TYRAK MIDI II
Thyristor convertor with microcomputer for d. c. drive systems

User's manual

Reg. nr. 3ASD 4890 01B 1002. Edition 3.

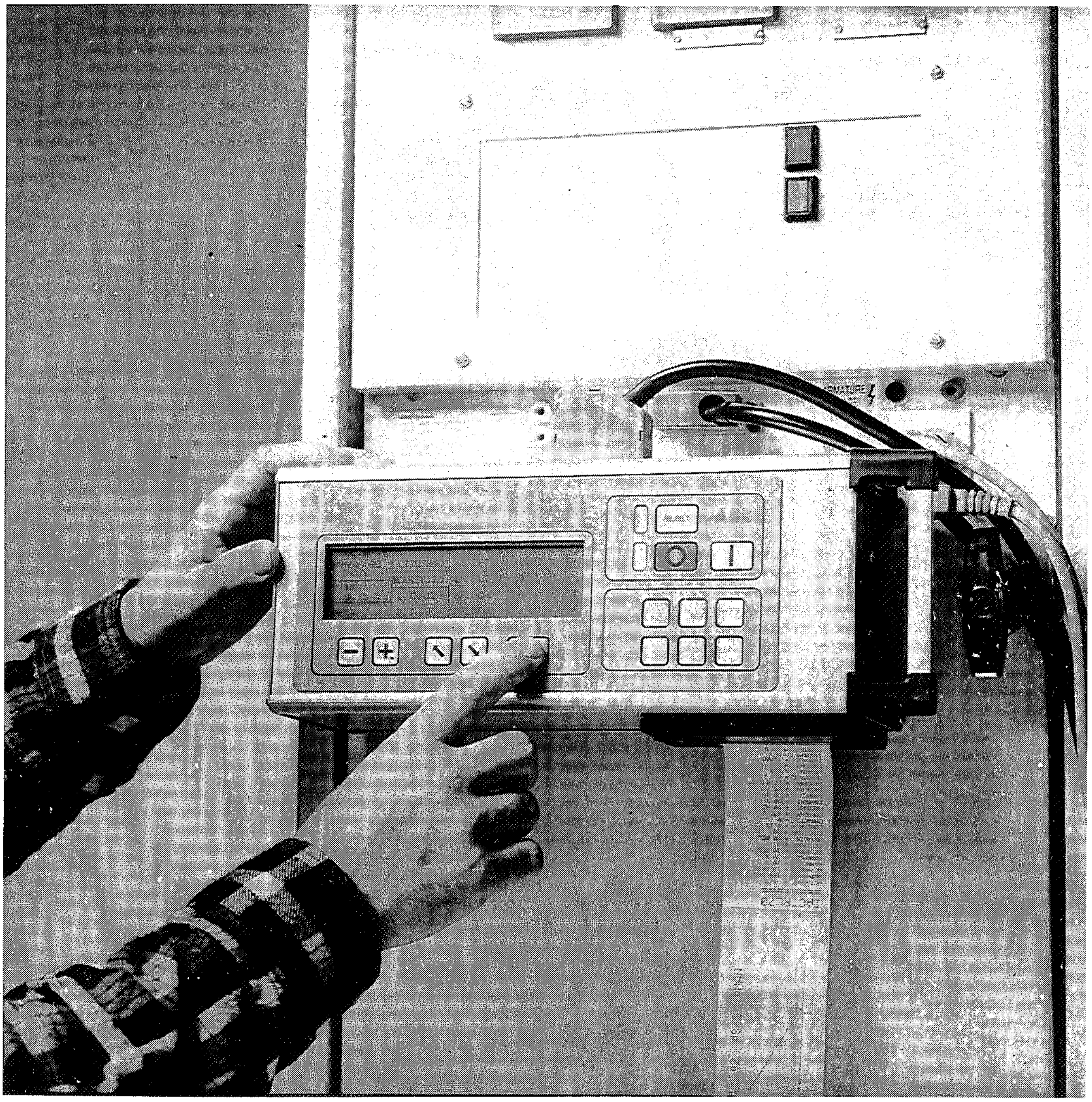


ABB Drives

ASEA BROWN BOVERI

TYRAK MIDI II
User's Manual

Contents

Description

Contents:

General

Tyrak Midi II 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 service unit simplifies commissioning, handling and fault tracing of the convertor.

Convertor module

Configuration

The convertor module includes a main circuit and a control equipment. The control equipment is common to all convertor modules while the main circuit differs with the current rating.

Control equipment

The basic control system consists of 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. Space is provided on the panel for additional functions, four expansion I/O-units on the front, control unit for the digital field exciter on the back-side.

Processor board YPQ201.

A powerful microcontroller 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 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 convertor is determined by the control program installed. The control program is stored in EPROM/EEPROM memory capsules on the memory module. A selection of standard memory modules are available, each 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.

Drive supervision and diagnostics

Tyrak Midi II convertors have an extensive system for status check, operational supervision and fault diagnosis. These functions, together, 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 back-up and it is therefore possible, at any time, to return to investigate 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 signals 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.

Main circuit

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

The power components are designed to allow connection to supply voltage up to 500 V or 660 V respectively.

Thyristor bridge

The thyristor bridge is built up as a three phase, fully controlled 6-pulse coupling. It is available, as a single convertor (YGMU) or as a double convertor (YHMU). In the double convertor version, the thyristors are directly anti-parallel coupled with common fusing and RC-circuits.

Thyristor blocks with two thyristors in each are used in convertors with current rating up to 530 A. Phase fuses, RC-circuits and phase inductors are used as protection for these blocks.

Convertors with larger current ratings are provided with "puck" thyristors. These are protected with the help of semiconductor fuses in the branches.

Trigger pulse transmission

The trigger pulses are conducted via a ribbon cable from the convertor control equipment to a pulse transformer board. After galvanic isolation in a pulse transformer, the gate pulses are conducted to the different thyristors. The trigger pulses can be measured via test terminals on the pulse transformer board. The test terminals are located on the primary side of the transformer i.e. separate from the main voltage.

In double convertors, the trigger pulses are coupled to the forward and reverse bridges with the help of electronic contacts on the pulse transformer unit. A green LED indicates that the forward bridge is conducting, a yellow LED for the reverse. This signal can also be measured at test terminals.

Current measurement

The d.c. current is measured on the a.c. voltage side of the thyristor unit with the 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.

Convertor fan

Convertors rated up to 120 A are provided with an axial fan powered with the operating voltage 110 V a.c. (M1).

Convertors rated 195 - 530 A are cooled with a radial fan, while convertors 640 - 1500 A are equipped with two axial fans for cooling. The supply is 220 V single phase M1 - M2.

Convertors rated 1530 - 3600 A are provided with a 3-phase fan. The fan is D-coupled for 380 V 50 Hz, 440 V 60 Hz and Y-coupled for higher voltages.

If the convertor is connected to an anti-clockwise phase sequence, the connections to the fan must be changed to obtain the correct direction of rotation.

Semiconductor fuses

The thyristors are protected by fast acting semiconductor fuses. Convertors rated up to 530 A have the fuses in the incoming phases, while convertors with higher ratings have branch fuses.

Auxiliary power supply

The auxiliary supply transformer, item 51, can be connected directly to 380 V, 415 V, 460 V and 500 V, 50 or 60 Hz and via an autotransformer, item 58, to 575 V and 660 V.
The transformer generates two 24 V voltages, designated Q1 and Q2. The microcontroller is supplied by Q1, while external circuits are supplied with Q2.

A high degree of immunity to interference is obtained with separate supply voltages. Each convertor's computer is directly grounded even in plants with a common reference system.

Both of the voltages are obtained from the same transformer, which is provided with screens between primary and secondary windings and between the two secondary windings. The transformer also contains a winding for synchronization of trigger pulses and for mains voltage monitoring.

The circuits are fused with miniature fuses, Q1 with 6.3 A and Q2 with 4 A fuses.

Approximately 0.5 A (Q2), depending of 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 B20.52.X1:9. If several convertors have a common reference system, the grounding of all of the convertors but one must be disconnected.

A.C. Power Distribution

Convertor built into an enclosure by ABB Drives in Västerås Sweden are equipped with following power distribution components:
Convertors rated up to 1160 A are provided with an incoming Molded Case Circuit Breaker, MCCB, and an a.c. contactor. The incoming breaker is of type ABB SACE Limitor, a current limiting breaker with high interrupting capacity.

Higher rated convertors are equipped with a motor operated air circuit breaker, type ABB SACE Megamax. For auxiliary power supply, an MCCB breaker is used.

Auxiliary circuits such as electronics supply, field supply and external cooling fan supply, are protected by circuit breakers of type Klockner Moeller PKZ2.

Accessories

Plug-in service unit

Circuit diagram, sheet 13.

The service unit requires a 110/220 V power supply.

The service unit includes an operator's panel and a printer. The service unit is plugged in to the convertor via a special connector.

The key-pad on the operator's panel has a fixed programmed section, ON, OFF and RESET with associated indication and a user defined section with six functional push-buttons and LEDs for indications Remote/ Local (Rem/Loc), Start/Stop and Reference+/Reference- (Ref+/Ref-). These texts appear on the push-button. If required, the functions can be changed and the button text amended accordingly. Digital signals can be connected optionally to any button or LED on the operator's panel by means of a "signal switch board" which is programmed via the operator's panel.

The operator's panel and its functions are described in more detail in "Operator's panel management",

110/220 V transformer

The control voltage transformer generates two voltages designated M1L and M2L. M1L and M2L are generated in a 2 x 110 V winding with the middle point as a common neutral (MN). Both circuits are protected by 4 A miniature circuit breakers.

M1L is a 110 V a.c. voltage 50/60 Hz, used as operating voltage for contactors and digital input channels. M1L is dimensioned for the main contactor, two additional contactors (field and motor blower) and 20 digital input channels. The 220 V voltage M1L-M2L is utilized to supply the fan in convertors rated 200 - 1500 A. There is 50 VA (110 V or 220 V) available for optional use.

Field supply

The Tyrak Midi II drive system comprises two different types of field exciters, a diode field exciter and a digitally controlled field exciter.

Diode field exciter

The diode field exciter comes in three current ratings, 2.5 A, 10 A and 25 A, and can via an auto-transformer be connected to line voltages between 380 - 660 V.

The diode field exciter consists of a two-pulse two-way diode bridge and a current sensitive relay. The transformer has outputs for 220 V or 310 V field voltage but taps on the transformer allows this voltage to be adjusted within 70 - 105 % of nominal value in 5 % steps.The current is dependent on the supply voltage and also on the field winding resistance (temperature). This means that the field current can become up to 150 % of rated value at cold field winding and 10 % line overvoltage. The field exciter is designed to manage this overcurrent until the field winding is warmed up.

