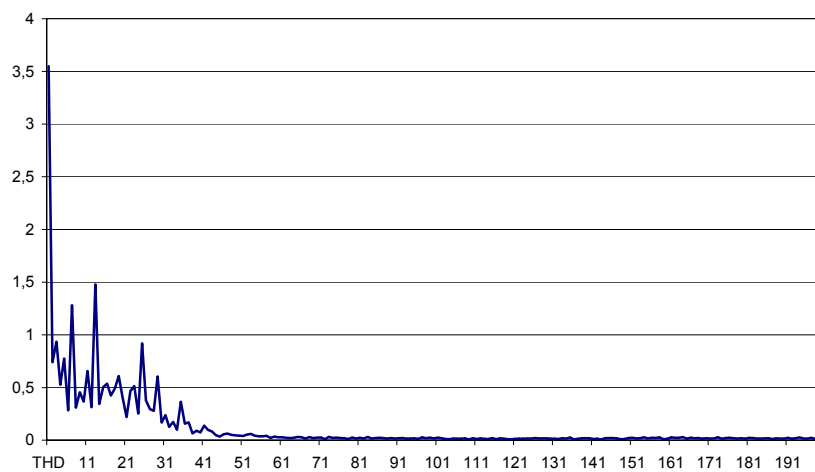
Spectrum of the Voltage Distortion

A typical spectrum of the voltage distortion at the output of the transformer is shown below. Each harmonic is presented as a percentage of the fundamental voltage. n denotes the ordinal number of the harmonic.



Spectrum of the Line Current Distortion

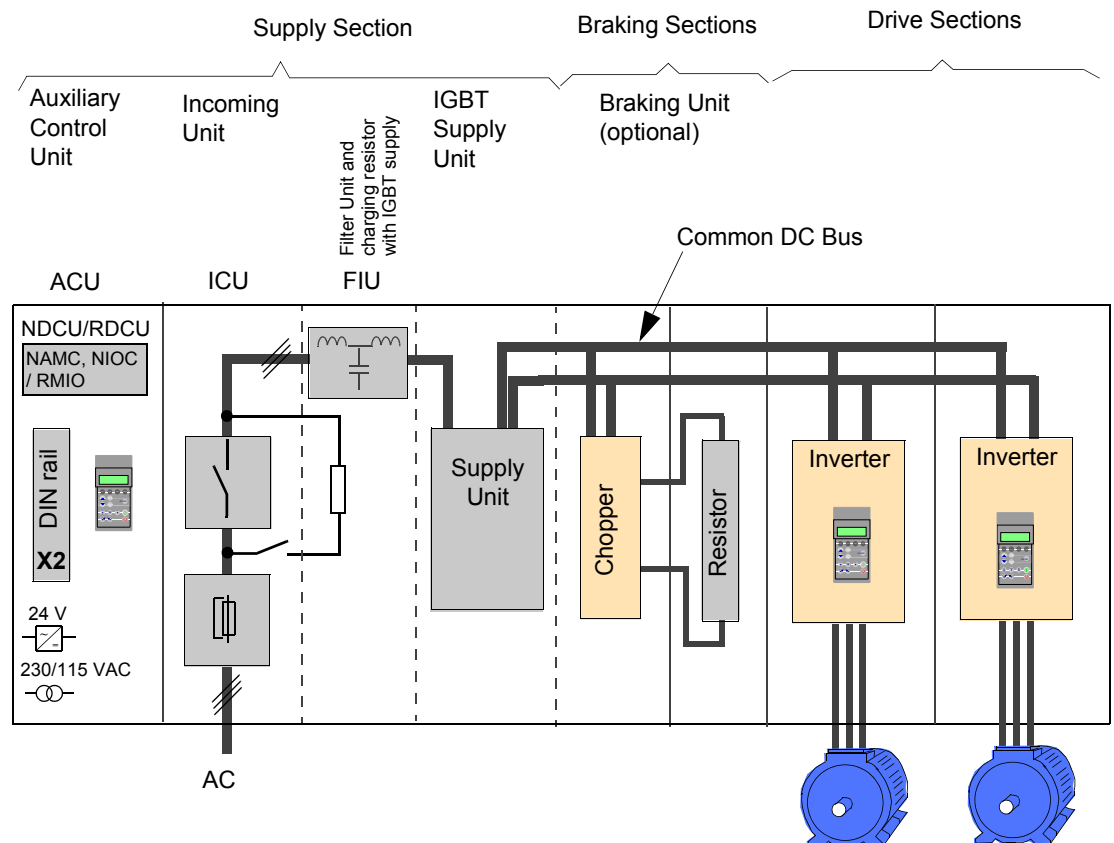
A typical spectrum of the line current distortion is shown below. Each harmonic is presented as a percentage of the fundamental current. n denotes the ordinal number of the harmonic.



Chapter 3 – Hardware Description

Main Components of a Drive with ISU

The main components of a drive equipped with an IGBT supply unit are shown below. Two drive sections are drawn in the diagram, in reality the number of them varies. The control panels are optional. This chapter describes the supply section.



Supply Section

The supply section consists of the units listed below:

- Auxiliary Control Unit (ACU)
- Incoming Unit (ICU)
- Filter Unit (FIU)
- IGBT Supply Unit (ISU).

- Auxiliary Control Unit** The following components are located in the Auxiliary Control Unit:
- Drive Control Unit (NDCU), which includes an Application and Motor Controller (NAMC) Board and a standard I/O (NIOC) Board; or Drive Control Unit (RDCU), which includes a Motor Controller and standard I/O Board (RMIO).
 - Optical Branching Unit (NPBU) with parallel connected IGBT Supply Units (frames 2 or 4 times R11i and R12i). NPBU is connected between NAMC/RMIO and NINT boards (inside the converter module).
 - Control voltage supply (fuses and transformer)
 - On/off switch on the cabinet door and relays
 - Optional CDP 312 Control Panel and NLMD-01 Monitoring Display
 - Optional voltage and current meters
 - Control wiring and relays
 - Auxiliary voltage filter for sensitive equipment ($I_N = 17 \text{ A}$, 230/115 V)
 - Optional emergency and earth fault protection components
 - Other options (fieldbus adapter modules, man/machine interfaces etc.)

- Incoming Unit** The following components are located in the Incoming Unit:
- Terminals for the input power (AC supply) connection
 - **Frames R6i to R9i:** switch fuse (including AC fuses) and main contactor. **Frames R11i and above:** air circuit breaker.
 - Optional earthing switch
 - Charging fuses and contactor
 - Current transformer of optional ammeters

- Filter Unit** The following components are located in the Filter Unit:
- LCL filter
 - Cooling fan for filter
 - Charging resistors
 - AC fuses (frames R11i and above)

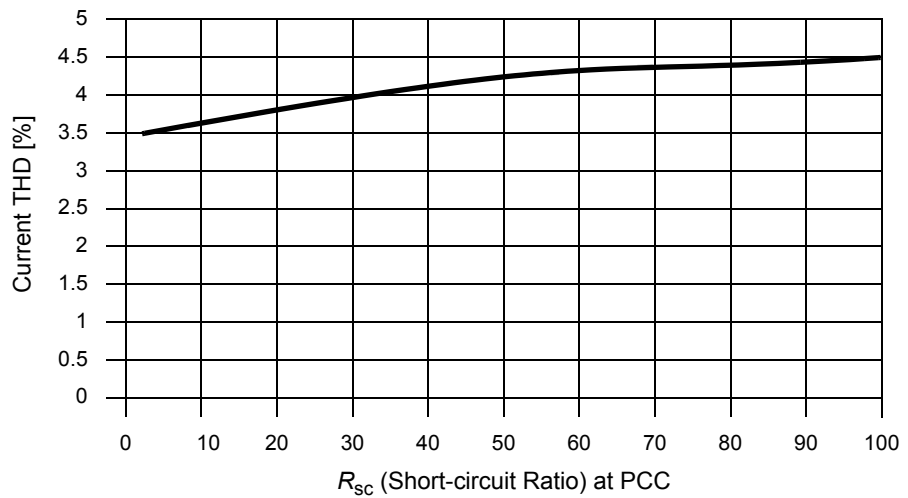
LCL Filters An LCL filter suppresses voltage and current distortion across a wide frequency range.

Short-circuit ratio (R_{SC}) describes the strength of the supply network. The diagrams below show the estimated voltage and current distortion as a function of short-circuit ratio.

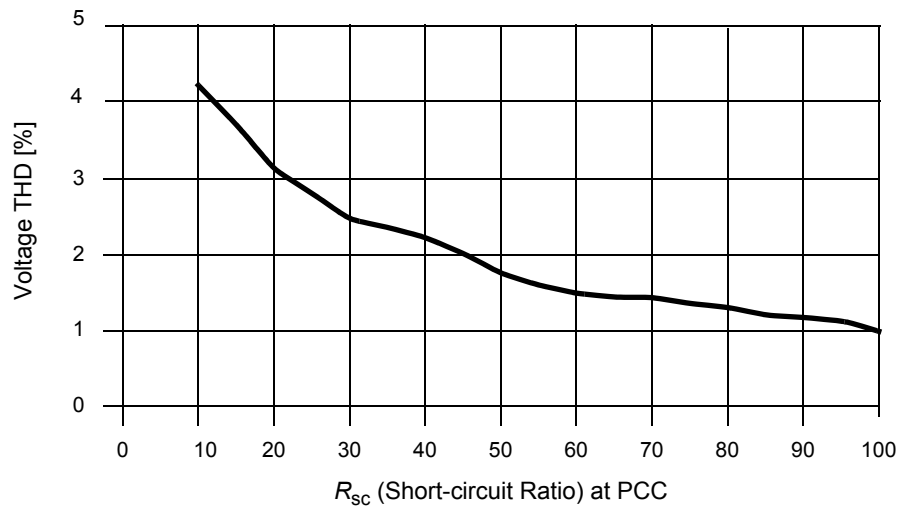
The short-circuit ratio can be calculated as shown in chapter *Appendix A – Technical Data / Harmonic Distortion*.

Please note that the curves are merely a visualisation of the effect of the LCL filter and supply network characteristics on the distortion, not a specification.

Current Distortion (up to 200th) Generated by the Supply Unit at PCC (Point of Common Coupling)




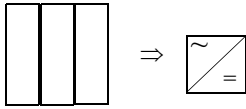
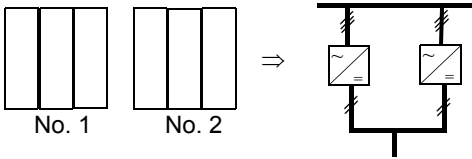
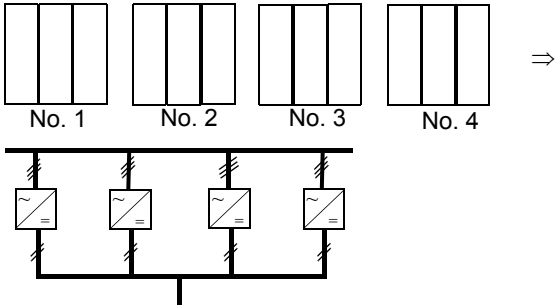
Voltage Distortion (up to 200th) Generated by the Supply Unit at PCC (Point of Common Coupling)



IGBT Supply Unit The IGBT Supply Unit includes the parts listed below:

- Converter (ACN 634 xxxx)
- Converter cooling fans
- DC fuses
- the following control boards inside the converter:
 - Thick-film Hybrid Board (NRED) in 690 V units only for limiting the maximum voltage
 - Power Supply Board (NPOW)
 - Main Circuit Interface Board (NINT)
 - Control Distribution Board (NXPP) in frame sizes R10i to 4 x R12i
 - Gate Driver Power Supply Board (NGPS) in frame sizes R12i and up for supplying power to NGDR boards
 - Gate Driver Board (NGDR)

Converter The converter consists of an IGBT bridge which forms controlled dc voltage from the supply network ac voltage. The bridge is capable of delivering braking energy back to the network.

Frame Size	A converter (ACN 634 xxxx) consists of
R6i to R9i	one converter module 
R11i to R12i	three phase modules (ACN 644 xxxx) = one converter 
2 x R11i, 2 x R12i	two times three phase modules (ACN 644 xxxx) = two phase module blocks => one converter 
4 x R11i, 4 x R12i	four times three phase modules (ACN 644 xxxx) = four phase module blocks => one converter 

Main Circuit Construction

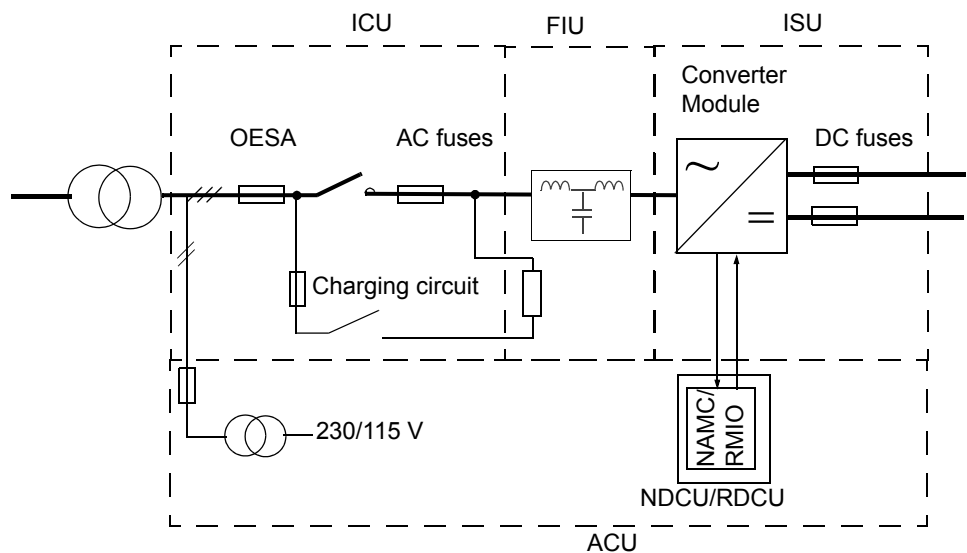
The converter consists of six insulated gate bipolar transistors (IGBT) with free wheeling diodes and DC capacitors. Frames R8i and R9i are equipped with parallel connected IGBTs for each phase located on three power plates. Frame size R11i includes six power plates and frame size R12i nine power plates.

Configurations

The sections below describe possible configurations of ISU modules.

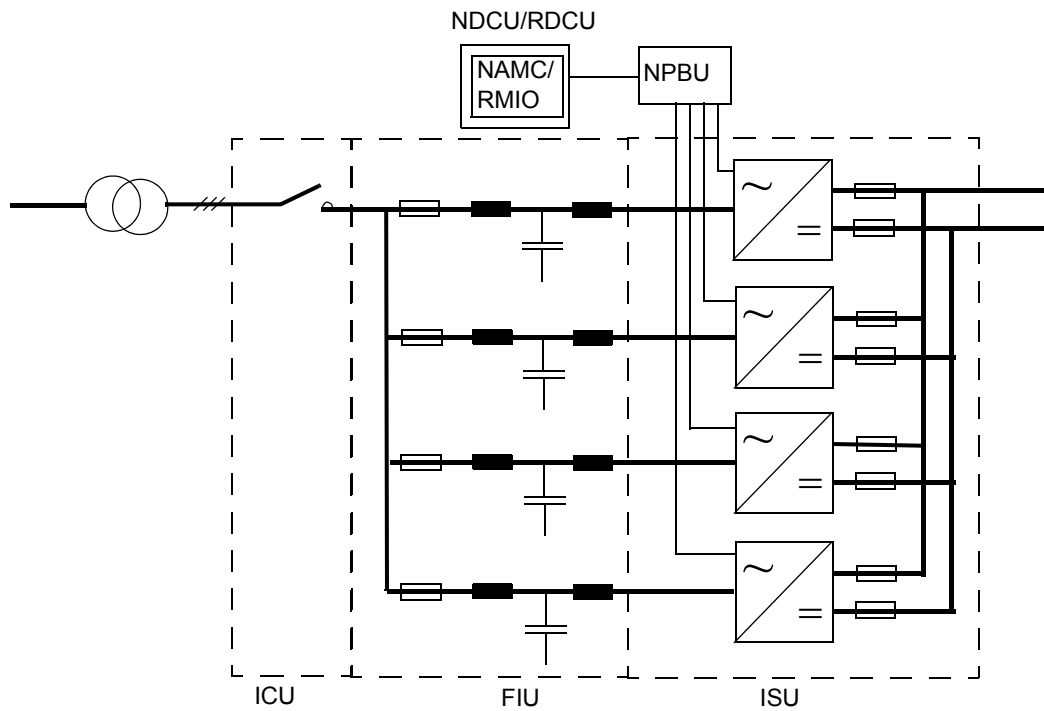
Basic Configuration

The hardware of the IGBT supply unit is similar to the hardware of the ACS 600 MultiDrive inverter. One NAMC/RMIO board controls the converter module. It is located inside the Drive Control Unit (NDCU/RDCU) box. The supply section is equipped with an LCL filter, DC fuses and AC-fuses/switch fuse OESA. AC fuses are used with a breaker and a switch fuse is used with a contactor.

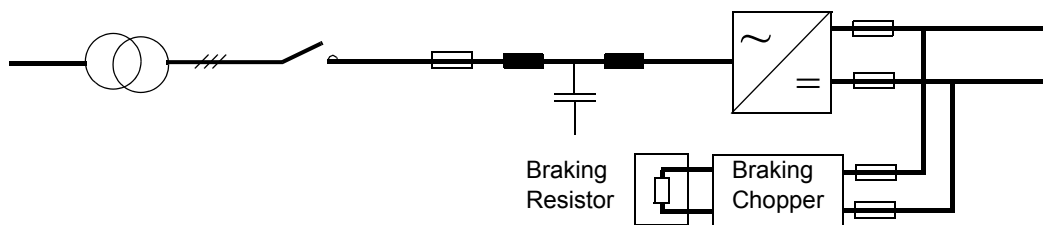


Parallel Connected Modules

Parallel connected IGBT supply converter module configuration is similar to parallel connected inverter module configuration of the ACS 600 MultiDrive. One NAMC/RMIO board controls all parallel connected modules. Each module is equipped with an LCL filter and AC and DC fuses. If one module fails, it can be disconnected by removing the fuses on both sides of it. The whole supply has a common disconnecting device. Full redundancy is not possible. The modules cannot supply the DC link separately, with independent NAMC/RMIO boards.



Braking Chopper A braking chopper can be connected in parallel with an IGBT supply unit. The configuration is beneficial when the braking is continuous and the drive is not allowed to stop if the supply network trips for a short time.



Chapter 4 – Commissioning the Supply Section with ISU

Overview

This chapter describes the commissioning of a supply section that is equipped with the IGBT Supply Unit (ISU).



WARNING! Only qualified electricians are allowed to commission the drive. The *Safety Instructions* on the first pages of this manual must be followed. Ignoring the safety instructions can cause injury or death.


Installation Checklist

The installation must be checked before commissioning the supply section. This table refers to the more detailed instruction.

Action	Information
<ul style="list-style-type: none"><input type="checkbox"/> Check that the mechanical and electrical installation of the frequency converter is inspected and OK.<input type="checkbox"/> Ensure that the insulation resistance of the assembly is checked according to instructions given in the <i>Hardware Manual</i>.<input type="checkbox"/> Ensure that the surroundings and inside of the cabinet are free from dust and loose objects (like cable trimmings and other waste left from the installation).	<p>See <i>ACS 600 MultiDrive Hardware Manual</i> (EN code: 63700118) or <i>ACS800-17 Hardware Manual</i> (EN code: 64638505). Refer to <i>Installation Checklist and Insulation Checks</i>.</p> <p>After the start, the cooling air fans may suck nearby loose objects into the unit. This might cause failure and damage the unit.</p>


Checks with No Voltage Connected

This table is a commissioning checklist for the supply section with no voltage connected.

Action	Information
 <p>WARNING! Ensure that the disconnecter of the supply transformer is locked to open position, i.e. no voltage is, or can be connected to the drive inadvertently. Check also by measuring that there actually is no voltage connected.</p>	
<p>1. Air Circuit Breaker, Relays, Switches</p>	
<ul style="list-style-type: none"> <input type="checkbox"/> If the supply section is equipped with an air circuit breaker, check the current trip levels of the air circuit breaker. <input type="checkbox"/> Check the settings of the relays for the emergency stop circuit. <input type="checkbox"/> Check the settings of the time relays. <input type="checkbox"/> Check the settings of other relays. <input type="checkbox"/> Check the settings of the breakers/switches of the auxiliary circuits. <input type="checkbox"/> Check that all breakers/switches of the auxiliary circuits are open. 	<p>The trip levels have been preset at the factory. In most applications there is no need to change these settings.</p> <p>See the circuit diagrams delivered with the device.</p> <p>See the circuit diagrams delivered with the device.</p> <p>See the circuit diagrams delivered with the device.</p> <p>See the circuit diagrams delivered with the device.</p>
<p>2. Supply Tripping Circuit</p>	
<ul style="list-style-type: none"> <input type="checkbox"/> Check the operation of the supply transformer tripping option. 	<p>This is an optional feature. See the circuit diagrams delivered with the device.</p>
<p>3. Auxiliary Control Voltage Transformer</p>	
<ul style="list-style-type: none"> <input type="checkbox"/> Check the wirings to the primary and secondary side terminals of the auxiliary control voltage transformer. 	<p>See the circuit diagrams delivered with the device for the correspondence between the wirings and the voltage levels.</p>


Connecting Voltage to Auxiliary Circuits

This table describes how to connect voltage to the supply section input terminals and to the Auxiliary Control Unit (ACU) for the first time.

Action	Information
 <p>WARNING! When voltage is connected to the input terminals of the supply section, the voltage will also be connected to the auxiliary control unit and to auxiliary circuits - also to the ones wired to drive sections.</p> <p>Make sure that it is safe to connect voltage to the input terminals. Ensure that while the voltage is connected:</p> <ul style="list-style-type: none"> • Nobody is working with the unit or circuits that are wired from outside into the cabinets. • The cabinet doors are closed. 	
<ul style="list-style-type: none"> <input type="checkbox"/> Disconnect the 230 VAC cables that lead from the terminal blocks to the outside of the equipment and have not yet been checked, and the connections which may not yet have been completed. <input type="checkbox"/> Make sure that the main contactor/air circuit breaker cannot inadvertently be closed by remote control, e.g. by temporarily opening some connection in its control circuit. <input type="checkbox"/> Be ready to trip the main breaker of the supply transformer in case anything abnormal occurs. <input type="checkbox"/> Ensure that all cabinet doors are closed. <input type="checkbox"/> Close the main breaker of the supply transformer. <input type="checkbox"/> Close the main disconnecting switch of the supply section. <input type="checkbox"/> Close the main disconnecting switch of the auxiliary circuit. 	


Checks with Voltage Connected to Auxiliary Circuits

This table is a commissioning checklist for the supply section with voltage connected to the input terminals, and Auxiliary Control Unit (ACU).

Action	Information
 <p>WARNING! This section includes instructions for checking/measuring circuits under voltage. Only a qualified person is allowed to do the work. An appropriate and approved measuring instrument must be used.</p> <p>IF IN DOUBT, DO NOT PROCEED!</p>	
<ul style="list-style-type: none"> <input type="checkbox"/> Ensure the actions described in section <i>Connecting Voltage to Auxiliary Circuits</i> are completed. <input type="checkbox"/> Measure phase voltages by using the switch and meter on the cabinet door. <input type="checkbox"/> Check the secondary side voltage of the auxiliary voltage transformer. Close the protection switch on the secondary side. <input type="checkbox"/> Close the breakers of the auxiliary circuits one by one. Check each circuit by <ul style="list-style-type: none"> • measuring for correct voltage at terminal blocks • checking the operation of the devices connected to the circuit. <input type="checkbox"/> Check the connection from all external auxiliary voltage sources (e.g. from an Uninterrupted Power Supply, UPS) to the auxiliary control unit. 	<p>This is an optional feature. If included, see the circuit diagrams delivered with the device.</p> <p>See the circuit diagrams delivered with the device.</p> <p>Note: The cooling fans of the IGBT supply unit will start after the main contactor is closed.</p> <p>This is an optional feature. If included, see the circuit diagrams delivered with the device.</p>


Connecting Voltage to IGBT Supply Unit

This table describes how to connect voltage to the IGBT supply unit and the DC busbars for the first time.

Action	Information
 <p>WARNING! When connecting voltage to the IGBT supply unit, the DC busbars will become live, as will all the inverters connected to the DC busbars.</p> <p>Make sure that it is safe to connect voltage to the IGBT supply unit. Ensure that:</p> <ul style="list-style-type: none"> • Nobody is working with the unit or circuits that are wired from outside into the cabinets. • All cabinet doors are closed. 	
<p>1. First Voltage Switch-on for the IGBT Supply Unit</p>	
<ul style="list-style-type: none"> <input type="checkbox"/> If the supply section is equipped with an air circuit breaker, set the air circuit breaker current settings to 50% of the on-load values. <input type="checkbox"/> Ensure that all cabinet doors are closed. <input type="checkbox"/> Be ready to trip the main breaker of the supply transformer if anything abnormal occurs. <input type="checkbox"/> Close the main disconnecting switch of the supply section. Close the main contactor / air circuit breaker of the supply section. 	<p>It is recommended to set relatively low current values at the first voltage switch-on.</p>
<p>2. Air Circuit Breaker Current Settings</p>	
<ul style="list-style-type: none"> <input type="checkbox"/> Increase the air circuit breaker current settings to the on-load values. 	


Starting

This procedure instructs how to start the IGBT supply unit.

