ACS 6000
Medium Voltage AC Drives

Commissioning Manual

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Chapter 1 - Overview

1.1 General

This manual describes the commissioning and operation of the ACS 6000 frequency converter, including all checking and tuning principles as well as measurements and recordings, added with hints based on practical experience.

Note: Parameter references in this manual are applicable for software versions **LxOC 3xxxx**.

1.2 Related Documents

3BHS125195	SigParACS6000-ARU_LNACxxxx
Technical Note	ACS 6000SD VC SW Commissioning Manual
3BHS120865	SigParACS6000AD_SD_INU
Technical Note	ACS 6000AD TC SW Commissioning Manual

1.3 Safety

Safety instructions, safety concept, warnings, intended audience, required qualification, responsibilities etc. apply according to the *ACS 6000 User's Manual*.

1.4 Operation and Maintenance

According to the *ACS 6000 User's Manual, Chapter 11* and *12*. Predefined preventive maintenance packages are from

ABB Switzerland Ltd.

Medium Voltage Drives

CH-5300 Tugi / Switzerland

1.5 Preparation for Commissioning (Project Management Input)

Preparatory steps must be taken and data must be collected before the commissioning is started.

Make sure that the following list is fulfilled:

- Motor parameters are available.
- Pre-setting of parameters is available.
- Commissioning spares are available or sent.
- Tools according to the list are available.
- Special tuning instructions are available.
- Commissioning program is available.
- Instructions for commissioning is received.
- Preparative work for possible drive upgrade is done.
- Latest updates of SW is received.

1.6 Preconditions for Commissioning

The following preconditions must be fulfilled before the commissioning of the drive can start.

NOTE! The item 7, ie. insulation test of cables, transformers and motor, can be made by the commissionig engineer. In that case, one additional day (per motor – drive combination) needs to be reserved.

After insulation test the mains cables can be connected, **except at converter end**.

General Preconditions

1 The Installation of the ACS 6000 must be completed according to the *ACS 6000 User's Manual Chapter 8 – Mechanical Installation* and *Chapter 9 – Electrical Installation*.

Shortly these installation requirements are the following:

- Deionised water available on site and raw water connections ready
- Auxiliary supply voltage available and related cable connections ready. The permission to switch on the auxiliary voltage must always be granted by the commissioning engineer (ref. 5.2)!
- Drive mechanical installation ready
- External wiring from and to the converter ready

High Voltage Equipment

2 High voltage (HV) switchgear is installed, connected and ready for operation.

3 Converter transformer is installed, connected and ready for operation.

4 The motor is installed, aligned, **uncoupled** and ready for operation. An official protocol document must be available.

5 Grounding cables of transformers, converter and motor are connected.

6 All cable screens are connected.

7 Insulation of cables, transformers and motor has been tested and complies with the specification (5 kV/60 sec.). An official test report must be available. Insulation test of the converter will be performed by the commissioning engineer.

8 Mains voltage supply is available.

9 The motor driven load (process) is ready for coupling and for operation under nominal conditions.

Auxiliary Voltage Supply and Control

10 All auxiliary cables are connected

11 Auxiliary voltage switchgear is connected and operable.

- Control cables are connected:
- MCB control cables are connected directly to the converter
- Tripping loop
- Remote control cabling

12 Cabling of options (transformer / motor protection, tachometer etc.)

13 Auxiliary voltage supply is available.

14 The plate of the grounding switch lock override is attached and secured

Miscellaneous

15 Spare parts available

16 All necessary process information has been handed over to your ABB sales representative. For details contact ABB.

1.7 Purpose of Commissioning

The purpose of commissioning is to accomplish the operation of the drive, which corresponds to the customer requirements. This is achieved by following the instructions given in this manual and performing the actions needed until the required operation is accomplished.

After the commissioning is finished the customer receives a commissioning report. When properly filled in, the warranty time is initiated. The condition for proper warranty is that the commissioning report together with the parameter files are sent to ***mv.ac.supportline@ch.abb.com.***

It must be pointed out, that only an electrical engineer, who has been properly trained and certified, is allowed to commission an ACS 6000 frequency converter.

Typically, commissiong has two parts, i.e. so called "Cold"- and "Hot"-commissioning.

Cold Commissioning

- Spare parts available
- Internal cabling, auxiliary voltage, converter cooling system
- Drive I/O, insulation resistance measurements, MCB
- SW parameterisation, no-load- tuning and running tests

Hot Commissioning

- Spare parts available
- Coupling test: integrated tests with the automation system
- Load tests: tuning controllers, mechanical operation and heat run

Additional work for the drive commissioning engineer (if so agreed):

- Commissioning of the motor / transformer
- Commissioning of MCB / protection relays
- Adjusting and tuning of external devises (like sensors, switches)

1.8 Commissioning Report

While commissioning the ACS 6000, the commissioning report must be filled out. After the commissioning this report must be mailed to ***mv.ac.supportline@ch.abb.com***.

Parameter and back-up file(s) must be:

1 stored with Drive*Window*, and if possible also with DriveDebug, PC-tool,

2 attached to the commisioning report,

3 printed out and filed in the *ACS 6000 User's Manual* on site.

In addition to the above mentioned commissioning report also the **internal field service report** must always be filled out. In this internal service report the following summary and data needs to be given:

- Open items
- Deviations to standard commissioning time
- Drive tuning report (pictures), tuning problems
- Special problems, experiences, etc.

Chapter 2 - Checking the Scope of Delivery

2.1 Rating Plate Data

The following items must be reported according to the list in the commissiong report:

Manufacturer information, manufacturing identification and rating plate data of the installed components (MCB, transformers, converters and motors)

Accessories and options of the installed components.

Manufacturer, type and length of the power cables.

Example of rating plate of an ACS 6000 multi-drive:

ACS 6000

Type	ACM 6207_A12_1a3_1s9_1s9_1s9_1V3_C26_C26_W5
Order number	
Year of manufacture / serial number	2003 /
Standard	IEC 60146
Degree of protection	IP 32 (standard)
Weight	

Converter	Line side converter	Motor converter 1	Motor converter 2	Motor converter 3	Motor converter 4
Rated apparent power	9400 kVA	2000 kVA	6000 kVA	6000 kVA	6000 kVA
Rated current	860 A	365 A	1100 A	1100 A	1100 A
Number of phases	2 x 3	1 x 3	1 x 3	1 x 3	1 x 3
Input voltage / output voltage range	3160 V +-10%	0 ... 3300 V			
Input frequency / output frequency range	50 Hz +-2%	0 ... 75 Hz (0 ... 8 Hz with derating)			
Duty class: Continuous overload capacity	115%	115%			
Short term overload capacity	150% / 60s	150% / 60s			
Total apparent power	18000 kVA				

Excitation		Unit 2	Unit 3	Unit 4
Type		AC / DC	AC / DC	AC / DC
Input voltage		3 x 400 V	3 x 400 V	3 x 400 V
Rated output current		A	A	A
Short term overload capacity	150% / 60s			

Cooling

Ambient temperature range	5..40°C
Primary / secondary coolant	deionised water / raw water
Raw water inlet temperature range	10..32°C
Raw water flow rate range	870 .. 1200 l/min
Raw water pressure	< 1000 kPa
Deionised water temperature range	10..37°C
Deionised water volume	300 l
Altitude above sea level	1000 m

2.2 Scope of Delivery

Before the drive system can be commissioned properly it is necessary to inspect all system components carefully to make sure that all components ordered have been delivered properly and that there are no transportation damages.

Normally all delivered components have been insured during transportation and if there are damages they can be claimed back from the insurance company. If the inspection indicates a shortage, damage or evidence of any damage, it must be reported to the carrier's representative and to ABB and / or ABB representative. Any damage during transportation or installation must be photographed and reported to the manufacturer.

Note: The inspection of transportation damages must be done before the installation of the drive, immediately after the components have arrived on site. Before starting the commissioning work, try to find out if any damages have been reported earlier.

Check if there are any transportation damages in the delivered components.

Check if the *ACS 6000 User's Manua*l has been delivered together with the drive and that it includes the description of all relevant options.

Check that the scope of delivery is in condition and that there are no missing parts or components.

Chapter 3 - Inspection of Installation

The mechanical installation and the electrical connections of the converter, transformer and motor should be checked and be confirmed that they have been carried out in accordance with the manufacturer's installation instructions. The installation of the whole drive equipment must also fulfill the local electrical safety regulations.

It depends on the project which parts (of other drive system) are included in the scope of commissioning. However, the items below have always to be checked or one needs to get the confirmation that they had been checked before.

3.1 Main Circuit Breaker (MCB)

Check that the main circuit breaker installation is according to the requirements and fulfills the local regulations. For details see the MCB documentation and document *Main Circuit Breaker Specification* (document number 3BHS125149).

Follow the checklist of the commissioning report regarding MCB installation.

3.2 Transformer

Check that the transformer installation is according to the requirements and fulfills the local regulations. For details see the transformer documentation

Transformer tank (oil transformers) or frame (dry-type transformers) must be connected to the plant earthing network, at least in one point. For more details, see instructions of the transformer manufacturer.

Follow the checklist of the commissioning report regarding transformer installation.

3.3 Converter

For the installation requirements of the ACS 6000, Refer to the information given in the *ACS 6000 User's Manua*l, *Appendix D – Mechanical Drawings.*

For example, Marine installations usually require mounting brackets to the converter roof for additional cabinet support.

Follow the checklist of the commissioning report regarding converter installation.

3.3.1 Ambient Conditions

Derating may be necessary due to the presence of elevated levels in ambient air temperature, altitude from the sea level, or external cooling water temperature.

Reffer the drive rating plate data for information.