Minimum field current is supervised by means of the current sensitive relay. The pick up/drop out values are fixed relative the field exciter rating according to table:

Rated current (A)	On-value (A)	Off-value (A)
2.5	0.32 - 0.47	< 0.2
10	1.3 - 1.9	< 0.8
25	3.25 - 4.75	< 2

Controlled field exciter

The field exciter is controlled with software functions in the convertor control program.

With a controlled field exciter, the field current is kept constant in accordance with a reference value, independent of line voltage and field winding resistance.

With a controlled field exciter, the nominal field current of the machine should not be lower than 20 % of the field exciter rated current.

The controlled field exciter consists of a power unit and a field control board with an interconnecting ribbon cable.

The power unit is available as a single or a double convertor with current rating 5 A, 10 A, 20 A or 40 A. The main circuit can be directly connected to supply voltages up to 500 V, or via an auto-transformer to voltages up to 660 V. The field control board, YPQ102, is installed in the convertor control equipment, while the power unit is mounted separately.

A.c. connection

The field exciter is connected to the mains via fuses/ circuit breaker and a contactor (included in enclosed convertors). The field contactor is controlled from the convertor control equipment, and is operated with 110 V a.c. (M1L).

Main circuit

The main circuit consist of a phase inductor for limitation of the rate of change of the current during commutation, a semiconductor bridge and a varistor for limitation of the voltage transients from the field winding.

Single field exciters have a non-uniform thyristor bridge with two diodes and two thyristors. The current can only pass in one direction and the voltage cannot change sign. This bridge can be used in field weakening systems with moderate acceleration requirement (>2 s from zero to max speed).

When shorter acceleration time with negative forcing voltage is required, the double field exciter must be used. The principal use of double field exciters is in systems with field reversal. The double field exciter has two anti-parallel with uniform connection bridges which can give positive and negative output voltage and current in both directions.

Trigger pulse circuits

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

Communication

Communication with the convertor control equipment is possible via the operator's 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. Following functions are included:

- Three digital output and four digital input channels with fixed functions, for fan, field and main contactor operation. These circuits are connected to the 110 V a.c. control voltage.
- Eight digital input channels, user defined function.
- Five digital output channels, 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 function.
- One analogue output for current actual value (buffer amplifier on current feedback signal).
- 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 synchronization pulse in positioning applications. The maximum pulse frequency is 50 kHz.
- Modem for service unit RS422.
  The service unit can be connected while the equipment is in operation. Information is transmitted from the convertor to the service unit, where it can be displayed on the operator's panel and/or printed out.

The setting of user defined input/output channels is performed from the service unit/operator's panel i.e. no service terminal/PC is required.

Expansion I/O units (CD 26-29)

The control equipment is prepared for four expansion I/O-units.
Note: Expansion I/O-units require a corresponding software function in the 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 convertor module. The other board accommodates the customer connection terminals, and is placed outside the convertor module for convenient connection of wires.

Following expansion units are available:

- Digital input unit (YPI103 + YPI104).
  Eight channels, adapted for 110 V a.c./d.c. supply.
- Digital output unit (YPO105 + YPO106).
  Eight channels, galvanically free relay contacts.
- Analogue input unit (YPG110 + YPG106).
  Four channels and a voltage divider for analog tachometer signal, a current generator for Pt100 supply and a reference voltage source ±10 V.
- Analogue output unit. (YPM102 + YPM105)
  Four channels.

Analog input channels
Basic I/O (AI37XX) (CD 24)
Expansion I/O (AI33XX) (CD 28)

Analog 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 analog 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 on channel 2 and 3 can be multiplied from -16 to +16 times, using parameter AI37.2MU/AI33.2MU or AI37.3MU/AI33.3MU. The parameters are on delivery set to 1.000.

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 analog input channel must be adapted to the signal type and level connected, for example:

D.c. voltage transducer:	10 V
Convertor temperature monitor, convertors 40 - 530 A:	1V
Convertor temperature monitor convertors 640 - 3600 A:	10 V

An analog 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 analog input channels.

On delivery, the 4 channels on the expansion analog 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.

Analog output channels
Basic I/O (AO37XX) (CD 23)
Expansion I/O (AO34XX) (CD 29)

The analog 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.

Two of the output signals can be multiplied up to 256 times, using parameters AO37.1MU/AO34.1MU and AO37.2MU/AO34.2MU. The signals can also be offset by ±100 % using parameters AO37.1OF/AO34.1OF and AO37.2OF/AO34.2OF.

Digital input channels
Basic I/O (DI37XX) (CD 22)
Expansion I/O (DI31XX) (CD 26)

The input resistors are on delivery designed for 110V a.c. or d.c. 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 kΩ	4.7 kΩ	10 kΩ	22 kΩ

Expansion

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

All input signals are operated individually. The signal to which the channel is connected is found in function module CONNECT1 and can be displayed on the operator's panel. The input signals can be individually inversed, using parameters DI37INV/DI31INV. Active signal is indicated by a yellow LED.

Digital output channels
Basic I/O (DO37XX) (CD 22)
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 inversed, using parameters DO37INV/DO32INV as shown in the circuit 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 kΩ, 5 W
Nominal input voltage:	110 V a.c./d.c.
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, cosΦι > = 0.4
Lim. breaking capacity d.c.:	1.2 A, 48 V 0.3 A, 125 V 0.2 A, 220 V

Analog 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

Analog 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, OPC

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 utilized 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 communicaiton, 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.

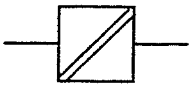
The master/follower communication link can handle up to eight followers connected to one master drive. The cycle time is 1 ms per follower connected.

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.

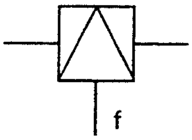
Diagram symbols

(from 2000 808 - 21, sheet 1)

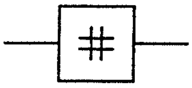
General symbols



Galvanic isolation.

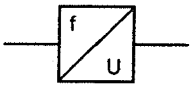


Modulator.



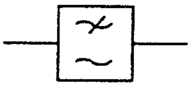
General symbol in digital signal systems.

Convertor from an analog signal to pulses.

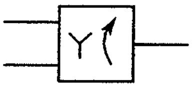


Convertor from freqvency to voltage.

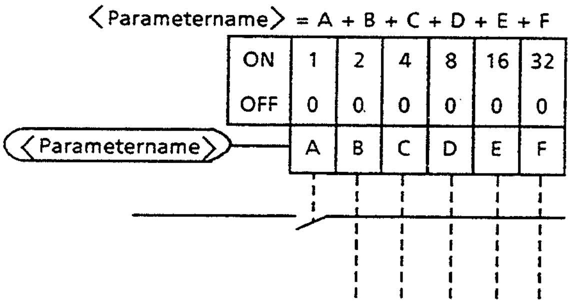
Convertor from a sine wave signal to a square pulse.



Low-pass filter.



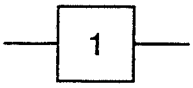
Clockwise phase sequence makes output = "1".



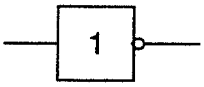
ON	1	2	4	8	16	32
OFF	0	0	0	0	0	0
	A	B	C	D	E	F

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.

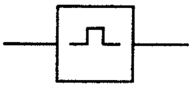
Logical elements



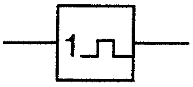
Buffer.



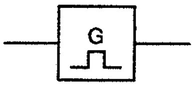
Logic inversion.



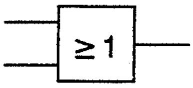
Monostable element.
Possible to re-trigger.



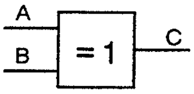
Monostable element.
Not possible to re-trigger.



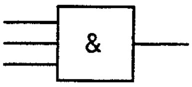
Pulse generator.



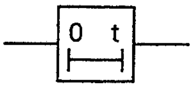
OR-gate.



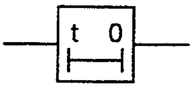
Exclusive-OR. C = "1" when only one of the inputs is "1".



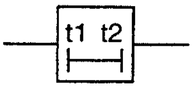
AND-gate.



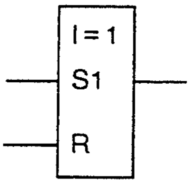
Time delay element.
Time delay when changing to "0"-position.



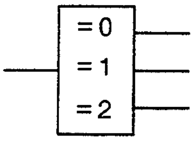
Time delay element.
Time delay when changing to "1"-position.



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".

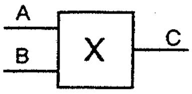


When input has any of values 0, 1 or 2, corresponding output is "1".

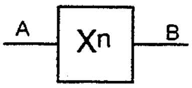
Diagram symbols

(from 2000 808 - 21, sheet 1)

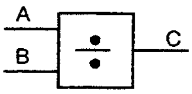
Arithmetical elements



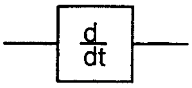
Multiplier
A × B = C



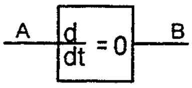
— B = A^n with n = 2, 3,....



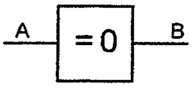
Division
$\frac{A}{B} = C$



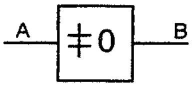
Derivating function.



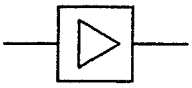
B = "1" when $\frac{dA}{dt}$ = 0.



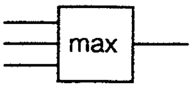
B = "1" when A = 0.



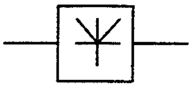
B = "1" when A is not zero.



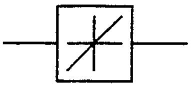
Amplifier.



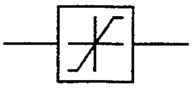
Max. value generator.



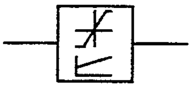
Absolute value generator.



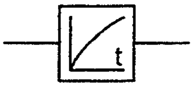
Linear amplifier.



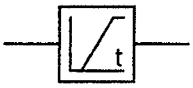
Linear amplifier with positive and negative limitation.



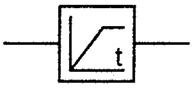
PI-controller.
Linear type with limitation.



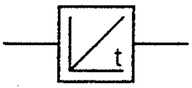
Element with time constant.



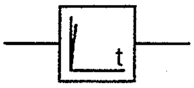
Function generator with limitation.



Ramp function.

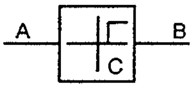


Integrating element.

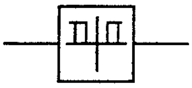


Derevating element.

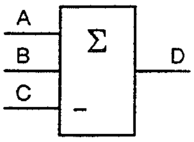
Derevating element with time constant.