Action	Information
 <p>WARNING! When starting the IGBT supply unit, the DC busbars will become live, as will all the inverters connected to the DC busbars.</p> <p>Make sure that it is safe to start the IGBT supply unit. Ensure that:</p> <ul style="list-style-type: none"> • Nobody is working with the unit or circuits that are wired from outside into the cabinets. • All cabinet doors are closed. • The covers of the motor terminal boxes are on. 	
<ul style="list-style-type: none"> <input type="checkbox"/> Ensure the actions described in subsections <i>Checks with No Voltage Connected</i> and <i>Checks with Voltage Connected to Auxiliary Circuits</i> are completed. <input type="checkbox"/> Be ready to trip the main breaker of the supply transformer if anything abnormal occurs. <input type="checkbox"/> Close the main disconnecting switch of the auxiliary circuit. <input type="checkbox"/> Close the main disconnecting switch of the supply section. <input type="checkbox"/> Start the ISU: <ul style="list-style-type: none"> • reset the starting logic by the RESET button on the cabinet door • turn the starting switch on the cabinet door from position 0 to 1 and • turn the starting switch to the START position and release it. 	

Checks with ISU Supply Started

This table is a list of checks to be done after the IGBT supply unit is started and the DC busbars are live.

Action	Information
 <p>WARNING! This section includes instructions for checking/measuring circuits under voltage. Only a qualified person is allowed to do the work. An appropriate and approved measuring instrument must be used.</p> <p>IF IN DOUBT, DO NOT PROCEED!</p>	
<p>1. Basic Checks</p>	
<p><input type="checkbox"/> Check that the cooling fan in the supply section rotates freely in the right direction, and the air flows upwards.</p>	<p>A paper sheet set on the lower gratings stays. Fan runs noiselessly.</p>
<p>FLOATING NETWORK (IT NETWORK)</p>	
<p>1. Earth Fault Protection Based on an Insulation Monitoring Device</p>	
<p><input type="checkbox"/> Check the setting of Parameter 30.04 EXT EARTH FAULT, and the connection to DI4.</p> <p><input type="checkbox"/> Check the tuning of the insulation monitoring device for the earth fault protection (Bender).</p> <p>The insulation monitoring device is tuned at the factory. If further tuning is required, see the <i>IRDH265 Operating Manual</i> by Bender (code: TGH1249).</p>	<p>This is an optional feature (IRDH265-x). If included, see the circuit diagrams delivered with the device. For information on the protection principle, see Chapter 5 – Earth Fault Protection and the <i>IRDH265 Operating Manual</i> by Bender (code: TGH1249).</p>
<p>SYSTEM EARTHED NETWORK (TN NETWORK)</p>	
<p>1. Earth Fault Protection Based on Internal Current Measurement</p>	
<p><input type="checkbox"/> Check the setting of Parameter 30.02 EARTH FAULT.</p>	<p>This is a programmable feature. For information on the protection principle, see Chapter 5 – Earth Fault Protection.</p>

Parameters

The parameters of the ISU need not be set in a normal start-up procedure or in normal use.

Controlling the ISU with an Overriding System

This procedure instructs how to control or monitor the IGBT supply unit from an overriding system by using data sets 1 and 2 or 10 to 33 with DDCS and DriveBus communication protocols.

The communication works via fibre optic cables connected to channels CH0 to CH3 on the NAMC board. When the RMIO board is used, channels CH0 to CH3 are provided by the DDCS communication option module (RDCO) which is inserted into the optional module slot marked “DDCS” on the RMIO board.

Action		Parameter																												
<input type="checkbox"/>	Set this parameter to MCW if the ISU will be controlled with an overriding system. Set to I/O if the ISU is only monitored.	98.01 COMMAND SEL																												
<input type="checkbox"/>	Set this parameter to FBA DSET1 or FBDSET 10 depending on what datasets the overriding system uses.	98.02 COMM MODULE																												
<input type="checkbox"/>	Connect the fibre optic cables to channel CH0.																													
<input type="checkbox"/>	Set the node address and communication mode for channel CH0 as follows: <table border="1" style="margin: 10px auto;"> <thead> <tr> <th rowspan="2">Controller</th> <th colspan="3">Node Address</th> <th rowspan="2">Par. 71.01 CH0 DRIVEBUS MODE</th> </tr> <tr> <th>DDCS</th> <th>DriveBus</th> <th>Module-Bus</th> </tr> </thead> <tbody> <tr> <td>APC2</td> <td>1</td> <td>-</td> <td>-</td> <td>NO</td> </tr> <tr> <td>AC70</td> <td>-</td> <td>-</td> <td>17...125</td> <td>NO</td> </tr> <tr> <td>AC80</td> <td>-</td> <td>1...12</td> <td>17...125</td> <td>YES</td> </tr> <tr> <td>FCI (CI810A)</td> <td>-</td> <td>-</td> <td>17...125</td> <td>NO</td> </tr> </tbody> </table>	Controller	Node Address			Par. 71.01 CH0 DRIVEBUS MODE	DDCS	DriveBus	Module-Bus	APC2	1	-	-	NO	AC70	-	-	17...125	NO	AC80	-	1...12	17...125	YES	FCI (CI810A)	-	-	17...125	NO	70.01 CH0 NODE ADDR 71.01 CH0 DRIVEBUS MODE Note: Setting of Par. 71.01 is valid after the next power-up.
Controller	Node Address			Par. 71.01 CH0 DRIVEBUS MODE																										
	DDCS	DriveBus	Module-Bus																											
APC2	1	-	-	NO																										
AC70	-	-	17...125	NO																										
AC80	-	1...12	17...125	YES																										
FCI (CI810A)	-	-	17...125	NO																										
<input type="checkbox"/>	Check that the communication is working.																													
<input type="checkbox"/>	Set the delay time for a communication fault indication.	70.04 CH0 TIMEOUT																												
<input type="checkbox"/>	Select the action upon a communication fault on channel CH0.	70.05 CH0 COMM LOSS CTRL																												
<input type="checkbox"/>	Select RING, if channels CH0 are connected in a ring. The default setting STAR is typically used with DDCS branching units NDBU-85/95.	70.19 DDCS CH0 HW CONN																												
<input type="checkbox"/>	If a PC is used for control/monitoring, set the node address for channel CH3. Addresses 1...75 and 126...254 are allowable. The rest of the addresses are reserved for branching units NDBU-85/95 (see <i>NDBU-85/95 User’s Manual</i> , code: 64285513). Note: If the channels CH3 of several supply units have been connected in a ring or in a star (via a branching unit), give each converter a unique node address. The new address becomes valid only on the next NAMC board power-on.	70.15 CH3 NODE ADDR																												

Action		Parameter
<input type="checkbox"/>	Select RING, if channels CH3 have been connected in a ring. The default setting STAR is typically used with DDCS branching units NDBU-85/95.	70.20 CH3 HW CONNECTION
<input type="checkbox"/>	Select the addresses for the data to be received from the overriding system and for the data to be transmitted to the overriding system. Note the different updating intervals.	Groups 90 and 91 DATASET RECEIVE ADDRESSES Groups 92 and 93 DATASET TRANSMIT ADDRESSES
<input type="checkbox"/>	Test the functions with received and transmitted data.	

Fieldbus Adapters

Action		Parameter
<input type="checkbox"/>	Set the communication with these parameters. See the appropriate fieldbus adapter manual.	Group 51 COMMUNICATION MODULE

On-load Checks

This table is a commissioning checklist for the loaded supply section.

Action		Information
<input type="checkbox"/>	Check the correct operation of the current meters.	This is an optional feature. See the circuit diagrams delivered with the device.
<input type="checkbox"/>	Check the correct operation of the emergency-stop circuits.	This is an optional feature. See the circuit diagrams delivered with the device.

Chapter 5 – Earth Fault Protection

Overview

This chapter contains descriptions of the earth fault protection solutions available for a drive equipped with an IGBT supply unit. The settings required at the start-up are given in [Chapter 4 – Commissioning the Supply Section with ISU](#).

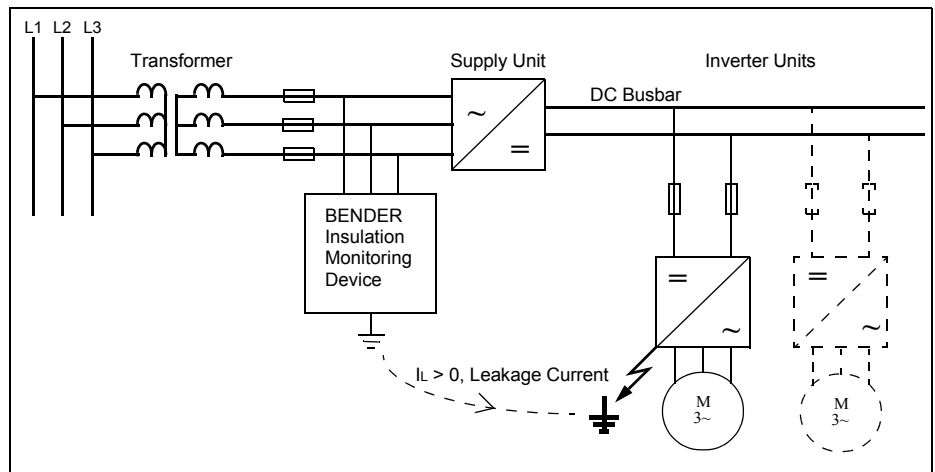
Floating Network

This section describes the earth fault protection principle in a floating network.

Insulation Monitoring Device

Diagram

This diagram shows earth fault protection implemented with an insulation monitoring device.



Description

The monitoring device is connected between the unearthed system and the equipotential bonding conductor (PE).

A pulsating AC measuring voltage is superimposed on the system (measuring principle *Adaptive Measuring Pulse, AMP* is developed by BENDER, patent pending). The measuring pulse consists of positive and negative pulses of the same amplitude. The period depends on the respective leakage capacitances and the insulation resistance of the system to be monitored.

The setting of the response values and other parameters can be carried out via the function keys. The parameters are indicated on the display and they are stored in a non-volatile memory after setting.

With Bender’s insulation monitoring device it is possible to set up two response values: ALARM1 and ALARM2. Both values have an own alarm LED, which illuminates if reading is below these selected response values.

In Case of an Earth Fault

An earth fault closes the measuring circuit. An electronic evaluation circuit calculates the insulation resistance which is indicated on an LC display or an external ohmmeter after the response time.

The alarm actions depend on the electric connection: for example ALARM1 can be wired to give a warning, and ALARM2 can be wired to trip the device.

Further Information

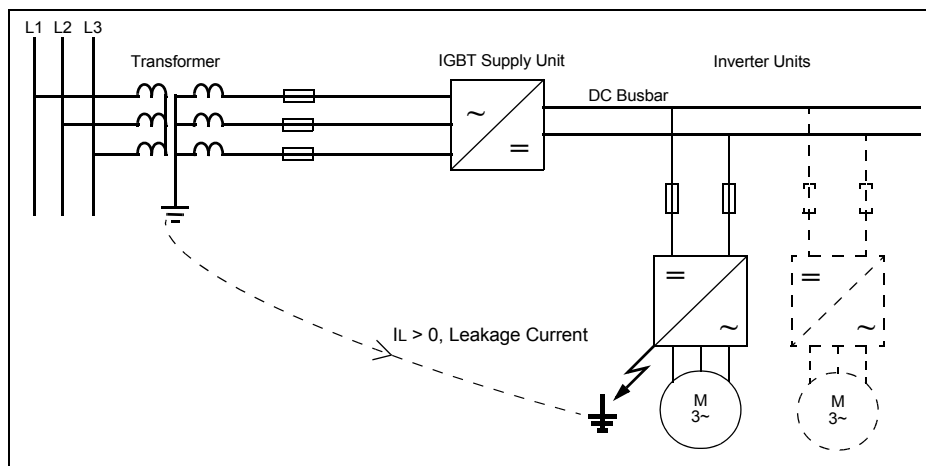
Further information about the insulation monitoring device is available in *IRDH265 Operating Manual (code TGH1249)* published by the manufacturer, BENDER companies.

System-earthed Network

In a system-earthed network, the neutral point of the supply transformer is earthed solidly. This section describes an internal earth fault protection principle in a system-earthed network.

Diagram

This diagram shows earth fault protection implemented with internal current transducers in the ACA 635.



Description

The line current unbalance is calculated from measured currents I_U , I_V and I_W .

In Case of an Earth Fault

In normal operation the current sum is zero. An earth fault leads to an unbalance in the 3-phase system and therefore to a current sum different from zero. If the current unbalance exceeds the limit set in Par. 30.03 EARTH FAULT LEVEL, an alarm is given or the device is tripped.

Chapter 6 – Firmware Description

Overview

This chapter describes the IGBT supply unit control program. **Note: The parameters listed in this chapter need not be set in normal use.** They are mentioned for explaining the control principle only.

The following symbols are used:

1.10 , 11.11	Actual signal or parameter (see Chapter 8 – Parameters).
113.05	Parameter above 100. These parameters are not visible to the user unless the passcode is entered for the Parameter Lock in Parameter 16.03 PASS CODE. These parameters are not allowed to be changed without ABB's permission.

Control Principle

The fundamental theory of line converter operation can be represented by an equivalent circuit with an AC choke and vector diagrams (below), where

— motoring

- - - generating

\bar{U}_1 network voltage vector

\bar{U}_2 line converter voltage vector

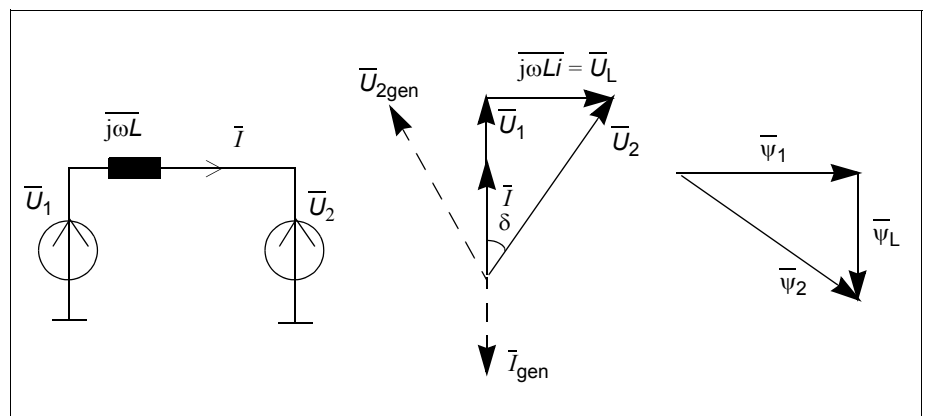
\bar{U}_L AC choke voltage vector

$\bar{\Psi}_1$ “network flux” vector

$\bar{\Psi}_2$ “line converter flux” vector

$\bar{\Psi}_L$ “AC choke flux” vector

δ power transfer angle.



The primary function of the ISU is to control the power transfer between the network and the DC link. The purpose of the AC choke (represented by reactance $X = j\omega L$) is to smooth the line current and to act as an energy storage for the switch-mode supply. Power transfer equation between the network and the ISU is presented below:

$$P = \frac{U_1 U_2}{X} \sin \delta$$

Real power is being transferred only if an angle difference exists between the two voltage vectors. Reactive power transfer equation is presented below:

$$Q = \frac{U_1^2}{X} - \frac{U_1 U_2}{X} \cos \delta$$

For the desirable magnitude and the direction of the power and reactive power flow, the length of the converter voltage vector and its phase angle δ (with respect to the line voltage vector) must be controlled. The DC voltage is controlled by keeping the power (energy) equilibrium between the line and the drives in the DC link constant. The sign of the angle determines the direction of the power flow.

The output AC voltage is controlled by setting the length of the flux reference to correspond to the desired output voltage level producing $\cos \theta = 1.0$.

The ISU control needs measurements of the DC link voltage and two line currents. The “stator flux” (integral of the voltage vector of the ISU) is calculated by integrating the voltage vector used to generate the output voltage of the ISU. This is due to the fact that the existing voltage in the network can be thought to be generated by a rotating magnetic flux encircled by coils. Each of these coils is one of the line voltage phases. The voltage in the coils can be expressed by the formula below:

$$\overline{U} = \frac{d \overline{\psi}}{dt}$$

The virtual torque generated by the ISU is calculated as a cross product of flux and current vectors:

$$T = \overline{\psi} \times \overline{I}$$

Power can also be expressed as a product of torque and angular velocity:

$$P = \omega T$$

If the network frequency is constant, power is directly proportional to the torque. By controlling torque, power transferred between the ISU and the network can be set to a value that keeps the DC link voltage constant. These basic facts enable the use of the DTC method which relies on control of flux and torque.

The main difference between DTC and conventional PWM is that the torque is controlled at the same time level as power switches (25 ms). There is no separate voltage and frequency controlled PWM modulator. All selections of the switches are based on the electromagnetic state of the ISU. This kind of control method can be realised only by using a high speed signal processing technology. The digital signal processor Motorola 56xxx is used in the ACS 600 product family to achieve sufficient speed.

Identification Routine

The ISU adapts itself to the supply network and no data concerning the network conditions is to be set. The converter rating plate data is downloaded in the software package.

When the ISU is connected to the network for the first time, an identification routine must be completed. The identification routine is executed each time after the NAMC/RMIO board is powered and the line-side converter is started provided that Parameter 99.08 AUTO LINE ID RUN is set to YES.

The identification routine can be executed manually also after the next start (without power up of the NAMC/RMIO board) by setting the Parameter 99.07 LINE SIDE ID RUN to YES and pressing the Control Panel Start key. This can be done if there is doubt that the automatic identification routine has failed, or an automatic routine is not desirable as it takes approximately 5 seconds and requires that the line-side converter is not loaded.

During ID Run voltage level in the supply network is estimated based on DC voltage measurement. The value is indicated by Parameter 2.07 DC REF INITIALIZ. If the value of Parameter 2.07 DC REF INITIALIZ is within allowed limits (see Par. 9.11 bit 9 NET VOLTAGE fault), the procedure goes on further to define the frequency of the network (50 Hz or 60 Hz) and the phase order.

The parameters concerning the identification routine are presented below.

Code	Parameter	Unit	Description
99.07	LINE SIDE ID RUN		Manual identification run
99.08	AUTO LINE ID RUN		Automatic identification run after power up of the NAMC/RMIO board and next start
2.07	DC REF INITIALIZ	V	Nominal DC reference
	Fault		
9.11 bit 9	NET VOLT FLT		Supply voltage is not valid

Charging

When the control has received a start command, the charging contactor is closed. When the DC link voltage is high enough, the main contactor/breaker is closed and the charging contactor is opened. This procedure is controlled by the NAMC board via NIOC board digital outputs RO1 and RO3 (or by the RMIO board via digital outputs RO1 and RO3).

If the charging is not completed, i.e. the DC link voltage has not exceeded the value of Parameter 30.12 DC UNDERVOLT TRIP or the charging current is not below 5% of $I_{10s/60s}$, a fault bit is set (Parameter 9.11 SUPPLY FAULT WORD bit 0 CHARGING FLT).

Synchronization

The ISU is synchronized to the network by three-phase short-circuits. On the basis of the short-circuit current, the ISU can identify the phase order of the supply network and the starting point for the flux/voltage vector. The phase order of the supply can be changed without performing the identification routine again.

The synchronization can also be done without phase order check by setting Parameter 99.06 FAST SYNC to YES.

If a synchronization trial fails, the ISU makes up to 9 additional trials if the supply has not been disconnected. One reason for a failed synchronization is too low a short-circuit current due to the high impedance of the network.

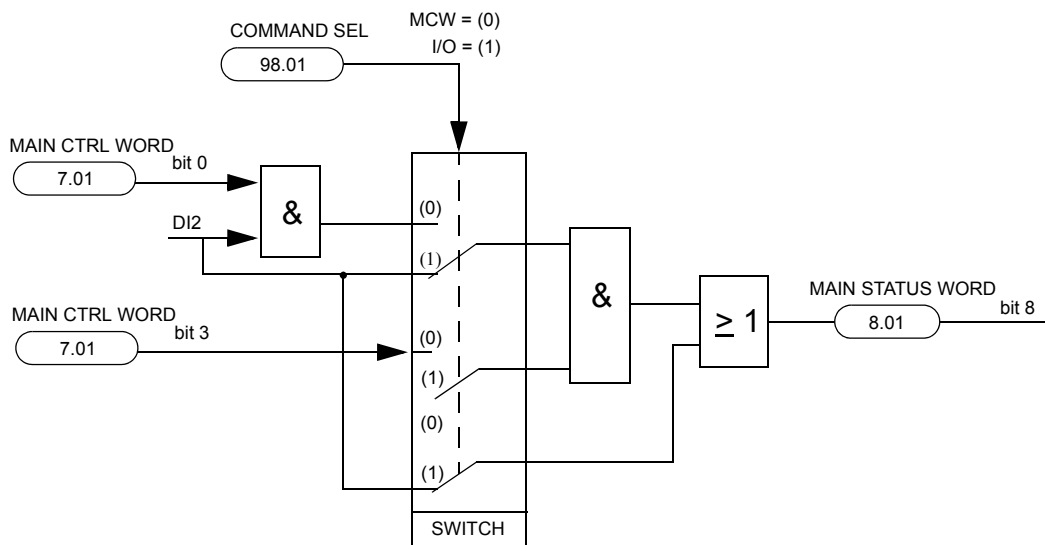
The synchronization parameters are listed below.

Code	Parameter	Unit	Description
99.06	FAST SYNC		One short-circuit pulse is used.
	Fault		
9.02	SUPPLY PHASE		Synchronization failed, phase(s) missing.
9.11	SYNCHRO FLT		Synchronization failed, short-circuit current below limit.

Starting Sequence

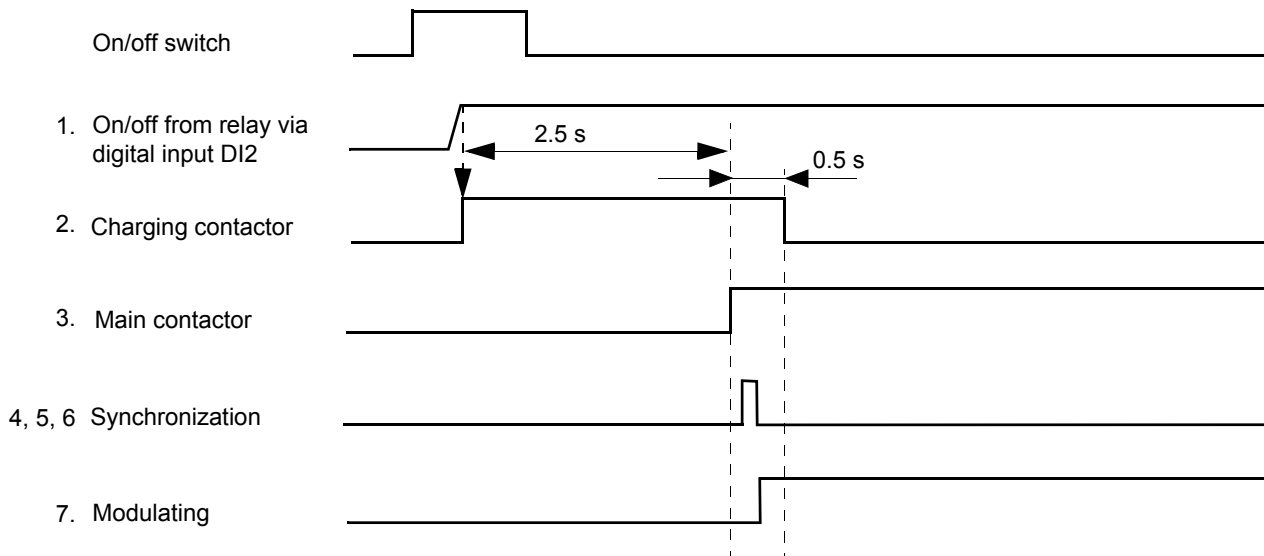
During the charging procedure the main contactor is closed, and after the synchronization routine is completed, the modulator is started and the ISU runs normally.

A simplified block diagram of the modulator starting (from starting switch on the cabinet door or via fieldbus) is presented below. For description of the starting procedure, see the next pages.



Start by the Starting Switch

By default, the ISU control commands (ON/OFF) are given by the starting switch on the cabinet door which is wired to digital input DI2. The starting sequence is as follows:

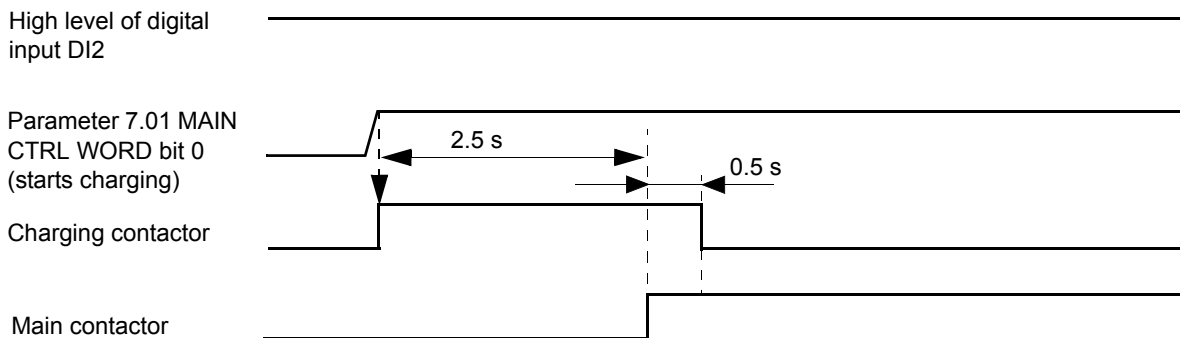


Step	Function
1.	ISU control receives the ON command (DI2 rising edge) from the starting switch.
2.	ISU control logic closes the charging contactor control circuit (RO1).
3.	ISU control logic closes the main contactor and cooling fan control circuit (RO3).
4.	ISU control logic receives the “main contactor on” acknowledgement (DI3).
5.	ISU control logic receives the “cooling air fan in operation” acknowledgement (DI1).
6.	ISU synchronizes itself to the supply network in case DC voltage is OK (charging is completed successfully).
7.	ISU control starts modulation and opens the charging contactor control circuit (RO1). The inverter units can be started.

