TYRAK LCI
Thyristor convertor with microcomputer for large a. c. drive systems

User's manual
Edition 4
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ABB Industrial
Systems

ASEA BROWN BOVERI

TYRAK LCI
User's Manual

Contents

Description

Contents:

General

Tyrak LCI convertors are designed in accordance with international standard IEC146, and meet the highest demands regarding performance, reliability and immunity to interference.

The control system is fully digital, from reference to trigger pulses. Both control procedures and sequential control functions are implemented digitally. Considerable emphasis has been placed on personnel safety. A powerful operators panel simplifies commissioning, handling and fault tracing of the convertor.

Configuration

The convertor equipment consists of a control cubicle, two thyristor cubicles, and a field exciter cubicle.

The type designation for a 12 pulse series convertor is: YRTK XXXX-YYYY, where X is the main supply voltage and Y is the rms phase current.

Form of protection	IEC 144-IP22 SEN 2121-S21 DIN 400S0-P21.

BS 2817-Screen protected Drip-proof.

A.C. Power Distribution

Main circuit breakers are not included in the Tyrak LCI delivery, however, one or two a.c. breakers can be controlled from the drive control equipment.

Control cubicle

The control cubicle contains circuits for auxiliary power supply, motor starters for cooling fans and drive and convertor control units.

Power supply

The control cubicle is supplied by cable from below, connected to terminals at the bottom of the cubicle. The supply voltage can be 380 V, 415 V, 440 - 460 V or 500 V.
The circuit is protected by an incoming current limiting moulded case circuit breaker (MCCB, pos H1.1) of type ABB Sace Limitor.

Control units

The control cubicle is equipped with three control units. One control unit contains the drive control system, while the two additional units contain the line convertor control and the machine control system.

The control units B2 and B20 contain three circuit boards, the processor board, YPQ201, the memory module, YPR201, and the I/O-board, YPQ202. The processor board and the I/O-board are mounted on opposite sides of a hinged panel, with the processor board facing front. The memory module is plugged in on top of the processor board. The unit B32 contains the control boards for the machine control.

The control units B2 and B20 are equipped with modem units for communication with a service terminal or PC. The units are equipped with optocouplers which galvanically isolate computer side and terminal side from each other.

Internal communication

The control units B2 and B20 communicate with each other through an internal serial bus for transmitting data at high speed. An opto link is used to eliminate electrical interference. A communication board, YPK 114, is connected to the ISBX connector on each of the processor boards. From the drive control unit, data is distributed via a distribution board, YPC 111.

Drive control unit, pos B2

The drive control unit (pos. B2) contains the drive's application control program. The unit is equipped with four expansion I/O-units, which are installed as required by the software control program. Space is also provided for a serial communication unit for ABB Master (option). Further, the drive control unit is equipped with two contactors intended for operating external a. c. breakers.

Convertor control unit, pos B20

The convertor control unit contains convertor control software. Opto couplers are used for galvanic isolation of the trigger pulses. The unit also contains a current measurement board and a connection unit for current and voltage measurement. Two analogue output channels for test purposes are included.
A contactor intended for tripping of an external a. c. breaker is also included.
The control unit also contains a transformer, which generates a reference voltage for the thyristor trigger pulses. The transformer is supplied (3X110 V) from a synchronising transformer in the thyristor cubicle.

Machine convertor control unit, pos B32

The unit B32 contains two synchronisation transformers, one for each three phase machine output. The unit also contains control boards for the machine convertor control, as well as optocouplers for galvanic isolation of the machine convertor firing pulses. Also circuits for the machine side current measurement are located here.

Processor board YPQ201.

A powerful micro controller of type Motorola MC68332, running at 16 MHz, is used. The operating system is monitored by diagnostic functions. The monitoring functions include a watch-dog, bus supervision, memory checking and power supply monitoring. In case of a fault, a flashing fault code appears on a two digit LED display. The fault codes are explained in the fault tracing section. During normal conditions the CPU load is monitored and displayed.
Error signals and log values are stored in a RWM (Read Write Memory) with voltage back-up. It retains its contents for 12 hours following a power loss.

Memory module, YPR201

The function of the drive equipment is determined by the control program installed. An application control program is installed in the drive control unit, the main thyristor convertors are controlled by convertor control programs, and the field exciter by a field control program. The control programs are stored in EPROM/ EEPROM memory capsules on memory modules. The control program (DSRB) contains a selection of standard memory modules. The program is delivered with a user manual with a functional description, signal and parameter list. For detailed description of the control program, refer to the user manual.

Electronics power supply

Each control unit is equipped with its own electronics power supply transformer, pos B51.

The three-phase transformer delivers two 24 V voltages, designated Q1 and Q2. The micro controller is supplied by Q1, while external circuits are supplied by Q2.
A high degree of immunity to interference is obtained with separate supply voltages. Each convertor's computers are directly grounded even in plants with a common reference system.
The supply transformers are provided with screens between primary and secondary windings and between the two secondary windings.
The circuits are fused with miniature fuses, Q1 with 6.3 A and Q2 with 4 A fuses.
Approximately 0.5 A (Q2), depending on optional functions added, is available for external circuits.

Grounding

Q1 (computer supply) is grounded directly in the chassis via the screws fixing the circuit boards. The neutral of the other supply voltage is connected and grounded via terminal block B2.52.X1:9. If several convertors have a common reference system, the grounding of all of the convertors but one must be disconnected.

Auxiliary distribution unit, pos B1

The distribution of auxiliary voltages in the control cubicle is shown on pages 60-65 in the CD. The different auxiliary power breakers are placed in pos. B1 in the right hand part of the cubicle. The number of breakers is dependent upon the needs of the actual application, for example whether external motors are to be controlled. The unit also includes a transformer (pos 20) supplying the operating voltages M1L and M2L. M1L is a 110 V a.c. voltage with a frequency of 50/60 Hz, and is used as operating voltage for contactors, optional power circuit breakers, digital input ports, and so on. M2L is 220 V alternating current, and can be used as operating voltage for digital input ports, on condition that the discharge resistors on the port are adequate.

The unit is also equipped with contactors intended for the functions "Electrical disconnect" and "Emergency stop".

Terminal units (B50, B51, B52)

The drive control unit is equipped with expansion I/O-units. The customer connection terminals for these units are placed on terminal rail B50 at the bottom of the left compartment of the cubicle.
B51 the terminal devoted for external connections such as operation functions and cooling fan supply. Terminal B51 is located at the bottom of the right compartment of the control cubicle.
Terminal B52, in the right compartment, consists of a number of plug in connectors for signal interchange between the control and thyristor cubicles. The control pulses, for example, are transmitted to the thyristor cubicle via this terminal.

Drive supervision and diagnostics

Tyrak LCI convertors have an extensive system for status check, operational supervision and fault diagnosis. These functions combined give a high degree of availability, protect the drive equipment and the object driven and facilitate fault tracing, upkeep and operation.

The control equipment monitors the operation and reports abnormal conditions.

- Protective functions such as earth fault, overload, supervision of speed feedback etc.

- Switch-on and switch-off sequences are supervised and evaluated.

If a command is not acknowledged within a certain time, an error message is presented on the operator's panel display.

The error messages are presented in plain language with first-fault indication and consequential faults with time of occurrence in relation to the first fault.

The error text can be presented in Swedish, German, English or French.

Error statistics

Each fault is allocated a consecutive number 1 - 99. Fault signals are stored in a RWM with voltage backup and it is therefore possible, at any time, to recall the circumstances of a particular fault. The complete fault list can also be printed via a separate printer.

Logger

This function permits the recording of values from up to six optional signals at individually optional intervals. The log function stores 186 values per signal and the value stored is the mean value during the measurement interval. The signals can be shown graphically on the operator's panel. The function can be used to show trends in certain signals or provide a basis for the analysis of faults which have resulted in tripping of the drive. Signals logged can be used in commissioning, for example when trimming a speed controller.

Thyristor cubicle

General description

The thyristor cubicle contains the convertors main circuits.
The incoming A.C. power from the main supply is converted to D.C. power by the line convertor and fed into the D.C. link, and then converted to variable frequency A.C. power by the machine convertor. The direction of the power transmission can also be reversed in order to brake the motor.

The thyristor cubicles central part comprises two thyristor modules in 6 pulse two-way connection, one for the line convertor and one for the machine convertor.

In addition a trigger pulse amplifier unit is included and so are units for protection, supervision and measurement.

The power components are designed to allow connection to the supply voltages 1190 or 1470 V.

Connection of main circuits

The convertor is to be connected to the mains by cables. Connection can be performed from the underside of the thyristor cubicle.

The convertor´s D.C.-link current connection can be arranged in the same way, that is by cables from the underside.

Thyristor module

The thyristor module (G1) is built up as two bridges in 6-pulse two-way connection. One thyristor module operates as the line convertor and the other as the machine convertor.

Each module comprises six thyristors sandwiched between seven heat sinks and thus forming a thyristor stack. The thyristors and heat sinks are held together by two tension bolts and with a straining clamp at the top to provide the holding force.
All the thyristors are equipped with transient protection in the form of an RC-circuit.

The thyristors are thermally overrated in order to allow for the fuseless design.

The thyristor module also comprises the firing pulse transformers, one for each thyristor.

Current measurement in the line convertor

The current is measured with the help of current transformers, located in two of the incoming phases of each group. A resistor is connected across the secondary to prevent voltage spikes in case of open load circuits, since the load resistors are located in the control cubicle.

The three-phase secondary currents are connected to a current sensor unit (B20.8) in the control cubicle.

After a 6 pulse rectification a current signal is obtained which is proportional to the convertor's D.C.-current. This current develops a voltage by passing through a load resistor. The voltage signal is then fed to the convertor computer, where it forms a current feedback signal for the current regulation.

Current measurement in the machine convertor

The current is measured on the machine side with the use of two current transformers, located in two of the phases of each group. A resistor is connected across each secondary for the same reason as described above for the line convertor.

The secondary currents are connected to a current sensor unit in the control cubicle. This unit contains three load resistors, one for each of the secondary phases. The voltage signals obtained across the resistors are brought to the Sync Filter Card YYI 107.

Trigger pulse transmission

The trigger pulses are transmitted via shielded cables from the control cubicle to the amplifier unit B15 in the thyristor cubicle. The trigger pulse amplifier unit includes four circuit boards, two of which are used to form the pulses and two are used to increase the steepness of the firing pulses, in order to give a safe triggering of the thyristors.
Trigger pulse transformers provide galvanic isolation between the main circuits and the control circuits.

The trigger pulse amplifier has inputs for blocking and deblocking of the trigger pulses. Deblocking of trigger pulses from the convertor computer, in the control cubicle, is performed via these inputs.

Transient protection (G1.81-89)

The transient protection consists of six capacitors which are connected to form three groups of two series connected capacitors. Each such group is connected between one line phase and earth. Each group is protected by a 1500 V, 6 A fuse.

Earth fault protection (B30)

The earth fault protection unit (of type RAERA) measures the main voltages via an artificial neutral (zero) point. The unit detects earth faults on all the main circuits galvanically connected to the 3 phase system A.C. terminals, i. e. the A.C. line supply, the D.C. link and the A.C. motor. For earth fault operation RAERA injects a D.C. voltage onto the system and then measures the direct current which arises during earth faults.

The resistors for voltage division are placed on the same chassis as the RAERA unit.

Operation is obtained, after 5-10 seconds, when the resistance to earth measures 2,5 kohm or lower.
The electronic evaluation circuits operate an auxiliary relay, whose contacts are used to operate a digital input of the line- and machine convertor. The earth fault protection is thereby integrated with the fault handling functions of the computer program.

Differential current detection

The TYRAK LCI convertor is equipped with a differential current protection. The aim of the differential current detection is to give a quick detection if a difference between the input and output a.c. current has arisen, for instance if there is a thyristor fault or a commutation failure in any of the thyristor bridges.

As mentioned above, the a.c. current is measured by means of current transformers on both the input and output side of the convertor. The sum of the two output side current feedbacks is obtained in a current measuring device based on the Hall effect (Brand name LEM). This current feedback is compared with the line current feedback in the convertor control software. If there is a difference, the protection is activated, giving a trip order and a fault message in the convertor control system.

D.C.-link voltage measuring device

The D.C.-voltage is measured with the help of an isolation amplifier. This module is fed with 220 VAC and allows galvanic separation of measuring and secondary circuits.

The voltage measuring device is protected with the help of fuses. By means of series resistors the primary current is limited to a suitable level. The amplification in the unit is 200 times, i.e. for an input signal of 0,1 mA, an output signal of 20 mA is obtained.

Signal handling takes place in an analogue input unit (YPG108) which is placed in the control cubicle.

Transformer for synchronising voltage to the line convertor

The transformer's primary winding is connected to the incoming mains via a fuse bank. The transformer creates a correct phase reference voltage (3X110 V) which is connected to the control cubicle, where it serves as reference voltage for synchronising the trigger pulse system in the convertor computer.

Transformer for synchronising voltage to the machine convertor

The transformer's primary winding is connected (via fuses) to the outgoing phase terminals for the motor. The transformer creates a secondary voltage (3X220 V) which is connected to the control cubicle. The voltage is stepped down through another transformer in the control cubicle and thereafter connected to the Sync Filter Card YYI 107, where it provides the synchronisation voltage for the trigger pulses to the machine convertor.

Convertor fan

The thyristor bridge is forced-air cooled and a fan unit provides the forced-air circulation. The fan takes in cooling air from the front side of the cubicle, through

the louvres at the lower end of the door and lets it out in the area in front of the thyristor heat sinks, building up at the same time a high static pressure there.
The high static pressure ensures an effective cooling of the thyristors when the air passes through the heat sinks and comes out into the air duct on the rear side. The air duct finally discharges the air at the top of the cubicle. The above cooling arrangement is advantageous.

The cubicle can be installed directly against a wall as well as beside other equipment on either side without demanding any free space from the cooling point of view.

Pressure monitoring switch

The pressure in the air duct is supervised by a pressure sensing switch. If the fan stops, the pressure switch sets off a signal to a digital input of the line- and machine convertor computer.

The air pressure protection is then integrated in the fault handling functions of the computer programs.

Temperature measuring element

In the thyristor cubicle the ambient temperature is measured with a Pt 100 element, the resistance of which varies linearly with the temperature. The element is fed with a constant current of 5 mA and the voltage drop across the element is used as a measure of the ambient temperature.

The signal handling is made in the convertor control system in the control cubicle, and integrated in the fault handling functions of the computer program.

Terminal units (B51, B52)

Terminal units B51 and B52 are located at the bottom of the apparatus compartment of the thyristor cubicle. Terminal B51 is used for power supply for the cooling fan. Terminal B52 consists of plug-in connectors for communication between the control and thyristor cubicles.

Field exciter

The motor field circuit is supplied from a three phase digitally controlled field exciter, housed in a separate cubicle. At delivery, the field exciter is bolted on to the control cubicle as shown on the dimension prints.
The field exciter is available in two versions, one for brushless field excitation (A.C.), and one for excitation via sliprings (D.C.).

The field exciter communicates with the drive control system via an optical serial link.

Power supply

The field exciter is supplied by cables from below, connected to terminals at the bottom of the cubicle. The thyristor bridge is protected by a moulded case circuit breaker. The standard supply voltages are 380, 415, 440/460 and 500 V.

Trigger pulse circuits

The pulse transformers are assembled on a circuit board together with current measurement circuits and RC-circuits. The trigger pulses are generated in the control equipment and are transmitted to the thyristor bridge via a ribbon cable.

Current measurement

The d.c. current is measured on the a.c. side of the thyristor unit with help of two current transformers. The output signal is rectified in a diode bridge and is adapted with load resistors so that the output voltage is 1,00 V at rated current.

D.C.-type field exciter

The field exciter consists of a main circuit breaker, thyristor bridge with current measurement, control unit, and a field discharge unit.

Main circuit

The main circuit contains phase inductors, thyristor bridge, cooling fan, fast acting fuses, field discharge unit, and auxiliary power supply for the control equipment.

The thyristor bridge is built up as a three phase, fully controlled 6-pulse bridge. It is available as a single or double bridge. Thyristor blocks with two thyristors in each are used.
Phase fuses, RC-circuits and phase inductors are used as protection for the blocks.

Convertor fan

Field exciters rated up to 115 A are provided with an axial fan powered with the operating voltage 110 V a.c. (M1).
Field exciters rated 195-515 A are cooled with a radial fan, supplied with 220 V a.c. (M1 - M2).

A.C.-type field exciter

The field exciter consists of a main circuit breaker, thyristor bridge with current and voltage measurement, and control unit.

Main circuit

The main circuit contains thyristor bridge with voltage and current measurement, cooling fan, and auxiliary power supply for the control equipment.
The thyristor unit consists of fully controlled anti parallel connected thyristors in the three phases. Thyristor blocks with two thyristors in each are used. RC-circuits are used as protection for the thyristor blocks.

Power measurement

The a. c. current is measured by means of measuring devices based on the Hall effect, so called LEM module on each of the three phases. The output signals from the LEM modules are adapted with load resistors, and then fed to the power measuring board YPG 111.

The supply voltage for the measuring modules is +/- 15 V.

Voltage measurement

The output voltage is measured with the help of a LEM module. This module is fed with +/- 15 V and allows galvanic separation of measuring and secondary circuits.
With the help of resistors the primary current is limited to < 10 mA. The output signal is fed to the power measuring board YPG 111.

Convertor fan

Field exciters rated up to 95 A are provided with an axial fan powered with the operating voltage 110 V a.c. (M1).
Field exciters rated 285-430 A are cooled with a radial fan, supplied with 220 V a.c. (M1 - M2).

Communication

Communication with the drive control equipment is possible via the operators panel, via I/O-units for discrete signals or with serial communication from other computer equipment.

I / O- system

Basic I/O-board YPQ202

External signals are connected to the basic I/O-board YPQ202 via individually disconnectable terminal blocks, accepting up to 2.5 sqmm (AWG14) wires. The following functions are included:

- Three digital output and four digital input channels with fixed functions, for external fans, oil pumps and main breaker operation. These circuits are connected to the 110 V a.c. control voltage.
- Five digital input channels, user defined function.
- One digital output channel, user defined function.
- Four analogue input channels, user defined function. The input signal can be ± 1 V, ± 10 V or 4 - 20 mA.
- Two analogue output channels, user defined functions, connected to test outputs in the door.
- One or two analogue outputs for current actual value, via buffer amplifier on current feedback signal (only on convertor control units).
- One analogue output for speed actual value (buffer amplifier on analogue tacho feedback signal).
- Pulse generator input.
  The unit has three inputs, two measurement channels to detect forward/reverse rotation and one 0-pulse input. One of the standard digital input channels can be programmed to give a synchronisation pulse in positioning applications. The maximum pulse frequency is 50 kHz.

The setting of user defined input/output channels is performed from the operator's panel or from a service terminal or PC.

Expansion I/O units (CD 26-29)

The drive control equipment is prepared for four expansion I/O-units which are installed as required by the application control program.

Each expansion unit consists of two circuit boards and an interconnecting ribbon cable. One board is plugged on to the computer board on the drive control module. The other board accommodates the customer connection terminals, and is placed outside the control module (pos. B50) for convenient connection of wires.

Following expansion units are available:

- Digital input unit (YPI103 + YPI104).
  Eight channels, adapted for 110 V ac/dc. supply.
- Digital output unit (YPO105 + YPO106).
  Eight channels, galvanically free relay contacts.
- Analogue input unit (YPG110 + YPG106).

Four channels and a voltage divider for analogue tachometer signal, a current generator for Pt100 supply and a reference voltage source ±10 V.

- Analogue output unit. (YPM102 + YPM105). Four channels (two of which are connected to test outputs).

Analogue output channels
Basic I/O (AO37XX) (CD 22)
Expansion I/O (AO34XX) (CD 29)

The analogue output channels on the basic I/O-board give ±10 V output. On the expansion unit the signal level can be set for either 0 - +10 V or -10 V - +10 V. using parameter AO34MODE.

The output signals can be multiplied up to 256 times, using parameters AO37.XMU/AO34.XMU. The signals can also be offset by ±100 % using parameters AO37.XOF/AO34.XOF.

Analogue input channels
Basic I/O (AI37XX) (CD 22)
Expansion I/O (AI33XX) (CD 28)

Analogue input channels are normally used for external references, armature voltage feedback, temperature measurement and tachometer generator input.

Both current and voltage signals can be connected to the analogue inputs. The reference type and level for each of the four channels is selected with parameter AI37MODE/AI33MODE as shown in the circuit diagram. The strapping arrays S1-S4 must be changed accordingly.

With a voltage reference with signal level ±1 V or ±10 V, either a differential or a bipolar input can be chosen.

Differential input: Neither strap 1 - 2 nor 3 - 4.
Bipolar input: Insert strap 3 - 4.

With a current reference signal 4 - 20 mA, insert strap 1 - 2. This will permit the passage of current through the 500 ohm resistor.
The input value can be multiplied from -16 to +16 times, using parameter AI37.XMU/AI33.X. The parameters are on delivery set to 1.000.

Note! The parameters AI33.XMU are not available on the OPC. Setting these parameters by terminal means that the value +/- 32767 is equal to +/- 16.

On the basic I/O-board, the filter time constant can be individually chosen for each channel from 3 to 40 ms set by strapping arrays S5 - S8.

On the expansion I/O-unit the filter time constant can be chosen 10 ms or 25 ms, strapping arrays S5 - S6.

The analogue input channel must be adapted to the signal type and level connected.

An analogue tachometer generator is connected to the voltage divider, voltage level chosen by jumpers A - D as shown in the circuit diagram. By inserting strap S9:1 - 2/S5:1 - 2, the signal is connected to one of the analogue input channels.

On delivery, the 4 channels on the expansion analogue input board are zero-balanced. If however it should be necessary during commissioning, channel 1 is zero-balanced with R58, 2 with R57, 3 with R60 and channel 4 with R59.

Digital input channels
Basic I/O (DI37XX) (CD 21)
Expansion I/O (DI31XX) (CD 26)

The input resistors are on delivery designed for 110V a.c. or dc signals, but other voltages may be used if the input resistors are changed accordingly.

Basic

Voltage	24 V	48 V	110 V	220 V
Resistor 5W	2.2 kW	4.7 kW	10 kW	22 kW

Expansion

Voltage	24 V	48 V	110 V	220 V
Resistor 5W	470 W	4.7 kW	12 kW	27 kW

All input signals are operated individually. The signal to which the channel is connected is found in function module CONNXXXX and can be displayed on the operator's panel. The input signals can be individually inverted, using parameters DI37.XIN/DI33.XIN. Active signal is indicated by a yellow LED.

Digital output channels
Basic I/O (DO37XX) (CD 21)
Expansion I/O (DO32XX) (CD 27)

All output signals are operated individually. Each channel is provided with a galvanically free relay contact. The output signals can be individually inverted, using parameters DO37.XIN/DO32.XIN as shown in the program diagram. The parameters are on delivery set to 0.

Signals connected to the output channels can be displayed on the operator's panel, and are found in the function modules from which they derive.

I/O channel data

Digital input

Basic I/O unit: 12 channels
Expansion I/O unit: 8 channels

Isolation by opto-coupler.
Input load resistor on soldering posts.

Resistor value:	10 kW, 5 W
Nominal input voltage:	110 V ac/dc.
Min. voltage for "1":	90 V
Max. voltage for "0":	11 V
Max. input voltage:	140 V
Filter time constant:	2.4 ms/10 ms

Digital output

Basic I/O unit:	8 channels
Expansion I/O unit:	8 channels

Isolation by relay.

Max. voltage:	250 V a.c./d.c.
Continuous current:	3 A
Relay contact data:	
Min. voltage and current:	5 V, 1 mA
Lim. making capacity:	30 A, 200 ms
Lim. breaking capacity a.c.:	8 A, 250 V, cosFi > = 0.4
Lim. breaking capacity dc:	1.2 A, 48 V
	0.3 A, 125 V
	0.2 A, 220 V

Analogue input

Basic I/O unit:	4 channels
Expansion I/O unit:	4 channels

Input type:	Differential ampl.
Max. common mode volt.:	±100 V
Input voltage:	±10 V, 5 mA
Current loop:	5 mA
Resolution:	12 bits
Linearity error:	±0.5 LSB

Analogue output

Basic I/O unit:	2 channels
Expansion I/O unit:	4 channels

Output:	±10 V, 5 mA
Resolution, basic I/O:	12 bits
Resolution, exp. I/O:	8 bits
Linearity error, basic I/O:	±0.5 LSB

Digital speed measuring

Max. input frequency:	50 kHz
Input signal:	12 V, 24 V, 13 mA
Pulse gen. power supply:	24 V

Serial communication for service unit

RS 422 interface

Max. cable length:	100 m

High speed serial bus

The communication unit, YPK107 (unit 41) has two channels. One channel is used for communication with an ABB Master, the other channel can be utilised for Master/Follower communication between drives.

One modem board, YPC104, per channel is mounted on top of the communication board, unit 41.1 for Master communication, unit 41.2 for master/follower communication.

The ABB Master communication link can address up to sixteen convertors in a multidrop configuration. The convertors are connected together with coaxial cable. The cycle time is 1 ms per drive connected, and the transmission speed is 2 Mbit/s.

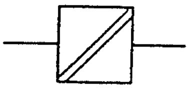
The master/follower communication link can handle up to eight followers connected to one master drive. The cycle time is 1 ms per follower connected.

The unit is provided with a communication circuit of DUSCC (Dual Universal Serial Communication Control) type, a double port memory, a 16 bits processor which reads and writes in this memory and a DMA (Direct Memory Access) circuit. The communication is half duplex in accordance with the specification for the Master Field Bus (modified SDCC protocol). The transmission code used is NRZI.

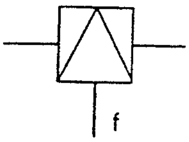
Diagram Symbols

(from 2000 808 - 21 sheet 1)

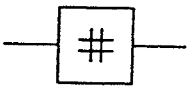
General symbols



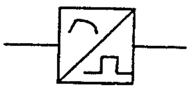
Galvanic isolation.



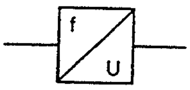
Modulator.



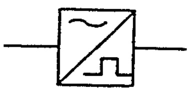
General symbol in digital signal systems.



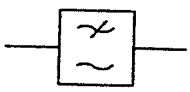
Convertor from an analog signal to pulses.



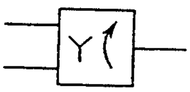
Convertor from freqvency to voltage.



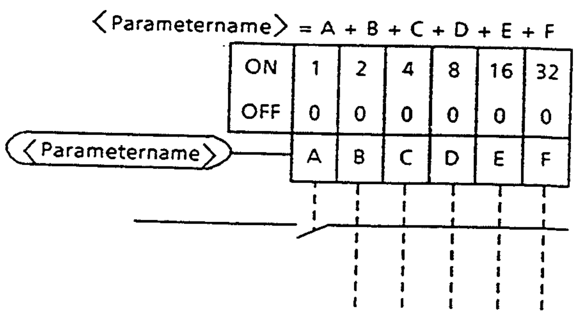
Convertor from a sine wave signal to a square pulse.



Low-pass filter.

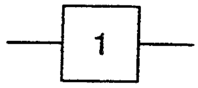


Clockwise phase sequence makes output = "1".

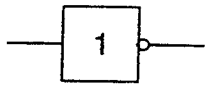


To unpack a compressed integer value to two or more boolean parameters. Above is shown a symbol with six sections (= six boolean parameters), there for example section A is controlling a signal switch.

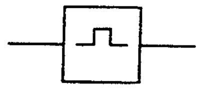
Logical elements



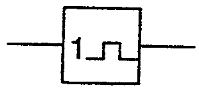
Buffer.



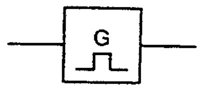
Logic inversion.



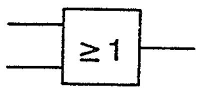
Monostable element.
Possible to re-trigger.



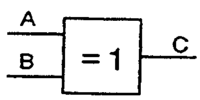
Monostable element.
Not possible to re-trigger.



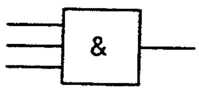
Pulse generator.



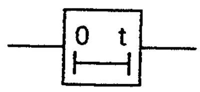
OR-gate.



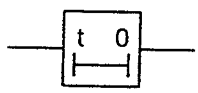
Exclusive-OR. C = "1" when only one of the inputs is "1".



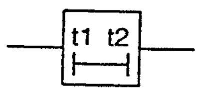
AND-gate.



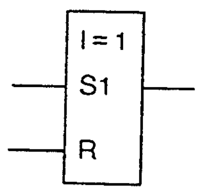
Time delay element.
Time delay when changing to "0"-position.



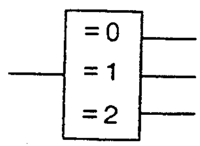
Time delay element.
Time delay when changing to "1"-position.



Time delay element.
Time delay t1 when changing to "1"-position and t2 when changing to "0"-position.



SR flip-flop with SET-signal dominating. At supply connection (Init) the output goes to "1".

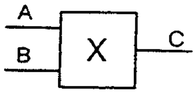


When input has any of values 0, 1 or 2, corresponding output is "1".

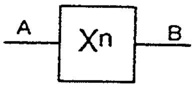
Diagram Symbols

(from 2000 808 - 21 sheet 1)

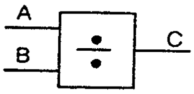
Arithmetical elements



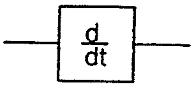
Multiplier
$A \times B = C$



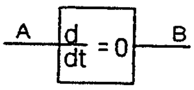
$B = A^n$ with $n = 2, 3, \ldots$



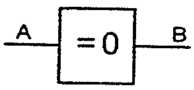
Division
$\frac{A}{B} = C$



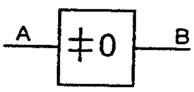
Derivating function.



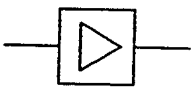
B = "1" when $\frac{dA}{dt} = 0$.



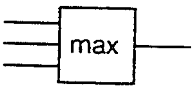
B = "1" when A = 0.



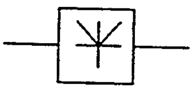
B = "1" when A is not zero.



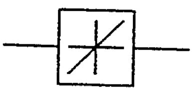
Amplifier.



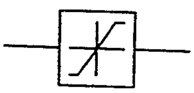
Max. value generator.



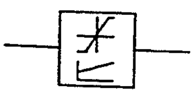
Absolute value generator.



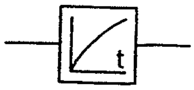
Linear amplifier.



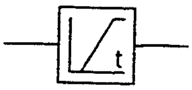
Linear amplifier with positive and negative limitation.



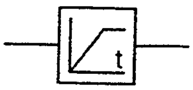
PI-controller.
Linear type with limitation.



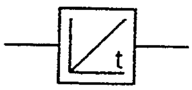
Element with time constant.



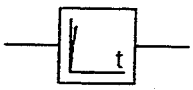
Function generator with limitation.



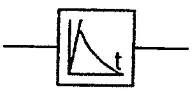
Ramp function.



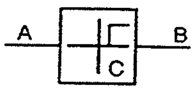
Integrating element.



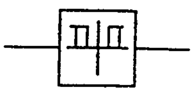
Derevating element.



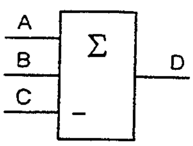
Derevating element with time constant.



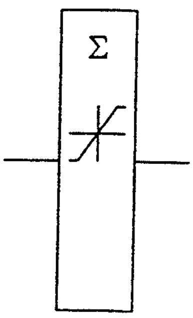
Level detector which makes B = "1" when A > C.



Symmetrical level detector with hysteresis.



Summation element.
D = A + B-C



Summation element with limitations.

Diagram Symbols

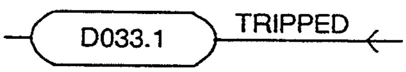
(from 2000 808 - 21 sheet 2)

Signal symbols

Output signal NREF6 with data size F2 (2 byte "fraction"). Available for operator's panel.

Output signal NFEEDBPT with data size 12.F2 (2 byte "integer" and 2 byte "fraction"). Not available for operator's panel.

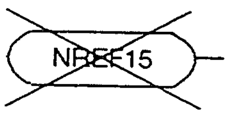
Output signal with data size F2 (2 byte "fraction"). Not available for operator's panel.



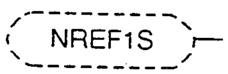
Signal switch-box

In this example the digital output board in pos. 33 channel 1 is connected to the software signal TRIPPED.

Parameter.
Setting value can be changed from operator's panel.

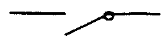


Parameter.
Setting value can only be changed from a data terminal.

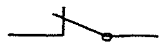


Parameter.
Setting value can only be changed from a data terminal.

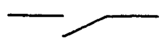
Remaining symbols



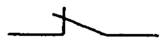
Closing contact.



Breaking contact.

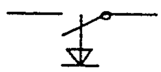


Closing function.

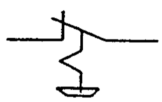


Breaking function.

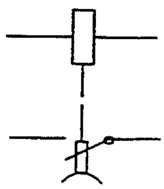
Change over function.



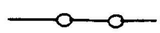
Control switch with automatic return.



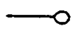
Control switch without automatic return.



Relay with closing contact which is time delayed at opening.

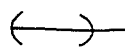


Jumper contact.



Terminal.

Soldering pin.



Disconnectable terminal with test points on both sides of the isolator.

Diagram Symbols

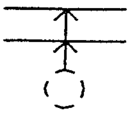
(from 2000 808 - 21 sheet 2)

Remaining symbols (cont.)

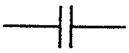

Test point, made as a cage device. Also used as a general symbol.

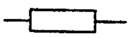

Test point, made as a pin device.

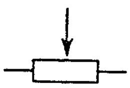

Earth (Ground).


Conductor with screen.

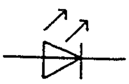

Twisted conductor.


Capacitor.


Resistor.

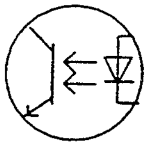

Potentiometer.


Semi-conductor diode.


Light emetting diode (LED).


Voltage regulator diode.


Signal lamp.
General symbol.


Opto-switch.

Indicating instrument, shown as A-meter.

Tachometer generator. :

Installation

Contents

General

This instruction apply to Tyrak LCI convertors type YRTK.

Note that the attached dimension drawings may be subject to revision. Dimension drawings for the actual equipment delivered should therefore be requested.

Transport and storage

The convertors are delivered in packaging suited to the mode of transport. Check the shipment towards the transportation documents on delivery. Any shortage or damage must be reported to ABB Industrial Systems immediately, to avoid delay in installation and commissioning.

If the equipment is not to be installed immediately on delivery, it must be stored suitably protected in its transport packaging, in dry premises protected from dust. The storage temperature must not fall below -25 °C and must not exceed +55 °C.

Enclosed convertors, which come attached to loading pallets, must be transported upright by fork-lift truck, trolley or similar equipment.

If there is an overhead travelling crane at the installation location, the lifting beams of the cubicles may be used, see Figure 1.

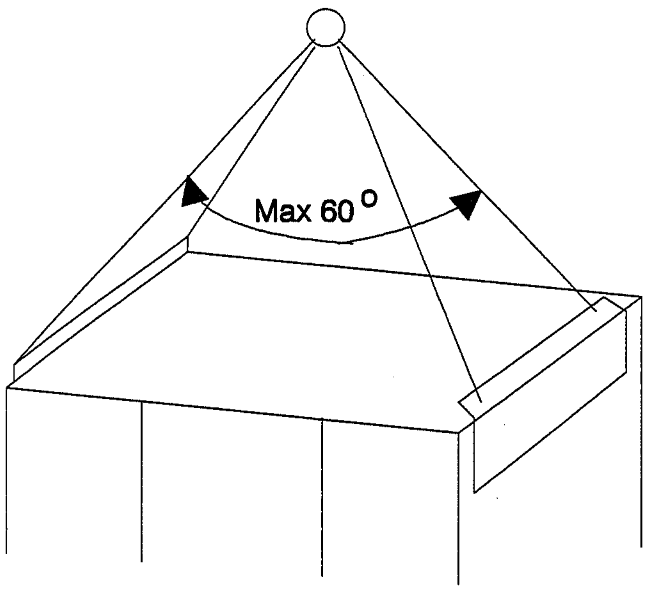


Figure : 1 Lifting instructions

Positioning

The convertors are intended for installation indoors in a normal industrial environment, with an ambient temperature of 0 °C - +35 °C (+50 °C with reduced loading). The air must be free from dust and corrosive gases.

Convertors with air filters may be located in a dusty environment. The filter, which is washable, must be inspected at regular intervals and cleaned if necessary, see section "Maintenance".

The recommended arrangement is for the cubicles to be located close together and preferably in line, directly adjacent to each other as shown in section "Dimensions". If the thyristor cubicle and the control cubicle must be placed apart, the control cables must follow the shortest route and be separated from cables carrying heavy currents.

No precise figure can be stated for the maximum distance between cubicles, since this depends greatly on the level of interference in the environment where the convertor is to be located (proximity of circuit-breakers, other large items of switchgear and magnetic field from inductors etc). As a guide, we recommend that the distance between control cubicles and thyristor cubicles should not exceed 12 metres (40 feet).

The minimum distance from the top of the convertor cubicles to the ceiling is shown on the dimension print. The minimum space between the side of a cubicle and the wall is 40 mm.

The construction of the cubicle requires a flat, well-levelled floor surface (Hus-AMA, tolerance 3B or Class 2), on which several cubicles can be bolted together without special measures being called for.

If several cubicles are to be joined together and the tolerance requirements for the floor surface are not met, each cubicle must be adjusted with respect to the floor, before the cubicles are joined together. This is done by placing sheet metal shims or similar between the bottom beam and the floor.

Cubicles must be assembled first by bolting them together, before they are tightened to the floor. Where cubicles are joined, the maximum tightening torque is 9 Nm.

The thyristor cubicles have doors only on front and may therefore be installed against a wall. Cooling air inlet is through louvres in the doors. The cooling fan is located below the thyristor bridge and the air outlet is through the roof of the cubicle. To ensure proper cooling there must be no external pressure drop. It is essential to keep the cooling air openings clear.

The noise level of a thyristor cubicle does not exceed 75 dBA with good natural damping in the room.

Connections

Main circuit

The main circuit of the convertor is to be connected to the supply and to the motor via cables from below. Cables are connected to bus bars in the thyristor cubicle.

Auxiliary power supply

The auxiliary power power supply voltage can be 380V, 415V, 440 - 460V or 500 V, connected by cable to bus bars marked L1, L2, L3 at the bottom of the control cubicle.

Field supply

The field exciter must be supplied separately by cable, connected to terminals marked L1, L2, L3 at the bottom of the cubicle. Supply voltage can be 380V, 415V, 440 - 460V or 500V. The supply cable to the motor field winding is connected to terminals L+ and L- in the field exciter cubicle.

Serial communication for ABB Master

External coaxial cables are connected to the serial communication connection boards, B53.1 and 2, located at the bottom of the cubicle (see dimension prints). The last convertor in the communication link must be provided with a termination plug, 5217 423-14 (included in the delivery).

Other circuits

Motor starters for convertor and d.c. motor cooling fans are located in the control cubicle with connection terminals (B51) as shown in the dimension prints. Motors starters for heavy start above 22 kW, are located in a separate 400 mm cubicle bolted to the control cubicle.

Interconnections

The control- and field exciter cubicles are on delivery bolted together with all interconnections ready-made. Connections between the contol- and thyristor cubicles are made by cables with plug-in connectors, which are included in the delivery. The cables are connected to terminal units designated B52 in the control and thyristor cubicle.

Cable routing

Convertors contain both electronics and equipment with high power ratings. Circuits in convertors therefore fall into two categories: those that cause interference and those sensitive to interference. The former are the main circuits, the latter the electronic control circuits.

To minimise the risks of interference, conductors sensitive to interference should be run separated, at least 100 - 300 mm, from cables generating interference. Signal cables (up to 110 V dc) connected to optocouplers on the control equipment should not have a length exceeding 300 m.

Electronic signals connected to the neutral of the electronic system (reference values, actual values and certain digital signals) are to be conducted in screened cables. The screen (SC inthe circuit diagram) must not form a closed circuit, since this might give rise to inductive currents.

Screens are connected to special terminal blocks on terminal row B50.

Cables must be dimensioned and installed in accordance with relevant rules and regulations (standards).

Earthing

All units in the convertor are connected to the frame via their fixings.

Since relatively high currents (5 - 10 kA or more) occur in these installations, it is important to earth the various parts of the installation with great care. From an interference point of view, it is important that potential differences, both transient and static, are eliminated to the greatest possible extent. This means that the installation must have a well-dimensioned and carefully-installed earthing network. The control and thyristor cubicles must be connected together with a reliable ground conductor. The cross-sectional area of the earth lines must be generous (to current standards) and must take the shortest possible route between parts of the installation.
For units that carry digital and analog signals it is especially important the earthing points are reliably connected to the common earthing network by earthing lines that are as short as possible. All cubicle frames have an earthing clamp to which the earth line may be connected.

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Introduction

This instruction describes the commissioning of a motor drive supplied from a TYRAK LCI convertor. The convertor configuration can be 6-pulse, 12-pulse parallel or 12-pulse series.

TYRAK LCI is a current source type of drive with a DC-link arrangement between the line side convertor(s) and the machine convertor(s). The torque control of the drive is principally performed via the line side convertor(s) (armature current control) but also the field exciter via the flux control and the machine convertor via the control of the machine triggerpulses (motor powerfactor) is participating.

In the instruction, the order of sections in which the different commissioning stages are described, follows in principle the same order as the proceeding of the commissioning process.

The aim of this instruction is that with its help an experienced commissioning engineer, used to smaller convertors as Tyrak Midi for example, should be able to handle the commissioning without earlier experiences of TYRAK LCI. The emphasis in the instruction has not been to lay down precise instructions for commissioning but rather to provide support and explain how functions in the control system should be set and tuned for the actual motor drive. In some parts of the instruction, additional functional descriptions are given which are not described elsewhere.

As this instruction is rather comprehensive it is provided with a check list. The check list contains a summary of the activities of a commissioning.

The control system of the convertor includes special functions to make the commissioning process easier, eg the TESTMODE-function. These special functions are described in the section Built-in aids to commissioning.

Important system parameters, eg various rated data, are grouped in special "start-up" modules (one for each control unit); see the section Setting rated data.

The decentralized convertor control system of TYRAK LCI consists of several control units. There are three types of control units in the control system; a drive system control unit, a convertor control unit and a field exciter control unit.

Commissioning a TYRAK LCI means more than just commissioning a convertor; it also involves commissioning of a complete motor drive system. That means that some time must be spent on preparations for powering-up the convertor, such as checking the groundings, measuring the insulation resistance as well as checking switchgears, transformers and other apparatus external to the convertor.

It is important to set aside time for a certain amount of supervision during the initial period for which the motor drive is in actual service, particularly at maximum load. Some adjustments may have to be made and some parameter settings may have to be changed. Further down in the text it will be specified, what to be checked.

Normally there is no need to change factory settings, unless the commissioning instructions or other documentation says so, but there may be special circumstances where it becomes necessary.

Prior to the start of the commissioning some calculations have to be made, in order to to set up the LCI-control for a specific motor and line supply . These calculations is performed by system calculation responsible SCR (a SCR is authorized by ABB Industrial Systems). The result shall be given to the commissioning engineer as a parameter list and a parameter dump file.

The text refers to signals and parameters in the software. To localise these a module name is given. The first six letters are the module name; the next two Xs represent the version and revision number.The module names are unique within the TYRAK LCI software. If the text doesn't refer to, in which control unit a function module is to be found, it can be found by using the module register (exists in the program diagram (PD) of every control unit).

Finally, a golden rule:
Never tune the control system "harder" than what is required by the process; otherwise it puts excessive strain on the mechanical equipment.

And remember Instructions are no substitute for common sense.

Commissioning procedure

The section headed Checklist below sets out a suitable procedure for commissioning. It shows, for example, that the commissioning of the field exciter may be started before power has been applied to the main circuit. As far as the sequence of the various activities is concerned, it will mostly be obvious to an experienced commissioning engineer.

Commissioning a large motor drive often includes commissioning high-voltage equipment and certain items of switchgear in the main circuit, such as high-voltage circuit-breakers. It is important to check these first, since the control system of TYRAK LCI and the switchgear are not tested together before delivery.

Before the motor can be rotated the motor lubrication must be in order. Some time has to be spent on commissioning this system and other motor auxillary systems. This can be performed prior to excitation of main circuits.

It is important to stress that the work with the commissioning should start before travelling to site. This instruction and other relevant documentation should be studied. A preliminary parameter setting list should be made in advance of the commissioning by SCR (System Calculation Responable) where the specific parameter settings for the LCI-control are to be found. It is important that the commissioning engineer and SCR have contact before and perhaps during the commissioning process.

> Note!
> Check the direction of rotation with the mechanical supplier before the cables are connected on the motor.
> The positive direction of rotation of the motor cannot be changed by other means than changing the phase order of the motor supply cables. This involves normally a lot of work since the big dimensions of the cables. It is therefore better to do this check before the cables are cut to right size and mounted on to the motor.

Checklist

Before starting the commissioning process

Read the chapter Introduction.
Study the description of built-in help to commissioning:
- The "TESTMODE" function
- The "TESTREF" function
- The "STEP" function.

Check equipment, instruments, documents etc required.
Read General instructions concerning:
- Measures of
  - Personal safety
  - Equipment protection.

Appoint authorised person to operate high-voltage circuit-breakers.
Decide the methods of commissioning.
Confirm the main motor positive direction of rotation.

Before powering up the control system

- Check:
  - Grounding of aux. system.
  - Auxiliary supply circuits.
  - Speed measurement and rotor position as regards:
    - Installation
    - Jumpers on measurement boards
    - Power supply of pulse transmitters.
  - Connection of other external apparatus.
  - Connection of seriellbus between Control cubicle and Field exciter.
- Short-circuiting the back-up capacitor of the memory boards.

After powering-up the control system.

- Parameter settings
  - Load the delivered parameter load files.
  - Check the setting of the start-up modules:
    - Drive system
    - Convertor
    - Exciter.
  - Check the pre-set protections.
  - Connection of signals via the "CONNECT" function.
- Checking operation of the convertor, "TESTMODE" = 0
  - Connecting a provisional synchronizing voltage.
  - Checking the field circuit.
  - Checking the direction of rotation of fans.
  - Trigger pulse check.
- Commissioning exciter
  - Via operator panel, SCFEASEL/SCFEBSEL= "0" & FLDEXNR = "0":
    - Set IFTEST = "1"
    - Setting the current measurement(done in workshop tests)
    - Setting fieldcurrent system gain.
    - Tuning the field current PI-controller gain and integration part.

Before powering-up the main circuits of the thyristor cubicle

- Checking the high-voltage supply (CB in test position):
  - Operation regarding:
    - On and off signals.
    - Trip of breaker from convertor.
  - Trip signal from CB to convertor
  - Setting the protections.
- Checking / inspection of entire drive system before powering-up:
  - Grounding system
  - Insulation resistance measurement
  - Motor (visual inspection).
- Checking/setting measurement of the main circuits.
  - Dc-link current (done in workshop tests).
- Checks and settings before connecting the high-voltage circuit-breaker:
  - Trip signal to high-voltage circuit breaker
  - Auxiliary supply for trigger pulse amplifier(s).
- Powering-up the main circuits of the thyristor cubicle.

After powering-up the thyristor cubicle

- Before starting the convertor:
  - Locking the drive from regenerative mode.
  - Checking the level of the supply voltage
- Checking the AC-supply voltage measuring
  - Setting the undervoltage protection.
- Controllability check, "TESTMODE" = 0
  - Checking the position of the firing pulses.
- Controllability check, "TESTMODE" = 1
  - Checking the current and DC voltage measurement
  - Calibration of the convertor delay angle.

Current regulation, "TESTMODE" = 3.
Setting the current regulator for:
6-pulse convertor(s)
12-pulse parallel convertor(s)
12-pulse series convertor(s).
Compensation of voltage drop in supply systems.
Checking the current indication level.
Setting and checking the current rate-of-change limiting.
First time rotation of the motor
Check the polarity of the speed feed-back
Direction of rotation of the motor
Checking of rotor position signals

After rotating the motor the first time

Speed control, "TESTMODE" = 6. (VARBETAS = "0" & OPTMAGS = "0".
Tuning of mach conv. firing angle, b, with UMONOMP.
Checking the speed measurement against actual speed
Provisional tuning of speed control
Checking the overspeed protection.
Checking the overvoltage protection.
Checking the DC voltage measurement.
Setting the noload characteristic of the motor (pre-set).
Setting the speed-dependent current limit (pre-set).
Setting the speed dep. min. flux-curve, (pre-set).
Setting the speed dep. min. mach. conv. firing angle, (pre-setted).
Setting and calibration of mach. voltage measurement.
Tuning of field direct current control, "TESTMODE" = 6 (brushless. field excitation only).
Checking the phaseorder of feeder mach..
Setting of field dc-current measurement.
Tuning of field dc-current control.
Checking of feeder machine model.
EMF control, "TESTMODE" = 7.
Checking of field weakening.
Setting the minimum field current.
Tuning the EMF controller.
Setting protections and limits.
Setting the EMF reference.
Actvation of the optimal motor utilisation control, (VARBETAS = "1", OPTBETAS = "1" & OPTMAGS = "1").
Tuning of the machine voltage filter, "TESTMODE" = 6.
Provisional setting of the armature reaction compensation.
Checking the settings of software based protections.
Speed regulation, final tuning, "TESTMODE" = 6.
Speed regulation, performance check, "TESTMODE" = 9.
Perform the "quick acceleration test".

Interaction with higher-level control system, "REMOTE"

MasterField Bus
Master Follower communication
Twin-drive

Final actions

Tuning the armature reaction compensation.
Checking the machine convertor control performance.
Dumping the parameter settings.
Documentation of regulator settings.
Documentation of performance during production operation.

Built-in aids to commissioning

"TESTREF" function

TESTREF is a signal which, with the aid of the "TESTMODE" function becomes the reference for the various setpoints in the control system.

Depending on the value of the TESTMODE signal, TESTREF becomes the reference for the delay angle, motor current, speed etc of the convertor. For TESTREF to become the motor current reference, the IDTEST parameter in the convertor control system must be reset to zero.

The TESTREF signal is controlled via an analog input signal TESTREF1 connected to a ramp circuit, or via increase/decrease buttons on the operator panel. The rate of increase of the signal is determined by the parameter RAMPTIME in the function module of TESTDS.

A potentiometer may be used to control TESTREF via the analog input. The centre tap of a potentiometer (10 kohm) is connected to B51.66. The end terminals of the potentiometer are connected to +10 V and -10 V. Signal TESTREF1 has to be connected to AI37.1 via switch box.

"STEP" function

The "STEP" function works together with the STEPTEST function of the operator panel; see PD. In the STEPTEST function a STEP signal is generated. With help of the "TESTMODE" function, this becomes a step disturbance for the various setpoints in the control system; see below. In addition, for STEP to become a step in the dc-link current reference, a parameter IDTEST must be set to zero in the convertor control system. When STEP =1 %, then one percent change in the actual setpoint is obtained.