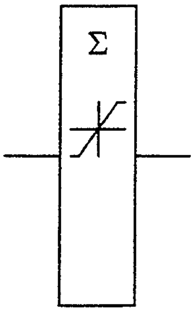
Level detector which makes
B = "1" when A > C.



Symmetrical level detector with hysteresis.



Summation element.
D = A + B-C

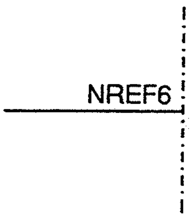


Summation element with limitations.

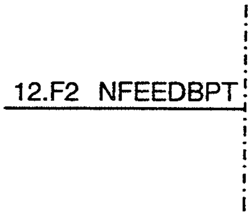
Diagram symbols

(from 2000 808 - 21, sheet 2)

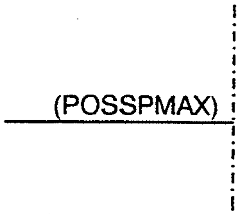
Signal symbols



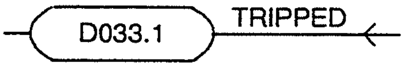
Output signal NREF6 with data size F2 (2 byte "fraction"). Available for operator's panel.



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



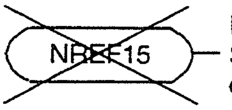
Output signal with data size F2 (2 byte "fraction"). Not available for operator's panel.



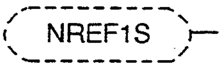
Signal switch-box

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

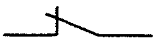
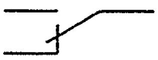
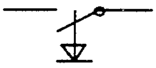
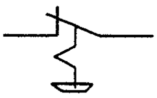
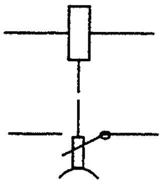
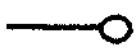
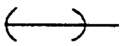
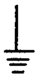
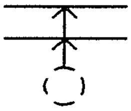
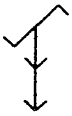
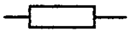
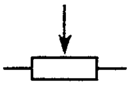
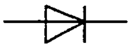
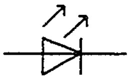
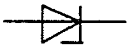
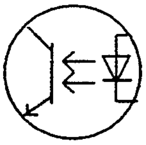
	Closing contact.
	Breaking contact.
	Closing function.
	Breaking function.
	Change over function.
	Control switch with automatic return.
	Control switch without automatic return.
	Relay with closing contact which is time delayed at opening.
	Jumper contact.
	Terminal.
	Soldering pin.
	Disconnectable 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 applies to enclosed convertors Tyrak Midi II of type YGMU/YHMU as delivered from ABB Drives AB, Västerås Sweden. Convertor modules built into enclosures by other ABB companies may differ from what is said here. Consult responsible Engineering Dept. for additional information.

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 immediately to ABB Drives to avoid delay in installation and commissioning.

If the equipment is not to be installed on delivery, it must be stored in its transport packaging in dry and dust-free premises. The ambient temperature during storage is to be above -25 °C and below +60 °C (max. 24 h average temperature +45 °C).

Convertors are normally delivered standing up, fixed to pallets.

If necessary, TYRAK Midi II convertors rated up to 1160 A can be transported in a horizontal position with the front door facing up.

Convertor cubicles can be moved by crane using the lifting devices fixed at the top of the cubicle, see fig. 1. When the cubicles are positioned, the lifting beams can be removed.

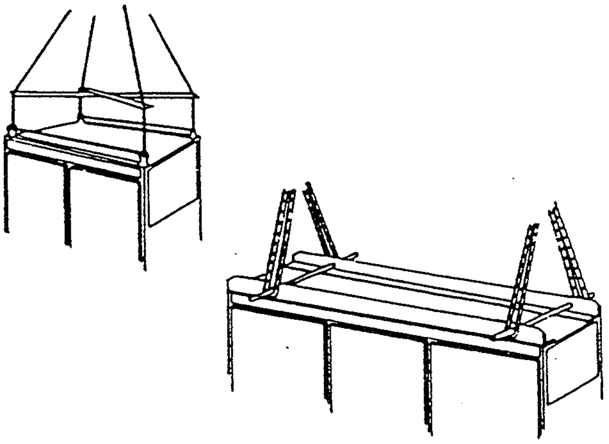


Fig. 1. Lifting instructions

Positioning

The convertors are intended for indoor installation in a normal industrial environment with ambient temperatures 0 °C - +40 °C (+50 °C with reduced loading). The air is to be free from dust and aggressive gases.

Convertors provided with air filters can be located in a dusty environment. The filter, which is washable, is to be inspected at regular intervals and cleaned if necessary. (See service instructions).

Minimum clearance from the top of the cubicle to the ceiling, and between its rear side and back wall are shown in the dimension drawings. Between cubicle side and wall the minimum space is 40 mm.

The design of the cubicle presupposes installation on a flat and well levelled floor (+3 mm). This applies particularly to several cubicles in a line-up.

Compensation for unevenness in the floor can be provided by adjusting bolts at the corners of the cubicle. See fig. 2.

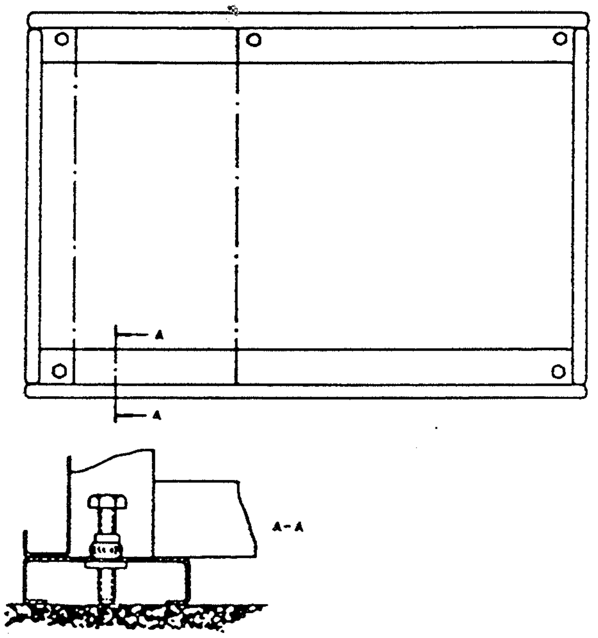


Fig. 2. Adjustment bolts

Procedure for installing a cubicle line-up

- Level each individual cubicle with the adjustment bolts. Once a cubicle is levelled, insert spacers to carry the load.
- Bolt the cubicles to each other.
- Bolt the cubicles to the floor, bolts tightened with 20 Nm.

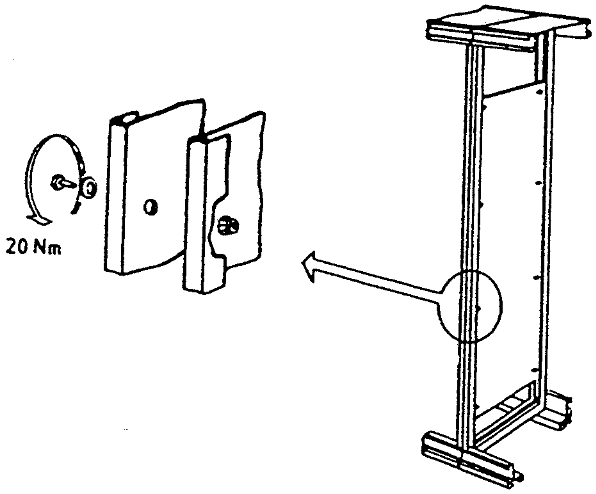


Fig. 3. Cubicle assembly with bolt joint

The dimension drawings include a pattern for locating passages for cables, air intakes and cooling air requirements, and the weight of the equipment.

To ensure adequate ventilation of the cubicle, there must be no external pressure drop. Cooling air passages must remain free at all times.

Connections

Main circuits

All convertors are designed for connection from horizontal bus bars. Convertors 40 - 515 A can be provided with integrated ac connection terminals as shown in the dimension print.

If cable connection is required for convertors with higher rating, a cable connection cubicle must be used. The cable cubicle is designed for incoming cables from below, and the connection to the convertor is via horizontal busbars.

The d.c. terminals are intended for cable connections and are located as shown in the dimension drawings.

The d.c. cables are dimensioned based on the current, voltage and breaker capacity. The catalogue and apparatus list provide the necessary information.

Jointing of horizontal busbars

The busbars are jointed from the front of the cubicle.

Any protective covers in front of the busbars are to be removed to permit access to the joint locations.

Loosen the bolts in the adjacent cubicles.

Slide the splicing bar over to the next set of bus bars.

Tighten the joint with 40 Nm with a torque wrench, see fig. 4.

Reinstall the protective covers.

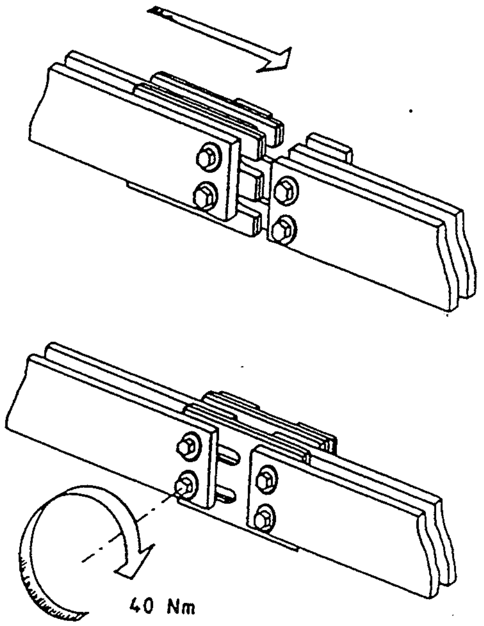


Fig. 4. Jointing of busbars

Jointing of grounding bars

The bars are jointed from the front of the cubicle.

Loosen the mounting clamps in two adjacent cubicles. Slide the splicing bar across the grounding bars as shown in fig. 5. Tighten the clamps to 9 Nm with a torque wrech.

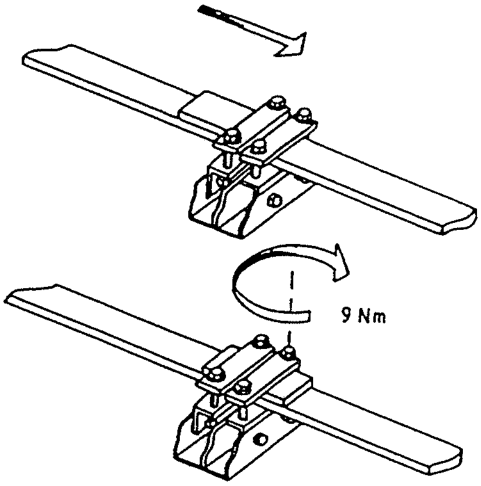


Fig. 5. Jointing of grounding bars

Serial communication for ABB Master

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

Other circuits

Terminal blocks for field supply, d.c. motor cooling fan supply and control voltage 110 V are located on terminal bar B51, located at the bottom of the control cubicle. Field and cooling fan supply use terminal blocks type UK10, max connectible area 6 mm^2. With a 40 A field exciter terminal blocks for max. 16 mm^2 are providied. Other terminal blocks are of type UK4, max area 4 mm^2.