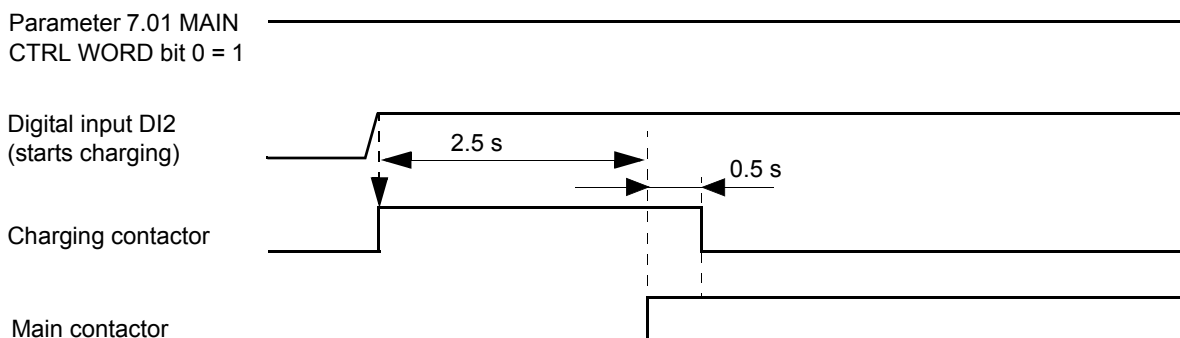
Start via Fieldbus

To enable the fieldbus control Parameter 98.01 COMMAND SEL must be set to MCW. The DC bus can be charged and the modulator started separately via fieldbus. The DC bus can be charged in two ways:

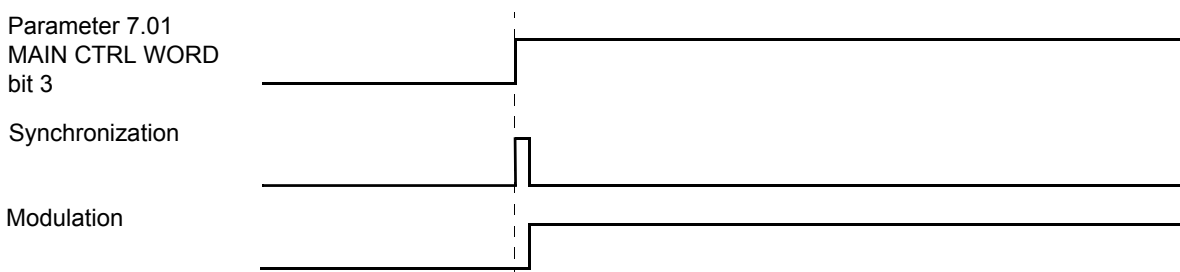
1. by rising edge of Parameter 7.01 MAIN CTRL WORD bit 0 and simultaneous high level of digital input DI2 (starting switch on the cabinet door in position 1).




2. by rising edge of digital input DI2 (from starting switch) and simultaneous high level of Parameter 7.01 MAIN CTRL WORD bit 0.



The modulator is started by high level of Parameter 7.01 MAIN CTRL WORD bit 3, and stopped by low level of bit 3. The modulator can be started only after the charging of the DC bus is completed.



Stop

A stop signal from the on/off switch on the cabinet door disables the modulator and opens the main contactor. The modulator can be stopped also from the  key on the Control Panel and from DriveWindow in local mode, and from an overriding system in remote mode. These functions do not open the main contactor.

When the modulator is stopped in local mode or by an overriding system, the ISU moves to 6-pulse diode bridge mode.

Missing Phase

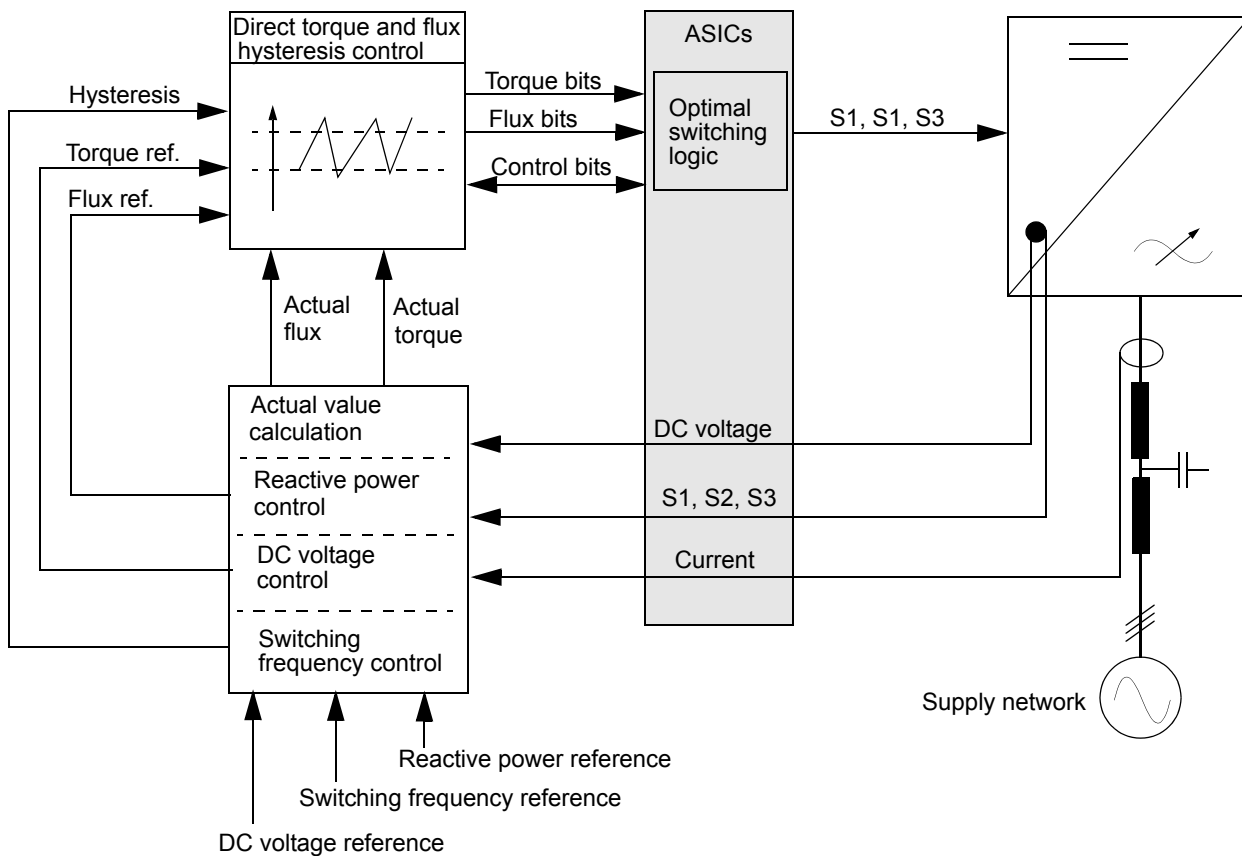
There is no direct AC voltage measurement in the ISU. The lost supply voltage is identified with current and DC voltage measurement.

When the ISU detects that the current has been below 0.64 percent of $I_{10s/60s}$ for 1.5 milliseconds, an alarm (Parameter 9.12 SUPPLY ALARM WORD bit 10 NET LOST) is generated. The ISU tries to resynchronize as long as the DC voltage is greater than the value of Parameter 30.12 DC UNDERVOLT TRIP. The resynchronizing checks are made at 20 ms intervals. If the voltage in the DC link falls below the limit defined by Par. 30.12 DC UNDERVOLT TRIP, the ISU will open the main contactor/breaker and a fault (Parameter 9.11 bit 14 DC UNDERVOLT) is generated.

Code	Parameters	Unit	Description
30.12	DC UNDERVOLT TRIP	V	Undervoltage tripping limit
	Alarm		
9.12 bit 10	NET LOST		Supply lost alarm
	Fault		
9.11 bit 14	DC UNDERVOLT		Undervoltage tripping

Control Diagram

A block diagram of the measurements and principle of the ISU control program is shown below. S1, S2 and S3 denote the power switches.



Controllers

The control includes two main controllers:

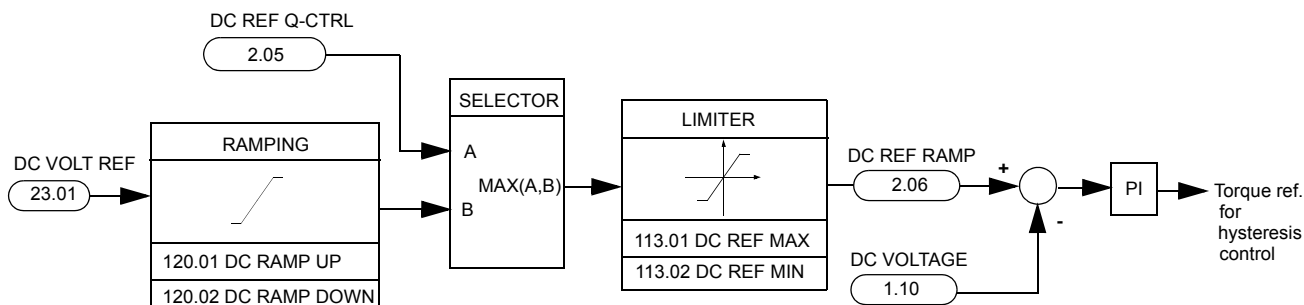
- torque and flux hysteresis control
- dc voltage controller.

On the basis of measurements the following items are calculated:

- actual value for flux
- actual value for torque
- actual value for reactive power
- estimate for frequency.

DC Voltage Controller The ISU control has two reference values for the DC voltage control:

- Parameter 23.01 DC VOLT REF (user given reference)
- Parameter 2.05 DC REF Q-CTRL (minimum DC voltage reference calculated by reactive power controller).



In normal mode, the ramped value of Parameter 23.01 DC VOLT REF is selected if it is higher than Parameter 2.05 DC REF Q-CTRL. The DC reference ramping times are set by Parameters 120.01 DC UP TIME and 120.02 DC DOWN TIME. Minimum and maximum values for the DC reference are set by Parameters 113.01 DC REF MAX and 113.02 DC REF MIN.

Reference List The references are listed below.

Code	Parameter	Unit	Description
23.01	DC VOLT REF	V	User given reference
	113.01 DC REF MAX	V	Upper limit for the reference = $1.2 \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$
	113.02 DC REF MIN	V	Lower limit for the reference = $0.65 \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$
	120.01 DC RAMP UP	s	DC voltage reference ramp time from 0 to $\sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$. Default 1 s.
	120.02 DC RAMP DOWN	s	DC voltage reference ramp time from $\sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$ to 0. Default 1 s.
	Actual Value		
1.10	160.04 DC VOLTAGE	V	Actual DC voltage
2.05	DC REF Q-CTRL	V	Reference from reactive power control
2.06	DC REF RAMP	V	Ramped and limited reference

The DC voltage controller is the primary controller for the ISU.

The DC voltage controller keeps the DC voltage in a preset reference in all load conditions. An error signal is calculated from DC voltage measurement (Actual Signal 1.10 DC VOLTAGE) and Actual Signal 2.06 DC REF RAMP. The output of the DC voltage PI controller is the torque reference for hysteresis control.

The PI controller parameters are pretuned. There is no need to retune them.

Reactive Power Control

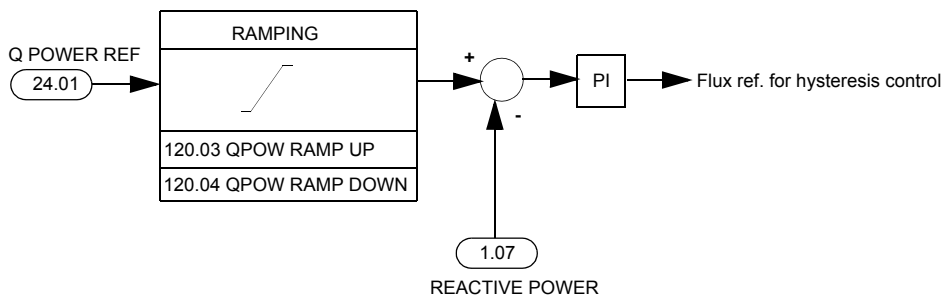
The reactive power control sets the flux reference for hysteresis control to values with which zero reactive power is achieved.

Reactive power control is capable of generating a preset amount of reactive power (Parameter 24.01 Q POWER REF) to the network (positive = capacitive, negative = reactive) by changing the flux length. Increasing the ISU flux length higher than the network flux length, capacitive power is generated to the network and vice versa. Increased flux means that the output voltage of the ISU is higher than the network voltage.

Reactive power control parameters are listed below.

Code	Parameter	Unit	Description
24.01	Q POWER REF	%	Reactive power in percentage of the nominal power
1.07	REACTIVE POWER	kVAr	Calculated reactive power
	120.03 QPOW RAMP UP	s	Reactive power reference ramp up time from 0 kVAr to the absolute value of Par. 4.06 CONV NOM POWER. Default 1 s.
	120.04 QPOW RAMP DOWN	s	Reactive power reference ramp down time from the absolute value of Par. 4.06 CONV NOM POWER to 0 kVAr. Default 1 s.

A block diagram of reactive power control is shown below.



Chapter 7 – Fault Tracing

Overview

This chapter explains the fault tracing procedure based on the warning and fault messages given by the ISU program. A factory installed control panel in the line-side converter is required in this procedure. For control panel use and motor-side inverter fault tracing, see the *Firmware Manual* of the application program.

All warning and fault messages are presented in tables below with information on the cause and remedy for each case. Most warning and fault conditions can be identified and cured with that information. If not, contact an ABB service representative.

CAUTION! Do not attempt any measurement, parts replacement or other service procedure not described in this manual. Such action will void guarantee, endanger correct operation, and increase downtime and expense.



WARNING! All electrical installation and maintenance work described in this chapter should only be undertaken by a qualified electrician. The *Safety Instructions* on the first pages of this manual must be followed.

Fault Tracing

The drive is equipped with advanced protection features that continuously guard the unit against damage and down time due to incorrect operating conditions and electrical and mechanical malfunctions.

The warning message disappears when any of the Control Panel keys is pressed. The warning will reappear in one minute if conditions remain unchanged. If the drive is operated with the Control Panel detached, the red LED in the Control Panel mounting platform indicates fault condition.

For setting of programmable warning and fault messages and functions, refer to *Chapter 8 – Parameters*.

Fault Resetting

An active fault can be reset either by pressing the keypad **RESET** key, by digital input or fieldbus, or switching the supply voltage off for a while. When the fault has been removed, the drive can be started.

Fault History When a fault is detected, it is stored in the Fault History. The last faults and warnings are stored with the time the fault was detected.



WARNING! After a fault reset, the drive will start if the start signal is on. Before the reset, switch off the external start signal or ensure that it is safe to start.

The Fault History can be viewed by pressing or in the Actual Signal Display Mode. The Fault History can then be scrolled with and . To exit the Fault History press or . The Fault History can be cleared by pressing the **RESET** key.

Fault and Warning Messages The tables below show the warning and fault messages.

Warning Messages		
Warning	Cause	What to do
ACS 600 TEMP/ ACS 800 TEMP Par. 9.12 bit 4	Excessive IGBT module temperature. A warning is given if the temperature exceeds 115 °C.	Check ambient conditions. Check air flow and fan operation. Check heatsink fins for dust pick-up. Check line current against unit current.
AI<MIN FUNC Par. 9.12 bit 3	I/O reference 4...20 mA is below 3.1 mA when Par. 13.06 MINIMUM AI2 or Par. 13.10 MINIMUM AI3 is set to 4 mA.	Check for proper analogue control signal level. Check the control wiring.
CH0 COM LOST Par. 9.12 bit 0	Communication break detected on CH0 receive. (can be deactivated: see Parameter 70.04)	Check the fibre optic cables between the NAMC board / RDCO module and overriding system (or fieldbus adapter). Test with new fibre optic cables. Check that the CH0 node address (Par. 70.01 CH0 NODE ADDR) is correct in the ISU. Check the status of the fieldbus adapter. See appropriate fieldbus adapter manual. Check parameter settings of Group 51, if a fieldbus adapter is present. Check the connections between the fieldbus and the adapter. Check that the bus master is communicating and correctly configured.
CURRENT LIM Par. 9.12 bit 5	Current limit is exceeded. The limit is 220% of $I_{1base(10s/60s)}$.	Limit inverter actual power or lower the reactive power percentage in Par. 24.01 Q POWER REF.
DI5 = 0 Par. 9.12 bit 14	Digital input DI5 is OFF (0).	Check the function indicated via digital input DI5.

Warning Messages		
Warning	Cause	What to do
E EARTH FLT Par. 9.12 bit 13	<u>IT (Ungrounded) Network</u> Impedance between a live part (e.g. phase conductor, DC link, motor cable or motor) and earth/ground is too low. Earth fault in LCL filter, line converter, DC link, inverter(s), motor cables or motor.	Check motors. Check motor cables. Check ISU. Check inverter(s). Check LCL filter.
EARTH FAULT Par. 9.12 bit 13	<u>Earthed/Grounded Network</u> The sum of line currents measured with internal current transducers is too high. Earth fault in LCL filter, line converter, DC link, inverter(s), motor cables or motor, or current unbalance in parallel connected converters.	Check motors. Check motor cables. Check ISU fuses (parallel connected units). Check ISU. Check inverter(s). Check LCL filter.
NET LOST Par. 9.12 bit 10	Network voltage is lost during modulation. Line current is below $0.0064 \cdot I_{10s/60s}$. The situation may cause DC link undervoltage.	Check network conditions.
PANEL LOST Par. 9.12 bit 1	A Local Control device (CDP 312 or DriveWindow) has ceased communicating. This can be caused by disconnection of the selected local control device during local control or an internal fault in the local controlling device. This warning transfers the ISU to remote mode.	Check Control Panel connector. Replace Control Panel in the mounting platform.
NO COMMUNICATION (x)	This message is generated by the Control Panel CDP 312 control program. There is a cabling problem or a hardware malfunction on the Panel Link. (4) = Panel type is not compatible with the version of the converter application program.	Check the Panel Link connections. Press the RESET key. The panel reset may take up to half a minute, please wait. Check the Panel type and the version of the drive application program. The Panel type is printed on the cover of the Panel.
ID N CHANGED	The ID number of the ISU has been changed from 1 (the change is not displayed on the Control Panel CDP 312).	To change the ID number back to 1 go to Drive Selection Mode by pressing DRIVE . Press ENTER . Set the ID number to 1. Press ENTER .
LOAD FACTORY	Factory parameter settings are being restored.	Please wait.

Fault Messages		
Fault Text	Cause	What to do
ACS 600 TEMP/ ACS 800 TEMP Par. 9.01 bit 3 Par. 9.11 bit 3	Excessive IGBT module temperature. The trip level is 125 °C.	Check ambient conditions. Check air flow and fan operation. Check heatsink fins for dust pick-up. Check line current against unit current.
AMBIENT TEMP Par. 9.02 bit 7	I/O control board temperature is lower than +5 °C or exceeds +73 °C.	Check ambient temperature in the auxiliary control unit (ACU).
CHARGING FLT Par. 9.11 bit 0	DC link voltage is not high enough after charging procedure. DC link voltage has not exceeded the value of Par. 30.12 DC UNDERVOLT TRIP or current is not below 5% of $I_{10s/60s}$ at the end of the charging.	Check charging circuit fuses. Check charging circuit. Check possible short-circuit in DC link. Check the setting of Par. 30.12 DC UNDERVOLT TRIP.

Fault Messages		
Fault Text	Cause	What to do
	Faulty PPCC link (DC voltage measurement is zero).	Check the PPCC link. See fault message PPCC LINK.
CH0 COM LOST Par. 9.02 bit 12 Par. 9.11 bit 10	Communication break detected on CH0 receive. (programmable fault, see Parameter 70.05)	Check the fibre optic cables between the NAMC board / RDCO module and the overriding system (or fieldbus adapter). Test with new fibre optic cables. Check that the CH0 node address (Parameter 70.01) is correct in the ISU. Check the status of the fieldbus adapter. See appropriate fieldbus adapter manual. Check parameter settings of Group 51, if a fieldbus adapter is present. Check the connections between the fieldbus and the adapter. Check that the bus master is communicating and correctly configured.
DC OVERVOLT Par. 9.01 bit 2 Par. 9.11 bit 15	Intermediate circuit DC voltage is excessive. This can be caused by 1. static or transient overvoltages in the mains. 2. too high supply voltage during synchronisation. The default trip limit is 740 VDC for 415 V units, 891 VDC for 500 V units and 1230 VDC for 690 V units. The trip limit can be changed with Par. 30.11 DC OVERVOLT TRIP.	Check the level of supply voltage, DC voltage and converter nominal voltage.
DC UNDERVOLT Par. 9.02 bit 2 Par. 9.11 bit 14	Intermediate circuit DC voltage is not sufficient. This can be caused by a missing mains phase, a blown fuse or a rectifier bridge internal fault. The default trip limit is 293 VDC for 415 V units, 354 VDC for 500 V units and 488 VDC for 690 V units. The tip limit can be changed with Par. 30.12 DC UNDERVOLT TRIP.	Check supply and inverter fuses. Check supply voltage.
DI5 = 0 Par. 9.11 bit 2	Digital input DI5 is OFF (0).	Check the function indicated via digital input DI5.
E EARTH FLT Par. 9.11 bit 4	<u>IT (Ungrounded) Network</u> Impedance between a live part (e.g. phase conductor, DC link, motor cable or motor) and earth/ground is too low. Earth fault in LCL filter, line converter, DC link, inverter(s), motor cables or motor.	Check motors. Check motor cables. Check ISU. Check inverter(s). Check LCL filter.
EARTH FAULT Par. 9.01 bit 4 Par. 9.11 bit 12	<u>Earthed/grounded Network</u> The sum of line currents measured with internal current transducers is too high. Earth fault in LCL filter, line converter, DC link, inverter(s), motor cables or motor, or current unbalance in parallel connected converters.	Check motors. Check motor cables. Check ISU fuses (parallel connected units). Check ISU. Check inverter(s). Check LCL filter.

Fault Messages		
Fault Text	Cause	What to do
FAN FLT Par. 9.11 bit 5	Fan is not rotating, or contactor connection is loose.	Check the acknowledge circuit connection to the digital input D11. Check the condition of the bearings of the fan motor by rotating fan motor manually. If the bearings are faulty replace the fan (available as spare part). Replace the fan if trippings continue and the bearings are OK.
IO FAULT Par. 9.02 bit 6	I/O communication fault or error detected on CH1. This can be caused by a fault in the NIOC board / RDCO module / RMIO board or a faulty/ loose fibre optic cable connection.	Check for loose connections between the NIOC and NAMC board (or on RDCO module). Test with new fibre optic cables. If the fault is still active, replace the NIOC board / RDCO module / RMIO board.
MAIN CNT FLT Par. 9.11 bit 6	Main contactor is not functioning properly, or loose wiring.	Check main contactor control circuit wiring and signal wiring. Check main contactor control voltage level (should be 230 V).
NET VOLT FLT Par. 9.11 bit 9	Mains voltage is out of allowable range during synchronisation or ID Run. Trip limits are 208 V for 415 V units, 250 V for 500 V units and 345 V for 690 V units.	Check mains voltage. Start again.
OVER SWFREQ Par. 9.02 bit 9	Switching overfrequency fault. This may be due to a hardware fault in the electronic boards.	Replace the NAMC/RMIO board. Replace the NINT board. On units with parallel connected inverters, replace the NPBU board.
OVERCURRENT Par. 9.01 bit 1 Par. 9.11 bit 1	Input current is excessive. The overcurrent trip limit is $0.98 \cdot$ (Par. 4.08 CONV MAX CURRENT). The trip limit is approximately 190% of the converter nominal current I_{1N} (Par. 4.05 CONV NOM CURRENT).	Check motor load. Check supply voltage. Check that there is no power factor compensation capacitors in the supply. Check ISU power semiconductors and current transducers.
PPCC LINK Par. 9.02 bit 11	NINT board current measurement or communication fault between the NAMC/RMIO and NINT boards. The fault indication is not activated, when the DC link voltage is disconnected, but the NAMC/RMIO board has an external power supply. The indication is activated when the charging is completed and the DC link voltage is "high".	Check the fibre optic cables connected between the NAMC/RMIO and NINT boards. In parallel connected inverters, also check the cabling on the NPBU-xx board. If the fault is still active, replace the NPBU board (only with parallel connected inverters), NAMC/RMIO and NINT board (in this order) until the fault disappears. Test with new fibre optic cables in the PPCC (power plate control board) link.
SHORT CIRC Par. 9.01 bit 0	Short-circuit current has been detected on a power plate.	Measure the resistance of the power plate(s). If a faulty power plate is detected, replace the power plate and the NINT and NGDR boards, or change the whole converter phase module. Check the main circuit.