Other ambient factors are:

- Relative humidity => Condensation is not allowed.
- Air contamination => No visible dust or corrosive gases.
- Shock and vibration => Drive not subjected to vibration.

3.3.2 Dimensions and Clearances

The converter must be mounted with adequate free space as described in the *ACS 6000 User's Manual*, *Appendix D – Mechanical Drawings*.

Spaces for access to installation site (clearances of passageways etc.) must follow the local requirements in each country.

3.3.3 Installation Place and Cable Ducts

The floor must be of non-flammable material, with smooth and non-abrasive surface, protected against humidity diffusion, levelled and able to support the weight of the drive cabinets (min. 1'000 kg/m2).

The maximum allowable overall unevenness is $\leq$ 5 mm / 5 m. Check that all converter doors can be opened and locked properly. If not, the cabinet levelling needs improvement.

Cable ducts must be of non-flammable material, with non-abrasive surface, and protected against humidity, dust and penetration of animals. Take appropriate fire protection measures; e.g.seal all openings to prevent the fire from spreading into the cabinets

3.3.4 Cooling Water System

The requirements for the raw water must be fulfilled. Refer to the *Data Sheets* of the Water Cooling Units for details. The *Data Sheets* are enclosed in *Appendix A – Water Cooling Unit* of the *ACS 6000 User's Manual.*

If you have any doubt about the local water quality contact ABB immediately.

Check the customer interface of the cooling water system. Information on the raw water connection can be obtained from:

- *Layout Drawing* in *Appendix C – Mechanical Drawings* of the *User's Manual* :
  - Plant specific pipe entry
  - Flange size
- *Water Cooling Datasheet* in *Appendix A – Water Cooling Unit* of the *User's Manual* :
  - Nominal values of flow rate, pressure range etc.
  - Industrial cooling water specification
- *Rating Plate* of the converter:
  - Type of water cooling unit
  - Project specific values of flow rate, pressure range etc.

3.3.5 Converter Power Circuit Connections

The power cable routing (mains and motor cables) must be carried out in compliance with the local regulations and according to the specifications and recommendations of the cable manufacturer.

All cable connections of the ACS 6000 to the transformer and motor are shown in the *ACS 6000 User's Manual, Appendix D – Electrical Drawings*. Project specific cable entries are indicated in *Appendix F – Mechanical Drawings*.

Note: The incoming cables must not touch the terminals of any other phase. A minimum sparking distance of 40 mm must be maintained between each cable and the terminals of any other phase.

Check especially that the entry and termination of the cables is done as required. Refer to the requirements in the *ACS 6000 User's Manual*, *Chapter 9 – Electrical Installation, External Power Cabling.*

Note: Power cabling is still left open at converter end until the insulation resistance of the converter has been verified. Thus, this part needs to be checked afterwards

3.3.6 Converter Internal Wiring

The ACS 6000 manufacturer delivers internal cables. These are cables between transportation units inside the converter. The correct connection and routing of these cables must be checked during the cable inspection. Information on cable connections can be found in the project related documentation of the *ACS 6000 User's Manual, Appendix D – Electrical Drawings.*

Note: The incoming cables must not touch the terminals of any other phase. A minimum sparking distance of 40 mm must be maintained between each cable and the terminals of any other phase.

3.3.7 Control Cables

The installation of the control cables on cable trays or in channels must be checked. Power cables and control cables must not be located on the same cable trays. A minimum distance between these cables is 30 cm.

Make sure that the cable entry and termination is done as required.

Special caution needs to be taken for the following:

- Shield grounding of encoders
- Wiring of MV-cables on insulated trays
- Bending radius of fiber optics

Refer to the *ACS 6000 User's Manual, Appendix D – Electrical Drawings*.

Example of communication interface (in *Figure 3-1* AMC3 controller is connected to AF100 fieldbus using an CI810B type adapter) and GRAY encoder cable installation inside ACS 6000 cabinet.

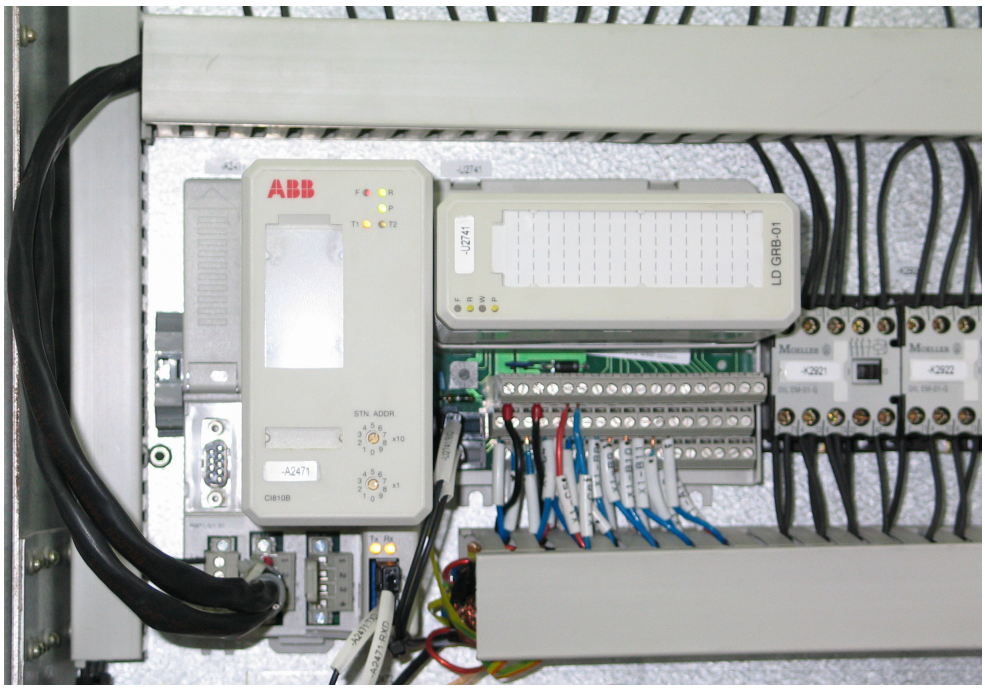


Figure 3-1

3.3.8 Converter Earthing Connections

The following items must be checked:

1. PE and safety ground busbars going through the converter cabinets must be connected with accessories delivered with the ACS 6000.
2. The safety ground busbar must be connected to the earthing network of the plant (factory) at only one point: at the busbar inside the TEU closest to the CBU. All these connections must be checked, and if necessary, verified by measuring the conductivity of the connected parts.
3. The routing of the grounding connection must comply with local regulations. In some countries redundant cable routing is required.
4. Metal shields of all power cables must be connected to the ground potential (Power Ground) as described above.
5. The cross section of the cable shields must be in accordance with the *Power Cable Specification* (document number: 3BHS125090).
6. Control cable shields must be earthed as described above (Safety Ground).

Check that converter earthing is carried out according to above checkpoints.

3.4 Motor

Check that the motor installation meets the requirements and fulfills the local regulations. For details see the motor documentation.

The motor installation includes alignment of mechanics, piping of the lubrication system and water cooling piping. An alignment protocol must be available on site.

Note: Couplings between the motor and the driven machine must be left uncoupled.

The motor frame must be connected to the plant earthing network at least at one point. For more details refer to the instructions of the motor manufacturer.

Motor bearing sleeves must be insulated from the motor frame, at least in one bearing. For more details, see instructions of the motor manufacturer.

Follow the checklist of the commissioning report regarding the motor installation.

3.5 Power Cables

Three-phase cables with individually shielded conductors are the preferred cable type for the ACS 6000. Single-phase cables can be used if the cable length is less than 100 m. These cables must be configured as shown in *Figure 3-2*.

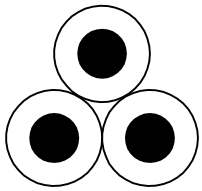


Figure 3-2 Configuration of single-phase Cables

An additional grounding cable along the power cables prevents screen overloading because of potential differences in the plant. This is needed, if the cross section of the cable screens is less than 50% of the cross section of one phase conductor.

Refer to *the ACS 6000 User's Manual*, *Chapter 9 – Electrical Installation*, section *Busbars and Grounding* and the *Power Cable Specification* (document number: 3BHS125090).

Follow the checklist of the commissioning report regarding the power cabling.

3.6 Protection Against Injuries

All earthing inspections described in the previous chapters must be carried out carefully, to avoid any dangerous potential rise in any parts that are subject to touching. Protections are checked as follows:

1 Protection covers inside converter cabinets must refitted if they had been taken off.

If covers have to be removed for measuring purposes for instance, warning signs and temporary covers must be used.

2 Cabinet door locks must be checked.

The door keys should be given exclusively to persons taking part in the commissioning. The doors should be kept closed whenever possible. This also helps to keep the cabinets clean.

3 All openings in the motor must be closed and the protective covers over the shaft must be reinstalled. The doors of the slip ring compartment must be closed.

4 All covers for the power cable terminals or terminal boxes in the ACS 6000, motor, transformers and MCB must be closed.

5 Open transformer and motor cable ends must be tied together and properly earthed.

Check that the above mentioned points are fulfilled before commissioning is continued.

3.7 Cleanness

Civil works must be finished in the converter room.

Cable openings should be closed to avoid dust entering into the cabinets.

The converter room must be clean and free of dust. Waste from any installation work must be removed.

The air conditioning of the room must be in operation. Requirements for ambient temperature, cooling water and converter room can be found on the rating plate of the ACS 6000.

Before any test is carried out, it must be checked that foreign parts and dust have been removed from the converter cabinets. It is very important that the cabinets are free of dust to prevent weakening of the busbar insulation and dust building up on air cooling elements.

Cooling air filters must be checked.