"TESTMODE" function

For commissioning and service the drive system includes a test function known as the "TESTMODE" function. See also the TESTDS function module in the program diagram (PD).

The TEST parameter in the TESTDSXX module is used to activate the "TESTMODE" function, provided that local operation at the operator panel has been selected.

The test function to be used is selected as shown in the table below, using the TESTMODE parameter. Depending on the value of that parameter, a signal TESTREF is connected as a reference for the various control quantities in the control system (eg delay angle, motor current, field current, rpm and angular position).

The output signal STEP of the "STEP" function automatically becomes (with help of the "TESTMODE" function), a step disturbance to the various control loops.

If the "TESTMODE" function is to be used, the convertor must be started via the ON button on the operator panel. A start-up order is then given, with the START button on the operator panel.

To change the "TESTMODE" function, eg the DRIVMODE signal, the convertor has to be switched off.

This means that, if, for example, trigger pulses are to be checked without power on the main circuits, a provisional synchronizing voltage must be connected.

Acknowledgement signals from circuit-breakers must be jumpered; see Fault tracing instructions, the section headed Trigger pulse check. When the convertor control system receives a ON–order , the main circuit of the convertor will normal be energized or the main circuit are energized.

Test modes

Value	Function
0	Open control of delay angle ALPHA with trigger pulses blocked in the trigger pulse amplifiers of the thyristor cubicles. The reference signal TESTREF is automatically connected as a reference for the delay angle. Current control is NOT active. Current measurement is active, and therefore overcurrent protection as well.
1	Open control of delay angle ALPHA with trigger pulses deblocked in the trigger pulse amplifiers of the thyristor cubicles. Current control is Not active. Current measurement is active, and therefore overcurrent protection as well.The motor field is automatically disconnected.The reference signal TESTREF is automatically connected as a reference for the delay angle.
2	Automatic setting of the current control in the armature circuit. Setting is to be done with field exciter connected to motor.Field can be disconnected with parameter FLDEXCS.
3	Checking armature current control. This function automatically disconnects the motor field. The field can be connected using FLDEXCS in the ORDERHXX module. The reference signal TESTREF is automatically connected as a current reference if the IDTEST signal in the convertor control system is set to zero. STEP automatically becomes a step in the dc-link current reference value if the IDTEST signal in the convertor control system, module IREFHAXX, is set to =1. Bear in mind that the limit on the current rate-of-change may affect the "step". With the parameter HIGHSTEP = "1" the current step disturbance via the signal STEP will be increased four times.
4	Automatic setting of the current control in the field circuit. This function is not yet implemented.
5	Test of field current control. TESTREF is automatically connected as a reference for the field current. STEP automatically becomes a step in the field current reference.
6	Test of speed control. TESTREF is automatically connected to the speed reference. STEP automatically becomes a step in the speed reference.
7	Test of EMF control. The EMF reference is not affected by TESTREF. TESTREF is automatically connected to the speed reference. STEP automatically becomes a step in the EMF reference.
8	Test of position control. The test signal TESTREF is automatically connected as the position reference. STEP automatically becomes a step in the position reference.
9	Performance check of speed control with respect to load disturbance. TESTREF is automatically connected to the speed reference. STEP automatically becomes a step in the torque reference.
10	This function is for normal running
11	Test of twin-drive controller. Test ref. is automatically connected to the speed reference. Step automatically becomes a step into the twin drive controller.

Example:If the delay angle is to be controlled without deblocking the trigger pulses to the thyristors, the TESTMODE parameter is set to 0. The convertor is then started and a release order to the control system is given via a start order. The delay angle can now be controlled with the TESTREF signal, and the positions of the trigger pulses can be checked with an oscilloscope.

Equipment required - instruments etc

Multimeter 0-1000 V AC and DC, and 10 A DC and AC.

Printer ABLE 24 including cable. Cat. no. YT 290 000-A
Accessories:
Ink ribbon, cat. no. 5697 799-3
Paper roll, cat. no. 5697 799-4.

Linear potentiometer, 10 kohm, 0.5 W, for setting the reference value and simulating signals.
ABB article number 5248 2051-10, for example.

A digital memory oscilloscope, triggerable from the mains frequency.
Insulating transformer for oscilloscope.

Insulation tester (≥1000 V), eg Megger.

A VT-100 compatible terminal, eg Microscribe.

Multi channel chart Recorder with at least four channels.

Personal Computer equipped with software for loading and dumping parameters. The requirement is: use the modem YPK111.
Cat. no. YT 204 001 – HH

The following documents are also required:

Circuit diagram (CD)
DSRBXXXX user's manual
CL12XXXX user's manual
FEDCXXXX / FEACXXXX user's manual
Test record for the motor.
Description of switch gears and breakers for the main circuit

Safety measures

Personal protection

To prevent accidents, observe the following rules:

Never work alone on commissioning.

Make sure that you and anyone else involved know how to switch off the power to the installation.

Appoint an authorised person to operate the high-voltage circuit-breaker. Only that person should operate the circuit-breaker.

Inform people working close to the motor that it may start without warning. If possible, screen off the motor.

As far as possible, work on the convertor should be done with the power off. The auxiliary power supply should also be off.

If the coupling between the motor and the driven machine is fitted with a provisional mechanical arrangement, such as a locking device, make sure that this device cannot constitute a hazard to the surroundings.

Equipment

To prevent damage to motor, convertor equipment or driven machine, observe the following rules:

If the motor cooling system has not been installed when the field exciter is started, there is a risk of the field winding overheating. In such cases the nominal field current must only be applied for two minutes at a time.

When rotating the motor, make sure that all necessary auxiliary systems are operational, i.e. lubrication etc.

Checking the auxiliary supply circuits (before powering-up)

Action when changing the program and on the first start at the customer's premises

To avoid problems during commissioning, the 1 farad capacitor on processor board YPQ201 must be shorted. This is done at pins X26:1 and X26:2 near the capacitor. This action is essential when the PROM on the memory board has been changed. Because of the high internal resistance of the capacitor, the short-circuit must be left in place for at least one minute.Do not forget to remove the short-circuit.

Checking the Grounding (auxiliary supply circuits)

Where several convertors share a common analog reference system, and where signal zero is used in the transmission of signals between the converter and the reference system, the zero line (0VE) of the auxiliary supply must only be grounded at a single point.

Checking the insulation resistance

Before the auxiliary system is powered up, the insulation resistance to ground must be checked. A 500 V insulation tester should be used.

Checking the installation of a coaxial cable for serial communication

Coaxial cables for serial communication to ABB Master and to another convertor must be checked to make sure that they have been correctly installed. The installation instructions describe how coaxial cables should be connected. Check that the termination sleeve is fitted at the FSK modem where the coaxial cable ends.

Adaptation of board YPQ202 digital speed feedback

The supply for the pulse transmitter can be taken from YPQ202 when it requires 24 V. The supply is brought out to terminals 87 and 88 on terminal block B51.

If the pulse transmitter requires another power supply, it must be taken from a separate power supply unit.

Terminal board YPQ202 must also be jumpered to suit the feedback from the pulse transmitter. Jumper positions are shown in a table in the circuit diagram.

24 V	S10: 3-4. 7-8, 11-12
13 mA	S10: 1-2, 5-6, 9-10.

Maximum pulse frequency from the pulse transmitter must be jumpered on I/O board YPQ202; it is calculated as follows:

$$\text{Maximum pulse frequency} = \frac{Nmax}{60} \times P$$

where

Nmax = the maximum speed at which the motor will be run and P = the number of pulses per revolution from the pulse transmitter.

The number of pulses for the transmitter is stated on its rating plate.The maximum pulse frequency is jumpered as shown on the circuit diagram (CD).

Checking the pulsetransmitter for speed measurement and rotor position

The machine convertor triggerpulse generator requiers a pulse frequency which is proportional to the electrical frequency of the motor voltage. Therefore must the pulses/ revolution be selected, see table below, depending on the number of pole pairs of the main machine.

Machine polepair number	Pulses per revolution
2	512
4	1024
6	1536

The adjustment of the rotor position is checked when it's possible to rotate the main machine.

Checking the main circuits

Checking the grounding system

Under the heading Grounding, the installation instructions describe how the various parts of the convertor should be grounded. It is extremely important for trouble-free operation that grounding is done correctly.

In an installation that includes an ABB Master control system, and this system communicates with the convertor via Master Field Bus, the ground connections of the higher-level control system must be checked relative to the convertor.

The higher-level control system must be grounded upstream relative to the grounding of the convertor, ie the convertor must be grounded closer to the grounding point than the higher-level control system. This is because transients in the supply network may cause high capacitive ground currents, and these ground currents may give rise to "common-mode" interference which may disrupt communication.

Checking the insulation resistance

Before the convertor and motor are powered up, the insulation resistance to ground must be checked. The lineside, machine side and dc-link of the convertor must be checked. If there are circuit-breakers on the AC-side, the insulation must be checked before and after them. A 1000 V insulation tester should be used.

The insulation resistance of the machine must be checked according to the maintenance instruction for the machine.

Before the measurement is carried out, the fuses to the transient protection and the ground fault protection G1:81,82 and 83 in both cubicles must be removed, to avoid incorrect ground fault readings.

Checking the motor

General

When commissioning the motor drive, it is essential to bear in mind that this will be the first time the motor has been started. The maintenance and commissioning instructions for the motor must be observed.

Before the first start

When the motor is run for the first time and the driven machine cannot rotate (or only slowly) in the opposite direction without the risk of damage, the coupling between the motor and the driven machine must be uncoupled, with the separate coupling halves fixed to their respective shafts.

Check that stator circuits, field circuits and pulse transmitter / tachometer are connected. See also note below

For brushless excited machines - check that the field windings are correctly connected. The phase sequence must be correct.

For machines excited via sliprings - check the brush gear and make sure that the brushes are in contact with the sliprings.

If the bearings of the motor require a lubrication pump to be running and certain oil flow and pressure to be present in the lubrication system, operation of the pump must be checked. Pressure and flow detectors can be connected to spare digital inputs. Using the "CONNECT" function, these can then be connected to the fault signal processing system in the drive system control unit, where module FSIGHAXX, signal MOALUBFT or MOBLUBFT are intended for this purpose.

> Note!
> Before the main cables to the motor are mounted is it advisable to check which direction of rotation is required for the driven object.
> The positive direction of rotation of the main motor is determined by the phase order of the main cables to the motor. A certain phase order gives a certain direction of rotation. Contact the motor supplier for information of which direction of rotation corresponds to a positive phase order.

Start-up modules of the drive system

DCBRS	This parameter is set to 1 when there is a DC circuit-breaker in the main circuit. (Set to zero for TYRAK LCI).
EMFNOM	This parameter is set to the value that corresponds to nominal EMF, Um0 at base speed. The nominal EMF derives from the system calculations, performed by SCR, and the value comes the presetted values.
FOLLOW1S	This parameter must be set to 1 in the convertor that is normally to operate as follower in the leader/follower operation.
IANOM	The parameter is set to the value which appears on the motor rating plate as the nominal armature current.
IFNOM	The parameter is set to the value which appears on the motor rating plate as the nominal value of the field current. For machines with slipring excitation the value is given in dc-amps. For machines with brushless excitation the value is given in ac-amps.
NBASE	The parameter is set to the value which appears on the motor rating plate as the base speed of the motor.
NBREDGES	When both channel A and channel B from the pulse transmitter are connected to terminal board YPQ202, this parameter is set to 4. (Channel A X6:1, channel B X6:3)
NBRPPR	This parameter is set to the number of pulses that the pulse transmitter gives per revolution.
NMAX	This parameter is set to the maximum speed of the drive.
ONEFLEX	This parameter is set to 1 if there is only one field exciter.
SEL12PP	This parameter is set to 1 if the convertor configuration is 12-pulse parallel.
SECTYPE	This parameter is used to define which of the convertors in a leader/follower drive is the leader and which is the follower.The values can be set as shown in the table below:

Value	Meaning
0	Leader/follower communication switched off. The parameter must be set to 0 when communication is not used.
1	If the motor drive is normally to serve as a leader drive.
2	If the motor drive is normally to serve as a follower drive.

UANOM	The parameter is set to the value which appears on the motor rating plate as the nominal armature voltage.

The start-up module of the convertor

CONVMODE — Convertor configuration mode select.
CONVMODE = 1: not used
CONVMODE = 2: 6-puse
CONVMODE = 3: 12-pulse series
CONVMODE = 4: bridge sequence control

FREQDEV — This parameter is set to a value expressed in Hz which is the highest permitted level of changes in the period-time measurement. A severely deformed voltage causes disturbances to the period measurement.

FREQNOM — This parameter is set to a value expressed in Hz which corresponds to the nominal frequency.

IVNOM — Set to the that appears on the rating plate of the convertor. It stands for nominal current .

LINEVOLT — This parameter is set to the line no load voltage, phase to phase.

LMAINS — Line short-circuit inductance per phase in uH.

MCURM — This parameter is always set to "1".

UVLEVEL — This parameter is set to a value relative to the nominal supply voltage level, 100 %.

UVNOM — This parameter is set to the value that appears on the rating plate of the convertor. It stands for nominal convertor no load voltage, phase-to-phase.

PHSHIFT — Slave convertors phase displacement relative to master.

The start-up module of the field exciter (with sliprings)

IDMN — This parameter is set to the value that appears on the rating plate of the field exciter convertor. It stands for nominal current.

FREQDEV — This parameter is set to a value expressed in Hz which is the highest permitted level of changes in the period-time measurement. A severely deformed voltage causes disturbances to the period measurement.

FREQNOM — This parameter is set to a value expressed in Hz which corresponds to the nominal frequency.

UVLEVEL — This parameter is set to a value relative to the nominal supply voltage level, 100%.

The start-up module of the field exciter (brushless excitation)

ACEXSEL — Adapt the control system for brushless excitation. Always set to the value 1.

IVNOM — This parameter is set to the value that appears on the rating plate of the field exciter convertor. It stands for nominal current.

FREQDEV — This parameter is set to a value expressed in Hz which is the highest permitted level of changes in the period-time measurement. A severely deformed voltage causes disturbances to the period measurement.

FREQNOM — This parameter is set to a value expressed in Hz which corresponds to the nominal frequency.

UVLEVEL — This parameter is set to a value relative to the nominal supply voltage level, 100%.

UVNOM — This parameter is set to the value that appears on the rating plate of the field exciter convertor. It stands for nominal no load voltage, phase-to-phase.

Control of operating circuits

General

The ON and OFF switches referred to in this document are marked with I and O on the operating panel. References to start and stop switches relate to the switches marked START and STOP.

When the convertor is tripped, a red lamp lights up on the operator panel. Resetting of error conditions is accomplished by pressing the RESET button on the operator panel. Certain self-correcting problems, for example a motor overload, do not require resetting before restarting the convertor.

A red flashing light on the operating panel indicates a warning of a problem which does not immediately lead to the convertor cutting out. In spite of the warning signal the convertor remains operative, that is the signal RDYREF remains ="1". However, after a certain period the warning results in a trip.

Preparation

If the operating circuits are intended to be checked before powering up the thyristor cubicle, a dummy sync. voltage (for the trigger pulse generation) must be switched in. For this purpose a power supply of 3 x 7 V is connected to terminal +Y.2.B20.X12 (CD 49).

Procedure below describes the connection of this dummy sync. voltage.

Under no circumstances should power be applied to the main circuits when the dummy sync. voltage is connected. This means that the high tension circuit breaker must be open, and that precautions must be taken to ensure that no-one closes the circuit breaker by mistake.

Before the dummy sync. voltage has been applied, the provisional connections can be made as follows:

B20.X12:1-4 moved to
B20.X12:5-8

This will allow for a "dummy" sync. voltage to be applied to the line convertor(s) control.

An acknowledgement signal must be received at terminals B51.95 and B51.96(CD 30) in order for the trigger pulses to be deblocked. If the installation does not have a low voltage circuit breaker, and the acknowledgement signal is received from the high tension breaker, provisional connectionss should be made as follows:

B51.97 => B51.95 (ACKMCA)
B51.97 => B51.96 (ACKMCB)

Do not forget to remove all provisional connections when the operating tests are completed.

Checking of auxiliary supply voltage

Use a voltmeter to check that the incoming auxiliary supply voltage is in accordance with the rating, with a tolerance of ±10 %. If the supply voltage is common with the exciter, the phase sequence should be positivee, that is L1, L2 and L3. If the phase sequence is incorrect, this will be indicated by the error signal PHSEQFLT, which will be set equal ="1".

Checking of emergency trip relay and emergency stop relay

In accordance with standards, the convertor is equipped with a mechanical emergency trip relay (B1.21). This relay is controlled by push button and cuts out the equipment upon deactivation. Check that the relay is activated and also check which external switches deactivate the relay (CD 64).

Connection of signals with help of signal exchange function CONNECT

Handling of this function is described in section "Operators panel manegement".

When the equipment is delivered, digital I/O ports are connected in accordance with the standard circuit diagram, unless the order for the convertor states otherwise.

Large motor drive systems may require control of external apparatus from the convertor's control system. Examples of this are the high and low tension circuit breakers. It may also be that there is a requirement to collect data (for example drive status) from apparatus external to the convertor control system, such as mechanical safety relays.

The control system for TYRAK LCI is prepared for communication with external apparatus to a greater extent that is usual for a less standard convertor. The error handling system is prepared with error messages and spare (reserved) entry points to function modules. For example, the sequence control function makes it possible to operate connecting devices in various different ways.

The software contains a source for every signal in the system, that is a function module, where the signal is defined. Normally, this source is another module, but to certain unused entry points there is no source module. Since all signals must be defined, these missing signals must be defined in another way.

When a program is created, the function modules are connected when input and output signals with identical names are linked. Input signals for function modules which are not linked to an output signal of another function module are automatically connected to a CONNECT module. The CONNECT module is a special function module for unconnected signals, and is called:

CONNXXXX in the drive system computer
CONNCSXX in the convertor computers
CONNFEXX in the exciter computers.

When there is a limit to the number of signals which the operator panel can handle, certain signals, which will normally not be used, are defined in CONNECT module but can not be accessed via operator panel. These signals can be connected to I/O by using terminal, and they are marked by parenthesis in PD.

Choice of start sequence

The convertor start sequence may be split or not split. When the start sequence is split, the preparatory service connection is made with the ON signal, whilst the convertor is prepared for reference with a START1 signal.

The convertor start sequence is described in the following table. More detailed information is given in the System description and in descriptions of the function modules.

Start Sequence	SEQMODE	Fan breakers	Field exciter	ac breaker	Prepared for reference
Not split	0	START1	START1	START1	START1
Split	1	ON	START1	START1	START1
Split	2	ON	ON	START1	START1
Split	3	ON	ON	ON	START1

Checking the convertor fans

The fans in the thyristor cubicle are supplied by motor starters in the control cubicle. When the convertor is erected at the installation site, a supply cable must be laid out between the control cubicle and the thyristor cubicle. See Instructions for installation.

In the function module TESTDSXX the parameter TESTMODE is set ="0" via the operating panel. If the motor's field winding cannot be connected to power, the SEQMODE parameter (see the reference above) should be set ="1". Local control is selected by pressing the LOC button on the operating panel, whereupon the associated LED will light up. Press the operating panel ON switch. Check that the convertor fan(s) start and that they rotate in the correct direction. The flow of air should be upwards. Adjustment of thermal protections for the motors and of pressure switches need not be done as it has been done at the factory test.

Checking external fans

Switch on the supply current to the fans and push the ON button (operating panel). Check that external fans rotate in the correct direction. If the motor is fitted with airflow protection, such as pressure switches, this must also be checked. The error handling system includes reserved entry points for airflow protection, which can be connected with the help of the CONNECT function to digital entry points.

Thermal motor protections for external fans should be set for the rated current of different motors. Additionally, a choice should be made between automatic or manual reset of these protections.

Commissioning of the field exciter (DC excitation)

General

Commissioning of the exciter takes place from the exciter operating panel on the exciter cubicle. In order to simplify problem correction and commissioning, the exciter control system is set up so it can also be controlled from its own operating panel. This is the preferred method for manual tuning of the field current.

If the operation of the exciter from the drive system computer is to be checked without operation of the main circuit breakers, the parameter SEQMODE should be changed to ="2". See the section Choice of start sequence.

Checking and adjustment of current measurement

The scaling of the current feedback, IDACT, is normalized so that the exciter's continuous rated DC current is equivalent to 100 % (internal representation $2^{13} = 8192$). When the field current shows 100 % the voltage level of the current feedback should be -5.0 V between YPQ201 X25:1 and X25:2 (CD75.01).

Checking the exciter supply voltage

With the help of a voltmeter please check that the incoming supply voltage agrees with the rated supply, and that it is within a ±10% tolerance. The phase sequence should be positive, that is L1, L2 and L3.

Operation from the exciter operating panel

When the exciter is to be operated from its own panel, the DS communication (communication between the drive system and exciter computers) should be shut off, and local control activated. The DS communication is shut off by setting parameter SCFEASEL/SCFEBSEL ="0" in drive system's function module DSCTRAXX, and parameter FLDEXNR = 0 in field exciter system,s function module FSCTRAXX. After setting this parameter, the control system must be restarted.

Local control is activated by setting the parameter IFTEST ="1" in function module IFREHAXX. The exciter can now be operated from its own operating panel, via the ON and OFF switches and can control the field current reference, IDREF, with help of parameter IFREFCOM. Before the exciter is started, the parameters in its start-up module should be adjusted (see section Adjustment of Start-up Modules). Additionally, since the DS communication is disconnected, the parameter IFNOMSTA in function module FSCRECXX must be set to a value which corresponds to the nominal field current of the motors.

Adjusting the system gain and proportional gain

The field current regulator's gain is the product of the value of the system gain, OMEGA_L and N_OMEGAL, and the value of the parameter IFGAIN. The system model can be adjusted with help of the parameters OMEGA_L and N_OMEGAL. An indication that the parameters are correctly set is that the signal I_CONT is set ="1" when the current is continuous.

The most natural way to determine whether the field current is continuous or not is to connect an oscilloscope to the field current feedback, YPQ201 X25:1 and X25:2. In certain cases it can nonetheless be difficult to determine, even with an oscilloscope connected, whether the field current is continuous or not.

Another method is to observe the exciter's output voltage with an oscilloscope. In this case, connect a measuring probe for high voltage (1 kV) to the exciters DC voltage. In this case the oscilloscope must be supplied via a insulating transformer.

When the field current is continuous, the DC voltage is saw-toothed, where every tooth is a part of the exciter's connection voltage. When the current is discontinuous, the appearance of the DC wave changes in such a way that the saw tooths changes somewhat from the form it had when the current was continuous. See figure 1 below.

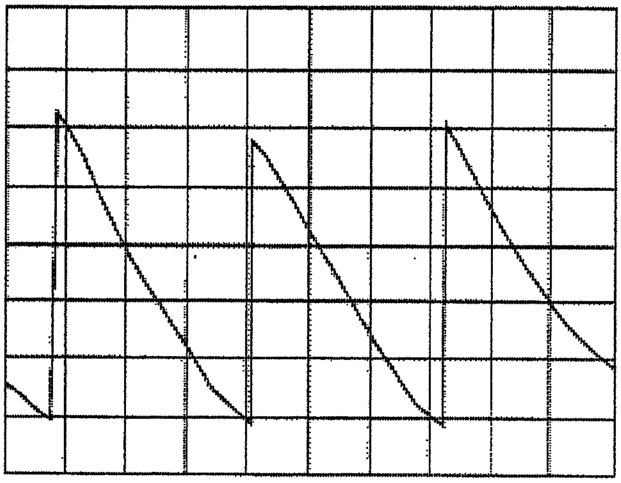


Figure 1. The shape of DC-voltage when current is discontinuous.

In both cases, when the changing-over current for continuous / discontinuous operation, Id0, is measurable, method 1 below should be used. If it proves impossible to determine by measurement whether the current is continuous or not, method 2 should be used.

Adjustment is as follows:

Method 1

Connect signal I_CONT by means of the CONNECT function to an indicator on the operating panel, for example DOOP.1.

Setting of system gain

The system gain should be set to a preliminary value. N_OMEGAL is set to the value =1 and OMEGA_L to the value 6900. Set IFGAIN =0.4. Start the exciter and adjust the field current reference using the parameter IFREFCOM until the current just becomes continuous. Increase the value of the parameter N_OMEGAL in steps of one unit until the signal I_CONT just changes and becomes ="1" (continuous current). Thereafter the value of parameter OMEGA_L should be reduced until the signal I_CONT just changes to ="0". At this point the system gain is correctly adjusted.

Tuning of proportional gain, IFGAIN

Tuning of current control should be performed with the largest possible field, that is with a field current where the inductance is at its lowest. Generate a step disturbance in the current reference with help of the signal IDSTEP in the STEPTEST function. The step disturbance is not allowed to be so large that it causes the delay angle to reach a limiting value, ALPHAMIN or ALPHAMAX. This is controlled by comparing the smallest / largest value of the signal ALPHA in the operating panel REGISTR image with the limiting values. IFGAIN is increased until a rise time of less than 20 ms is obtained or until a ringing starts on the current feedback.See picture, figure 2, below.

Method 2

In this case another adjustment method is used, where the parameters for system gain are set by fine tuning of the regulatory current ratio. This method lacks the precision in setting the system gain, but in most instances the lack of precision is not significant.

Set the parameter IFGAIN =0.5. Generate a step disturbance in the current reference with help of the signal IDSTEP in the STEPTEST function. The step disturbance does not need to be so large that it causes the delay angle to reach a limiting value, ALPHAMIN or ALPHAMAX. This is controlled by comparing the smallest / largest value of the signal ALPHA in the operating panel REGISTR image with the limiting values. IFGAIN is increased until a rise time of less than 20 ms is obtained or until a ringing starts on the current feedback. N_OMEGAL should be seen as the coarse adjustment parameter, and OMEGA_L should not be set higher than 8000. See picture, figure 2, below.

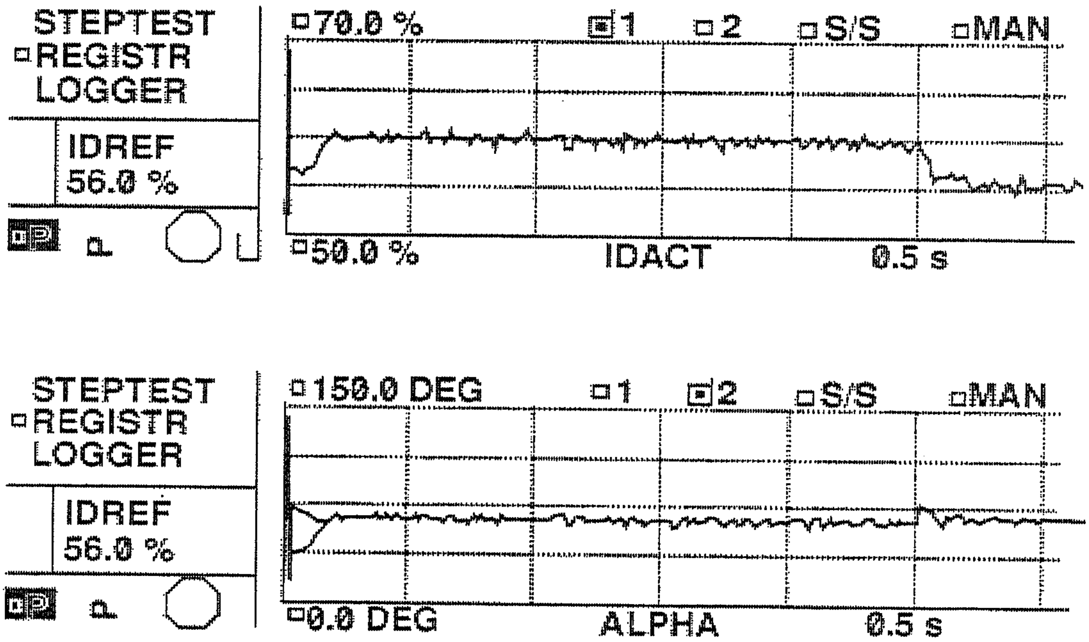


Figure 2. Field current control.

Tuning of integration time, IFCON_TI

Tuning of the integration time should be done with the lowest possible field current, that is when the inductance is as high as possible.

Set IFCON_TI to 200 ms. Start the exciter and generate a step disturbance. Check in the same manner as for fine tuning of proportional gain that the delay angle does not reach a limiting value. Nonetheless, the step disturbance should be as great as possible.

Reduce IFCON_TI until an overshoot in the step feedback becomes noticeable or until an overshoot which was present increases. Then increase IFCON_TI until the change in the overshoot disappears.

Check the step feedback for overshoot with large step disturbances and adjust IFCON_TI if necessary.

Commissioning of the field exciter (AC excitation)

General

For brushless excited machines, the exciter will have a variable, 3-phase AC output instead of DC. This AC-current is then supplied to the stator of an exciter machine. The rotor of the exciter machine is mounted on the main rotor shaft and is connected to the main machine field winding via a diode rectifier.

The field excitation current control consists of an underlying current control of the exciter machine stator current and a main machine field current control. This control consists of a feed forward control via a exciter machine model and a feed back control. The exciter machine model transforms the exciter stator current reference from the rotor system over to the stator system. The feedback control of the field DC current is working in parallel with the feedforward control via the machine model. Since the current feedback for this control is not direct measurable, is it reconstructed from the power consumption of the exiter machine. The output signal from the field current controller is then correcting the gain in the feedforward path.

The commission of the exciter system must be divided into two parts.
The first part is to commissioning the current control of the exciter machine stator current. This is done with the motor at stand still and can be done prior to the commissioning of the armature circuits, main machine stator. Be aware of that high voltages can be induced on the main motor stator winding when the exciter stator current is changed rapidly.
The second part is to commissioning the main rotor field current control. To accomplish this second part it is necessary to rotate the machine at base speed. This normally means that this part has to wait until it's possible to run the main machine speed controlled.

Commissioning of the exciter shall take place from the exciter operating panel. In order to simplify problem correction and commissioning, the exciter control system is set up so that it can also be controlled from its own operating panel.

First part commissioning.

Checking and adjustment of current measurement

Normally not needed since it's done in factory test.
The scaling of the current feedback, IDACT, is normalized so that the exciter's continuous rated AC current is equivalent to 100 % (internal representation 2^{13}). When the field current shows 100 % the voltage level of the current feedback should be -5.0 V between YPQ201 X25:1 and X25:2.

Checking and adjustment of power measurement

Normally not needed since it's done in factory test.
The excitation power is used to reconstruct the main rotor field current.
The scaling of the power measurement, PSTACT, is normalized so that the exciter's continuous rated AC apperant power, sqrt(3) * UVNOM * IVNOM, is equivalent to 100 % (internal representation 2^{14}).

Checking and adjustment of US(voltage) measurement

Normally not needed since it's done in factory test.
The phase to phase voltage is used to reconstruct the main rotor field current. The scaling of the voltage measurement, USACT, is normalized so that exciter nominal no load voltage UVNOM is equivalent to 100.0% (internal reperesentation 8192).

Checking the exciter supply voltage

With the help of a voltmeter please check that the incoming supply voltage agrees with the rated supply, and that it is within a ±10% tolerance. The phase sequence should be positive, that is L1, L2 and L3.

Operation from the exciter operating panel

When the exciter is to be operated from its own operator panel, the DS communication (communication between the drive system and exciter computers) should be shut off, and local control activated. The DS communication is shut off by setting parameter SCFEASEL/SCFEBSEL ="0" in function module DSCTRAXX in drive system's computer control and parameter FLDEXNR = 0 in function module FSCRECXX in exciter system's computer control. After setting this parameter, the control system must be restarted.

Local control is activated by setting the parameter IFTEST ="1" in function module IFREH4XX. The exciter can now be operated from its own operating panel, via the ON and OFF switches and can control the field current reference, IDREF, with help of parameter IFREFCOM. Before the exciter is started, the parameters in its start-up module should be adjusted (see section Adjustment of Start-up Modules). Additionally, since the DS communication is disconnected, the parameter IFNOMSTA in function module FSCRECXX must be set to a value which corresponds to the nominal field current of the motors.

Current control of exciter machine

The same current controller is used as for DC field excitation. Some of the parameters are not relevant for this application but they are not disturbing the operation.
This is the case with the system model mentioned below.

The field current regulator's gain is the product of the value of the system gain, OMEGA_L and N_OMEGAL, and the value of the parameter IFGAIN. The system model can be adjusted with help of the parameters OMEGA_L and N_OMEGAL. An indication that the parameters are correctly set is that the signal I_CONT is set ="1" when the current feedback is continuous.

The most natural way to determine whether the exciter current feedback is continuous or not is to connect an oscilloscope to the field current feedback, YPQ201 X25:1 and X25:2.

Setting of system gain

Connect signal I_CONT by means of the CONNECT function to an indicator on the operating panel, for example DOOP.1.

The system gain should be set to a preliminary value. N_OMEGAL is set to the value =1 and OMEGA_L to the value 6900. Set IFGAIN =0.1. Start the exciter and adjust the current reference using the parameter IFREFCOM until the current feedback just becomes continuous. Increase the value of the parameter N_OMEGAL in steps of one unit until the signal I_CONT just changes and becomes ="1" (continuous current feedback). Thereafter the value of parameter OMEGA_L should be reduced until the signal I_CONT just changes to ="0". At this point the system gain is correctly adjusted.

Tuning of proportional gain, IFGAIN

The tuning of the current controller can be done at any current level since the exciter machine is not affected by saturation.

Generate a step disturbance in the current reference with help of the signal IDSTEP in the STEPTEST function. The step disturbance is not allowed to be so large that it causes the delay angle to reach a limiting value, ALPHAMIN or ALPHAMAX. This is controlled by comparing the smallest / largest value of the signal ALPHA in the operating panel REGISTR image with the limiting values. IFGAIN is increased until a rise time of less than 20 -30 ms is obtained or until a ringing starts on the current feedback.

Note! Oscillations of the current can arise when the machine is rotating at certain speeds. This is caused by a varying inductance of the exciter machinee, It is important that this is checked, when it's possible to run drive, by ramping the motorspeed up and down, zero to base speed.

Tuning of integration time, IFCON_TI

Set IFCON_TI to 200 ms. Start the exciter and generate a step disturbance. Check in the same manner as for fine tuning of proportional gain that the delay angle does not reach a limiting value. Nonetheless, the step disturbance should be as great as possible.

Reduce IFCON_TI until an overshoot in the step feedback becomes noticeable or until an overshoot which was present increases. Then increase IFCON_TI until the change in the overshoot disappears.

Check the step feedback for overshoot with large step disturbances and adjust IFCON_TI if necessary.

Second part commissioning (rotating machine).

General

To be able to commissioning the excitaion control correctly it's necessary to know some data regarding the excitor machine. From this data parameter settings are calculated for a machine model. This model adjust automaticly the excitor stator current reference to a changed speed which affects the slip in the exciter machine. Parameter settings regarding the exiter machine model must be determined by SCR before the starting of the commissioning.

For calibrating the DC-current reconstruction it is needed to know a value of the noload voltage of the machine at base speed and the corresponding values of the exiter current, the main machine field current (DC) and the main machine power factor.

The meassuring of the main machine stator voltage must be checked and calibrated.

Setting and adjustment of the exciter machine model

See PD page 428.01. The settings for this parameters must be delivered from SCR.
The purpose with the exiter machine model is to convert the the main machine field current reference to a reference for the exciter machine stator current. The transformation is speed dependent and the parameter POLENBR must have a setting that agrees with the number of pole pairs of the exciter machine.

Checking procedure

The settings must be checked in order to avoid that the field current controller, PD page 428.03 is reaching its limitations.

An easy way for checking the settings is to run the motor, from 10 % to base speed, at no load and with constant magnetisation of 100 %. This can be achieved by the following temporary settings; IFSET = 0 and IFMIN = 100 %. Record the output from the field current controller (IDREFR) and the voltage feed-back EMFACTMM.
The voltage feed-back should increase proportional to the speed and the controller output should remain approximate constant. The important thing with the controller output is that it isn't reaching its limitations. There must also be a margin of at least 50 % to the levels of limitation.

If the deviation of the controller output is too big and independent of the speed, the deviation can be decreased by changing the setting of KT. If the deviation is too big and dependent of the speed, the setting of XM must be altered.

Calibration of main field current measurement

Static performance

Set CONBETA for the machine convertor control to a rather big value, e.g. 45 degrees.

Check that FEEDF is equal to 1 and set IFCTR to 0.

Start the drive and adjust the exciter machine's stator current to 90 % of the required no load value at base speed.

Increase the speed of the drive to base speed (NPROP of the speed controller must be 0) and let it run there. Read the actual main current referece, IDREF1, and adjust the current limit IALIMMAX to a value slightly bigger than this value.

Lower the setting of CONBETA so that no load power factor is equal to the cosine of CONBETA. If the given power factor is equal to 1.0 the value of

CONBETA is decreased to 15 degrees, not lower. It is here asumed that the machine convertor firing angle is calibrated with the parameter UMONOMP.

Increase the excitation current until the no load voltage agrees to the given value at base speed.

Do the following settings in the function module IFRECXX:

Adjust RFIELD0 to the given value, expressed in mOhms.

Adjust the parameter EFFC until the reading of IFAMP agrees to the given main rotor DC current at no load and base speed.

This reconstruction must be checked at different motorspeeds later on when the DC field current control is activated. The controller output signal, IDREFR, must then be within the controller limitations.

Dynamic performance

Connect the hardware signal MACHEMF and the signal ILW to a chart recorder.

Let the motor run at base speed.

Set STEPTIME, PD page 428, to approx. 30 seconds. Adjust IDSTEP2 so IDREF1 changes 50 % of its nominal no load value.

Examine the recordigs of MACHEMF and ILW. Adjust the parameter TAUF until the shape of ILW agrees with MACHEMF.

Connect IFACTR instead of ILW to the recorder and adjust DWKORR until the shape of IFACTR agrees with the shape of MACHEMF, more or less.

Field current control

Connect IFACTR, IDACT and the correction signal IFCORR to a chart recorder. IDACT can be meassured direct as a hardware signal, YPQ201 X25:1 and X25:2. The other two signals are connected to analog output, AO37.

Let the motor be running at base speed, still at no load. Check that IFCGADAP is set to 0, IFCTIME to 5000 ms and IFCGAIN to 0.05. Set the parameter IFCTR equal to 1.

Generate stepchanges in the current reference IDREF1 via IDSTEP2, page 428. Set parameter STEPTIME to a rather large time, for example 30 sec.

Final check of field current control

Check that the regulator output signal, IDREFR, is not reaching the limitation values, IFCLIMP and IFCLIMN, when the speed is ramped from zero to base speed.
Record the stepfeedback withe the regulator settings above, final settings.

Operation of main circuit connecting devices

General

AC circuit breaker

The control system of the TYRAK LCI is designed to operate the AC circuit breaker either on the low tension side or the high tension side.

If the AC circuit breaker is on the high tension side, there are two ways to operate it.

The usual method, which is the recommended one, is that closing of the high tension circuit breaker is not controlled by the TYRAK LCI, but by separate operation. Opening of the circuit breaker should, in this case, be ordered from the TYRAK LCI control system. For this purpose, special digital outputs are reserved, AC BREAKER OFF_N (MSOFF_N) in the convertor control unit and a.c breaker A/B TRIP_N(ACBRATRP/ACBRBTRP) in the drive control unit. The drive system control unit is prepared with two digital outputs. One for breaker A (B51:60,61) and one for breaker B (B51:62,63). The reason is that the drive can contain two h.t. breakers. The convertor control unit has one digital output, B51:114,115 from the control unit for convertor A.

The digital output for breaker A from the drive system control unit is connected in series with the digital output from the control unit in convertor A and on to the trip-coil for breaker A.

The other method of operation of high tension circuit breakers, which is not recommended (too high switching frequency) is to operate it as a low tension breaker, as described below.

If the AC circuit breaker is a low tension breaker, it is dimensioned for a high switching frequency. In this case, both the opening and closing of the breaker is controlled from the TYRAK LCI. For this purpose two special digital outputs are reserved on the drive system control unit. These are MCONTA ON (the signal MCONTAON), and MCONTB ON (the signal MCONTBON), in the function module ORDERHXX is controlled by the signal MCONTON. The two signals MCONTAON and MCONTBON are controlling two auxiliary contactors +Y.2.B2:6 and 7 (CD 30)

For every low tension breaker A and B which shall be operated, a potential free contact from each contactor shall be connected in series to the respective digital output AC BREAKER OFF (the signal MSOFF_N) from the convertor control unit.

The MCONTON signals are also available as pulse signals, one for closing (MCONTONP) and one for opening (MCONTOFP). These can, if necessary, be switched out, with help of the CONNECT function, to spare digital outputs.

There are two digital inputs reserved in the drive system control unit for acknowledgement signals from the AC circuit breakers. These are ACK MCONTA B51:95 for breaker A and ACK MCONTB B51:96 for breaker B (CD 30).

Another way to operate the high tension breaker is to order closing via the MCONTAON/MCONTBON-signals, and to order to trip via the ACBREAKER OFF_N(signal MSOFF_N),AC BREAKER A/B TRIP_N(signals ACBRATRP/ACBRBTRP).

Checking the low tension circuit breaker operations

If the convertor transformer has not been powered up special preparations will be necessary. See the section Preparations under Checking the operating circuits.

When the parameter TESTMODE ="0", the control pulses are blocked in the control pulse amplifier, and the exciter does not start. It is therefore desireable to exploit this solely when the breakers operation is to be checked. The parameter SEQMODE should be given the value =3. Check that local operation is selected, ie the corresponding LED is lit.

Press the ON switch on the operating panel. Check that the low tension circuit breaker operates correctly, and that the acknowledgement signal is received. In certain cases if may be necessary to take a check measurement of the resistance at the breaking point in order to verify the function.

If the low tension circuit breaker includes a function for trip in conditions of undervoltage, this must be removed. Undervoltage trip will be determined by the TYRAK LCI control system.

If the low tension breaker includes a function for overcurrent trip, the trip level must be adjusted for selectivity. See the section Adjustment of protection for high tension supply.

Checking the trip order to high tension circuit breakers

If low tension circuit breakers are not included in the installation, the high tension breakers will, in accordance with the section General, above, trip with help of the signal MSOFF_N. This signal is generated in the control units of both the drive system and the convertor. A check must be made before powering up, that this signal really activates the breaker. Tripping should be activated if any of the conrol units deenergize their outputs.

Checking the high tension CB reaction time

Later on in the commissioning process, when the current control of the main circuit is ready, must the reaction time be checked. A short reaction time is essential, especially for fuseless LCI-drives, and must not exceed 0.1 second.

Connect the rectified main voltage (Udi0) at terminal X1:5 on the terminal board YPG109, CD page 45, and the current feedback signal to a chart recorder. The strapping S3:1-2 must be installed in order to measure the main voltage.

Start the convertor with TESTMODE = 3 and increase the current IDACT to approx. 10 %. Lower the overcurrent setting to zero and measure the time elapsed from the instant of a low current feedback to the instant of a low main voltage.

High tension supply

Adjustment of protection

When the high tension circuit breakers are taken into operation, the commissioning instructions for them must be carefully observed.

Set the trip level for overcurrent at the desired level.

Checking of trip signal from high tension circuit breakers

In order to allow the TYRAK LCI control system to down control the motor current before the high tension circuit breaker opens, information from the breaker relay must be switched to a special digital input on the control unit of the convertor.

The information that the breaker is about to open should ideally be received by the convertor control unit(s) 70-100 ms before it actually does open. For this purpose there is a reserved digital input,
AC BREAKER TRIP (B51:111) in the control unit for the convertor.

The interval between the signal from the breaker being set ="1" and the breaker opening should be verified by measurement. This is most easily done by the use of a recorder. The signal from the breaker is connected to one channel. The other channel is connected to I/O port YPG109 X1:5, where the rectified reference voltage is accessible if a clamp is mounted on pin S3:1-2.

After power up of main circuits

Checking of phase sequence

In high-power applications it is essential that the convertor's connection voltage is positive, ie that L1, L2, L3 permits only a positive phase sequence.

The phase sequence is checked with help of signal PHSEQFLT in function module FIACS from the operating panel. If this signal is ="1", the phase sequence is not positive (L1, L2, L3), which is wrong.

Check - for 12-pulse serial convertors only

General

A 12-pulse convertor consists of two 6-pulse convertors connected in series. There is only one convertor control unit, controlling both of the 6-pulse convertors. The 6-pulse convertor receiving it's pulses from board YPQ203 is called the slave convertor..

Checking of the slave convertor's phase sequence.

There is, in contrast to the master convertor, no measuring of the mains supply voltage in the slave computer. Manual checking of phase sequence must be done. A three phase voltage, 3x110 V, with the same phase order as the main voltage of the convertor can be available at the secondary terminals of transformer .+Y.4.B8.1. Use a line triggered oscilloscope to measure the phase sequence.

NOTE!	Slave convertor must have the same phase sequence as the master convertor!

Checking of the slave convertor's phase displacement relative to the master.

The parameter PHSHIFT in the convertor's startup-module determines the phase shift of the thyristor firing pulses to the master and the slave convertor and must be correctly adjusted. It is important that this phase check is done due and concious. An inncorrect value of PHSHIFT may, in the worst case, cause a huge overcurrent which will trip the breakers.

The particular phase shift must be known and always be measured at commissioning, because there is no monitoring of the mains supply voltage in the slave convertor control system. If, f.ex. PHSHIFT = 150 DEG, while the real phase displacement is -30°, consequences might be fatal!

To achieve correct firing instants, the parameter PHSHIFT in the startup module of the master convertor control system must be set in accordance with the relative phase angle between the main voltages of the master and the slave convertor. Generally there are 6 possible phase shifts, dependant on different transformer connections. Thus, the program accepts one of the following 6 angles that may enable 12-pulse operation. Other values cause trip of convertor. Possible phase shifts are:

The phase shift of the slave relative to the master.

-150°	30°
-90°	90°
-30°	150°

Negative values means lagging of the firing pulses to the slave convertor of the master convertor.

Practical accomplishment:

Set the parameter TESTMODE =0. That means that all firing pulses are blocked. It's useful to use a line triggered oscilloscope when measuring the incoming 110 V as follows:

Master: L1,L2 and L3 at +Y.3.B8.1. Slave: L1,L2 and L3 at +Y.4.B8.1 (CD 80, 90).

Measure f.ex. the phase angle between the RS-voltage in the master and in the slave.

NOTE!	If the slave lags the master, PHSHIFT must be positive! Select PHSHIFT and make a new init, (operating voltage off and on). If the phase angle does not equal one of the values given, 12-pulse drive can never be achieved. The transformer(s) must be incorrect, and extensive changes are needed.

Checking the voltage level

After powering up the convertor's main circuits, the connection voltage level must be checked. This is best achieved by measuring the main voltage on the primary side of the transformer +Y.3.B8.1 in the thyristor cubicle. See the circuit diagram (CD), pages 81 and 91.

NOTE!	It is important thet the voltmeter is connected to the main circuits by fuses. Before the voltmeter is connected, a check must be made that the voltmeter is correctly rated for the voltage class to which it is intended to be used.

If the phase-to-phase voltage is too high for the voltmeter there is phase-to-zero voltage to be used for measuring. In the ground fault protection device +B30, page 80 in the circuit diagram (CD), there is a zero point available via terminal X1:4.

The connection voltage without load should be in agreement with rating (Uv0 on the convertor's rating plate), with a tolerance of ±10 %. Consideration should be given to possible fluctuations in the high tension supply, by consulting someone with experience of the local situation, before the actual voltage level is considered satisfactory. If necessary the transformer ratio must be changed at the incoming transformer. Lower nominal level of the connection voltage is handled by the LINEVOLT parameter, see below.

Checking of supply voltage measurement

In the TYRAK LCI control system the convertor's connection voltage is measured via a rectified reference voltage, UDI0. In connection with powering up, this measurement should be checked. If the connection voltage is measured in accordance with the foregoing section, the voltmeter's reading should be in agreement with the value shown on the operating panel of the signal UVVOLT in function module IUMEASXX. Signal UDI0 is normalized so that the convertor's ideal DC no-load voltage, Udi0, corresponds to 100 % (internal representation 2^{13}).

If parameter LINEVOLT in the convertor's start-up module,STRTCLXX, agrees with the voltmeter, if parameter UVNOM agrees with the rating plate, but signal UVVOLT does not agree with the value shown on the voltmeter, the scale value must be changed.

If a new scale value shall affect the voltage measurement the control system must be restarted. Restart is effected by switching the supply voltage off and on.

Adjustment and checking of undervoltage protection

The level of undervoltage protection is set with the parameter UVLEVEL in function module STRTCLXX. In the TYRAK LCI there are two undervoltage protections, a fast hardware-based protection (MSUV) and a somewhat slower, software-based protection (LOWMAIN). The level for the latter protection can be differentiated from the former with the parameter LOWMAINL in function module IREGSXX.

At no load

Adjustment of the hardware-based protection should be checked and calibrated with the help of a test. This test is performed by increasing the value of UVLEVEL successively from a low level until indication of undervoltage is received. If the actual value of UVVOLT is measured, and set, in relation to parameter UVNOM, the actual trip level is obtained from the following:

$$\text{Real setting} = \text{UVLEVEL} \frac{\text{UVVOLT}}{\text{LINEVOLT}}$$

UVLEVEL should be set so that actual trip occurs at 80 %. This adjustment must be checked under load (see below).

Parameter UVLEVEL is setting the fast acting hardware-based part of the undervoltage protection.

The parameter LOWMAINL should be set so that indication of undervoltage occurs at 85 % of nominal connection voltage.

Under load

When power is applied to the convertor, a check should be made that undervoltage trip is not achieved. Therefore generate a large current step, less than 5 seconds in duration, from zero to a current corresponding to the maximum current limit. Give the motor time to cool down between current steps. Check that the convertor does not trip and then reduce the value of parameter UVLEVEL successively, until indication of undervoltage is received. Set the parameter to 85 % of the level at which undervoltage was indicated, if that level is lower than the level which was set at no load.

If necessary parameter LOWMAINL must be adjusted so that indication of undervoltage is achieved at 85% of nominal connection voltage.

Check of controllability

If the previous check of the main power phase sequence is OK, a verification must be done that the firing pulses give correct voltage. Select TESTMODE = 1, so the delay angle can be varied from TESTREF. Block the trigger pulses to machine converter by setting parameter BLKPLS to "1". Prior to the test, adjust TESTREF to 0 and set the overcurrent-protections OCURFL to very low level.
Push the ON-button. Then if the behaviour is normal, release the control by a START-order. Increase the reference very slowly when reading the signal ALPHA in the OP-panel INDIC display. With an incorrect PHSHIFT (twelve pulse series convertor only) the convertors DC voltage will be distorted. Check the measured DC-link voltage with an oscilloscope. The DC voltage is measurable at X1:1-2 on the terminal board YPG109, CD page 45. The number of pulses of the sawtooth shaped voltage per, periodtime of mains, must agree with the pulsenumber of the convertor, except for 12-pulse parallel. Change PHSHIFT if necessary and repeat the test.