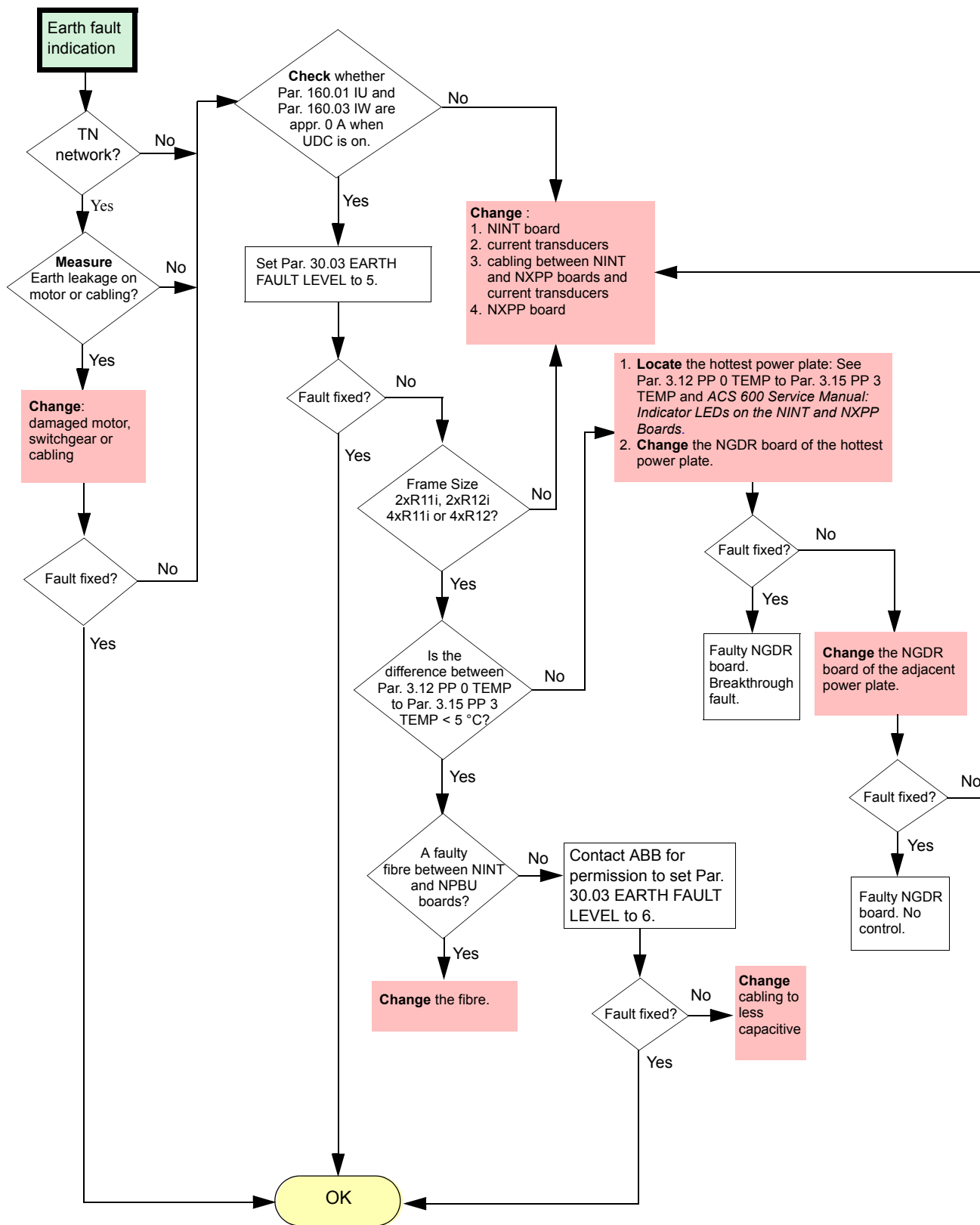
Fault Messages		
Fault Text	Cause	What to do
SC (INU 1) Par. 9.01 bit 12	Short-circuit in parallel connected phase module block 1	Check the fibre optic cables between the NPBU board channel CH1 and the NINT board of phase module block 1. Check the motor and the motor cable. Check all power plates in the phase module block 1. If a faulty power plate is detected, replace the whole phase module.
SC (INU 2) Par. 9.01 bit 13	Short-circuit in parallel connected phase module block 2	Check the fibre optic cables between the NPBU board channel CH1 and the NINT board of phase module block 2. Check the motor and the motor cable. Check all power plates in the phase module block 2. If a faulty power plate is detected, replace the whole phase module.
SC (INU 3) Par. 9.01 bit 14	Short-circuit in parallel connected phase module block 3	Check the fibre optic cables between the NPBU board channel CH1 and the NINT board of phase module block 3. Check the motor and the motor cable. Check all power plates in the phase module block 3. If a faulty power plate is detected, replace the whole phase module.
SC (INU 4) Par. 9.01 bit 15	Short-circuit in parallel connected phase module block 4	Check the fibre optic cables between the NPBU board channel CH1 and the board of phase module block 4. Check the motor and the motor cable. Check all power plates in the phase module block 4. If a faulty power plate is detected, replace the whole phase module.
SUPPLY PHASE Par. 9.02 bit 0	Missing phase during synchronisation	Check supply fuses. Check for supply network unbalance.
SYNCHRO FLT Par. 9.11 bit 13	Synchronisation to supply network is failed. Supply frequency has changed too much after ID Run.	Perform the ID Run again. See Parameter 99.07.
USER MACRO	There is no User Macro saved or the file is defective.	Create the User Macro again.

What to Do in Case of an Earth Fault Indication

This section describes how to trace the cause of an internal earth fault indication (Warning/Fault EARTH FAULT).

An earth fault indication does not always signify an actual earth fault. The indication can sometimes be caused by a faulty IGBT or a faulty NGDR control board.

Flowchart Use this flowchart for tracing the cause of an earth fault indication and for locating faulty parts. The flowchart includes remedies.



Chapter 8 – Parameters

Overview

Parameters for the IGBT supply unit control program are described in the tables below.

Symbols used in the tables:

Column Type: I = integer, R = real, B = boolean, C = character string

ISU = IGBT Supply Unit

1 Actual Signals

Code	Parameter	Range/Unit	Description	Integer Scaling
1	ACTUAL SIGNALS			
1.05	FREQUENCY	Hz	Calculated line frequency	100 = 1 Hz
1.06	LINE CURRENT	A	Measured line current	1= 1 A
1.07	REACTIVE POWER	kVAr	Calculated reactive power (positive = capacitive, negative = reactive).	1 = 1 kVAr
1.08	POWER	kW	Calculated line converter power (positive = power flow from supply network to intermediate circuit, negative = power flow from intermediate circuit to supply network).	1= 1 kW
1.09	POWER	%	Input power in percentage of nominal value (Par. 4.06 CONV NOM POWER)	1= 1%
1.10	DC VOLTAGE	V	Measured intermediate circuit voltage	1= 1 V
1.11	MAINS VOLTAGE	V	Calculated input voltage	1= 1 V
1.12	PP TEMP	°C	Temperature of the power plate in degrees Celcius	1 = 1 °C
1.13	TIME OF USAGE	h	Elapsed time meter. The timer is running when the NAMC/ RMIO board is powered.	1 = 1 h
1.14	KWH SUPPLY	kWh	This actual signal counts the kilowatt hours in operation.	1 = 100 kWh
1.15	DI6-1 STATUS	0000000... 0111111	Status of the digital inputs DI6 to DI1 in the software. 0 VDC = "0" +24 VDC = "1" <i>Example</i> Control Panel (CDP 312) display when digital inputs DI1 and DI4 are activated is 0001001, where the digits for digital inputs are read from right to left (DI1 to DI6).	1= 1
1.16	KWH MOTORING	kWh	This actual signal counts the kilowatt hours of motoring (power flow from supply network to intermediate circuit).	1 = 100 kWh
1.17	KWH GENERATING	kWh	This actual signal counts the kilowatt hours of regenerative braking (power flow from intermediate circuit to supply network).	1 = 100 kWh
1.19	AI1 [V]	0...10	Non-scaled value of analogue input AI1. See Par. 13.01 AI1 HIGH VALUE and 13.02 AI1 LOW VALUE.	10000 = 10 V or 20 mA
1.20	AI2 [mA]	0...20	Non-scaled value of analogue input AI2. See Par. 13.04 AI2 HIGH VALUE and 13.05 AI2 LOW VALUE.	20000 = 20 mA, 2 V or 10 V
1.21	AI3 [mA]	0...20	Non-scaled value of analogue input AI3. See Par. 13.08 AI3 HIGH VALUE and 13.09 AI3 LOW VALUE.	20000 = 20 mA
1.22	RO3-1 STATUS	0000000... 0000111	Status of the standard I/O board relay outputs. <i>Example</i> Control Panel (CDP 312) display when relay outputs 2 and 3 are activated is 0000110, where the digits are read from right to left (DO1 to DO6)	1 = 1
1.23	AO1 [mA]	0...20 mA	Value of analogue output 1 signal in milliamperes. For signal selecting and scaling, see Parameter Group 15.	20000 = 20 mA
1.24	AO2 [mA]	0...20 mA	Value of analogue output 2 signal in milliamperes. For signal selecting and scaling, see Parameter Group 15.	20000 = 20 mA
1.26	LED PANEL OUTPUT	%	Monitoring of the NLMD-01 LED panel output. See Parameter Group 18.	1= 1
1.27	COSFII		Calculated cosfii	100 = 1

2 Actual Signals

Code	Parameter	Unit	Description	Integer Scaling
2	ACTUAL SIGNALS			
2.05	DC REF Q-CTRL	V	Minimum voltage reference of intermediate circuit calculated by reactive power control	1 = 1 V
2.06	DC REF RAMP	V	Ramped and limited intermediate circuit voltage reference for power control	1 = 1 V
2.07	DC REF INITIALIZ	V	Initialized intermediate circuit voltage reference based on line-side ID Run. The voltage reference is calculated from DC voltage measurement and is approximately $\sqrt{2}$ · supply network voltage.	1 = 1 V

3 Actual Signals

Code	Parameter	Unit	Description	Integer Scaling
3	ACTUAL SIGNALS		These parameters are visible in parallel connected units (frame sizes 2xR11i/R12i and 4xR11i/R12i) only and show the highest power plate temperatures of the phase module blocks no. 1 to 4 (see <i>Chapter 3 – Hardware Description: IGBT Supply Unit</i>). LEDs on the NINT board indicate the hottest phase (U, V or W) of each module block. See <i>Chapter 7 – Fault Tracing / What to Do in Case of an Earth Fault Indication</i> .	
3.12	PP 0 TEMP	°C	The highest power plate temperature of phase module block 1.	1 = 1 °C
3.13	PP 1 TEMP	°C	The highest power plate temperature of phase module block 2.	1 = 1 °C
3.14	PP 2 TEMP	°C	The highest power plate temperature of phase module block 3.	1 = 1 °C
3.15	PP 3 TEMP	°C	The highest power plate temperature of phase module block 4.	1 = 1 °C

4 Information

The software version (Parameters 4.01 and 4.03) is expressed as follows:

Character no	Example	Meaning
1	I	I = Input bridge software
2	X	Product: X= ISU
3	X	Software type: A = application software (Parameter 4.03)
4	G	Control board: G = NAMC-51, R = RMIO
5 to 8	6000	Software version number: 6000 = NAMC-51, 7000 = RMIO

Code	Parameter	Type	Range/Unit	Description	Integer Scaling
4	INFORMATION				
4.01	SOFTWARE PACKAGE VER	C	IXXx xxxx	This signal describes the software of the downloaded loading package.	-
4.02	DTC VERSION	B	xxxx	Software version number of the flux software. This fixed part of the software consists of the line converter control, operation system, communication control of the DDCS channels and Modbus software for the control panel.	-
4.03	APPLIC NAME	C	IXAx xxxx	The application software name can be identified by means of this signal. This part of the software has been written using PC elements.	-
4.04	CONV NOM VOLTAGE	R	V	Downloaded line converter nominal supply voltage	1 = 1 V
4.05	CONV NOM CURRENT	R	A	Downloaded line converter nominal line current	1 = 1 A
4.06	CONV NOM POWER	R	kW	Line converter nominal power.	1 = 1 kW
4.07	CONV MAX VOLTAGE	R	V	Maximum value of converter voltage measuring range	1 = 1 V
4.08	CONV MAX CURRENT	R	A	Maximum value of converter current measuring range	1 = 1 A
4.09	INVERTER TYPE	C	xxxxxx x xxx	Line-side converter type	-

7 Control Word

Parameter 7.01 is the control word of the line converter. The control word is a 16-bit packed boolean word displayed as a hex value and updated at 10 ms intervals.

Parameter 7.01 MAIN CTRL WORD (Control word of the line converter)			
Bit	Name	Value	Description
0	ON	0 ⇒ 1	Starts charging
	OFF	0	Opens main contactor
1, 2		0	Not in use
3	START	1	Starts modulation
		0	Stops modulation
4...6		0	Not in use
7	RESET	0 ⇒ 1	Makes a reset
		0	–
8...15		0	Not in use

8 Status Word

This parameter is a 16-bit packed boolean word displayed as a hex value and updated at 4 ms intervals.

Parameter 8.01 MAIN STATUS WORD (Status signals of the line converter)			
Bit	Name	Value	STATE/Description
0	RDY_ON	1	Ready to switch on = no fault
		0	Not ready to switch on = fault
1	RDY_RUN	1	Ready to operate = DC bus charged
		0	Not ready to operate
2	RDY_REF	1	Operation enabled
		0	
3	TRIPPED	1	Fault
		0	No fault
4, 5, 6		–	Not in use
7	ALARM	1	Warning
		0	No Warning
8	MODULATING	1	Line converter modulates.
		0	Line converter not modulating
9	REMOTE	1	Drive control location: REMOTE
		0	Drive control location: LOCAL
10	NET OK	1	Network voltage is OK.
		0	Network voltage is lost.
11		–	Not in use
12, 13		–	Not in use
14	CHARGING	1	Charging contactor closed
		0	Charging contactor open
15		–	Not in use

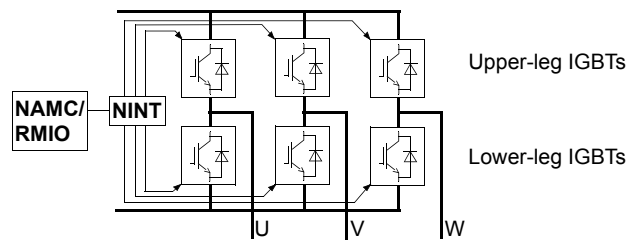
9 Fault Words

These parameters are 16-bit words. They are displayed as hex values. Bit value 1 = Fault, and 0 = No Fault. Parameters are updated at 100 ms intervals.

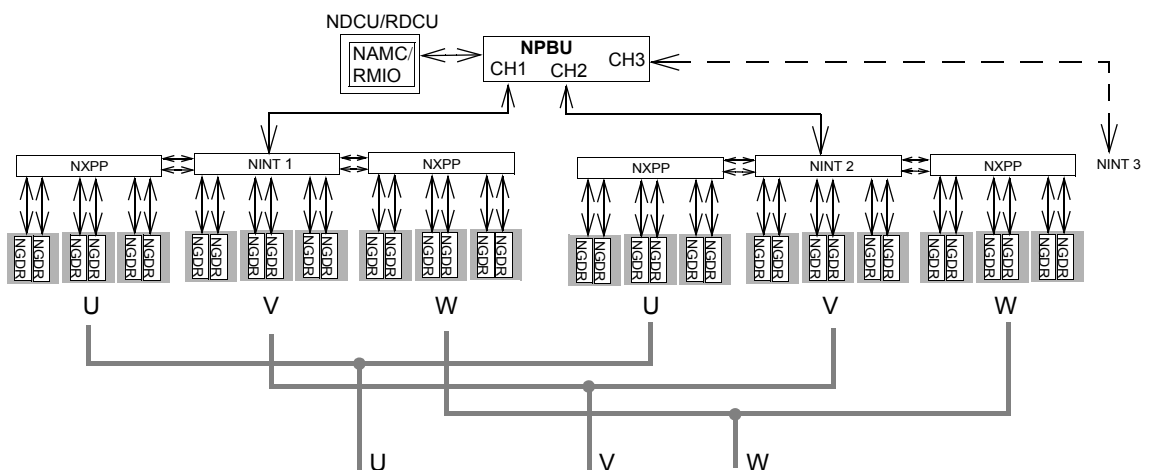
Code	Parameter	Bit	Name	Description
9	FAULT WORDS			
9.01	FAULT WORD 1			
		0	SHORT CIRC	Short-circuit in the main circuit
		1	OVERCURRENT	Overcurrent
		2	DC OVERVOLT	Intermediate circuit DC overvoltage
		3	ACS 600/800 TEMP	IGBT module overtemperature
		4	EARTH FAULT	Internally detected earth fault
		5, 6		Not in use
		7		Internal faults. If this bit is 1, write down the value of Parameter 9.03. Contact ABB.
		8...11		Not in use
		12	SC (INU1)	Short-circuit in parallel connected phase module block 1
		13	SC (INU2)	Short-circuit in parallel connected phase module block 2
		14	SC (INU3)	Short-circuit in parallel connected phase module block 3
		15	SC (INU4)	Short-circuit in parallel connected phase module block 4
9.02	FAULT WORD 2			
		0	SUPPLY PHASE	Missing phase during synchronisation
		1		Not in use
		2	DC UNDERVOLT	Intermediate circuit DC undervoltage
		3...5		Not in use
		6	IO FAULT	I/O device fault on CH1
		7	AMBIENT TEMP	I/O control board temperature
		8		Not in use
		9	OVER SWFREQ	Switching overfrequency
		10		Not in use
		11	PPCC LINK	Current measurement or communication fault of NINT board
		12	CH0 COM LOST	Communication break on CH0
		13...15		Not in use
9.03	FAULT WORD 3			
		0	FLT (F1_7)	Factory default parameter file error
		1	USER MACRO	User Macro file error
		2	FLT (F1_4)	EPROM operating error
		3	FLT (F1_5)	FEPROM data error
		4	FLT (F2_12)	Internal time level 2 overflow (100 ms)
		5	FLT (F2_13)	Internal time level 3 overflow (1 ms)
		6	FLT (F2_14)	Internal time level 4 overflow (50 ms)
		7	FLT (F2_15)	Internal time level 5 overflow (1 s)
		8	FLT (F2_16)	State machine overflow
		9	FLT (F2_17)	Application program execution error
		10	FLT (F2_18)	Application program execution error
		11	FLT (F2_19)	Illegal instruction
		12	FLT (F2_3)	Register stack overflow
		13	FLT (F2_1)	System stack overflow
		14	FLT (F2_0)	System stack underflow
		15		Reserved

Code	Parameter	Bit	Name	Description
9	FAULT WORDS			
9.07	INT FAULT INFO			* Bits 0 to 3 are in use with parallel-connected converters only. Control board NINT 1 (of phase module block 1) is connected to branching unit board NPBU channel CH1, NINT 2 is connected to channel CH2 etc.
		0	NINT 1 FAULT	NINT 1 board fault *
		1	NINT 2 FAULT	NINT 2 board fault *
		2	NINT 3 FAULT	NINT 3 board fault *
		3	NINT 4 FAULT	NINT 4 board fault *
		4	NPBU FAULT	NPBU board fault *
		5		Not in use
		6	U-PH SC U	Short-circuit in phase U upper-leg IGBT(s)
		7	U-PH SC L	Short-circuit in phase U lower-leg IGBT(s)
		8	V-PH SC U	Short-circuit in phase V upper-leg IGBT(s)
		9	V-PH SC L	Short-circuit in phase V lower-leg IGBT(s)
		10	W-PH SC U	Short-circuit in phase W upper-leg IGBT(s)
		11	W-PH SC L	Short-circuit in phase W lower-leg IGBT(s)
		12...15		Not in use

Converter Phase Module Block



Converter Constructed of Two to Four Parallel-connected Phase Module Blocks



Code	Parameter	Bit	Name	Description
9	FAULT WORDS			
9.11	SUPPLY FAULT WORD			
		0	CHARGING FLT	DC link short-circuit during charging
		1	OVERCURRENT	Overcurrent
		2	DI5 = 0	External fault indicated via DI5
		3	ACS 600 TEMP / ACS 800 TEMP	IGBT module temperature is excessive.
		4	E EARTH FLT	Earth fault detected by an external monitoring device
		5	FAN FLT	Fan failure. Fault is activated 5 seconds after failure.
		6	MAIN CNT FLT	Main contactor failure
		7	SHORT CIRC	Short-circuit in the main circuit (indication from power plate).
		8		Internal faults. If this bit is 1, write down the value of Parameter 9.03. Contact ABB.
		9	NET VOLT FLT	Supply voltage out of range during synchronisation
		10	CH0 COM LOST	Communication break on CH0
		11		Not in use
		12	EARTH FAULT	Internally detected earth fault
		13	SYNCHRO FLT	Synchronisation to supply failed
		14	DC UNDERVOLT	Intermediate circuit DC undervoltage
		15	DC OVERVOLT	Intermediate circuit DC overvoltage
9.12	SUPPLY ALARM WORD			
		0	CH0 TIMEOUT	Communication break detected
		1	PANEL LOST	Local control lost
		2		Not in use
		3	AI<MIN FUNC	Current below 4 mA (4 mA minimum selected)
		4	ACS 600 TEMP/ ACS 800 TEMP	IGBT module temperature is excessive.
		5	CURRENT LIM	Current limit exceeded
		6...9		Not in use
		10	NET LOST	Network voltage lost
		11, 12		Not in use
		13	EARTH FAULT	Internally detected earth fault
			E EARTH FLT	Earth fault detected by an external monitoring device
		14	DI5 = 0	External fault indicated via DI5
		15		Not in use

11 Reference Selects

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
11	REFERENCE SELECT					
11.01	DC REF SELECT	I	PARAM 23.1	(1) PARAM 23.1; (2) AI1; (3) AI2; (4) AI3	Source for intermediate circuit DC voltage reference	1 = 1
11.02	Q REF SELECT	I	PARAM 24.1	(1) PARAM 24.1; (2) AI1; (3) AI2; (4) AI3	Source for reactive power reference	1 = 1

13 Analogue Inputs

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
13	ANALOGUE INPUTS					
13.01	AI1 HIGH VALUE	I	20000	-32768...32767	This value corresponds to the maximum input voltage on analogue input AI1.	1 = 1
13.02	AI1 LOW VALUE	I	0	-32768...32767	This value corresponds to the minimum input voltage on analogue input AI1.	1 = 1
13.03	FILTER AI1	R	1000	0...30000 ms	Filter time constant for analogue input AI1. The hardware filter time constant is 20 ms.	1 = 1 ms
13.04	AI2 HIGH VALUE	I	0	-32768...32767	This value corresponds to the maximum input in milliamperes (20 mA) on analogue input AI2.	1 = 1
13.05	AI2 LOW VALUE	I	0	-32768...32767	This value corresponds to the minimum input in milliamperes (0 or 4 mA) on analogue input AI2.	1 = 1
13.06	MINIMUM AI2	I	0 mA	(1) 0 mA; (2) 4 mA	This value corresponds to the minimum reference from analogue input AI2.	
13.07	FILTER AI2	R	1000 ms	0...30000 ms	Filter time constant for analogue input AI2. The hardware filter time constant is 20 ms.	1 = 1 ms
13.08	AI3 HIGH VALUE	I	10000	-32768...32767	This value corresponds to the maximum input in milliamperes (20 mA) on analogue input AI3.	1 = 1
13.09	AI3 LOW VALUE	I	0	-32768...32767	This value corresponds to the minimum input in milliamperes (0 or 4 mA) on analogue input AI3.	1 = 1
13.10	MINIMUM AI3	I	0 mA	(1) 0 mA; (2) 4 mA	This value corresponds to the minimum reference from analogue input AI3.	
13.11	FILTER AI3	R	1000 ms	0...30000 ms	Filter time constant for analogue input AI3. The hardware filter time constant is 20 ms.	1 = 1 ms
13.12	MINIMUM AI1	I	0 V	(1) 0 V; (2) -10 V	This value corresponds to the minimum reference from analogue input AI1.	

14 Digital Outputs

Code	Parameter	Type	Default	Range	Description	Integer Scaling
14	DIGITAL OUTPUTS					
14.04	DO2 GROUP+INDEX		801	-199999...+199999	<p>This parameter selects the signal that controls digital output D02 by the bit specified with Par. 14.05 DO2 BIT NUMBER.</p> <p>Example: When bit number 0 (RDY_ON) of Par 8.01 MAIN STATUS WORD is selected to digital output D02, the value of Par. 14.04 is set to 801, where 8 indicates the group and 01 the index of the selected signal. The bit number is specified with Par. 14.05 DO2 BIT NUMBER.</p> <p>Note: Inversion of the output is set with a minus sign of the Par. 14.04 value.</p>	1 = 1
14.05	DO2 BIT NUMBER		0	0...15	<p>This parameter specifies the bit number of the signal selected with Par. 14.04 DO2 GROUP+INDEX. See the example above.</p>	1 = 1


15 Analogue Outputs

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
15	ANALOGUE OUTPUTS					
15.01	ANALOGUE OUTPUT 1	I	106	0...30000	Analogue output signal 1 source selection. <u>Example:</u> To link Par. 23. 01 DC VOLT REF to analogue output 1, set Parameter 15.01 to value 2301.	1 = 1
15.02	INVERT AO1	B	NO	(0) NO; (1) YES	Analogue output signal 1 inversion	
15.03	MINIMUM AO1	I	0 mA	(1) 0 mA; (2) 4 mA; (3) 10 mA	Analogue output signal 1 offset in milliamperes	
15.04	FILTER AO1	R	0.10 s	0...10 s	Filter time constant for AO1	100 = 1 s
15.05	SCALE AO1	R	100	0...65536	Nominal value of AO1 (Par. 15.01 ANALOGUE OUTPUT 1). It corresponds to 20 mA at the output. <u>Example:</u> Par. 1.06 LINE CURRENT is linked to Parameter 15.01 ANALOGUE OUTPUT 1. The value of Par. 15.05 is 100. When the value of Par. 1.06 LINE CURRENT is 100 A, the output of AO1 is 20 mA.	1 = 1
15.06	ANALOGUE OUTPUT 2	I	101	0...30000	Analogue output signal 2 source selection. See example in Par. 15.01.	1 = 1
15.07	INVERT AO2	B	NO	(0) NO; (1) YES	Analogue output signal 2 inversion	
15.08	MINIMUM AO2	I	0 mA	(1) 0 mA; (2) 4 mA (3) 10 mA	Analogue output signal 2 offset in milliamperes	
15.09	FILTER AO2	R	0.10 s	0...10 s	Filter time constant for AO2	100 = 1 s
15.10	SCALE AO2	R	3000	0...65536	Nominal value of AO2 signal (Par. 15.06 ANALOGUE OUTPUT 2). It corresponds to 20 mA at the output. See example in Par. 15.05.	1 = 1

**16 System Control
Inputs**

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description
16	SYSTEM CTR INPUTS				
16.02	PARAMETER LOCK	B	OPEN		Using this parameter, unauthorised parameter changes by CDP 312 Control Panel or the <i>DriveWindow</i> PC tool can be inhibited for Parameter Groups 0...99.
				(1) LOCKED	Parameter changes are disabled.
				(0) OPEN	Parameter changes are enabled.
16.03	PASS CODE	I	0		Pass code for the Parameter Lock. The default value is 0. To open the Parameter Lock for parameter groups below 100, change the value to 358. After the Parameter Lock is opened, the value is automatically reset.
16.06	PARAMETER BACKUP	I	DONE		
				(0) DONE	Parameter value after the saving has been completed.
				(1) SAVE	Parameter saving from RAM to permanent FEPROM memory. Note: Parameter changes done through the CDP 312 Control Panel or <i>DriveWindow</i> are saved automatically to FEPROM. Parameter changes done by an overriding control system (e.g. fieldbus or AC 80) via CH0 of the NAMC board / RDCO module are saved only to the volatile RAM memory. The changes need to be saved to FEPROM separately using this parameter selection.