The motor area must be cleaned so that it is safe to run the motors. All waste that can be in contact with the shaft or the cooling air inlets must be removed. The slip rings, brushes and brush holders of synchronous motors must e checked for cleanness. Cleaning of the whole slip ring compartment before start-up is recommended.

The transformer area must be cleaned and waste from installation work must be taken away.

Cleanness of the equipment should be checked at least twice during commissioning.

Chapter 4 - Commissioning Other Drive Components

In general, the scope of the commissioning is determined by the project.

The items in the following sections must be checked or confirmation obtained that they have been checked (e.g. measurement results of insulation resistances of other drive components and cables).

4.1 Main Circuit Breaker (MCB)

Refer to the manufacturer's documentation for commissioning instructions of the MCB. The correct operation of the MCB will be tested later when the converter will be energized for the first time.

If MCB is new and insulation tests have not been carried out, all tests must be carried out according to the instructions of the manufacturer.

The must have the following features:

- 1 closing (shunt release ON) coil
- 2 opening (shunt release OFF) coils

  Installation of only 1 opening coil is not recommended
- 1 undervoltage release coil
- A maximum total breaking time of 60 ms must be guaranteed

Note: Protection relays in feeding switchgear must be tested and in operation, especially the relays of converter transformers. The set values of these relays must be checked by the commissioning engineer and compared with the calculated drive currents. Relay test protocols must be available at site during the whole period of the commissioning.

For details on MCB requirements refer to the *Main Circuit Breaker Specification* (document number 3BHS125149).

See project related documentation (wiring diagrams) for applications, where the auxiliary power for the MCB undervoltage opening coil is supplied by the ACS 6000..

Follow the checkpoints of the commissioning report.

4.2 Transformer

Alll checks and insulation measurements of transformers must be performed according to the instructions of the transformer manufacturer.

Note that the I/O interface to the converter will be tested later.

Checking of the transformer includes the following:

- Insulation resistance

  The insulation resistance must be measured or the confirmation of the measurement must be obtained.

- Oil quantity, in case of oil type transformer

  Oil quantity can be checked on the oil level gauge located on the oil expansion vessel.

- Valves between transformer tank and radiator

  All valves must be in open position to allow free oil flow between tank and radiators.

- Condition of dehydrating breathers.
- Sense of rotation of fans and pumps (if applicable).
- Protection devices of transformers

  Will be checked together with the external signals of the ACS 6000, see Chapter 8 - Checking I/O, 8.3.2 Transformer Signals.

- Cleanness, rating plate values and thermal protective devices of dry-type transformers (ABB Resibloc)

Follow the checkpoints of the commissioning report.

4.3 Motor

All checks and insulation measurements of the motor and its auxiliary systems must be carried out according to the instructions of the motor manufacturer.

Checking of the motor includes the following:

- Insulation resistance

  The insulation resistance must be measured or the confirmation of the measurement must be obtained.

- Oil quantity.
- Visual check of electrical and pneumatic instrumentation.

All electrical instruments as well as pumps and electrically controlled valves are shown in the circuit diagram of the motor auxiliaries. Operation of these devices will be checked when the external signals of the drive are tested, see *Chapter 8 - Checking I/O, 8.3.1 Motor Signals*.

- Quality and flow rate of the cooling water.
- Visual check of the instrumentation.

  Instruments and cooling fans are shown in the circuit diagram of the motor auxiliaries. Operation of these devices will be checked when the external signals of the drive are tested, see *Chapter 8 - Checking I/O, 8.3.1 Motor Signals*.
- Leakage

  During the first operating hours of the water cooling system, it must be checked that the cooling system of the motor does not leak.
- Connection of space and oil heaters.

Follow the checkpoints of the commissioning report.

Chapter 5 - Preparing the Converter

5.1 Selection Switches and Protective Settings

Settings of control board selection switches, protective circuit breakers of fans and pumps, earth fault relays and timers etc. must be checked according to the project related circuit diagrams. See *ACS 6000 User's Manual, Appendix D – Electrical Drawings*.

1. Check that the node addresses of the I/O cluster modules in COU, WCU and possible customer specific control cabinets are as specified in the circuit diagrams.
2. In case of a synchronous drive:
    1. Check the node address switches or jumpers of excitation control boards (CCB, PAI, MTR and MUB boards) in EXU cabinet according to the wiring diagrams.
    2. Check the node address switch of the rotor shaft position measurement unit (GRB unit) in the COU cabinet.

When finished, check off the above mentioned items in the commissioning report.

The supportline must be informed if any changes have been made!

5.2 Connecting the Auxiliary Supply

Normally, the ACS 6000 is connected to a 3-phase 380….690 VAC auxiliary supply. Typically, there may also be a single-phase secured auxiliary supply for the control electronics.

The terminals and the main switch of the auxiliary supply are located in the WCU cabinet. Before closing the main switch, proceed as follows:

1. Make sure that all auxiliary switches, optional circuit breakers and protection switches have been switched off and power supplies have been removed from the boards.

Note: Do not switch on the motor protection switches of the cooling pumps before the cooling system has been filled. If a pump runs dry the pump seals will be damaged immediately.

Since the software has already been downloaded to the AMC board in the factory, the pumps will start after the Emergency OFF signal has been reset, depending on the setting of parameter 33.20.

2 Check that the voltage selection at the 3-phase auxiliary transformers is made correctly in each phase.

3 Check that the external 3-phase auxiliary voltage is according to the project data and within the permitted range.

4 The main switch of auxiliary supply can now be turned on.

Note: The EMC-filter (-Z5002) inside the drive may need to be temporarily bypassed in case the fault current relay on the customer side trips.

5 Check the output voltage of the auxiliary transformers.

After that, the voltage distribution inside the converter cabinets can be switched on one by one by closing the respective circuit breakers and protection switches.

6 Check the level of the AC/DC voltages (24 and 27 VDC).

5.3 Filling and Starting up the Cooling System

Follow the instructions in the *Operation and Maintenance Manual* in *Appendix A – Water Cooling Unit* of the *ACS 6000 User's Manual* when filling and starting up the water cooling system.

Related parameter settings and measuring signals must be checked before the cooling pumps are started.

Note: References to the parameter indices are valid for software versions **3xxx**. For other software versions, refer to the latest signal and parameter documents delivered with the loading package.

Water cooling related parameters and signals are located in the following groups:

- Group 4: Actual Values (from S800 I/O)
- Group 33: WCU Control
- Group 34: WCU Supervision

The following signals and parameters must be checked and set:

- Parameter **34.06 Water Inp Press Supervis**

  The parameter enables / disables the measurement the inlet pressure of the cooling pumps in closed type water cooling systems.

- Parameter **34.21 FAIL Safe EOFF Input**

  The parameter enables / disables the Emergency OFF fail-safe function. If enabled thesSource of the Emergency OFF signal is input C2P3, AI810, Ch8.

- Parameters **34.26….31**

The parameters enable optional monitoring functions and select the trip reaction. Refer to the WCU diagram and set the parameters accordingly.

- Parameters **33.8….9**

  The parameters limit the upper value of the measuring range of the output pressure sensors. The measuring rangemay vary depending on the type of the WCU. The measuring range of the sensors is given in the component list of the WCU.

- Parameter **33.20 EOFF WCU Stop**

  The parameter determines the reaction of the water cooling unit on an Emergency OFF command. If set to 1, an Emergency OFF command stops the main pumps and the 3-way valve.

- Actual value, groups **4.01 – 04**

  In this parameter groups the actual values of conductivity, temperature and pressure can be checked.

Chapter 6 - Insulation Resistance Measurement

Before any of the drive system components is energized, the insulation resistance of each component must be measured to verify their ablility to withstand voltage stress. The results of the measuremnets must be noted in the commissioning record.

The water conductivity must be lower than 0.5 µS during the insulation check of the converter. In case you need to wait for the conductivity to come down you can proceed with the section about parameter settings.

In case checks of motor and transformer are included in the commissioning, refer to the applicable manual for additional information. It is also advisable to compare the measured results with the test reports from the supply factory.

6.1 Type of Measuring Device

The insulation test of the ACS 6000 drive system is carried out with a test voltage of 5 kV DC. Since the insulation resistance of a mult-drive converter may be as low as 0.5 MΩ a megger with a current capability of 2 mA is required. These devices are not common. Therefore it is important that such the megger is ordered in time.

If a less powerful megger is used and the 5 kV test voltage cannot be reached smaller the converter has to be tested in smaller sections. To do this the section to be tested is isolated from the adjacent sections by opening the busbar connectors.

6.2 Preparations for the Measurement

Before starting the insulation measurements do the following:

1 Check that the power cables are disconnected and securely grounded.

2 Make sure that the main circuit breaker is not able to close (by means of mechanical interlocking).

Note that the grounding switch of the ACS 6000 must be in the unearthed position during the measurement.

3 Make sure that no energy can be fed from the motor side.

No motor must be rotating.

4 The cooling water conductivity must be below 0.5 µS.

Note that the insulation measurement must be carried out within 1 hour. Otherwise the cooling water conductivity might become too high.

5 Switch off the auxiliary voltage of the converter.

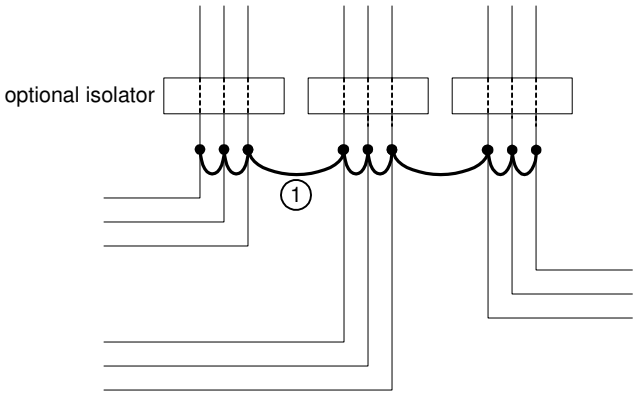
6 Prepare each ACS 6000 cabinet for the measurement as described in the following chapters.