NOTE!	**The direct control of delay angle will be very sensitive with respect to unrush current in the DC-link. No current control is active at TESTMODE = 1. TESTREF must be operated with great care**

Un-Block the trigger pulses to machine converter and repeat the test with current, remember to start testref from 0 and increase slowly. Current will be continuous at delay angles as follows:

PHSHIFT is correct:	Continuous current at a = 90°
PHSHIFT is 60° too low	Continuous current at a = 60°
PHSHIFT is 120° too low	Continuous current at a = 30°
PHSHIFT is 60° too high	Continuous current at a = 120°
PHSHIFT is 120° too high:	Continuous current at a = 150°.

PHSHIFT is 180° too high: WORST CASE. WILL CAUSE HIGH OVERCURRENT EVEN AT START. (According to a delay angle of 60°).

If phase position is incorrect, change PHSHIFT and repeat the test!

Checking and calibration of delay angle

General

In the FACSSXX module of TYRAK LCI's software based control pulse device, the parameter TLAG is used to calibrate the internal delay angle against the actual physical delay angle. The internal delay angle, signal ALPHA_M/ALPHA_S, can be measured on the operating panel in the function module IREGSXX.

Calibration of control pulses and tuning of parameter TLAG is conducted as part of the factory testing, and the results are documented in the test report. If, however, there is reason to suspect that the calibration is faulty, it must be checked.

A quick method of checking this is to set TESTMODE =1 and set delay angle ALPHA_M to 90.0°, with the help of TESTREF. At that setting of the delay angle the direct current through the convertor should just be continuous. If this is not the case, the delay angle must be recalibrated.

Calibration

Connect an oscilloscope to the current feedback and start the convertor. Release control and increase TESTREF until the delay angle is 90.0° or until the current is continuous, whichever occurs first. If the current becomes continuous before the delay angle reaches 90.0° TLAG must be adjusted until the current becomes definitely discontinuous. The delay angle can then be increased until it reaches 90.0°.

By holding the value of the delay angle ALPHA_M constant and simultaneously carefully increasing or decreasing the parameter TLAG, the current can be changed so that it just becomes continuous. The change to TLAG should not exceed ±200 units.

Current control

General

The current through the main machine stator windings is the same as the current in the DC-link, except during some rare fault conditions. By controlling the amplitude of the DC-link current is therfore the amplitude of the main machine stator current, the armature current, is controlled.
For tuning the DC-link current control during standstill, the normal current circuit through invertor thyristors and motor windings can be used. Selecting testmode 3, no field current will be applied to the machine. Using this method one must keep in mind that the machine can still start turning when current is applied, also the heating resulting from the current must be regarded.

As an alternative, the DC-link can be short circuited on the machine side of the DC-link reactor. This will give a closed current circuit with the reactor as a load. Note that the short circuit must be able to withstand the current. Busbars or heavy cables must be used.

As an alternative, a closed current circuit can be formed the normal way through invertor thyristors and motor windings. Using this alternative one must keep in mind the heating resulting from the DC-current.

A precondition for tuning of the current control is that the current measurement has been calibrated and tuned. This is normally done at the factory test. If the current feedback requires recalibrating, see the section Other convertor functions.

Current control includes functions for automatic tuning of the system gain in the armature circuit. The system gain is an important information for the control system, and is used by several control functions.

In order that automatic tuning of the system gain will work, the average value of the current ripples (current bubbles) must be greater than a certain value. This average value falls where the level for the limit current, discontinuous / continuous operation, is greater than 7 – 8 % of the convertor's rated current.

The current control includes in addition a convertor model of which the value of the system gain is a part. The model is adjusted with the system gain, that is with the parameters OMEGA_L and N_OMEGAL. An indication that the parameters are correctly set is that the signal I_CONT becomes ="1" when the current is continuous.

System gain = (OMEGA_L) x $2^{\text{(N\_OMEGAL)}}$
N_OMEGAL = COARSE TUNING
OMEGA_L = FINE TUNING

The current control's performance is adjusted with the parameters IAGAIN and IACON_TI under continuous current,
and IADIS_TI under discontinuous current.

The preset values of IAGAIN =0.30, IACON_TI =25 ms and IADIS_TI =20 ms for the regulator's tuning parameters will provide a suitably fast current control for most applications, when the system gain has been tuned. The step feedback should none-the-less be documented in the usual way. If a different level of performance is required, the control should be tuned as described below.

Step generator for tuning of current control

In the function module IREFHLXX in the convertor's control system is a step generator which can be activated by setting the parameter IDTEST = "1". With the parameter STEPTIME the period of the generator's output signal can be set (period = STEPTIME x 3.3 ms (50 Hz) or STEPTIME x 2.7 ms (60 Hz)). The base reference is normally set via the reference TESTREF, but can also be set with a parameter represented by IDREFCOM.

Automatic tuning of system gain – TESTMODE = 2

The automatic tuning function will need a certain amount of current ripple in the DC-link to find the correct system parameters. For most TYRAK-LCI applications, the selected DC-reactor will reduce this current ripple to very small amplitudes, especially 12-pulse series convertors. The special function for automatic tuning is therefore not recommended to use for any TYRAK-LCI application, manual setting with testmode = 3 must be used.

Manual setting of the amplification, TESTMODE = 3

Connect signal I_CONT with the help of the CONNECT function to an LED-indicator on the convertor's operating panel, for example to DOOP.1.

Connect an oscilloscope to the current feedback.

Give the system gain a preliminary value. N_OMEGAL should be set to the value "1" and OMEGA_L to 6900.

Start the convertor and adjust the current reference with help of parameter TESTREF until the current is just continuous on,
see figure 3 below.

Increase the value of parameter N_OMEGAL in steps of one unit until the signal I_CONT just changes to "1" (continuous current).

Then reduce the value of parameter OMEGA_L until signal I_CONT just becomes ="0" (OMEGA_L must be less than the value of parameter LOWMAINL x 8192).

The system gain is then tuned.

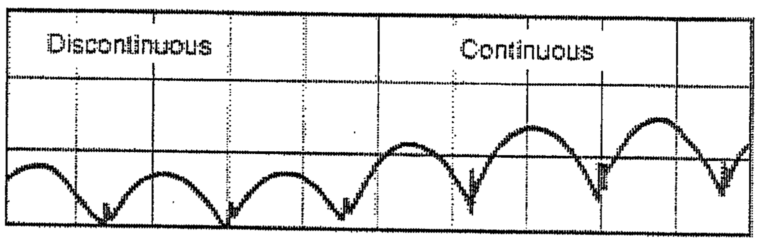


Figure 3. Discontinuous and continuous current.

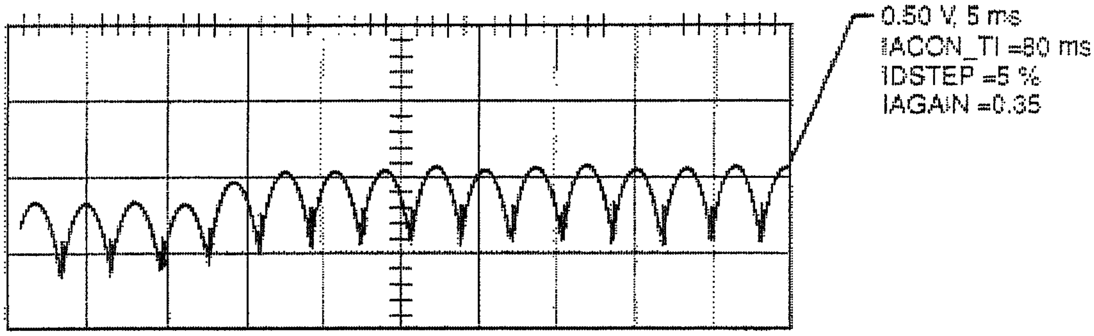


Figure 4. Step response, continuous current.

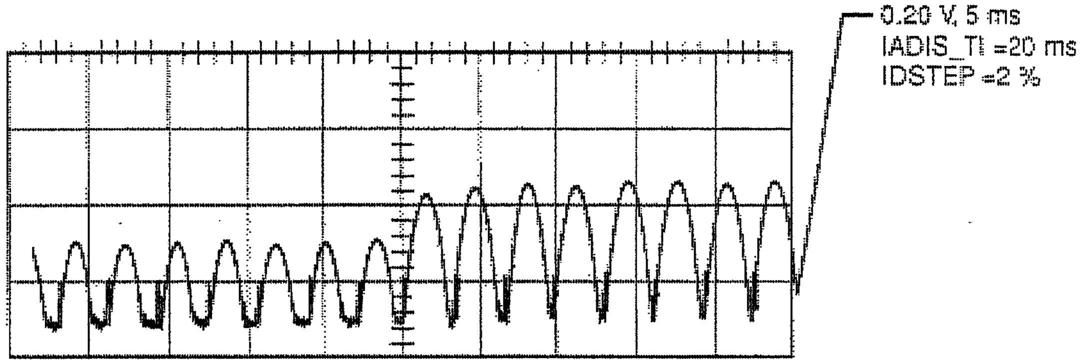


Figure 5. Step response, discontinuous current.

Figure 5. Step feedback, discontinuous current.

Tuning of control at continuous current, TESTMODE = 3

Preliminary adjustments

Set IACON_TI to a value of 100 ms.

Fine tuning of P-part, IAGAIN

Start the convertor and release the current regulator with a START order. Increase the current reference until the current is continuous. Generate step disturbances either with IDSTEP or with the STEP function in the drive system. Adjust the current's step feedback with IAGAIN in order to obtain the required rapidity. The current regulation should be trimmed for rapidity so that the first current bubble reaches approximately 70 % of the final value. See figure 4 above.

Fine tuning of I-part, IACON_TI

Reduce IACON_TI until an overshoot in the step feedback becomes noticeable, or until the overshoot which was present increases. IACON_TI should then be increased until the change in the overshoot disappears. Check the step feedback with large step disturbances to see if overshoots appear. If so, increase the value of IACON_TI.

Tuning of control at discontinuous current

Tuning of regulator parameter IADIS_TI is not necessary to ensure a rapid control. The main determinant of the rapidity of current regulation is the feed forward technique used in the regulator under discontinuous current operation. Step feedback should be documented and should have a shape as in figure 5 above.

Other convertor functions

Checking and tuning of current response

The current is measured in two different ways in TYRAK LCI. First line side measurement, which is the main source in current control, and second machine side current measurement which is used for the machine convertor current control , and for the current unbalance protection.

Line-side current measurement

Tuning of the current measurement, ID1SCAL, is preformed as part of the factory testing, and is documented in the test report.

The calibration of the current feedback is normalized so that the convertor's continuous rated DC current in the forward direction Idmn(f) is equivalent to 100 % (internally represented by 8192).

Calibration of the current feedback is controlled most easily by simulating a current feedback with the help of an adjustable stabilized DC voltage source.

NOTE!	The mains supply must not be connected to the thyristor cubicle bridge during this test.

The connection unit to Y.3.B13 is unplugged and an adjustable DC voltage source is connected via an ammeter to Y.3.B13. See the circuit diagrams (CD), page 81. This simulates current in convertor A.

If a current simulation is also required in convertor B, under 12-pulse parallel and tandem driving, the adjustable DC voltage source is connected in the same way.

The voltage from the adjustable DC voltage source is increased until the ammeter shows 1 A. Then, provided that parameter IDMNF in function module STRTCLXX is properly set, the signal IDAMP in function module

IUMEAS should show a value which agrees with the current on the primary side of the current transformer. The value of the primary current is obtained by multiplying the transformer's output (from the table below) by 1 A.

A measurement error can be corrected by changing the parameter ID1SCAL. In order that a new calibration should affect the current feedback, the control system must be restarted so that the initialization routines are performed.

Machine current measurement

Tuning of the current measurement, ID2SCAL is performed as part of the factory testing, and is documented in the test report. The calibration of the current feedback is normalized so that the convertor's continuous rated d.c. current in the forward direction Idmn(f) is equivalent to 100%. Calibration of the current feedback is controlled most easily by simulating very low current in A. Depend on the size of convertor, the simulated current is as follow:

385 mA	for 1200 A convertor
494 mA	for 1540 A convertor
558 mA	for 1740 A convertor
596 mA	for 1860 A convertor

NOTE! The main supply must not be connected to the thyristor cubicle during this test.

Disconnect B52.X7:7-9 and X8_7-9 and connect the simulated current(mA). Check the signal IDACT2 by terminal (PD324) the value should be about 8192 (100%).

Before doing this test, the parameter MCURM in start-up-module STRTCLXX has to be set to "1" and control system must be restarted.

A measurement error can be corrected by changing the parameter ID2SCAL. In order that a new calibration should affect the current feedbackm the control system must be restarted so that the initialization routines are performed.

Auto correction of IDACT

Line side current measurement is always included and used for current control and for the monitoring functions. For double convertors d.c.-side current measurement is also inluded. This measurement is used for detection of differential current between the d.c. and a.c. side, and to auto-calibrate the current feed-back from the line side current measurement, in order to get the same high precision as the d.c. shunt measuring. The terminal parameter IDGAIN is normally not to be touched but the auto-correction ca be switched off by IDGAIN = 0.

Differential current detection

The current measurement on line side should always be the same as current feedback from d.c. side with respect to differences in the precision. If a significant difference occurs, the trip signal DIFCUR is set to "1". The trip level can be set by parameter DIFCURL in function module IUMEASXX if the preset value is causing nuisance trips.

Checking DC-voltage measurement

Tuning of voltage measurement (UDSCAL) is performed during normal factory testing and the result is documented in the test report.

In connection with the provisional commissioning of the speed control, the DC voltage measurement should be checked.

A voltmeter should be connected between F61,F62 in the convertor's thyristor cubicle(CD 81,91). The voltmeter is connected to the convertor's dc-link via fuses.

NOTE!	It is important that the voltmeter is connected to the main circuits by fuses. Before the voltmeter is connected, a check must be made that it is correctly rated for the voltage class to which it will be connected. Remember that the DC voltage contains a superposed ripple voltage.

Block the trigger pulses to machine convertor(s) by setting parameter: BLKPLS = "1" (function module MCTPUOXX). Make sure that the red LED is "on" on circuit board(s) V2.11 (V20.11) YYX144 (ack "blocked pulses").

Thereafter the convertor can be started with parameter TESTMODE set ="1". Half of the DC voltage measurement in module IUMEASXX via signal UDVOLT should then agree with the value displayed on the voltmeter.

The scale of the voltage measurement is normalized so that the convertor's ideal no load DC voltage, Udi0 represents 100 % (internal representation 8192).

Measuring errors can be corrected by altering the parameter UDSCAL. In order for a new scale value to affect the calibration of the current feedback, the control system must be restarted, so that the initialization routines are performed.

Preliminarilyting of machine convertor control

The LCI sync. filtercard(s) YYI 107 (V2.21 and V16.21) needs to be preliminarily before running of the motor. In 12-pulse connections, two filtercards are used, one for each 3-phase system. There are interconnecting signals between the two cards in these cases. These interconnections must be checked according to the table below:

When running in the direction defined as positive rotation

Reference 3-phase system		3-phase system lagging by 30 deg
YYI 107		YYI 107
Jumper S4 = 1-2		Jumper S4 = 3-4
Terminal X8:4	connected to	Terminal X9:3
Terminal X9:4	connected to	Terminal X10:3
Terminal X10:4	connected to	Terminal X8:3
Terminal X8:3	connected to	Terminal X8:4
Terminal X9:3	connected to	Terminal X9:4
Terminal X10:3	connected to	Terminal X10:4

Information on phase sequence between the two 3-phase systems can be supplied by the machine manufacturer.
Information about preliminary filter setting could be a part of the setting list from SCR (system calculation responsible), if not, the potentiometers for current derivative addition should be set to their minimum position (R228, R229 max counter clockwise).
A simplified figure of the function and testpoints of the YYI 107 filter is shown below. Testpoints and terminals of all three filter channels are indicated but the function of only one channel is shown.

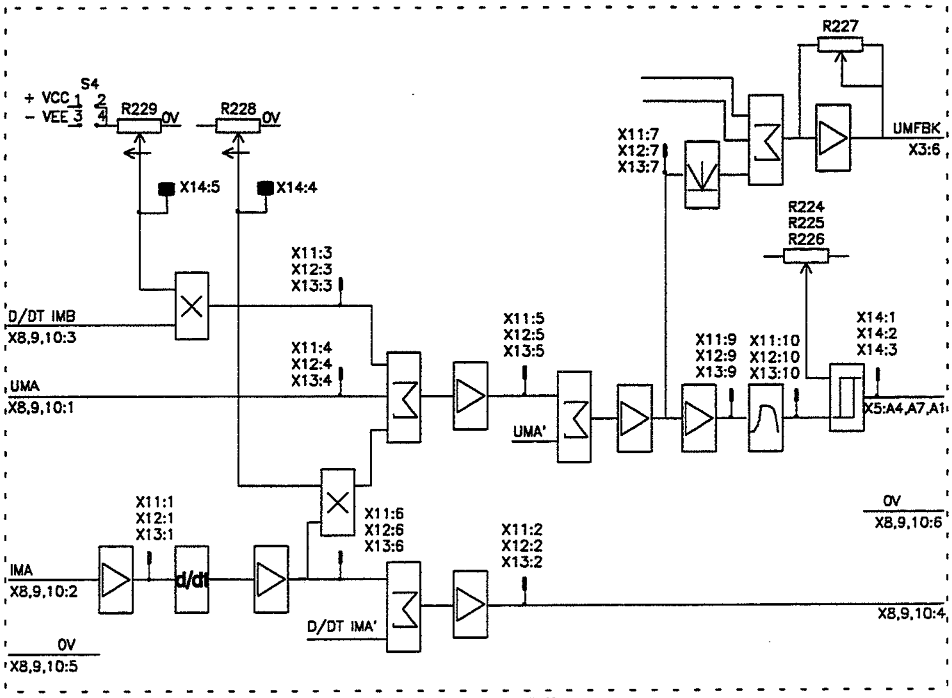


Figure 6, principle of machine voltage filter YYI 107

If the motor can be turned manually, the sequence of the rotor position signals should be checked. Manually turn the machine in the direction defined as positive rotation, lubrication system should be running and auxiliary power should be turned on in the convertor.
Check the LED:s on the terminal units B50.71-76, the correct sequence should be 71-72-73 and 74-75-76. If manual turning is difficult, this check is later described under section "procedure of torque controlled rotation" but checking by manual turning is recommended as this will simplify later stages.

Torque direction control function

General

Since there is only one current direction for the DC-link current the blocking system in a DC-convertor is replaced by a torque direction control function.

Direction control

During commissioning and testing the bridge switching can be locked by setting parameter LOCKBRCH ="1". The parameter LOCKDIR determines which torque direction should be active. For normal use the parameter should be set ="1".
The function is equipped with a zero-current detector since the changing of the torque direction can only take place when the current is zero. A well established discontinuous current is taking as a zero current. The level is adjustable with I0LEV but should normally not be changed during commissioning from its default value. This is also the case with the parameter I0MIN that limiting the zero current detection level to a min. value.

> Note!
> The direction control should be locked until the measured value of the motor voltage, UM0VOLT is checked. See section Setting of EMF feedback below.

Threshold function

The order to change the torque direction of the motor is controlled by a threshold function. The threshold level is not fixed level but a varying one. The actual threshold level is lowered at every sample with the actual value of the current reference IDREF from an initial level. This initial level is adjustable with ILEVBRCH in a range 0 - 400 % of convertor current. Each time the current reference is changing sign theactual threshold value is receiving a new start value determined by ILEVBRCH.

Compensation for mains drop in UDI0

In the function module IUMEASXX is a parameter MDROPCOM, which should be set so the signal UDI0 is not affected by the voltage drop which the current in the convertor causes to the voltage at the convertor connection point.

The Tuning is performed by the generation of large step disturbances of short duration in the dc-link current, via the STEP function, and studying the effects of the disturbance on the UDI0 signal. This process should not last more than about four seconds at a time. By connecting the signal UDI0 to a recorder via the signal switch, the change can be studied and tuned away with the help of parameter MDROPCOM.

Setting of EMF feedback and motor voltage measuring.

An EMF actual value, EMFACT1, as a feedback to the EMF - control is calculated in function module EMFCAL by rescaling the signal UM0ACT. The scaling of UM0ACT is adjusted so that 100 % means a motor voltage equal to the convertor no-load voltage UVNOM.

Note!
The reading of the measured value, UM0VOLT, must be checked with the real motor voltage. For that reason the motor voltage must be measured with voltmeter, of true-rms type, and compared with the reading of UM0VOLT before the optimal motor control and torque direction function is activated.

Voltage adaption

Voltage adaption is used to control the convertor output voltage (via its delay angle) to a value close to the motor's counter voltage (EMF).The voltage adaption is activated when the current control is released and makes the time between release order and control contact (for the current controller) as short as possible.

The voltage adaption is made in two stages:

1. Via feed-forward of the measured motor voltage via the EMFFILT signal to the delay angle ALPHA.
2. With the OPTVEC-function which selects which thyristor pair are the most optimal to fire on.

In order to have a correct feed-forward control of the delay angle ALPHA, the measuring of the motor voltage must be correct, see section above.

In most applications the OPTVEC function does not need to be activated. It is accessible through the terminal, and, when the OPTVEC parameter is set to zero, the function is deactivated.

With the parameter CURRARL in function module IREFHALXXthe reference value is set for the first current pulse after a release order to the current control and with this parameter the voltage adaption can be set safely. When CURRARL is set to a value <100 % the current reference IDREF1 is equal to ID0 * CURRARL. When CURRARL is set to value =100

% the current reference IDREF1 is not affected by the parameter CURRARL.

Independent of which value, the current reference for the first currentpulse, has got from the CURRARL parameter, no higher value then IADERMAX is possible, see below. Normally the factory-set value does not need to be altered.

Current rate-of-change limiter

Current derivative limitation is a protection for the machine convertor (against commutation failure) and driven machine (the load object). The value of this parameter on 10.0 % / ms gives a rate of change of 100 times the rated current of the convertor per second and if higher rates of change are required, the value of the parameter can be increased. Normally the value is determined during the system calculations, performed by SCR, and should not be changed.

The rate-of-change limit ican be made speed dependent by setting different values to IDDERMAX, IDDERM and IDDERMIN, but this must be confirmed by SCR.

Protection against line side inverter collapse

Selection of maximal EMF on inversion

The EMF reference to field weakened motor drives is adjusted with help of parameter EMFNOM in the drive system start-up module, STRTDSXX, and parameter EMFSETP in function module EMFRG1XX. When the EMF reference and the machine convertor regenerative firing angle, BETAGEN, is to be set attention should be paid, amongst other things, to the ability of the mains supply to commutate the current in the convertor. This ability results from the short circuit power at the convertor's terminal. The maximum EMF to be set in connection with inversion is dependent upon the required braking torque, which is proportional to a regenerative current.The maximum current with regenerating limits the highest permissible value of the delay angle, β_{min}, via the parameter BETALIM. See the section, Delay angle limits below.

The level of the DC-link voltage, mentioned below as $Emf_{max(vx)}$, shall be selected, according to equation (1) below. The reason to this is to ensure that the value of the maximal delay angle limitation (β_{min}) will be enough in order to control the current down into the discontinuous area when inverting mode, with a good margin. For a convertor, of the 6- or 12-pulse type, which is single connected to a transformer, the following relation is relevant:

$$Emf_{max(vx)} = k * 1.35\ Um0 * \cos(BETAGEN)$$

k = 1 for 6-pulse and = 2 for 12-pulse series.

where U_{v0} = the voltage level in the connection point of the convertor when no load condition

0,9 = is equivalent to an 10 percentage decreasing of mains

Limiting of inverter current

If the maximum delay angle, β_{min}, as above is set in equation (2) below, a value is obtained for the maximum permitted inverter current I_{dbr}. For a convertor of the 6-pulse or 12-pulse type, which is connected alone to a transformer, the following applies:

$$Idbr = \frac{0{,}9 * Uv0 * 1{,}414}{4\Pi * f * Lk * 1{,}25} \qquad (2)$$

where: L_k = commutation inductance per phase

I_{dbr} = maximum regenerating current

U_{V0} = nominal voltage at the convertor's connection point

0.9 = the equivalent of a 10 % drop in supply voltage

1.25 = safety factor.

In order to avoid commutation breakdown, there is a parameter IDBRMAX, which limits the current reference value in inverter mode. The parameter should be set to the value obtained from equation (2) above. If there is uncertainty about the value of the commutation inductance (short circuit reactance) at the convertors connection point, there are experimental methods for determining this value. If necessary, please contact ABB for directions.

Limiting of maximal delay angle

Constant maximum delay angle limit

The maximum value of the delay angle limit is adjusted via parameter BETALIM to the value obtained from equation (1) above.

Provisional commissioning of the speed control

General

At this stage only a provisional commissioning of the speed control is possible, since a final adjustment can only be made when the motor is coupled to its load. The final adjustment also requires that the excitation (motor voltage) control has been commissioned.

In order to be able the check several functions, such as field DC current control for a brushless drive, the drive must be ready to run speed controlled.

The first step, in order to commissioning the speed control, is to rotate the machine and to check and adjust the rotor position transducer. The easiest way to do this is to use the machine itself.

Preparations

The preparations made here is valid for both the first trials with speed control and also for the settings of the machine convertor control.

Before the motor is rotated for the first time

Mechanical coupling between the motor and its loading object should be opened. Check that the loosened coupling half on the motor axle is properly attached. This prevents the possibility of loose parts coming free when the motor starts rotating.

Since the motor, during the commissioning process, can start without previous warning it must be marked with signs indicating the danger of rotating shaft ends, etc.

Wiring check

Check carefully, with the circuit diagram, the connection of the cables from the rotor position tranducer/pulse transmitter and to the B50 terminals of the control cubicle. See CD page 51,55 and 58.

Provisional parameter settings

The field exciter shall operate <u>separated</u> from the drive system control. In order to achieve this the following parameters have to be changed:

Field exciter => FLDEXNR = 0
IFTEST = "1"
IFNOMSTA = same setting as IFNOM

Drive system => SCFEASEL = "0"
IFAACKBL = "1"

Before starting the convertor, its delay angle should be limited to 80°. This is done in function module FIALCLXX using parameter ALPHALIM (if the system has two convertor control systems, this must be done for both of them).

The convertor's torque changing function should also be locked with the parameter LOCKBRCH (function module TQDIRCXX) in the convertor's control unit. If the convertor is a 12-pulse parallel this must be done in both control units.

The machine convertor have two modes of operation, forced commutation during low speed and machine commutation during normal and high speed. When rotating the motor the first time the mode change to machinee commutation must be prevented. This is done by setting parameter FREGTMHL to high level, maximal setting.

The current reference should be limited to approximately 5 -10 %, which is most easily achieved with the help of parameter IALIMMAX (PD page 279).

The trip-out level of the overspeed protection, the parameter MOTOSPL in function module SPMONXX, should be given a low value, such as 20 %.

Speed controller settings

The Speed control's gain - NGAIN - is temporarily set to a low value, about 1.0, and the regulator's integral action is uncoupled with the help of parameter NPROP.

Set the speed controller integral time constants to temporary values.Set NTC1 = 1000 – 2000 ms, set NTC2 and NTC3 =100 ms respectively.

Settings digital speed measurement

Check that parameter ADIGSP in function module SPMEASXX is set ="1".

Parameter NFEEDBTC (the filter time constant) should normally be set to 10 ms. If extremely fast speed control is required, the parameter can be set to 5 ms. It should not be set higher than 63 ms.

Check that the parameters in the drive system's start-up module, STRTDSXX are properly adjusted.

NOTE!	If the adjustment of parameter NMAX NBRPPR (in function module STRTDSXX) or MOTOSPL (in function module SPMONXX) goes over the maximum pulse frequency of 50 kHz, the convertor will cut because of "OVERRUNNING".

First time rotation

Considerations before starting

Rotating the motor for the first time is a critical moment in the commissioning process especially when the rotor position of the motor is not preadjusted at the motor factory test. At that time, incorrect handling can damage the motor and other equipment.

The first step of the speed control commissioning is to check and adjust the rotor position signals. If the motor is started with a wrongly adjusted transducer, the power factor of the motor is wrong which leads to different cases, such as:
Zero power factor, which means that despite high current the motor refuses to rotate.
Negative power factor which forces the motor to rotate in opposite direction, relative to the direction of positive phase order.

Normally there is no other way to rotate the motor than using its own torque. In this case consider the previous paragraph, above. The preferred method is to run the motor with torque control, current control selected

(TESTMODE = 3) and field excitation present (local mode operation of the field convertor).
Sometimes the rotor position can be adjusted by rotating the motor with the help of another motor drive connected to its shaft. The checking and the adjusting is then simplified since it's only necessary to magnetise the motor and check the signals.

Since the motor drive will race if the applied torque is greater than the loading torque and if the commissioning engineer is not observant. It is important for the commissioning engineer to limit the effects of racing. This is achieved by:

- limiting the output voltage from the convertor via the a-limit
- excitation of the motor with maximum field current
- preventing the activation of machine commutating.

The motor should be excited with a nominal magnetising current when it is rotated for the first time. This must be checked when the convertor is started.

Since the motor cooling fans are operated from the drive system the applied excitation power can harm the machine windings if it will be left on, a long time with no forced cooling on the motor. A time less than five minutes doesn't harm the motor if the motor is given time to cool off in between.

It is recommended that the armature current reference is controlled with the help of a potentiometer, as this will give a better control over the reference handling than push-buttons for increase / decrease.
See the section "the TESTREF function" and secition "Temporary reference" below.

When the motor rotates for the first time, it should be kept under observation by someone, who can warn the commissioning engineer if there is a tendency to race.

Sometimes it occurs that the motor is just allowed to rotate slow in one of the two directions. The commissioning engineer must, in such a case, be warned if the motor starts to rotate in the wrong direction.

Temporary reference

In order to run the motor torque is controlled a temporary reference source shall be arranged by using a potentiometer. It can be connected to analog input B51:66(CD page 22).

The stabilised voltage + 10 V can be found on some of the terminal boards for analogue inputs, for example B51:74 (CD page 22). The zero voltage (0 V) can be found on the same terminal board B51:80.

Note!
If the normal direction of rotation is negative the reference value must also be negative. In this case the + 10 V is replaced by - 10 V.

Direction of rotation and rotor pos signals

The desired direction of rotation (positive rotation) is selected by the phase sequence of the main circuit between convertor and motor. For clockwise rotation (facing shaft end) defined as positive rotation , motor terminals U, V, W are to be connected to convertor terminals U, V, W (12-pulse: motor U1, V1, W1 to convertor +Y3: U, V, W and motor U2, V2, W2 to convertor +Y4: U, V, W). For counter clockwise rotation defined as positive rotation, motor terminals U, V, W are to be connected to convertor terminals W, V, U (12-pulse: motor U1, V1, W1 to convertor +Y3:W, V, U and motor U2, V2, W2 to convertor +Y4:W, V, U). With the phase sequence selected accordingly the convertor control system will operate with positive reference for the defined positive rotation. If selection of positive rotation is not possible by main circuit connections, other convertor internal modifications can be made to give the same result as above. This second alternative (internal modifications) is only to be considered when main circuit reconnection is practically difficult to make. Contact ABB Industrial Systems AB for advice.
When the motor is running for the first time the rotor position signals must be adjusted compared to the machine voltages. The rotor position signals are, during forced commutation, replacing the machine voltage as trigger pulse synchronization (to obtain the correct trigger pulse information the rotor position signals must be calibrated to be in phase with machinee voltage)

When the machine is rotating in the positive direction (torque controlled rotation) check that the sequence of the rotor position signals are positive according to section "torque controlled rotation".

When the phase sequence of the rotor position signals has been recorded, disconnect two of the three rotor signals from the recorder. Keep rotor position signal P1 (terminal B50.71) and connect motor phase-to-phase voltages U_{TR}, (phase T positive) from the two 3-phase systems A and B, to the recorder. These signals are not available on the terminals. To record these signals, use two differential channels in the chart recorder. To record signal U_{TRA} , connect U_{TA} on terminal +B32.12; X10:1 (CD page 54) to the "+"-input of the first differential channel. To the "-"-input of the same channel, connect signal U_{RA}, [+B32.12;X8:1 (CD page 54)]. To record signal U_{TRB} , connect U_{TB} on terminal +B32.22; X10:1 (CD page 57) to the "+"-input of the second differential channel. To the "-"-input of the same channel, connect signal U_{RB}, [+B32.22;X8:1 (CD page 57)].

For a 12-pulse series drive, the rotor position signals P1a and P1b will be identical and it's position relative voltage shall be leading system A Utr voltage by 15deg and lagging system B Utr voltage by 15deg, see figure 7 below.

Measure corresponding signals with a chart recorder and make the necessary adjustments by manually turning the rotor position signal device on the motor (a mechanical angle X will correspond to an electrical angle Y by: X=Y*p/2 where p is the number of poles. Turning rotor position signal device X degrees in the direction of positive rotation will delay the signal by Y degrees). Record all signals after final adjustment.

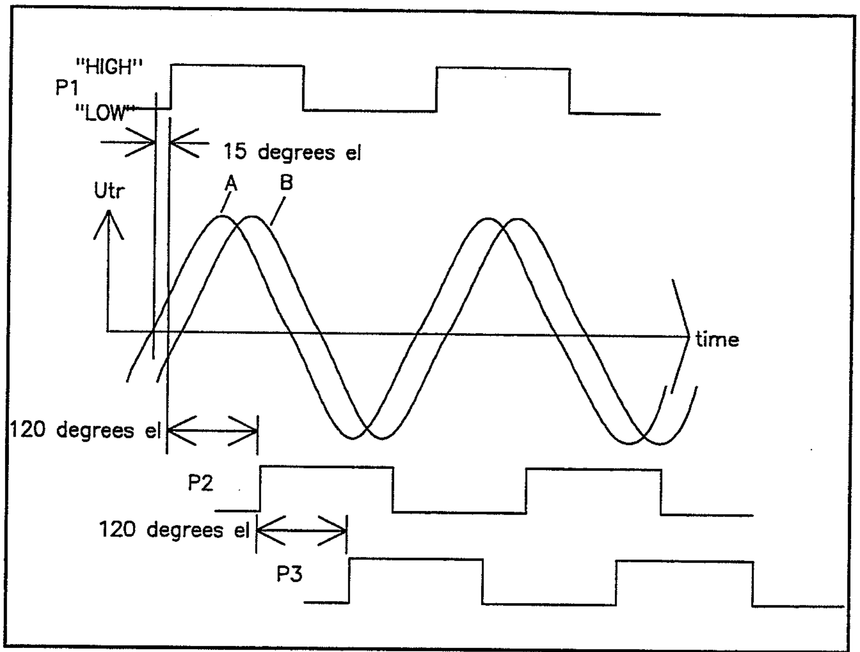


Figure 7, Rotor position signals and motor voltage, 12-pulse series drive

Procedure of torque controlled rotation

Set parameter TESTMODE = "3".

Check that the ramp-time of TESTREF (PD page 227) is set to a small value, 5 sec.

Connect all three position signals P1 - P3 (CD page 51) to a multichannel chart recorder together with the current feedback and speed feedback.

Caution!
If the current feedback is short circuited by mistake or by faulty equipment the current control and protections will be out of order.

Start the field exciter convertor via its operating panel.
Check that the field excitation is nominal, which means that signal IVAMP, PD page 424, agrees with rating plate data of the motor. Which, in case of a brushless system, is the stator current of the exciter machine or, in case of a machine with sliprings, is the field DC-current,.

Start after that the convertor with an ON-order from the drive system operator panel. Check that the motor is excited with nominal field current.

Therafter a release order is given to the entire control system for the drive, via the push-button marked with START on the drive system operating panel.

Carefully increase the current reference with the help of the potentiometer . Check that an armature current is obtained, by watching the ampere meter on the door of the cubicle. The current reference should be increased until the motor begins to rotate, which means that the light from the LED:s on the terminal units, B50:71 - 73, starts to flash (CD 51).
When the motor starts to rotate, the current must be decreased to zero by the potentiometer. The direction of rotation must be checked and the sign the speed feedback must be noted. The direction of the rotation must correspond to the sign of the current reference.
A positive current reference shall give a positive direction of rotation.

If the sign of the speed feedback, NACT (PD page 223), is wrong it's necessary to shift the wires from the pulse transmitter on the terminals,see CD page 23.

If the motor starts to turn in a wrong direction, relative to the positive direction of the phase order, and is stopped after some degrees of turning, the phase order must of the transducer signals be wrong.
Shift therefore the tranducer signals P1 and P3 and check again.
The correct phase order of the rotor position signals is; signal with a positive edge on terminal 71 followed by a positive edge on 72 and after that on 73. The same for signals on 74, 75 and 76.

With TESTMODE =3 it is not possible to maintain a constant speed, since the drive wants to race. The commissioning engineer must replace the speed regulator and lower the TESTREF when the motor starts to race.

Sometimes the necessary turning torque to loosen the rotor may be considerable if the rotor has not been rotated for a long time.

If the speed of the motor shall be increased and the required current is continuous, the current reference via TESTREF must be oscillating. This can be achieved by changing the reference, manually via potentiometer up and down from zero to maximum.

If the rotor does not rotate in spite of relatively high current, the motor and the rotor positioning system must be examined.

First time with speed control

Rotating the motor for the first time, with a closed speed control loop, is a critical moment in the commissioning process. At that time, incorrect handling can damage the motor and other equipment.
If the speed feedback has wrong sign adjusted there is a risk that the motor will race.

It's advisable to keep the provisional settings , which was done in the previous section " Torque controlled rotation", until the drive has been rotating speed controlled. Despite that the sign of the speed feedback should be OK.

The motor's current, speed and voltage should be recorded with the help of a chart recorder or equivalent instrument. The actual values for current and voltage are obtainable as analogue signals, for which see the circuit diagrams (CD), current Id1 on page 47 and MACHEMF on page 42. For digital speed measurement there is no analogue measurement signal available. On the other hand, the digital measurement signal NACT via an analogue output board.

Caution! If the current feedback is short circuited by mistake or by faulty equipment the current control and protections will be out of order.

Set parameter TESTMODE = "6".
Start after that the convertor with an ON-order from the drive system operator panel. Check that the motor is excited with nominal field current.Therafter a release order is given to the entire control system for the drive, via the push-button marked with START on the drive system operating panel.

Carefully increase the speed reference with the help of the potentiometer, check that an armature current is obtained, with the help of a chart recorder. The speed reference should be increased until the motor's rotor begins to rotate or the armature current reaches its limit.

If 5 – 10 % current is insufficient to turn over the rotor, the value of the parameter IALIMMAX must be increased. The necessary turning torque to loosen the rotor may be considerable if the rotor has not been rotated for a long time.

When the motor is rotating with a slow speed it should be checked that it's possible to speed control the drive.

Adjustment of machine voltage feed back

Stop the motor and reset the parameter FREGTMHL to a value 4 Hz. Select a constant speed delay angle of 45^{o} el with parameters VARBETAS and CONBETA. Selected TESTMODE =6. Set speed reference to zero. Start the drive and watch the signal FREGTMIN. Slowly increase the speed reference until FREGTMIN becomes "1", the machine is now operating in machine commutation mode. Increase the speed reference to approximately 50% of base speed.
Measure machine voltage with a voltmeter on the secondary side of transformer +Y3.G2(CD 84). Voltage shall be approximately 50% of nominal.
Measure the DC-voltage on B32.12, circuit board YYI 107, testpoint X15:4. Adjust with potentiometer R227 the voltage in the testpoint to be equivalent to -7.00V at machine voltage (UMOVOLT equal to UVNOM) within the operating speed range.
The machine voltage feed-back must also be calibrated at the analog input to the control system. This calibration is made by software parameter and is described under previous section "Other convertor functions".

Increase the speed to base speed and make a fine tuning of R227.

When the voltage feed back has been calibrated with potentiometer R227 and the analog input, a preliminary setting of the filter phase lag compensation shall be done. The phase lag compensation is made in the software and is controlled by the hidden parameter UMONOMP (PD 64). To get access to this parameter a computer terminal or PC connected to the RS232 communication, convertor system, must be used.

Run the drive at base speed.
Measure the AC-voltage rms on B32.12, circuit board YYI 107, testpoint X11:9 (CD 54).
Measure at the same time the software signal UMOACT (use computer terminal or PC).
Calculate a preliminary value, parameter UMONOMP according to:

UMONOMP = k * Urms(X11:9) / UMOACT

k : constant = 6 350 000 +/-10%
Urms(X11:9) : Measured voltage in volts rms acc. above
UMOACT : Value of software signal measured with terminal or PC

Set parameter UMONOMP to this preliminary value, fine tuning is described in the following section.

Calibration of machine conv. firing angle

The drive shall operate with a fixed convertor firing angle Beta of 45 degrees, parameter VARBETAS="0" and CONBETA=45.0 degrees.
Memory type oscilloscope must be used.
Run the drive at base speed.

Method 1:

The calibration (fine tuning) of machine convertor firing angle Beta might need some load on the machine to make commutation notches clearly visible. Short time accelerations (inertia) can be used to produce commutation notches.
Measure the phase to phase voltage with an oscilloscope on the inputs of the machine voltage filter. Measure B32.12, circuit board YYI 107 (CD 54), oscilloscope channel A connected to testpoint X11:4 and channel B connected to testpoint X12:4 (phase to ground voltages R and S). Invert oscilloscope channel B and add A and B (create phase to phase voltage R-S).

Measure the time between phase to phase voltage zero crossing and corresponding commutation notch (see figures under section "Adjustment of machine conv. control, cont.").

Method 2:

If a third channel is available on the oscilloscope, a more accurate method can be used. Measure the same phase-to phase voltage as above, Urs. Connect the firing pulse P1 (se figure below) to the third channel of the oscilloscope.

Component placed on YYX144

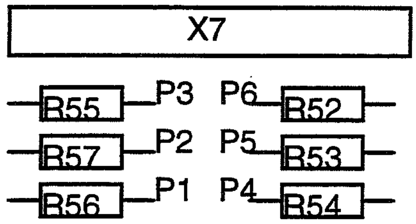


Figure where to measure firing pulses on YYX144

Measure the time , t , between the first positive edge of the firing pulse P1 to the zero-crossing of the Urs-voltage.
If the machine is rotating very light(no load, power almost zero) then the best result of the calibration is achieved when the measuring is performed after the applied motor power is removed(about constant speed).
The measured time is equivalent to firing angle Beta according to:

Beta = 360* t / T

Beta : machine convertor firing angle
t : measured time acc. to above
T : electric period time at selected speed

Compare this value with the selected parameter value of CONBETA. A difference can be adjusted with the parameter UM0NOMP.
Measured Beta to small -> reduce UM0NOMP in steps of 50
Measured Beta to large -> increase UM0NOMP in steps of 50
This check must be made at different speeds but first make a temporary tuning of speed control.

NOTE!	Do not forget to reset provisionally altered parameters. Do not forget to reset provisional alterations to the measuring circuits.

Temporary tuning of speed control

In order to avoid unnecessary problems with instability of speed control it is suitable to make a temporary tuning of the controller.

Start the motor with TESTMODE =6 and increase the speed setpoint to 50 % of base speed (NBASE).
Begin with tuning of proportional gain, NGAIN with NPROP ="1". Set up a suitable speed step (STEP), eg SIZE =1 % and TIME =500 ms. Increase the setting of the parameter IALIMMAX so the current reference value is not limited.

Connect the signal NSTEPEV, in the function module NCTR2XX to channel 1, and actual current IAACT, in the function module ASIGHAXX, to channel 2 of the operater panel logger.

Adjust the gain of the displayed picture, see Instruction YT 280 – 304. Increase NGAIN in steps, until a step feedback like in figure 8 below is recieved.

Set NPROP ="0" and a tuning of the controller's time-constants is not needed at this stage of the commissioning.NTC1 = 1000 – 2000ms.

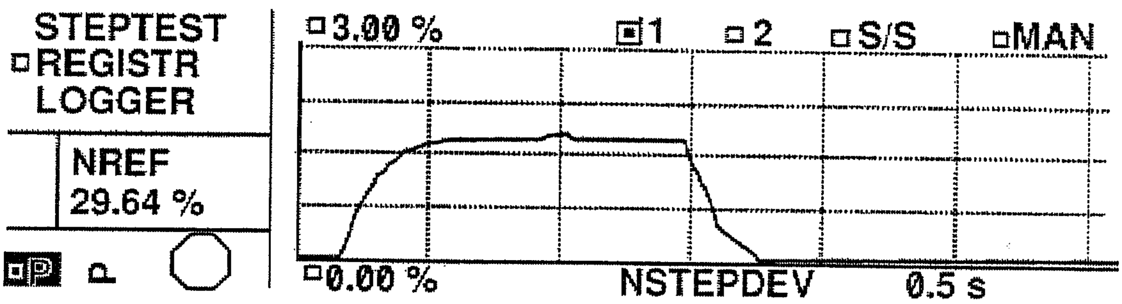


Figure 8. Step feedback of a temporary tuned speed control.

Checking the motor speed measurement

Static conditions

The speed measurement which is connected to the speed controller's feed-back input should be checked by independent measurement. The pulse transducer/ tachometer may be faulty. It may be, for example, the transducer does not give the correct number of pulses per revolution.

It is most satisfactory if the motor's revolution count can be checked directly on the motor shaft, with the help of a hand tachometer.

If this is not possible, the speed of the motor a indirect meassure can be obtained from the frequency of the signals from the rotor position sensors.

NOTE!	In order that the new scale values (NMAX, NBRPPR and NBREDGES) will affect the speed measurement, the motor drive must be stopped.

Speed ripple

The speed feed-back normally contains a superinposed ripple on the measured signal. The amplitude of this ripple is varying from values hardly noticeable to values which cause problems.The ripple is caused by nonsymmetrical slots in the pulse transmitter and perhaps of bad alignment of the pulse transmitter due to bad mounting (erection).

A check of the ripple must be carried out before the motor is coupled to the loading object. The loading object can introduce additional disturbances on the speed measurement.

The ripple should not exceed 0.5 %. A normal value is 0.2 % of maximum speed. If the ripple is too large the pulse transmitter installation should be checked. For filtering of the actual speed measuring, function module SPMEASXX contains a first order low-pass filter. The filtering time constant can be altered by changing the value of parameter NACTTC

NOTE!	The filtering time constant must be kept to a value as low as possible.

Checking the overspeed protection

Start the motor drive and increase the speed reference to 50 % or to a value which is proportional to the base speed.
Check that the protection is tripping the motor drive, by reducing the trip level MOTOSPL in function module SPMONXX. The convertor will trip as a result of overspeed. Check the fault indication.

Adjustment of machine convertor control cont.

General

An advanced machine voltage filter is used to find the correct firing angle for the machine convertor. The terminal voltage of the machine is highly distorted due to thyristor commutations (commutation notches). To find an undistorted voltage, representative for the commutation voltage, the machine air gap voltage is created by the filter. The measured terminal voltage is compensated by machine internal voltage drops by the filter. In a 2*3 phase machine (12-pulse), compensation is made for both 3 phase systems. To produce a true creation of the air gap voltage the filter must be programmed with the correct machine parameters. This is done as a tuning procedure described below. A preliminary setting value can be part of the pre-calculated setting list from SCR

Filter tuning

An oscilloscope with memory function is recommended to be used when filter is tuned. The calibration (fine tuning) of machine voltage commutation notches will need load on the machine to make commutation notches clearly visible. Short time accelerations (inertia load) can be used to produce commutation notches, using a memory oscilloscope it is possible to make a preliminary tuning of the filter. Final tuning must be made with the machine running at high load.
Tuning can be described as a two step procedure, first the commutation notches produced by the "own" three phase system is compensated, second the commutation notches produced by the magnetic connection to the "other" three phase system is compensated (six phase machine). If the drive is using a three phase machine (six pulse drive), only step one in the following description is done (no "other" three phase system present).

Step one, compensation of commutation notches in the "own" three phase system. When the machine is running with load (normal load or inertia loading) make the following measurements.
Measure the machine phase to ground voltage with the oscilloscope on B32.12, circuit board YYI 107, testpoint X11:5 (CD 54).
Measure the machine current derivative on testpoint X11:6
Current derivative signals will be present at the same place as corresponding commutation notches in machine voltage. Note that compensation of a commutation notch is only possible where a derivative signal is present. See figure 9.

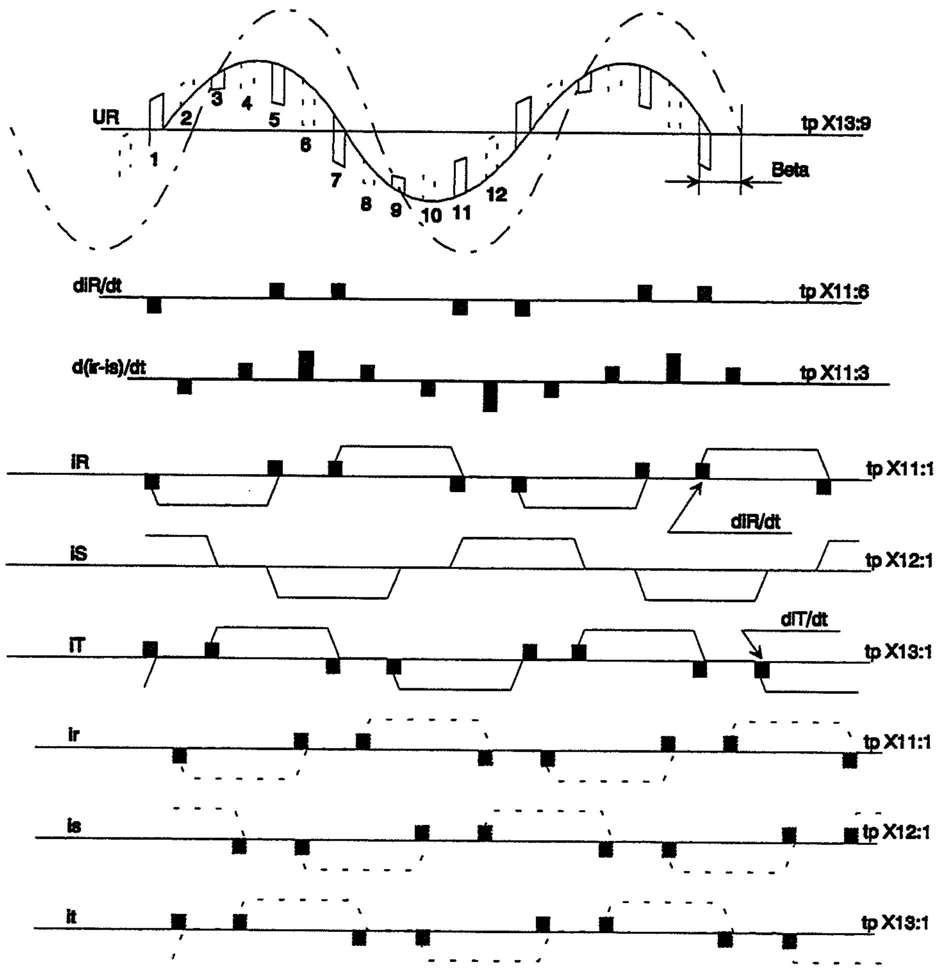


Figure 9, filter signals for a twelve pulse drive. R-S-T reference system, r-s-t system lagging by 30 electrical degrees.