18 LED Panel Control

Code	Parameter	Type	Default	Range	Description	Integer Scaling
18	LED PANEL CTRL				<p>The NLMD-01 Monitoring Display has a LED bar to show an absolute real type value: 0 50 100 150 %  .</p> <p>The source and the scale of the display signal are defined by this parameter group.</p> <p>Note: If NLMD -01 and CDP 312 Control Panel are used together, Actual Signal 1.26 LED PANEL OUTPUT must be the first signal in CDP 312 Actual Signal Display Mode. Otherwise the NLMD-01 LED bar display will show an incorrect value.</p>	
18.01	LED PANEL OUTPUT	I	109	0...30000	<p>Signal source selection for the NLMD-01 Monitoring Display. <u>Example:</u> To link Par. 1.09 POWER to the display set Parameter 18.01 to value 109.</p>	1 = 1
18.02	SCALE PANEL	R	100	0...65536	<p>Scaling factor for the NLMD-01 Monitoring Display. <u>Example:</u> Par. 1.05 FREQUENCY is linked to Parameter 18.01. The frequency is 50 Hz (= 100 · 50 = 5000 as integer scaled). Value 5000 of Parameter 18.02 gives 100% display on the NLMD-01.</p>	1 = 1

19 Data Storage

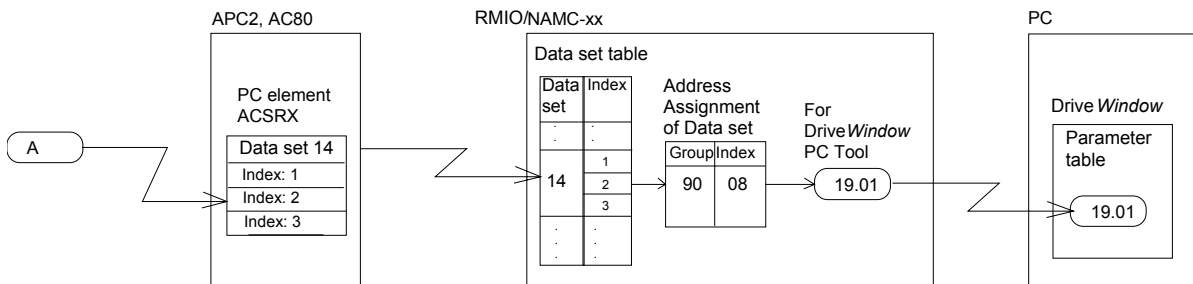
Parameters of this group are storages for receiving information from or sending it to an overriding system. The parameters are unconnected. They can be used for linking, testing and commissioning purposes.

Trend Monitoring with Drive Window

Example 1.

Address of data set 14 index 2 is 90.08. To monitor a signal assigned for drive control from data set 14 index 2 (data word 14.2) using *DriveWindow*, follow the steps below.

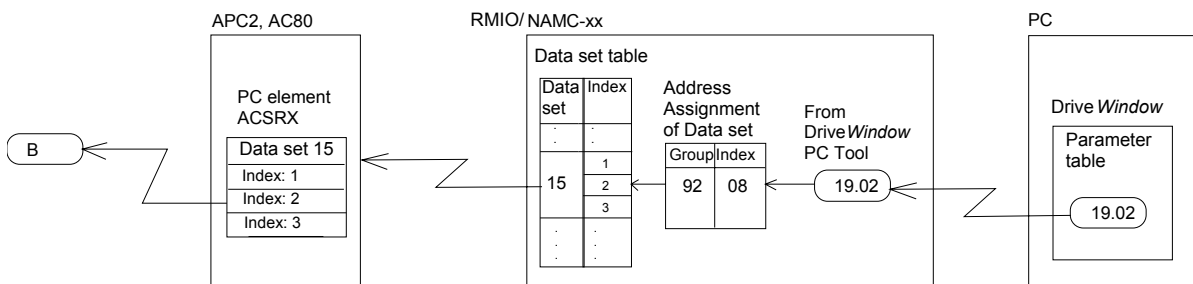
3. Set Parameter 90.08 D SET 14 VAL 2 to 1901 (denoting Parameter 19.01).
4. Set *DriveWindow* monitoring channel to read Parameter 19.01.



A = a value assigned from overriding system to drive control

Sending a value Example 1.

To send a value to overriding system data set 15 index 2, set Parameter 92.08 D SET 15 VAL 2 to 1902 by a CDP 312 Control Panel or *DriveWindow*.



B = a value assigned for overriding system application

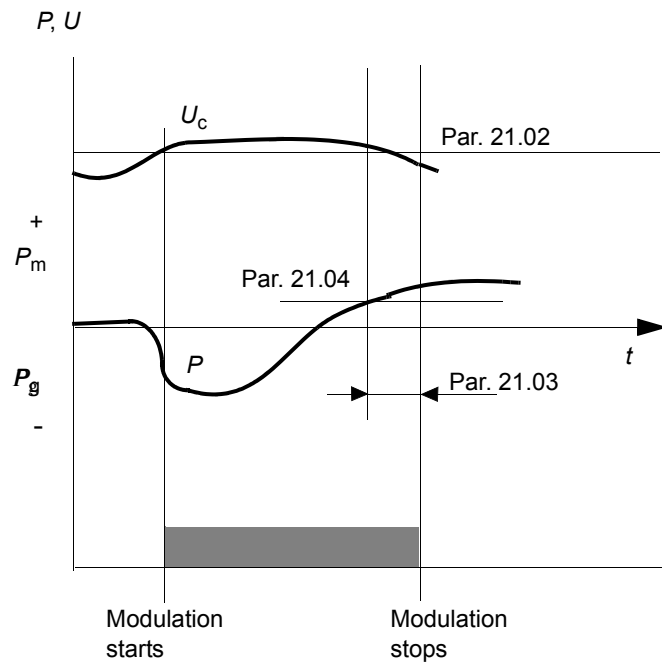
19 Data Storage Parameter Table Integer scaling of these parameters is 1 = 1, the type is real and the range is -32768...+32767.

Code	Parameter
19	DATA STORAGE
19.01	DATA 1
19.02	DATA 2
19.03	DATA 3
19.04	DATA 4
19.05	DATA 5
19.06	DATA 6
19.07	DATA 7
19.08	DATA 8

21 Start/Stop Functions

Code	Parameter	Type	Default	Range/Unit	Description																				
21	START/STOP																								
21.01	DC LEVEL START	B	NO	(0) NO (1) YES	Disable level start Enable level start. The selection is not recommended for units with an LCL filter. Consult ABB before setting this parameter to YES. Note: If Par. 99.08 AUTO LINE ID RUN is set to YES, the ISU performs the ID Run in NAMC/RMIO board power-up and modulates for one second thereafter. The ISU stops and waits until DC voltage exceeds the level of Par. 21.02 DC VOLTAGE LEVEL.																				
21.02	DC VOLTAGE LEVEL	R	See table below.	See table below.	Intermediate circuit DC voltage level at which the modulation starts																				
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Par. 4.04 CONV NOM VOLTAGE (V)</th> <th style="width: 25%;">Default of Par. 21.02: $1.1 \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$ (V)</th> <th colspan="2" style="width: 50%;">Range of Par. 21.02: $(65\% \dots 120\%) \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$</th> </tr> <tr> <td></td> <td></td> <th style="width: 25%;">Minimum (V)</th> <th style="width: 25%;">Maximum (V)</th> </tr> </thead> <tbody> <tr> <td>415</td> <td>646</td> <td>380</td> <td>706</td> </tr> <tr> <td>500</td> <td>778</td> <td>457</td> <td>851</td> </tr> <tr> <td>690</td> <td>1073</td> <td>632</td> <td>1174</td> </tr> </tbody> </table>						Par. 4.04 CONV NOM VOLTAGE (V)	Default of Par. 21.02: $1.1 \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$ (V)	Range of Par. 21.02: $(65\% \dots 120\%) \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$				Minimum (V)	Maximum (V)	415	646	380	706	500	778	457	851	690	1073	632	1174
Par. 4.04 CONV NOM VOLTAGE (V)	Default of Par. 21.02: $1.1 \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$ (V)	Range of Par. 21.02: $(65\% \dots 120\%) \cdot \sqrt{2} \cdot \text{Par. 4.04 CONV NOM VOLTAGE}$																							
		Minimum (V)	Maximum (V)																						
415	646	380	706																						
500	778	457	851																						
690	1073	632	1174																						
21.03	STOP LEVEL TIME	R	1000 ms	ms	Modulator is stopped when the power is higher than defined with Par. 21.04 STOP LEVEL POWER for a time defined with this parameter.																				
21.04	STOP LEVEL POWER	R	0 kW	kW	Motoring power to stop the modulator																				

The functions set by this parameter group are visualised below. U_c stands for intermediate circuit DC voltage. P stands for converter supply power.



23 DC Bus Reference

By changing the value of Parameter 23.01 DC VOLT REF from the default setting, the DC link voltage can be raised higher than with a conventional 6-pulse diode rectifier in order to compensate a low voltage level in the network.

Note: Check the motor insulation requirement. See *ACS 600 MultiDrive Safety and Product Information* guide (EN code 63982229) or *ACS800-17 Hardware Manual* (EN code 64638505).



WARNING! When setting this parameter, consult your local ABB representative. The LCL filter of the supply section may overheat.

Example

If the supply voltage is 380 V, and the motor voltage 400 V, the voltage difference can be compensated simply by setting Parameter 23.01 DC VOLT REF to value 565 (i.e. $\sqrt{2} \cdot 400$ V). However, the line converter power is still calculated on the basis of 380 V:
 $P = \sqrt{3} \cdot 380 \cdot \text{line current}$.

Code	Parameter	Type	Range	Description	Integer Scaling															
23	DC VOLT REF																			
23.01	DC VOLT REF	R	See table below.	User-given setpoint value for intermediate circuit DC voltage reference	1 = 1 V															
		<table border="1"> <thead> <tr> <th>Par. 4.04 CONV NOM VOLTAGE</th> <th colspan="2">Range of Par. 23.01: (65% ...120%) · $\sqrt{2}$ · Par. 4.04 CONV NOM VOLTAGE</th> </tr> <tr> <td>(V)</td> <th>Minimum (V)</th> <th>Maximum (V)</th> </tr> </thead> <tbody> <tr> <td>415</td> <td>380</td> <td>706</td> </tr> <tr> <td>500</td> <td>457</td> <td>851</td> </tr> <tr> <td>690</td> <td>632</td> <td>1174</td> </tr> </tbody> </table>		Par. 4.04 CONV NOM VOLTAGE	Range of Par. 23.01: (65% ...120%) · $\sqrt{2}$ · Par. 4.04 CONV NOM VOLTAGE		(V)	Minimum (V)	Maximum (V)	415	380	706	500	457	851	690	632	1174		
Par. 4.04 CONV NOM VOLTAGE	Range of Par. 23.01: (65% ...120%) · $\sqrt{2}$ · Par. 4.04 CONV NOM VOLTAGE																			
(V)	Minimum (V)	Maximum (V)																		
415	380	706																		
500	457	851																		
690	632	1174																		
<p>Note: The program limits the minimum value to $\sqrt{2} \cdot U_{AC}$, where U_{AC} denotes the actual supply voltage.</p>																				

24 Reactive Power

Code	Parameter	Type	Default	Range	Description	Integer Scaling
24	REACTIVE POWER					
24.01	Q POWER REF	R	0%	-100%...+100%	Setpoint value for reactive power control in percentage of Par. 4.06 CONV NOM POWER. Reactive power control is capable of generating the set amount of reactive power to the network (positive = capacitive, negative = reactive).	1 = 1%

30 Fault Functions

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
30	FAULT FUNCTIONS					1 = 1
30.02	EARTH FAULT	B	WARNING	(0) WARNING (1) FAULT	A warning is given in an earth fault condition. Converter trips in an earth fault.	1 = 1 1 = 1
30.03	EARTH FAULT LEVEL	R	4 for frame sizes R6i to R12i; 5 for frame sizes 2xR11i, 2xR12i, 4xR11i, 4xR12i		<u>Non-parallel connected converters (frame sizes R6i, R7i, R8i, R9i, R11i and R12i):</u> This parameter sets the earth fault trip level through the PPCC link. In frame sizes R6i and R7i, the default setting cannot be changed. <u>Parallel connected converters (frame sizes 2xR11i, 2xR12i, 4xR11i, 4xR12i):</u> current unbalance protection of converter output, e.g. in a short-circuit.	1 = 1
				1	1% unbalance in the sum current	
				2	3% unbalance in the sum current	
				3	8% unbalance in the sum current	
				4	13% unbalance in the sum current	
				5	18% unbalance in the sum current	
				6	28% unbalance in the sum current	
				7	39% unbalance in the sum current	
				8	62% unbalance in the sum current	
30.04	EXT EARTH FAULT	I	NO	(1) NO (2) DI4=0 FAULTS (3) DI4=1 FAULTS (4) DI4=0 ALARMS (5) DI4=1 ALARMS	Earth fault detector is connected to digital input DI4. This parameter selects the converter reaction. Not in use Converter trips on EARTH FAULT if DI4 is OFF (0). Converter trips on EARTH FAULT if DI4 is ON (1). A warning is given if DI4 is OFF (0). A warning is given if DI4 is ON (1).	1 = 1
30.05	EXT EVENT	I	NO	(1) NO (2) DI5=0 ALARMS (3) DI5=0 FAULTS	This parameter selects the converter reaction to the state of digital input DI5. Not in use A warning is given if DI5 is OFF (0). Converter trips if DI5 is OFF (0).	
30.11	DC OVERVOLT TRIP	R	740/891/1230	0...747 VDC (415 V units) 0...900 VDC (500 V units) 0...1242 V DC (690 V units)	Intermediate circuit DC overvoltage trip limit. The lower range limit is determined by Par. 30.12 DC UNDERVOLT TRIP. When the setting of this parameter is changed, the corresponding higher range limit of Par. 30.12 DC OVERVOLT TRIP will also change.	1 = 1

30.12	DC UNDERVOLT TRIP	R	293/354/488	0...747 VDC (415 V units) 0...900 VDC (500 V units) 0...1242 V DC (690 V units)	Intermediate circuit DC undervoltage trip limit. The higher range limit is determined by Par. 30.11 DC OVERVOLT TRIP. When the setting of this parameter is changed, the corresponding lower range limit of Par. 30.11 DC OVERVOLT TRIP will also change. This parameter also determines DC voltage check limit during charging.	1 = 1
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51 Communication Module

Code	Parameter	Type	Description
51	COMMUNICATION MODULE		This group defines the communication parameters for a fieldbus adapter module. The parameter names are copied from the module when it is installed and its connection to the drive is activated with Parameter 98.02 COMM MODULE. See the module manual.
51.01	FIELDDBUS PAR1	C	Module type and software version
51.02 ... 51.15	FIELDDBUS_PAR2 ...15	R	According to module type

70 DDCS Control

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
70	DDCS CONTROL					
70.01	CH0 NODE ADDR	R	1	1...125	Node address for channel CH0. When using the AC 80 system, the address must be 1 to 12. When using the APC2 system, the address must be 1. In other control systems, the node address is set according to the application.	1 = 1
70.02	CH0 LINK CONTROL	R	10	1...15	DDCS channel CH0 intensity control for transmission LEDs. This parameter can be used in special cases to optimise the communication performance in the link.	1 = 1
70.03	CH0 BAUD RATE	I	4 Mbit/s	(0) 8 Mbit/s (not in use); (1) 4 Mbit/s; (2) 2 Mbit/s (not in use); (3) 1 Mbit/s	Channel CH0 communication speed. This parameter must be set to 4 Mbits/s, when FCI communication module is used. Otherwise, the overriding system automatically sets the communication speed.	

70.04	CH0 TIMEOUT	R	100 ms	0...60000 ms	The delay time before a communication break fault is indicated. The time count starts when the link does not update the message. During the time elapsing, CH0 TIMEOUT warning is set by 9.12 SUPPLY ALARM WORD bit 0. When the value of Par. 70.04 is zero, timeout is not monitored and CH0 COM LOST fault is not indicated regardless of the value of Par. 70.05.	1 = 1 ms
70.05	CH0 COMM LOSS CTRL	I	FAULT		This parameter is in use when Par. 98.01 COMMAND SEL is set to MCW and Par. 98.02 COMM MODULE to FBA DSET1, FBA DSET10 or INVERTER.	
				(1) NO FAULT	A warning is given on communication loss on channel CH0.	
				(2) FAULT	Converter trips on communication loss on channel CH0.	
70.06	CH1 LINK CONTROL	R	10	1...15	DDCS channel CH1 intensity control for transmission LEDs in each device in a link. The parameter can be used in special cases to optimise the communication performance in the link.	1 = 1
70.15	CH3 NODE ADDR	R	1	1...254	Node address for channel CH3. This channel is normally used with the start-up and maintenance tools. If the CH3 channels of several drives have been connected in a ring or star (by branching unit) configuration, each one must be assigned a unique node address. The new node address becomes valid only after auxiliary power shutdown of the NAMC/RMIO board.	1 = 1
70.16	CH3 LINK CONTROL	R	15	1...15	DDCS channel CH3 intensity control for transmission LEDs in each device in a link. The parameter can be used in special cases to optimise the communication performance in the link.	1=1
70.19	DDCS CH0 HW CONN	B	STAR		This parameter is used for enabling or disabling regeneration of channel CH0 optical transmitter in DDCS mode. DDCS mode is typically used with APC2, AC70 and AC450 controllers. In regeneration mode, any message received by the channel is echoed back. This parameter is not in use in DriveBus mode.	1=1
				(0) RING	Regeneration enabled. Select RING if the CH0 channels on the NAMC boards / RDCO modules are connected in a ring configuration.	
				(1) STAR	Regeneration disabled. Select STAR with a star configuration such as AC450 – CI810 – NDBU-95 optical branching unit(s) – NAMC board / RDCO module (RMIO board).	

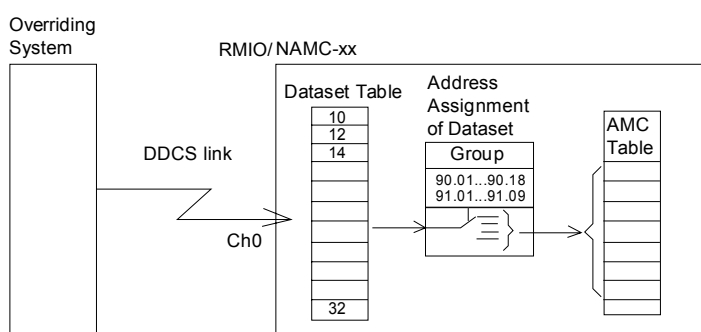
70.20	CH3 HW CONNECTION	B	STAR		This parameter is used for enabling or disabling regeneration of channel CH3 optical transmitter. In regeneration mode any message received by the channel is echoed back.	1=1
				(0) RING	Regeneration enabled. Select RING if the CH3 channels on the NAMC boards / RDCO modules are connected to a ring configuration.	
				(1) STAR	Regeneration disabled. Select STAR with a star configuration such as DriveWindow (PC) – NDBU-95 optical branching unit(s) – NAMC board / RDCO module (RMIO board).	

71 DriveBus Communication

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description	Integer Scaling
71	DRIVEBUS COMM					
71.01	CH0 DRIVEBUS MODE	B	YES		This parameters selects the communication mode for channel CH0 on the NAMC board / RDCO module. The new mode becomes valid only on the next NAMC/RMIO board power-on.	1 = 1
				(0) NO	DDCS mode	
				(1) YES	DriveBus mode with AC 80 controller	

90, 91 Data Set Receive Addresses

Parameters of this group are addresses for received data from the overriding system.

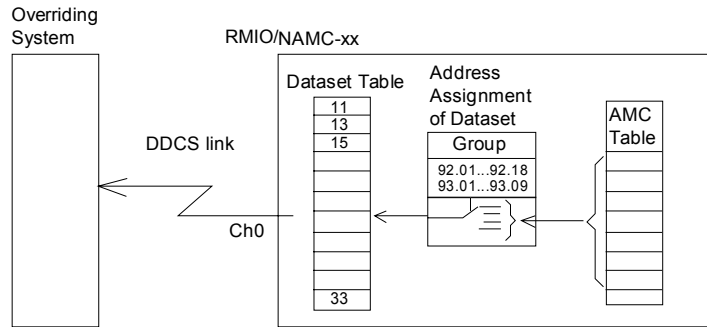


Data set receive addresses with the NAMC-51/RMIO board are given below. D SET 10 VAL 1 denotes the receive address of data set 10 value 1. Integer scaling of the parameters is 1 = 1 and range 0...9999.

Code	Parameter	Default	Updating Interval (ms)
90, 91	DATA SET RECEIVE ADDRESSES		
90.01	D SET 10 VAL 1	701	2
90.02	D SET 10 VAL 2	0	2
90.03	D SET 10 VAL 3	0	2
90.04	D SET 12 VAL 1	0	4
90.05	D SET 12 VAL 2	0	4
90.06	D SET 12 VAL 3	0	4
90.07	D SET 14 VAL 1	0	10
90.08	D SET 14 VAL 2	0	10
90.09	D SET 14 VAL 3	0	10
90.10	D SET 16 VAL 1	0	10
90.11	D SET 16 VAL 2	0	10
90.12	D SET 16 VAL 3	0	10
90.13	D SET 18 VAL 1	0	100
90.14	D SET 18 VAL 2	0	100
90.15	D SET 18 VAL 3	0	100
90.16	D SET 20 VAL 1	0	100
90.17	D SET 20 VAL 2	0	100
90.18	D SET 20 VAL 3	0	100
91.01	D SET 22 VAL 1	0	100
91.02	D SET 22 VAL 2	0	100
91.03	D SET 22 VAL 3	0	100
91.04	D SET 24 VAL 1	0	100
91.05	D SET 24 VAL 2	0	100
91.06	D SET 24 VAL 3	0	100
91.07	D SET 32 VAL 1	0	100
91.08	D SET 32 VAL 2	0	100
91.09	D SET 32 VAL 3	0	100

92, 93 Data Set Transmit Addresses

Parameters of this group are signal addresses for transmitted data to the overriding system.



Data set transmit addresses with the NAMC-51/RMIO board are given below. D SET 11 VAL 1 denotes the transmit address of data set 11 value 1. Integer scaling of the parameters is 1 = 1 and range 0...9999.

Code	Parameter	Default	Updating Interval (ms) / Description
92, 93	DATA SET TRANSMIT ADDRESSES		
92.01	D SET 11 VAL 1	801	2
92.02	D SET 11 VAL 2	110	2
92.03	D SET 11 VAL 3	0	2
92.04	D SET 13 VAL 1	0	4
92.05	D SET 13 VAL 2	111	4
92.06	D SET 13 VAL 3	106	4
92.07	D SET 15 VAL 1	911	10
92.08	D SET 15 VAL 2	0	10
92.09	D SET 15 VAL 3	0	10
92.10	D SET 17 VAL 1	912	10
92.11	D SET 17 VAL 2	115	10
92.12	D SET 17 VAL 3	122	10
92.13	D SET 19 VAL 1	0	100
92.14	D SET 19 VAL 2	0	100
92.15	D SET 19 VAL 3	0	100
92.16	D SET 21 VAL 1	108	100
92.17	D SET 21 VAL 2	112	100
92.18	D SET 21 VAL 3	0	100
93.01	D SET 23 VAL 1	0	100
93.02	D SET 23 VAL 2	0	100
93.03	D SET 23 VAL 3	0	100
93.04	D SET 25 VAL 1	0	100
93.05	D SET 25 VAL 2	0	100
93.06	D SET 25 VAL 3	0	100

98 Option Modules

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description
98	OPTION MODULES				
98.01	COMMAND SEL	B	I/O		This parameter selects the control command interface(s).
				(0) MCW	The ISU control program reads the control commands via a serial link and through the digital input terminals.
				(1) I/O	The ISU control program reads the control commands through the digital input terminals.
98.02	COMM MODULE	I	NO		This parameter defines the control mode and place in the REMOTE mode.
				(1) NO	The drive is controlled using I/O: DI2.
				(2) FBA DSET1	The drive is controlled through the communication link (CH0) using datasets 1 and 2. This is a typical setting for use with a fieldbus adapter module.
				(3) FBA DSET10	The drive is controlled through the communication link (CH0) using datasets 10 to 33. (for example APC2, AC 70, AC80, NPBA-02, NCSA-01)
				(4) INVERTER	Not in use

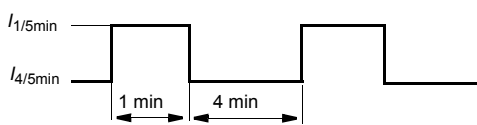
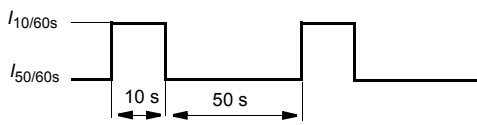
99 Start-up Data

Code	Parameter	Type	Default	Alternative Settings () Fieldbus Equivalent	Description
99	START UP DATA				
99.01	LANGUAGE	I	ENGLISH	(0) ENGLISH (1) ENGLISHAM (2) DEUTSCH (3) ITALIANO (4) ESPAÑOL (5) PORTUGUÊS (6) NEDERLANDS (7) FRANÇAIS (8) DANSK (9) SUOMI (10) SVENSKA	The line-side converter displays the information in the selected language. Note: only English is available at the time of publishing.
99.02	DEVICE NAME	C		Max. 32 characters	The name of the supply section can be typed here by DriveWindow. The name is shown in the System Configuration display of DriveWindow.
99.06	FAST SYNC	B	YES	(0) NO	Synchronization with phase order check
				(1) YES	Synchronization without phase order check
99.07	LINE SIDE ID RUN	B	NO	(0) NO	Line-side converter ID Run is not performed after next start.
				(1) YES	Next start makes ID Run for the line-side converter. It takes about 5 seconds. After the ID Run, the converter keeps on modulating. It is not allowed to load the line-side converter during the ID Run.
99.08	AUTO LINE ID RUN	B	YES	(0) NO	No automatic line-side converter ID Run after power-up of the NAMC/RMIO board and start. The parameter does not set Par. 99.07 to YES (ID Run request can still be set with Par. 99.07 if required).
				(1) YES	Line-side converter ID Run is performed automatically after power-up of the NAMC/RMIO board and next start . The parameter sets Par. 99.07 to YES. Note: ID Run takes about 5 seconds. It is not allowed to load the line-side converter during the ID Run. If the ID Run has been performed once, Par. 99.08 can be set to NO (ID Run request can still be set with Par. 99.07 if required).
99.09	APPLIC RESTORE	B	NO	(0) NO	
99.10	SUPPLY ID NUMBER	I	0	0...32767	This parameter can be used by the overriding system to check the right connections of the optical cables to the drive type. This parameter requires support from the overriding system to verify the correct connection.