Control signals are connected to terminals at the bottom of the convertor module, B20.X1:11 - 66. The terminals are individually disconnectable, and can accomodate max 2,5 mm^2 wires (AWG14).

Cable routing

A convertor contains both high power circuits and electronics which means that the circuits can be divided into two groups, those generating interference and those sensitive to interference. The former are the main circuits and the latter the electronic control circuits.

To minimize the risk of interference, conductors sensitive to interference should be separated, at least 100 - 300 mm, from those generating interference. Signal cables (up to 110 V d.c/a.c.) which are connected to optocouplers on the control equipment should not have a length greater than 300 m.

Electronics signals connected to the neutral of the electronic system (references, actual values and certain digital signals) are to be conducted in screened cables. The screen (SC in the circuit diagram) is grounded at the SC terminals on the convertor module.
All cables are to be dimensioned and installed in accordance with relevant rules and regulations.

Grounding

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

The cubicle frame is provided with a grounding clamp to which a ground wire or bar to a reliable ground is to be connected. The ground wire is dimensioned in accordance with the relevant regulations.

The neutral (MN) of the operating voltages M1L and M2L is connected to the ground as shown on page 50 and 51 in the circuit diagram.

Grounding of electronic supply (24 V)

There are two 24V supplies. One, Q1+, supplies the micro processor board, and the neutral, Q1M, is directly grounded in the convertor module. The other supply, Q2+, is used for external circuits. On delivery the neutral, Q2M, is grounded with a ground wire from terminal B20.52.X1:9.

Note! In coordinated drive systems, the common of the reference system is to be grounded at one point only. This is obtained by removing the ground wire B20.52.X1:9 in all convertors except one.

Commissioning

Contents Page

Introduction

This Information describes the commissioning of a Tyrak Midi II convertor, as delivered from ABB Drives AB in Västerås Sweden, equipped with a standard software control program.

Enclosed convertors designed and built by otherABB Companies may differ from what is said here,consult the responsible Engineering Dept. in case additional information is required.

If the convertor is provided with an overriding control system, the supplementary commissioning instruction at system level must be studied.

To avoid problems during commissioning, the 1 F capacitor for memory back-up on the processor board YPQ 201 is to be short-circuited between pins X26:1 and :2 adjacent to the capacitor. This action is absolutely necessary when the PROM's on the memory board have been replaced. Because of the high internal resistance in the capacitor, the short-circuiting of the capacitor must be maintained for at least one minute.

The commissioning requires access to a portable service unit, or a built-in operator's panel, and in certain cases also a service terminal/PC.

Service unit/Operator's panel

When switching on the supply, "TYRAK" appears on the display for approximately 20 sec. When this text is replaced by the INDIC (indication) menu, the operator's panel is ready for operation. A detailed description of how to use the operators panel is given in section "Operator's panel management". For commissioning purposes, the most common functions are:

Convertor control

The convertor can be controlled from the operator's panel when LOCAL mode is selected. The upper right hand section includes push buttons for ON (I) and OFF (O) and a LED indicator for TRIP. When the convertor is tripped,the LED illuminates. The convertor can be reset by pressing the RESET push button. If the TRIP indicator starts to twinkle, this is a warning signal, but operation is continued.

The lower section include six push buttons with user-defined function, for example:

REMOTE/LOCAL, START/STOP and REF+/REF-.

(the function may differ between different control programs)

Each push button has a built-in LED, indicating active function. The speed reference is increased/decreased with the REF+ and REF- buttons respectively. The START/STOP push buttons are used with a divided start sequence, as described on page C - 8.

Important: Switch over to REMOTE mode before un-plugging the service unit, or the convertor will trip after appr. 10 s.

I/O connections (CONNECT)

Signals in the control program are tied to selected I/O channels using the operator's panel CONNECT menu, as described in chapter F "Operator's panel management". Recommended connection of signals is indicated in the User manual for the control program installed. Input signals accessible are found in function module CONNECT. Output signals are found in the function modules from which they derive.

Signal reading (MEASURE)

Signal values can normally be displayed on the OP-panel. Signal names within brackets in the program diagram can only be accessed via a terminal.

Parameter setting (SETTING)

The convertors are delivered with a standard parameter setting, which in most cases does not need to be changed unless specified in the commissioning instruction or otherwise.

Note: Parameter values can be changed only if the blocking switch on the processor board is deactivated. Parameters can normally be set from the operator's panel. Certain parameters however, require the use of a terminal. Such parameters are indicated in the program diagram with a dotted instead of a solid line around the parameter name.

Trimming of controllers (STEPTEST)

A step is introduced in the reference signal, and the step response is displayed on the REGISTR menu.

Service terminal/PC

Certain signals and parameters can only be accessed from a terminal (signals within brackets, parameters shown with dotted line in the program diagram).

Connection

The service terminal is connected to the drive via an isolating modem, YPK111 with RS232 communication.The modem is connected to terminal X50 on the processor board YPQ201. Enclosed convertors may have the modem permanently installed (option), with the connector accessible on the front test panel. With the modem permanently installed, the terminal can be plugged in while the convertor is in operation.

The strapping array on the modem is set for Terminal or PC as shown in the circuit diagram, sheet 14.

For simple connection, pre-fabricated cables are available as described under "Equipment required". Following pins are used on the modem:

	PC	**Terminal**
2	Receive	Transmit
3	Transmit	Receive
4	+10 V output	-
5	0 V	0V

Settings

Transmission code:	Length	7 bits
	Parity	Even
	Stop bits	1 bit
Transmission speed:		4800 Baud

Using the terminal

The operating system supports a vast number of terminal commands. The terminal commands are split up in two modes:

- USER mode (U>)
- SUPERVISOR mode (S>)

The reason is to avoid hazardous mistakes when using the terminal on a convertor in operation. The supervisor mode is used for fault tracing by specialists only, and is not further explained here.

For commissioning purposes only a few commands in the USER mode need to be used.

System information

- SD System Display. Provides information about the system, for example sample times.

Reading a signal value:

- O Open. Type O + the signal name.
  Important: Type . (period) to return to promt.

Example:

```
U>O NACT
NACT   = 45 (dec) ? .
U>
```

Setting parameters

- OP Open Parameter. Type OP + the parameter name, wait for a new value input. Enter the new value. Type = to permanently set the value.
  Note: Parameter values can be changed only if the blocking switch on the processor board is deactivated.

Example

```
U>OP UNOM
UNOM   = 380 (dec) ? 500
UNOM   = 500 (dec) ? =
E2PROM:380 (dec) -> 500 (dec)
U>
```

Setting of number base

- DEc Set number base to 10 (default value)
- HEx Set number base to 16 (hexadecimal)

Example:

```
U>HE
Base = 16
U>O NACT
NACT   = 002D (hex) ? .
U>DE
Base = 10
U>O NACT
NACT   = 45 (dec) ? .
U>
```

Listing of all signals and parameters.

- SY Symbol. All signals and parameters existing in the program are listed with their abs. adresses

Documents required

- Circuit diagram for the particular equipment.
- Tyrak Midi II User's Manual.
- Control Program User Manual for the program installed
- Apparatus list

How to read the schematics

The Tyrak Midi II convertors are delivered with two sets of schematics, the Circuit Diagram (CD) and the Program Diagram (PD).

The circuit diagram shows the exact configuration of each convertor equipment (hardware).The circuit diagram is drawn in accordance with IEC rules for plant documentation.

The Program Diagram shows the software control functions, and is included in the User Manual for the program installed. A control program is built up from a number of function modules, each performing a certain function. In the program diagram the function modules are listed in their order of execution.

Each function module is named, usually an abbreviated description of the function.

Example:

IACTR71: **I**(current) **A**rmature **C**on**TR**ol.

IACTR is the reference to the current controller, 71 indicates the version and revision number of the delivery. The name, version and revision no's are displayed on the operator's panel. In the program diagram the function module is shown as IACTR7X, i. e. the revision no. is not shown.

Note: In this instruction, the module name will be referred to as IACTR.

The figures in brackets in the section headings refer to the relevant circuit diagram (CD) or program diagram(PD) sheet numbers.

Note: **All PD sheet references in this manual apply to the latest release of control programs. Certain sheet numbers may have been changed from previous release.**

Equipment required

1 pcs Portable service unit, 3ASD399002A66 or a built-in operator's panel and a portable printer, YT 290 000 - A.
Accessories:
Printer ribbon, part no. 5697 799 - 3.
Printer paper, part no. 5697 799 - 4.

1 pcs Service terminal/PC
Connection cables:
PC: 2639 403 - KH + 2639 403 - KF
Terminal: 2639 403 - KH + 2639 403 - KG
(Terminal with 25 pole male conn.)
or 2639 403 - HJ (25 pole female conn.)

1 pcs Terminal modem (RS232), YT 204 001 - HH (unless installed in the cubicle)

1 pcs. Multimeter 0 - 1000 V a.c./d.c., 0 - 20 A d.c.. Ri 10 kohm/V DC, for example an UNIGOR or an AVO-meter.

4 pcs. Instrument leads with 4 mm banana plugs and reduction sockets, part no. SK 175 2160 for 2 mm terminal contacts.

1 pcs. Potentiometer, 10 kohm, 0.5 W, linear for setting of references and simulation of signals, such as ABB part no. 5248 2051 - 10.

1 pcs. Oscilloscope (preferrably memory type), which can be line-triggered, to be used for trimming of armature current control.

1 pcs. Recorder, 2 channels, high-impedance input.

1 pcs. Hand tachometer with pulse generator feedback.

Safety measures

Protection of personnel

The following rules are to be observed to reduce the risk of personnel injury:

A. Never work alone!

B. Ensure that all personnel involved know how to switch off the supply voltage.

C. Inform persons near the machine that it may start without warning. Screen the machine if possible.

D. If the machine rotor is mechanically locked, make sure that the locking device is sufficiently strong and properly installed.

E. Work in the convertor should, whenever possible, be performed with the power supply disconnected. This includes the auxiliary power supply.

Protection of equipment

The following instructions should be obeyed to protect the convertor, the d.c. machine and the driven object from damage.

A. Do not switch off a convertor in operation with the main circuit breaker. Press the OFF-button first. In case of emergency, press the "El. Disconnect" switch on the front.