Adjustment is made by potentiometer R228, compensation is possible for notches 1, 5, 7, 11....
Turning R228 clockwise will increase compensation.
Adjust until notches are compensated and the best possible sinusoidal voltage is obtained. Avoid over compensation.
When tuning is completed, check the result by measuring the individual phase to ground voltages (now compensated) at testpoints X11:5, X12:5 and X13:5. For a six pulse drive the tuning procedure is now completed, for a twelve pulse drive repeat the procedure for the second filter B32.32(CD 57). When step one tuning of both filters are completed, continue with step two.

Step two, compensation of commutation notches in the "other" three phase system. When the machine is running with load (normal load or inertia loading) make the following measurements.
Measure the machine phase to phase voltage with the oscilloscope on B32.12, circuit board YYI 107, testpoint X13:9 (CD 54).
Measure the machine current derivative difference on testpoint X11:3 and X13:3 (altering if a two channel oscilloscope is used).
Current derivative difference signals will be present at the same place as corresponding commutation notches in machine voltage. Note that compensation of a commutation notch is only possible where a derivative signal is present. See figure 10.

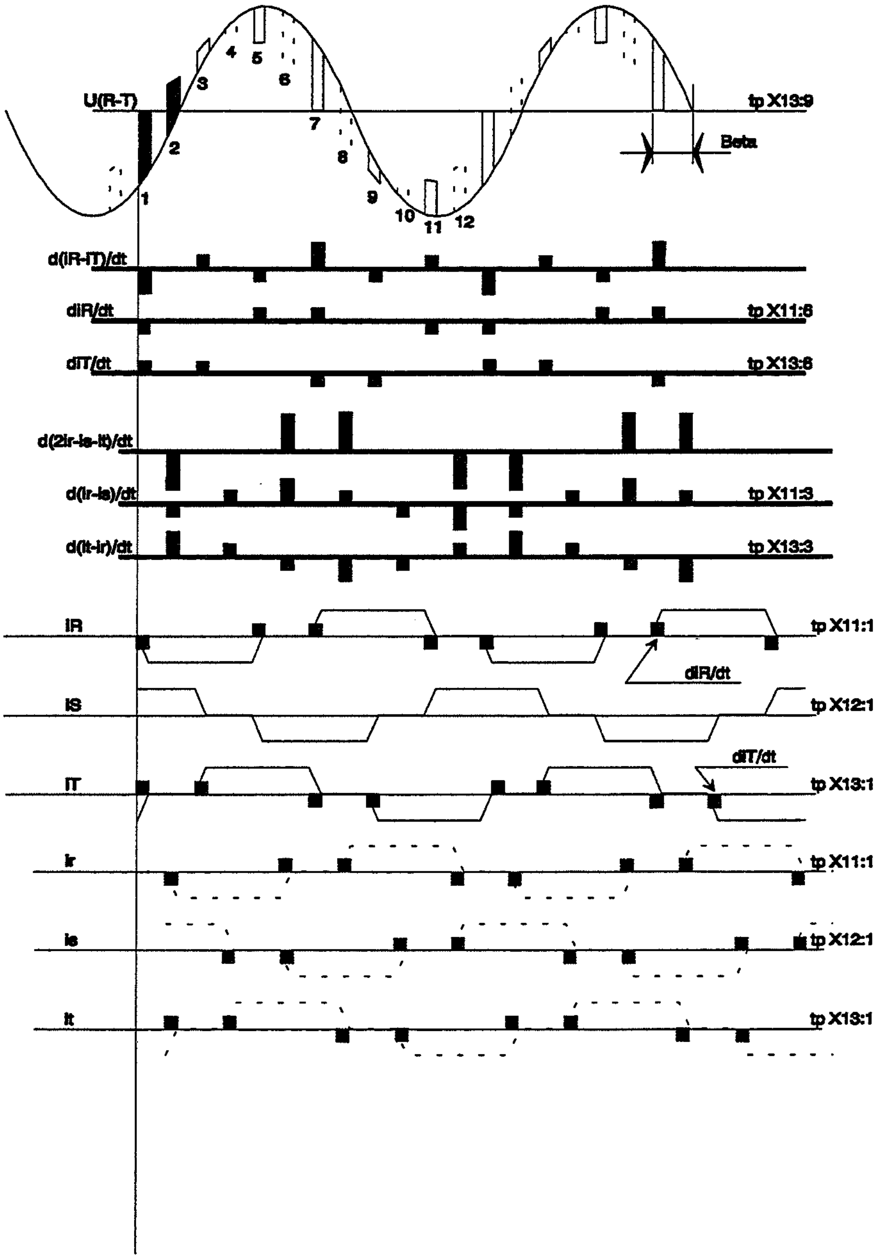


Figure 10, filter signals for a twelve pulse drive. R-S-T reference system, r-s-t system lagging by 30 electrical degrees.

Adjustment is made by potentiometer R229, compensation is possible for notches 2, 6, 8, 12....
Turning R229 clockwise will increase compensation.
Adjust until notches are compensated . Avoid over compensation. Most important is to get voltage zero crossings that is as smooth as possible.
When tuning is completed, check the result by measuring the individual phase to phase voltages (now compensated) at testpoints X11:9, X12:9 and X13:9. Repeat the procedure for the second filter (B32.32).
If the tuning has been made with light motor load or inertia loading the tuning result must be checked when the motor is running at full load or close to it.

Adjustment of armature current limits

General

A superior control system has the possibility to control the armature current limitation, see PD page 279.
It is also possible to set the current limits locally in the convertor, in the drive system control unit in function module IAREFHXX, PD page 279. Locally set current limits can be made speed dependent. And for applications with field weakening this limitations must be used.

In generating mode

Current limit in generating mode (of operation) is set in the convertor control unit in the function module TQDIRCXX, see PD page 362, with parameter IDBRMAX.

Since this limitation is set in ampere DC, a limitation relative to the nominal motor current must be recalculated as:
IDBRMAX = X % of IANOM * 1.283

Normally the needed breaking current is less than the nominal motor current. In most cases 40 - 60 % is sufficient. Read also under the previous section headed "Protection against line side inverter collapse".

In motoring mode

Constant current limits

By setting the value of the parameter NDPIA, which is a terminal accessible parameter, to ="0", and the value of IALIMPC to ="1", the current limits are determined by the parameters IALIMPS and IALIMNS. This is subject to the condition that the absolute value of these parameters is less than the value of parameter IALIMMAX.

Speed dependent current limits

For field weakened LCI-drives, the maximum current which can be applied is dependent upon the speed. The reduction of current with the speed is normally supplied by SCR (System Calculation Responsible) as precalculated parameter settings.

By setting the value of the parameter NPDIA (NPDIA is a terminal accessible parameter) to ="1", the function is activated.

The speed dependent current limits are generated in a function generator whose break point is set with the help of parameters NBP1-IBP1, NBP2 - IBP2 and NBP3 - IBP3. A terminal is needed for the setting. The number 1000 is equal to 100.0 % for NBP1- NBP3 and 4000 is equal to 400.0 % for IBP1 - IBP3.
The constant current limits IALIMPS, IALIMNS and IALIMMAX are set to a somewhat higher value than the highest permissible current in the motor.

For adjustment

Begin the adjustment by setting IBP1 to the maximum permitted current from zero speed to the first break point, NBP1. Subsequently the break points are IBP2 / NBP2 and IBP3 / NBP3 adjusted. Verify the adjustment by driving the motor through the speed range and measure the signal IALIMP1 or IALIMN1.

Motor voltage control

General

The emf-voltage of LCI-drive is a voltage behind the subtransient reactances inside the machine. For this reason, as for a dc-drive, is the emf is not meassurable.

The EMF control in TYRAK LCI consists of three parts.
- Feed-forward control of noload excitation direct from actual motor speed (the conversion from flux to field current is done in a function generator).
- Feed forward compensation of the armature reaction voltage drop.
- Feed-back control of the EMF by a PI-controller.

The total control is divided in two function modules, EMFRG1XX and ECTRL1XX, PD page 425 and page 426.

Setting of nominal field current

The parameter IFNOM must have a correct setting, see section " Setting of rated data".

The parameter IFADAP, PD page 426, is set equal to the ratio between the nominal field current at noload and the nominal field at nominal load, both at base speed. Values of this currents must come from motor manufacturer.

Normally there is no need to adjust the default setting, 100 %, of the parameter IFSET in function module ECTRL1XX. But in special circumstances it can be used to correct the field current reference.

EMF feedback

The 100 % value corresponds to an actual motor EMF equal to EMFNOM, which is a voltage behind the sub transient reactance's in the machine. For adjustment, see section "Other convertor functions".-

Setting of EMF reference

The EMF reference is set with parameter EMFNOM in function module STRTDSXX. Parameter EMFSETP in function module EMFRG1XX is used to reduce the motor's EMF, if needed.

Parameter EMFSETP has a double function, which means that it also changes the speed level at which field weakening takes effect. This means that under that speed level, the motor is excited with nominal flux. If the mains voltage falls below the nominal level this produces the same effect as if the value of parameter EMFSETP is reduced.

In order to avoid too rigid coupling to the mains, the increase (which occurs when the main's line voltage increases from a low level) takes place via a ramp function. The parameters UDIOCOMO can if it is set to positive value create a deadzone in the dependence for the voltage variations. The default setting, 5 %, means that the voltage must change more than 5 % before the reference system is affected.

Since the reference handling system is dependent on the actual voltage level of the main supply must, in case of under voltage, this dependence must be limited. With the parameter MUDIOCOM is this achieved.

Parameters EMFSCAL and PHIREF1 shall normally, unless otherwise stated, not be changed from its default settings of 100 % and 0 %.

Setting of flux feed forward (function generator)

Manual setting

From SCR (System Calculation Responsible) a parameter list shall be supplied which contains all parameters for setting this function.

The settings are calculated from the noload characteristic at base speed for the machine. For a brushless drive it's also needed to know the relation between exciter stator and main machine rotor current, since the output from the function generator is the rotor current DC-ampere.

The maximal excitation, EMFMAX = maximal Um0 at base speed, must be known. Since the nominal emf is known as EMFNOM it is a simple matter to find the corresponding field currents from the noload characteristic.

The field current, IF(100 %) A , needed for 100 % voltage, EMFNOM, is taken as 100 %.

The parameter values can be calculated as:

FIMAX = (EMFMAX V / EMFNOM V) * 100 %
IFMAX = (IF(MAX) A / IF(100 %) A) * 100 %
IFCONST 3 = (IF(90 %) A / IF(100) A) * 100 %
IFCONST 2 = (IF(70 %) A / IF(100) A) * 100 %
IFCONST 1 = (IF(40 %) A / IF(100) A) * 100 %

Automatic setting

Preparations

To achieve correct result of the automatic setting, be sure that the e.m.f and field current measurements are correct.The maximal excitation current, If(max) A, at base speed and maximal armature current, must be known. Set the parameter IFMAX = [If(max) / If(100%)].* 100 %.
If(100%) is the field current at base speed and nominal armature current.

Set temporary FIMAX to the same value as IFMAX.

The setting of IFADAP must be correct see previous section.

Set temporary IFMIN to a low value, such as 10 %.

For LCI-drives make the following settings in the machine convertor control:
Set CONBETA = 30 degrees.
Set VARBETAS = "0"

In order to generate a FLUXREF-signal , the input to the flux-to-current function generator, which is bigger than FIMAX, set PHREF1S to "1" and PHIREF1 to 8192 (50 %). The actual field current reference is then determinded of the setting of IFMAX.

Check that the torque direction switching function is locked, ie that LOCKBRCH is set ="1".

Make the following temporary settings of the EMF feedback controller.

EMFPROP	= "0"
EMFTC	= 500 ms
EMFGAIN	= 0.05
FILIMP	= 0%
FILIMN	= 0 %.

Set temporary IFMIN to a low value, such as 10 %.

Procedure

Start the motor drive and let it run at base speed.

Activate the automatic function by FITEST = "1". Then it takes some time until it's noticeable that the function is in operation, e.g. field current starts to decrease.

When the field current reference is decreased to a value, which corresponds to IFMIN, the automatic function is ready.

Use the operating panel to read the values of; FIIFMAX, IFFI90, IFFI70 and IFFI40. Make a note of the values.

Stopp the motor drive and set FITEST = "0".

Use the operating panel and set:

FIMAX	= FIIFMAX
IFCONST3	= IFFI90
IFCONST2	= IFFI70
IFCONST1	= IFFI40

Tuning of EMF control

In case of brushless excitation, make sure that the second part commissioning(rotating machine) is performed.
The fast variations of the motor voltage is too fast for the feedback controller. It's for this reason there are feedforward control of the field current, from both speed and armature current. The output of the EMF FB-controller is correcting the total via the signal FLUXCORR.

Set the parameter INPSEL = "0" and EREFTC= 30 ms
The proportional gain shall be low, EMFGAIN = 0.05.

Set the parameter TESTMODE =7.

The EMF feedback controller shall now have the settings mentioned in previous section.

Start the motor and increase the speed reference using the TESTREF-function until approximately base speed.

Connect the hardware signal MACHEMF(CD page 42), the signal FLUXCORR (PD page 426) and the field exciter actual current (CD page 75.01) to a chart recorder.

Check, with a terminal, so that the FB-controller signal EREGOUT isn't in limit. If so, check the setting of the flux-to-current function generator and the setting of the parameter IFADAP.

When the signal EREGOUT is 0, ±10%, then the settings are OK so far.

Read the actual value of the field current reference, IFREF1. Set IFMIN temporarily equal to this actual value decreased by 15 %.

Set a stepreference, PHIREF1, of -10% (-1638 with a terminal).
Generate a step-disturbance by changing PHIREF1S, "0" => "1"," 0", with a terminal.

Check if there is an overshoot in the motor voltage. In case there is an overshoot, increase the setting of EMFTC. Try to increase the setting of EMFGAIN as much as possible, without having an overshoot.Start to decrease EMFTC, in step of 50 ms and after checking the recorded stepfeedback. The overshoot mustn't exceed 5 % of the generated step-disturbance.

There is no need to exaggerate this tuning just to achieve high dynamic behaviour, since there is no need for it. Therefore EMFTC shouldn't be set lower than 250 -300 ms.

Document the dynamic behaviour with a recorder.

Generate step disturbances with the STEP-function. The overshoot mustn't exceed 5 % of the generated step-disturbance. If so, must EMFTC be increased.

The EMF FB-controller output is adapted by the actual speed (NACT) in order to maintain constant gain in the whole speed range. If there is a need for a lower closed loop gain at low speed this can be achieved with the parameter NADAPTLI.

Activation of EMF-controller

At zero speed there is no EMF-voltage to control, since the machine needs to rotate in order to induce an EMF-voltage. With the parameter RELCTRLL it's possible to set the EMF-level at which the FB-control is activated.

At low speed and at standstill the field current of the motor should be highest possible, that is a current which agrees with the nominal value on the motor's rating plate. With the parameter FILREL_N it's possible to set this current.

Checking the field weakening

The result of the settings and tunings which has been done so far, see above, should be checked by increasing the speed reference value to max. speed and thus activating the field weakening function..

When speed exceeds the speed level of NBASE the function is activated.

The easiest method to check the field weakening is by using a multi channel chart recorder and record (during acceleration) the actual speed (NACT), EMF actual value and the actual field current. The EMF actual value is accessible as a hardware signal, MACHEMF (CD page 42).

Check the field weakening by increase the speed above NBASE. If the field weakening is working properly the field current is lowered when speeds exceeds NBASE.

Connect also the signal UDACT (PD page 324) to a chart recorder. Check that the value is approximately constant in the field weakening area.

Thereafter both MACHEMF and UDACT should be checked when accelerating the motor with the fastest ramp time which the drive system will be exposed to.The ramptime for this test can be set in function module TESTDSXX with the help of parameter RAMPTIME.

Check that this ramp time is the shortest in the reference path. For example, in the program DSRB there is a function module NRAMP3XX, which includes a ramp function. This ramp time must be temporarily set to a shorter time than RAMPTIME or to an equal time, when this check of field weakening is done.

When an acceleration has been recorded then a result similar to figure 11 below should be achieved. If the overshoot of the emf actual value is too high when the motor speed is accelerated into the field weakening region, then a slower ramp time must be used. A somewhat better result can may be obtained if more effort is laid down on tuning the field current control

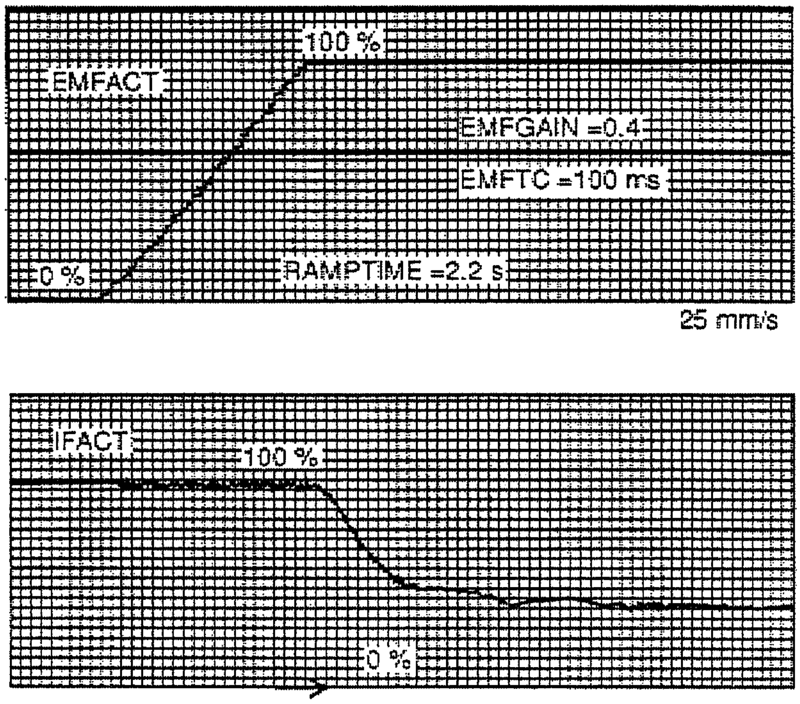


Figure 11. Emf actual value when acceleration with a fast ramp.

Another way to record the performance of the field weakening function is to use the built-in log, in the operating panel. In order to trigger the log, use function module TEST3X. Connect signal EMFACT to AO72.1 in the CONNECT menu. Set parameter AATRIGL to 20 %, this corresponds to EMFACT=80 %. Parameter ATRIG is calibrated for signals with 100 % as their maximum value. EMFACT has 400 % as the maximum value.

Increase the speed by pressing the REF+ button on the operating panel. When the value for signal EMFACT =80 % the log is triggered and the text ANALOG TRIGGER is shown. Check the REGISTR screen for signal EMFACT.

NOTE!	If the recording must be repeated, press the RESET button on the operating panel.

If the overshoot is greater than 5 %, a slower ramp time must be used. The overshoot can possibly be reduced if the EMF regulator's parameters are adjusted.

Tuning the armature reaction compensation

General

In demanding applications, such as rolling mills, the loading of the motor drives is changing very abrubtly, when for example a bar enters the rolls. It's in these applications very important that the excitation control is reacting fast in order to minimize the error between the reference and the feedback values. The armature reaction can for certain motor types be as big as 100 % or more of the noload magnetisation at nominal load.

For drives in the most demanding applications a preliminary setting of the armature reaction should be followed by a final tuning, when the application process is loading the drive during production.

Preliminary setting

The tuning done here is using the inertia of the drive as a load. The best effect is achieved when the motor is connected to its loading object, e.g. max. inertia.

The best result of this tuning is achieved when the machine convertor control filter cards are properly tuned, see section " Adjustment of machine convertor control".

Start the drive, with TESTMODE = 6, and accelerate the drive to approx. 75 % speed by using a speed reference from a potentiometer, see section "Test reference".

Change the ramptime of the speed reference to a low value. When the motor is running at the speed which corresponds to the speed setpoint.

Note !
If the drive should stop for any reason, it is important that the ramp time is increased to nominal setting before it's restarted. This because of the forced commutation start of the drive, which generates heavy low frequency torque disturbances.

Set IALIMMAX (PD page 279) to 50 %.

Check that CONBETA is approx. 40 degrees and that VARBETAS is "0".

Reduce the setting of the ramptime to approx.. 10 sec.

The following signals should be connected to a multi channel recorder; IDACT (PD page 324), NACT (PD page 223), MACHEMF (CD page 42) and and field current feedback X25:1-2 on board YPQ201.

Record with rather high paper speed the signals mentioned above when the speed is changed by pressing REF+ on the operating panel of the drive system.

Check the the alteration of the motor voltage during acceleration and compare it with the speed feedback. If the shape of the recorded voltage follows the shape of the speed during the first 100 -200 ms, the tuning is OK. The degree of compensation is adjustable with the parameter SYNCREAC (PD page 355).

Step by step can the ramptime be decreased and IALIMMAX be increased in order to have heavy disturbances on the motor voltage by the armature reaction.

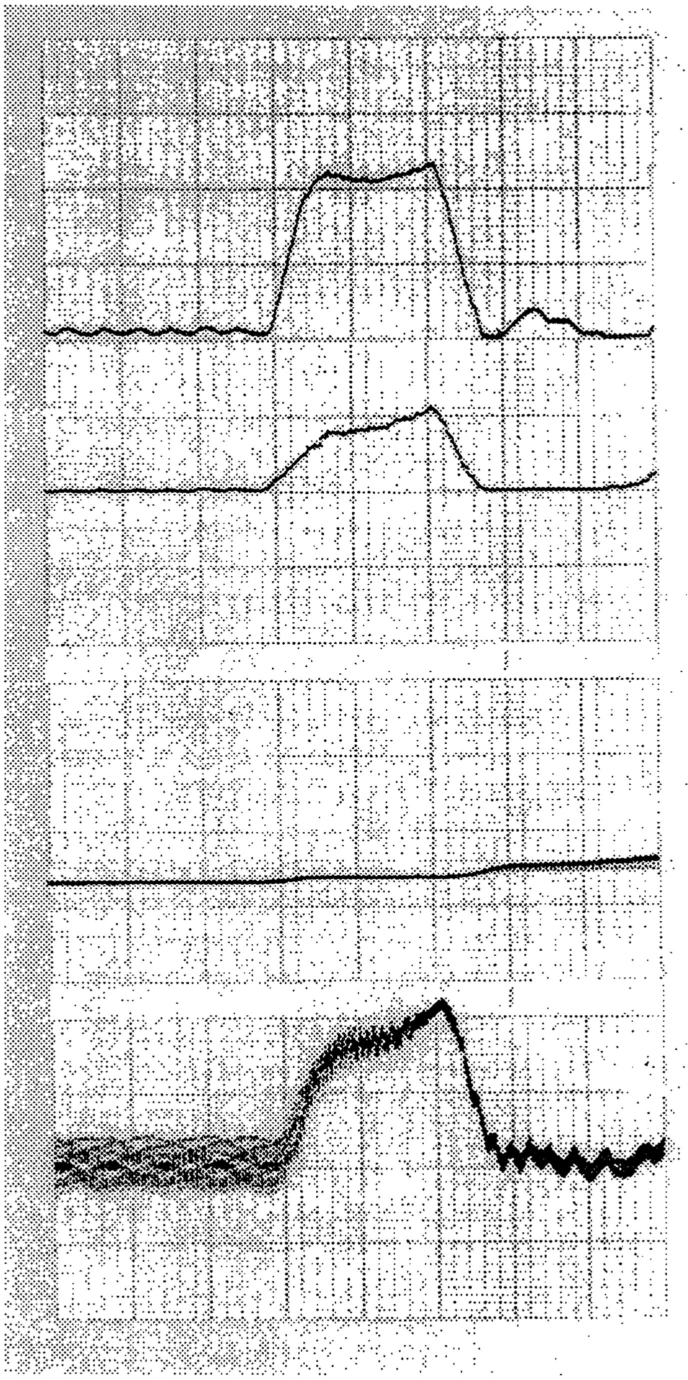


Figure 12 Result of prel.setting of arm. reac. comp..

Final tuning

A final check and eventually a tuning of the setting of the armature reaction compensation , parameter SYNCREAC,must take place when the equipment is in production. This is especially important for drives i demanding applications.

Record on a chart recorder the same signals as mentioned in the previous section. Check that the motor e.m.f, AMCHEMF, remains approximately constant in the first moment after a load impact has occured.

In the figure below is the motor EMF shown during a heavy load impact with a correct setting of SYNCREAC.
NOTE!! Don't overcompensate. It's better that the motor e.m.f is slightly decreasing rather than uncreasing.

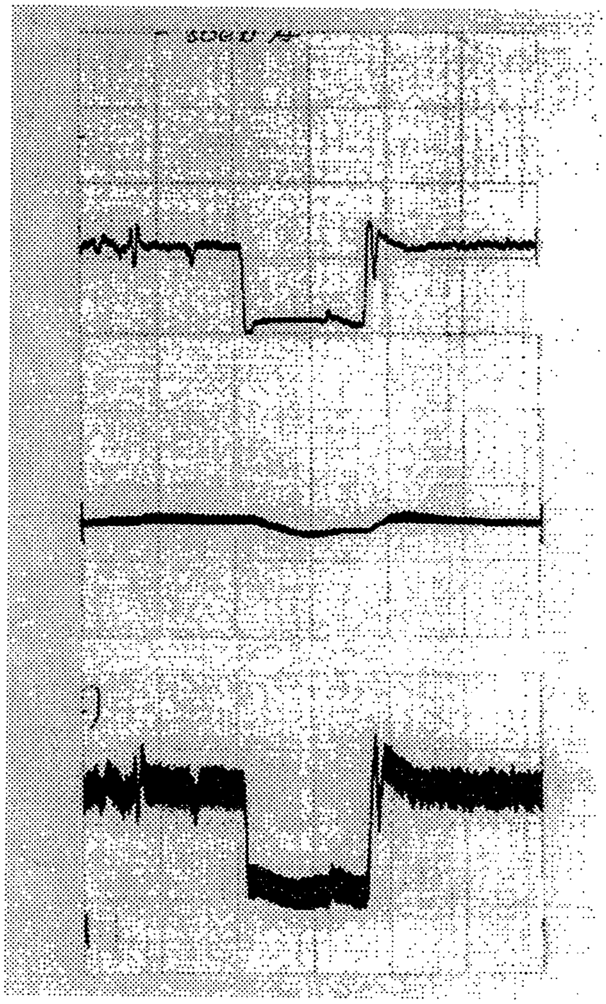


Figure 13 motor EMF at load impact.

Optimal motor utilisation control

The purpose of the optimal utilisation control is to minimize the thermal heating of the motor due to excess reactive power production.
In order to achieve an optimal utilisation of the motor with respect to the power factor, the control system is equipped with a two functions. One function , the machine convertor firing angle control (BETA-CALC), is minimising the machine convertor firing angle, b, The other function (PHIREF-CALC)is controlling the motor voltage level in the field weakening region.

The machine convertor firing angle control

The function is activated by setting OPTBETAS = "1" & VARBETAS = "1".
At low loadings, < 60 - 75 %, there is no need to minimize the -angle of the machine convertor in order to reduce the thermal heating of the motor. For this reason a speed dependent firing angle is used to limit the optimal firing angle.
SCR (System calculation responsable) must give information of how to set the speed dependent minimum b-angle, e.g. the parameters; BMAX, BMIN, BLEV2, BLEV3, NLEV1, NLEV2 and NLEV3. The settings of BFILTTC, LK, TQ and POLENR must also come from SCR. BETAMMAX must be set to 52 degrees for a 12-pulse series convertor.

The motor voltage level control

The function is activated by setting OPTMAGS = "1".
This function is calculating a signal, PHIREF, that is meassure of the relative magnetisation of the motor in order to achieve a constant dc-link voltage in the field weakening region.
The level of the dc-link voltage is set by the parameter DCLVOLT and the actual setting must come from SCR.
SCR must also give information of how to set the speed dependent limitation of PHIREF.

Speed control

General

Final tuning of the speed control should be done when the motor has been mechanically coupled to the drive object. Another precondition is that the control system for the motor's excitation (for example control of field weakening) has been adjusted and fine tuned. Additionally the tuning should be done in no load condition, ie with an unloaded drive object.

The speed control of the motor is a part of the convertor control system, which, in many applications, has a major influence on the entire performance of the process, ie the kind of industrial process where the motor-drive is a part. A good rule is therefore to determine the dynamic requirements on the speed control from the actual application and then not tune the control harder than required.

Advanced speed controller

The speed controller can be given different characteristics by parameter NMODE.

NMODE setting	Function
0	PI
1	PIPI or PDPI
2	PI-LP
3	RFE

Preparations

Set the parameter TESTMODE ="6".
Release the possibility for regenerative braking (only dual convertors) by setting parameter LOCKBRCH ="0".
Check the setting of the current limit.

Pre-set the speed control as follows:
NPROP ="1"
NGAIN = 1.0 or that value which the provisional setting gave
NTC1 = 1000 ms
NDERKD = 0.0.

Connect actual values for speed and current to a multichannel recorder.

Since the speed step disturbance is small compared to the speed set-point, the setpoint value has to be subtracted from the speed feedback signal connected to the chart recorder. This is done to get a good resolution of the step responce. For this purpose one output signal NSTEPDEV is generated in the speed controller.
The actual values of the current are accessible as hardware signals.

The speed actual value, NACT, is coupled on delivery to an analogue output port, see the circuit diagrams, CD. The current actual value is accessible as a hardware signal.

A suitable step disturbance is about 2 % and of one second duration for each step. The step's size should not be so large that the regulator's output signal is limited by the installed current limits.
In order to find the regulator settings quickly, the operating panel's REGISTR function can be used with advantage.

Adjustment of the speed control

NMODE = 0, PI controller

In drives without resonances of back-lash (fixed coupling - short shaft), the PI controller is often a good solution.

Set parameter NMODE = 0.

PI controller with derivating feedback gain

The controller's proportional part is set via the parameter NGAIN. The time integrating constant is set with parameter NTC1. The size of the derivating feedback gain is set via parameter NDERKD.

Increase the speed of the motor drive to a speed just below the base speed so that STEP and the actual NREF are less than the base speed. Generate a step disturbance by activating STEP. Check the step feedback and increase NGAIN in successively smaller steps till the shortest step feedback without overshoot is obtained. See figure 14 below.

Check the step feedback after each adjustment.

Check also that the current reference value is not limited by the current limit settings.

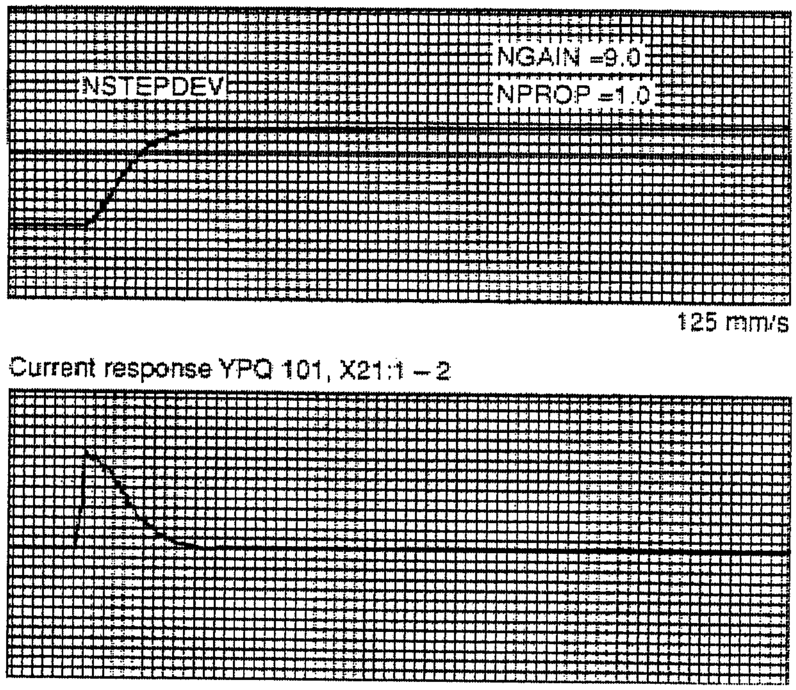


Figure 14. Step feedback when tuning NGAIN.

Subsequently set the parameter NPROP ="0". Then reduce the regulator's time constant via parameter NTC1 until a certain overshoot is noticed. See figure 15 below. Check the result after each adjustment.

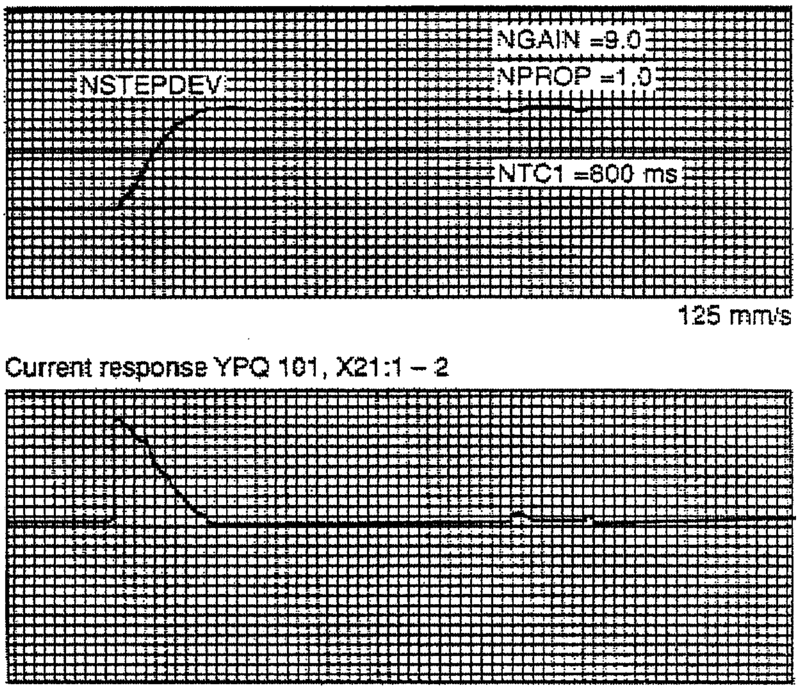


Figure 15.

Low dynamic requirements

If no high dynamic requirements are placed on the speed control, the tuning is completed by increasing the time constant NTC1 until overshoot just disappears.

Guide for minimizing impact speed drop

Following describes a quick method to find the optimal tuning of the speed controller to minimize the influence of load changes, which is normally the most important requirement on a drive system.

Normally the filter time constant NACTTC = 10 ms. The parameter is found in function module SPMEASXX. Choose a value of parameter NTC1 from table 1 below and increase NGAIN until the overshoot and rise time are in accordance with the table below. The estimated rise time is shown in column 3.

NTC1	Overshoot	Estimated rise time
600 ms	10 %	100 ms
300 ms	20 %	60 ms
180 ms	30 %	40 ms

Table 1. NACTTC = 10 ms

In case the performance achieved with this method is insufficient, the filter time constant NACTTC can be set to 0 ms.

Tune the controller in accordance with table 2 below.

NTC1	Overshoot	Estimated rise time
190 ms	20 %	35 ms
110 ms	30 %	25 ms

Table 2. NACTTC = 0 ms

When the performance is sufficient, the derivating function (NDERKD) is used to minimize the overshoot.

In case the performance is still not sufficient, it can be further improved by using the derivating function together with a retuning of the speed controller in accordance wiht table 3 (Kp0 and Ti0 are the values of NGAIN and NTC1 achieved form the tuning above).

NDERKD	NGAIN	NTC1
1.0	1.3 x Kp0	0.7 x Ti0
2.0	1.4 x Kp0	0.4 x Ti0
3.0	1.2 x Kp0	0.25 x Ti0

Table 3. Tuning with derivating function.

Note that with NDERKD = 1 the impact drop is reduced by 50% with NDERKD = 3 the reduction is 4.8 times.

If neccessary the tuning can be further improved by making torque steps with the TQSTEP function (TESTMODE = 9). Minimise the impact drop by adjusting NGAIN and NTC1.

NMODE = 1, PIPI/PDPI-controller

The PIPI/PDPI controller provides the possibility of increasing the gain within certain frequency ranges more than what is possible with an ordinary PI-controller. The adjustment is simplified if the system resonance frequency is known. The controller can then be adjusted with a lower gain in the range around the resonance frequency range around the resonance frequency and higher gain in other ranges. The controller can be adjusted either as a PIPI controller fig. 16 or as a PDPI-controller fig. 17.

The selection of either PIPI or PDPI depends on the total system. The PIPI controller is normally more stable than PDPI while the latter is faster.

The PIPI/PDPI controller is adjusted as follows:

1. Set the speed controller parameter NPROP to "1" to P-couple the controller.

2. Start the convertor. Increase the speed to approcimately 30% of nominal with the REF+ button. Make steps in the speed reference, using the STEPTEST function. A suitable step is approximately 2% and the duration can be approximately 2s. IAACT and NACT are to be logged. A suitable time setting on the logger for the two signals is 0.5-2 seconds.

Note! IAACT and NACT are normally preset on two of the logger channels when the equipment is delivered.

PIPI-controller

A PIPI-controller is obtained when NTC1 > NTC3 > NTC2. The setting is done as follows:

Set NMODE = 0. Make reference steps and increase NGAIN in suitable steps until signal NACT starts to oscillate.

Measure the time t of n peaks.

Calculate the resonance frequency (Hz) as follows:

$$f_{osc} = \frac{n}{t}$$

t = time in seconds

n= number of peaks

Reduce NGAIN until an overshoot of approximately 10 % is obtained.

Set parameter NPROP to "0".

Adjust NTC1 as for an ordinary PI-controller.

Calculate NTC2 (ms) as follows:

$$NTC2 = \frac{1}{2 \times p \times f_{osc}} \times 1000 \qquad \text{(ms)}$$

Set NMODE = 1. Set NTC2 to the calculated value , but not lower than 5 ms.

Set NTC3 to a value 2 to 3 times the value of NTC2.

Adjust the controller with parameters NGAIN and NTC3. If NTC3 is increased it is normally also possible to increase NGAIN and vice versa.

The regulator is adjusted until the performance required for the application is reached. The oscillations in current initiated by the resonance must also be kept at an acceptable level.

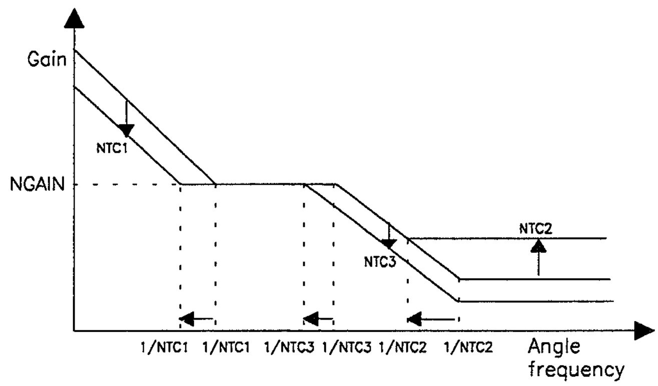


Fig. 16.

PDPI-controller

A PDPI-controller is obtained when NTC1 > NTC2 > NTC3.

The setting is done as follows:

Set NMODE = 0. Adjust NGAIN and NTC1 as for an ordinary PI-con-troller. Measure the rise time of the speed feedback. Set NMODE = 1. Set NTC2 to 0.5 times the rise time as start value. Set NTC3 to 0.5 times NTC2 as start value.

This setting will make it possible to increase NGAIN and decrease NTC2 and NTC3.

As a result of the adjustment the rise time is to be shorter than with a PI-controller.

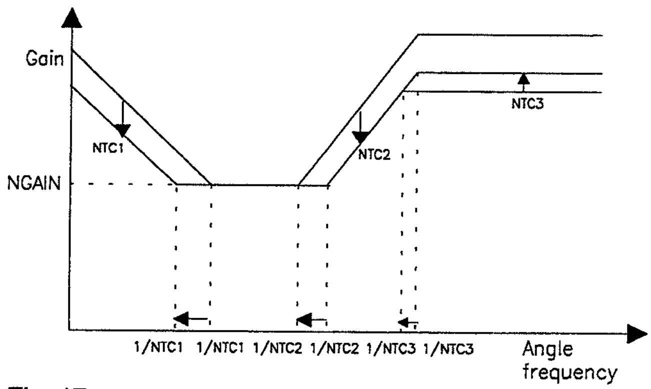


Fig. 17.

NMODE = 2, PI - LP-controller

The PI-LP controller is a PI controller with a second order Butterworth filter. The LP-filter is used in systems with speed measurement noise. It will effectively eliminate high frequency noise. Normally this is not used on resonant systems.

Tuning

Set NMODE = 2 and NTC2 = 0. NTC3 will become the time constant for the LP-filter. NTC3 should be set to approximately the rise time divided by 4 - 5. Setting NTC3 too close to the rise time will generate a too big overshoot.

Tune the PI-controller as described for standard speed controller.

NMODE = 3, RFE-controller

The RFE speed controller is used in systems with resonances and backlash to increase performance by means of active elimination of resonances.

Parameters for tuning the RFE-controller:

NGAIN	proportional part
NTC1	integration time constant
NTC2	lead time constant
NLAG	lag constant (lead time/lag time)
NKSI0	damping (default 0)

The tuning parameters NGAIN and NTC1 are equivalent to the PI controller. The RFE function is mainly tuned with NTC2 and NLAG. NKSI0 is then used for reducing overshoot in speed step responce.

Set the speed measurement filter time constant to 0 (Function module SPMEASXX, parameter NACTTC). Parameter NDERKD is normally not used and should remain 0.

Find resonance

If the resonance is not known it can be measured by the following sequence:

Record NSTEPDEV from a TQSTEP (TESTMODE = 9). NGAIN should in this case be tuned as low as possible. Use the PI - LP function (NMODE = 2, NTC2 = 0) to avoid controller action for high frequencies.

Recommended settings:

Function module TQLST1:
  TQSTRATE = 0
Function module NCTRL2:
  NMODE = 2, NTC2 = 0 (PI - LP controller)
  NGAIN = 1 (or as low as possible)
  NTC1 = 8.19 s (max value)
  NTC3 = 200 ms

Step test:
  TESTMODE = 9, STEP = 10 % (or more if needed)
  TIME = 0.1 s

Measure the time t of n peaks.

Calculate the resonance frequency (Hz) as follows:

$$f_{osc} = \frac{n}{t}$$

t = time in seconds

n= number of peaks

$$tosc = \frac{1}{2 \times p \times fosc} \times 1000 \text{ (ms)}$$

Tuning

Set NMODE = 3.

Initial settings are: NTC2 = 2 x t_{osc}
NLAG = 2

Adjust NGAIN and NTC1 until acceptable performance is achieved. (This is done with NSTEP of 1 - 2 %). Start as usual with low gain and increase the gain until acceptable performance is achieved. If necessary adjust NLAG. To reduce low frequency oscillations, decrease NLAG, to avoid resonance oscillations, increase NLAG. Typical setting of NLAG is 1.0 - 3.0.

In special cases it may be necessary to reduce NTC2. Typical setting of NTC2 is 1.1 x t_{osc} - 2.0 x t_{osc}.

Optimizing the RFE function

The damping is optimized by finding the best combination of NTC2 and NLAG. This is best done by performing a TQSTEP (TQSTRATE = 0). Normally the optimum is found by first adjusting NLAG and then NTC2.

The high frequency gain is NGAIN/(NLAG)^2. This means that a high value of NLAG is preferred.

The value of NTC2 must be greater than t_{osc}
If NTC2 is less than t_{osc} the system will normally become unstable. Remember that the effect of backlash can give variations in the resonance frequency.

Final tuning

Check the step feedback. If the overshoot is too high, it can sometimes be reduced by increasing parameter NKSI0.

If higher performance is needed, try to increase NGAIN and/or decrease NTC1. You can change NTC1 without making a new tuning of the RFE, but after changing NGAIN you have to tune the RFE over again (go back to "Optimizing the RFE function").

Remark

The RFE function can in special cases be tuned with NMODE = 2. Then the time lag constant NTC3 should be set to NLAG x NTC2, and NTC2 should be tuned as with NMODE = 3.

In this case the optimization is more difficult.

Robustness test

For all types of controllers it is essential to make a robustness test before leaving the system to production. This is done by checking the stability at a higher NGAIN.

Checking of control above base speed

This check is only needed when the motor drive is going to be run in the field weakening region.

Testing of the speed control is done in the same way as described earlier, with the difference that a step is generated when the motor speed is 90 % of the maximum speed.

The step feedback for the signal NACT should be the same as after earlier adjustments of the speed control because of signal FLUXREF. This signal increases the speed control's gain, as compensation for lower field current. If the speed control becomes unstable the following two alternatives provide

1. Reduce parameter ADAPTLIM to half of the difference between maximum and base speed.

2. Reduce NGAIN in the speed control.

Check the above by generating step disturbances and studying the step feedback. Begin with alternative 1. If the speed control is still unstable, the value of the parameters must be reduced further until the control is stable.

Test of the control regarding to load change

This test is needed only in applications with high dynamic requirements on the speed control.In certain applications the ability of the speed control to fast eliminiate the speed error, due to a sudden load change, is the most important requirement. In order to simplify this test the TESTMODE =9 exsists. The signal STEP from the STEP-function is added to the torque reference value after it has passed a ramp function. The time characteristic of the "step" can be adjusted by the parameter TQSTRATE. This is a way of simulating the impact speed drop caused by a bar entering a roll-gap, for example. Thus:

Set TESTMODE =9.
Adjust a suitable value on the "torque disturbance", STEP
Start the motor drive and increase the speed setpoint to
a suitable value. Generate a step disturbance with help of the STEP-function. If the signal NSTEPDEV is registered via a chart recorder, a speed feedback identical to the picture in figure 18 below will be obtained.

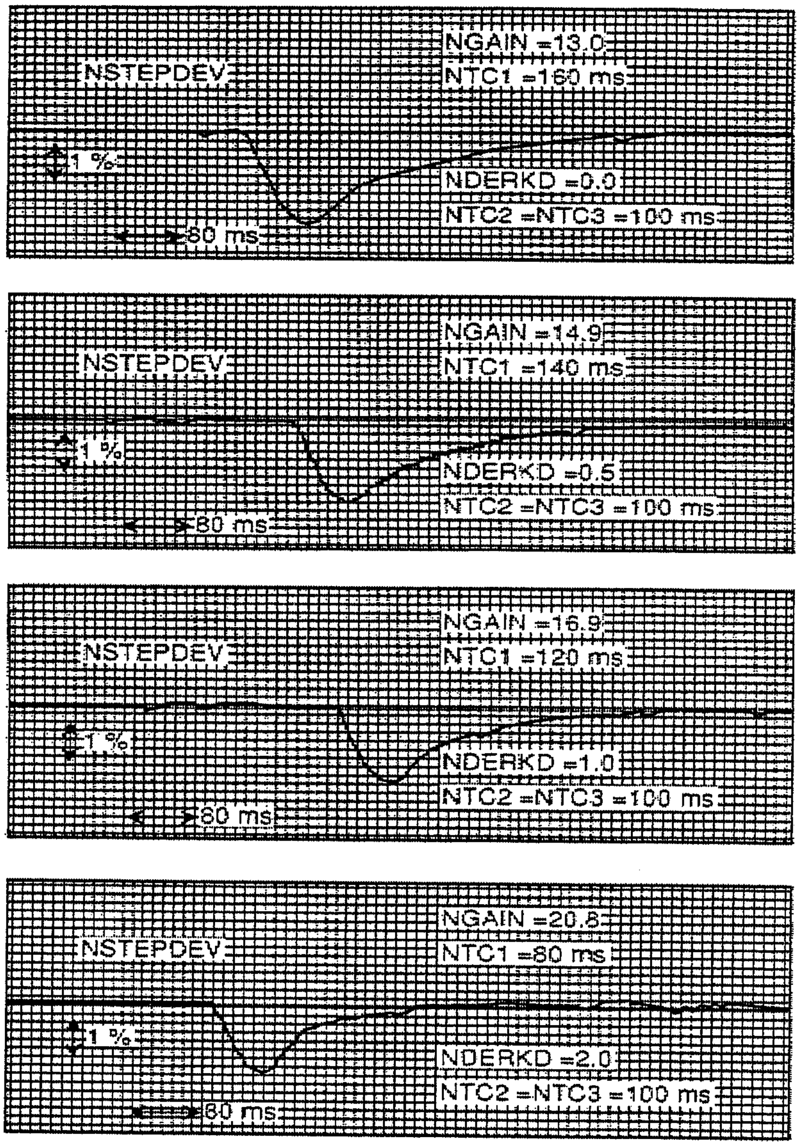


Figure 18. Step response for load change.

The total time to recover after a torque step should be 4 – 6 times the time for the initial speed drop. The initial speed drop counts from the point where speed starts to fall, the time when the step was generated, until the point where it just starts to rise again.

Thyristor temperature, supervision via thermal model

Description

Temperature supervision

The function module TYTEMPXX contains an advanced temperature model for the supervision of the thyristor junction temperature, which should normally not exceed 125°C. The input signals to the module are, amongst others, the ambient temperature inside the thyristor cubicle and the average value of the currents in the forward and reverse bridges. The thyristors' power dissipation consists of on-state power loss and switch losses, which are continuously calculated. The calculation of the switch losses is based upon the actual delay angle and the level of the main circuit voltage.

The heat is conducted away by heat sinks and forced air flow. The temperatures are calculated in the model. The model is a series of low-pass functions with different time constants and heat transfer data. Information about actual physical data and time constants are to be found in a library for all possible combinations of thyristors and heat sinks. If the fan stops or the air pressure falls too low, the input signal COOLON is set to zero, and the temperature model is given new heat transfer data. The model is in this way adapted automatically to the new condition, and a warning is activated.

Testing and commissioning function

In order to study the thyristor temperature under various loading conditions, with the convertor in off-condition, there is a special test module, TYTESTXX. The module generates special actual values of current for the testing of TYTEMPXX. For commissioning and test, a special load cycle simulator can be used, in which the parameters are set in accordance with a desired load profile. Alternatively a constant current can be generated in the forward or reverse direction. The module can be used as a field tool for testing whether the convertor can handle a particular load or load profile.

Adjustment of TYTEMPXX

Choice of components

In order to have the right data in the temperature model, a component choice must be made.

1) Thyristors, main type

Parameters WE540S, YST14S, YST35S, YST45S and YST60S are all of a logical nature. The parameter corresponding to the actual thyristor type should be activated.

2) Thyristors, voltage class

The thyristors have an extension in their type number, which refers to the voltage class. This must be supplied using parameter RATESEL.
When the thyristor type is WE540-a1 then set parameter RATESEL = 1.

3) Heat Sink

There are two types of heat sinks:
YAP 8-03 (older type heat sink) and YAP X-XX (new heat sink).
Parameter YAP803S or YAPXXXS should be activated.

The temperature model's data is calculated at the start of the control system (INIT level). If any component choice is incorrect, for example double-defined components, or a voltage class which does not exist, an error message is activated on the operating panel:
"THERMAL DATA INCORRECT".

Example:
A bridge with YST 45-27 and YAP 8-03.

The parameters should be supplied as follows:

WE540S = "0", YST14S = "0", YST35S = "0", YST45S = "0",
YST60S="0", RATESEL=27, YAP803S="1", YAPXXXS="1"

If an error message is presented, the parameters should be corrected. Switch the operating voltage off and on, so that a new INIT will be effected.

Other parameters to be set

If the thyristor ambient temperature is measured with the Pt100-element inside the thyristor cubicle the parameter PT100S is set ="1". If the ambient temperature is not measured it is adjusted to a value equivalent to the highest likely ambient temperature with the parameter AMBTEMPS. In another case it can also be set with the parameter AMBTEMPS. AMBTEMPS is set to a constant value, equivalent to the highest likely ambient temperature.