Appendix A – Technical Data

Ratings

Abbreviations This table explains the abbreviations used in the following rating table.

Supply Section	
I_{1N}	Total rms input current (continuous AC current)
Duty Cycle (1 min / 5 min)	
$I_{4/5min}$	Maximum base current with $I_{1/5min}$.
$I_{1/5min}$	Short term rms overload AC current (allowed for one minute every 5 minutes).
	
Duty Cycle (10 s / 60 s)	
$I_{50/60s}$	Maximum base current with I_{1max} .
$I_{10/60s}$	Short term rms overload AC current (allowed for 10 seconds every 60 seconds)
	
S_N	Rated apparent supply power of the supply section
P_{2N}	Nominal power of intermediate DC link (continuous active motor or generator power)
P_{loss}	Power loss
U_N	Nominal mains voltage

Notes **Note 1:** The ratings correspond to voltage U_N and fan supply voltage 230 V or 115 V.

Note 2: P_{loss} is the heat loss of a unit with basic options. The value depends on the options included.

Note 3: Noise level applies to echoless room.

Ratings 380...690 V This table shows the nominal ratings for the IGBT supply sections.

Type Marking	Nominal Ratings			Duty Cycle (1 min / 5 min)		Duty Cycle (10 s / 60 s)		Frame Size	Air Flow m ³ /h	P _{loss} kW	Noise Level dBA
	S _N	I _{1N}	P _{2N}	I _{4/5min}	I _{1/5min}	I _{50/60s}	I _{10/60s}				
	kVA	A	kW	A	A	A	A				
IGBT supply sections (380...415 V Range, U _N = 415 V)											
ACA 635-0265-3	260	379	254	284	426	260	520	R8i	2100	6.4	60
ACA 635-0405-3	400	576	386	432	684	395	790	R9i	2100	9.7	60
ACA 635-0765-3	760	1006	673	755	1132	691	1384	R11i	4180	16.8	65
ACA 635-1125-3	1120	1494	1000	1121	1681	1036	2072	R12i	5680	25.0	68
ACA 635-1440-3	1440	1913	1280	1434	2152	1381	2762	2xR11i	8210	32.0	68
ACA 635-2145-3	2140	2838	1900	2129	3193	2072	4144	2xR12i	11210	47.5	70
ACA 635-2820-3	2820	3744	2506	2809	4212	2762	5524	4xR11i	16270	62.7	71
IGBT supply sections (380...500 V Range, U _N = 500 V)											
ACA 635-0325-5	320	368	308	276	414	240	480	R8i	2100	7.7	60
ACA 635-0495-5	490	565	473	424	636	365	730	R9i	2100	11.8	60
ACA 635-0935-5	930	987	826	741	1111	638	1277	R11i	4180	20.7	65
ACA 635-1385-5	1380	1466	1227	1099	1649	957	1914	R12i	5680	30.7	68
ACA 635-1760-5	1760	1876	1570	1407	2110	1276	2552	2xR11i	8210	39.3	68
ACA 635-2625-5	2620	2784	2329	2088	3133	1915	3829	2xR12i	11210	58.2	70
ACA 635-3450-5	3450	3673	3073	2754	4132	2552	5104	4xR11i	16270	76.8	71
IGBT supply sections (525...690 V Range, U _N = 690 V)											
ACA 635-0315-6	310	264	305	198	297	179	358	R8i	2100	7.6	60
ACA 635-0485-6	490	410	473	308	461	265	530	R9i	2100	11.8	60
ACA 635-0900-6	900	695	802	521	781	464	927	R11i	4180	20.1	65
ACA 635-1385-6	1380	1064	1229	798	1196	695	1389	R12i	5680	30.7	68
ACA 635-1710-6	1710	1320	1524	990	1485	926	1853	2xR11i	8210	38.1	68
ACA 635-2545-6	2540	1959	2262	1469	2204	1390	2780	2xR12i	11210	56.6	70
ACA 635-3350-6	3350	2584	2984	1938	2907	1853	3706	4xR11i	16270	74.6	71
ACA 635-5140-6	5140	3956	4568	2967	4451	2778	5557	4xR12i	22270	114.2	71

PDM code 00145936-F

Dimensions and Weights

This table shows the dimensions and weights of the IGBT supply sections. The weights are estimates and apply to units with basic options and aluminium DC busbars. The width and weight of the auxiliary control unit are included: 400 mm (for frame sizes R8i and R9i, approximately 100 kg) or 600 mm (for frame sizes R11i and above, approximately 150 kg).

Type Marking	Width mm	Height ¹⁾ mm	Weight kg
IGBT supply sections (380...415 V Range, $U_N = 415$ V)			
ACA 635-0265-3	1600	2130	550
ACA 635-0405-3	1600	2130	550
ACA 635-0765-3	2800	2130	1180
ACA 635-1125-3	3300	2130	1780
ACA 635-1440-3	4200	2130	2060
ACA 635-2145-3	5200	2130	3210
ACA 635-2820-3	7600	2130	3820
IGBT supply sections (380...500 V Range, $U_N = 500$ V)			
ACA 635-0325-5	1600	2130	550
ACA 635-0495-5	1600	2130	550
ACA 635-0935-5	2800	2130	1180
ACA 635-1385-5	3300	2130	1780
ACA 635-1760-5	4200	2130	2060
ACA 635-2625-5	5200	2130	3210
ACA 635-3450-5	7600	2130	3820
IGBT supply sections (525...690 V Range, $U_N = 690$ V)			
ACA 635-0315-6	1600	2130	550
ACA 635-0485-6	1600	2130	550
ACA 635-0900-6	2800	2130	1180
ACA 635-1385-6	3300	2130	1780
ACA 635-1710-6	4200	2130	2060
ACA 635-2545-6	5200	2130	3210
ACA 635-3350-6	7600	2130	3820
ACA 635-5140-6	9600	2130	6120

PDM code 00145936-F

- 1) Height of the cabinet is 2074 for IP 54R.

Input Power Connection

Voltage (U_1):

380/400/415 VAC 3-phase for 415 VAC units
 380/400/415/440/460/480/500 VAC 3-phase for 500 VAC units
 525/550/575/600/660/690 VAC 3-phase for 690 VAC units

-40...+10% variation from converter nominal voltage is allowed.

Short-circuit Capability (IEC 439): The rated short-time withstand current of a drive equipped with an IGBT supply section is given below.

Frame Size	$I_{cw / 1 s}$ kA	I_{pk} kA
R8i, R9i	37	78
R11i, R12i	50	105

Frequency: 50 ± 2 Hz or 60 ± 2 Hz. Maximum rate of change 17%/s.

Unbalance: Max. ± 3% of nominal phase to phase input voltage

Voltage Dips: Max. 25%

Power Factor:

$$\cos \varphi_1 = 1.00 \quad (\text{fundamental at nominal load})$$

$$\lambda = \frac{I_1}{I_{rms}} \cdot \cos \varphi_1 > 0.98 \quad (\text{total}), \text{ where}$$

λ is power factor

I_1 is fundamental input current rms value,

I_{rms} is total input current rms value.

Harmonic Distortion This table gives total harmonic distortion (THD) of the ACA 635.

THD Voltage %	THD Current %	R_{sc}
4	4	20
0.8	4	100

Definitions

Total Harmonic Distortion:

$$THD = \sqrt{\sum_2^{40} \left(\frac{I_n}{I_1} \right)^2}$$

I_n n^{th} harmonic component
 I_1 fundamental current

THD is calculated as follows: ratio of the rms value of the harmonics ($n = 2 \dots 40$) to the rms value of the fundamental. The voltage THD depends on the short-circuit ratio. The spectrum of the distortion also contains interharmonics. See also [Applicable Standards](#).

Ratio of the short-circuit power of the supply network (source) to the fundamental apparent power of the ACA 635 at point of common coupling:

$$R_{sc} = S_{cc}/S_{equ}, \text{ where}$$

S_{cc} = short-circuit power at point of common coupling (PCC),

S_{equ} = apparent power of the equipment calculated with rated rms line current.

Switching Frequency 3 kHz (average).

Ambient Conditions See *ACS 600 MultiDrive Safety and Product Information* (EN code: 63982229) guide or *ACS800-17 Hardware Manual* (EN code: 64638505).

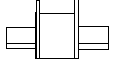
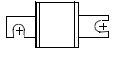
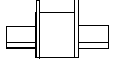
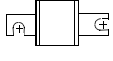
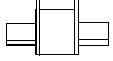
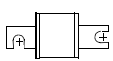
Efficiency > 97.5% at nominal power level

Fuses

The fuses (ultrarapid) of the IGBT supply section are given below. Only ultra rapid fuses guarantee proper protection for the rectifier semiconductors. Equivalent fuses from other manufacturers can also be used. U_N and I_N denote nominal voltage and current of the fuse respectively.

IGBT Supply Section AC Fuses

The AC fuses used in the ACA 635 IGBT supply sections are listed below.

IGBT Supply Type	Fuse				
	U_N (V)	I_N (A)	Type		Size
ACA 635-0265-3	660	630	170M6810	DIN 43620 	3
ACA 635-0405-3	660	1000	170M6814		3
ACA 635-0765-3	690	700	170M5874	DIN 43653 	2
ACA 635-1125-3	690	900	170M5876		2
ACA 635-1440-3	690	700	170M5874		2
ACA 635-2145-3	690	900	170M5876		2
ACA 635-2820-3	690	700	170M5874		2
ACA 635-0325-5	660	630	170M6810	DIN 43620 	3
ACA 635-0495-5	660	1000	170M6814		3
ACA 635-0935-5	690	700	170M5874	DIN 43653 	2
ACA 635-1385-5	690	900	170M5876		2
ACA 635-1760-5	690	700	170M5874		2
ACA 635-2625-5	690	900	170M5876		2
ACA 635-3450-5	690	700	170M5874		2
ACA 635-0315-6	1250	400	170M6303	DIN 43620 	3SHT
ACA 635-0485-6	1250	630	170M6205		3SHT
ACA 635-0900-6	690	900	170M5876	DIN 43653 	2
ACA 635-1385-6	690	700	170M5874		2
ACA 635-1710-6	690	900	170M5876		2
ACA 635-2545-6	690	700	170M5874		2
ACA 635-3350-6	690	900	170M5876		2
ACA 635-5140-6	690	700	170M5874		2

IGBT Supply Unit DC Fuses The DC fuses (Bussmann) used in the IGBT supply units are listed below.

IGBT Supply Section Frame Type	U_N [V]	Size	I_N [A]	Type	IGBT Supply Section Frame Type	U_N [V]	Size	I_N [A]	Type
415 V and 500 V Range					690 V Range				
R8i	660V	3	630	170M6810	R8i	1250V	3SHT	400	170M6303
R9i	660V	3	1000	170M6814	R9i	1250V	3SHT	630	170M6205
R11i					R11i				
2xR11					4xR11i				
4xR11i					R12i				
R12i					2xR12i				
2xR12i					4xR12i				

PDM code 00018306

Power Cable Entries Notes concerning the cable entry table are below.

Tightening Torque The tightening torques for screw connections, applicable to zinc and chrome platings and screw strength class 8.8 are presented below.

Screw	Torque (Nm) *	
	Soft aluminium	Alloyed aluminium and copper
M5	3.5	3.5
M6	6	9
M8	17	20
M10	35	40
M12	55	70
M16	130	180

* valid also for greased screws

Marking Below is explained how cable connections are marked in the following table. The terminals accept cable lugs according to DIN 46234 for copper cables and DIN 46329 for aluminium cables.

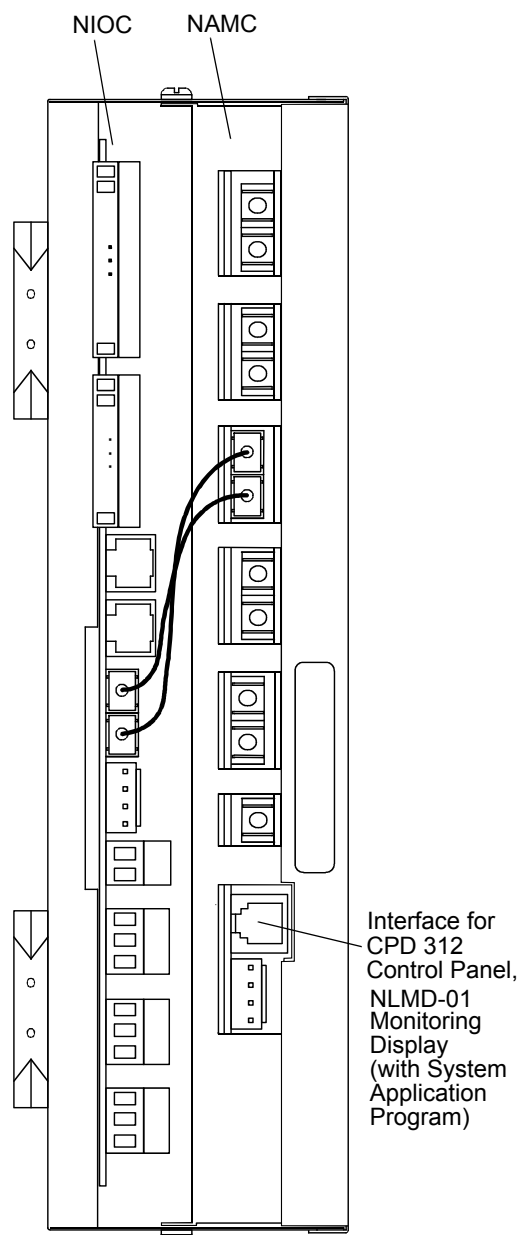
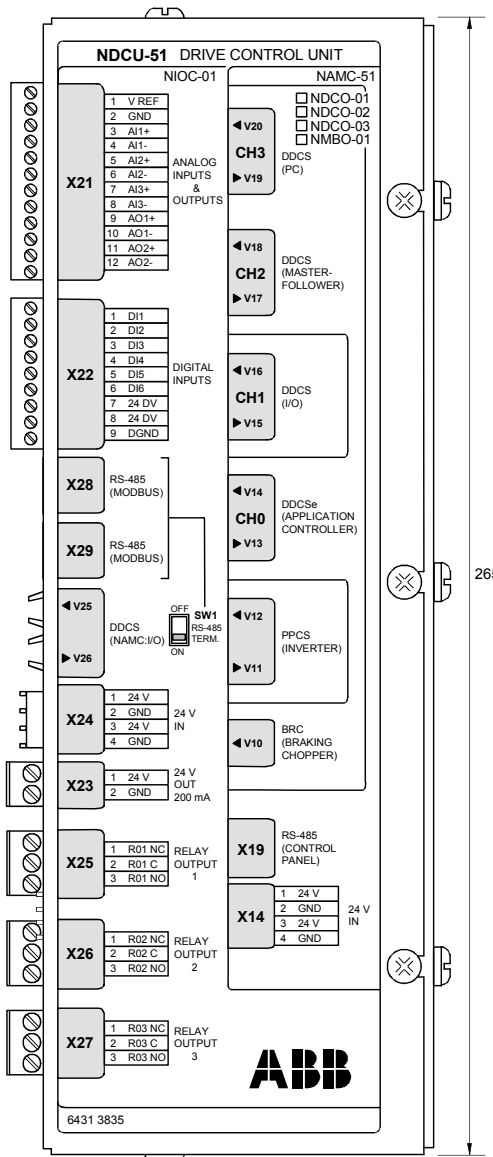
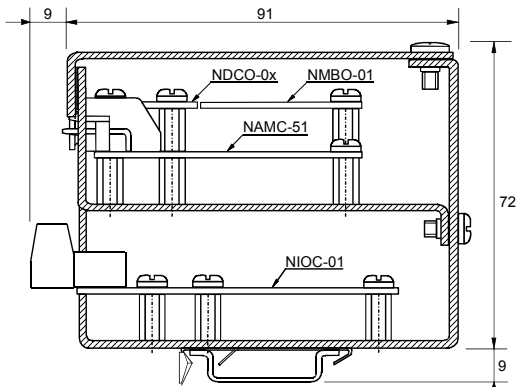
<p>Number of connection holes in a terminal</p> <p>Connection hole (max. screw) diameter in mm</p>	<p>4x(13)</p>
<p>Note: Cable lugs can also be fastened using screws one size down from the hole size. <u>Example:</u> A cable lug with a hole diameter of 12.5 mm can be fastened with either a M12 or a M10 bolt.</p>	

IGBT Supply Sections The connection holes for cable lugs are presented below.

Type	Holes for cable lugs per phase	Number of cable entries at bottom (diameter 60 mm)	Bottom plate opening dimensions (mm)	Number of cable entries at top (diameter 60 mm)
380V, 400V, 415V				
ACA 635-0265-3	4x(Ø14)	6	270x511	6
ACA 635-0405-3	4x(Ø14)	6	270x511	6
ACA 635-0765-3	6x(13x18)	6	270x911	6
ACA 635-1125-3	8x(13x18)	12	195x501	12
ACA 635-1440-3	16x(13x18)	18	270x711	18
ACA 635-2145-3	16x(13x18)	18	270x711	18
ACA 635-2820-3	16x(13x18)	18	270x711	18
440V, 460V, 500V				
ACA 635-0325-5	4x(Ø14)	6	270x511	6
ACA 635-0495-5	4x(Ø14)	6	270x511	6
ACA 635-0935-5	6x(13x18)	6	270x911	6
ACA 635-1385-5	8x(13x18)	6	270x911	6
ACA 635-1760-5	16x(13x18)	12	195x501	12
ACA 635-2625-5	16x(13x18)	18	270x711	18
ACA 635-3450-5	16x(13x18)	18	270x711	18
575V, 660V, 690V				
ACA 635-0315-6	4x(Ø14)	6	270x511	6
ACA 635-0485-6	4x(Ø14)	6	270x511	6
ACA 635-0900-6	6x(13x18)	6	270x911	6
ACA 635-1385-6	8x(13x18)	12	195x501	12
ACA 635-1710-6	8x(13x18)	12	195x501	12
ACA 635-2545-6	16x(13x18)	18	270x711	18
ACA 635-3350-6	16x(13x18)	18	270x711	18
ACA 635-5140-6	32x(13x18)	18	270x911	18

**Drive Control Unit
NDCU-51**

The Drive Control Unit NDCU-51 containing an NAMC-51 board and an NIOC board is shown below. NMBO is an optional Memory Backup board.



PDM code 00057607-A

NIOC Board Connections

External control connections for the IGBT Supply Unit on the NIOC board are shown below.

Terminal Block Size

X21, X22: cables 0.5 to 1.5 mm²
 X23, X25, X26, X27: cables 0.5 to 2.5 mm²

Factory Settings

X21		Programmable
1	VREF	Reference voltage 10 VDC
2	GND	$1\text{ kohm} \leq R_L \leq 10\text{ kohm}$
3	AI1+	By default, not in use.
4	AI1-	0(2) ... 10 V, $R_{in} > 200\text{ kohm}$
5	AI2+	By default, not in use.
6	AI2-	0(4) ... 20 mA, $R_{in} = 100\text{ ohm}$
7	AI3+	By default, not in use.
8	AI3-	0(4) ... 20 mA, $R_{in} = 100\text{ ohm}$
9	AO1+	By default, not in use.
10	AO1-	0(4) ... 20 mA, $R_{in} = 100\text{ ohm}$
11	AO2+	By default, not in use.
12	AO2-	0(4) ... 20 mA, $R_{in} = 100\text{ ohm}$

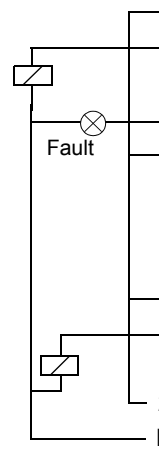
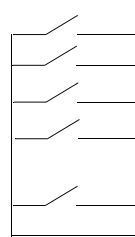
X22		Fixed
1	DI1	Acknowledgement of converter fan
2	DI2	Stop/Start
3	DI3	Acknowledgement of main contactor
4	DI4	Earth fault
5	DI5	External fault indication
6	DI6	Reset
7	+24V	+24 VDC max. 100 mA
8	+24V	
9	DGND	Digital Ground

X23		Fixed
1	+24 V	Auxiliary voltage output, non-isolated, 24 VDC 250 mA
2	GND	

X25		Fixed
1	RO11	Relay output 1 Charging contactor control
2	RO12	
3	RO13	

X26		Fixed
1	RO21	Relay output 2 Fault (-1)
2	RO22	
3	RO23	

X27		Fixed
1	RO31	Relay output 3 Main contactor control
2	RO32	
3	RO33	



RS 485 serial line connector X28 *

1	TRANS	Standard Modbus link
2	GND	
3	B-	
4	A+	
5	GND	
6	+24V	

RS 485 serial line connector X29 *

1	TRANS	Standard Modbus link
2	FAULT	
3	B-	
4	A+	
5	GND	
6	+24V	

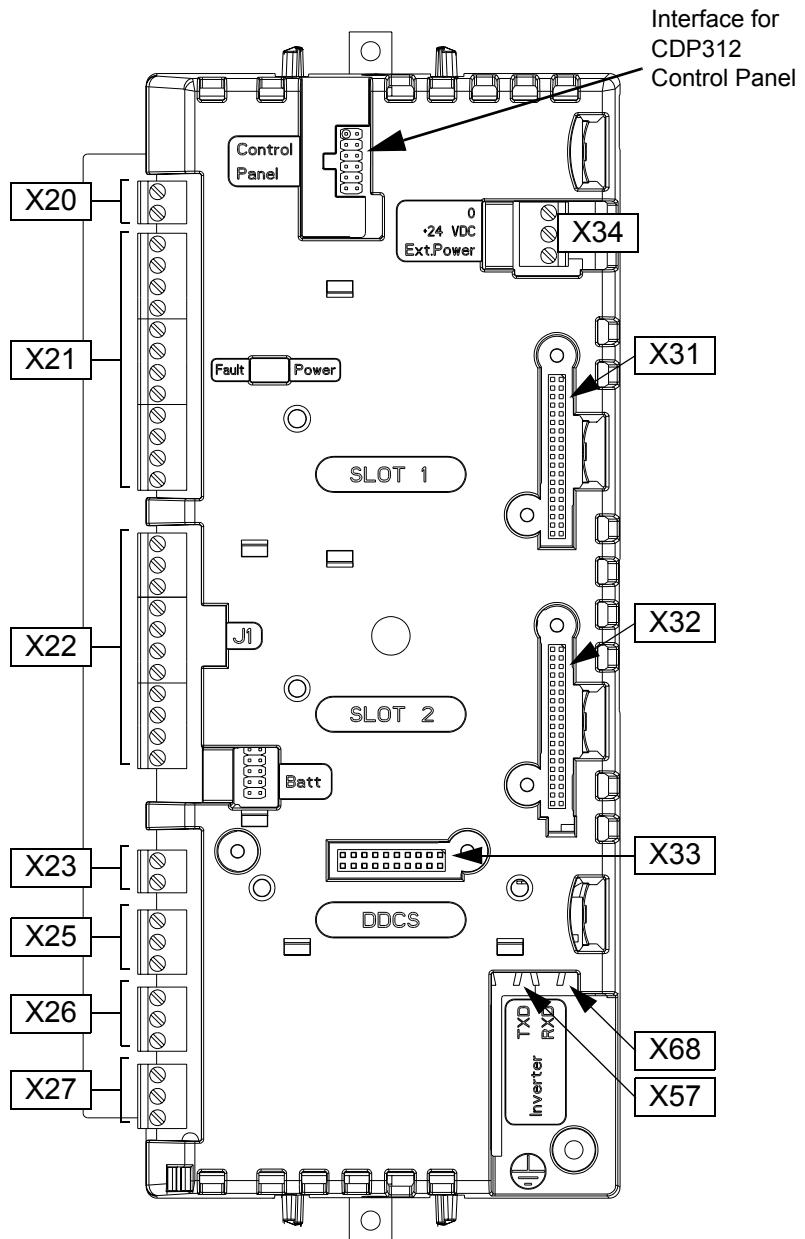
* Connector shield is connected via RC filter to the frame.