The preparation described in this manual refers to insulation measurement which is carried out with 5kV DC voltage. For high voltage tests additional preparation will be necessary!

6.2.1 TEU Preparation

The following preparatory measures must be taken in a Terminal Unit (TEU):

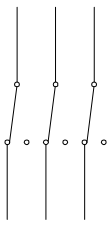
1 Short circuit input and output (motor) terminals.



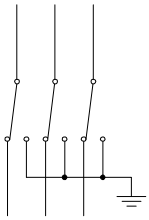
2 Make a short circuit between shorted terminals, DC plus, DC neutral point and DC minus busbars.

3 Turn optional isolators into the required position.

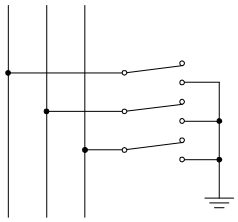
Type 1: Isolator switch must be closed



Type 2: Grounding isolator must be open

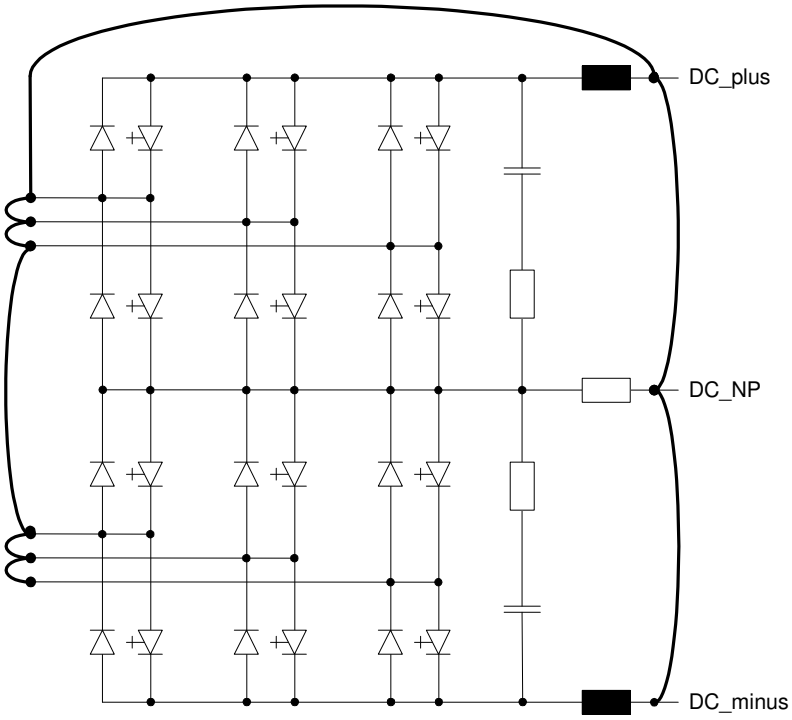


Type 3: Grounding switch must be open



6.2.2 LSU Preparation

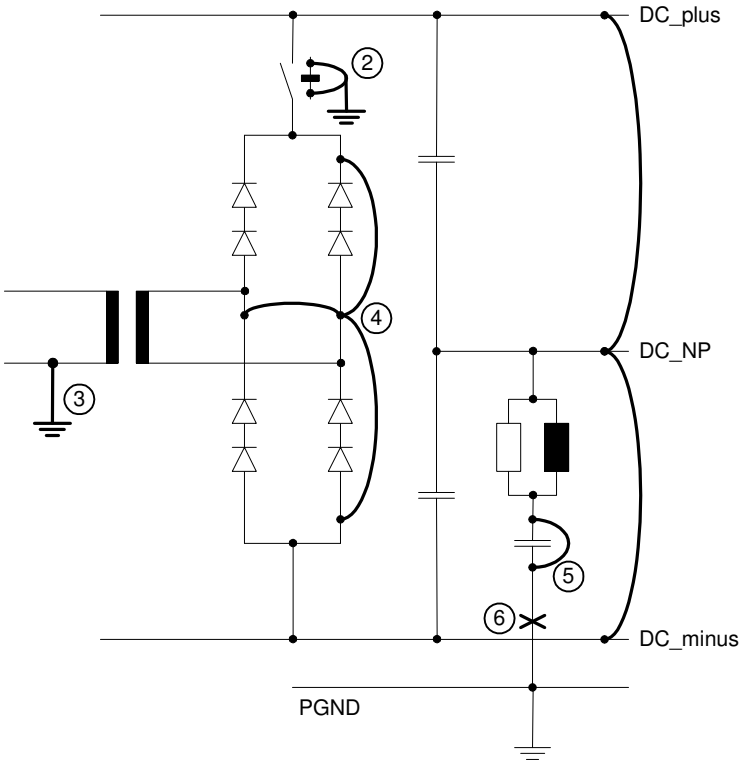
The following preparatory measures must be taken in aLine Supply Unit (LSU):



All necessary short circuit connections are already made in TEU.

6.2.3 CBU Preparation

The following preparatory measures must be taken in a Capacitor Bank Unit (CBU):



Short circuit of DC link busbars is already made in TEU.

1 Make a short circuit between the auxiliary contacts of the earthing isolator and connect it to ground (-X715 / 9,10).

Note that the earthing isolator must be in position “NOT EARTHED”.

2 Short circuit and ground the coil of the charging relay K2CHU (-X714 / 1,2)

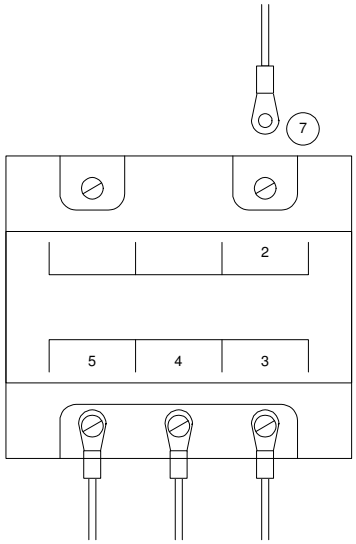
3 Ground the primary side of the charging transformer TCHU (-X710 / 7)

4 Connect the secondary side of the charging transformer TCHU to the DC link and short circuit the charging diode bridge.

5 Short circuit the common mode filter capacitor CGND.

6 Disconnect the common mode filter capacitor CGND from PE (protective earth).

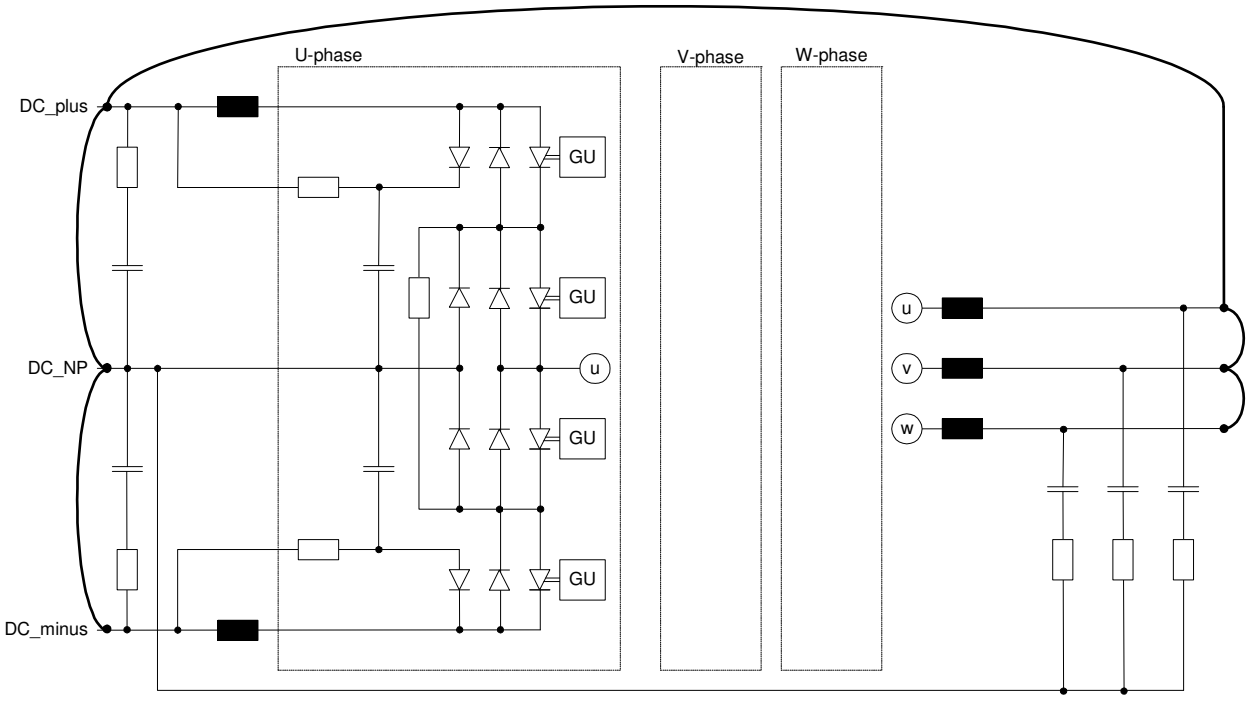
7 Disconnect the HV-line from the coupling unit AGH520S, if included in the converter configuration.



8 In case a Braking Chopper Unit (BCU) is part of the drive, make a short circuit between the output terminals of the external resistor.