B. Set protections at a low level when beginning the commissioning. For example, when adjusting the armature current control, set the overspeed tripping level very low.

C. If the d.c. machine is located out of sight or earshot, an assistant should be placed to observe and give warning at any tendency of the machine to race.

D. When adjusting the armature current controller and compensation of the armature voltage drop with EMF-control, armature current is conducted through the d.c. machine at stand-still. The field circuit is not energized on these occasions, but the field winding must be connected to the field exciter (risk of high induced voltages).

Static friction is generally sufficient to hold, at least larger machines stationary. If a small machine begins to rotate or race, the rotor can be locked mechanically. It is important that the means of locking is sufficiently strong, not to break under load and endanger the surroundings.

E. Current should not be conducted through a stationary rotor for more than 20 s. at a time. The current should not exceed the rated current and the rotor should be rotated between each loading to avoid stressing the same commutator segments each time.

F. If the cooling equipment of the dc machine is not in operation when the field exciter is commissioned, the field winding may become overheated. Apply field current for max. 2 minutes at a time.

Commissioning procedures

General

The commissioning can be performed in basically the same way regardless of type of drive. A master control system, if existing, must not neccessarily be commissioned, however, if a mechanical or dynamic brake is included, the master control system must be operational.

Recommended sequence of operations:

1. Perform certain checks and settings without voltage in the main circuit.
2. Check of the ON/OFF circuits and fan supervision.
3. Commissioning of the field exciter.
4. Provisional start of the speed controller.
5. Trim the rotor current control.
6. Set the rotor current limitation.
7. Trim the EMF control.
8. Trim the speed control, voltage adaption and rate of change of the armature current.
9. Set protective and supervision functions with which the convertor is equipped.
10. Check the input and output boards.

Checks and setting before voltage is applied.

Check of earthing, auxiliary supply circuits (CD 50, 51, 53).

On delivery, the neutral of the auxiliary system, Q2M, is connected to earth from terminal B20.52.X1:9.

When several convertors have a common reference system, the neutral is to be earthed in one convertor only. Remove all earth connections but one.

Check that jumpers on the circuit boards are in accordance with the circuit diagram.

I/O channels

Basic I/O-board YPQ202 (CD21 - 25)
Expansion I/O-units (CD 26 - 29)

Check that each channels is adapted for the type of signal connected. Setting possibilities are explained in the "Description" part of this manual, and in the circuit diagram.

Check of d.c. machine

Check that no transport damage has occurred. When commissioning a convertor, it must be considered that also the DC-motor concerned is probably being started for the first time. The motor maintenance and commissioning instruction are to be observed both prior to and during the commissioning.

If the object driven can not rotate in the reverse direction or can only be run slowly at start without risking damage, the coupling between the d.c. machine and object driven is to be open with the separate sections fixed to the shafts of machine and object. Check this with the manufacturer or user of the equipment.

The armature circuit, field circuit and tachometer/ pulse transmitter are to be connected. Check particularly that the field windings are connected for the correct voltage. Any series winding is to be active.

Check the contact between the brushes and the commutator.

Check the pulse transmitter grounding brush.

Check of supply voltage

Check with a voltmeter that the mains voltage corresponds to the rated voltage for the convertor, UVN ±10 %.

Switch on the main circuit breaker. The text "TYRAK" appears on the display.

Note: Do not try to control the convertor from the OP-panel until "TYRAK" is replaced by the "INDIC" menu on the display.

Check of phase sequence (PD 78, 79)

The convertors are on delivery set for positive phase sequence, L1, L2, L3. The control system can however operate also with negative phase sequence, L1, L3, L2, if following adjustments are made:

Measure signal PHSEQCW1 in the current controller IACTR. If this signal is "1", the phase sequence is positive and the commissioning can continue. If however the signal is "0", the convertor supply has negative phase sequence.

Two alternatives are given:

Alternative 1
Disconnect the voltage and switch two of the incoming phases. Switch on the main circuit breaker and check that the signal PHSEQCW1 is "1", for positive phase sequence.

Alternative 2
The parameter PHSEQCW (IACTR) is set to "0" via the OP-panel. Negative phase sequence is now selected.

Note: The phase sequence to the cooling fan in convertors rated 1530 - 3600 A must be changed accordingly. If a controlled field exciter is installed, parameter PHASE in function module IFCTR must be changed, see page C - 9.

Setting of thermal overload relays (CD 50).

The enclosed convertor is provided with motor starters for cooling fan(s) on the dc machine, H12.3.2 and 4.2 are to be set for the load current of each motor (yellow dial). The red dial, for overcurrent protection, can be set at its maximum value.

Check of El. disconnect and emergency stop relays (CD 22 and 50)

The enclosed convertor is provided with two timer relays, one for "El. disconnection" (H12.R1),and one for "Emergency stop" (B51.R2).

To test the El. disconnection relay, press the push button on the front of the cubicle. An OFF order is given instantaneously, and after a short delay (appr. 0,1 s) the main circuit breaker is tripped. To reset, first press the handle to OFF (hard), then back to the ON position.

Check the Emergency stop relay by disconnecting terminal B51.10 (or by pressing an external Em.Stop push button) Check that the timer relay is activated. When the set time has elapsed (on delivery set to 15 s.), the relay drops out and disconnects the control voltage to fan, field and main contactors.

Connection and disconnection of expansion I/O-boards

If during commissioning or fault tracing the convertor is to be supplemented with one or more expansion I/O-boards, such as an analogue output board, the following procedure is to be followed:

1. Open the main circuit breaker.

2. Mount the terminal board YPM 105 on the B50 mounting rail. Connect auxiliary supply from the convertor module T37.X31 to X32 on the terminal board with a 10-conductor ribbon cable.

3. Mount the I/O board YPM 102 on position 34 on the control panel, and connect a 10-conductor ribbon cable between the I/O-board X31 and the terminal board X31.

4. Close the main switch and set, in menu SET on the OP-panel, parameter AAO34 to "1". The function module is activated during the initialization of the program. Open the main switch briefly for this. The analogue output board can be used when the main switch is closed again.

To remove an expansion I/O board, such as a digital output board, following procedure is to be followed:

1. Set in function module DO32 on the OP-panel parameter ADO32 to "0" and open the main switch.

2. Close the switch and check that the red LED on YPO 105 illuminates.

3. Open the switch and remove the board.

If, by mistake, a parameter is set for an I/O-board, for example AI, not physically installed, the mistake must be corrected using a terminal. Do following:

1. OP AAI33 "1" @@ "0" ENTER = "0" ENTER

2. Make a new init (= main switch off-on).

Connection of signals to I/O channels

Software signals in the control program are, using the operators panel "CONNECT" facility, connected to suitable I/O channels, as recommended in the User's Manual for the program installed, chapter "Signal connections".

Setting of parameters in current controller IACTR (PD 78, 79)

Following parameters must be set inaccordance with present conditions:

UNOM: Set to nominal voltage
FREQNOM: Set to nominal frequency
IADOUBLE: = "0" with a single convertor (YGMU)
= "1" with a double convertor (YHMU)
IASCALE: This parameter is set to a value corresponding to the quota between the rated current of the thyristor unit over the lower of the rated current of the dc machine or the power distribution equipment.

Following parameter values apply to an enclosed Tyrak Midi II convertor (convertor current rating shown on data plate on the test panel):

Current rating convertor	Current rating thyristor unit	Parameter IASCALE, min
40	40	1.000
64	70	1.094
115	120	1.043
195	200	1.026
300	350	1.167
515	530	1.029
640	750	1.172
930	1000	1.075
1160	1250 (>=575V)	1.078
1160	1500 (<=500V)	1.293
1530	1800	1.176
2400	2400	1.000
3060	3600	1.176

If the rated current of the dc machine is lower than that of the convertor, parameter IASCALE must be further increased per formula:

IASCALE = rated current thyristor unit/rated current d.c. machine

The rated current of the thyristor unit for each type of convertor is shown in the table above, and on a data plate on the thyristor bridge.

Setting of delay angle limitation

On delivery, parameter ALPHALIM is set to 10° and parameter BETALIM to 30°.

Selection of start sequence (PD 76)

The main line-, field- and motor starter switches are controlled (switched on/off) via signals from the convertor control eq. The start/stop sequence is integrated in the software control program and the status is constantly monitored. Upon a "START" order circuits are connected in the following sequence:

- Cooling fans
- Field supply
- Main line switch
- Release (signal START1=1)

Each step must be followed by an acknowledgement signal within a certain time, or the start sequence will halt. With parameter SEQMODE the start sequence can be divided between any of the steps above into two stages, ON/OFF and START/STOP. This allows for example the fan and the field circuits to be activated on an "ON" order, while the main contactor is operated with "START/STOP. The setting of parameter SEQMODE is shown in table below:

Start-sequence	Parameter SEQ-MODE	Cooling fan	Field excitation	Main contactor	Ready for reference
Un-divided	0	START	START	START	START
Divided	1	ON	START	START	START
Divided	2	ON	ON	START	START
Divided	3	ON	ON	ON	START

The commissioning requires a divided start sequence. This is normally obtained if the signal connections are made in accordance with the recommendations in the control program User's Manual, chapter "Signal Connections".

Example: If the operator's panel is connected as follows, a divided start sequence is obtained (applies to control program TGD1).

DIOP.3 (START) connected to NIDSTART .
DIOP.4 (STOP) connected to STOPLOC2 .
DIOP.7 (OFF) connected to OFF2 .
DIOP.8 (ON) connected to ON2 .

If this is not the case, the signals can be temporarily connected to channels per above. After this, the convertor can be operated as follows:

On-button (I); preparatory connection of drive (ON).

Off-button (O); disconnection of the equipment.

Check of ON/OFF circuits and fan supervision (SEQCON) (PD 76, CD 50, 53)

Set parameter SEQMODE to "1". Select local control (LOC) on the OP-panel and check that the corresponding LED illuminates.

Press the ON button and check that the convertor fan(s) start and that the air flow direction is correct. Check that the external fans rotate in the correct direction.

Leave the convertor on. Test the external fan supervision by entering a screw driver in the "Test" hole on motor starters H12.3 and 4. The convertor is now to trip. Check the fault indication.

If the motor is provided with air flow loss protection, following test is made:

Prevent the air flow to the motor. The convertor shall trip or give warning.

Switch off the convertor.

Commissioning of field exciter

Note: When measuring current with an ammeter in the field circuit, do not turn the range selector on the ammeter with current flow in the field windings.

Diode field exciter (CD 64)

Connect an ammeter in the field circuit. Prevent the main contactor from closing by setting parameter SEQMODE in function module SEQCON to "2". Switch on the main circuit breaker. Do not press the START-button on the front panel! Press "ON" and check that the field current and field voltage are in agreement with their calculated values. The current is not to exceed the rated field exciter current when the d.c. machine is **warm**.