The parameters CURSHF and CURSHR are current sharing factors for forward and reverse bridges. The net inductance per phase, the short circuit inductance at the convertor's connection point, should be input in µHenry with the parameter LMAINS found in the start-up module STRTCS.

The number of parallel thyristors in the forward and reverse bridges is set with the parameters NOPFTHY and NOPRTHY.

Adjustment of indication levels

Normally the same levels will be set for forward and reverse bridges. A high temperature is indicated by signal THYHT and an error message about which bridge is indicating high temperature is written into the fault logger. The levels are set with the parameters THYHTLF and THYHTLR, normally 115°C.

The level for overtemperature should be 125°C and is set with parameters THYOTLF and THYOTLR. At overtemperature, the convertor will trip.

Adjustment of ambient temperature (calibration of input signal from Pt100 element).

The metering resistance for a Pt100 element, according to DIN 43760, is: T=0°C: R=100 OHMS , T=100°C: R=138.5 OHMS ; the resistance increases linearly with the temperature. The Pt100 element is connected to a 5 mA current generator on board YPQ202.

Adjustment can be performed in two ways:

<u>A) Ambient temperature is known</u>

If there is a thermometer available, for example a mercury thermometer, the adjustment is made as follows:

Set parameter PT100S="1". Read off the signal AMBTEMP on the operator panel. The signal is adjusted with parameter AI37.1MU/AI37.2MU, until it shows the same value as the thermometer.

<u>B) Ambient temperature is unknown</u>

A potentiometer of maximum 500 W is set to 100 W, and coupled to AI37.1/AI37.2. The parameter PT100S="1". Read off AMBTEMP on the operator panel and adjust with AI37.1MU/AI37.2MU until the signal displays 0°C. Replace the potentiometer thereafter with the Pt100-element.

Testing of protection with help of TYTESTOX

Load cycle simulator

Load cycle simulation is activated by setting the parameter TESTTYPE=1. In order to use this function, the program diagram (PD) should be available.

The use of the simulator is explained best with an example.

Assume that, for a certain type of production, a mill generates a certain load profile for the convertor, such as, for example:

Acceleration	3 s	130%	of the convertor's rated current
Working	20 s	80%	of the convertor's rated current
Braking	5 s	100%	of the convertor's rated current
Idling	10 s	3%	of the convertor's rated current

The load consists of 8 rolling passes, ie a total load cycle which consists of 8 shorter cycles.

Set the parameters thus:

IDACCEL	=130 %,	TBASE	=20 s,
IDWORK	=80 %,	TRETARD	= 5 s,
IDRETARD	=100 %,	TIDLE	=10 s,
IDIDLE	=3 %,	NCYCLES	= 8.
TACCEL	= 3 s,		

If the direction of rotation should change after every pass, the parameter ALTROTD should be ="1". For a fixed positive direction, the parameter ALTROTD should be set to "0". With the parameter EXPFACT it is possible to expand the time for load, in accordance with the following formula:

$TWORK_1$ =TBASE $TWORK_{(k+1)}$=EXPFACT x $TWORK_k$

Example:
There is a requirement that the working interval should expand 150 % for each new pass. Set EXPFACT to 150 %. This means that the times will become:

$TWORK_1$ =20s, $TWORK_2$ =30s, $TWORK_3$ =45s.

If the work interval should be constant, EXPFACT is set to 100 %.

Test with constant current

Set parameter TESTTYPE=2. In this state it is possible to enter a constant load in percentage of the convertor's rated current, with the parameter IDTETEST. The direction is determined by the parameter IDTEFWD, which is set to "1" for forward direction. The load can be changed, by changing the parameter IDTETEST at any time during the test.

Activation of the test

When all parameters are correctly entered, the test can begin. It is activated by setting parameter TESTON="1". The test can be stopped at any time by resetting TESTON="0". If TESTON is activated again, the test restarts from the beginning. The temperatures, TYTEMPF and TYTEMPR can be read on the operating panel under the caption for function module TYTEMPXX. When the convertor has received an ON order, the test can not be conducted. If the parameter COOLONT is set to "0" during the test, the temperature development can be studied in the thyristors when the fan stops or the cool air flow falls too low.

> **NOTE!** Remember to reset TESTTYPE = 0 and TESTON = "0" when the test is completed.

Adjustment of various protective and supervisory functions

General

The protective functions mentioned below is not a complete list. Only those protective functions are mentioned, which cannot be finally set during factory testing, and which do need to be tested together with the actual motor.

Choice of trip or warning

It is possible to choose warnings instead of cut-outs for a number of the convertor's protective and supervisory functions. During commissioning, the choice of warning or trip is made in consultation with the customer.

When a signal is sent from a protective or supervisory function, and the signal is coupled for a warning, the red lamp on the drive system operator panel begins to blink. An error message is sent to the error log, where it is stored as the last message.

When a warning (the signal TRIPWARN) has been activated, a timing element is started. When the time period, TPWARDEL, has expired, the signal TRIPWTO (trip warning time out) is set to "1". This generates a trip via the signal TRIP3, if parameter REMSTOR is "0". If this parameter, on the other hand, is set to "1", it is possible to block a trip via the superior control system, provided signal ACKTRIPW="1" when the information about the warning is received by the superior control system.

Speed supervision

Over speed

Check

Start the convertor and increase speed to 100%.

Set parameter MOTOSPL in function module SPMONXX to 99 %. The convertor should trip because of over-speeding.

Adjustment

Normal adjustment of parameter MOTOSPL is 110 %, which allows the speed to be 10 % higher than nominal.

NOTE!	With pulse transducer feedback the following applies. If parameter MOTOSPL is set much too high, so that it results in a pulse frequency higher than the maximum pulse frequency of 50 kHz, the convertor trip because of "OVER-SPEEDING".

Loss of speed feedback

Adjustment

Normal adjustment of the protective feature is as follows: parameter ALPHANSP is equal to 60, parameter MOTNSPL is equal to 5 %. The time delay, parameter NSPTIME, is set equal to 200 ms.

It must be checked that the protection is not tripping the convertor when the motor accelerates fully from stationary state with rated load.

If the convertor cuts out because of lost speed feedback, the value of parameter ALPHANSP must be reduced (5^o at a time, but not below 30^o). Alternatively the time delay must be increased.

Overvoltage protection

General

It is possible to supervise the motor voltage in several ways: in the convertor control unit (function module IUMONLXX) and in the drive system control unit (in function modules EMFMONXX and FSIGHAXX).

The overvoltage of the armature circuit is generated by the motor itself. There is two components of the drive package that can be damaged due to the overvoltage, machine convertor and the motor (the main stator winding). Normally is the machine convertor is the most sensitive component of the two. But the ability for the machine convertor to withstand high voltage is changed if the firing pulses to the machine convertor is blocked.

In order to deal with this situation the overvoltage protection is designed in a special way. Which means that a detected overvoltage doesn't lead to a trip of the drive immediately, but to block the machine convertor thyristor trigger pulses.

Convertor control system

In the convertor control unit, in function module IUMONLXX, PD page 329, the motor voltage via UM0ACT is supervised.

The over voltage detection level is set by the parameter UMOVL [V]. The detected over voltage is then generating a blocking of the machine convertor firing pulses via the signal ARMOV1 and a suppression of the current control via the signal RETARMOV. To release the detected over voltage the actual motor voltage must decrease under a level that is defined by the setting of the hysteresis, UMOVLL [%].

If the motor voltage exceeds the setting of UMOVHL, this leads to a trip of the drive.

Normal adjustment:
UMOVL equal to 1.25 * UVNOM
UMOVLL equal to 95 %
UMOVHL equal to 1.2 * UMOVL

Note! If the motor is equally sensitive regarding over voltage as the machine convertor, the setting of UMOVVHL should be the same as for UMOVL.

Drive system control

There are two possibilities to supervise the motor voltage.
With the CONNECT function it is possible to connect an analogue signal proportional to the motor's voltage to the input signal EMFACT1 in function module EMFMONXX. With parameter MOTOVL the trip level is set. Alternatively, a digital signal can be connected to the signal MOT1OV/MOT2OV, via the CONNECT function. This digital input signal is prepared to come from an electromechanical overvoltage relay, which can be ordered as an option.

Overload protection of the motor

The output signals from this function module are connected to function module FSIGHAXX, in which signal ARMOL is created from ARMOL1 and ARMHL from signals ARMHL1.

The output signal ARMOL is normally set to trip, but, with the help of parameter ARMOLS in function module TRPDSXX the trip can be disconnected, and a warning selected instead, with the parameter AOLTRP3S, which is accessed via the terminal.

Adjustment of parameters MOTCURM and MOTORTC, in function module MOTOL1XX, is dependent upon the type of motor being used. Examples of satisfactory settings for a large motor is MOTORTC =600 s and MOTCURM =200 %.

NOTE!	After adjustment of the parameters in function module MOTOL1XX the control system must be restarted, in order that the change will be activated.

Overload protection of the field

The output signal FLDOL from the function module FLDOLMXX is normally set to trip, but with the help of parameter FLDOLS in function module TRPFEXX the trip can be disconnected, and a warning will be activated. Adjustment of parameters FLDCURM and FLDTC, in function module FLDOLMXX, is dependent upon the type of field being used. Default setting is normally OK. FLDTC = 300 sec and FLDCURM = 200 %.

NOTE! After adjustment of the parameters in function module FLDOLMXX the control system must be restarted, in order that the change will be activated.

Overcurrent protection

Overcurrent protection is set to 140% of the highest value on the installed current limit in function module IAREFHXX, positive current limit (signal IALIMP1) or negative current limit (signal IALIMN1). The trip level is set in amperes, with the aid of parameter OCURFL (forward direction) in function module IUMONLXX.

Indication of interruption in the current circuit

The protection is used to detect fuse interruptions or to indicate a thyristor which does not trig. If the indication via signal ARMNC is to result in a trip, parameter ARMNCTS must be set to "1".

The signal ARMNCNBR indicates which thyristor is not conducting current.

Supervision of motor temperature with Pt100 transmitter

Function module MOTEM1XX is normally used to supervise the motors winding temperature, but can also be used to supervise the bearing temperature and, in certain cases, air temperature.

On delivery of the motor which has been equipped with the Pt100 transmitter, the enclosed documentation (XO manual) gives the temperature level at which a temperature warning should be given, and the temperature level at which the protection will trip the convertor.

See also maintenance and commissioning instructions for the actual motor.

On the terminal card to the analogue input card is a 5 mA current generator for supplying the Pt100 transmitter with 5 mA. Jumpers 1-2 and 3-4 should be removed on the actual input. The actual input on the analogue input card should have jumpers set for 1 V.

The trip level for overheating of the windings is set with parameter MWOTL. Warning of high temperature in the windings is set by the parameter MWHTL, accessible via the terminal, in such a way that its value is subtracted from the value of the parameter MWOTL.

Supervision of bearing lubrication

Digital input signals from, for example, pressure switches, can be connected to the input signals MOALUBFT and LOBLUBFT in function module FSIGHAXX, with the aid of the CONNECT function.

Supervision of thyristor temperature with the Pt100 transmitter

Function module TYTEMPXX supervises the thyristor junction temperature with the aid of the Pt100 transmitter mounted on the thyristor heat sink.

On the terminal card to the analogue input card is a 5 mA current generator for supply of the Pt100 transmitter. Jumpers 1-2 and 3-4 should be removed for the actual input. The actual input on the analogue input card should have jumpers set for 1 V.

High thyristor temperature is indicated by the signal THYHPT and the level is set with parameter THYHTL. If the level of parameter THYOTL is exceeded, signal THYOPT is set to "1" and the convertor will trip.

The parameters are adjusted in connection with factory testing, and do not normally need to be altered on commissioning.

Installing of protection against external problems

In the module it is possible to choose between delay for trip or warning. It is also possible to choose whether an external problem should result in trip or warning.

NOTE!	The standard setting of the parameter gives a warning

Adjustment of drive stalled protection

The drive stalled protection is primarily intended to be a protection for the motor.

In applications where large vibrational torque can be needed it may be necessary to adjust the pre-installed parameter values.

Normally the dc-link current level is set to 100%, via parameter STALLIAL. The speed level is set with parameter STALLSPL to 2 %. The delay is set with parameter STALLTD to 3 seconds.

Earth fault protection

Main circuit

Earth fault protection in main circuits is using an active, injecting type of protection. The protection will be active also with no power on main circuits. For testing; disconnect main power. Make a temporary connection between one phase and ground . Earth fault should indicate. Make sure to remove the temporary connection.

Auxillary circuit and field exicter

Earth fault in aux. circuits and field exciter is using a single current transformer . For testing, use a separate current source and inject current. Earth fault should indicate this unbalanced current.

Combined running of the superior system, with another drive system

Master field bus

Check that the node number, that is the value of parameter UNIT_NO, agrees with the value used in the ABB Master system.

The communication is activated by first setting parameter BUSSEL to "1", and then restarting the control system, ie a re-initialising of the program.

It is easy to check that communication as been correctly established, that is that ABB master has contact with the convertor and vice versa, by observing whether the LEDs RX and TX on the modem card YPC104, position 1, are lit.

If the system consists of a tandem coupled motor drive, and if the possibility is desired to choose from the superior control system whether convertor A or convertor B or both are active, Parameter CONLM in function module CONSEL must be set to "1".

Leader-follower communication

Check that parameters SECTTYPE and FOLLOW1S in function module STRTDSXX and parameter FNOD_NO in function module CVTRAXX are properly set.

DRIVE TYPE	Single	Leader	Follower
SECTTYPE	0	1	2
FOLLOW1S	"0"	"1"	"0"
FNOD_NO		0	1

It is easy to check that communication as been correctly established, that is that ABB master has contact with the convertor and vice versa,
by observing whether the LEDs RX and TX on the modem card YPC104, position 1, are lit.

Concluding measures

The connections of I/O-signals which are required for the drive (signals to meters for example) should be done if this has not yet been done. Connection of signals can naturally be done successively during the commissioning and documented by entering signal name and page references in the circuit diagram (CD).

Remove the error log by occasionally setting the parameter FCLEAR in function module FLTLXXXX to "1".

Preset the signal logger to six signals which may be of interest at fault tracing, and start the log.

Set breaker S10, at the top of the computer card YPP105, in position PS. A cross should now be visible in the circle on the monitor (prevents resetting of the parameter).

Final actions

Tuning of arm. reaction comp.

In demanding applications a final tuning of the armature reaction compensation is needed while the motor drive is operating in production. The motor drive will then be loaded and unloaded in a way which makes it easy to find the correct setting of the compensation. See also previous section headed "Tuning the arm. reaction comp.".

Checking the machine convertor control performance

The tuning of the machine voltage filtering must be checked during production when the motor loading is close to the rated.
With a steady state load its easy to make a fine tuning of the filtering.

When the machine is loaded with a steady state load it is important to check the control angle definition.

Check the pulse train at B32.12 and B32.32, YYI 107, testpoints X14:1, X14:2 and X14:3 with an oscilloscope.
The pulses shall be symmetrically "high" and "low", symmetry can be adjusted on:
X14:1 by R226
X14:2 by R224
X14:3 by R225
Make fine tuning if necessary
The actual machine convertor firing angle must be checked while the drive is loaded close to the rated. The actual firing angle must agree with the ordered, by the software controlled, firing angle, BETAM.

See also the previous section headed " Adjustment of machine convertor control cont."

Parameter dumping

The parameter settings in all control units, drive system, convertor system and field exciter, must be dumped on PC-files. A copy of these files should be sent to ABB Industrial Systems AB, after a finished commissioning.

Documentation of regulator settings

The settings of the regulators for the various control loops in system must be documented together with a recording showing the step feedback with the actual regulator setting.

Documentation of performance

For demanding applications, for example rolling mills, the performance of the drive must be recorded when it's operating in production or production like circumstances.

The actual values of speed, motor current, motor voltage and applied field current, which means exciter stator current for brushless drives. All these values must be recorded together on a common chart. It's of particular interest to see the variations of these values caused by variations of the load.

Maintenance

Contents

General

Tyrak LCI convertors contain no components subject to wear in the usual sense of the word.

The maintenance of these convertors is therefore mainly of a preventive nature. This type of maintenance is common to all electrical equipment and can therefore be included in the general service routine of the installation.

Check points

The convertor should be inspected at regular intervals, determined by the nature of its operation and its working environment (vibration, dust, humidity etc.).

The following points should then be checked:

- Fouling
- Connections
- Fixings

Personnel safety! The power supply to the convertor must be disconnected during maintenance work.

Fouling

Cubicles must be cleaned from all accumulated fouling. Dust and scraps of material are easiest removed with a vacuum cleaner. Compressed air can be used in extreme cases but the air supply must be free from condense.

Stubborn fouling can be removed with isopropyl alcohol solvent followed by blowing with clean compressed air. If badly soiled, the display can be cleaned with a cloth dampened with a mild solution of detergent.

If the convertor cubicle contains an air filter or screened ventilation opening, this should be checked at regular intervals and cleaned as necessary or replaced. The filter should be removed from its holder and cleaned at such a distance from the convertor that the dust etc. does not reenter the cubicle.

A lightly soiled filter can be cleaned carefully with compressed air but any considerable fouling may require washing in a mild detergent solution.

The convertor should be inspected for signs of physical damage, overheated components etc. after cleaning.

Connections

Main circuits

Test with a torque wrench all cable termination's and bus bars joints. Check particularly connections to aluminium parts and connections to the thyristor. Following torque values should be set on the wrench:

	Mechanical fixings
M4	1.4 Nm
M5	2.9 Nm
M6	9 Nm
M8	20 Nm
M10	40 Nm
M12	72 Nm

For thread-forming screws in sheet metal (T = 2 mm), use 6 Nm.

Other circuits

Check, with a screwdriver, wire connections to electrical components and to terminal blocks.

Fixing

Ensure that all parts are fixed securely and that there are no loose screws or nuts.

Check the fixing and connections of the circuit boards on the control equipment.

Cables are to be routed and supported to avoid chafing against sharp edges.

Replacement of parts

Fast acting fuses

When replacing fuses, ensure that the new fuses are of the correct type and rating. Check towards the apparatus list of the convertor concerned.

Fan, d.c field exciter 40 - 120 A, a.c field exciter 55-95 A

- Un-plug the fan connector and remove the earth connection. Remove one screw holding the fan. Slide the fan sideways (right) and out.
- Move the fan connector to the new fan, (check connections) and install the new fan in the opposite manner.

Fan, d.c field exciter 195 - 530 A, a.c field exciter 285-430 A

- Un-plug the fan connector and remove the earth connection. Remove the two screws holding the fan. Lift the fan up and out.
- Move the fan connector to the new fan, (check connections) and install the new fan in the opposite manner.

Fan, armature bridge

- Disconnect the cable at the fan motor terminals.
- Disconnect the earth cable between the fan housing and the cubicle.
- The fan housing can now be unscrewed and lifted out.

Thyristor

Installation of thyristors

The following procedures must be followed when installing thyristors and thyristor modules on heat sinks.

- If the contact surfaces of the heat sink and/or the thyristor are uneven, oxidised or soiled:

  Polish the contact surface very lightly (2 strokes) with abrasive cloth (gauge 600). Clean the contact surfaces with denatured alcohol and a lint-free cloth. Apply a very thin layer of silicon grease to the contact surface using a lint-free cloth.

- Field exciter thyristor modules:

  Place the module in position and tighten the screws with the following torque:

	Mechanical fixings	Electrical connections
M5	4 Nm	4 Nm
M6	5.5 Nm	5.5 Nm
M8		15 Nm

- "Puck" thyristors:

  Locate the thyristor between the heatsinks and push it inwards so it makes contact with the support. Check that the thyristor is oriented correctly (a conduction symbol is located on the component).

See also the installation instructions supplied with the thyristor.

Thyristor, d.c field exciter 40 - 115 A, a.c field exciter 55-95 A

Each thyristor module contains 2 thyristors.

- Disconnect all cables from the module which is to be replaced. Note the markings of all conductors to avoid confusion when these are replaced.
- Unscrew the thyristor module itself.
- Check towards the apparatus list that the new module is of the correct type before installing it.

Thyristor, d.c field exciter 195 - 515 A, a.c field exciter 285-430 A

Each thyristor module contains two thyristors.

- Disconnect the flat tabs to the trigger pulse cables on the thyristor module concerned. Note the cable numbers, to avoid confusion when replacing these. ate and cathode have flat tabs of different sizes so that these cannot be replaced incorrectly.
- Slacken, approximately 5 turns, all screws to the copper bars L1,L2,L3, and U1,V1,W1 (for d.c exciter L+ and L-) which connect the modules.
- Remove all screws to the module which is to be replaced.
- The module can now be removed towards the left.
- Check towards the apparatus list that the new module is of the correct type before it is screwed in place.

Thyristor, armature bridge

- Remove the trigger pulse connections (red and white leads).
- Loosen the mounting clamp at the top of the thyristor stack. After initial loosening, make sure to snap out the indication spring to avoid damage during the continued loosening.
  When the force of the mounting clamp is released, the tip of the indication spring should be flush with the upper surface of the mounting clamps.
- Attach the disassembly tool at the faulty thyristor and pry the upper and lower heat sinks apart, see fig. 1. The copper bars need not to be loosened.
- Pull out the thyristor.
- Check towards the apparatus list that the new thyristor is of the correct type before it is put in place. Ensure that the thyristor is correctly oriented.

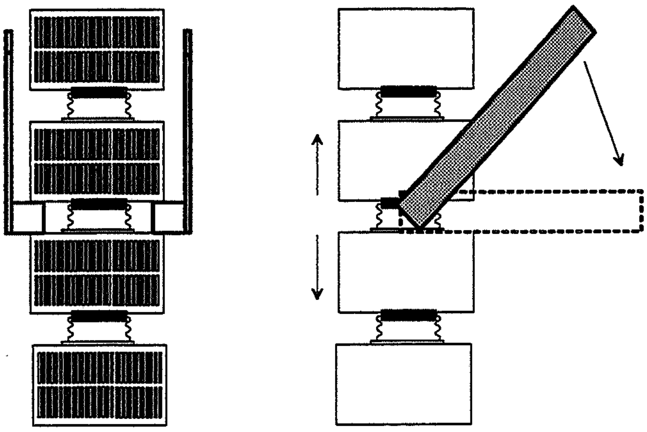


Fig. 1 Thyristor stack armature bridge
Front view Side view

Circuit boards

The main voltage must be disconnected when replacing circuit boards.

Important!
Circuit boards are easily damaged by discharge of static electricity.

The person handling a circuit board should always first discharge himself to the cubicle frame, preferably using an earthed wrist band. Circuit boards are always to be stored in envelopes of conductive plastic.

Remove all ribbon cables and/or screw terminal blocks from the board.

Remove all screws holding the board.

Check jumpers and components on solder posts to ensure agreement between the new and the old board.

Some boards require special handling.

Pulse transformer unit, field exciter 40 - 530 A

- Disconnect ribbon cable X31 and the screw connector X14(for d.c exciters screw connector X1).
- Lift the upper part of the PC board off its plastic holders.
- Pull the board straight out. Remove the trigger pulse connectors.

Circuit board for operator's panel

- Remove the ribbon cables X32 (key pad) and X33.
- Remove the 4 nuts holding the board.

PROM-capsules

Unnecessary handling of loose PROM's should be avoided. When exchanging control programs, it is recommended that the complete memory board is replaced.

If, however, replacement of any individual PROM-capsule is necessary, the following rules are to be observed:

- The convertor must be switched off.
- The operator should use a conductive wristband.
- Handle the PROM's carefully, protected from static electricity. It is recommended that PROM's are stored in the packing in which they were received from ABB Industrial Systems.
- Make sure that the correct PROM was removed, that the replacement is correct and properly inserted in the socket.
- Before the convertor is returned to service after replacement of a PROM, the 1 F capacitor for memory back-up power on processor board YPQ201 must be short-circuited at pins X26.1 and 2 adjacent to the capacitor. Because of the high internal resistance in the capacitor, the short-circuiting must continue for at least 1 minute.

Key pad for operator's panel

- Disconnect ribbon cable X32 to the key pad.
- Remove the text strip for the push buttons.
- Lever up one corner of the key pad, for example with a knife, and remove the complete key pad.
- Clean the panel carefully with denatured alcohol and allow to dry before pasting on the new button set.
- Remove the protective backing paper on the new button set and slide in the ribbon cable in the opening. Note! The adhesive sticks immediately.
- Use the display as a guide and press from the middle toward the edges.
- Return the text strip and connect the ribbon cable.

  Note! A button set installed incorrectly cannot be removed without being damaged and must therefore be scrapped.

Fault tracing

Contents

Introduction

General advice for fault tracing is given in the section headed **General.**

Important advice on Safety is given in the section headed **Personal Safety.**

Certain faults do not result in an indication on the operator panel. See the section headed **General malfunctions.**

The operator panels display the faults that are detected by the built-in protection and monitoring functions. The faults, together with possible causes and corrective action, are covered in appendices entitled **fault texts, drive system, fault texts converter**, and **fault texts exciter.**

Many of the printed circuit boards have LEDs for indications. These are explained in the section headed **LED indications on boards.**

In a control system with feedback it is often hard to determine what is cause and, what is effect. The control system for TYRAK LCI is therefore equipped with a special test function that makes it possible to test each control loop individually. This is described in the section headed **Built-in test function.**

Faults in the software application are sometimes of an intermittent nature. In such cases the operator panel is used for fault tracing, as described in the section headed **Fault tracing using the operator panel.**

General

When the convertor will not start, or when a malfunction occurs in service, a hardware fault should always be suspected. Generally this is due to a badly connected cable, or a fault in a switching device, transducer or electronics board.

Converter malfunctions may also arise in conjunction with changes in duty, such as higher load, higher speed, etc. These malfunctions are generally due to commonly protection circuits that are too narrowly set. Another cause of malfunctions that take the form of software errors is variation of measurement signals due to temperature drift, causing the signals to violate limits set in the software.

Recommended procedure on fault tracing is to read indications on operator panels, determine the operating conditions associated with the tripping and note the location of any faulty components or circuit boards.

The aim of fault tracing on this level is to eliminate the cause of a malfunction that disturbs operation. The actual cause of the malfunction may not be traced, but the system is restored to operation.

The precise cause of the malfunction need not be determined as far as the system hardware is concerned, simply traced to a replaceable unit.

For certain types of fault, for instance tripping for over-current or differential current, repeated switching-on of the convertor should be avoided as this puts unnecessary strain on the convertor, motor and switchgear.

The power supply to the main circuit and control system MUST be switched off when convertor components (such as circuit boards) are being replaced.

After each fault tracing operation, check that any jumpers on newly-fitted circuit boards are correctly set, and that any parameters that have been temporarily changed for fault tracing purposes have been restored to their original settings.

Safety

The greatest possible care must be taken when tracing faults in the main circuits of TYRAK LCI. In most cases the voltage and prospective short-circuit current at the connection point of the convertor are so high that a mistake could have disastrous consequences for personnel and equipment.

The converter control equipment is located in a special cubicle, separate from the main circuits in the thyristor cubicle. All measurement signals in the control cubicle are galvanically isolated from the main circuits.

Normally there is no need to use a voltmeter or ammeter on the main circuit, since the parameters that are of most interest, such as voltage and current, are measured by the control system and can be read on the operator panel in volts and amperes.

If is essential to carry out measurements on the main circuit, fuse-protected test points are available.

It is never necessary to undertake fault tracing in the thyristor cubicle with the main supply switched on. In exceptional cases, faults may be located more rapidly by doing so, but ***Extreme Caution Must Be Taken.***

There are no hazardous voltages on the circuit boards in the control units.

Fault tracing equipment

The circuit diagram (CD) and the program diagram (PD) must be available. The parameter setting list should also be available.

An oscilloscope is essential for certain operations, such as fault tracing on trigger pulse circuits or in current measurement circuits. The oscilloscope must have at least two measurement channels. It must obtain its auxiliary power supply from an isolating transformer.

Fault tracing is easier with a current measuring probe such as the Tektronix P6021.

A multimeter to measure voltage, current and resistance will be required.

In certain cases, fault tracing is easier if a chart recorder is available. It must be of the y-t type and have at least two inputs.

A VT-100 compatible terminal is necessary for some fault tracing operations, e.g. on the system hardware. A printer for the operator panel, ABLE 24, cable included. Catalogue number YT 290 000 - A.

Accessories:

Colour tape. Catalogue number 5697 799-3.
Paper roll. Catalogue number 5697 79-4.

Built-in test function

For fault tracing and other purposes the system includes a function known as the TESTMODE function.

The TEST parameter in the TESTDSXX module activates the function, provided that local operation has been selected at the operator panel.

The TESTMODE parameter is used to select the test function to be used; see the list below.

Depending on the value of this parameter, a signal TESTREF is applied as the reference value for delay angle, armature current, field current, speed and position.

The TESTREF signal is either controlled via an analog input signal TESTREF1, which is connected to a ramp unit, or via raise/lower push buttons on the operator panel. The rate of increase of the signal is determined by the parameter RAMPTIME in the TESTDSXX module.

A potentiometer may be used to control TESTREF via the analog input. The slider terminal of a 10 kohm potentiometer is connected to B51.66. The two outer terminals of the potentiometer are connected to +10 V and -10 V.

If the TESTMODE function is to be used, the convertor must be started with the ON button on the operator panel. A start order is then given with the START button on the operator panel.

TESTMODE

Value	Function
0	Open control of the delay angle ALPHA with the trigger pulses blocked in trigger pulse amplifiers Current regulation NOT active. Current measurement active.
1	Open control of the delay angle ALPHA with the trigger pulses deblocked in trigger pulse amplifiers Current regulation NOT active. Current measurement active.
2	Automatic setting of current regulation in the armature circuit. Setting is done with the field connected to the motor; the field can be switched out with the FLDEXCS parameter.
3	Test of the dc-link current regulation. The function automatically switches off the motor field. The field can be switched on with FLDEXCS in the ORDERHXX module. The reference signal TESTREF is automatically switched in as a current reference.The current will flow through the windings of the still-standing synchronous motor,since two thyristors in the respective machine convertor thyristor bridge are receiving continuous trigger pulses, and thereby providing a closed path for the current.
4	Automatic setting of current regulation in the field circuit. The function is not yet implemented.
5	Test of field current control. The reference signal TESTREF is automatically switched in as a field current reference.
6	Test of speed control. The reference signal TESTREF is automatically switched in as an speed control reference.
7	Testing of EMF-controller. Step is used as EMF-step.
8	Position control test. The reference signal TESTREF is automatically switched in as a position control reference.
9	Speed controller performance test. Step is used as torque step.
10	Normal mode for running
11	Test of twin-drive controller. Test ref. is automatically connected to the speed reference. Step automatically becomes a step into the twin-drive controller.

Example:

If the delay angle has to be controlled without de-blocking control pulses to the thyristors, the TESTMODE parameter is set to 0. The converter is then started and a phase-advance order is given via a start order. The delay angle can now be controlled with the TESTREF signal, and the position of the trigger pulses can be checked with an oscilloscope.

Fault tracing using the operator panel

For more detailed study, Operators panel management.

Persistent faults in control functions

The operator panel is used for fault tracing in the software. The display on the operator panel is used for measurements.

Signals for measurement are to be found under the heading for the module from which they originate.

Unconnected input signals are grouped in the module CONNXXXX.

For visual checking, connection boards for logical output and input signals have LED's that indicates when inputs or outputs are active.

A signal can be connected via the signal switch, for testing hardware inputs. For test purposes any signal can be connected temporarily to any output.

NOTE:	Remember to re-connect the signal after the test is complete.

An external chart recorder can be connected via ANALOG OUT. Using the signal switch, any signal in the software can be connected. For the four channels, facilities for adjustment of the offset and for multiplication are provided.

Intermittent faults

The operator panel display for logger and registration must be used. The logger can register up to six different signals, logical or arithmetical. Suitable signals are set. The time scale is chosen for good resolution.

The event line is set so that the signals can be studied with sufficient length before and after tripping. The logger is started. The program now reads these signals with 186 measured values per set time scale. On tripping, the measured values are frozen and the values for every set channel can be studied under the registration display. The logger can also be stopped manually by pressing ENTER with the cursor at the s/s position on the registration display.

If required, the printer can be connected and hard copies of the displays can be made.

With module TESTXX it is possible to connect any signal, logical or arithmetic. When the signal exceeds the triggering level the logger stops and stored logger values are frozen. There is also a facility for stopping the logger by rate-of-change-dependent triggering.

Registration over a long period

The operator panel displays for logger and registration are used. The logger is set to a logical or arithmetical signal. The time scale is set to ±500 ms.

On the registration display, the text for "AUTO" is scrolled up in the top right-hand corner.

The signal will now be updated with 186 measured values over the set time scale. This updating is continuous and can be seen on the registration display. The s/s position is used to stop updating. If required, the printer can be connected and hard copies of the displays can be made.

General malfunctions

In the event of faults that are not indicated on the operators panel check:

- The two-digit LED display on the YPQ201 board. If system error is indicated see section **System Hardware.**
- No fuses are blown and no compact breaker (MCCB) has tripped. A blown fuse or a tripped compact breaker must always be treated as a secondary fault. The circuits or equipment supplied must therefore be checked.
- That the electronic supplies are correct. The two-digit LED display on the YPQ201 board indicates code 15 or 24 upon voltage failure.
- That 110/220 V control voltage is OK. Measure across terminals on supply transformer B1.20:

  7 - 8 is to be 110 V a.c.
  8 - 9 is to be 110 V a.c.
  7 - 9 is to be 220 V a.c.

In certain cases other parts of the auxiliary power supply system must be checked with a voltmeter, from the incoming power feed.

Refer to the circuit diagram (CD) especially the pages covering "POWER SUPPLY" and "POWER DISTRIBUTION".

The values of the supply voltages are given in the circuit diagram (CD).

The cabling on the control system should be checked in certain cases, for example if malfunction occur in service or if there are problems with operating the motor drive.

In such cases check:

- that cabling between the control system cubicle and the superior control system and between the control system cubicle and the thyristor cubicle is securely terminated and correctly installed. Screw terminals should be tightened after the convertor has been in service for about six months.
  See servicing and maintenance instructions.

- that the screen and earth connections have been properly made. See servicing and maintenance instructions.

- that earth connections to control, exciter and thyristor cubicles are securely terminated and correctly installed. See installation instructions.

- Finally, check that none of the cable cores is open-circuit.

Control system hardware

Brief description

The control system of TYRAK LCI consists of a number of units that communicate with each other via a Drive System bus (the DS-bus). The DS-bus is an opto serial link communication system which is a way of sending / receiving data.

A control unit comprises a computer unit, an operator panel, a unit for serial bus communication and I/O units. In a control cubicle for TYRAK LCI there are three different types of control unit. These are:

- drive system control
- line and machine convertor control.
- exciter control.

There is a standard application program for each type of control unit. It is stored in removable EPROM memory chips mounted on removable memory boards (YPR201).

The various types of standard control unit are equipped with different numbers of I/O units.

General instructions for fault tracing in the control system

The strategy that should be applied during fault tracing is to attempt to trace the fault to one of the control units. After this, the fault is traced to one or more electronics boards, which can then be replaced.

When tracing faults in the system hardware it is important to note the information provided by the system itself. For example, if the computer unit has stopped, the LED's light up in different patterns to indicate the cause. See the section headed **LED indications on boards.**

If it proves impossible to trace the fault to a control unit, boards must be replaced in turn until the fault disappears. The fault can be traced to a particular board at a later time when operation of the system will not be affected.

Faults in the computer unit

The two-digit LED display indicates system faults by a fault code.(see the section headed **LED Indication on boards**)

Check that the LED 24VOK is lit on all computer units of the control system. If the LED is not lit, check the power supply; see the section headed **General malfunctions.**

Check the two-digit LED display, to check the power supply, hardware and system faults.(see the section headed **LED Indication on boards**)

If there is indications for ±15V and +5V fault, change the computer unit.

If the two-digit LED display indicates for system faults, try to restart the system..

To start with, perform a "warm start" of the entire control system (i.e. restart the programs of all control units without clearing the voltage back-up parts of RAM memories). This is done by switching off the supply voltage, for example by operating switch unit B1.1, leaving the power off for a minute or so and then switching it on again.

If the LED still indicates for system fault after a "warm start", perform a "cold start". To do this, switch of the power supply (switch B1.1) and short-circuit the capacitor that backs up the RAM memory. This capacitor is located on the CPU board. Short-circuit pins X26:1 and 2 and keep them shorted for at least one minute. Then remove the short circuit and switch on the power supply.

If the LED after a "cold start" still indicates for system faults, a terminal should be connected for fault tracing.

A system fault may be due to the DS-bus communication. See the section headed **Other faults in the control unit.**

Carry out a number of start attempts and note the error messages that are printed out on the terminal screen.
The whole print-out on the terminal screen has to be noted and sent to ABB. An example of the print-out is shown below:

```
>
Time-out trap at address :
Stack overflow, check .....
AA = xxx  IR = xxx SC = xxx
PC = xxx  SR = xxx US = xxx SS = xxx.
```

If an error has occurred in a control unit where a terminal was not connected, the message of error is still saved in the computer unit memory. If the control system should be restarted or if the computer voltage supply disappears, the message of error will also disappear. If a read-off of the message of error is wanted then a terminal is to be connected to the computer unit without disconnecting the voltage supply. With help of the command ER a printed copy of the message of error is obtained, see example below.

Example:

Press <ENTER> until...

```
>
```

Write ER...

```
> ER
```

and press <ENTER> .

Then the following message of error is obtained.

```
Last error = Time-out trap at address:
AA = xxx  IR = xxx SC = xxx
          PC = xxx  SR = xxx US = xxx
          SS= xxx
```

Other faults in a control unit

DCB bus communication

To get the communication to start the green LEDs V9 of all communication boards YPK114 must be lit, indicating that the initiation of the program on YPK114 has executed correctly. If not there could be a faulty board YPK114 or that the software for serial bus communication is not present in the application program.

When communication is working properly the yellow led V16 on YPK114 is lit for broadcast communication and the yellow led V11 for normal communication

If the green LEDs are lit on all YPK114 boards and the communication fail to start, check the following parameters.
In the Drive system:
SCCASEL, SCCBSEL, SCFEASEL, SCFEBSEL are set to =1
In the converter:
CONVNR set to respective number
In the field exciter:
FLDEXNR set to respective number
Check that the green led on the optical star board is lit.
Check the connections between the drive system and the optical star board and the connections between the optical star board and the converters field exciters.
For broadcast communication check that:
Drive system channel A, D22 on the board YPK114, is connected to the converter, D21 on the board YPK114 with optical fibre cable.
For normal communication check that:
Drive system channel B, D6 and D8 on the YPK114, are connected to V2,V1 on board YPC111, and then

from (V11,V12),(V21,V22),(V31,V32) on this board to D8,D6 on each convertor(A,B)/exciter.
On the YPK114 check that the strapping S3:1-2 and S3:5-6 are connected with jumpers and that the 2 sockets for flash prom are containing programmed flash proms.

Convertor control

In certain cases, the zero-current indication must be checked, for example if there has been differential current trip. The simplest way to do this check is to use the TESTMODE function; see the section headed **Built-in test function.**

Connect an oscilloscope to the current feedback signal.

Using TESTMODE=3, raise and lower the current around the limit level for continuous current.

Check that the signal CURZERO in the module FACSSXX is set ="1" on discontinuous current and that it changes status when the current is continuous; see diagram below, figure 1.

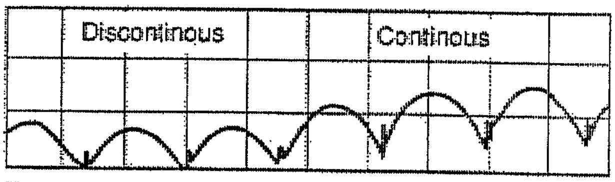


Figure 1.

MP communication

In the event of a fault on MP communication and leader/follower communication, check which LED's on board YPK107 and YPC104 are lit; see the section headed **Board indications.**

A common reason for communication not starting is that jumpers on YPK107 are missing or wrongly set. Check the jumpers against the circuit diagram (CD), page 18.

When communication with the ABB Master system is established, the two yellow LED's on YPC104 and the yellow LED CHA on YPK107 must be lit.

If the only LED lit is RX, this is probably because the wrong node number has been given.

Check the parameter UNIT_NO in the module MFBREXXX against what is used in ABB Master.

Another possible cause of faults is failure of communication to start because the communication program has not been activated by BUSSEL, in the function module SEQH1XX

Check that the MP communication is connected to YPK107 via a modem board YPC104, in the upper position B2.41.1.

In leader/follower communication this must be done via the modem board at position B2.41.2. When communication with the control system of the follower has been set up, the two yellow LED's on YPC 104, position 2, and the yellow LED CHB on YPK107, must be lit.

Measuring board YPG108

A self-test of the board is carried out whenever the control system is started. See the section headed **Faults in the computer unit.**

If a fault is found it is indicated as a fault code; see the table below. The fault code can be read via the operator panel as a value of the signal AIERR33 in the function module IUMEASXX.

Fault code	Cause of fault	Action
0		None
1	Jumpers set wrong.	Check against circuit diagram.
2	Counter not working.	Check external supply,±15 VE.
4	No measurable signal.	Check external supply,±15 VE.

A simple function test of the measuring board can be carried out using the parameter AITESTV. The test must be done with the convertor switched off. With AITESTV, process signals are disconnected and constant signals are automatically connected to the board, as shown in the table below. The value of the AITESTV parameter determines the measuring function.

AITESTV	Board measures:
0	Process signals
1	0 V
2	10,0 V

Measuring circuits

General

The measuring circuits include units in both the control cubicle and thyristor cubicle.

There are many different kinds of faults and errors, such as scaling errors, open measurement circuit or defective hardware (transducers, I/O units etc.). If there is a scaling error, the internal representation of reality inside the control system does not agree with reality (current/voltage in the thyristor cubicle, motor speed etc.)

Hardware faults

Measuring board YPG108 can be checked by activation its test function; see the section headed Measuring board YPG108. Check that the parameters in the STRTCSXX module in all control units are correct. See the **Commissioning instructions**.

Current measurement

Line current measuring

Scaling of the current feedback signal is standardised so that the continuous rated dc-link current Idmn corresponds to 100% (internal representation 2^{13}). The easiest way to check the scaling of the current feedback signal is to simulate a current feedback signal with a stabilised DC power supply .

NOTE:	The mains voltage must not be connected to the thyristor unit during this check.

Unplug two of the a.c. connections on the diode bridge B13.1 and B13.2.(see page 81 in the circuit diagram) and connect the d.c.-power supply via an ammeter. This simulates current in the convertor.

Increase the voltage from the DC power supply until the ammeter reads 1.000 A. The signal IDAMP in function module IUMEASXX shall then show a value which corresponds to the primary current in the current transformers. The value of the primary current is obtained by multiplying 1.000 A by the ratio of the actual current transformer. Scaling errors can be corrected by changing the parameter ID1SCAL. A new scaling factor only affects the scaling of the current feedback signal after the system has been restarted.

If there is an open-circuit in the current measuring circuit, the above method may be used to study the measurement function. In addition, use an ohm-meter to check that the circuit through the current transformers is complete.

Alternative method to check current measurement with live convertor.

A simpler method is to connect an oscilloscope to the input X25:1-2 on YPQ201 and use the TESTMODE function with TESTMODE =1. See the section headed **Built-in test function**.

Start up the convertor and carefully increase the value of TESTREF until the dc-link output voltage of the convertor just becomes a sawtooth voltage without a zero-voltage interval, see figure 2 below. The current in the armature circuit should now be between 5 and 40 % of the nominal current of the motor, i.e. the current must be measurable. After this, it is a simple matter to check the current in the measuring circuit by checking the voltage across the current feedback signal resistors, on the YXA118 board (see page 47 in the circuit diagram).

NOTE:	Do not forget to restore the original parameters after any temporary changes. Do not forget to restore the original circuits after temporary changes in the measuring circuits.

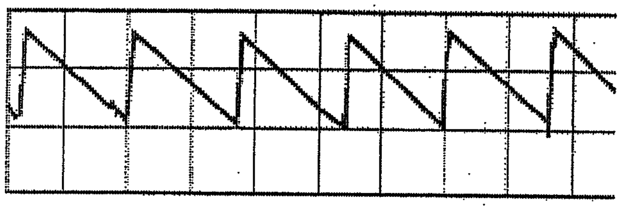


Figure 2. DC voltage (t) from thyristor bridge.

Machine current measuring

The machine side current measurement is used for the machine convertor current control, and for the current unbalance protection.
Note: The mains voltage must not be connected to the thyristor unit during this check.
Scaling of the current feedback for the unbalance protection (ID2), is made in the same way as the line current feedback ID1 (ARMCUR). The rated continuous convertor current corresponds to 100% (internal representation 8192, terminal signal ID2ACT= 8192).'Scaling errors can be corrected by changing the parameter ID2SCAL. A new scaling factor only affects the scaling of the current feedback signal after the system has been restarted.
An easy way to check scaling of the current feedback ID2 is to simulate the current feedback signal with a DC power supply. To check the current feedback, disconnect the terminals B20.X1:15, 16, 17 and B20.X1:18, 19, 20, see the CD page 53. The hardware signal ID2 (CD page 45 and 53) should be about 5V DC at rated continuous convertor current. Connect the DC power supply via an ammeter to the terminals B20.X1:15 and 16. Increase the current to a value equal to the nominal current divided by 4000 (which is the current ratio of the CT:s). The signal level of ID2 should then be about 2,5V DC, as only one of the two bridge current is simulated. Make the same check with the current from the power supply connected to terminals 16 and 17, 18 and 19, 19 and 20 (CD page 53).
In addition to the above check, use an ohmmeter to check that the circuit through the current transformers is complete (CD pages 52, 53, 84, and 94)

Machine voltage measurement

The machine voltage measurement is used for the machine convertor control system.
Scaling of the voltage feedback is made in analog input unit AI37.3 with parameter AI37.3MU. The input voltage level is adjusted on board YYI107. Measure the DC-voltage on B32.12, circuit board YYI107, testpoint X15:4. The potentiometer R227 is adjusted so that the voltage in the testpoint is approximately -7V at machine voltage (Um0) UM0VOLT equal to UVNOM. In case of readjustment of potentiometer R227, following procedure can be used.
NOTE: The mains has to be disconnected from power bridge during the readjustment of R227.

Disconnect the sync voltage(CD 49) and connect the testsync insted of sync for line convertor. For the machine convertor disconnect (CD 52) sync X12:1-8 and connect the testsync X13:1-8. Check the operator signal UVVOLT and adjust the potentiometer R227 so that the DC-voltage on terminal X15:4 is equal to:
If UVVOLT > UVNOM
(UVVOLT/UVNOM) * 4 V
If UVVOLT < UVNOM
(UVNOM / UVVOLT) * 4V
This procedure will be used altso when the circuit board YYI107 is replaced by a new one.
Do not forget to set back SYNC after readjustment.

DC voltage measurement

If a dc-link voltage measurement fault is suspected proceed as follows:

Connect a voltmeter between the fuses F61 and F62 in the line thyristor cubicle. Doing this connects the voltmeter to the DC side of the convertor via fuses.

NOTE:	It is important to connect the voltmeter to the main circuit via fuses. The voltage class of the voltmeter must be checked before it is connected. Remember that a ripple is superimposed on the DC voltage.

Block the trigger pulses to the machine convertors by setting parameter BLKPLS in the function module MCPTUOXX equal to "1". *Visually check that the pulses are blocked by reading the LEDs on the machine convertor control boards YYX 144!*

Use TESTMODE=1 and start up the convertor. Use Testref to control the delay angle so that the DC-voltage becomes 1000V (or another suitable level). The voltage measured in the module IUMEASXX via the UDVOLT signal must equal the sum of the readings of the voltmeters.

The scaling of the voltage measurement is normalised so that the ideal no-load DC voltage Udi0 corresponds to 100% [(internal representation 8192(=2^{13}))].

A scaling error can normally be corrected by changing the parameter UDSCAL in the module IUMEASXX. **A new scaling factor does not affect the scaling of the voltage measurement until the system has been restarted!!!**
If an open-circuit in the measurement circuit is suspected, this can be checked by measuring the voltage at the input of connection unit YPG109; see CD page 45. Measure the voltage between X1:1 and X1:2 on connection board YPG109.

NOTE:	Do not forget to restore the original parameters after any temporary changes. Do not forget to restore the original settings after temporary changes in the measuring circuits.

Mains voltage measurement

If it is suspected that the mains voltage is being incorrectly measured, this can be checked by measuring the voltage on the primary side of transformer B8 in the thyristor cubicle. See the circuit diagram (CD), pages 81 and 91.

NOTE: It is important to connect the voltmeter to the main circuit via fuses. The voltage class of the voltmeter must be checked before it is connected. Remember that a ripple is superimposed on the AC voltage.

The voltmeter reading must correspond to the reading of the UVVOLT signal in the IUMEASXX module, on the operator panel.

The scaling of the voltage measurement is standardised so that the ideal no-load DC voltage Udi0 corresponds to 100% (internal representation 2^{13}). A scaling error can normally be corrected by changing the parameter UDI0SCAL in the module IUMEASXX. A new scaling factor only affects the scaling of the voltage measurement after the system has been restarted.

If an open-circuit in the measurement circuit is suspected, this can be checked by measuring the voltage at the input of connection unit YPG109; see CD page 45. Measure the voltage between the terminals X1:6, X1:7, X1:8 and X1:4 on connection board YPG109. The voltage should be proportional to the line convertor supply voltage.

NOTE:	Do not forget to restore the original parameters after any temporary changes. Do not forget to restore the original settings after temporary changes in the measuring circuits.

Speed measurement

The probable causes of a scaling error are that the parameter NMAX in the module STRTCLXX is wrongly set, or that, for some reason, the pulse transmitter is not delivering the correct number of pulses per revolution.

A new scaling factor only affects the scaling of the voltage measurement after the system has been restarted.

One result of an open-circuit in the connection between the pulse transmitter and the speed measurement board for one or both pulse transmitter channels is that the measured speed is zero. To find out where the fault lies - pulse transmitter, pulse transmitter cable or measurement board - the motor must be rotated, otherwise the pulse transmitter will not deliver any pulses. Since the motor is often too large to be rotated manually, the convertor must be used to rotate the motor. The simplest way to do this is to use TESTMODE=6. See the section headed **Built-in test function.**

> Before the convertor is started, its delay angle must be limited to 75 °. This is done in the FIALCSXX module via the ALPHALIM parameter. In addition, the current reference must be limited to 5-10%. The simplest way to do this is to use the IALIMMAX parameter (in the IAREFHXX module) in the control unit of the drive system.

In addition, torque direction should be locked using the LOCKDIR parameter in the TQDIRCXX module in the control unit of the convertor.

The gain of the speed control system - NGAIN is set temporarily to a low value, about 1.0. The integral action of the controller is disabled with the NPROP parameter. Since 5-10% current is not enough to rotate the armature, the value of the IALIMMAX signal must be increased.

NOTE	Do not forget to restore the original parameters after any temporary changes. Do not forget to restore the original circuits after temporary changes in the measuring circuits.