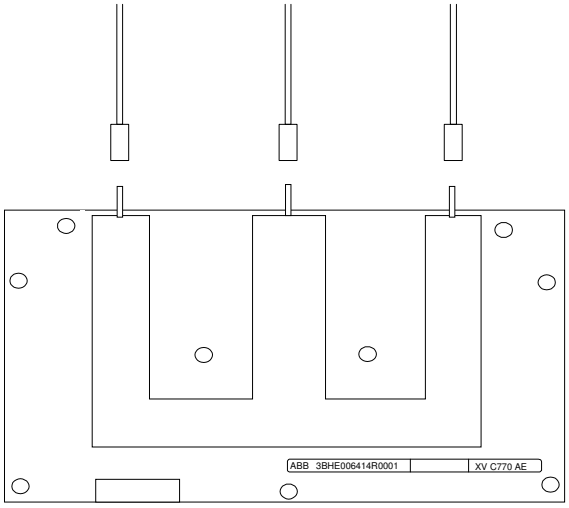
6.2.4 ARU / INU Preparation

The following preparatory measures must be taken in an Inverter Unit (INU). The same instructions apply to an Active Rectifier Unit (ARU), if present in the line-up.

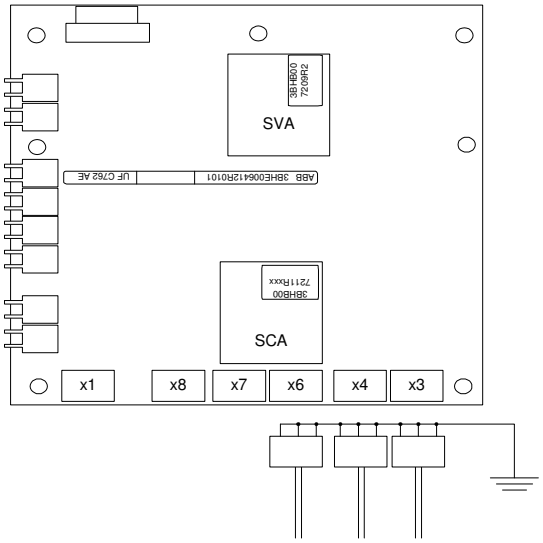


Short circuit of phase outputs and DC link busbars is already made in TEU.

1 Disconnect and isolate the high voltage measurement on the HVD board (ADCVI board in older drive versions).

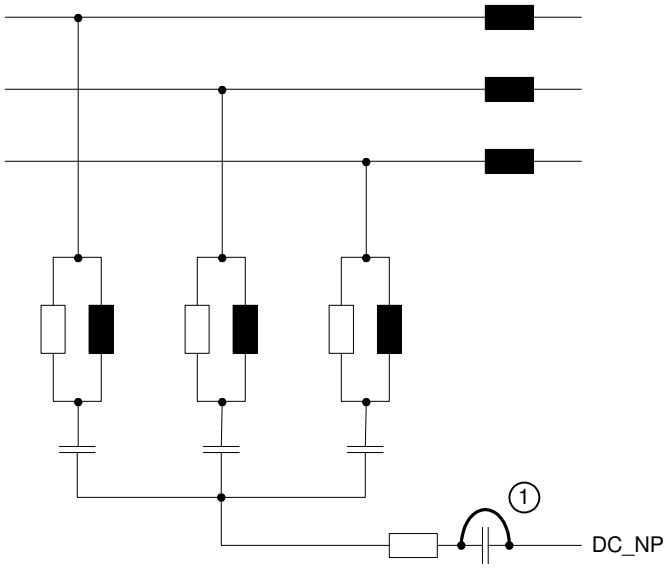


2 Disconnect and ground all three LEM current transducers on CVMI board (ADCVI board in older drive versions).



6.2.5 IFU Preparation

The following preparatory measures must be taken in an Input Filter Unit (IFU):



1 Short circuit the NP capacitor.

6.2.6 Main Circuit Measurement

- The insulation measurement is carried out with 5kV DC voltage.
- The plus terminal is connected to the combined circuit of the DC link. The minus terminal is connected to the ground potential.
- The measurement time is 60 sec.
- The lowest value is to be recorded.
- The value of the insulation resistance must be higher than 0.5 MΩ.

In the commissioning record, write down the measured value of the insulation resistance and the value of the water conductivity present at the time of measurement. Carry out the measurement as soon as the pumps have stopped to avoid an error in the conductivity reading.

6.2.7 Excitation Circuit

When commissioning an ACS 6000 for synchronous motors, the insulation resistance of the excitation circuit must measured as well.

Take the following preparatory measures for an Excitation Unit (EXU):

Direct Excitation

1 Make a short circuit between the two output terminals.

2 Make a short circuit between the input phases and connect it to the output terminals.

3 Short circuit switch –K6201.

4 Short circuit circuit and ground terminal block –X614 / 1-4.

5 Short circuit and ground terminal block –X617 / 1,2.

6 Short circuit and ground terminals 3 and 7 of board –A6032.

7 Short circuit and ground terminals x13 and x14 of board –A6033.

8 Disconnect inputs P and N of power supply –G6041.

9 Short circuit and ground the 24V output on terminal blocks –X66 and –X68.

10 Disconnect and isolate terminals 5, 9, 20, 22 of MR 627 –A6041.

11 Disconnect and isolate terminals 25 and 33 of MZ 611 –A6142, if present in the configuration.

12 Short and ground terminals X2_7, X2_8, X2_11 and X2_12 of board –A6051.

Brushless Excitation

1 Make a short circuit between the three output terminals.

2 Make a short circuit between the input phases and connect it to the output terminals.

3 Short circuit circuit switch –K6201.

4 Short circuit and ground terminal block –X614 / 1-4.

5 Short circuit and ground terminal block –X617 / 1,2.

6 Short circuit and ground terminals 3 and 7 of boards –A6032 and –A6034.

7 Short circuit and ground terminals X13 and X14 of boards –A6033 and –A6035.

8 Disconnect inputs P and N of power supply –G6041.

9 Short circuit and ground the 24 V output on terminal blocks –X66 and –X68.

10 Disconnect and isolate terminals 4, 7, 10, 20, 22 of MR 627 –A6041

11 Short circuit and ground terminals X2_11 and X2_12 of board –A6051

The water conductivity must be lower than 0.5 µS during the measurement.

Measurement is carried out with 1 kV DC voltage and a measurement time is 60 sec.

The plus terminal is connected to the combined circuit of output and three input terminals. The minus terminal is connected to the ground potential.

The value of insulation resistance must higher than 1 MΩ.

In the commissioning record, write down the measured insulation value and the value of the water conductivity present at the time of measurement.

Note: Remove all short circuit connections and restore the original state, when finished.

Chapter 7 - Parameter Settings

Project related parameter settings must be made on site. This chapter describes only parameters requiring special attention. In general, the signal and parameter table and the motor control SW documentation delivered with the loading package must be used when setting parameters.

Note: References to the parameter indices are applicable for software version 3200 (ACS 6000 with asynchronous motors) and 300x (ACS 6000 with synchronous motors). For other software versions refer to the latest signal and parameter documents delivered with the loading package.

7.1 Common Parameters

The converter must be in **RDY ON** state (MCB open and DC link uncharged) when parameters are initialized. External signals may have to be masked to avoid tripping of the drive, warnings coming up / emergency stop being activated etc.

Note: If the drive does not proceed to the "ReadyOn" state check the condition and proper connection of the PPCS communication fibers and the condition of all the control HW boards. Check also the optical fibers of the FT-link.

Parameter Group 11: Start, Stop, Direction, MCB Control

Group 11 defines the source of start, stop and on commands for external control location 1 (11.01) and 2 (11.02).

If fieldbus communication is used the setting is 11 = COMM. MODULE.

Parameter Group 12: Reference Selection

Group 12 defines the source of the external reference value. If fieldbus communication is used parameter **12.2 EXT1/EXT2 Select** is typically set to EXT1 and **12.3 EXT REF1 Select** to COMM. REF.

Parameter Group 16: System CTRL Inputs

Parameter **16.7 Comm.module Control Place** selects the serial communication channel 0 or 4.

Channel 4 is to be selected if an AC 80 controller is used to control the I/O interfaces of the converter and to communicate to an overriding control system.

Parameter Group 20: Limit Values

In the beginning of the commissioning, torque and overspeed limits **12.5 – 7** should be set to a low value.

When setting limit values always refer to the motor data, the documentation of the motor manufacturer and the project related documentation.

Parameter Group 21: Start/Stop/MCB Function

Parameter **21.1 Start Function** selects the start mode (for asynchronous motors only).

Parameters 21.3 – 5 select the process stop mode and the MCB reaction.

Note! Source of the process stop (if enabled) is selected with parameter **16.1 Process Stop**.

Parameters **21.10 – 11** select number and monitoring of MCB feedback signals. Refer to MCB data for correct setting.

Parameter Group 22: Ramp Functions

Parameter **22.1 Acc/Dec 1** / **2 Sel.** selects the acceleration/decelaration ramp. Typical seting: (ACC/DEC 1)

Parameters **22.2 – 3** determine the ramp times.

It is recommended to set slow ramp times when commissioning is started and to decrease the values to suit the process requirements when commissioning proceeds.

Parameter Group 23: Speed Reference

Parameters **23.2 - 3 Inching Speed 1** / **2** dertermine the reference for the inching speed (applicable for metals applications)

Parameter Group 24: Speed Control

Parameters goup 24 provides all settigs for speed controller tuning.

At this stage of commissioning, it is recommended to decrease the setting for the gain to 1…2 (**24.2 KPS).**

Tuning of speed controller is discussed later in this document.