If the field current is too high or too low, this can be adjusted on the supply transformer.If this is insufficient, an external serial resistor must be introduced.

Switch off the field circuit breaker H12.2, and check that the convertor trips, indicating low field current.

Controlled field exciter (PD 84, CD 65)

If a controlled field exciter is included, the software module IF1CTR must be activated, parameter AFETYPE:

0: Inactive
1: Single field exciter
2: Double field exciter, utilized as a single.
3: Double field exciter

Follow the same procedure as when activating expansion I/O-units, see page C - 7.

The main circuit of the field exciter is normally connected to phases L2 and L3. If the field exciters in several convertors are to be distributed between the phases to give a symmetric loading, parameter PHASE is to be set in accordance with the following.

PHASESEQ			POS	NEG
L1	L2	L3	PHASE	PHASE
U	V		1	5
	U	V	2	4
V		U	3	6

Check of IFCALVAL

Parameter IFCALVAL is used to adjust the current feedback. The parameter is adjusted in the test room towards a defined load.

This means that the parameter is normally not to be changed. If however board YPQ 102 is replaced, parameter IFCALVAL must be adjusted.

Default value of parameter IFCALVAL is 170.

The setting can be adjusted on site using one of following methods:

a) Connect a d.c.-ammeter in the field circuit.
Warning! Be careful, highly inductive load. Check that the measured value is in agree ment with IEXCACT. If not, adjust with IFCALVAL.

b) Switch off the convertor. Set parameter FLDOCL to 150 % and IFTRIM to "1". This connects a voltage (1.235 V ±1%) instead of the ordinary current feedback. Check that IEXCACT shows 123.5 %. If not adjust with IFCALVAL. Set parameter IFTRIM to "0" and FLDOCL to its original value.

c) Measure the voltage on board YXU172 or YXU173. 1 V between X31:13A and 13B corresponds to 100 % of the field exciter current rating. Check that the measured value is in agreement with IEXCACT. If not adjust with IFCALVAL. This alternative needs detailed information about YXU172, 173 and YPQ102.

Adjusting the field current controller IF1CTR (PD 84, CD61)

Check the d.c. voltage rating of the field exciter. If this exceeds the maximum permissible field voltage of the d.c. machine, (rated d.c. voltage + permitted degree of forcing), the maximum field exciter voltage is to be reduced by increasing FLDALIM.

Prevent the main contactor from closing by setting parameter SEQMODE in function module SEQCON to "2". Select LOCal mode to allow control from the OP-panel. Set following parameters:

Function module	Parameter	Setting
IF1CTR	AFETYPE	0=No YPQ102 1=Single field exiter 2=Double field exiter used as a single 3=Double field exiter
	IFSCALE	I exciter/I field (Rated current field exciter/ Rated current field winding)
	FLDCONI FLDCONP FLDCONR FLDCONL	0.0 0.0 0.0 0.0
IAREFH (Double field exciter)	IALIMNS IALIMPS	0 % 0 %
IFREFG (Fixed field current)	IFNOM	100 %
ECTRL (EMF control)	IFNOM	100 %
SEQCON	IFACKBLK SEQMODE	1 2

How to adjust the field current control for single and double field exciters.

Parameters FLDCONI, FLDCONL, FLDCONP and FLDCONR are to be set when adjusting the field current control.

The I-part is set with parameter FLDCONI. Parameter FLDCONL provides compensation for inductive voltage drop in connection with stepping. The P-part is set with parameter FLDCONP. The delay angle for the trigger pulses with stationary current is given with parameter FLDCONR.

IFACT and FLDALPHA are to be logged. A suitable time setting on the logger is 0.5 to 2 seconds. Set the event line in the REGISTR menu at the extreme left for registration, 186 points after the event. The resolution on the channels must also be reset as the step is only 3 %. It is recommended that the step should occupy half of the available height on the display.

Connect signals IFACT and FLDALPHA through CONNECT1, to the analog output channels for registration on a recorder. Actual field current can also be measured on test terminals X21:1 - 2 on the field control board YPQ102.

Select LOCal mode and press the ON button on the operator's panel.

Connect a voltmeter to the field terminals. Increase parameter FLDCONR successively until 70 % of rated field voltage is reached.

Adjustment of IF1CTR with fixed field current.

With fixed field only parameter FLDCONR needs to be adjusted per the instruction.
The other parameters are set as follows:

FLDCONI	10
FLDCONL	0
FLDCONP	15

Make step in the field current reference IFSTEP using the OP-panel STEPTEST function. The steps have to be small enough so that signal FLDALPHA does not reach the limits FLDALIM or FLDBLIM. Suitable steps are 0.5 - 1 % and step duration 0.5 sec. The field current shall go between the two levels without overshoot, rise time less than 0.2 sec.

Adjustments of IF1CTR with controlled field current.

Note! Start values for parameter FLDCONI, FLDCONP and FLDCONL according to table.

Make step in the field current reference IFSTEP using the OP-panel STEPTEST function. The steps have to be small enough so that signal FLDALPHA does not reach the limits FLDALIM or FLDBLIM. Suitable steps are 0.5 - 1 % and step duration 0.5 seconds.

Adjust FLDCONP while making steps in IFSTEP. FLDCONP is adjusted in steps 1, 2, 5, 10, 15 etc. IFACT is to go between the two levels without over- or undershoot. The rise time in current has to be less than 100 ms.

This value has to be checked for stability margins. Therefore increase FLDCONP to 1.3 times the previous value. Repeat the step and check that no continuous oscillation occurs.

If no oscillations occur:
Set FLDCONP to previous value.

If oscillations occur:
Stop oscillations by setting FLDCONP to 0.0. Set FLDCONP to the value that gave no overshoot. Increase FLDCONP with 1 at a time and make steps until continuous oscillation occurs. Decrease FLDCONP to 0.77 times this value.

FLDCONL is adjusted in steps 0.1, 0.2, 0.5, 1.0, 1.5 etc. Check the result between each adjustment by performing IFSTEP. IFACT is to go between the two levels without overshoot or undershoot as quickly as possible.

Finally FLDCONI is adjusted in steps 1, 2, 5, 10, 15 etc. Check the result between each adjustment by performing IFSTEP. IFACT is to go between the two levels as quickly as possible, without over- or undershoot.

Print the REGISTR-display of IFACT and FLDALPHA for documentation.

Reduce IFNOM to the lowest field current occurring (maximum field weakening). Perform step testing and check the step response. The step time is longer than with rated current because of greater inductance.

Print the REGISTR-display of IFACT for documentation.

Double field exciter

Check that the field current can be reversed by pressing REF+ or REF-. (The sign of signal IAREF3 will change the direction of field current, unless forced field reversal is used).

At field reversal the overshoot in field current control must also be checked.

Log signal IFACT. Logger channel set at 180 points and time 2 seconds. To trig the logger module TEST is used. Connect signal FLDCH to DO71.3 in CONNECT menu.

Reverse the field current by pressing the REF+ or REF- button. When signal FLDCH goes high the logger will be triggered and the text DIGITAL TRIGG is displayed. Check the REGISTR display of signal IFACT. Signal IFACT must not make an overshoot of more than 5 %.

Note! If the registration needs to be repeated, the RESET-knob on the OP-panel must be pressed.

If the overshoot is higher than 5 %, read just the field current controller.

Setting of field overcurrent protection

The overcurrent protection parameter FLDOCL is set at 15 % above the rated field current. Increase IFNOM progressively and check that the convertor trips at the correct level. Return IFNOM to its original level.

Setting of field minimum current supervision

Set IFACKBLK to "0" (SEQCON). Start the convertor. Set the minimum current level IFGTMINL to 70 % (approx.) of the field current at max. speed. Reduce IFNOM progressively and check that the convertor trips at the level expected. Reset IFNOM to its original level.

Setting of reduced field current

If parameter IFREDSEL (ECTRL1) is set to "1", signal IFREF will go to the value of parameter IFRED, 10 seconds after RDYREF goes low.

Setting of field heating current

If parameter FLDHEATS (ECTRL1) is set to "1", signal IFREF will go to the value of parameter IFHEAT when signal FANSON goes low.

Provisional commissioning of speed protection

The speed control loop should be commissioned provisionally at this stage to make sure that the connection of the tachometer generator/pulse transmitter is correct. The overspeed protection is checked to prevent the d.c. machine from racing during the commissioning.

Set the parameters in accordance with the table below. Switch off the main circuit breaker.

Function module	Parameter	Setting
IACTR	OVERCUR	30%
NFBADJ	NFBADJ NFEEDBS	4.000 0=Pulse transmitter 1=Tacho generator 2=Voltage control
NCTRLX	NPROP NGAIN	1 1.0
MONIT/SPMON	ALPHANSP MOTOSPL	75 DEG 30 %
CTRLSH/EMFREF	NBASE	Base speed of motor

Calculation and strapping of tachometer feedback signal on I/O board YPQ202 (CD 23).

Calculate the tachometer voltage with maximum speed using the equation:

$U_{max} = k \times n_{max}$

where k = 0.1 for type BD 2510
0.2 for type TDP 1306
0.06 for type REO 444
0.025 for type TGRB 1 - 5

Strap the input board YPQ202 in accordance with the table on page 23 in the circuit diagram. Select the voltage range immediately above that calculated.

Using the OP-panel, connect signal NFEEDBTG to analog input channel 4.

Adaptation of board YPQ202 with pulse transmitter. (PD 15, CD 25).

The strapping of YPQ202 is dependent of the pulse transmitter selected. How to strap the board is shown on page 25 in the circuit diagram, array S10 for signal level, array S11 for max. pulse frequency.

Leine & Linde (18 - 30V) and QGFA 110, 120:
Supply voltage +24 V available at terminals X1:11,12.

AVTRON: Supply voltage 12 V from external source.

Leine & Linde (18 - 30V):
24 V, S10:3 - 4, 7 - 8, 11 - 12

QGFA 110, 120:
13mA, S10:1 - 2, 5 - 6, 9 - 10

AVTRON:
12 V, S10:1 - 2, 5 - 6, 9 - 10

The maximum pulse frequency from the pulse transmitter is calculated in accordance with the following:

$$\text{Max pulse frequency} = \frac{N_{max}}{60} \times P$$

Where: N_{max} $^{1)}$ = Max. speed at which the d.c. motor will be run.
P = Number of pulses/revolution from pulse transmitter (NBRPPR).

1) The maximum speed allowed is the lower of following conditions:

$$n_{max1} = \frac{50\,000 \times 60}{\text{NBRPPR}} \text{ rpm}$$

$$n_{max2} = 1.5 \times \text{N100 rpm}$$

The pulse number for the transmitter is indicated on the rating plate. The maximum pulse frequency is strapped in accordance with the table on sheet 25 in the circuit diagram.