Fault tracing in main circuits

Earth faults

If an earth fault has been indicated, the insulation resistance between the main circuit and earth must be checked. Before doing this it is extremely important to ensure that the main circuit cannot become live.

Thyristor faults

Generally there are two types of fault, anode-cathode short circuit and firing failure.

Short circuit

Anode-cathode short circuit is indicated by an over current tripping.

If an ohmmeter connected across a thyristor reads less then 100 ohm, the thyristor or the capacitor in the RC circuit may be faulty.

Thyristor replacement is described in the servicing and maintenance instructions.

After a thyristor has been replaced it is advisable to check that the current feedback signal is correct, i.e. that the current feedback signal contains six current "bubbles" per mains cycle. The simplest way to do this is to use the test function TESTMODE=3. See also the section headed **Built-in test function.**

If faults recur, the trigger pulses must be checked; see the subsection headed Trigger pulse check in this section.

Failure to fire

Failure of a thyristor to fire as a result of a fault in the thyristor itself is extremely unusual. A more likely cause of failed firing is a fault in the trigger pulse circuits. Fault tracing is described in the section headed Trigger pulse circuits.

Trigger pulse circuits

Transmission/generation

Failure of one or more thyristors to fire is the most likely result of faults in the trigger pulse circuits.

Trigger pulses for the line convertors are generated by the software-based trigger pulse unit in the convertor control system. On their way to the thyristors in the thyristor cubicle they pass through the following circuit boards: convertor board YPQ201, optocoupler board YXM187D, trigger pulse amplifier YXU201 and the speed up unit YXU202. Between the trigger pulse amplifier and the thyristor there is a trigger pulse transformer to isolate the control electronics from the main circuits.

The machine convertor trigger pulse board YYX 144 generates trigger pulses to the machine convertor. The pulses are transmitted to the thyristor cubicle and its thyristors as described above for the line convertor.

In view of the danger, fault tracing should only be done when there is no voltage on the main circuit. For this to be possible, a temporary reference voltage must be applied to the trigger pulse unit. See the section headed **Checking the trigger pulses** below.

NOTE:	Do not forget to remove the temporary reference voltage after checking the trigger pulses.

The method to be used when tracing faults without voltage on the main circuit are described below in the section headed **Checking the trigger pulses.**

If fault tracing has to be done on the trigger pulse circuits with voltage on the main circuit, avoid measuring directly across the thyristor gate, i.e. between gate and cathode. This is inadvisable, since these points are not accessible via fuses. Use a current measuring probe when measuring the thyristor gate current.

Low amplitude and steepness of gate current

Another fault that may be due to faulty trigger pulses is that the amplitude and steepness of the gate current are too low at the thyristor gates. This is a serious fault which may lead to thyristor failure.

Figure 3 shows what a correct gate pulse should look like. To check the amplitude and steepness of the trigger pulses, carry out the check described below in the section headed Checking the trigger pulses, except that here it is the first part of the trigger pulse that is of interest.

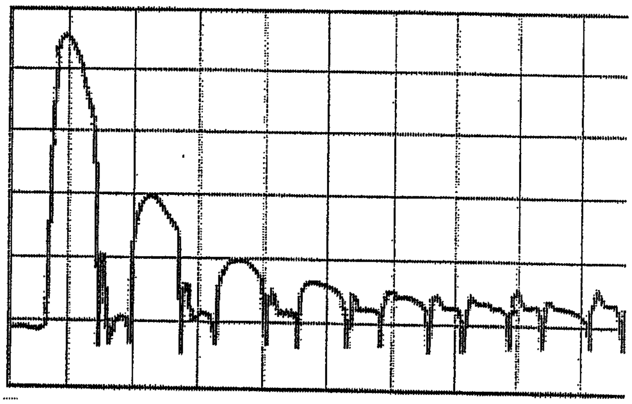


Figure 3. Trigger pulse current (t).

Interference

Faulty trigger pulses may also be due to interference. This may be caused by the trigger pulse cables. The routing of the trigger pulse cables may be unsuitable, and this may result in them picking up interference.

The control and thyristor cubicles may not be properly earthed; see Installation instructions. The earthing method is particularly important when the control cubicle is installed separately from the thyristor cubicle.

Check that the earth connections of control cubicle, thyristor cubicle and exciter cubicle comply with the recommendations given in **Installation instructions.**

Trigger pulse check in the line convertor

Check with no voltage on main circuit

- Take steps to ensure that no voltage can be applied to the main circuit.

  Temporarily remove terminal B20.X12:1-4 and replace it by terminal B20.X12:5-8.

- Set the TESTMODE parameter to 1 and follow the instructions given in the section headed **Built-in test function.**

- Set the following parameters in module TQDIRCXX of the convertor system:

  LOCKBRCH= 1 to interlock the torque reversal,
  LOCKDIR= 1 to set torque

- Connect one channel of an oscilloscope to the gate terminal of the thyristor via the current measuring probe. Connect the other channel to the trigger pulse amplifier output that generates the trigger pulse for the thyristor in which the current is to be measured. The test terminals for measurement are listed in the tables below.

- Start the convertor, deblocking the trigger pulses.

- Check gate pulse/gate current to each individual thyristor. The gate pulses must be 120° el. apart. Compare the trigger pulses with Figure 4 below.

- When the trigger pulse check is complete, remove the temporary bridges to B20.X12. Reset any changed parameters.

Table for trigger pulse checking

Gate pulse no.	YXM187D Terminal	YXU201 test point	Thyristor position
P1	X1:1	X2:1-2	1 (L1+)
P2	X1:2	X3:5-6	2 (L3-)
P3	X1:3	X2:3-4	3 (L2+)
P4	X1:4	X3:1-2	4 (L1-)
P5	X1:5	X2:5-6	5 (L3+)
P6	X1:6	X3:3-4	6 (L2-)

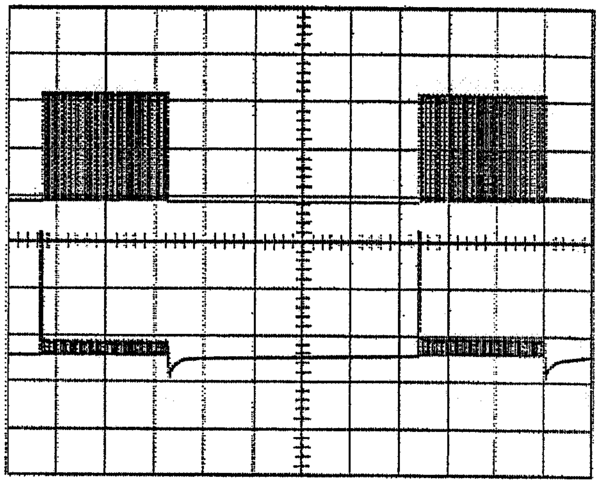


Figure 4. Upper signal; input signal for YXU201. Lower signal; the current for the Thyristor Gate.

Controllability check

It may sometimes be necessary to check the controllability of the convertor, for example if it is suspected that the thyristors are NOT firing at times corresponding to the delay angle ALPHA. For this check the TESTMODE function must be used, with TESTMODE=0. See the example in the section headed **Built-in test function.**

To check the controllability, one channel of an oscilloscope must be connected to a trigger pulse, for example to P1, test point X2:1-2 on trigger pulse amplifier YXU201, i.e. trigger pulses to thyristor 1. See the circuit diagram (CD) page 82 (and page 92). The second channel is connected to the phase voltage L11. See the circuit diagram (CD) page 49.

When the convertor has been started and has received a release order, the delay angle ALPHA, the signal ALPHA_M/ALPHA_S in module IREGSXX, can be controlled with TESTREF. When the delay angle is equal to 150°, the display on the oscilloscope looks like Figure 5 below.

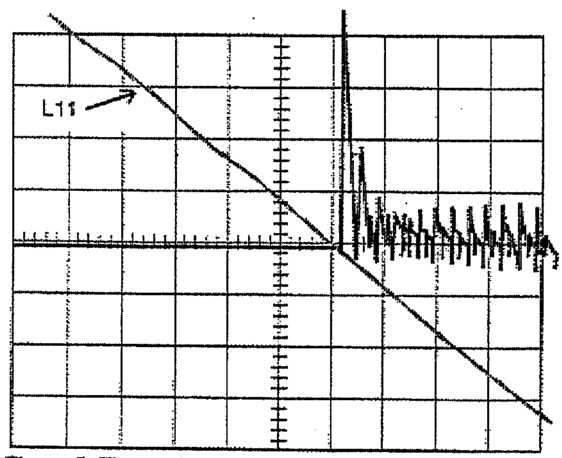


Figure 5 The position of control pulse relative L11

Figure 5. The position of control pulse relative L11. The figure shows the gate current. The shape of the voltage measured on the test points on YXU201 is shown in figure 4.

Trigger pulse check in the machine convertor

The trigger pulses are generated in different ways in Mode1(DC-link commutation) and Mode2(machine commutation).

MODE1:
At standstill the following rule shall be observed:

Continuous trigger pulses are being generated to *exactly 2 thyristors* in each 6-pulse bridge of the the machine convertor. This can be visibly checked by observing the yellow LEDs on the boards YYX144 (Compare section "LED indications on boards " in this manual) .

The pair-combination of trigger pulses is dependant on the rotor position of the AC machine, as indicated by the optocouplers(with LED indicators) located in terminals B50.71-73.

When observing the group of three terminals 71,72 and 73, the following rule applies at standstill:
One or two of the terminals shall simultaneously indicate signal continuously(ie. never none or all the three).

MODE2:

To check the trigger pulses requires that both a speed feedback is simulated and that the machine sync voltage is simulated.

The sync voltage is connected similarly as for the line convertor above:

Temporarily interconnect the following terminals to supply a synchronizing voltage to the machine convertor trigger pulse unit.

Keep the connections to B20.X12 as was done for the line convertor and add the following connections.

To check machine conv. master:
Move terminal B32.X12:1-4 to test sync terminal X13:1-4.

To check machine conv. slave:
Move terminal B32.X12:5-8 to test sync terminal X13:5-8.

Apply the sync voltage and adjust temporarily the parameter NBRPPR in the STRTDSXX-module of the drive system to 10 and check that a signal NACT can be measured(The level can be adjusted by parameter NBRPPR)

Set the parameter TESTMODE="1" in drive system and terminal parameter TPCIMC="1" in convertor system.

The line-and machine computer control will now switch to MODE2 which is visible on the board YYX144, where the green LED is on instead of the yellow..

All the six yellow LEDs indicating trigger pulses on the board YYX144 should also be lit.
Follow the instructions given in the section headed **Built-in test function,** for TESTMODE="1".

Connect one channel of an oscilloscope to the gate terminal of the thyristor via the current measuring probe. Connect the other channel to the trigger pulse amplifier output that generates the trigger pulse for the thyristor in which the current is to be measured. The test terminals for measurement are listed in the tables below.

Take steps to ensure that no main voltage can be applied to the line convertor

Push the "ON"-button and check that the ON-light is acknowledged on the drive system OP-panel. This operation results in deblocking of the trigger pulses in the trigger pulse amplifier YXU201/YXU202.

Check gate pulse/gate current to each individual thyristor. The gate pulses must be 120° el apart. Compare the trigger pulses with Figure 6 below.

When the trigger pulse check is complete, restore the temporary connections to B32..X12. Reset changed parameters, don´t forget TPCIMC="0"

Table for trigger pulse checking

Gate pulse no.	YXM187D Terminal	YXU201K test point	Thyristor position	
P1	X1:1	X2:1-2	7	(U1+)
P2	X1:2	X3:5-6	8	(W1-)
P3	X1:3	X2:3-4	9	(V1+)
P4	X1:4	X3:1-2	10	(U1-)
P5	X1:5	X2:5-6	11	(W1+)
P6	X1:6	X3:3-4	12	(V1-)

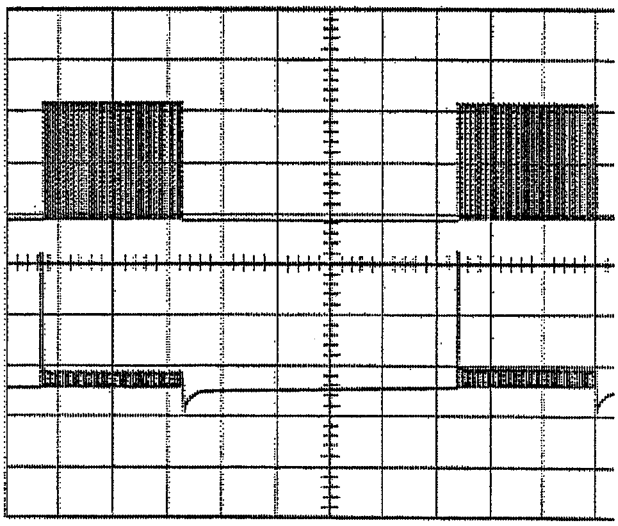


Figure 6. Upper signal; input signal for YXU201. Lower signal; the current for the Thyristor Gate.

Exciter

General fault tracing

Normally the exciter receives ON and OFF orders from the drive system control unit, but in some cases there may be advantages in controlling the exciter from its own control panel. For this, the parameter IFTEST in PD page 428 must be set to 1 and the parameter FLDEXNR in the FSCTRAXX module and the parameter SCFE(A,B)SEL in the DSCTRAXX module (in the drive system) must be set to 0. The parameter IFNOMSTA has to be set to the nominal excitation current of the motor. The system must then be restarted.

Current measurement

Scaling of the current feedback signal - IDACT is standardised so that the continuous rated DC current of the exciter corresponds to 100% (internal representation 2^{13}). The internal measuring circuit in the control unit can be checked by simulating dc-voltage on board YPQ201 X25:1,2, at -5V the signal IDAMP (or IVAMP in the a.c. exciter)) in the IFMEASXX module should be the same as IDMN (or IVNOM) in ampere.During this test the ribbon cable X72 on YPQ201 must be disconnected.

IMPORTANT: Never do this with the exciter switched on.

Faults in the control unit

See the section headed Control system hardware.

LED indications on boards

Explanations of the LED's used

CPU board YPQ201

24V OK (green) = lit when incoming 24V supply is correct.

The two-digit LED display indicates system faults by a fault code. The fault code appears flashing with appr.1 Hz frequency. Other fault codes than the ones listed below must be analyzed by ABB Drives system specialists.

Code 00 No application program installed
15 15 V power supply failure
24 24 V power supply failure
30 Hardware fault. Check ribbon cable and coaxial cable connections.
9X System fault. Try to restart the system.

Basic I/O-board YPQ202

Yellow LED's indicates active digital input- and output signals.

Digital input YPI103

Fault (red) = Hardware fault. Board parameter ADI3X is set to zero.

Digital output YPO103

Fault (red) = Hardware fault. Board parameter ADO3X is set to zero.

Analog input YPG110

Fault (red) = Hardware fault. Board parameter AAI3X is set to zero.

Analog output YPM102

Fault (red) = Hardware fault. Board parameter AAO3X is set to zero.

Analog output YPM106

Fault (red) = Hardware fault. Board parameter AAO3X is set t zero.

MP communication YPK107

CHA	(yellow)	=	Channel A communicatin
CHB	(yellow)	=	Channel B communicatin
OK	(green)	=	Program initialising complete.
FLT	(red)	=	Hardware fault.
BERR	(red)	=	Computer bus error.

Star board YPC111

(green) = The green led are lit whe the 24 V DC is OK.

(yellow) = The yellow LEDs for eac used channel are glowin

FSK modem YPC104

RX = V1	(yellow)	=	Receiving.
TX = V2	(yellow)	=	Sending.
PW = V3	(green)	=	Lit when 5 V supply is OK

Communication board YPK114

V9	(green)	=	Lit when YPK114 progran have made initiation.
V11	(yellow)	=	Lit when normal communication is workin
V15	(yellow)	=	Lit when terminal contact established to YPK114.
V16	(yellow)	=	Lit when broadcast communication is workin Other LEDs on YPK114 are not used in this application.

Analog input YPG108

FAULT (red) = Lit for hardware fault or if jumpers on the board hav been wrongly set.

Motor Voltage Sync Filter Board YYI 107

POW OK (green) = Lit when +/-15V electronics power supply is OK.

POW +5V (green) = Lit when +5V supply is OK

Master/ Slave	(yellow)	= Lit when the board is HW programmed as master in the machine control system

Machine Convertor Trigger Pulse Board YYX 144

POW OK	(green)	= Lit when +15V electronics power supply is OK.
Mode 1	(yellow)	= Lit when the motor is operated in the pulse mode
Mode 2	(green)	= Lit when the motor is operated in the machine commuted mode(natural commution)
Block	(red)	= Lit when the trigger pulses to the machine convertor are blocked.
P1	(yellow)	= Indicates trigger pulse to thyristor 1 (L1+)
P2	(yellow)	= Indicates trigger pulse to thyristor 2 (L3-)
P3	(yellow)	= Indicates trigger pulse to thyristor 3 (L2+)
P4	(yellow)	= Indicates trigger pulse to thyristor 4 (L1-)
P5	(yellow)	= Indicates trigger pulse to thyristor 5 (L3+)
P6	(yellow)	= Indicates trigger pulse to thyristor 6 (L2-)

Fault texts

Drive system

The faults in the tables are listed in alphabetical order.

Fault text	Signal name	Cause/corrective measure
AC BREAKER FAULT	ACBRFLT	Main breaker cooling fan inoperative.
AC EARTH FAULT	ETHFTAC	Tripped for earth fault on AC side. See **Main circuits** under **Earth faults.**
AIR PRESSURE FAULT	APREFL	Cooling air pressure low. Check air filter.
BEARING HIGH TEMPERATURE	MOBEARHT	Incorrect transducer signal. Parameters wrongly set. Bearing lubrication failed. Contact person responsible for lubrication.
BEARING OVER TEMPERATURE	MOBEAROT	Incorrect transducer signal. Check for wrongly set parameters. Bearing lubrication failed. Contact person responsible for lubrication.
CONV.CONTR NOT RUNNING	CPUSTLCS	Convertor control unit not working. See System hardware for further information.
CONVERTER A FAULT	DRIVEA	Fault in convertor A. See fault text on operator panel.
CONVERTER B FAULT	DRIVEB	Fault in convertor B. See fault text on operator panel.
COOLING AIR HIGH TEMP.	CAHT	Incorrect transducer signal. Check for wrongly set parameters. Cooling air temperature is high.
COOLING AIR OVER TEMP.	CAOT	Incorrect transducer signal. Check for wrongly set parameters. Cooling air temperature is high.
DC BREAKER EQUIPM.FAULT	DCBRFLT	DC breaker tripped. No acknowledgement signal.
DC BREAKER TRIPPED	DCBRTRP	DC breaker is tripped.
DC EARTH FAULT	ETHFLTDC	Tripped for earth fault on DC side. See **Main circuits** under **Earth faults.**
DRIVE STALLED	STALL	DC machine overloaded. Field current too low. No speed feedback signal. Wrongly set parameters in the STALLM module.
EARTH FAULT	ETHFLT	Earth fault in one of the power or auxiliary supplies. Check whether the parameters in the ECURM module are wrongly set.
EXCITER EARTH FAULT	FLDEFLT	Check for wrongly set parameters. Check insulation resistance of field winding.
EXCITER A FAULT	EXCITA	Fault in exciter A. See the fault text on the exciter operator panel.
EXCITER B FAULT	EXCITB	Fault in exciter B. See the fault text on the exciter operator panel.
EXTERNAL FAULT A1	EXFLTA1F	External arithmetic signal has exceeded the set tripping level.
EXTERNAL FAULT D(1,2)	EXFLTD(1,2)F	External logic signal has indicated a fault state.
EXTERNAL FAULT WARNING	EXFLTW	External signal indicated warning.
FAULT DC BREAKER	DCBRF	DC circuit-breaker faulty. No acknowledgement. Possible open circuit in a wire. Check sensing voltage.
FAULT MAIN CONTACTOR	MCONTF	Main contactor/circuit-breaker faulty. No acknowledgement, wire open-circuit. I/O unit YPQ 202 faulty. Supply voltage M1L absent.
FIELD EXC. CONT. NO RUN	CPUSTLFE	Exciter control unit not working. See System hardware for further information.
LOW FIELD CURRENT A	FLDALC	Check whether the exciter has tripped. Check for blown fuses. Check for open field circuit. Check whether contactor is faulty. The level of the field current is lower than the level for high field current. See **Exciter.**

LOW FIELD CURRENT B	FLDBLC	Check whether the exciter has tripped. Check for blown fuses. Check for open field circuit. Check whether contactor is faulty. The level of the field current is lower than the level for high field current. See **Exciter**.
MECH. BRAKE FAULT	BRAKEFLT	Brake fault. Check for open circuits in wiring or poor contact. Check for wrongly set parameters in the BRMEC module.
MOTOR OVERLOAD	MOTOL	The signal is an external monitoring of the motor for overloading. Check the setting of protections.
MOTOR COOLING FAULT (1-5)	COOLFLT(1-5)	Motor cooling faulty. Check setting of protection.
MOTOR FAN OVERLOAD	FANOL	Fan motor thermal protection has tripped. Check setting of protection. Measure motor current.
MOTOR GENERAL FAULT	MOGENFLT	General motor fault.
MOTOR LUB.FAULT	MOLUBFLT	Motor bearing lubrication inoperative.
MOTOR OVER SPEED	MOTOSP	Speed control not properly adjusted. Check whether the MOTOSPL parameter is wrongly set.
MOTOR OVERVOLTAGE	MOTOV	External indication of over voltage. Acceleration too great at speeds above base speed. Maximum EMF is too high. Field weakening not working. Check for any wrongly set parameters in the EMFMONXX module. Check for any wrongly set parameters in the EMFRG1XX or ECTRL1XX modules in the field exciter system..
NO ACK. DC BREAKER	DCBRNA	No acknowledgement signal. DC circuit-breaker faulty.
NO ACK. MAINCONTACTOR	MCONTNA	Contactor/main circuit-breaker faulty. I/O unit YPQ 202 faulty. Supply voltage M1L absent.
NO ACKN. MOTOR FAN	FANNA	No acknowledgement signal. Thermal protection of fan motor has tripped.
NO ACK. FIELD CURRENT (A,B)	FLD(A,B)NA	Exciter does not start. Check for blown fuses. Check for open field circuit. Check whether contactor is faulty. The level of the field current is lower than the level for high field current. See **Exciter**.
NO CONVERTOR SELECTED	NCONVSEL	Parameters wrongly set.
NO DATA FR. OP PANEL	LNK35F	Communication with the operator panel has stopped. Press any button on the operator panel. Check sending and receiving on the SOUT and SIN LED's on YPQ201. Change YPP109 (YPN107) first, and secondly YPQ201.
NO DATA FR.CONVERTOR	LNK32F	Leader/follower communication has stopped (time-out). Check LED's on YPK107 and YPC104 as described under LED indications on boards, in all convertors that are inter linked via the leader/follower connection. The interference level on the leader/follower communication line is too high. Check earth connections of YPK107 and YPC104. Check routing and connection of coaxial cable.

NO EMF-FEEDBACK	ARNEMF	Open circuit or poor contact in the measuring circuit. See the section **Measuring circuits DC-voltage measurement.**
NO SPEED FEEDBACK	NSPFBACK	For information see Measuring circuits.
OIL PUMP NOT ACK	OPUMPNA	No acknowledgement signal.
OIL PUMP OVERLOAD	OPUMPOL	Thermal protection of oil pump motor has tripped.
OVERCURRENT FIELD	FLDOC	Check the external field exciter.
OVERLOAD ARMATURE	ARMOL	Excessive load on DC machine. Check for any wrongly set parameters in the MOTOL1XX module.
SERIAL COM BOARD FAULT	HWFDSC	**HWFDSC** set when YPK114 fails to change a toggle bit in the dual port memory, indicating that YPK114 has stalled or stop functioning.
SUP CONTR NOT RUN	CSTALLMP	Check for wrongly set parameters. Check whether communication between MP and convertors is faulty. See Control system hardware.
TESTREF TOO HIGH	TESTREFTH	Reduce the value of the reference.
TORQUE FAULT	TQFLT1	Excessive load on DC machine. Motor stalled. No speed feedback signal. Check for faults in the external monotoring.
TRANSM FAULT SERIAL BUS	DSCLNK	DSCLNK is the overall fault signal for serial bus communication in the Drive system. Receive: converter/field exciter A-C not responding or semaphore time out in the dual port memory of YPK114 have occurred. Transmit: broadcast or normal communication stops transmitting or semaphore time out in the dual port memory of YPK114.
TRANSM. FAULT CONVERTOR	LNK37F	Leader/follower communication suffering interference. Check earthing of YPK107 and YPC104. Check routing and connection of coaxial cable. Parameter LNK37D is set with too little margin.
TRANSM. FAULT OP PANEL	LNK40F	Communication with operator panel suffering interference. Check earthing of YPP109 (YPP106) and YPQ201 and the ribbon cable between them.
TRIP FROM OVERRIDING	TRIPMP	Tripping ordered from superior control system (MasterPiece)
TRIP WARNING	TRIPWT	Warning of tripping
TRIP WARNING TIME OUT	TRIPWTO	Delayed tripping.
TRIP1 EXTERNAL FAULT	TRIP1EX	External tripping signal category 1.
TRIP2 EXTERNAL FAULT	TRIP2EX	External tripping signal category 2.
TRIP3 EXTERNAL FAULT	TRIP3EX	External tripping signal category 3.
UNDERVOLTAGE AUX.SUPPLY	ASUV	Voltage Q1 or Q2 missing (+24 V DC). Check for open circuits in wires or faulty connectors. Check for blown fuses. Check whether there is a transformer fault.
WINDING HIGH TEMPERATURE	MOWINHT	Warning. The air filters may be clogged. Transducer signal may be incorrect. Parameters wrongly set. Extreme motor load? Consult the person in charge of production.

WINDING OVER TEMPERATURE	MOWINOT	Check whether the air filters are clogged. Check whether the transducer signal is faulty. Check whether any parameters are wrongly set. Check whether the motor load is excessive. Consult the person in charge of production.

Line and machine convertor

The faults in the table are listed in alphabetical order.

Fault text	Signal name	Cause/corrective measure
AC BREAKER IS TRIPPED	MSEF	External fault indication for main supply.
CONVETOR DIFF. CURRENT	DIFCUR	Differential current is in convertor bridge. Check the current measuring circuit. Check for short circuits in the cabling or thyristor bridge.
CURRENT ASYMMETRY	CURRASYM	Poor current sharing between valve units connected in parallel. Check the fuses. Check whether any trigger pulses are missing. See the **Fault tracing instructions** for further information.
DRIVE CONTROL IS STOPPED	CPUSTLDS	The control unit of the drive system is not working. See Control system hardware for further information.
EARTH FAULT AC VOLTAGE	ETHFLTAC	Tripped for earth fault on AC side. See **Main circuits** under **Earth faults.**
ERROR IN PHASE SEQUENCE	PHSEQFLT	Main supply connected with wrong phase sequence. Reconnect the phases correctly.
FAULT IN AI UNIT POS 33	HWF10.33	Board YPG108 is faulty. Change the board. Check that any jumpers on the new board are correctly set.
FAULT IN MAIN SUPPLY	MSFLT	Group indication for main supply fault.
FAULT IN UNIT YPQ203	HWF_203	Board YPQ203 is faulty. Change the board. Check that all jumpers on the new board are correctly set.
FREQ MEASURE NOT STABLE	FREQUSTA	Parameters for frequency filters wrongly set. Contact ABB Drives if a fault is indicated.
FREQUENCY FAULT MAINS	FREQFLT	High-voltage circuit-breaker tripped; AC machines that are running maintain the voltage level for a time, but at low frequency. The supply frequency is not stable. Wrongly set parameters, FREQNOM and FREQDEV.
FUSE FAULT	FUSEF	Check the thyristor fuse, one or more may be faulty
HIGH TEMP THYRISTOR FWD	THYHTF	Warning. High temperature in thyristor bridge, forward direction.
HIGH TEMP THYRISTOR REV	THYHTR	Warning. High temperature in thyristor bridge, reverse direction.
INCORRECT THERMAL DATA	SELNOTOK	Not permitted combination, thyristors and cooler. Please check the parameters set in function module TYTEMP.
LOW VOLTAGE MAINS SUPPLY	LOWMAIN	Low main supply voltage. Check whether the parameters LOWMAINL and MDROPCOM are wrongly set. See **Commissioning instructions**. Check whether the fault is in the measuring circuit. See **Fault tracing instructions**, the section headed **Measuring circuits.**
NO ACKN. THY FAN (1-2)A	CFAN(1-2)ANA	Fan contactor for fan convertor 1 or 2 is faulty. Open circuit in wires or poor contact at connectors. Supply voltage M1L missing. Thermal overload protection has tripped (fuse blown).

NO ACKN. THY FAN (1-2)B	CFAN(1-2)BNA	Fan contactor for fan convertor 1 or 2 is faulty. Open circuit in wires or poor contact at connectors. Supply voltage M1L missing. Thermal overload protection has tripped (fuse blown).
NO EMF FEEDBACK	ARMNEMF	Interruption or poor contact in the measurement circuit.
MAIN SUPPLY OVER VOLTAGE	MSOV	Main power too high, check transformer, you may need to reduce the rate of output voltage from transformer.
MAIN SUPPLY HIGH VOLTAGE	MSHV	Reduce the input voltage,check the output of transformer
MACHINE OVERVOLTAGE	ARMOV	Acceleration too great at speeds above base speed. Maximum EMF is too high. Field weakening not working. Check for any wrongly set parameters in the IUMON module. Check for any wrongly set parameters for emf control. See **Commissioning instructions**, the section headed **EMF control**.
OVERCURR ARMATURE FWD	ARMOCF	Using the signal ARMOCNBR, check in which thyristor branch the fault occurs before pressing the Reset button. Armature current control may be incorrectly set. Check for short circuits in the cabling or armature winding. Check for commutator flashover. Check for possible thyristor faults or trigger pulse faults. Loss of power supply in inverted mode. Check whether over current protection is incorrectly set.
OVERCURR MACHINE	MAROC	Using the signal ARMOCNBR, check in which thyristor branch the fault occurs before pressing the Reset button. Armature current control may be incorrectly set. Check for short circuits in the cabling or armature winding. Check for commutator flashover. Check for possible thyristor faults or trigger pulse faults. Loss of power supply in inverted mode. Check whether over current protection is incorrectly set.
OVERLOAD THY FAN (1-2)A	CFAN(1-2)AOL	Thermal overload protection tripped for fan convertor 1 or 2. Check for blown power supply fuse. Fan convertor 1 or faulty. Check for open circuit in wires or poor contact. Check whether connection unit YPQ202 is faulty. Supply voltage M1L missing.
OVERLOAD THY. FAN (1-2)B	CFAN(1-2)BOL	Thermal overload protection tripped for fan convertor 1 or 2. Check for blown power supply fuse. Fan convertor 1 or faulty. Check for open circuit in wires or poor contact. Supply voltage M1L missing.
OVERTEMP THYRISTOR FWD	THYOTF	Excessive load on thyristor bridge, forward direction. Cooling air flow non-existent or insufficient. Check that air filter is not clogged. Check whether Pt100 sensor is faulty. Check for wrongly set parameters in the TYTEMP module.

OVERTEMP THYRISTOR REV	THYOTR	Excessive load on thyristor bridge, reverse direction. Cooling air flow non-existent or insufficient. Check that air filter is not clogged. Check whether Pt100 sensor is faulty. Check for wrongly set parameters in the TYTEMP module.
PRESSURE FAULT (1-2) THY AIR	APREFLT(1-2)	Low pressure in the cooling air flow of the thyristor cubicle. Check air filter. Pressure transducers may be faulty.
REDUNDANT FAN STARTED	RDFANONF	Redundant fan has started.
REDUNDANT FAN TRIPPED	RDFANTRP	Redundant fan has tripped.
SERIAL COM BOARD FAULT	HWFCSC	**HWFCSC** set when YPK114 fails to change a toggle bit in the dual port memory, indicating that YPK114 has stalled or stop functioning.
TRANSM FAULT SERIAL BUS	CSCLNK	**CSCLNK** is the overall fault signal for serial bus communication in the converter. Poll from drive system, both in broadcast and normal communication mode, is not coming during time out time or semaphore time out have occurred in the dual port memory of YPK114.
TRIGGER PULSE FAULT	TRIPUFLT	There are no control pulses to the thyristors of the convertor .
UNDERVOLTAGE COMPUTER	ASUV	Voltage Q1 or Q2 missing (+24 V DC).Check whether there is an open circuit in a wire or connector. Check for blown fuses. Check for transformer faults.
UNDERVOLT TRIG PULSE AMP	TAMPUV	Power supply to trigger pulse amplifier missing. Miniature circuit-breaker tripped. See circuit diagram.
UNDERVOLTAGE MACC UNIT	POWMUF	Low supply voltage. Check for blown fuses. Check whether there is an open circuit in a wire or connector. Check whether the MINVOLT parameter is wrongly set. Check for transformer faults.
UNDERVOLTAGE MAIN SUPPL	MSUV	Low supply voltage. Check for blown fuses. Check whether there is an open circuit in a wire or connector. Check whether the MINVOLT parameter is wrongly set. Check for transformer faults.

Exciter

The faults in the table are listed in alphabetical order.

Fault text	Signal name	Cause/corrective measure
DRIVE CONTROL NOT RUN	CPUSTLDS	The control unit of the drive system is not working. See Control system hardware for further information.
EARTH FAULT	EARTHFLT	Earth fault in one of the power or auxiliary supplies. Check whether the parameters in the ETHMFE module are wrongly set.
ERROR IN PHASE SEQUENCE	PHSEQFLT	Main supply connected with wrong phase sequence. If possible, Reconnect the phases correctly.for positive phase sequence.
FAULT IN AI UNIT POS33	HWF10.33	Board YPG108 is faulty. Change the board. Check that any jumpers on the new board are correctly set.
FAULT MAIN CONTACTOR	MCONTF	Main contactor faulty. Acknowledgement may have been lost in service. Check whether connection unit YPQ202 is faulty.

FIELD OVERCURRENT	FLDOC	Check whether the field current regulation is wrongly set. Check whether there is a short circuit in the cabling or the field winding. Check whether the over current protection is wrongly set. Check whether there is a fault in the current measurement system.
FIELD OVERVOLTAGE	FLDOV	Field discharge circuit indicates high voltage. There may be a fault in the exciter control system. Check whether the fault is a secondary fault due to high transient current in the armature circuit.
FREQ MEAS NOT STABLE	FREQUSTA	Check whether parameters for frequency filters are wrongly set. Contact ABB Drives if a fault is indicated.
MAIN SUPPL.UNDERVOLTAGE	MSUV	Low supply voltage may be the cause. Check for blown fuses. Check whether there is an open circuit in a wire or connector. Check whether the UVLEVEL parameter is wrongly set. Check for transformer faults.
MAINS FREQUENCY FAULT	FREQFLT	High-voltage circuit-breaker tripped; AC machines that are running maintain the voltage level for a time, but at low frequency. The supply frequency is not stable. Wrongly set parameters, FREQNOM and FREQDEV.
NO ACK FIELD EXCITER FAN	CFANNA	Fan contactor is faulty. Check for open circuit in wires or poor contact at connectors. Check whether connection unit YPQ202 is faulty. Supply voltage M1L missing. Thermal overload protection may have tripped (fuse blown).
NO ACK MAIN CONTACTOR	MCONTNA	Contactor faulty. There is no acknowledgement, possibly because of an open circuit in a wire or poor contact. Check whether connection unit YPQ202 is faulty.
OVERLOAD EXCITER MACHINE	FLDOL	The signal is an external monitoring of the exciter machine motor for overloading. Check the setting of protections.
OVERLOAD FAN	CFANOL	Thermal overload protection may have tripped. Check for blown power supply fuse. Check whether the fan motor is faulty. Check for open circuit in wires or connectors. Connection unit YPQ202 may be faulty. Supply voltage M1L missing.
OVERTEMP+THYRISTOR	THYOT	Excessive load on thyristor bridge. Cooling air flow non-existent or insufficient. Check that air filter is not clogged. Check for wrongly set parameters in the THYTEMXX module.
POWER LOW COMPUTER	ASUV	Voltage Q1 or Q2 missing (+24 V DC).Check for open circuits in wires or faulty connectors. Check for blown fuses. Check whether there is a transformer fault.
SERIAL COM BOARD FAULT	HWFFSC	**HWFFSC** set when YPK114 fails to change a toggle bit in the dual port memory, indicating that YPK114 has stalled or stop functioning.
TRANSM FAULT SERIAL BUS	FSCLNK	**FSCLNK** is the overall fault signal for serial bus communication in the field exciter. Poll from drive system, both in broadcast and normal communication mode, is not coming during time out time or semaphore time out have occurred in the dual port memory of YPK114.

Operator's panel management

Contents

Operator's panel management

Introduction

There is a continuous demand for improved communication between man and machines. ABB has developed an operator's panel to satisfy this requirement with respect to motor drive systems.

The operator's panel permits simple and accurate measurement of variable signals, setting of parameters, the performance of step tests in drive systems etc.

The different displays which can be presented on the operator's panel have been designed to enable the operator to learn quickly the functions used most frequently. To obtain basic knowledge it is sufficient to read Section **"General characteristics of the operator's panel"**. The next step is to continue with practical training with the equipment.

This document can then be used as a reference to provide more detailed information when required.

General characteristics of the operator's panel

Display design

The total display is divided into four fields.
The format of Field 1 remains constant. The three display designations at the top of Field 1 can be varied as described below.

The contents of fields 2 - 4 vary and depend upon which display designation is in the middle position of the three currently presented in Field 1.

To change the display , the display designations are moved upwards or downwards as described under "Display Exchange" below.

Cursor movement

The operator's panel can be used to change the value of a system parameter, command a printout, change a scale value etc. The factor common to these operations is that a cursor is moved to specific positions on the display. The positions to which the cursor can be moved are marked with squares. For examples, see fig. 2.

The buttons ↘ or ↖ are pressed to move the cursor to the position required.

Figs 3 and 4 show examples of the path of the cursor when ↘ or ↖ are pressed under different conditions.

When the ↘ or ↖ button is depressed continuously, the cursor moves automatically between the different cursor positions.

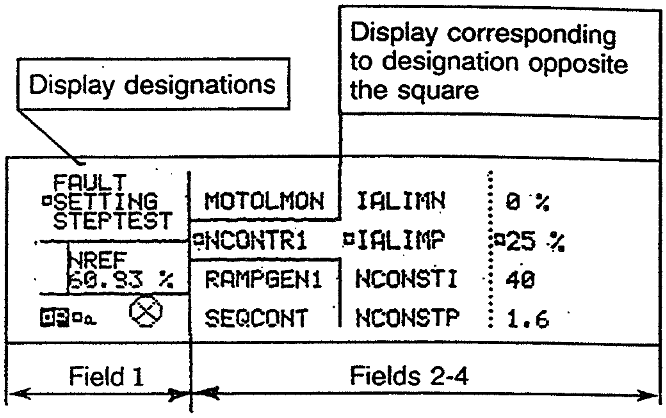


Figure 1. Arrangement of operator's panel display.

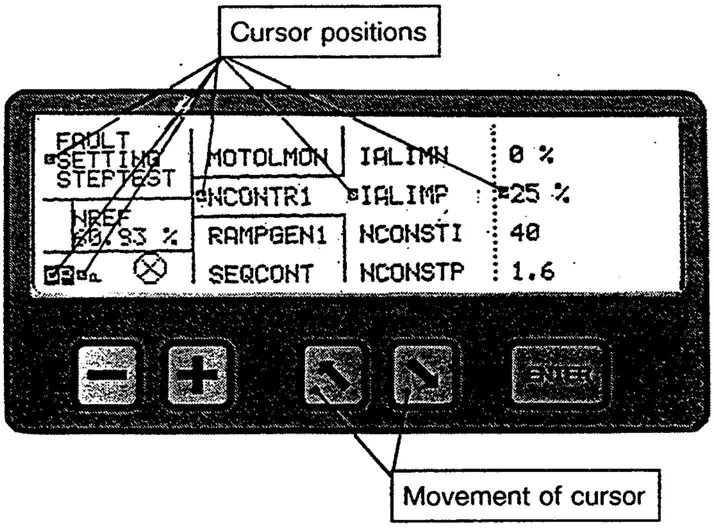


Figure 2.

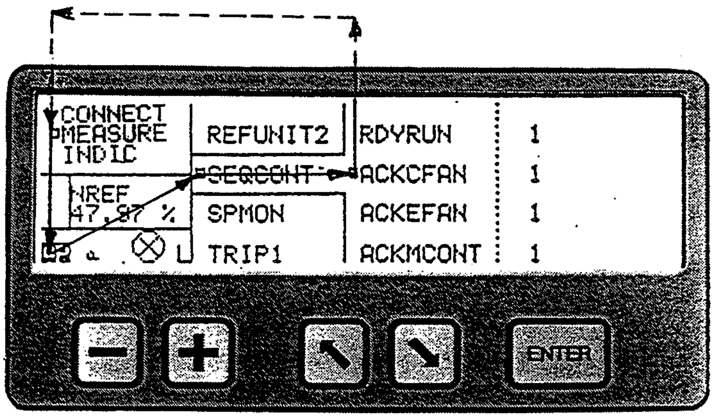


Figure 3. Display MEASURE. Example of cursor movement on pressing ↘ . The cursor moves in the opposite direction when ↖ is pressed.

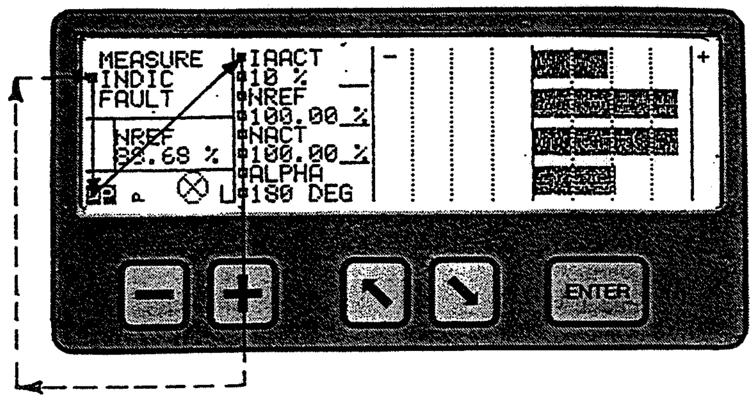


*Figure 4. Display INDIC (ATION).
Example of cursor movement on pressing ↘ . When ↖ is pressed, the cursor moves in the opposite direction.*

Display exchange

Different displays can be obtained on the operator's panel by placing the cursor as shown in fig. 5 and then pressing + or – .

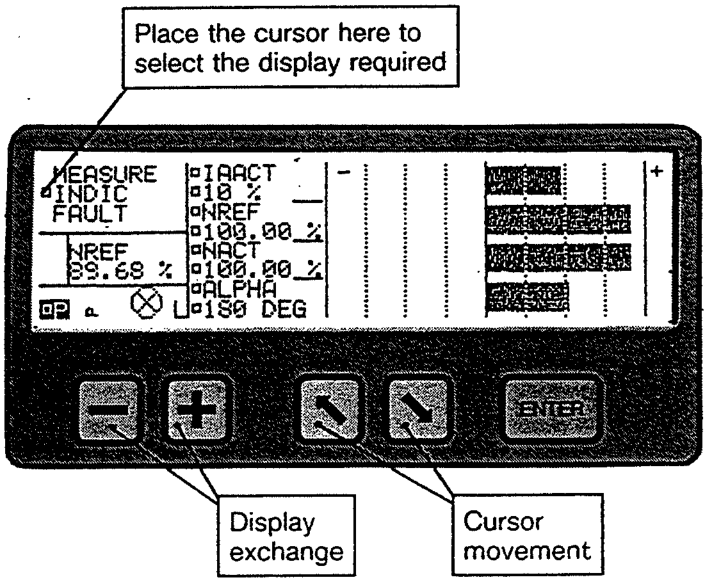
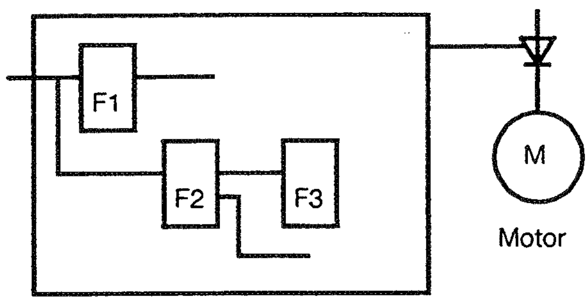


Figure 5. Display selection.

Functions, signals and parameters

The control and regulation system of a motor drive system is an assembly of a large number of function modules. See fig. 6.

These function modules contain parameters and signals and a typical function module is illustrated in fig. 7. The signals and parameters with identities given on the circuit diagram can be measured and set respectively via the operator's panel.



F1 - F3: Function modules.

Figure 6. Control and regulation system for motor drives.

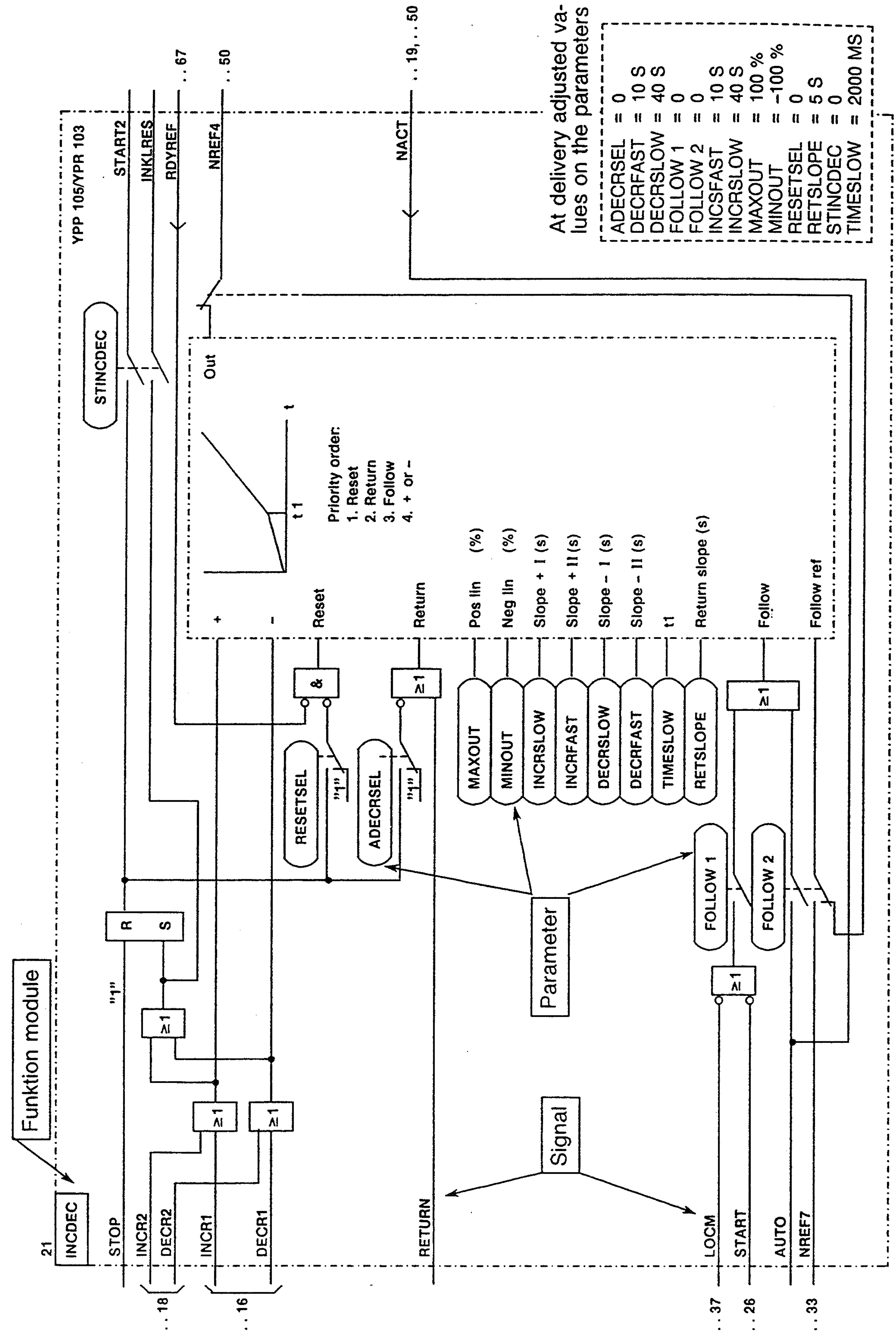


Figure 7. Example of a function module.

The figures 8 and 9 show the displays for measurement (MEASURE) and parameter setting (SETTING) respectively.

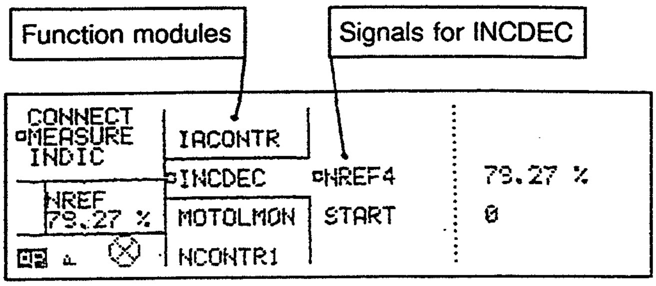


Figure 8. Measurement.

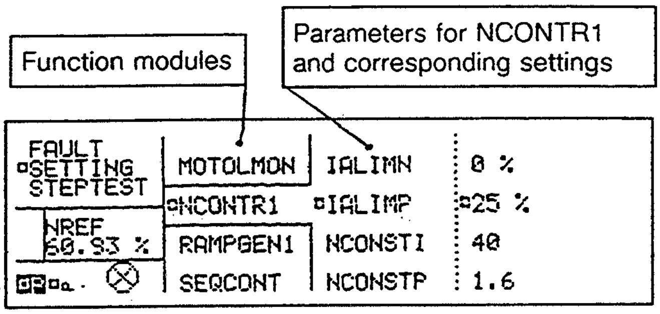


Figure 9. Parameter setting.

Table arrangement

The + or – buttons are pressed to change between different displays on the operator's panel or to switch between function modules during parameter setting for example. See **"Display exchange"** above. The texts can be considered to be on a rotating drum which rotates forwards one step when + is pressed and backwards one step when – is pressed. See fig. 10. This model applies for all of the displays available.

The tables for function modules, signals and parameters are arranged in alphabetical order.