Parameter Group 25: Torque Reference

Torque reference settings are applicable when the drive is in torque control mode selected with parameter **26.1 Torque Selector**.

Parameter Group 30: Motor Fault Functions

Activation and trip reaction of stall protection function is set with parameter **30.1 Stall Function**. Pay special attention to stall protection parameters **30.2 – 4** so that it does not cause unnecessary trips in such processes where torque is required at low speeds.

In case of ACS 6000sd, a special SW overload protection function for the excitation circuit is used. The protection function is tuned with parameters **30.5 – 9** , see example in *Signal and Parameter Table* (SigParACS 6000AD_SD_INU_LXAC...).

Parameter Group 31: Standard Converter Fault Functions

Hint! In case of a multi-drive configuration, cabinet temperature monitoring must be disabled with parameters **31.2 and 31.4 – 6**.

Parameter Group 32: Other Fault Functions

This group includes several optional monitoring functions. To see which optional protection functions are in use the actual hardware set-up must be compared with the ACS 6000 circuit diagrams and the parameters set accordingly.

Note! All the monitoring functions are enabled by default and thus the default settings are fail-safe.

Parameter Group 33 and 34: WCU Control and Supervision

The parameters provide settings for the internal water cooling system of the converter (see *Signal and Parameter Table,* version LXAC).

Parameter Group 35: DC Link Control

The default settings of this group do not have to be changed. The only exception is parameter **35.9 VLU Ctrl & Supervision** which needs to disabled in case a slave control unit is present in a multi-drive configuration.

Parameter Group 40: Load Sharing

This parameter group is only used only in case the AMC3 DDCS channel 2 is used for load sharing function between two drives in speed control mode (e.g. hot rolling mill top and bottom motor).

Parameter Group 50: Speed Measurement

Parameter **50.1 Speed Scaling** defines the scaled value which corresponds to the actual speed in rpm.

Parameter groups above 100 provide further settings regarding speed and position measurements. See documents:

- ACS 6000AD Torque Control SW (TC SW) TC SW Commissioning manual
- ACS 6000AD Torque Control SW (TC SW) TC SW Commissioning manual

Parameter Group 57: Critical Speed

Note: Parameter group 57 is not available in all software versions.

Speed ranges which have to be avoided during operation because of resonances can be defined in parameter group 57.

Refer to project data if the function is required.

Parameter Group 75: Option Modules

See also section *7.2 Communication Parameters* for information on settings for the communication module.

Parameter **75.3 Encoderless Drive** activates the pulse encoder for the motor speed measurement of an asynchronous drive. Note that the AMC controller must be re-booted to activate after the parameter has been set.

See the wiring diagrams for optional S800 I/O module configuration and set the parameters accordingly.

Parameter Group 77: System Configuration:

Parameter group 77 defines the drive configuration, e.g. asynchronous or synchronous drive, the type of line rectifier, the number of inverter units etc.,

Parameter **77.9 Drive Type** activates the control and monitoring functions related to the excitation unit.

Parameter Groups 81-84: Optional I/O

These groups provide settings for optional S800 I/O modules of **Cluster 3** in the WCU. Refer to the wiring diagramsto see if I/O modules are installed and set the parameters accordingly.

Parameter Group 98: Real Time Clock

The local time is set manually (98.07 "SET") unless there is automatic time synchronization from the overriding system.

7.2 Communication Parameters

This section provides information on parameters related to communication interfaces.

Communication to an overriding control system is typically accomplished via a fieldbus adapter (FBA) or an ABB Advant controller (e.g. AC110). Both are connected to channel 0 of the AMC board.

If an AC 80 Advant controller is part of the converter (CIU option) the overriding system can communicate via this controller which is linked to channel 4 of the AMC board.

A possible configuration an be that FBA and AC 80 controller (option: CIU) are both present in the converter. The task of the FBA is to communicate with the overriding control system and the AC 80 is used to control and monitor external equipment.

7.2.1 Fieldbus Adapters

Parameter **75.1 Comm Module** defines if FBA or ABB Advant Controller is used to communicate an overriding control system.

After setting parameter 75.1 the ACS 6000 identifies the type of communication interface and opens parameter group **51**. Group 51 becomes visible after the signal and parameter table has been uploaded again. The content of this group depends on the type of communication interface in use. Changes to the group do not come into effect immediately, but only after the power of the fieldbus adapter has been switched off and on again.

Parameter **groups 90 and 91** define the dataset communication of the FBA. Refer to the customer / automation supplier for information on the dataset communication.

7.2.2 Advant Bus Communication

If an ABB Advant controller (e.g. AC80, FCI, NPBA-02, NCSA-01) is part of the converter parameter **75.1 Comm Module** is set to 4 (DSET 10 R/W) or 5 (ReadOnly mode for DS10). In this case, dataset communication **groups 92 – 95** will be opened in the signal and parameter table.

7.2.3 AC 80 Communication

Th AC 80 controller connected to channel 4 is activated with parameter **75.2 AC80 Advant Controller**. Parameter **groups 60 – 63** define the dataset communication. Refer also to the AC 80 documentation if this option is used.

Check that parameter **16.7 Comm.module control place** is set to channel 4 if the AC 80 controls (on/off, start/stop, n ref) the converter.

Check that parameter **70.17 CH4 Baud Rate** is set to 4 Mbit/s.

7.2.4 DDCS Communication

Settings regarding node address and link control of channel 4 are made in parameter group **70**.

Check that parameter **70.3 CH0 Baud Rate** is set to 4 Mbit/s.

7.3 Limiting Parameters

7.3.1 Dynamic Torque Limiters and VLU/RBU Settings

There are three dynamic torque limiters. They are able to change (limit) torque reference in order to prevent **overvoltage**, **undervoltage** or too high **angular frequency**. The dynamic limiters are located after the static limiters. In principle they are P-controllers with a threshold level and gain as parameters.

See section 6 of the ACS 6000AD Torque Control SW (TC SW) TC SW Commissioning manual

VLU/RBU (Voltage Limiter Unit / Resistor Braking Unit) thermal model protects resistors of VLU/RBU against overheating. This task is carried out by enabling and disabling VLU, which is based on either resistor temperature model or pre-defined enabling / disabling pulse mode (control scheme). A separate thermal model / control for both halves of VLU/RBU (upper and lower) is implemented.

Same SW module also delivers discharging command to VLU/RBU control logic and takes care of configuring VLU/RBU operation on EPLD level.

Another routine calculates generative torque limit corresponding to RBU breaking power capability. RBU braking power is selected according to RBU maximum temperature with hysteresis.

See ACS 6000 TC SW (Torque Controller Soft Ware) commissioning manual for details (ACS6000ad or sd).

7.3.2 Gray and Pulse Encoders

Synchronous motor control requires always shaft speed and position measurement feedback signals.

The following parameters are needed for encoder initialization:

Parameter	*Name*	*Unit*
165.23	Pulse number of the speed encoder (NTAC pulse number)	pulses/rev
165.30	Selection if the used speed encoder has zero channel signal	TRUE/FALSE
166.21	Position encoder type (GRAY pos. source)	TRUE/FALSE
166.22	Position encoder bit number (GRAY bit number)	-

All others than zero channel selection and position encoder type are explicit values. Zero channel selection is defined

TRUE ~ zero channel is used

FALSE ~ zero channel is not used

Position encoder type is defined:

TRUE ~ SSI serial communication interface

FALSE ~ Parallel communication interface

Confirmation that the parameters have been checked is asked in the commissioning report.

After all parameter settings have been done, certain internal and external I/O signals must be tested.

When parameter setting has been completed, it is reasonable to clear the fault logger and re-boot AMC board by cycling the auxiliary power.

Drive should be in local mode and in "ReadyOn"-state with no alarms or trips active. This way observing correct operation of the signals and drive is possible.

8.1 Checking Principle

Main principle is that the wiring which has been implemented on site only should be tested.

Note that correct operation of main circuit breaker signals will be tested also later in connection with charging / discharging test.

8.1.1 Digital Inputs

All signals should be checked as primary as possible meaning that the state of each sensor should be changed. Checking of binary input signals is done by changing the state of each input in process side, that is CBs, contactors, etc. If state of switch can not be changed, test is done from the nearest terminals of the device.

All signals are connected to S800 IO modules. S800 I/O modules have led indication of input status for each channel and an indication of trip / alarm is shown in SW.

- In CDP panel the alarms are displayed in Actual Signal Display Mode. The alarm name should correspond (in relation) to input signal name shown in circuit diagrams.
- In DriveWindow the alarms are displayed in “Fault Logger” display. Name of each signal is the same as in CDP and in circuit diagrams.

8.1.2 Digital Outputs

Cabling can be checked by forcing the status (setting / releasing with jumper) on I/O modules end.

8.1.3 Analog Inputs

External analog signals mainly consist of temperature measurements. Pt-100 sensors may be used for stator winding, cooling air and bearing temperature supervision. Also transformer temperature may be measured with Pt-100.

Inspection of analog input signals to S800 I/O modules must be done by reading the actual value of the measurement in group 4 (81 and 82 optionals) Actual Values (S800 I/O values) of AMC table.

Pt-100 temperature measurement signals can be checked by disconnecting one wire from sensor end. The signal should then go to the negative value and sensor failure fault should appear (AMC table group 85)

Other type of analogue signals should be tested by changing the analog signal value as primary as possible.

8.2 Converter Internal Signals

The following internal wiring may have been done on site (depending on the drive configuration also) and should thus be checked:

- Internal fiber optics of FSCD boards to INT board on the next unit.
- Firing through (FT) link, which is an optical link between all INT (and PINT) boards.
- Power Forward Link in case of multidrive configuration.
- Status indication of both door monitoring and doorlock monitoring signals of each medium voltage cabinet.
- External EOFF and ESTOP wiring.
- Wiring of internal EOFF signal (from COU doors).
- Interlocking and status signals of grounding switch.
- Cabinet temparature supervision signals.
- Control and supervision signals of optional output isolator.
- Control and status signals of excitation circuit breaker in case of ACS 6000sd drive.