Switch on the main circuit breaker. Set following parameters in function modules DSP37.

- Parameter NBRPPR is set at the number of pulses which the pulse transmitter gives per revolution.
- Parameter N100 is set at the maximum speed of the drive.
- Parameter NFEEDBPT, filter time constant, is normally set at 10 ms.

Note! If the setting of parameter N100, NBRPPR and MOTOSPL (in module MONTT/SPMON) exceeds maximum pulse frequency 50 kHz, the convertor will trip for "OVERSPEED".

Check of rotation direction (CD 23, 25, PD 76)

Applies to both tachometer generator and pulse transmitter.

Switch on the main circuit breaker. If the convertor has been temporarily reconnected in accordance with the instructions under the heading "Selection of start sequence", the original connections should now be reinstated in accordance with the circuit diagram.

With an un-divided start sequence, the signal which switches the convertor on, (normally NIDSTART) is to be connected to the OP-panel's ON (I) button.

In single convertors, OFF2 can be connected to the Off (O) button. In double convertors, when regenerative braking to zero speed is required, signal STOPLOC2, for example, must be coupled to the O button.

If the d.c. machine is out of sight or earshot, an assistant should be placed to observe and give warning at any tendency of the machine to race.

Start the convertor but be prepared to press the OFF button (or the "EI, disconnect" button)if the machine should begin to race. If the d.c. machine begins to race, the connections of either the tachometer (pulse transmitter) or of the field winding are reversed.

Analog tachometer
With racing in the correct direction of rotation, the speed feedback has incorrect polarity. Switch the tachometer connections.

If the machine races in the incorrect direction, the field current polarity is incorrect. Switch the connections to the field winding.

If the d.c. machine is continuously controllable with a positive reference, but rotates in the incorrect direction, the connections to both tachometer and field winding must be switched.

Pulse transmitter
When racing in the correct direction, shift channels A and B from pulse generator, terminals B20.X1:61 - 64. When racing in the incorrect direction, the field current polarity is incorrect. Switch the connections to the d.c. motor field winding.

If the d.c. machine is continuously controllable with a positive reference, but rotates in the incorrect direction, switch the connections to the field winding and channel A and B from the pulse transmitter.

Overspeed protection (MONIT/SPMON) (PD 34)

Overspeed protection is always included. Check the function by setting parameter MOTOSPL to a low value, 2 - 3%. Increase slowly the speed reference. The convertor is to trip for overspeed. Check the fault indication.

Setting nominal speed with tachometer generator feedback

- Set parameter MOTOSPL to 110 %.
- Set parameter NPROP in function module NCTRL to "0" which means that any speed error is integrated out in the speed controller.
- Start the convertor and increase the speed (NREF) to 50 %.
- Check with a voltmeter that the armature voltage does not reach a too high value. if so reduce NBASE (EMFREF/CTRLSH).
- Check with a voltmeter connected to the tachometer generator, that the maximum speed is not exceeded.
- Adjust parameter NFBADJ in function module NFBADJ until 50 % of maximum speed is obtained. A reduction of the parameter gives a higher speed. Do not lower the parameter by more than 5 % at a time and never to a value lower than 1.050.
- Increase NREF to 100 % and check that the motor now rotates with maximum speed.

Single convertor
Lower the reference to 0 and switch off the convertor.

Double convertor
Check with NREF set to -100 % that the motor rotates in the opposite direction with maximum speed. Reduce the reference to 0 and switch off the convertor.

Checking of nominal speed with pulse transmitter feedback

- Set parameter MOTOSPL (MONIT/SPMON) to 110 %.
- Set parameter NPROP (NCTRL) to "0". This means that any speed fault is integrated out in the speed controller.
- Start the convertor and increase the speed (NREF) to 50 %.
- Check with a hand tachometer that the d.c. motor rotates at 50 % of its maximum speed.
- Check with a voltmeter that the armature voltage does not reach a too high value. if so reduce NBASE (EMFREF/CTRLSH).
- Increase the reference to 100 % and repeat the check with the hand tachometer which should now indicate maximum speed.

If the measured speed does not correspond to the setting, check the rating of pulse transmitter.

Single convertor
Lower the reference to 0 and switch off the convertor.

Double convertor
With NREF set to -100 % (or base speed) check that the motor rotates in the opposite direction at maximum speed (base speed). Lower the reference to 0 and switch off the convertor.

Voltage adaptation

General

Voltage adaptation is used with double convertors to adapt the output voltage of the convertor, to the present EMF in connection with armature current reversal. The parameter is set at 180 degrees on delivery, giving phase retardation to the beta-limit. Upon pole reversal, the firing pulses are controlled from the beta-limit until the EMF induced in the motor is obtained.

Parameter ALPHAADJ in the current controller IACTR is adjusted to optimize the voltage adaptation. The lowest value of ALPHAADJ which can be set is 0 degree which gives the shortest reversal time of armature current. A normal setting is 0 - 10 degrees.

The adaptation can be performed in two ways:

- With a fixed field current, the speed actual value, NACT, is used.
- In drives with EMF-controlled field weakening, the EMF actual value is used.

Adjusting of the EMF actual value with EMF control.

- Connect a voltmeter to the armature voltage terminals L+, L- on the test panel.
- Increase the speed until the convertor output voltage has reached the level for which the drive is dimensioned.
- Measure signal ARMVOLT (CONNECT1). The signal ARMVOLT and the voltage L+, L- measured with the voltmeter are to be in agreement. If adjustment is required, this is done with parameter AI37.3MU.
- Set parameter ARMRVOLT (EMFMEM) to 0 V. Measure signal EMFACT. This signal is to show 100 % when the convertor gives the maximum EMF voltage of the drive. If not, adjust with parameter EMFADJ.
- Compensation for armature voltage drop is set as descriped on page C - 18.

Setting voltage adaptation and adjusting signal EMFVOLT for drives with fixed field (PD 80, 81)

Set parameters in the current controller IACTR as follows:

- Set EMFACTS to "0".
- Set UNOM to nominal mains voltage, UvN.
- Increase the speed to 75 % of nominal speed.
- Set parameter ACTADAP (IACTR) to 75 %
- Measure the output voltage from the convertor. Set parameter EMFADAP to the voltage measured.
- Parameter ALPHAADJ is to be set as 0 degree.

Setting of voltage adaptation and adjusting of the signal EMFVOLT for drives with EMF control (PD 80, 81)

Set parameters in the current controller IACTR as follows:

- Set EMFACTS to "1".
- Set UNOM at nominal mains voltage, UvN.
- Increase the speed until 75 % of nominal EMF is obtained.
- Read signal EMFACT (EMFMEM) and set parameter ACTADAP to this value.
- Measure the output voltage from the convertor. Set parameter EMFADAP to the measured value.
- Set parameter ALPHAADJ to 0 deg.

Adjusting of armature current control
(IACTR) (PD 78, 79, CD71)

General

Parameter IACALVAL adjusts the current feedback level. This parameter is set in the workshop towards a well-defined load. The parameter is normally not to be changed unless board YPQ201 is replaced.

IACALVAL default value: 68.1 %.

The setting can be adjusted on site in accordance with the following.

Connect a digital voltmeter over the current feedback resistor on the pulse transformer unit, (detailed information about the pulse transformer board is needed) page 76, (between X31.A13 and B13) and set following parameters:

- NPROP (NCTRLX) to "1".
- IFACKBLK (SEQCON) to "1".
- IFGTMINL (IF1CTR) to 0 %.
- AFETYPE (IF1CTR) to 0
- MOTOSPL (MONIT/SPMON) to 30 %.
- NDEVL (MONIT/TQMON) to 100 %.
- STALLIAL (MONIT/STALLM) to 100 %.
- Switch off the field exciter circuit breaker H12.2.
- Read parameter IASCALE.
- Set parameter IASCALE to 1,000.
- Adjust the armature current until 0.50 V (0.5 x I_{dmN1}) is measured with the voltmeter.
- Measure signal IAACTI1 in function module IACTR. IAACTI1 is to show 50 %. If not, adjust with parameter IACALVAL after the current has been reduced to zero.

When there is agreement with half rated current (0.5 V over the current feedback resistor), increase the armature current until the voltmeter shows 1.0 V, if the motor allows. Signal IAACTI1 is now to show 100 %. Lower the armature current to 0 and switch off the convertor. Return all other parameters to their original value.

Connection and presetting

With manual setting, the armature current controller is adjusted with the d.c. machine stationary and with the field winding disconnected in accordance with the following:

Connect a voltmeter to the speed actual value output or read NACT on the operator's panel, to check that the machine remains stationary.

The armature current can be measured with a voltmeter connected to the terminals on the test panel, or on test terminals X25:1 - 2 on the processor board YPQ201. FWD I_{dmN1} = -5 V.

Disconnect the field exciter by switching off the field circuit breaker H12.2. It is important that the field winding is still connected to the field exciter to limit high induced voltages.

Warning!
Without current in the field winding, the inductance in the armature circuit is higher. This fact can, if the current controller is optimally adjusted, give unstable current, when the field circuit later is reconnected.

This will most likely appear at low speed with high current.

Set following parameters with the OP-panel.

Function module	Parameter	Setting
IACTR	OVERCUR	230 % or 1.15 x I_{dm}
NCTRLX	NPROP NGAIN NMODE	1 1.0 0
IAREFH NCTRL1	IALIMPS IALIMNS	Set to ±100 % corresponding to d.c. motor rating
IAREFH	IALIMMAX	Set to a value corresponding to max. load current
IF1CTR	IFGTMINL	Set to 0 %. Signal FLDCH goes low
SEQCON	IFACKBLK	1
MONIT	MOTOSPL	30 %

How to adjust the armature current controller

Following three parameters are to be adjusted in the current controller:
CONSTCON, CONSTRL and IAGAIN.

The parameters CONSTCON and CONSTRL create a model of the DC-motor.Parameter CONSTCON corresponds to the inductive and resistive armature voltage drop. Parameter CONSTRL gives the relation between inductive and resistive armature voltage drop.

Normal settings of parameter CONSTCON is 20 - 300. Parameter CONSTRL is normally set to 0.05 - 0.30. Parameter IAGAIN sets the gain in the whole current range, both discontinuous and continuous current.

To adjust the armature current controller, a repetitive step in the armature current reference is introduced. The magnitude of the step is set with parameter IASTEP1 in the current controller IACTR.

Preparing test

Start the convertor and increase the current with the REF+ button, up to rated current and back to zero.

If the rotor of the DC machine rotates, it must be locked in a suitable manner. Remember that current should only be applied for 20 seconds with intermediate cooling periods, and that the rotor should be turned between each loading with current.