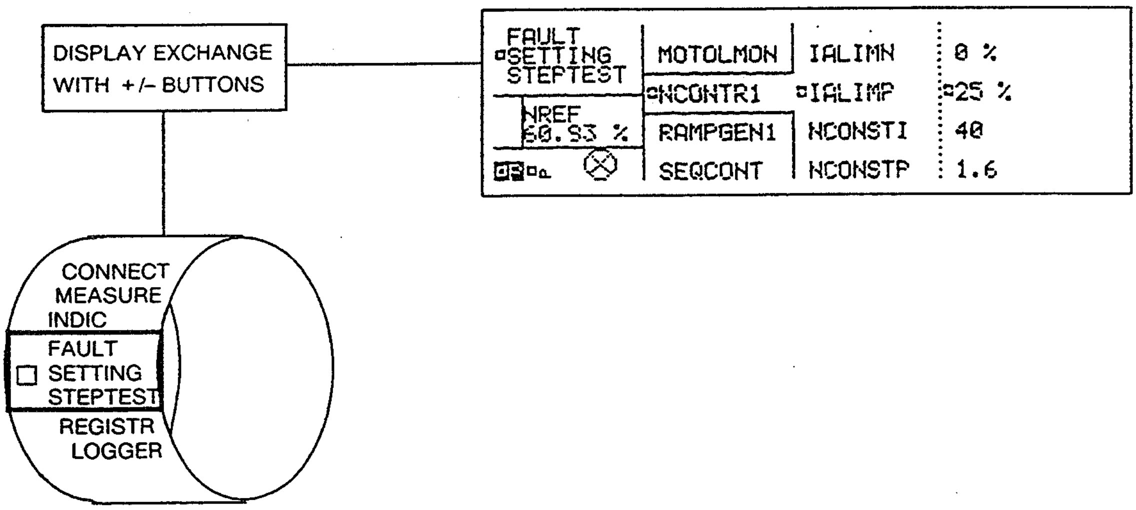


Figure 10. Model to illustrate text presentation (in this case, display designations at top of Field 1).

Printout

Printouts of the operator's panel display are available in three different sizes with different degrees of resolution. When a printout is required, place the cursor in the position shown in fig. 11. Then press **ENTER**, + or – . The printout size is dependent on whether + or – is pressed, as shown in figs 12 - 14. The printer is connected at contact X31 on the operator panel circuit board on the inside of the door.

The printer can be connected or disconnected during operations.

It is not possible to print the GENERAL screen.

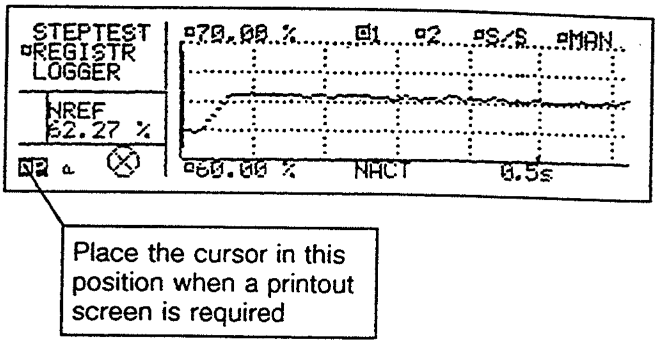


Figure 11. Printout.

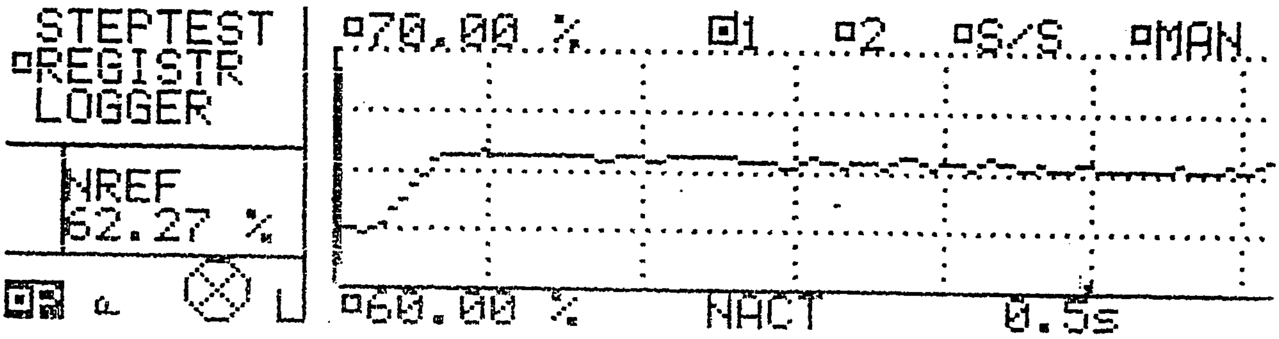


*Figure 12. Appearance of printout when **ENTER** is pressed.*

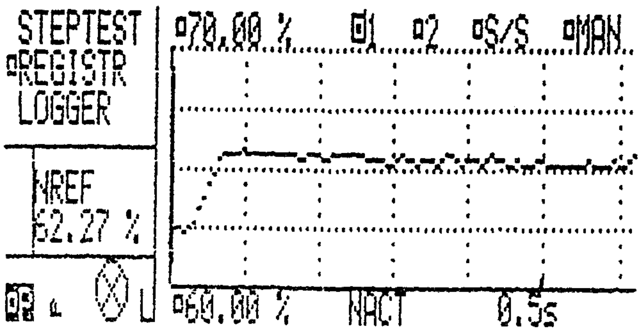


Figure 13. Appearance of printout when + is pressed.

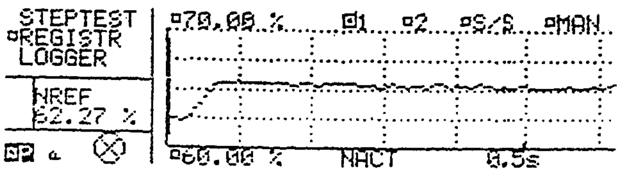
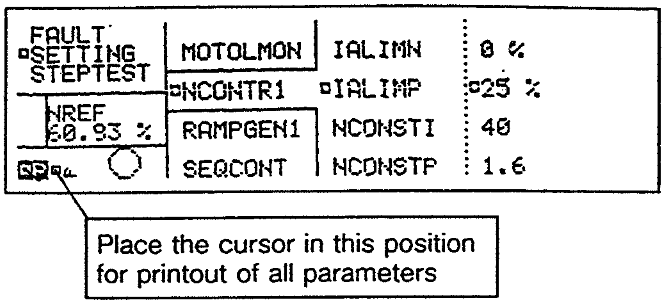


Figure 14. Appearance of printout when – is pressed.

The number of signals and parameters within a function module as well as fault signals can exceed the number which it is possible to show at one time on the operator's panel. If a printout of all signals or parameters within a function module or a printout of all fault signals is required, the cursor is first placed as shown in fig. 15. Then press **ENTER**.

The printer can be stopped by pressing the **– button**.

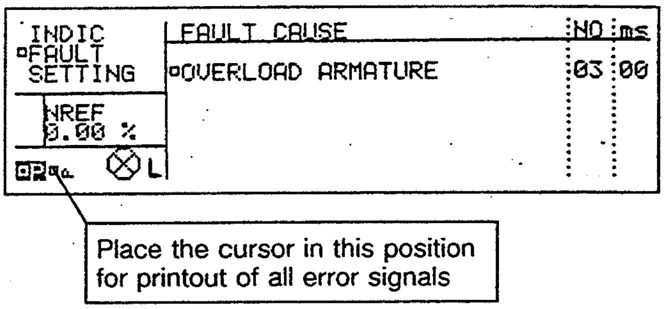



```
NCONTR1
=======
IADERMAX = 100
IALIMN   = 0 %
IALIMP   = 25 %
NCONSTI  = 40
NCONSTP  = 1.6
NDERCONS = 6.9
NFILTTC  = 121 MS
```

Appearance of printout

Figure 15. Printout of all parameters within a function module.

If instead **+** is pressed in the SETTING screen all parameters in all function modules will be printed.




```
FAULTS  TYRAK
==============

OVERLOAD ARMATURE
GROUP : 03    TIME : 00

HIGH ARMATURE CURR DIFF
GROUP : 02    TIME : 00

OVERCURR ARMATURE
GROUP : 02    TIME : 00

UNDERVOLTAGE MAINS SUPPL
GROUP : 01    TIME : 00

NO EARLIER FAULTS STORED
```

Appearance of printout

Figure 16. Printout of all error signals within a function module.

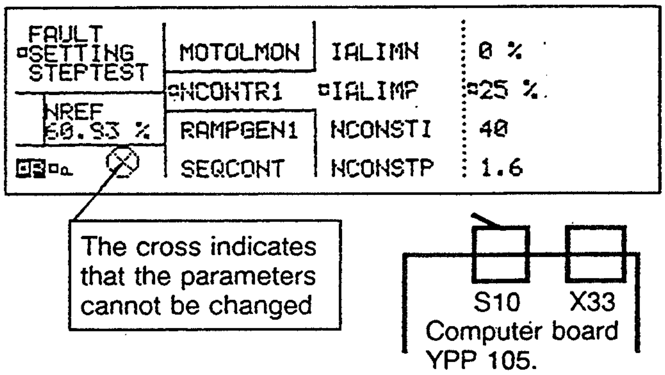


Figure 17. Latch function active. Parameters cannot be changed.

Latch function

A latch function has been introduced to prevent unintentional change of parameters. If the parameters are blocked, a cross appears in the ring as shown in fig. 17. This cross disappears when parameter values can be changed. See fig. 18. The latch is located on the computer board YPP 105 and its status, active or inactive, can be changed by operating switch S10 at the top of the computer board.

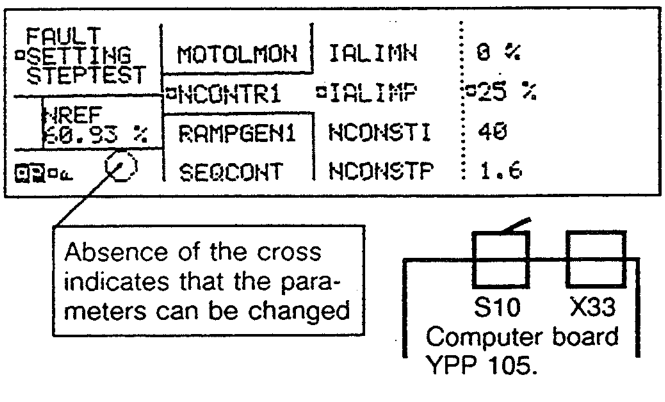


Figure 18. Latch function inactive. Parameters can be changed.

Pushbuttons for convertor operation

To activate the convertor press button **I**. To deactivate the convertor, press button **O**. When the convertor is active, a green field illuminates. This extinguishes when the convertor is deactivated. See Fig. 19.

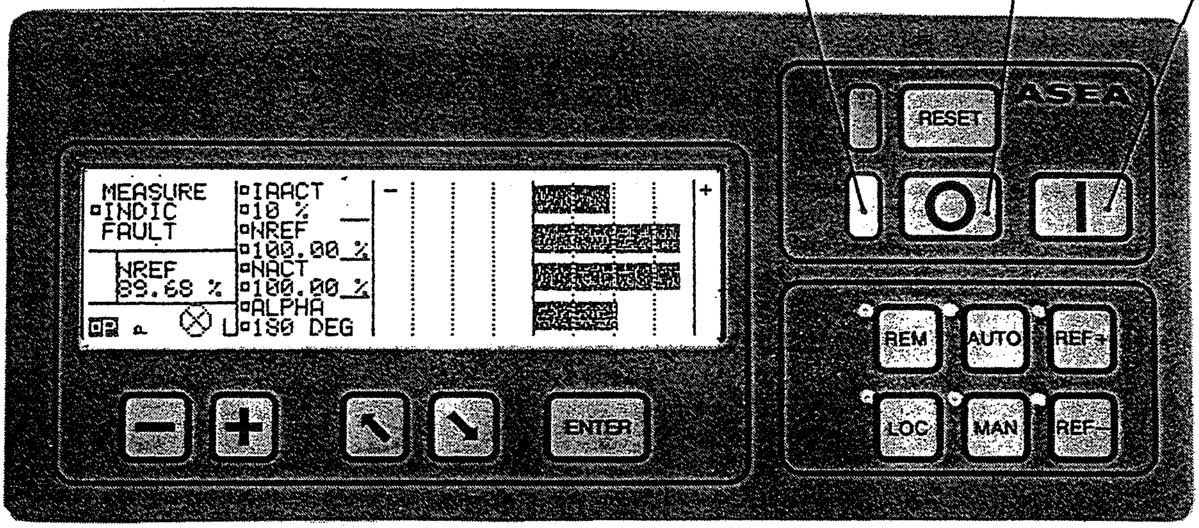


Figure 19. Activation and deactivation of convertor.

If a protection trips because of some malfunction, a red field illuminates and the drive system is deactivated. The malfunction must be corrected and the **RESET** button pressed, extinguishing the red field, before the system can be restarted. See Fig. 20.

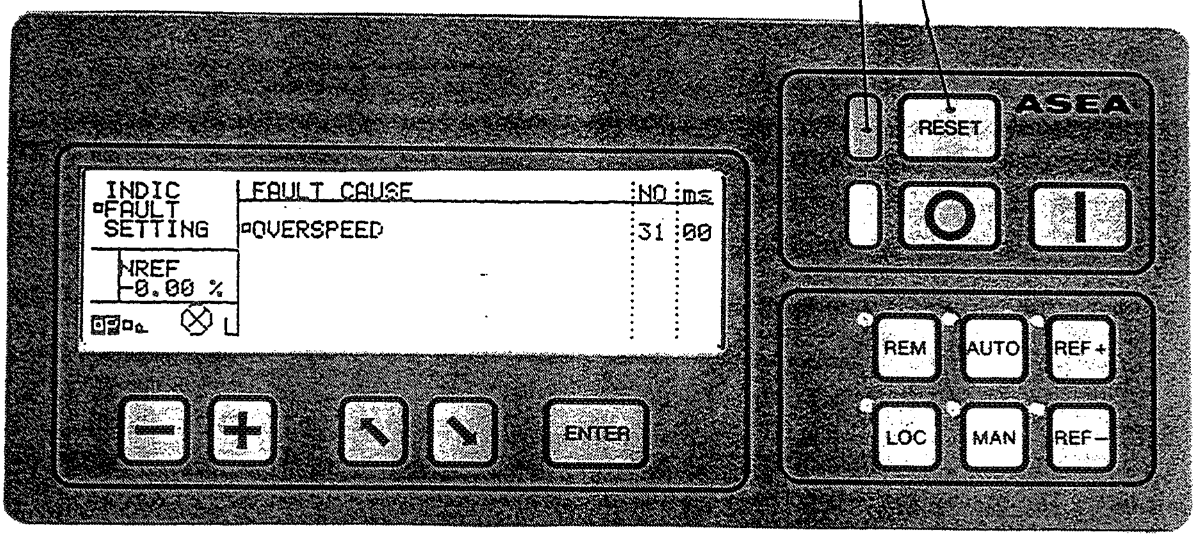
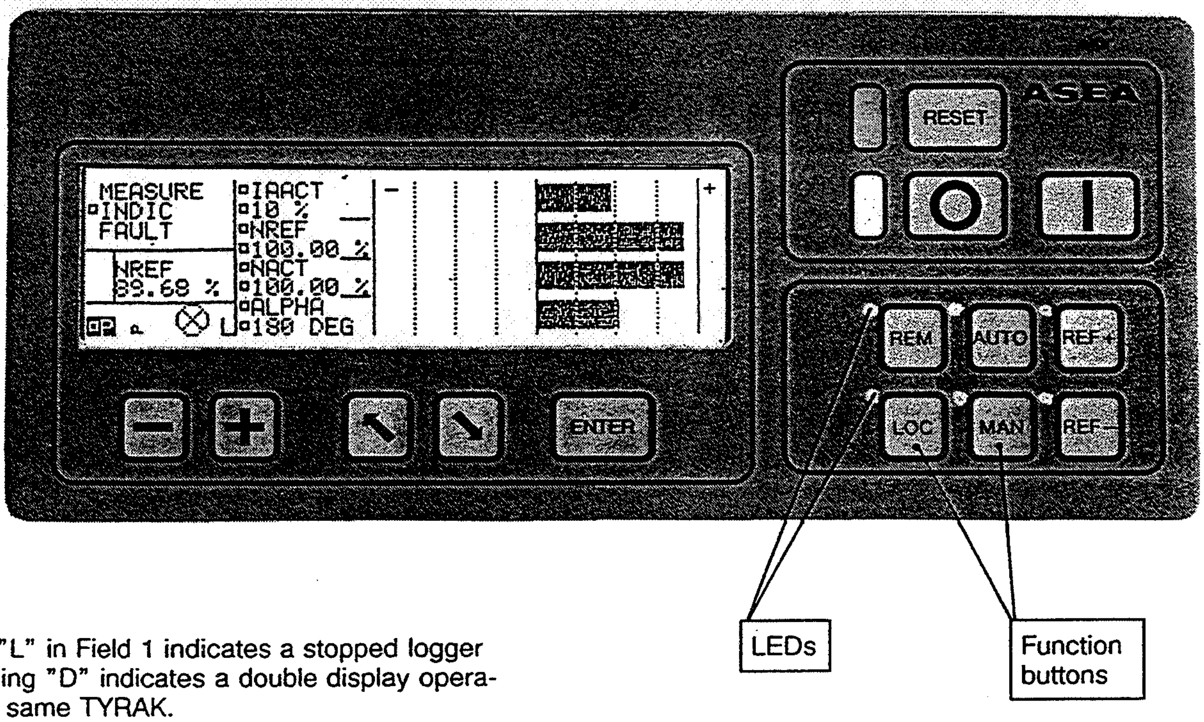


Figure 20. Resetting of convertor before reactivation .

Six buttons for commanding functions are located at the lower right hand corner of the panel. See Fig. 21. The function of each push button is inscribed on each button. The functions of the buttons can vary in different installations and the text can be changed accordingly. Each button contains a light emitting diode which may be used as a feedback from the application process.



A flashing "L" in Field 1 indicates a stopped logger and a flashing "D" indicates a double display operation on the same TYRAK.

Figure 21. Function buttons.

General display, designation GENERAL

The operator's panel text is available in 4 different languages, Swedish, English, German and French. To change the language, the cursor is placed as shown in fig. 22 and the + button is pressed until the required language is opposite the cursor. If **ENTER** is pressed also all fault texts will be changed into the selected language.

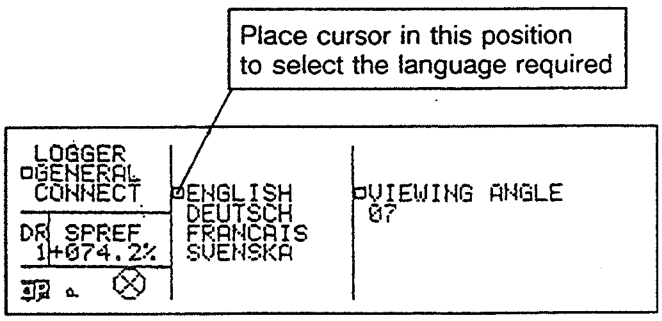


Figure 22. Display General. Selection of language.

Function module names, parameter names and signal names do not change when the panel language is changed.
See figs. 23 and 24.

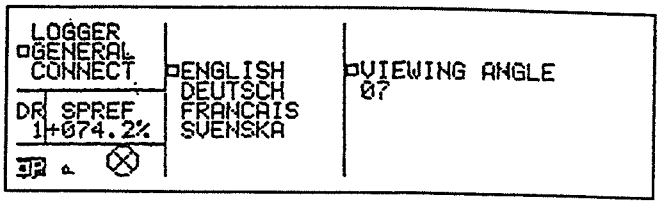


Figure 23. General.

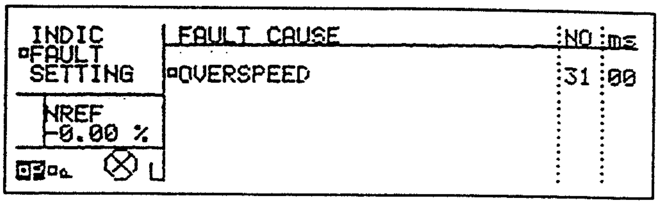


Figure 24. Fault Indication.

The operator's panel was only clearly legible when viewed from within a limited angle. This angle is adjustable to permit the best viewing conditions for both tall and short operators. To adjust the viewing angle, the cursor is first placed as shown in fig. 25 and then the + or – button is pressed. The angle can be varied through a scale range 0 - 15. Press **ENTER** for permanent storage of the viewing angle selected.

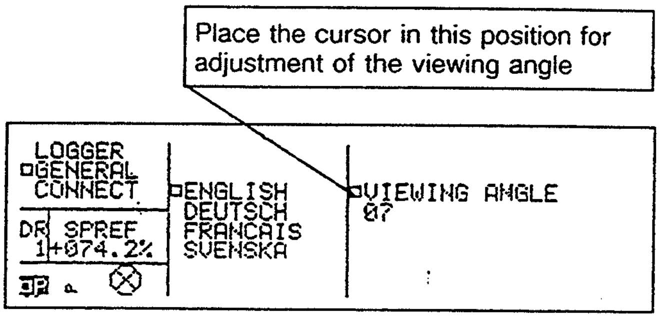


Figure 25. General.
Adjustment of viewing angle.

Indication display, designation INDIC

Four **arithmetical** signals can be measured and presented simultaneously when the INDIC display is selected. The magnitudes of the signal values are indicated by horizontal staples.

If a signal is to be exchanged, the cursor is to be placed before the signal to be replaced. Press + or – until the required signal is presented and then press **ENTER**. The result of pressing + or – is explained above under **"Table arrangement"**.

When setting a scale factor, place the cursor in front of the number which is to be changed. Then press + or – to increase or decrease the scale factor.
See fig. 27.

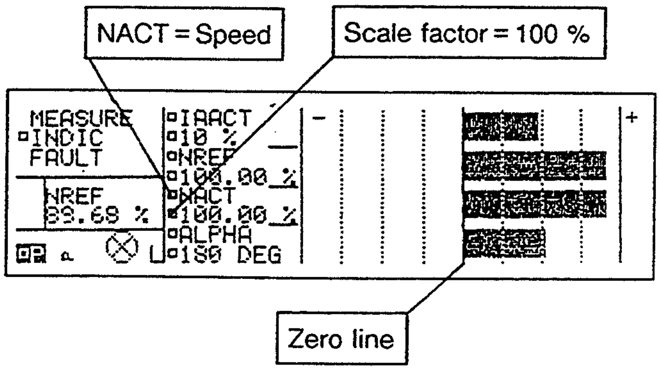


Figure 26. Appearance of Indication display.

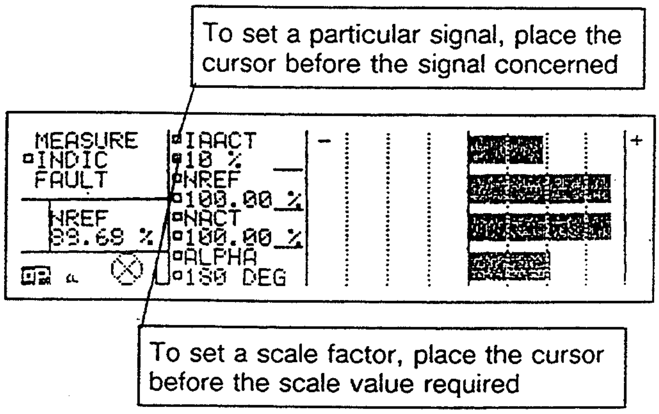


Figure 27. Display INDIC.
Setting of signal and scale factors.

Fault indication display, designation FAULT

The Fault Indication display is of great assistance when tracing faults. The display FAULT is shown automatically when a fault is detected and if a series of faults occurs, these are presented in order of occurrence. The first fault is given the time 0 and the subsequent faults are time tagged in relation to this. See fig. 28. Only the faults in the sequence which occur within 255 ms are indicated. Each fault is given a number. Only the first fault within a group get the group number. The rest just gets " + ".

After the fault has been corrected, the faulty status is concluded by the operator processing the **RESET** button.

To obtain a survey of all of the faults which have occurred after the commissioning of the convertor, the cursor is placed as shown in fig. 29 and the + or – button is pressed. Fault texts are not normally displayed until a fault is detected. This means that the latest error message is "above" the uppermost line on the operator's panel. The most recent fault can then be presented by pressing the – button.

The fault memory accommodates 200 faults. The group numbering is restarted at 99. If it should become fully occupied, the oldest error is written over and the group numbering restarts at 01.

The contents of the fault memory can be erased after commissioning by briefly setting the parameter FCLEAR to 1 in the function module $FLTLOG_{XX}$.

When malfunction has been detected its cause must be corrected first. After this, the **RESET** button must be pressed before the drive system can be reactivated.

Measurement display, designation MEASURE

For measurement of signal values in the control system, the display MEASURE is paged forward. Four signal values can be presented at a time on this display. The appearance of the measurement display is shown in fig. 30.

When a signal within a certain function module is to be measured the cursor is first placed in Field 2 to scroll the function module required. See fig. 31.

When the cursor is placed in Field 2, press the + or – button until the function module required is presented opposite the cursor. The modules are available in alphabetical order. A table of the signals included in the module is now presented in Field 3.

When the function module required is set, the cursor is placed in Field 3 to permit "rotating" forward the signal required. See fig. 32. Press then the + or – button until the signal required appears on the operator's panel.

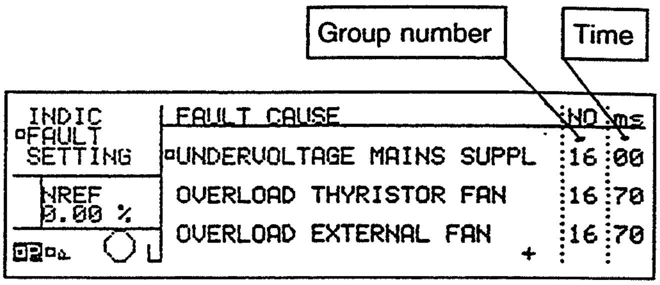


Figure 28. Fault Indication.

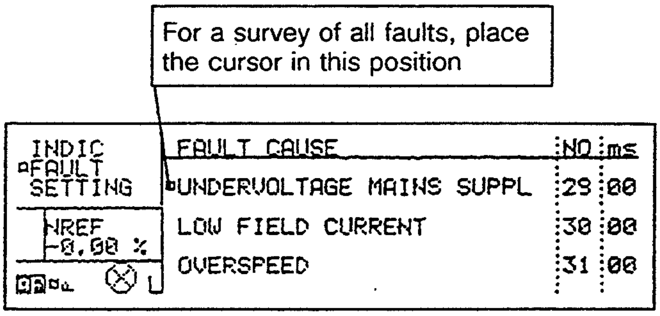


Figure 29. Fault statistics.

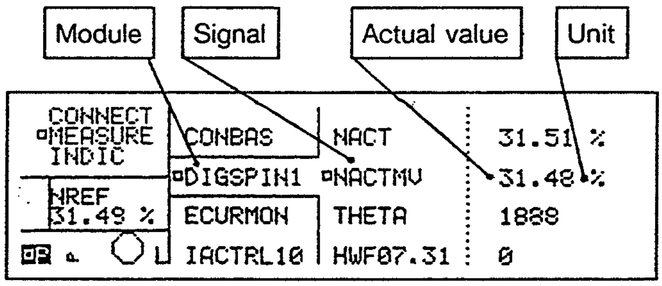


Figure 30. Measurement of signals.

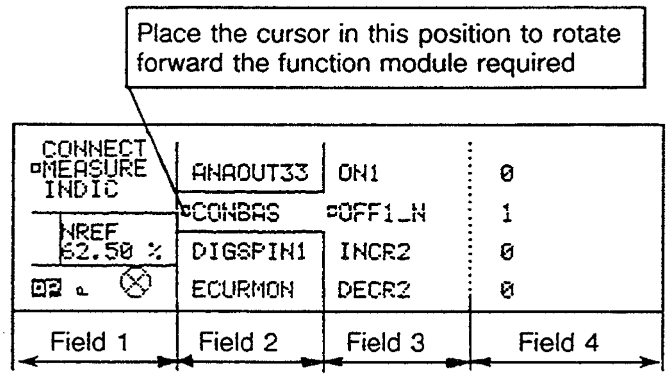


Figure 31. Measurement of signals.
Setting of required function module.

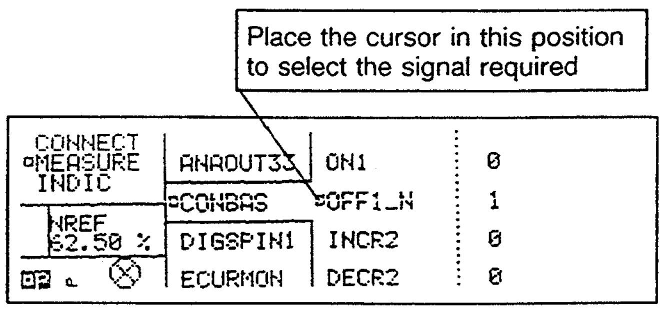


Figure 32. Measurement of signals.
Selection of a signal.

Display for setting of parameters, designation SETTING

The function of a control system is determined by a large number of parameters which can be increased or decreased via the operator's panel.

To determine the current value of a parameter or to give a parameter a new value, the function module containing the parameter is selected first. The cursor is located as shown in fig. 33. Press then the + or – buttons until the name of the required module appears by the cursor. The modules are stored in alphabetical order. A table of the parameters included in the function selected now appears to the right of the function table.

When the required function module has been selected, the cursor is moved to the position shown in fig. 34. Press then the + or – button until the parameter required appears on the screen. The parameters are also stored in alphabetical order.

When a parameter value is to be changed, the parameter concerned is placed opposite the cursor in Field 3, see fig. 35.

The latch must first be inactivated. See section **"Latch function"**. When double display operation is used also the authority parameters in module $OPCH_{XX}$ must have appropriate settings.

When the name of the parameter concerned is placed as shown in fig. 35, the cursor is moved to Field 4. Press the + or – buttons until the parameter value required is shown. When the value set is that required, the button **ENTER** is pressed. The new parameter value is now transmitted to the convertor computer where it is stored in an EEPROM and is used directly in the control system.

N.B: The previous parameter value is stored in the display computer so that it can be recalled quickly if any control probem should develop with the new value. The previous value is obtained if ENTER is depressed a second time.

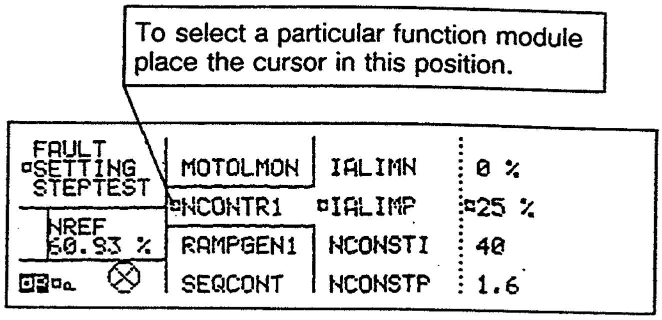


Figure 33. Parameter display.
Selection of function module.

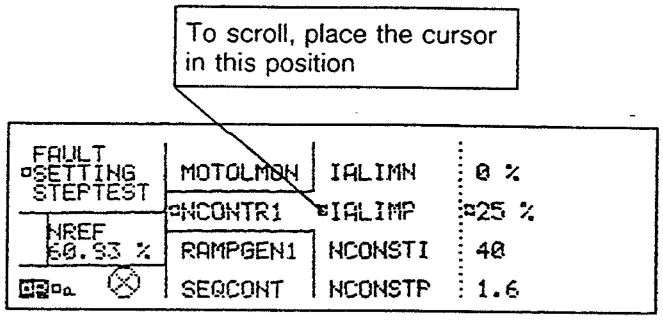


Figure 34. Parameter display.
Parameter check.

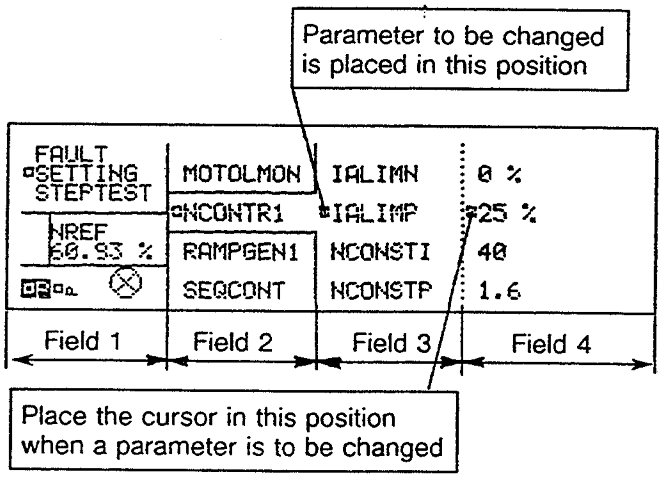


Figure 35. Parameter display.
Setting of parameter.

Registration display, designation REGISTR

The behavior of an arithmetic or logic signal can be registered with the display REGISTR. When a step test is performed on an optional signal the response to the step becomes available for study.

The logger can be stopped in three different ways:

1. The convertor has been tripped by a fault signal.
2. A step test has been commanded.
3. The logger is stopped manually.

A flashing "L" on the display indicates that the logger has stopped. If the convertor has tripped, the logger must be restarted manually by pressing **ENTER** in position S/S.

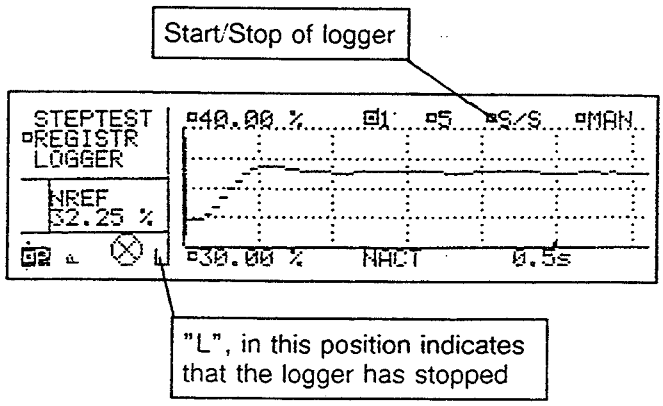


Figure 36. REGISTR.
Start of logger.

When the upper limit of the amplitude scale is to be changed, the cursor is first placed in the upper position as shown in fig. 37. Press + or – until the required value is presented and then **ENTER**. The procedure is similar for changing the lower limit.

If the upper limit is selected slightly above the lower, a "part- enlargement" of a control level of particular interest can be obtained.

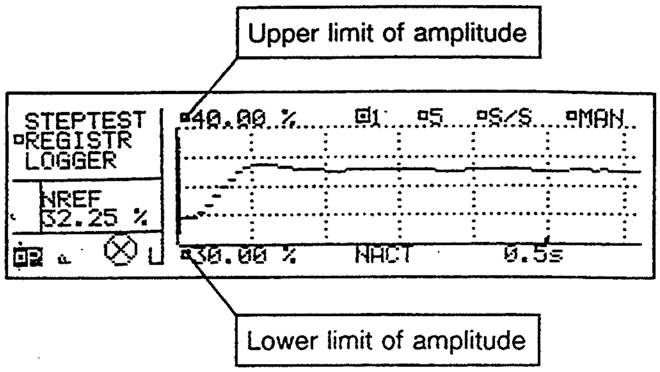


Figure 37. Registration.
Setting of amplitude.

To select a channel on the registration display, the cursor is placed as shown in fig. 38. The signal which is active in the channel is specified in the display LOGGER. When the cursor is placed in the required position, press + or – until the channel required is presented. Then press **ENTER**.

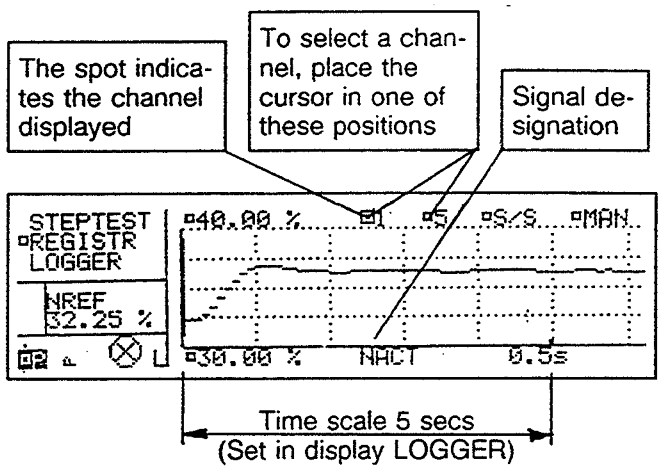


Figure 38. Registration.
Selection of channel.

Two logger channels can be stored simultaneously in the display computer. The number of the channel required is specified in position A or position B as in fig. 39. If **ENTER** is then pressed the signal in the channel selected is presented. The logger must be inactive if the channel is to be changed i.e. a flashing "L" must be visible.

If the signal currently displayed is to be compared with another signal, the cursor is placed in position A or position B. See fig. 39.

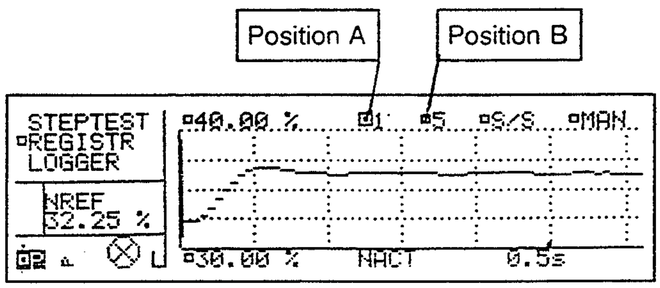


Figure 39. Registration.

Then press ENTER to obtain a presentation of the other signal. The original signal is recovered by pressing **ENTER** again. A rapid exchange is obtained if **ENTER** is held in its depressed position.

Example: Assume that the signal on channel 1 is displayed and that the cursor is at position A as in fig. 40. If **ENTER** is pressed, the signal on channel 5 is presented and the cursor moves to position B as in fig. 41. If **ENTER** is pressed again, the display shown in fig. 40 returns.

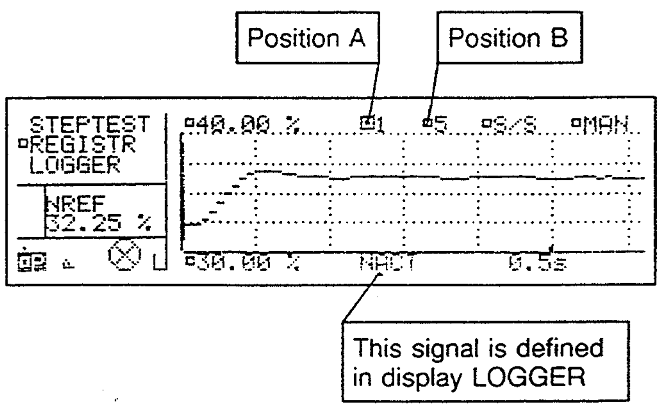


Figure 40.

Step testing is defined in the section **"Display for setting of step testing, designation STEPTEST"**. Step testing can however be commanded in the display REGISTR, either manually in single steps or automatically in a series of steps.

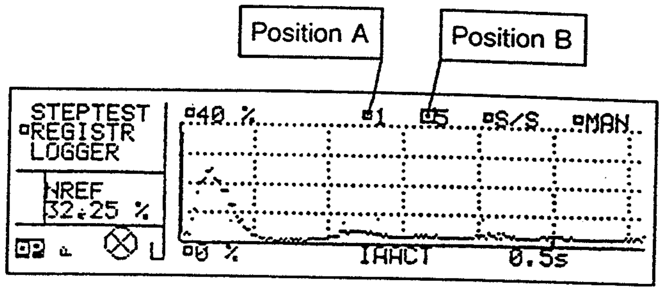


Figure 41.

When a manual step test is to be performed, the cursor is placed in the position shown in fig. 42. Press + or – until MANual is presented. **ENTER** is pressed to activate the stepping in the value. This triggers the logger which means that the logger registers the signal and continues recording until its memory is filled. The signal curve is then presented on the REGISTR display.

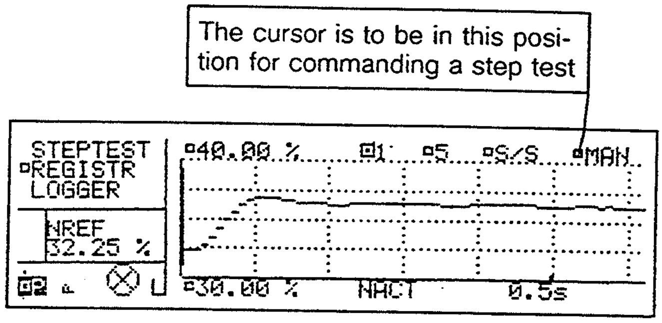


Figure 42. Registration.
Manual step testing.

If a step test is to be repeated automatically, the cursor is first placed in the position shown in fig. 43 and the + or – button is pressed until the text REP is presented. Automatic repetition of the step test is started when **ENTER** is depressed.

The step test is stopped by pressing **ENTER** once again. The cursor will then move out to the text REGISTR in Field 1 as in fig. 43.

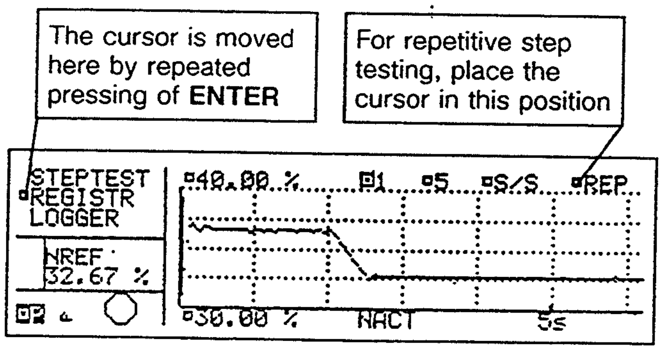
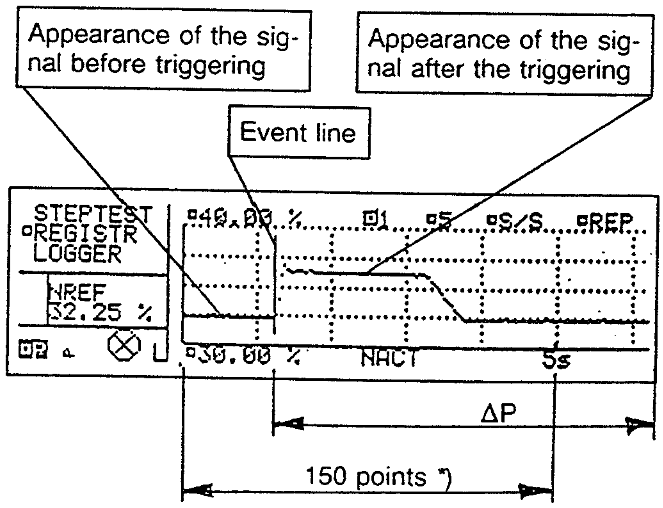


Figure 43. Registration.
Repetition of step testing.

The amplitude of the step, its duration and the signal to which it is applied are set on the STEPTEST display. The time between each test step is dependent on where the event line is placed and the time scale factor in the registration display. It is however always greater than ten seconds. See fig. 44.

The different durations of the square wave steps are described in more detail in fig. 45.



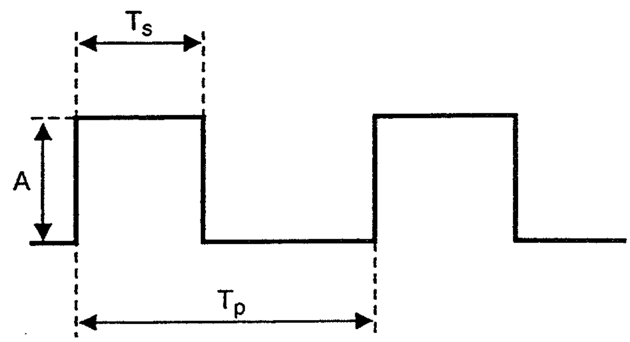
*) For Tyrak: 150 points in a 50 Hz-system
180 points in a 60 Hz-system

ΔP: Number of points after the event line.
Defined in display LOGGER.

Figure 44.

The amplitude +100 % means a maximum positive step.

This is equal to the maximum of any other signal even if maximum of a tested signal is defined e.g. as 400 %.



A: Amplitude of the test step. Defined in display STEPTEST

T_s: Duration of the test step. Defined in display STEPTEST

T_p: The time between each step

$$(T_p)_{max} = \Delta P \times \frac{\text{Scale factor for time in registration display}}{150} + 1 \text{ (sek)}$$

ΔP: Number of points after the event line. Defined in display LOGGER.

Figure 45. Step test with automatic repetition.

If the variations in a signal are to be studied continuously, the cursor is placed as shown in fig. 46. Press + or – until the text AUTO is presented. Then press **ENTER**, the display then showing how the signal varies in time. Note that the time scale for the channel must then be set to ≥ 500 seconds.

To stop the automatic updating, place the cursor in front of AUTO and press **ENTER**. The cursor is then automatically transferred to the display designation REGISTR.

A documentation of the variation of an interesting signal may be required. The cursor should be placed at S/S (Start/Stop) and the button **ENTER** pressed. Make a printout, return the cursor to S/S and then press **ENTER** again.

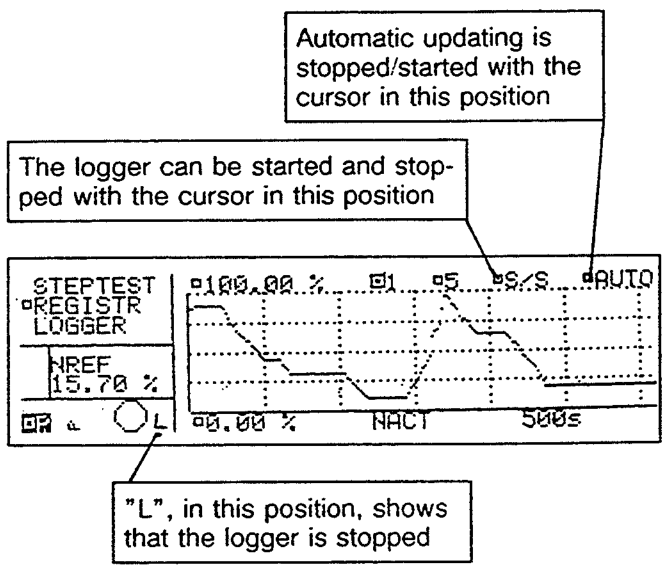
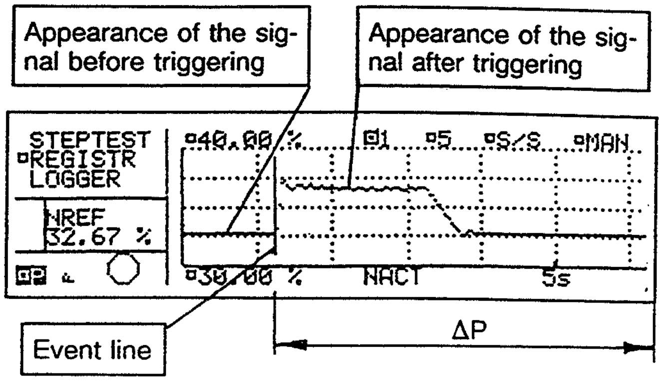


Figure 46. Registration.
Automatic updating.

When performing step tests, the signal after the triggering point is that most interesting. The event line is then set at the extreme left (ΔP 157 or 186). In the case of a fault, the events leading up to the failure are of more interest. The event lines are therefore to be set at the extreme right during normal operations (ΔP approx. 30).

If the logger is not started before the steptest is done, the display will show old values before the event line.



ΔP: Number of points set in the LOGGER display.

Figure 47. Registration. Significance of the event line.

The position of the event line is set in the LOGGER display. The number of points is specified there. See fig. 48. For a more detailed description of the logger, see below.

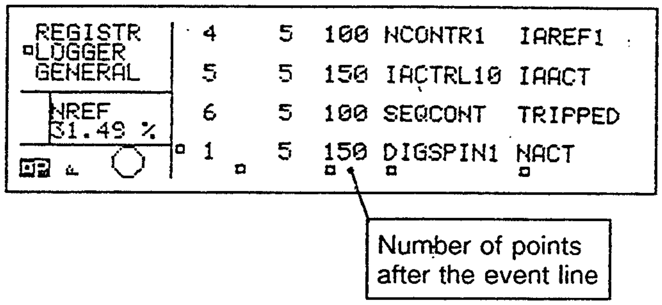


Figure 48. Logger. Setting of event line.

Logger display, designation LOGGER

The logger is a memory in which 186 values from each of 6 channels can be stored. When a new value is stored in a channel, the oldest value from the channel disappears. The contents of the logger can be read in graphic form on the REGISTR display, each point corresponding to a mean value of measured values.

The signals in the different channels are specified in the LOGGER display. The time scale and the number of measured values after the event line are also given there. See fig. 49.

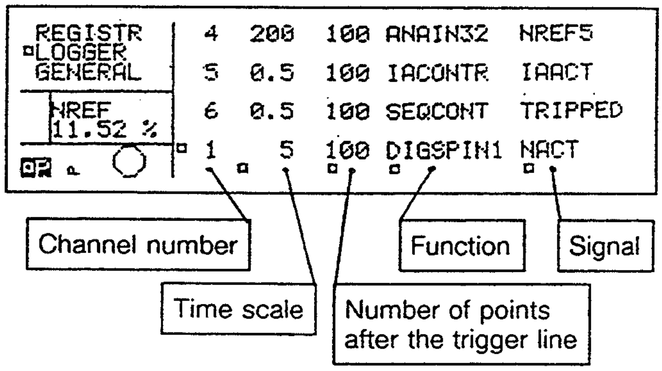


Figure 49. Logger.

A function for table scrolling is used to determine the signals in all of the channels in the logger. The cursor is first placed in the position shown in fig. 50 and then + or – is pressed.

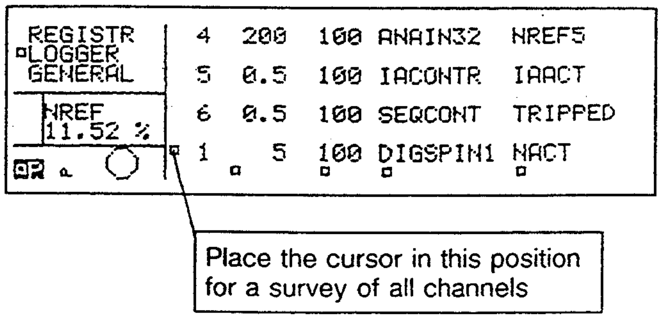


Figure 50. Logger. Channel survey.

If new data is to be defined in the logger, the channel to be changed is first placed on the bottom line as shown in fig. 51.

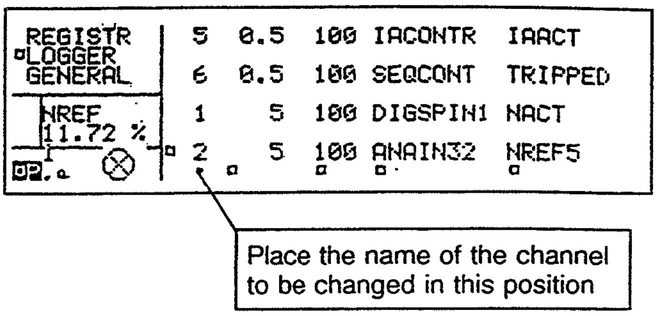


Figure 51. Logger.

To change the time scale, the cursor is placed in the position shown in fig. 52. Press + or – until the time scale required is shown. The time from the start to the time markings on the REGISTR display is given in seconds.