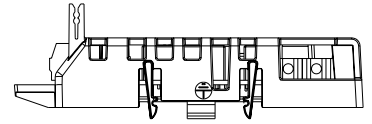
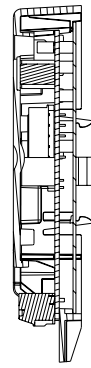
NIOC Board Specifications

	IGBT Supply Section NIOC Board
Constant Voltage Output	Voltage: 10 VDC \pm 0.5% (Full-scale Range) at 25 °C. Temperature Coefficient: \pm 100 ppm/°C, max. Maximum Load: 10 mA Applicable Potentiometer: 1 kohm to 10 kohm
Auxiliary Power Output	Voltage: 24 VDC \pm 10%, Short-circuit proof Maximum Current: 250 mA or 130 mA with NLMD-01 option
Analogue Outputs	Two Programmable Current Outputs: 0 (4) to 20 mA, $R_L \leq 700$ ohm Resolution: 0.1% (10 bit) Inaccuracy: \pm 1% (Full-scale Range) at 25 °C. Temperature Coefficient: \pm 200 ppm/°C, max. Output Updating Time: 4 ms
Digital Inputs	Six Digital Inputs (Common Ground): 24 VDC, -15 to +20 % Logical Thresholds: < 8 VDC $\hat{=}$ "0", > 12 VDC $\hat{=}$ "1" Input Current: DI1 to DI 5: 10 mA, DI6: 5 mA Filtering Time Constant: 1 ms Internal Supply For Digital Inputs (+24 VDC): Short-circuit proof, group isolated Isolation Test Voltage: 500 VAC, 1 minute Input Updating Time: 10 ms An external 24 VDC supply can be used instead of the internal supply.
Relay Outputs	Three Relay Outputs Switching Capacity: 8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC Maximum Continuous Current: 2 A rms Isolation Test Voltage: 4 kVAC, 1 minute Output Updating Time: 100 ms
DDCS Fibre Optic Link	Protocol: DDCS (ABB Distributed Drives Communication System)

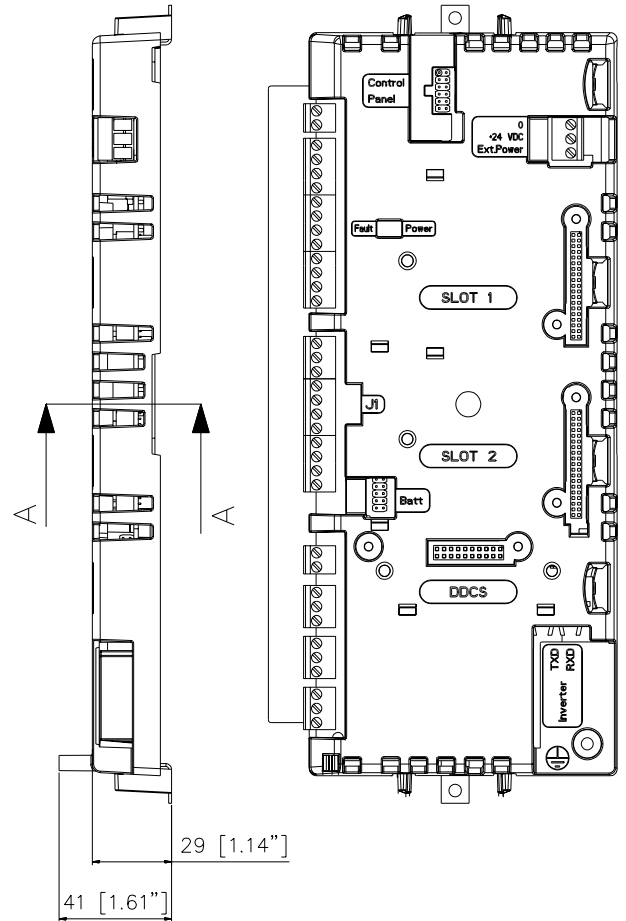
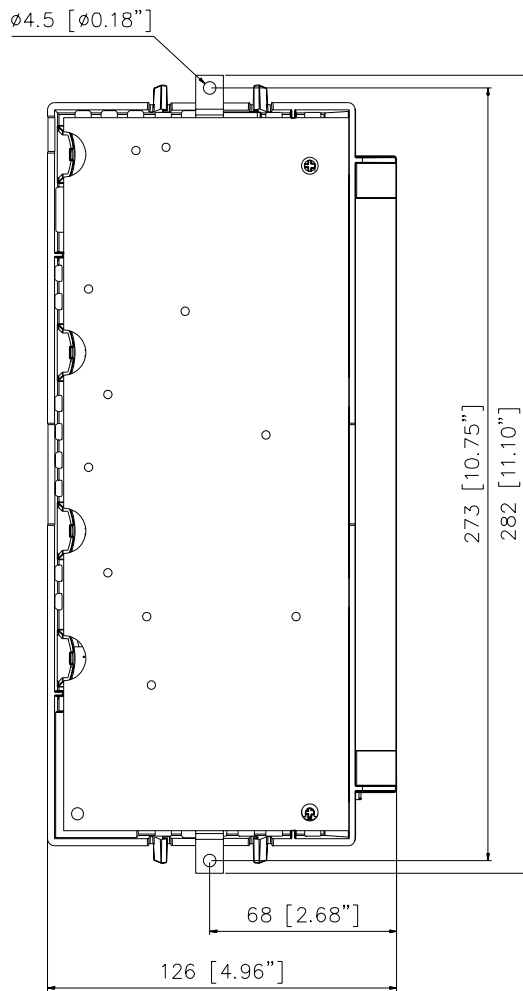
**Drive Control Unit
RDCU**

The Drive Control Unit RDCU containing an RMIO-01 board is shown in the pictures below





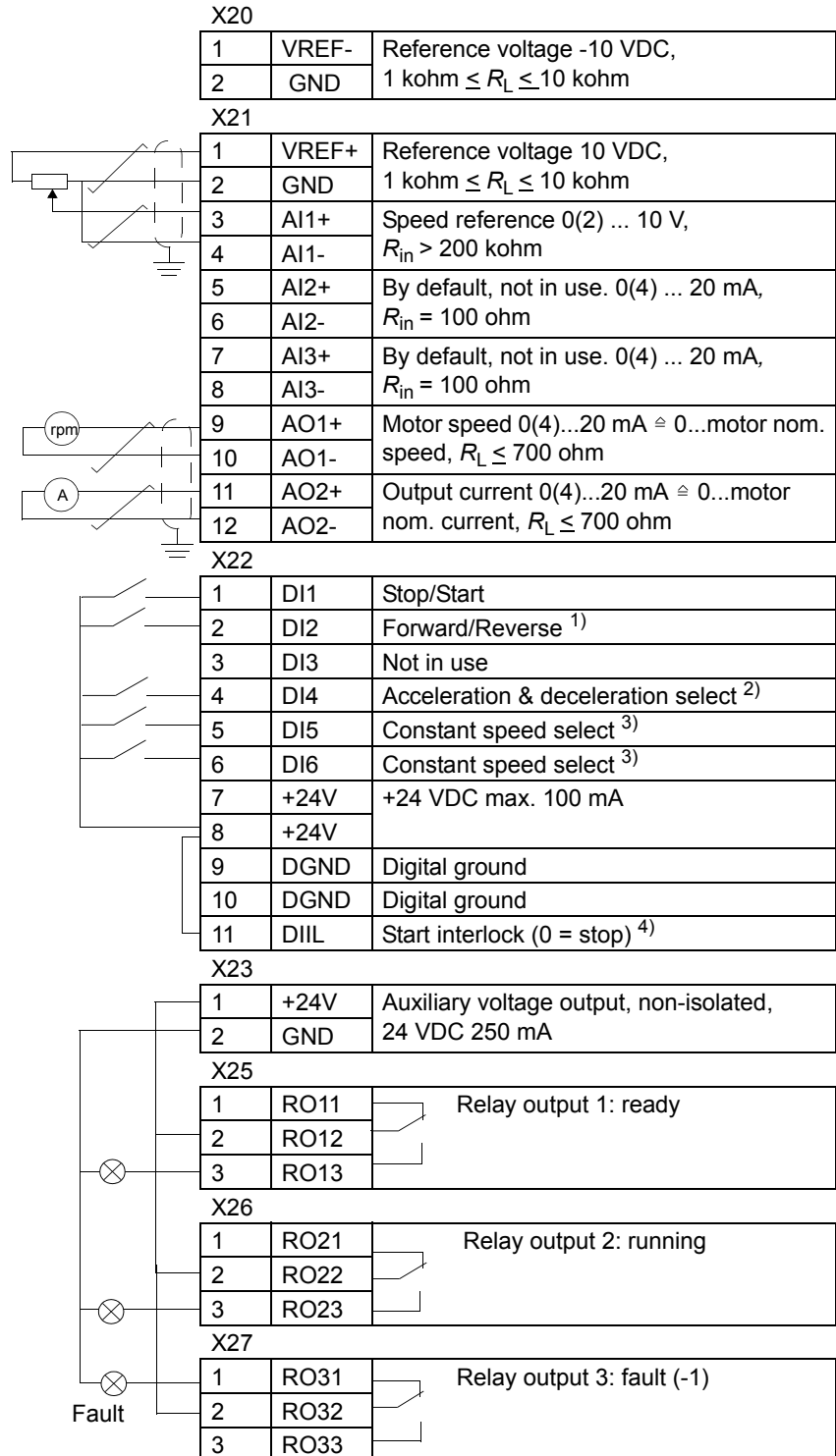
A – A



Motor Control and I/O board RMIO-01

External control cable connections (**non-US**) to the RMIO board for the ACS 800 Standard Application Program (Factory Macro) are shown below. For external control connections of other application macros and programs, see the appropriate *Firmware Manual*.

Terminal block size:
cables 0.3 to 3.3 mm² (22 to 12 AWG)
Tightening torque:
0.2 to 0.4 Nm (2 to 4 lbf in.)



¹⁾ Only effective if par. 10.03 is set to REQUEST by the user.

²⁾ 0 = open, 1 = closed

DI4	Ramp times according to
0	parameters 22.02 and 22.03
1	parameters 22.04 and 22.05

³⁾ See par. group 12 CONSTANT SPEEDS.

DI5	DI6	Operation
0	0	Set speed through AI1
1	0	Constant speed 1
0	1	Constant speed 2
1	1	Constant speed 3

⁴⁾ See parameter 21.09 START INTRL FUNC.

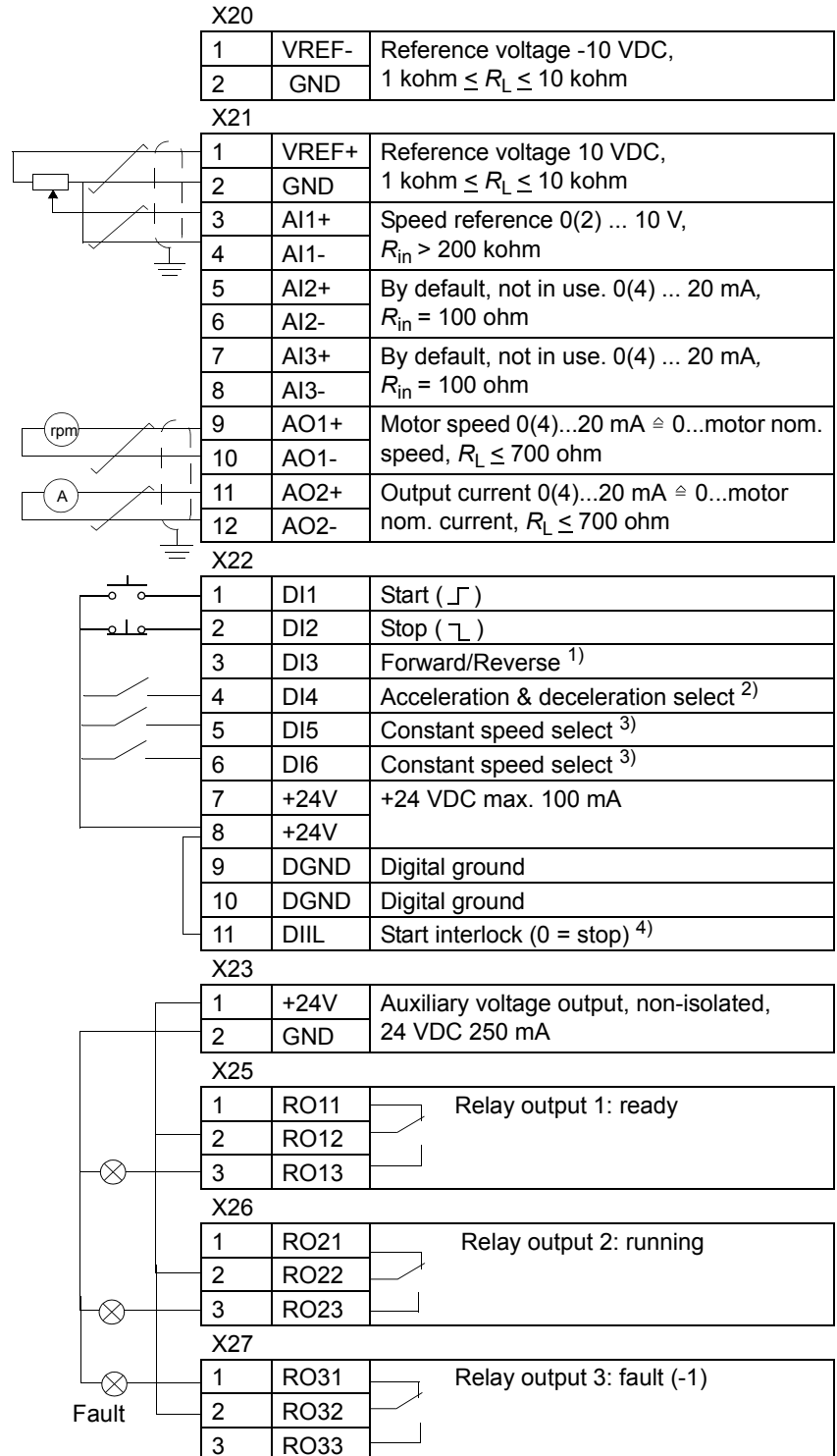
External control cable connections (**US**) to the RMIO board for the ACS800 Standard Application Program (Factory Macro US version, +N665) are shown below. For external control connections of other application macros and programs, see the appropriate *Firmware Manual*.

Terminal block size:

cables 0.3 to 3.3 mm² (22 to 12 AWG)

Tightening torque:

0.2 to 0.4 Nm (2 to 4 lbf in.)



¹⁾ Only effective if par. 10.03 is set to REQUEST by the user.

²⁾ 0 = open, 1 = closed

DI4	Ramp times according to
0	parameters 22.02 and 22.03
1	parameters 22.04 and 22.05

³⁾ See par. group 12 CONSTANT SPEEDS.

DI5	DI6	Operation
0	0	Set speed through AI1
1	0	Constant speed 1
0	1	Constant speed 2
1	1	Constant speed 3

⁴⁾ See parameter 21.09 START INTRL FUNC.

RMIO board specifications

Analogue inputs	<p>With Standard Application Program two programmable differential current inputs (0 mA / 4 mA ... 20 mA, $R_{in} = 100 \text{ ohm}$) and one programmable differential voltage input (-10 V / 0 V / 2 V ... +10 V, $R_{in} > 200 \text{ kohm}$).</p> <p>The analogue inputs are galvanically isolated as a group.</p> <p>Isolation Test voltage: 500 VAC, 1 min</p> <p>Max. common mode voltage between the channels: $\pm 15 \text{ VDC}$</p> <p>Common mode rejection ratio: $\geq 60 \text{ dB}$ at 50 Hz</p> <p>Resolution: 0.025% (12 bit) for the -10 V ... +10 V input. 0.5% (11 bit) for the 0 ... +10 V and 0 ... 20 mA inputs.</p> <p>Inaccuracy: $\pm 0.5 \%$ (Full Scale Range) at 25 °C. Temperature coefficient: $\pm 100 \text{ ppm/}^\circ\text{C}$, max.</p>
Constant voltage output	<p>Voltage: +10 VDC, 0, -10 VDC $\pm 0.5\%$ (Full Scale Range) at 25 °C. Temperature coefficient: $\pm 100 \text{ ppm/}^\circ\text{C}$ ($\pm 56 \text{ ppm/}^\circ\text{F}$) max</p> <p>Maximum load: 10 mA</p> <p>Applicable potentiometer: 1 kohm to 10 kohm</p>
Auxiliary power output	<p>Voltage: 24 VDC $\pm 10\%$, short circuit proof</p> <p>Maximum current: 250 mA (without any optional modules inserted onto slots 1 and 2)</p>
Analogue outputs	<p>Two programmable current outputs: 0 (4) to 20 mA, $R_L \leq 700 \text{ ohm}$</p> <p>Resolution: 0.1% (10 bit)</p> <p>Inaccuracy: $\pm 1\%$ (Full Scale Range) at 25 °C (77 °F). Temperature coefficient: $\pm 200 \text{ ppm/}^\circ\text{C}$ ($\pm 111 \text{ ppm/}^\circ\text{F}$) max.</p>
Digital inputs	<p>With Standard Application Program six programmable digital inputs (common ground: 24 VDC, -15% to +20%) and a start interlock input. Group isolated, can be divided in two isolated groups (see Isolation and grounding diagram below).</p> <p>Thermistor input: 5 mA, $< 1.5 \text{ kohm} \hat{=} \text{“1”}$ (normal temperature), $> 4 \text{ kohm} \hat{=} \text{“0”}$ (high temperature), open circuit $\hat{=} \text{“0”}$ (high temperature).</p> <p>Internal supply for digital inputs (+24 VDC): short circuit proof. An external 24 VDC supply can be used instead of the internal supply.</p> <p>Isolation test voltage: 500 VAC, 1 min</p> <p>Logical thresholds: $< 8 \text{ VDC} \hat{=} \text{“0”}$, $> 12 \text{ VDC} \hat{=} \text{“1”}$</p> <p>Input current: DI1 to DI 5: 10 mA, DI6: 5 mA</p> <p>Filtering time constant: 1 ms</p>
Relay outputs	<p>Three programmable relay outputs</p> <p>Switching capacity: 8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC</p> <p>Minimum continuous current: 5 mA rms at 24 VDC</p> <p>Maximum continuous current: 2 A rms</p> <p>Isolation test voltage: 4 kVAC, 1 minute</p>
DDCS fibre optic link	<p>With optional communication adapter module RDCO. Protocol: DDCS (ABB Distributed Drives Communication System)</p>
<p>The RMIO board as well as the optional modules attachable to the board fulfil the Protective Extra Low Voltage (PELV) requirements stated in EN 50178.</p>	

Applicable Standards

The ACA 635 complies with the following standards:

- EN 60204-1: 1992 + Corr. 1993 (IEC 60204-1). Safety of machinery. Electrical equipment of machines. Part 1: General requirements.
- EN 60529: 1991 (IEC 60529), IEC 60664-1: 1992. Degrees of protection provided by enclosures (IP code).
- EN 50178: 1986. Electronic equipment for use in power installations.
- EN 61800-3: 1996, Amendment A11: 2000 (IEC 61800-3). EMC product standard including specific test methods.
- IEC 61000-3-4 TR2 Stage 3. Limitation of emission of harmonic currents in low voltage power supply systems with rated current greater than 16 A (for line current).
- IEC 61000-2-4 Class 3. Compatibility levels in industrial plants for low-frequency conducted disturbances. (for line voltage)
- IEEE 519: 1992. Recommended practices and requirements for harmonic control in electrical power systems. Total demand distortion (TDD).

CE Marking

A CE mark is attached to ACS 600 MultiDrive frequency converters (380...690 V ranges) to verify that the unit fulfils the European Low Voltage and EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC and Directive 89/336/EEC, as amended by 93/68/EEC).

Definitions

EMC stands for **E**lectromagnetic **C**ompatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard EN 61800-3 covers requirements stated for drives.

First environment includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

Second environment includes establishments connected to a network not supplying domestic premises.

Restricted distribution: mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

Unrestricted distribution: mode of sales distribution in which the supply of equipment is not dependent on the EMC competence of the customer or user for the application of drives.

Compliance with the EMC Directive

The ACA 635 supply sections comply with the EMC Directive in industrial low-voltage network, and IT networks (unearthed mains) with the following provisions. For ACS800-17 units, refer to *ACS800-17 Hardware Manual* (EN code 64638505).

Second Environment (Unrestricted Distribution)


1. The motor and control cables are selected as specified in the *Hardware Manual*.
2. The drive is installed according to the instructions given in the *Hardware Manual*.
3. Maximum cable length is 100 metres.

WARNING! The drive may cause radio interference if used in a residential or domestic environment. The user is required to take measures to prevent interference, in addition to the requirements for CE compliance listed above, if necessary.

Note: It is not allowed to use EMC filters on an unearthed mains supply network, unless the filters are able to withstand the unearthed network. (EMC filters are used to minimise the RFI emission of the unit.)

Note : With cables longer than 100 metres, the ACA 635 supply sections comply with the EMC Directive in restricted distribution mode when the installation is described in an EMC plan (a template is available from the local ABB representative).

Table A-1 The EMC cabinet option is marked in the type code as follows. 0 = No EMC cabinet, 1 = EMC cabinet (does not include RFI filters)

ACS 600 Type	Type Code	
	Character no.	Options
ACA 635	ACA635xxxxxxxxxxxx... <div style="text-align: center;">  16 </div>	0,1

Machinery Directive

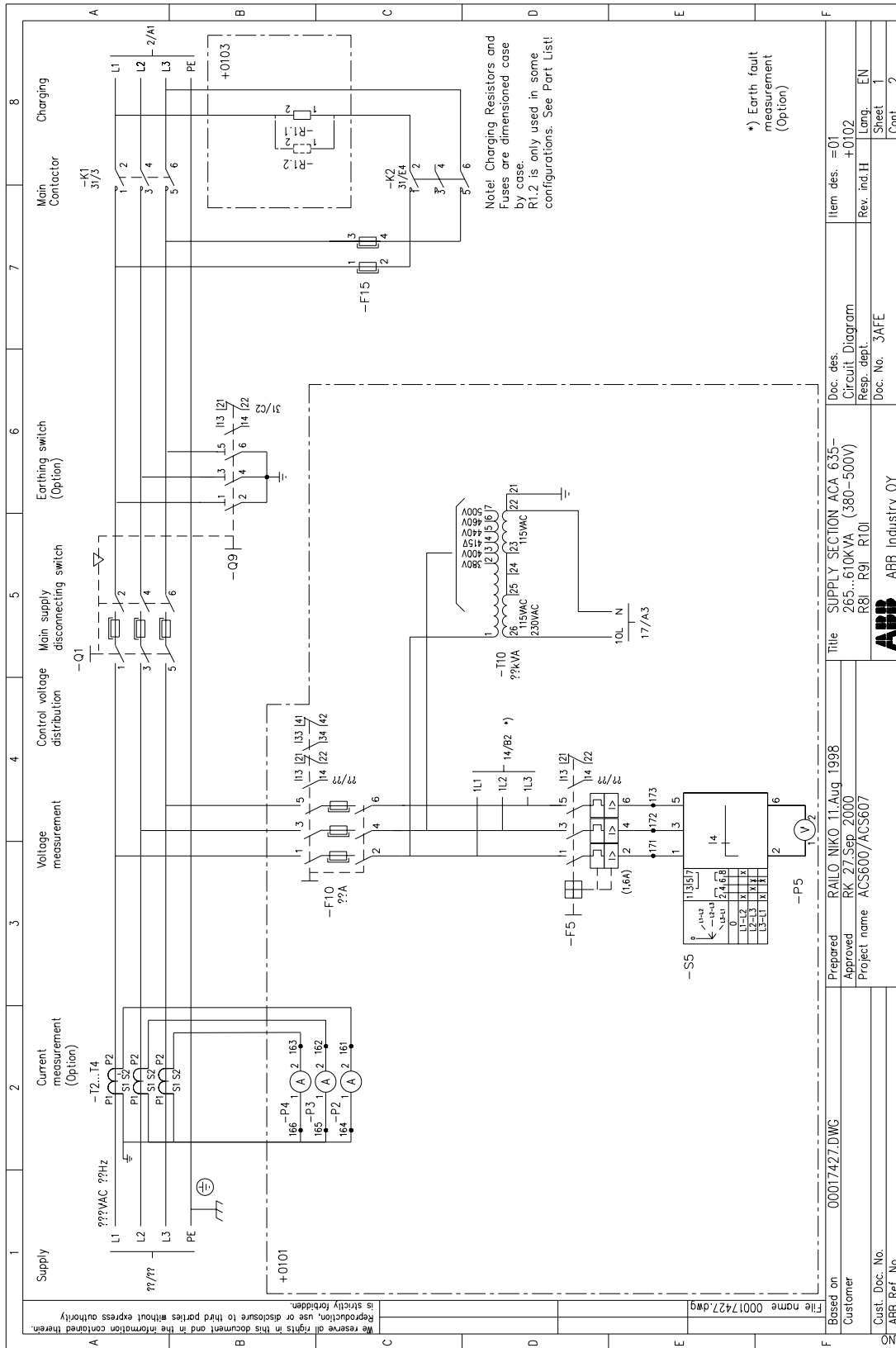
The drives comply with the European Union Machinery Directive (98/392/EEC) requirements for an equipment intended to be incorporated into machinery.