8.3 External I/O

All external signals are shown in application related circuit and terminal diagrams and in I/O list. Project related circuit diagrams must be referred in order to check what optional supervision functions are wired to ACS 6000 control.

8.3.1 Motor Signals

Motor may have the following optional signals:

1 Typically the synchronous motor has at least the following instruments giving binary signals: cooling water flow indicators, oil flow indicators, jack-up oil pressure indicators, oil filter condition

indicators. Lubrication unit signals are supervised by control only when pumps are running.

2 Winding temperature signals should be tested as discribed above.

3 Cooling fans, lubrication and jack-up pumps are controlled with binary outputs. Direction of the pumps should be checked.

4 Operation of the disk brake should be done by using test mode. Brake is opened and closed to see correct operation. If adjusting of the brake is needed it should be done according the manufacturer's documentation.

8.3.2 Transformer Signals

Checking of transformer protection signals (digital inputs) must be done in similar way. Oil immersed transformers may have the following optional instrumentation giving binary signals to the ACS 6000 control: gas relay, pressure relief valve, oil thermometer, and oil level indicator.

Dry-type transformers have normally only winding temperature measurements. The supervision is implemented with thermistor relays.

Oil transformers may also have Pt-100 measurements for oil temperature supervision.

Later when main circuit breaker control is checked also gas relay's opening of main circuit breaker is tested.

8.3.3 Switchgear Signals

From feeding switchgear there are normally three signals: two status signals from high voltage circuit breaker and pretrip signal from MCB overcurrent relay.

Operation of the MCB will be verified during charging test later. The Excitation circuit breaker (ECB) can be tested manually. In most cases there is no control signal from the ACS 6000 to the ECB and only the drive internal excitation contactor is controlled and monitored.

1 Pull supply breaker to TEST position so that closing of the breaker without energising transformers is possible. Close the breaker manually, from switchgear or from ACS 6000 (if control possible). Check the status from S800 I/O module and from AMC-table.

2 Open the breaker by activating the emergency off button on the door of the ACS 6000. The emergency off signal, a normally closed loop, can come from one or more pushbuttons (one button on the door of the ACS 6000). Operation of this signal must be tested; it gives open command to breaker.

8.3.4 Serial Data Communication

Connection of the ACS 6000 to a higher level automation system is typically done via a fieldbus adapter. The signals can be tested, when the auxiliary supply of the converter is on and the main and excitation supply is off. Confirm with automation commissioning personnel / customer that interface operates as intented.

Follow the checklist of the I/O signals in the commissioning report.

After the insulation tests have been finished and all cables have been connected, the next step in commissioning is to energise the converter and to close the Main Circuit Breaker (MCB).

The first energising of the converter must be done by a qualified electrician who has been trained in the product. During the energising follow carefully the safety instructions given at the beginning of this document and in the *ACS 6000 User`s Manual*.

Before energizing the converter, all doors and possibly removed cover plates must be properly closed and all preparatory works such as inspections, measurements and I/O signal tests must be done. This means, all actions described in the previous chapters should be done and possible defects found must be eliminated. No alarms are allowed to be active, neither in the ACS 6000 nor in related switchgear feeders. Instructions given in the *ACS 6000 TC SW Commissioning Manual* must be followed.

9.1 Energizing the Drive

In the ACS 6000 converter, charging of the intermediate DC link is done from auxiliary power supply by means of a charging transformer. This allows to charge up the DC link to the nominal voltage level without the main (HV) supply.

Note ! Never connect the ACS 6000 drive to the live supply network before the DC link is charged up close to nominal operation level (>4kV). See parameter group 35 (DC link control) for charging level settings (SigParACS 6000AD_SD_INU_LXAC).

9.1.1 Charging Test

Note: Before this DC charging test is started, the **MCB must be pulled out** into a TEST-position, **in a way that it can be controlled without energising the transformer** !

Converter(s) must be in “Ready On” state without any active faults. Control location needs to be local. Discharge mode must initially be with VLU/RBU.

Start charging by pressing local "ON push button" on COU door. Charge the DC link up to approximately 1000 V and start discharging before MCB closing level is reached (using OFF push button). Record upper and lower DC voltages in all of the units and compare that the values are the same. See from the recording that charging and discharging looks normal.

9.1.2 MCB Control Test

In order to test correct operation of the MCB control, the breaker must still remain in **TEST position**. Charge the DC to full level and record the MCB control and feedback signals, see example in *Figure 9-1* below. Note that signal numbering in the picture may be different in the current SW version.

Discharge the DC voltage using Emergency OFF button from the cabinet door or from external emergency OFF. Check that the MCB control works properly, that feedback signals comes correctly to the SW and DC is discharged with VLU/RBU.

Charge and close the MCB again and open this time by making a trip to the drive. (for example changing parameter **32.4 Earth Fault Alarm** to FC1). Record the MCB signals and DC voltage. Check that signal are correct and that the DC is discharged (short delay, based on rotor time constant is used before discharging is started).

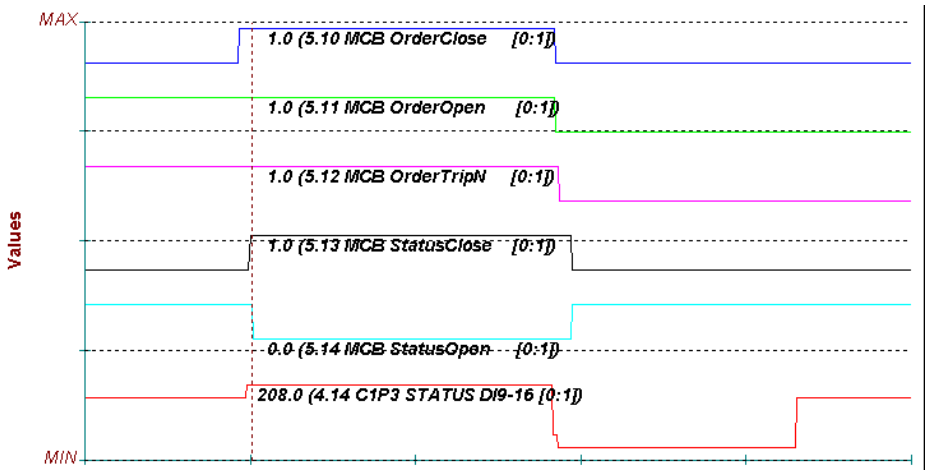


Figure 9-1

9.1.3 MCB Emergency Stop/Off

Check emergency stop and off functionality before starting up the drive and later also while the motor is in running condition!

Note: Depending on the **type of ACS 6000** proceed with **chapter 10** or **11**.

Before idle running the motor, all preparatory works such as inspections, measurements and I/O signal tests must be done. That means, all actions described in the previous chapters should be done and possible defects found must be eliminated. No alarms are allowed to be active, neither in the ACS 6000 nor in related switchgear feeders.

10.1 Motor Idle Run

Check that the motor is ready for start (aligned, coupling is OK, necessary lubrication is OK etc) and that starting the motor does not cause any danger.

It is recommended that the driven equipment is discoupled from the motor when the first start is performed if there is a risk of damage to the driven equipment in case of incorrect rotation direction of the motor.

10.1.1 First Start-up with No Load

When doing the first start one should keep in mind that in order to prevent the unnecessary rushing of the motor, all limits should be set to safe values. If there is no certainty that phase order of the motor and positive direction of rotation on the speed encoder coincides, there is the possibility that first start ends with rushing of the motor (direction of rotations are different).

To avoid the possible motor rushing during the first start, make the following precautions:

- Check phase order between the inverter and motor.
- Use DC magnetizing mode by setting parameter 131.01 to value CNST DC MAGN.
- use encoderless operation mode (parameter 111.02 set to TRUE).

See *ACS 6000AD TC SW (Torque Controller Software) Commissioning Manual* for detailed instructions !

Before the first start see *Chapter 13 - Speed Controller Tuning* section *13.1* for preliminary tuning of speed controller.

Before idle running the motor, all preparatory works such as inspections, measurements and I/O signal tests must be done. That means, all actions described in the previous chapters should be done and possible defects found must be eliminated. No alarms are allowed to be active, neither in the ACS 6000 nor in related switchgear feeders.

Check that the motor is ready for start (aligned, coupling is OK, necessary lubrication is OK etc) and that starting the motor does not cause any danger.

It is recommended that the driven equipment is discoupled from the motor when the first start is performed if there is a risk of damage to the driven equipment in case of incorrect rotation direction of the motor.

11.1 Excitation Start-up

Excitation current control should be tested first. Constant excitation current test can be used for that purpose. The excitation current control can be activated when ARU is in MODULATING state (INU control at READY RUN state).

11.2 Motor Idle Run

Prior to the first start the absolute encoder has to be positioned. Using following semi automatic procedure it is possible to measure the offset of the encoder.

11.2.1 Absolute Encoder Positioning Routine

At the same time it is possible to check that current measurement chain is operating correctly. It is also possible to measure the transient inductances of the motor. Operation is done via AMC-table group 191 DIAGNOSTICS.

11.2.2 First Start with No Load

During positioning routine the operation of the excitation converter, power stage modulation and phase order of the current measurement was already checked. Drive should be now ready to first start.