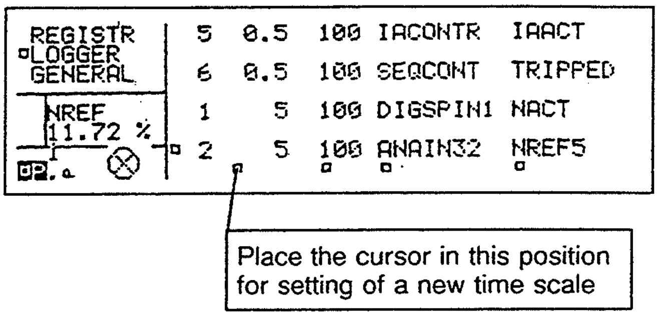


Figure 52. Logger.
Setting of time scale.

To change the number of measured values after the event line, the cursor is placed in the position shown in fig. 53. Press + or – until the number of measured values after the event line is that required.

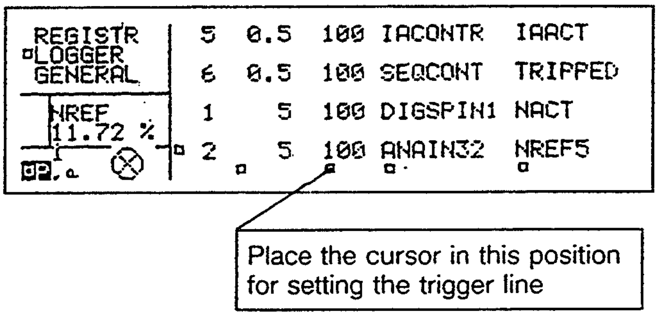


Figure 53. Logger.
Setting of event line.

The function module concerned must be defined before the new signal can be found. This is done by first placing the cursor as shown in fig. 54 and then pressing the + or – button until the identity of the required function module is shown. The first signal within this function module is then shown at the right.

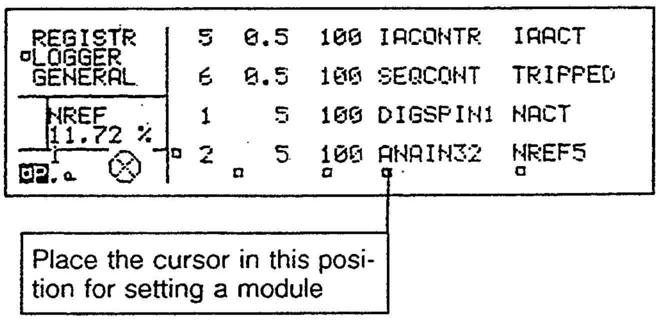


Figure 54. Logger.
Setting of function.

When the function module required is set, the cursor is placed as shown in fig. 55 and + or – pressed until the signal required is presented within the function module.

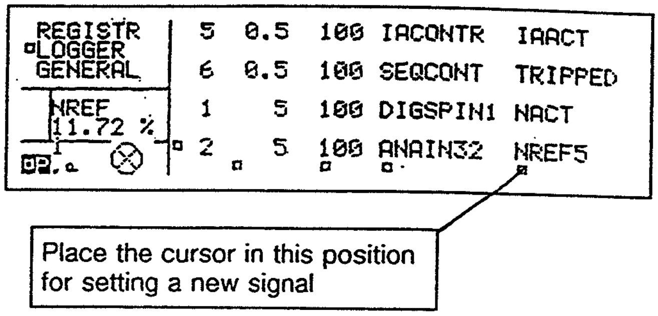


Figure 55. Logger. Setting of a new signal.

When the new setting is that required, the cursor is placed as shown in fig. 57 and the **ENTER** button pressed. The new setting will now be stored.

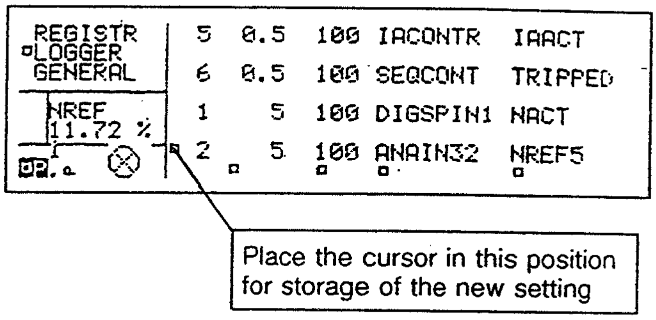


Figure 56. Logger. Storage of a new setting.

If a step test is performed (manually or automatically) or if a fault is detected, the logger is stopped and an "L" on the operator's panel begins flashing, irrespective of the display set. See fig. 57.

If any fault develops in the drive system, the logger is tripped and all signal values are frozen. It is therefore important to restart the logger before the drive system is restarted after malfunction or a step test. This is done by placing the cursor in position S/S (Registration display) and then pressing **ENTER**. See fig. 57.

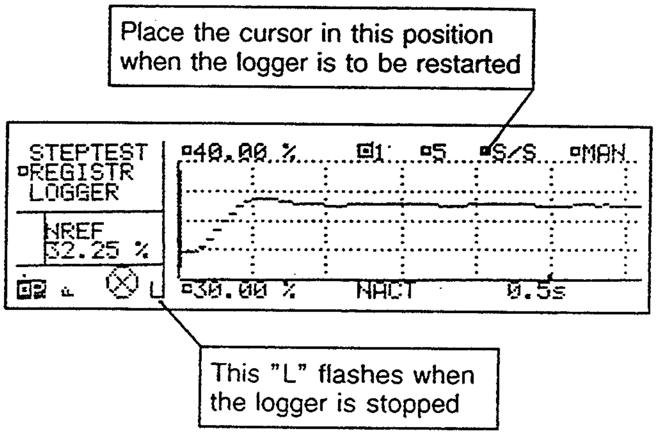


Figure 57. Registration display.

Display for setting step testing, designation STEPTEST

STEPTEST, REGISTR and LOGGER are three interdependent displays. When a step test is performed, the registration display changes forward automatically when the logger memory is fully occupied. The functions of the registration and logger are described under **"Registration display, designation REGISTR"** and **"Logger display, designation LOGGER"**.

When a step test is to be performed on a function, the cursor is to be placed in Field 2. Press + or – until the required function is presented beside the cursor. See fig. 58.

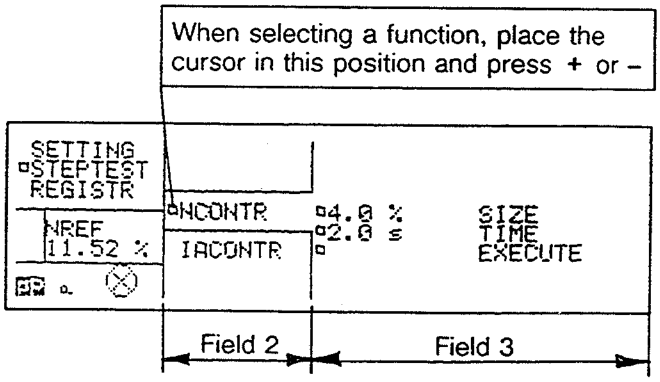


Figure 58. Step testing. Selection of function.

When the required function is set in Field 2, place the cursor in front of the text SIZE in Field 3 and then press + or – until the amplitude required is displayed. When the required amplitude is reached, press **ENTER**.

To set the duration of the step in the value, place the cursor in front of the text TIME. Press + or – until the required time is presented on the operator's panel and then press **ENTER**.

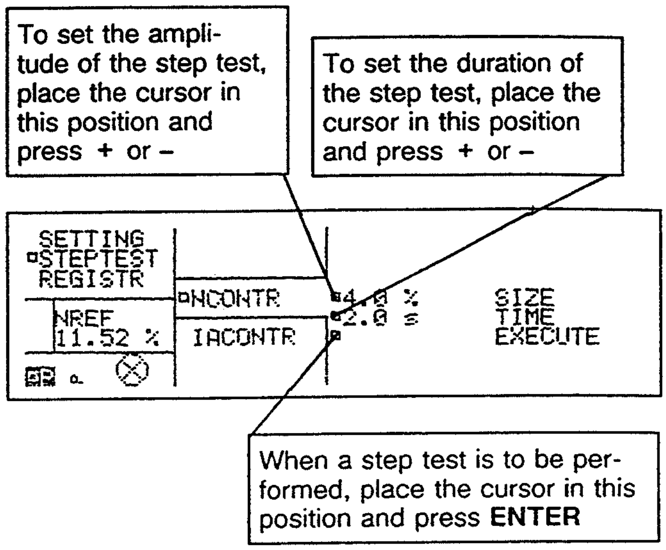


Figure 59. Step testing.
Setting of amplitude.

When the required function, amplitude and duration of the test step have been set, place the cursor in front of the text EXECUTE and press **ENTER**.

The REGISTR display will then be presented as soon as the logger memory is full. The measurement time is set in the LOGGER display. See fig. 60.

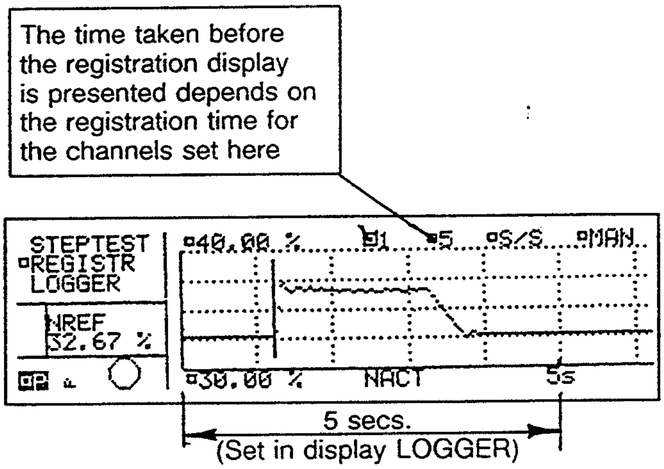


Figure 60. Registration.

Display for connection of external signals, designation CONNECT.

With the display CONNECT, it is possible to reconnect the signals on the different I/O units connected to the computer board. It is also possible to redefine push buttons and LEDs on the operator's panel.

The CONNECT display appears as shown in fig. 61. The significance of, for example, DOOP.3 is given in the section **"Abbreviations"**.

When signals are to be reconnected, the channel concerned is first placed on the bottom line by placing the cursor in position 1 and then pressing + or – until the channel required is presented, see fig. 61. The required function module is given in position 2 and the signal required is given in position 3. When the new setting is performed, the cursor is returned to position 1 and **ENTER** is pressed.

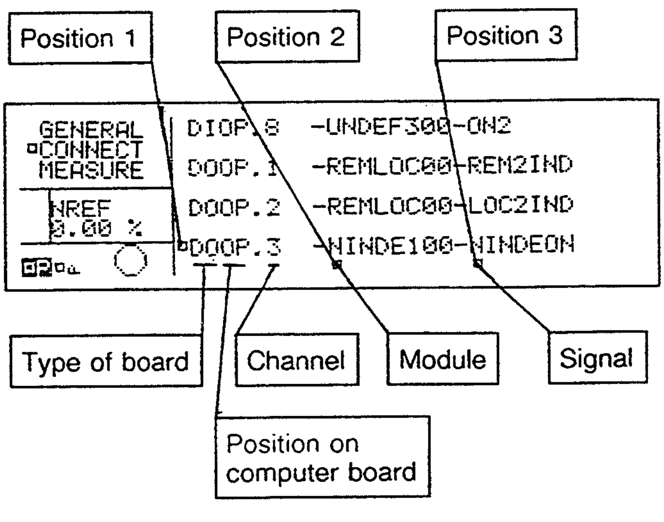


Figure 61. Appearance of the display.

Safety

Certain blocking functions are provided for protection against incorrect handling. In addition, when signals are exchanged in position 3, only arithmetical signals are selected for analogue units and logical signals for digital units. See fig. 62.

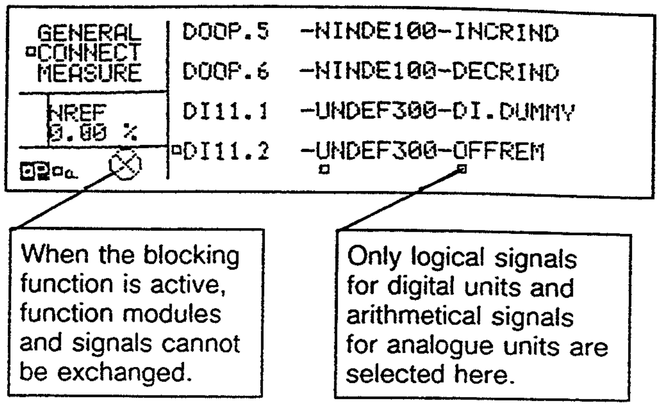


Figure 62. Safety functions.

The situations against which no protection is provided are shortcircuiting and the connection of an output to an inport or vice versa. See fig. 63.

N.B. The operator must be observant here and register the connections made.

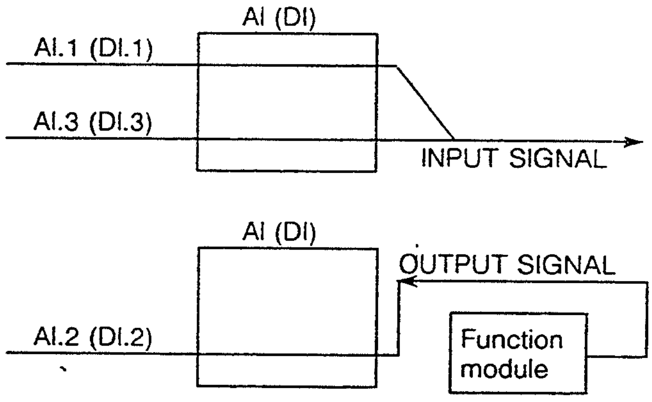


Figure 63. Situations against which no protection is provided.

Abbreviations

AI = Analogue IN-put.
AO = Analogue OUT-put.
DI = Digital IN-put.
DO = Digital OUT-put.

The numbering of the positions on the computer board and the operator's panel are numbered as shown in figs 64 and 65.

AI33.4 corresponds to ANALOGUE IN, placed in position 33 and the signal concerned is connected to channel 4.

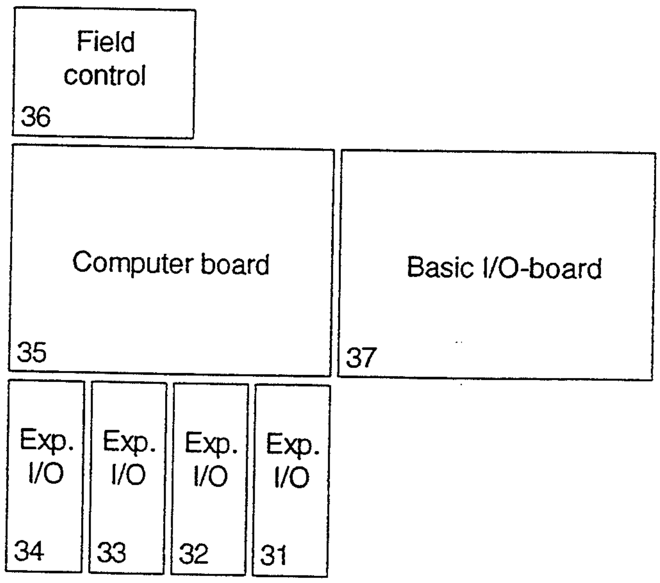


Figure 64. Board item designations, Tyrak Midi II.

DOOP.3 corresponds to LED number 3 (Digital OUT) on the operator's panel.

DIOP.5 corresponds to push button number 5 on the operator's panel.

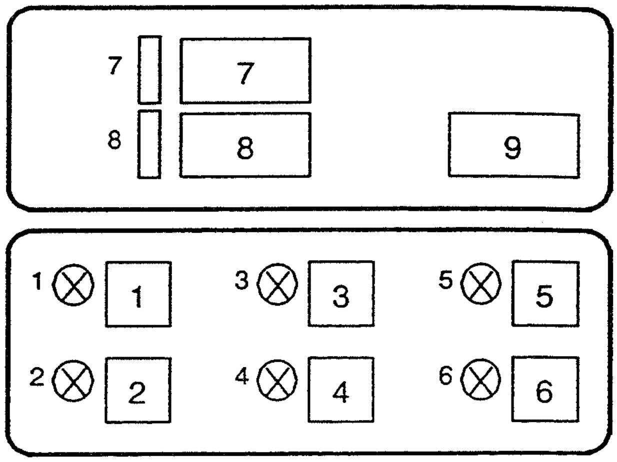
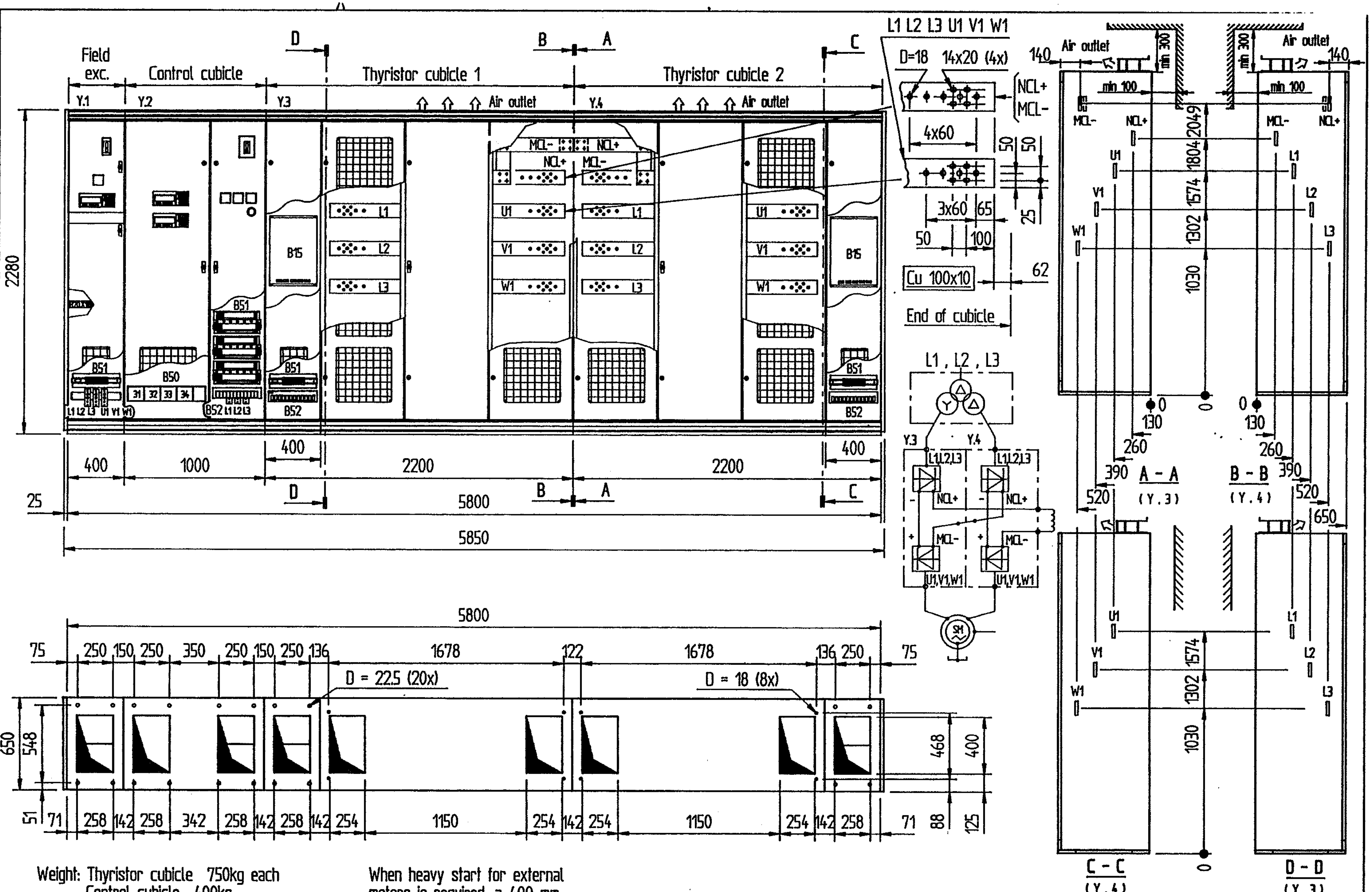


Figure 65. Numbering of push buttons and LEDs on the operator's panel.

Dimension Drawing

Contents



Weight: Thyristor cubicle 750kg each
Control cubicle 400kg
Field exciter 200-250kg

Air flow: Thyristor cubicle 4000m^3/h each
Field exciter 100-500m^3/h

When heavy start for external motors is required, a 400 mm cubicle is added between the control- and thyristor cubicle.

Accepted by qual. control	Accepted for prod by DPA/T EKSTRAND	Description (English) DIMENSION PRINT YRTK	
Design checked by G PETERSSON	Drawn by A BJÖRK	Description (own language) MÅTTSKISS LCI YRTK	
Drawing checked by G PETERSSON	Issued by Dept DKK, Year 94, Week 05	3ASD 489306C397	Lang EN, Sheet 1, Cont -
ABB Drives AB			

List of Apparatus

Contents

Field exciter YGHR 40-115 A Y.1

Supply unit A32 3ASD 489306B43

Item	Qty	Name		Type/Data	Part number
1	1	Transformer	SLMF123	110/220V	4781 020-ADU

Heater element A40 3ASD 489301A424

Item	Qty	Name		Type/Data	Part number
1	1	Heater element		100W, 240V	5291 2011-30

Main contactor unit B8 3ASD 489306B45

Item	Qty	Name		Type/Data	Part number
1	1	Inductor unit		3x6 uH	3ASD 489301A250
40	1	Contactor		B50-30-11	FPL3511001R0114

Main circuit unit B20

YGHR 40/64 A 3ASD 489306B5
YGHR 115 A 3ASD 489306B6

Item	Qty	Name	Convertor	Type/Data	Part number
1 to 3	3	Thyristor block	40/64A	40 A, 1600 V	4858 232-16
		Thyristor block	115A	90 A, 1600 V	4858 234-16
13,14,15	3	SCR fuse	40/64A	63 A, 660 V	5675 582-411
		SCR fuse	115A	125 A, 660 V	5675 582-414
19	1	Snubber circuit		YXI 115C	3ASD510001C19
35	1	Computer board		YPQ 201A	YT 204 001-KA
35.1	1	Memory board		FEDC01XX	3ASD 510001C4
35.2	1	DCB board		YPK 114A	3ASD 399002C4
37	1	I/O board		YPQ 202A	YT 204 001-KB
38	1	Trigger pulse board		YXU 167E	YT 204 001-JA
42,43	2	Current transformer		600/1	4762 0318-8
50	1	Fan		110 V, 50/60 Hz	6480 177-1
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20

Field discharge unit B35 3ASD 489306B27

Item	Qty	Name		Type/Data	Part number
1	1	Varistor		400 A	3ASD 524801C1
2	1	Thyristor module		TT210N1800KO(	4858 445-18
3	1	Resistor		10kOhm 50W 5%	5245 2063-510
4	1	Field disch. board		YXZ 225A	3ASD 510001C14

Instrument door D1					3ASD 489306B24
Item	Qty	Name		Type/Data	Part number
1	1	Voltmeter		10-0-10 VDC	5697728-31
99.1	1	Display control		YPP 109A	YT 204 001-HS
99.2	1	Indication unit		YPN 107A	YT 204 001-DM
99.3	1	Illuminated display		YPN 104C	YT 204 001-DS
99.4	1	Membrane keyboard			5372 396-10

Test panel D15 3ASD 489306B33

Item	Qty	Name		Type/Data	Part number
1	1	Terminal modem		YPK 111	YT 204 001-HH
3	1	El. outlet			3ASD 538101A320

MCCB unit H1 3ASD 489301A251

Item	Qty	Name	Convertor	Type/Data	Part number
1	1	MCCB breaker	40,64A	80 A	3ASD534402A1007
	1	MCCB breaker	115A	125A	3ASD534402A1009
4	1	Frame transformer			4762 079-5
4 1	1	Trans. suppr. diode			4856 210-213

Distribution unit H12 3ASD 489306B61

Item	Qty	Name		Type/Data	Part number
1	1	Base device			3ASD 534301A130
1 1	1	Tripping device		6-10 A	3ASD534303A1001

Field exciter YGHR 195-515 A Y.1

Supply unit A32 3ASD 489306B43

Item	Qty	Name		Type/Data	Part number
1	1	Transformer	SLMF123	110/220V	4781 020-ADU

Heater element A40 3ASD 489301A424

Item	Qty	Name		Type/Data	Part number
1	1	Heater element		100W, 240V	5291 2011-30

Main contactor unit B8

195A	3ASD489306B46
300A	3ASD489306B47
515A	3ASD489306B48

Item	Qty	Name		Type/Data	Part number
1	1	Inductor unit		3x6 uH	3ASD 489301A250
40	1	Contactor	195A	EH90-30-11	SK 823 022-AP
			300A	EH150-30-11	SK 825 002-AP
			515A	EH250-30-11	SK 826 001-AP

Main circuit unit B20

YGHR 195A	3ASD 489306B12
YGHR 300A	3ASD 489306B14
YGHR 515A	3ASD 489306B16

Item	Qty	Name	Convertor	Type/Data	Part number
1 to 3	3	Thyristor block	195,300A	1800V	4858 445-18
	3	Thyristor block	515A	1800V	4858 446-18
13,14,15	3	SCR fuse	195A	200A, 660V	5675 582-416
	3	SCR fuse	300A	315A, 660V	5675 582-418
	3	SCR fuse	515A	550A, 660V	5675 582-422
19	1	Capacitor unit		YXI 116A	YT 204 001-AN
25,26	2	Power resistor set	195,300A	3x15 Ohm	3ASD 524503A215
	2	Power resistor set	515A	3x6,8 Ohm	3ASD 524503A168
35	1	Computer board		YPQ 201A	YT 204 001-KA
35.1	1	Memory board		FEDC01XX	3ASD 510001C4
35.2	1	DCB board		YPK 114B	3ASD 399002C4
37	1	I/O board		YPQ 202A	YT 204 001-KB
38	1	Trigger pulse board		YXU 167G	YT 204 001-JE
42,43	2	Current transformer		600/1	4762 0318-8
48	1	Contactor		110V 50/60Hz	GJL1211001R0014
49	1	Capacitor (50Hz)		6 uF 250V	4984 219-7
49	1	Capacitor (60Hz)		5 uF 250V	4984 219-6
50	1	Fan		110V 50/60Hz	3ASD 648001A399
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20

Field discharge unit B35					3ASD 489306B27
Item	Qty	Name		Type/Data	Part number
1	1	Varistor		400 A	3ASD 524801C1
2	1	Thyristor module		TT210N1800KO(	4858 445-18
3	1	Resistor		10kOhm 50W 5%	5245 2063-510
4	1	Field disch. board		YXZ 225A	3ASD 510001C14

Instrument door D1 195,300A 3ASD 489306B24
515A 3ASD 489306B25

Item	Qty	Name		Type/Data	Part number
1	1	Voltmeter		10- 0 - 10 VDC	5697 728-31
99.1	1	Display control		YPP 109A	YT 204 001-HS
99.2	1	Indication unit		YPN 107A	YT 204 001-DM
99.3	1	Illuminated display		YPN 104C	YT 204 001-DS
99.4	1	Membrane keyboard			5372 396-10

Test panel D15 3ASD 489306B33

Item	Qty	Name		Type/Data	Part number
1	1	Terminal modem		YPK 111	YT 204 001-HH
3	1	El. outlet			3ASD 538101A320

MCCB unit H1 195-300A 3ASD 489301A283
515A 3ASD 489301A285

Item	Qty	Name	Convertor	Type/Data	Part number
1	1	MCCB breaker	195A	200A	3ASD534403A1002
	1	MCCB breaker	300A	320A	3ASD534403A1004
	1	MCCB breaker	515A	500A	3ASD534404A1004
4	1	Current transformer			4762 079-5
4 1	1	Trans. suppr. diode			4856 210-213

Distribution unit H12 3ASD 489306B22

Item	Qty	Name		Type/Data	Part number
1	1	Base device			3ASD 534301A130
1 1	1	Tripping device		6-10 A	3ASD534303A1001
41	1	Contactor		110V 50/60Hz	GJL1211001R0014

Field exciter YQNG 55-95A Y.1

Supply unit A32 3ASD 489306B43

Item	Qty	Name		Type/Data	Part number
1	1	Transformer		110/220V	4781 020-ADU

Heater element A40 3ASD 489301A424

Item	Qty	Name		Type/Data	Part number
1	1	Heater element		100W, 240V	5291 2011-30

Main contactor unit B8 3ASD 489306C426

Item	Qty	Name		Type/Data	Part number
40	1	Contactor		B50-30-11	FPL3511001R0114

Main circuit unit B20

55A 3ASD489306C371
95A 3ASD489306C372

Item	Qty	Name	Convertor	Type/Data	Part number
1 to 3	3	Thyristor block	55A	40 A, 1600 V	4858 232-16
		Thyristor block	95A	90 A, 1600 V	4858 234-16
		SCR fuse	95A	125 A, 660 V	5675 582-414
19	1	Snubber circuit		YXI 114B	YT 238 001-AB
35	1	Computer board		YPQ 201A	YT 204 001-KA
35.1	1	Memory board		FEAC01XX	3ASD 510001C27
35.2	1	DCB board		YPK 114B	3ASD 399002C4
37	1	I/O board		YPQ 202A	YT 204 001-KB
38	1	Trigger pulse board		YXU 169H	3ASD 273001B5
41,42,43	3	Current transformer		600/1	4762 0318-8
50	1	Fan		110 V,50/60Hz	6480 177-1
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20
33	1		Analog input	YPG108E	YT204001-FV
F11,12,13	3	Current sensor			4760081-5

Instrument door D1					3ASD 489306B24
Item	Qty	Name		Type/Data	Part number
1	1	Voltmeter		10-0-10 VDC	5697 728-31
99.1	1	Display control		YPP 109A	YT 204 001-HS
99.2	1	Indication unit		YPN 107A	YT 204 001-DM
99.3	1	Illuminated display		YPN 104C	YT 204 001-DS
99.4	1	Membrane keyboard			5372 396-10

Test panel D15 3ASD 489306B33

Item	Qty	Name		Type/Data	Part number
1	1	Terminal modem		YPK 111	YT 204 001-HH
3	1	El. outlet			3ASD 538101A320

MCCB unit H1 3ASD489301A251

Item	Qty	Name	Convertor	Type/Data	Part number
1	1	MCCB breaker	55A	80 A	3ASD534402A1007
	1	MCCB breaker	95A	125A	3ASD534402A1009
4	1	Current transformer			4762 079-5
4 1	1	Trans. suppr. diode			4856 210-213

Distribution unit H12 3ASD 489306B61

Item	Qty	Name		Type/Data	Part number
1	1	Base device			3ASD534301A130
1 1	1	Tripping device		6-10 A	3ASD534303A1001

Terminal unit B50

Item	Qty	Name	Convertor	Type/Data	Part number
33	1	Con.unit analog input		YPG109	3ASD273001B3
31	1	Power measuring		YPG111A	3ASD273001B1
X1	3	Resistor	55A	RM1,2,3	52482112-282
			55A	RM11,12,13	52482111-368
			95A	RM1,2,3	52482112-247
			95A	RM11,12,13	52482111-339

Voltage meas. unit B35 3ASD489306C375

11,21	2	Resistor		22 kohm 50w	52452063-522
12,22	2	Resistor		22 kohm 50w	52452063-522
10	1	Voltage measuring			4760081-10

Field exciter YQNG 285-430A Y.1

Supply unit A32 3ASD 489306B43

Item	Qty	Name		Type/Data	Part number
1	1	Transformer		110/220V	4781 020-ADU

Heater element A40 3ASD 489301A424

Item	Qty	Name		Type/Data	Part number
1	1	Heater element		100W, 240V	5291 2011-30

Main contactor unit B8 285A 3ASD 489306C427
430A 3ASD 489306C428

Item	Qty	Name		Type/Data	Part number
1	1	Inductor unit		3x6 uH	3ASD 489301A250
40	1	Contactor	285A	EH150-30-11	SK 825 002-AP
			430A	EH250-30-11	SK 826 001-AP

Main circuit unit B20 285A 3ASD489306C381
430A 3ASD489306C382

Item	Qty	Name	Convertor	Type/Data	Part number
1 to 3	3	Thyristor block	285A	1800V	4858 445-18
	3	Thyristor block	430A	1800V	4858 446-18
19.1,2,3	3	Capacitor unit		0,5uF,630V	4984229-1
25.1,2,3	3	Power resistor set		3X47 Ohm 50W 5	3ASD524503A247
35	1	Computer board		YPQ 201A	YT 204 001-KA
35.1	1	Memory board		FEAC01XX	3ASD 510001C27
35.2	1	DCB board		YPK 114B	3ASD 399002C4
37	1	I/O board		YPQ 202A	YT 204 001-KB
38	1	Trigger pulse board		YXU 169H	3ASD 273001B5
41,42,43	3	Current transformer		600/1	4762 0318-8
48	1	Contactor		110V 50/60Hz	GJL1211001R0014
49	1	Capacitor (50Hz)		6 uF 250V	4984 219-7
49	1	Capacitor (60Hz)		5 uF 250V	4984 219-6
50	1	Fan		220 V, 50/60 H	3ASD 648001A399
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20
B20.33	1	Analog input		YPG108E	YT204001-FV
F11,12,13	3	Current sensor		1:5000	3ASD 476001C1

Instrument door D1

285A 3ASD 489306B24
430A 3ASD 489306B25

Item	Qty	Name		Type/Data	Part number
1	1	Voltmeter		10-0-10VDC	5697728-31
99.1	1	Display control		YPP 109A	YT 204 001-HS
99.2	1	Indication unit		YPN 107A	YT 204 001-DM
99.3	1	Illuminated display		YPN 104C	YT 204 001-DS
99.4	1	Membrane keyboard			5372 396-10

Test panel D15

3ASD 489306B33

Item	Qty	Name		Type/Data	Part number
1	1	Terminal modem		YPK 111	YT 204 001-HH
3	1	El. outlet			3ASD 538101A320

MCCB unit H1

195-300A 3ASD 489301A283
515A 3ASD 489301A285

Item	Qty	Name	Convertor	Type/Data	Part number
1	1	MCCB breaker	285A	320A	3ASD 534403A1004
	1	MCCB breaker	430A	500A	3ASD 534404A1004
4	1	Current transformer			4762 079-5
4 1	1	Trans. suppr. diode			4856 210-213

Distribution unit H12

3ASD 489306B22

Item	Qty	Name		Type/Data	Part number
1	1	Base device			3ASD 534301A130
1 1	1	Tripping device		6-10 A	3ASD 534303A1001
41	1	Contactor		110V 50/60Hz	GJL1211001R0014

Terminal unit B50

Item	Qty	Name	Convertor	Type/Data	Part number
33	1	Con.unit analog input		YPG109	3ASD273001B3
31	1	Power measuring		YPG111A	3ASD273001B1
X1	3	Resistor	285A	RM1,2,3	52482112-239
			285A	RM11,12,13	52482111-333
			430A	RM1,2,3	52482112-227
			430A	RM11,12,13	52482111-318

Voltage meas. unit B35

3ASD489306c375

Item	Qty	Name	Convertor	Type/Data	Part number
11,21	2	Resistor		22kohm 50w	52452063-522
12,22	2	Resistor		22kohm 50w	52452063-522
10	1	Voltage measuring			4760081-10

Control cubicle Y.2

Heater element A40 3ASD 489301A425

Item	Qty	Name		Type/Data	Part number
1,2	2	Heater element		100W, 240V	5291 2011-30

Aux. supply unit B1 3ASD 489306C51

Item	Qty	Name		Type/Data	Part number
1	1	Base dev. control mod.			3ASD 534301A130
1 1	1	Tripp. dev control mod.		6-10A	3ASD534303A1001
2 to 5	1 to 4	Base dev. trigger pulse			3ASD 534301A130
2.1 to 5.1	1 to 4	Tripp. dev. trigger pulse		1,6-2,4A	3ASD534302A1004
6 to 9	1 to 4	Base dev. fan			3ASD 534301A130
6.1 to 9.1	1 to 4	Tripp. dev. fan	Fan connection: Y	2,4-4,0A	3ASD534302A1005
	1 to 4	Tripp. dev. fan	Fan connection: D	6,0-10A	3ASD534302A1007
6.2 to 9.2	1 to 4	Contactor block fan			3ASD 534301A137
6.3 to 9.3	1 to 4	Aux. contact fan			3ASD 534301A139
10 to 13	0 to 4	Base dev. pump			3ASD 534301A130
10.1 to 13.1	0 to 4	Tripp. dev. pump		0,4-0,6A	3ASD534302A1001
	0 to 4	Tripp. dev. pump		0,6-1,0A	3ASD534302A1002
	0 to 4	Tripp. dev. pump		1,0-1,6A	3ASD534302A1003
	0 to 4	Tripp. dev. pump		1,6-2,4A	3ASD534302A1004
	0 to 4	Tripp. dev. pump		2,4-4,0A	3ASD534302A1005
10.2 to 13.2	0 to 4	Contactor block pump			3ASD 534301A137
10.3 to 13.3	0 to 4	Aux. contact pump			3ASD 534301A139
14 to 17	0 to 4	Base dev. external fan	Ext.fan 0,4-40A		3ASD 534301A130
14 to 17	0 to 4	D-O-line starter	Ext.fan 40-45A		3ASD 534401C1
14.1 to 17.1	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	0,4-0,6A	3ASD534301A1001
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	0,6-1,0A	3ASD534301A1002
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	1,0-1,6A	3ASD534301A1003
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	1,6-2,4A	3ASD534301A1004
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	2,4-4,0A	3ASD534301A1005
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	4,0-6,0A	3ASD534301A1006
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	6,0-10,0A	3ASD534301A1007
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	10,0-16,0A	3ASD534301A1008
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	16,0-25,0A	3ASD534301A1009
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	25,0-32,0A	3ASD534301A1010
	0 to 4	Tripp. dev. external fan	Ext.fan 0,4-40A	32,0-40,0A	3ASD534301A1011
14.2 to 17.2	0 to 4	Contactor block ext. fan	Ext.fan 0,4-40A		3ASD 534301A137
14.3 to 17.3	0 to 4	Aux. contact ext. fan	Ext.fan 0,4-40A		3ASD 534301A139
20	1	Transformer		SLMF 123	4781 020-ADU
21,22,23	3	Contactor		B9-30-10	FPL1411001R0104
21.1,22.1	2	Pneumatic timer		TP 40 I	FPTN477016R0008
25,26,27	0 to 3	Time relay	Ext.fan >40A		3ASD 563201A324
30,31	2	Capacitor		0,33 uF 10%	4984 220-2

Control module B2

3ASD 489306C2

Item	Qty	Name		Type/Data	Part number
6,7	2	Contactor		110V 40-60Hz	GJL1211001R0014
10	1	Terminal modem		YPK111	YT 204 001-HH
31	1	Exp. I/O dig. input		YPI 103E	YT 204 001-FB
32	1	Exp. I/O dig. output		YPO 105E	YT 204 001-FR
33	1	Exp. I/O analog input		YPG 110E	YT 204 001-FD
34	1	Exp. I/O analog output		YPM 102E	YT 204 001-FL
35	1	Computer board		YPQ 201T	3ASD 299001B2
35.1	1	Memory board		DSRB01XX	3ASD 510001C2
35.2	1	DCB board		YPK 114B	3ASD 399002C4
36	1	Distribution board		YPC 111B	3ASD 510001C18
37	1	I/O board		YPQ 202A	YT 204 001-KB
41	1	MP-communication		YPK 107A	3ASD 489301A410
41.1,41.2	1 or 2	Modem board		YPC 104B	YT 204 001-BT
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20

Control module B20

3ASD 489306C343

Item	Qty	Name		Type/Data	Part number
1,4	2	Control circuit		YXM 187D	3ASD 510001C16
2	1	Conn.unit analog output		YPM 105A	YT 204 001-BH
3	1	Conn.unit analog input	1200A	YPG 109BS	3ASD 489306C435
	1	Con.unit analog input	1540A	YPG109BT	3ASD 489306C436
	1	Con.unit analog input	1740/1860A	YPG109BU	3ASD 489306C437
5	1	Trigg. transformer		SLTF 0020	3ASD 478101C1
6	1	Contactor		110V 40-60Hz	GJL1211001R0014
8	1	Current feedback board	1200A	YXA 118P	3ASD 489306C350
	1	Current feedback board	1540A	YXA 118R	3ASD 489306C351
	1	Current feedback board	1740A	YXA 118S	3ASD 489306C352
	1	Current feedback board	1860A	YXA 118T	3ASD 489306C353
10	1	Terminal modem		YPK 111	YT 204 001-HH
31	1	Analog output		YPM 106E	YT 204 001-FN
33	1	Analog input		YPG 108E	YT 204 001-FV
35	1	Computer board		YPQ 201T	3ASD 299001B2
35.1	1	Memory board		CL1201XX	3ASD 510001C26
35.2	1	DCB board		YPK 114B	3ASD 399002C4
37	1	I/O board		YPQ 202A	YT 204 001-KB
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20
13,14	2	3-phase bridge rectifire			4858444-14
38	1	Trigger pulse board		YPQ203A	3ASD 510001C17
34	1	Interface LCI		YPQ109B	3ASD510001C20

Convertor module B32					3ASD 489306C345
Item	Qty	Name		Type/Data	Part number
1,4	2	Control circuit		YXM 187D	3ASD 510001C16
6,7	2	Transformer		SLTF 0140	4781 0624-AZ
11,21	2	Trigger pulse unit		YYX 144	YT 242 001-AG
12,22	2	Sync. filter board		YYI 107B	3ASD 489306C421
51	1	Transformer		SLTF 0070	3ASD 478101A302
52	1	Rectifier		YXE 152A	YT 204 001-AF
52.F1	1	Min fuse		6,3 A	5672 2011-22
52.F2	1	Min fuse		4,0 A	5672 2011-20
R1-R6	6	Power resistor		2,7 Ohm 50W 125(	5245 284-127

Terminal unit B50

Item	Qty	Name		Type/Data	Part number
31	1	Conn.unit digital input		YPI 105C	YT 204 001-BK
32	1	Conn.unit digital output		YPO 106A	YT 204 001-EG
33	1	Conn.unit analog input		YPG 106A	YT 204 001-BL
34	1	Conn.unit analog output		YPM 105A	YT 204 001-BH
71,72,73	3	Opto-coupler			3ASD562001C1

Connection unit B53

Item	Qty	Name		Type/Data	Part number
1,2	1 or 2	Connection board		YPC 105A	YT 204 001-HE

Instrument door D1 3ASD 489306C26

Item	Qty	Name		Type/Data	Part number
1	1	Voltmeter		10-0-10VDC	3ASD569701C34
2	1	Voltmeter		10-0-10VDC	3ASD 569701C15
3	1	Voltmeter		10-0-10VDC	3ASD569701C34
6	1	Actuator		CBK	SK 616 227-A
6	1	Contact block			SK 616 001-B

Display unit E1

Item	Qty	Name		Type/Data	Part number
1	1	Display control		YPP 109A	YT 204 001-HS
2	1	Indication unit		YPN 107A	YT 204 001-DM
3	1	Illuminated display		YPN 104C	YT 204 001-DS
4	1	Membrane keyboard			5372 396-10

Display unit E2					
Item	Qty	Name		Type/Data	Part number
1	1	Display control		YPP 109A	YT 204 001-HS
2	1	Indication unit		YPN 107A	YT 204 001-DM
3	1	Illuminated display		YPN 104C	YT 204 001-DS
4	1	Membrane keyboard			5372 396-10

MCCB unit H1			Ext.fan 0,4-40A		3ASD 489301A251
Item	Qty	Name		Type/Data	Part number
1	1	MCCB breaker	Ext.fan 0,4-40A	125A	3ASD 534402A1009
4	1	Frame transformer		ILDE 22,3 N=40(	4762 079-5
4 1	1	Trans. suppr. diode			4856 210-213

Thyristor cubicle Y.3

Heater element A40 3ASD 489301A425

Item	Qty	Name		Type/Data	Part number
1,2	2	Heater element		100W, 240V	5291 2011-30

Sync. transformer unit B8 3ASD 489306C150

Item	Qty	Name		Type/Data	Part number
1	1	Transformer		SLTF 0370	3ASD 478101C2

Current measuring unit B13 3ASD 489306C152

Item	Qty	Name		Type/Data	Part number
1,2	2	1-phase bridge		20A 400V	4858 267-4

Trigger pulse unit B15 3ASD 489306C335

Item	Qty	Name		Type/Data	Part number
1 1	1	Base unit		YXU 201A	3ASD 510001C9
1 2	1	Acceleration unit		YXU 202A	3ASD 510001C10
2 1	1	Base unit		YXU 201A	3ASD 510001C9
2 2	1	Acceleration unit		YXU 202A	3ASD 510001C10
3 51	1	Transformer		SLTF 0070	3ASD 478101A302
3 52	1	Aux. supply rectifier		YXE 152A	YT 204 001-AF
4	1	Relay			3ASD 563201C1
5 to 8	4	Power resistor		3x22 Ohm 50W 5	3ASD 524503A222

Measuring unit B26 1190V 3ASD 489306C473
1470V 3ASD 489306C475

Item	Qty	Name		Type/Data	Part number
2	1	Insulation amplifier		1000 V	3ASD 569702C2
3,4	2	Resistor unit	1190V	5x500ohm	3ASD 524501C1
	2	Resistor unit	1470V	5X1Mohm	3ASD524501C4

Earth fault protection B30 3ASD 489306C356

Item	Qty	Name		Type/Data	Part number
1	1	Earth fault protection		RAERA	RK 667 005-DB
2 to 4	3	Resistor		33kOhm 100W 5	5245 2564-533

Resistor element F35

Item	Qty	Name		Type/Data	Part number
1	1	Resistor element		PT100	4276 500-1

Thyristor unit G1

1200A 1190V	3ASD 489306C337
1740A 1190V	3ASD 489306C338
1540A 1470V	3ASD 489306C339
1860A 1470V	3ASD 489306C340

Item	Qty	Name	Convertor	Type/Data	Part number
1 to 12	12	Thyristor	1200A 1190V	YST 45-27 P42	3ASD485507B4235
	12	Thyristor	1740A 1190V	YST 45-27 P42	3ASD485507B4235
	12	Thyristor	1540A 1470V	YST 45-21 P52	3ASD485507B5240
	12	Thyristor	1860A 1470V	YST 60-23 P52	3ASD485509B5240
13-24	12	Capacitor		,1uF10%2.0kVA	4984 305-1
25-48	24	Power resistor	1190V	55 Ohm 900w 5%	5245 0053-4
	24	Power resistor	1470V	140 ohm	5245 0053-1
50	1	Fan		380/660V	6480 221-2
51,52,53,54	2	Current transformer	1200A 1190V	1500/1 720V	3ASD 478115B3
55,56,57,58	4	Resistor		80 Ohm 100W 5	5245 2064-368
61-72	12	Transformer		SHPC 42	4783 335-V
75	1	Pressure switch		30-600pA250VAC	3ASD 566301B1
84-89	6	MP-capacitor		0,33 uF	4984 220-2
81-83	3	Fuse		6A, 1500V	5675563-703

Sync. transformer unit G2

Item	Qty	Name		Type/Data	Part number
1	1	Transformer		SLTF 0520	4781 0630-AF

Reactor unit B31

Item	Qty	Name	Convertor	Type/Data	Part number
1,2,3	3	Inductor		SLM61R	4782016-SG

Fuse unit

Item	Qty	Name	Convertor	Type/Data	Part number
F21,22,23	3	Fuse		6A 1500V	5675563-703
F31,32,33	3	Fuse		6A, 1500V	5675563-703
F61,62	2	Fuse		6A,7,2kv	3ASD567401B1

Thyristor cubicle Y.4

Heater element A40 3ASD 489301A425

Item	Qty	Name		Type/Data	Part number
1,2	2	Heater element		100W, 240V	5291 2011-30

Sync. transformer unit B8 3ASD 489306C150

Item	Qty	Name		Type/Data	Part number
1	1	Transformer		SLTF 0370	3ASD 478101C2

Current measuring unit B13 3ASD 489306C152

Item	Qty	Name		Type/Data	Part number
1,2	2	1-phase bridge		20A 400V	4858 267-4

Trigger pulse unit B15 3ASD 489306C335

Item	Qty	Name		Type/Data	Part number
1 1	1	Base unit		YXU 201A	3ASD 510001C9
1 2	1	Acceleration unit		YXU 202A	3ASD 510001C10
2 1	1	Base unit		YXU 201A	3ASD 510001C9
2 2	1	Acceleration unit		YXU 202A	3ASD 510001C10
3 51	1	Transformer		SLTF 0070	3ASD 478101A302
3 52	1	Aux. supply rectifier		YXE 152A	YT 204 001-AF
4	1	Relay			3ASD 563201C1
5 to 8	4	Power resistor		3x22 Ohm 50W 5	3ASD 524503A222

Measuring unit B26 1190V 3ASD 489306C473
1470V 3ASD 489306C475

Item	Qty	Name		Type/Data	Part number
2	1	Insulation amplifier		1000 V	3ASD 569702C2
3,4	2	Resistor unit	1190V	5x500kohm	3ASD 524501C1
	2	Resistor unit	1470V	5x1Mohm	3ASD 524501C4

Resistor element F35

Item	Qty	Name		Type/Data	Part number
1	1	Resistor element		PT100	4276 500-1

Thyristor unit G1

1200A 1190V	3ASD 489306C337
1740A 1190V	3ASD 489306C338
1540A 1470V	3ASD 489306C339
1860A 1470V	3ASD 489306C340

Item	Qty	Name	Convertor	Type/Data	Part number
1 to 12	12	Thyristor	1200A 1190V	YST 45-27 P42	3ASD485507B4235
	12	Thyristor	1740A 1190V	YST 45-27 P42	3ASD485507B4235
	12	Thyristor	1540A 1470V	YST 45-21 P52	3ASD485507B5240
	12	Thyristor	1860A 1470V	YST 60-23 P52	3ASD485509B5240
13-24	12	Capacitor		,1uF10%2.0kVA	4984 305-1
25-48	24	Power resistor	1190V	55 Ohm 900w	5245 0053-4
	24	Power resistor	1470V	140 ohm	5245 0054-1
50	1	Fan		380/660V 3,8kW	6480 221-2
51,52,53,54	2	Current transformer	1200A 1190V	1500/1 720V	3ASD 478115B3
55,56,57,58	2	Resistor		680 Ohm 100W 5	5245 2064-368
61-72	12	Transformer		SHPC 42	4783 335-V
75	1	Pressure switch		80-600pA250VA	3ASD 566301B1
84-89	6	Capacitor		0,33 uF	4984220-2
81-83	3	Fuse		6A, 1500V	5675563-703

Sync. transformer unit G2

Item	Qty	Name		Type/Data	Part number
1	1	Transformer		SLTF 0520	4781 0630-AF

Reactor unit B31

Item	Qty	Name	Convertor	Typr/Data	Part number
1,2,3	3	Inductor		SLM61R	4782016-SG

Fuse unit

Item	Qty	Name	Convertor	Type/Data	Part number
F21,22,23	3	Fuse		6A,1500V	5675563-703
F31,32,33	3	Fuse		6A,1500V	5675563-703
F61,62	2	Fuse		6A,7,2kv	3ASD567401B1

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