Appendix B – Circuit Diagrams

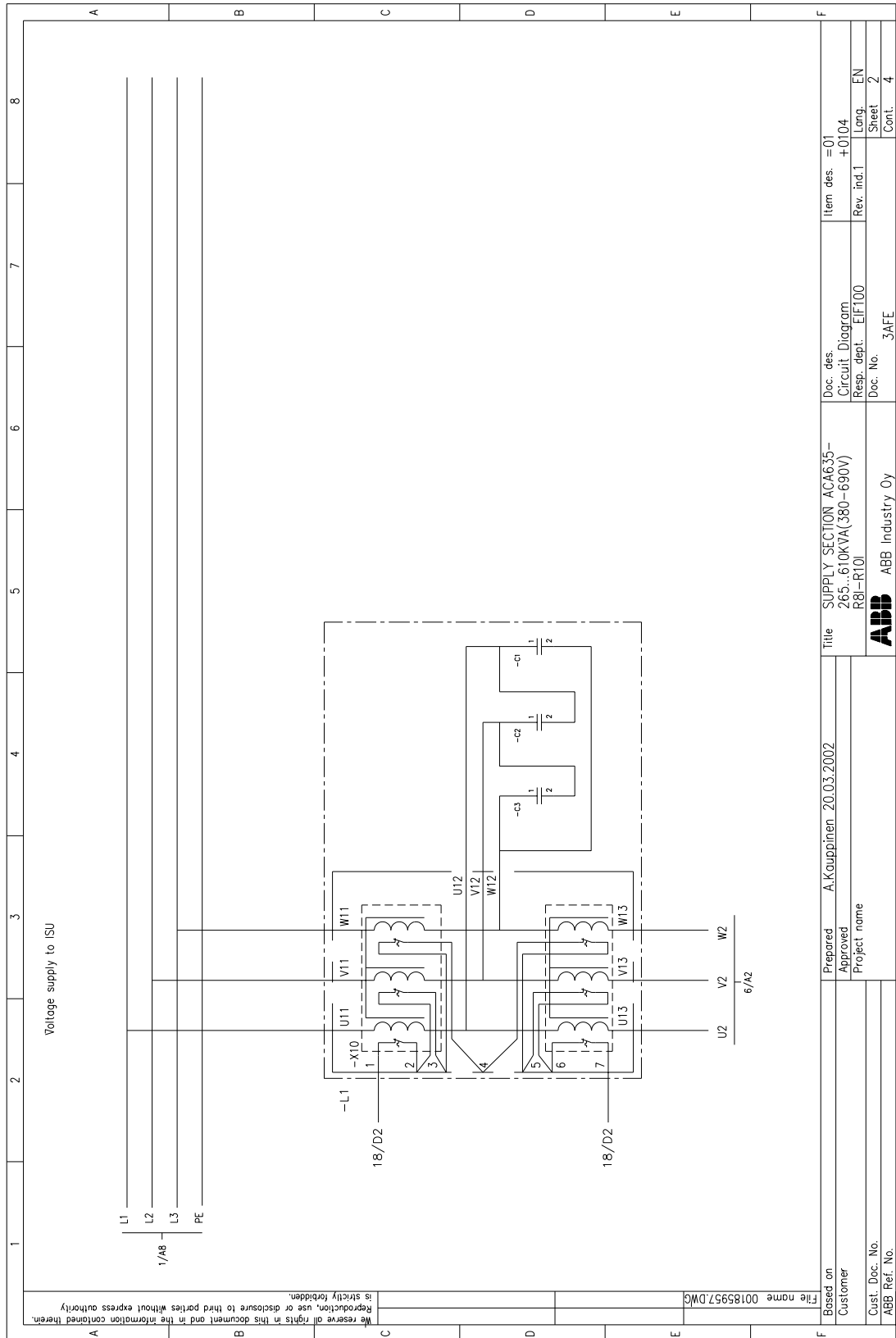
Overview

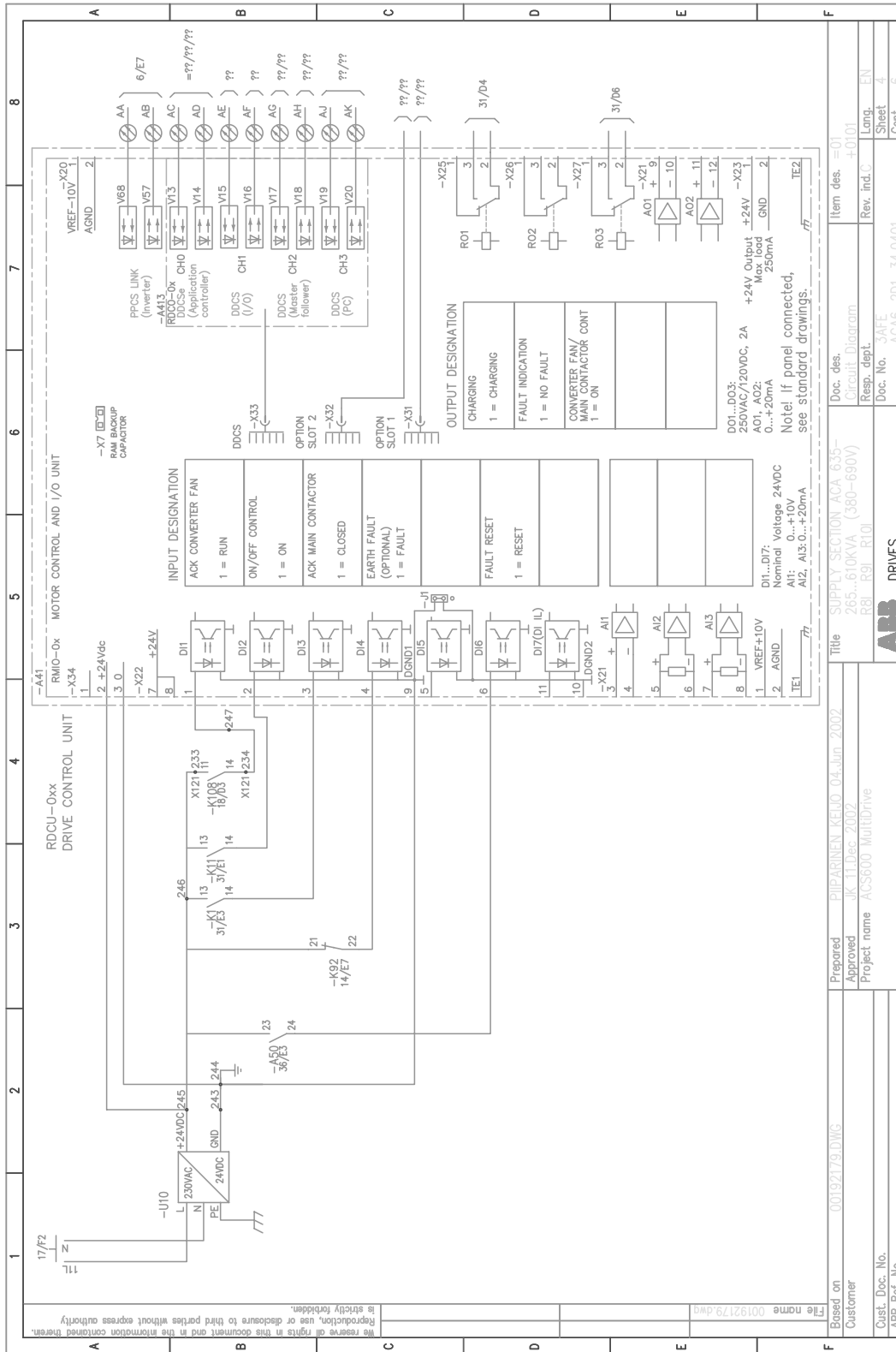
The following pages contain some circuit diagrams of supply sections equipped with an IGBT supply unit for helping to understand the configuration of the supply section. The diagrams do not necessarily match with each delivery. The wiring varies depending on the power rating and the selected equipment. The circuit diagrams valid for each supply section are included in the delivery.

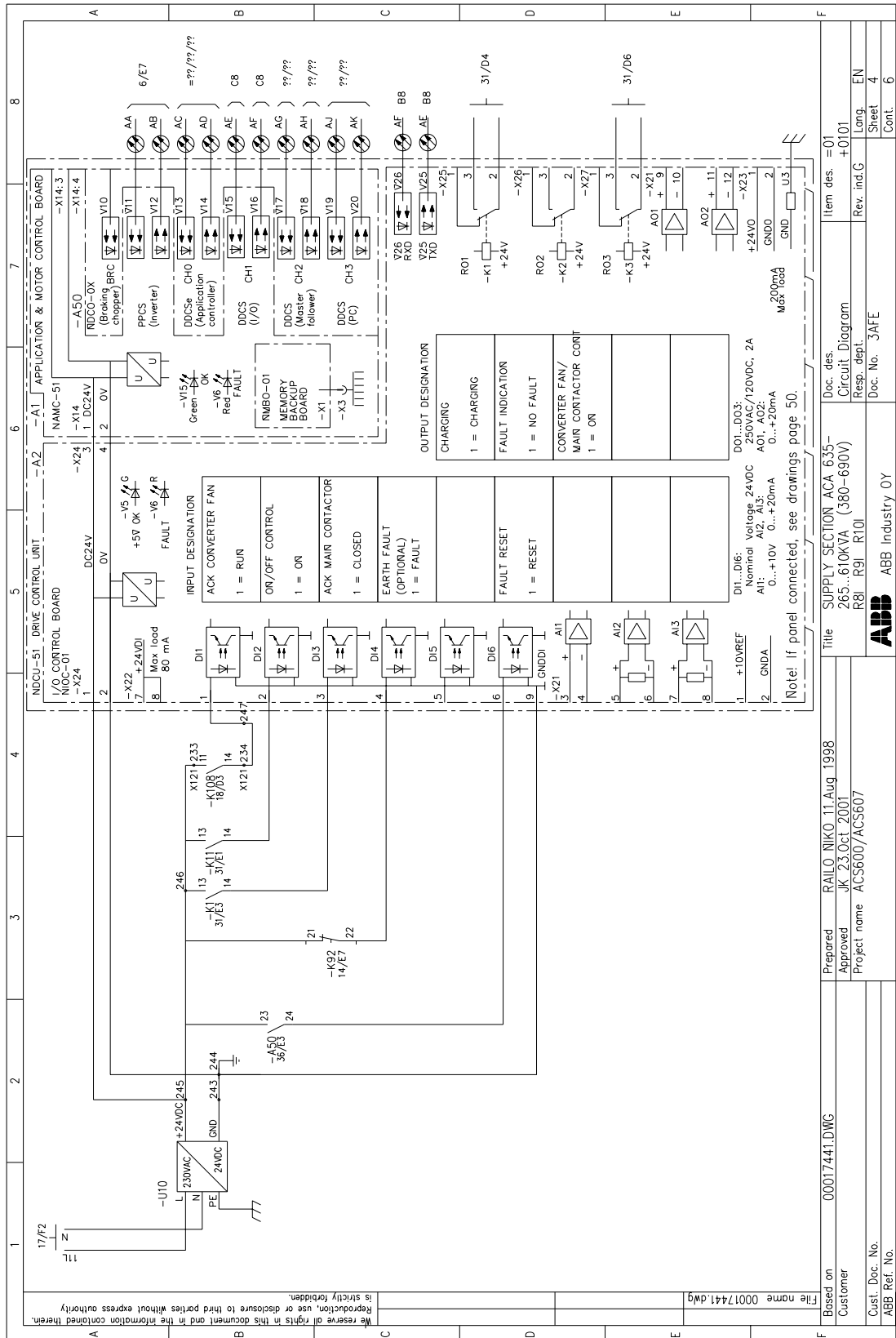
Appendix B – Circuit Diagrams



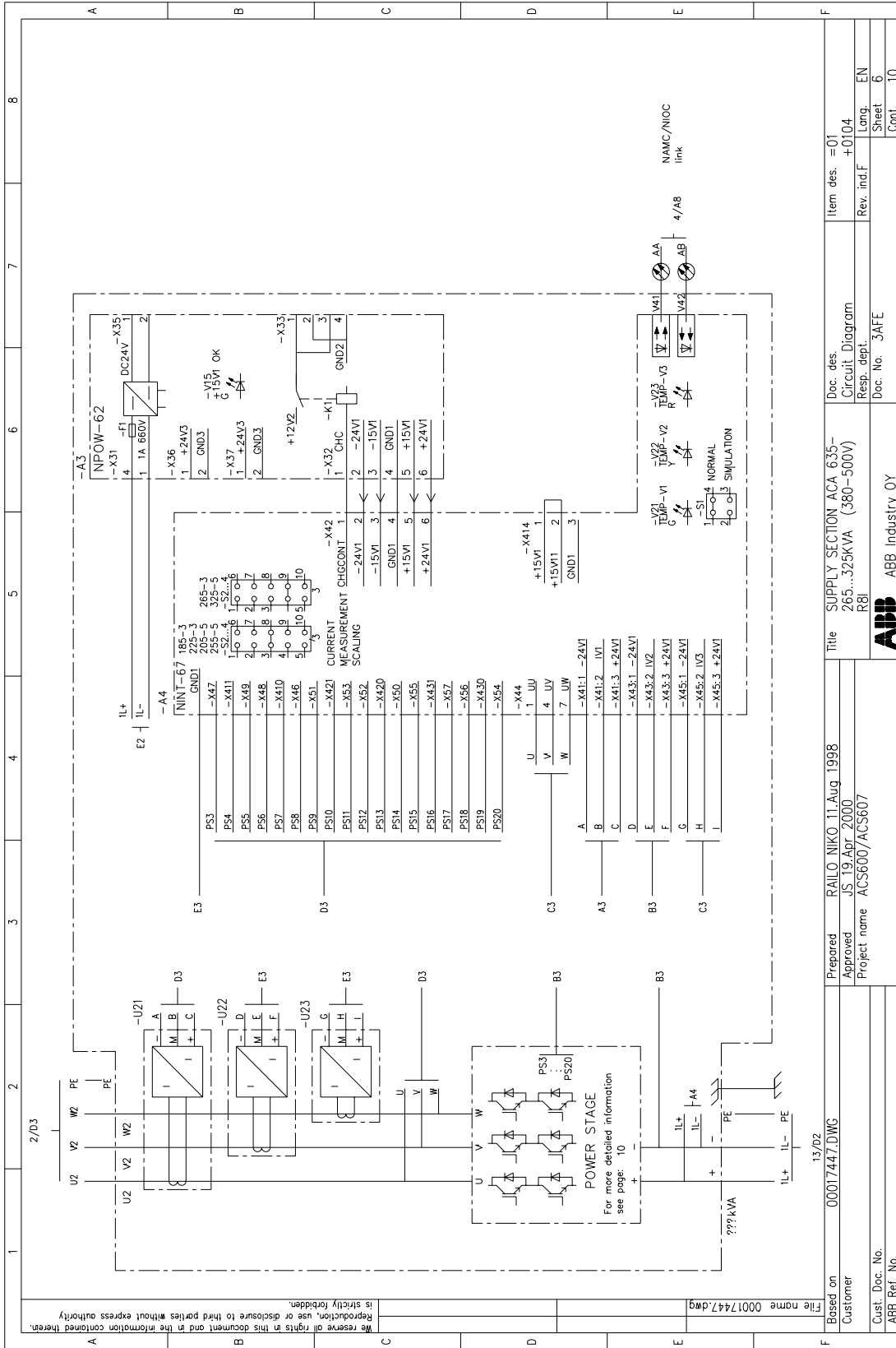
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Project name	ACS600/ACS607	Resp. dept.	Rev. ind.H
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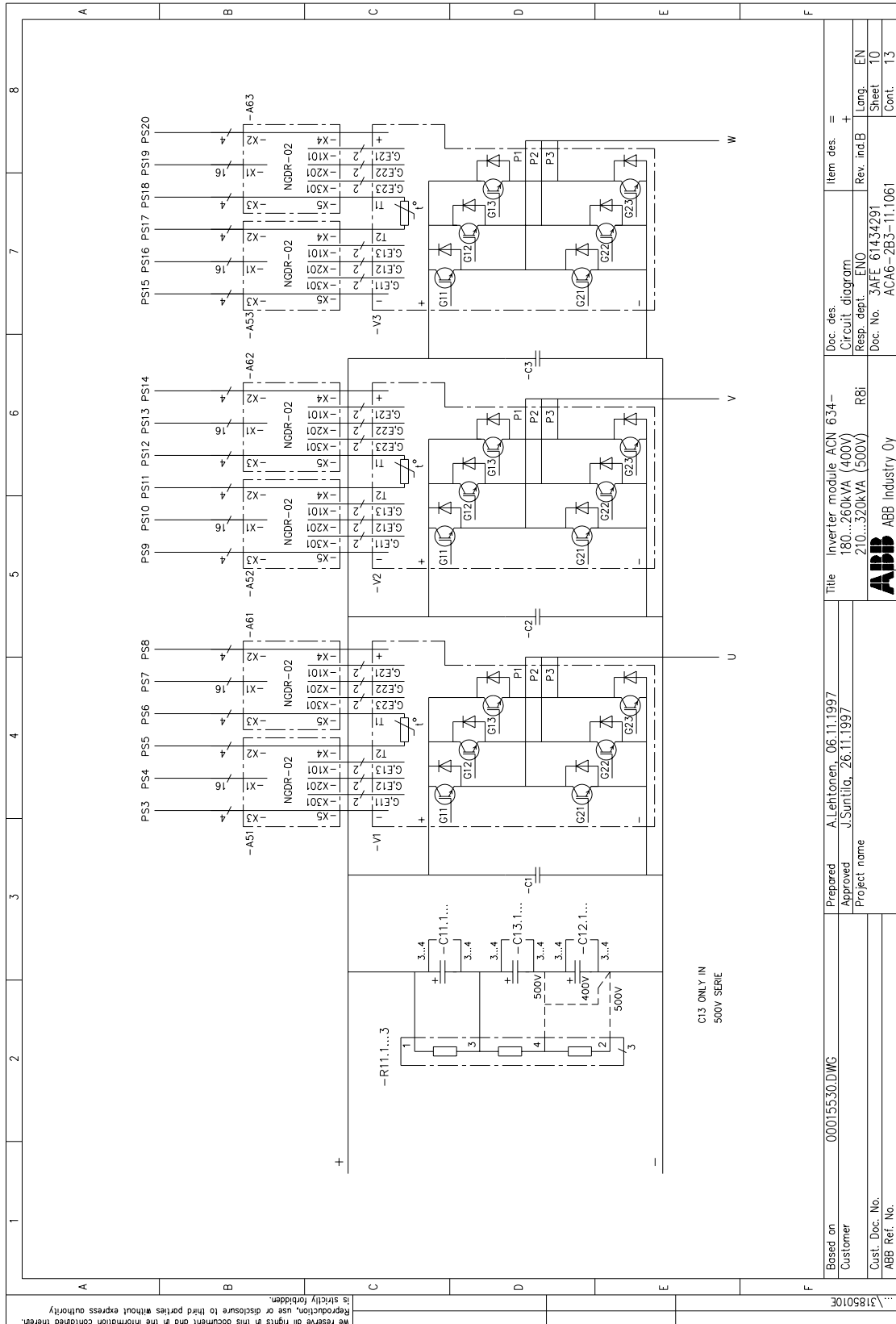


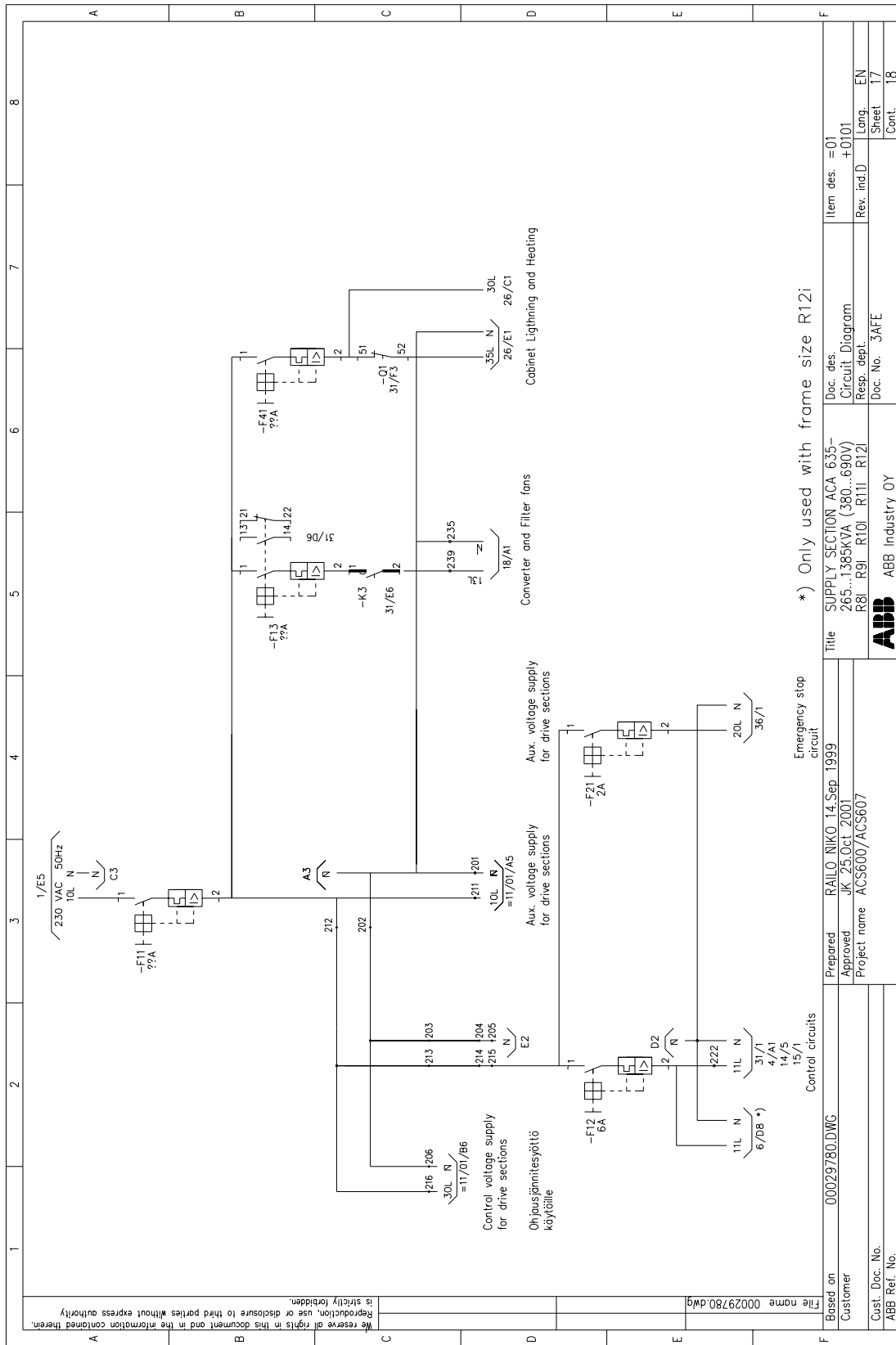
Appendix B – Circuit Diagrams



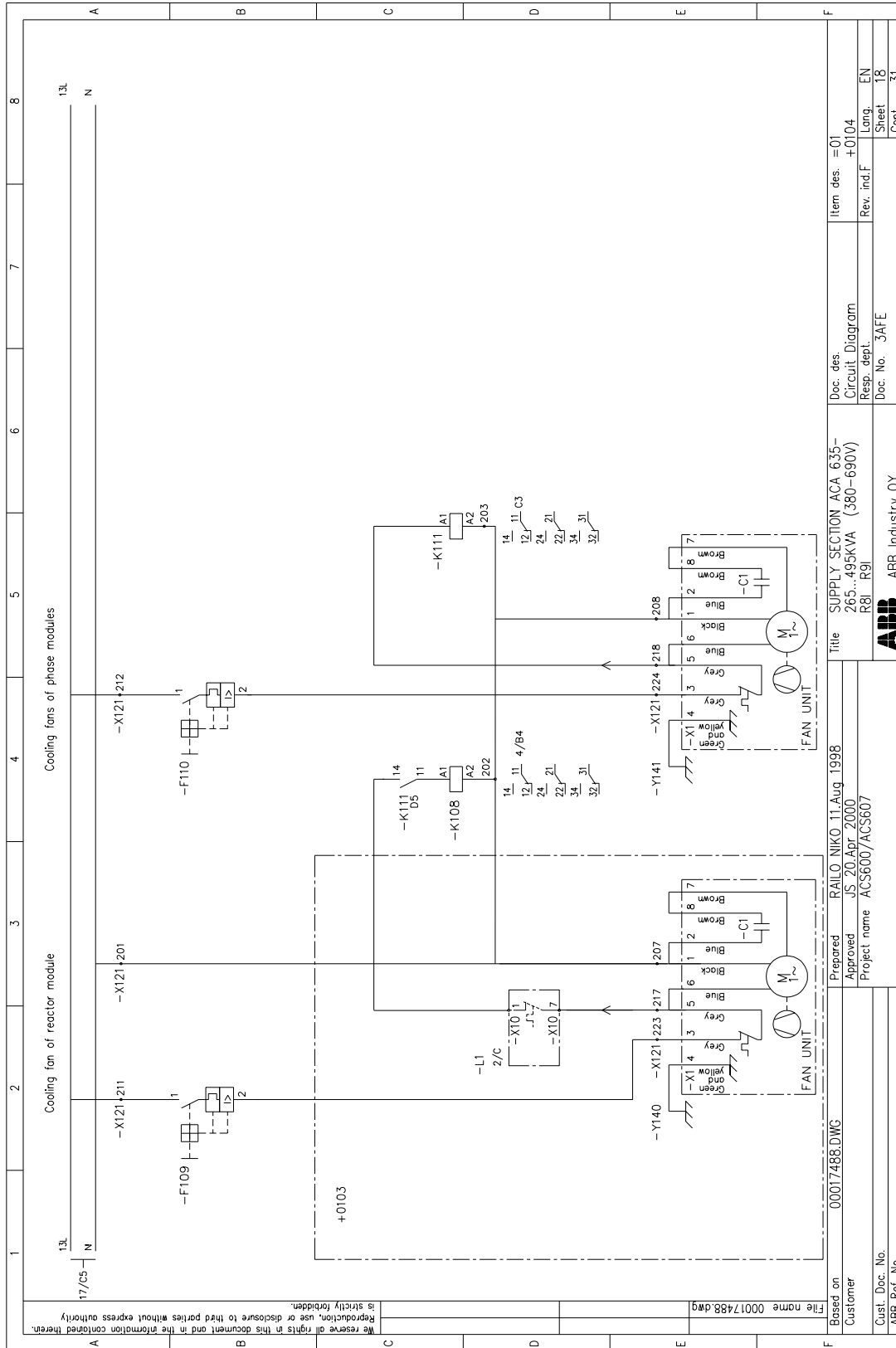
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Appendix B – Circuit Diagrams



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Based on 00017488.DWG
 Prepared RAILO NIKO, 11 Aug 1998
 Approved JS, 20 Apr 2000
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 Title SUPPLY SECTION, ACA 635-
 265...495KVA (380-690V)
 R81 R91
 Doc. des. Circuit Diagram
 Resp. dept.
 Doc. No. 3AFE
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 Rev. ind.F +0104
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 Sheet 18
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