When doing the first start, one should keep in mind that in order to prevent the unnecessary rushing of the motor, all limits should be set to safe values. If there is no certainty that phase order of the motor and positive direction of rotation on the speed encoder coincides, there is the possibility that first start ends to rushing of the motor (direction of

rotations are different). For avoiding the possible motor rushing during first start special “first start mode” can be used.

See *ACS 6000AD TC SW (Torque Controller Software) commissioning manual* for detailed instructions !

Before the first start see also *Chapter 13 - Speed Controller Tuning* section *13.1* for preliminary tuning of speed controller

Note: Before the coupling test can be started, the no-load run must be properly carried out.

If the motor is equipped with speed encoder, the recommendation is also to take recordings from the speed actual signal while the motor is still uncuopled.

After the motor can be run up to maximum speed and down to minimum speed without problems, the driven equipment can be connected.

Open the main circuit breaker and ground the converter before connecting the driven equipment. Make sure that the driven equipment is ready for speeding up.

12.1 Mechanical Heat Run

After mechanics are connected, some mechanics manufacturer require mechanical heat run. In mechanical heat run the speed is increased step by step to maximum during few hours and at the same time bearing temperatures etc. are measured.

Note: After motor is coupled and run with driven equipment, all the interlockings from automation systems has to be in operation. These interlocks should stop the drive if there is lack of lubrication or other critical function needed to run mechanics. Most commonly fast stop signal is used for this purpose.

12.2 Final Tuning

It is assumed in this chapter, that checking and possible tuning is done on-line during the loading conditions, which are defined by the process (during normal operation). Measures must only be taken if unwanted operation of the drive is detected.

See *ACS 6000AD TC SW (Torque Controller Software) commissioning manual* for details.

See also *Chapter 13 - Speed Controller Tuning* section *13.2* for final tuning of speed controller.

13.1 Preliminary Tinung of Speed Controller

The first start is normally made using "slow" speed controller. For the first start change Kp temporarily from the initial value 10, for example to 3 (Par 24.02). After the first start, the speed controller can be made faster step by step.

Final tuning of the speed controller will be done with coupled mechanics but it is recommended to check the tuning preliminary also as uncoupled. This is to clarify that speed controller loop works correctly. With uncoupled motor one should reach a better step response as finally with the coupled motor.

The idea is to get the drive performing as well as required by the driven process. **The main requirement is not to make the control as fast as possible, but only fast enough to make the changes required by the process,** without conflicting with other control loops. Too fast speed controller may cause unnecessary stress on the mechanical system (gearbox, belts, etc.).

Tuning of the speed controller must be checked at few different speeds, for example at 50% of base speed and 50% of maximum speed with 2% step of the maximum speed. The tested speed points depend naturally on the process requirement. See also section *13.2* for final tuning for performance criterias.

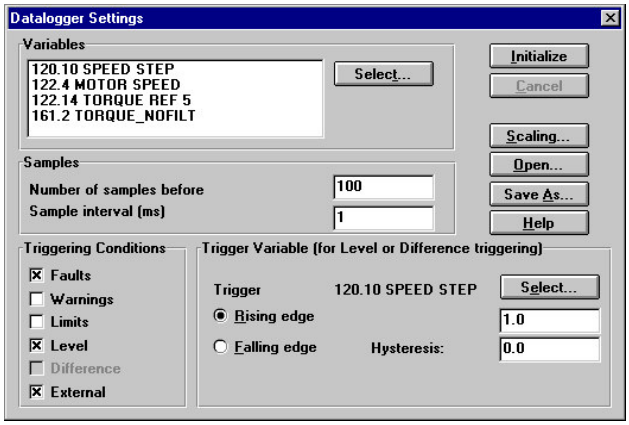
Speed step is given in the following way:

Pictures in Drive*Window* 2.x versions or in DriveDebug differ from the following, but the monitored signals are still the same.

1 Run motor to speed you are using for the test.

2 Set Drive*Window* STEP function to the signal 120.10 SPEED_STEP. Set step to 2% of the maximum speed and duration for 3000 ms as shown in the figure below.

3 Set datalogger to trig from 120.10 SPEED_STEP – signal. Add signals 120.10 SPEED_STEP, 122.4 MOTOR SPEED, 122.14 TORQUE_REF_5 and 161.2 TORQUE_NOFILT to datalogger like shown below.



4 Start datalogger and apply steps. Tuning is done by using AMC parameters 121.01 KPS which is proportinal gain and 121.05 TIS which is integration time of speed controller.

After speed controller has been tuned, the speed ramp test with short acceleration and deceleration time must be done. Ramp can be shortened until appr. nominal current is reached. This test is done only from nominal speed. Also normal acceleration and deceleration shoud be tested from maximum positive to maximum negative speed.

13.2 Final Tuning of Speed Controller

The next step is to make the final tuning of the speed controller. The idea is to get the drive performing as well as required by the driven process. The main requirement is not to make the control as fast as possible, but only fast enough to make the changes required by the process, without conflicting with other control loops. Too fast speed controller may cause unnecessary stress on the mechanical system (gearbox, belts, etc.).

The tuning must be checked under different load conditions and over the whole speed range. When carrying out tuning under actual load conditions, the values obtained during pre-tuning normally need readjustment.

Some methods to tune the speed controller are given next but methods other than those presented in this chapter can also be used.

Speed steps of 2% of maximum speed or bigger are applied to see the response behaviour of actual speed. See instructions for speed step tests and for monitored signals in the previous section *13.1 Preliminary Tinung of Speed Controller*.

The integral time constant 24.08 TIS is reduced until overshoot is observed in the response. The integral time constant is then adjusted such that there is no overshoot or only a slight overshoot (depending on the drive application). The function of the integral part is to remove as quickly as possible the difference caused by the proportional control between the reference and the actual value. If the drive is stable and allows a high proportional gain, the integral time constant can be set short and an overcompensated step response is obtained.

If the drive goes to the torque limit in a step, a further compensation of the response should not be attempted.

See *Figure 13-1* for different kind of step responses.

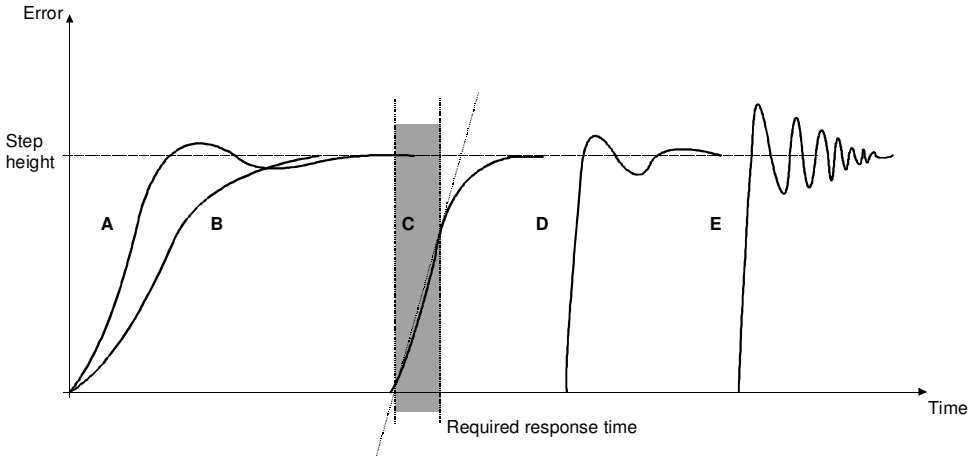


Figure 13-1 Step Response of Speed Control

A = undercompensated, too short intergration time and low proportional gain

B = undercompensated, too low proportional gain

C = normal

D = norma, when better dynamic performance is needed

E = overcompensated, short intergration time and high proportional gain

Chapter 14 - Finishing the Commissioning

14.1 Spare Parts

Check that the spare parts are available at site and are according to ordered scope of supply. If they have not been ordered, make a remark in the commissioning report.

If there is a spare AMC board, the final version of the FLASH circuit must be copied on it.

14.2 Customer Training

Instruct the customer's operators how to use the drive. Explain different control modes (local/remote) if applicable.

If customer has not been trained by ABB, explain that the customer has the possibility to participate ABB training programs in training centers worldwide.

14.3 Parameter Back-up

Read all the parameters from the drive by using Drives*Window* program and save them into a file. Be sure that all parameter groups are open and that all parameter values are saved properly. In Drives*Window* use the option "open all groups".

Hand out a copy of the parameter settings to the customer or, if available, save parameter files on the PC of the customer.

14.4 Customer's Signature

After the test runs have been performed and the commissioning report has been filled in properly, print out the report and ask the customer for acceptance. **This will initiate the warranty period**.

The commissioning report must be sent to the MV AC Supportline (for address see *14.6 Documents and Back-up Copies*), preferably in electrical format. Thus, fill in information about customer's representative who signed the report; ie. name, date and place and where the original document with the signature is stored.

14.5 Documents and Data for Customer

After the commissioning, the following data need to be given to the customer:

- Paper copy of the commissioning report.
- Back-up files of the AMC3/CCB signal and parameter table in Drive*Window* and TXT -format.
- Possible changes made in the mechanical and/or electrical drawings (CHIND is to be informed about changes to converter part).

14.6 Documents and Back-up Copies

MV AC Supportline (address below):

- Commissioning report, preferably as file.
- Parameter back-up files.
- Travel report.
- Warranty reports of replaced components, if any (to Logistics Center).
- If you have possibility to take photographs of the installation, send also the pictures to MV AC Supportline.

Delivery address of the documentation is as follows:

Lotus Notes: MV AC Supportline/CHIND/ABB
Internet: **mv.ac.supportline@ch.abb.com**

In addition:

If any changes, "red corrections", are made to part lists, spare part lists or to circuit diagrams, this information is to be delivered to the responsible project manager of the converter factory (CHIND)!