The sequence of setting the current controller:

1. **Optimal setting of CONSTCON and CONSTRL in continuous current mode, with IAGAIN=1.0.**
   Start with following default value CONSTCON=20 and CONSTRL=0.13.
2. **Verification of the result in discontinuous current mode.**
3. **Change IAGAIN to 0.5 - 0.8 and reduce CONSTCON with 30 %.**

1. Optimal setting with continuous current.

Increase the armature current to continuous mode. Current pulsations can occur in the area between discontinuous current and continuous current. It may be necessary to go up relatively high in the range of continuous current to obtain stability.

Set a step, approximately 7 - 18 % with parameter IASTEP1. A suitable sweep speed on the oscilloscope is 5 - 10 ms/division.

If the oscilloscope picture does not remain stable, adjust the calibration so that the picture is stationary and that the front of the step appears.

Adjust with parameter CONSTCON the first current pulse according to fig. 1. In all alternatives shown in fig. 1, parameter CONSTCON is adjusted correctly.

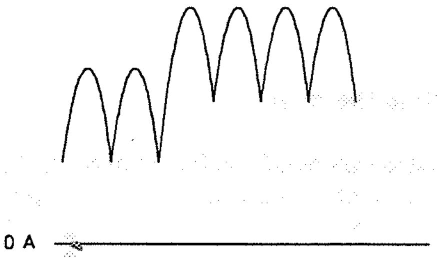


Fig. 1a

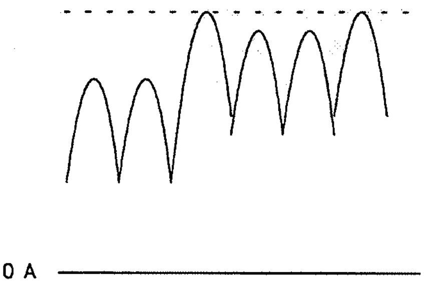


Fig. 1b

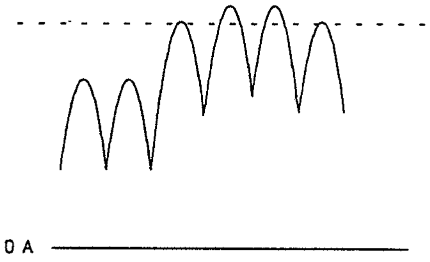


Fig. 1c

The faults shown in figure 1b or 1c are corrected with parameter CONSTRL.

In fig. 1b the parameter CONSTRL is set too low.
In fig. 1c the parameter CONSTRL is set too high.
After setting parameter CONSTRL the result shall be in accordance with fig. 1a.

2. Verification of the result with discontinuous current.

Reduce the current to discontinuous mode. Reduce the magnitude of the step by appr. 5%. The result shall be in accordance with fig. 2.

If the step response with discontinuous current does not correspond to fig. 2, the adjustments made with continuous current are not correct. Start from point 1 again.

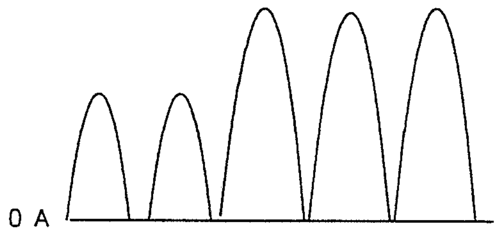


Fig. 2

3. Setting the gain

When parameters CONSTCON and CONSTRL are set, the gain of the current controller is set with parameter IAGAIN.

Parameter IAGAIN is on delivery set to 1.0, which also is the maximum value of the parameter. When the parameter value is reduced the gain becomes lower, giving more stable control.

To achieve stable current control, with the field supply connected, set parameter IAGAIN to 0.5 - 0.8, and reduce parameter CONSTCON by 30 %.

Increase the armature current from the discontinuous current mode up to rated current and back again. No abnormal current pulsations may occur at any time during this test.

Set parameter IASTEP1 to 0 % and repeat the last test.

For documentation of the trimming of the current controller, a step of appr. 10 % of the motor rated current can be introduced with parameter TQSTEP in the STEPTEST menu. The step is performed within continuous current, for example between 40 - 50 %

Note! A negative TQSTEP gives a positive step in the armature current. The registration is printed out and kept in the commissioning file.

Compensation of armature voltage drop, function module EMFMEM (PD 20)

- Measure signal ARMVOLT (CONNECT1). Start the convertor and increase the armature current to rated motor current. Read the ARMVOLT value.
- Lower the armature current to 0. Enter the ARMVOLT value as parameter ARMRVOLT.
- Measure signal EMFACT. Increase the armature current to rated motor current. Signal EMFACT is to show 0 % over the complete range.
- Lower the armature current to zero and switch off the convertor.

Setting of armature current limitation (PD 77)

Single convertor

The armature current limitation is set with parameter IALIMPS in function module IAREFH (parameter IALIMP with standard speed controller NCTRL1). The setting range is 0 - 200 % of the convertor current rating.

Note: Parameter IALIMNS/IALIMS is set to 0 %.

Note! If field reversal is included, parameter IALIMPS (IALIMS) is set for positive torque direction and parameter IALIMNS (IALIMN) for negative torque direction.

Double convertor

The armature current limitation is set with parameters IALIMPS for forward direction, and IALIMNS for reverse direction, both found in function module IAREFH. (parameters IALIMS and IALIMN in standard speed controller NCTRL1)

Setting range is 0 - 200 % of the convertor current rating.

Note! Parameter IALIMNS/IALIMS is to be set at a negative value, for example - 80 %.

Setting of armature current rate of change (PD 78)

The rate of change is set with parameter IADERMAX in the current controller IACTR.

On delivery, the parameter is set at 10.0 %/ms which gives a rate of change of one hundred times the rated convertor current per second. In case a higher rate of change is required, the parameter can be increased but not normally higher than to 20 %/ms, giving a rate of change of 200 times the rated convertor current per second.

Note! With older, not fully laminated motors, even the parameter value 10 %/ms can be too high. If so, sparking might occur causing damage to the commutator.

The commutator must always be checked during normal operation of the drive after completed commissioning.

Adjusting of speed controller

Preparations (PD 24, 67)

Parameter MOTOSPL (MONIT/SPMON) is set to 110 %. Return parameter IFGTMINL (IF1CTR) to appr. 70 % of the field current at max. speed.

Parameter IFACKBLK (SEQCON) is set to "0". Switch on the field circuit breaker H12.2.

Remove any locking of the rotor on the d.c. machine. If the driven object has not previously been coupled to the rotor shaft, it can be connected now. Check the lubrication.

Note! The driven object should be run with no load when the speed control is adjusted.

Standard speed controller (NCTRL1) (PD 67)

This describes the conventional method of adjusting a PID speed controller, i.e. by first adjusting the P-part, then the I-part and finally the derivating feedback. The P-part is set with parameter NGAIN, the time constant with parameter NTC1 and the magnitude of the derivating feedback with parameter NDERKD.

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

2. Start the convertor. Increase the speed to approximately 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 2 s. 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. Set the event line in the REGISTR display to the extreme left (186 points after the event). The resolution of the channels must be set, as the steps are only 2 %. It is appropriate if the step occupies half of the available height of the display.

Increase NGAIN in suitable steps, bigger steps with low gain, smaller steps as the rise time gets shorter. Check the result after each adjustment by performing steps. A rise time between 100 and 200 ms can be accepted for normal drives. Set parameter NPROP to "0". Continue the adjustment by reducing parameter NTC1. After each adjustment, check the result (also the behaviour of the current). A normal value of NTC1 is in the range 100 - 600 ms. Overshoots can be reduced with parameter NDERKD. The normal setting range is 0.5 - 4.0.

Guide for minimizing impact speed drop

This is valid only for standard speed controller.

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 NFEEDBTC= 10 ms. The parameter is found in function module DSP3X. 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. NFEEDBTC = 10 ms.

In case the performance achieved with this method is insufficient, the filter time constant NFEEDBTC 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. NFEEDBTC = 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 re-tuning of the speed controller in accordance with table 3 (Kp0 and Ti0 are the values of NGAIN and NTC1 achieved from 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. Minimise the impact drop by adjusting NGAIN and NTC1.

Advanced speed controller (NCTRL2) (PD 67)

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

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

Remark: Early releases of NCTRL2 lacks the parameter NMODE. For these releases NTC2 = NTC3 = 100 ms, corresponds to NMODE = 0. All other settings correspond to NMODE = 1.

NMODE = 0, PI controller.

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

Set parameter NMODE = 0. Adjust the controller the same way as the standard speed controller.

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 and higher gain in other ranges. The controller can be adjusted either as a PIPI controller fig. 4 or as a PDPI-controller fig. 5.

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 approximately 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 2 s. 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:

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

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.

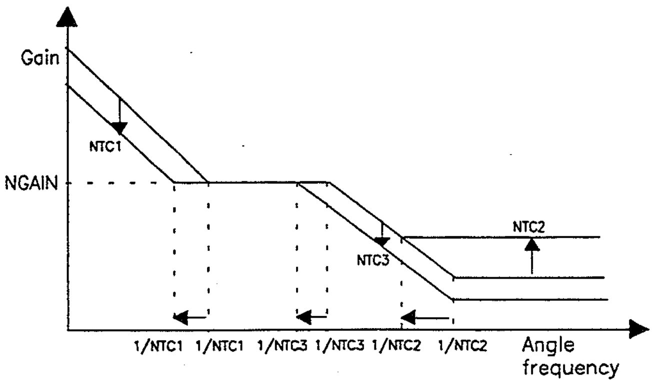


Fig. 4.

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.

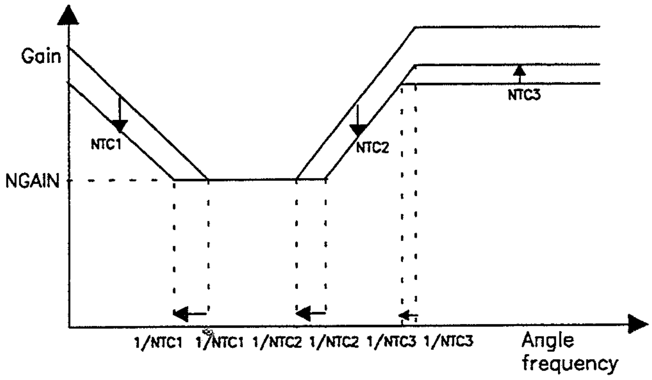


Fig. 5.

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 DSP3X, parameter NFEEDBTC). 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. 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 STEPG:
  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:
  TQSTEP = 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

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

Tuning

Set NMODE = 3.

Initial settings are: NTC2 = 2 x τ_{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 τ_{osc} - 2.0 x τ_{osc}.

Optimizing the RFE function

The damping is optimized by finding the best combination of NTC2 and NLAG. This is best done with 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 τ_{osc}

If NTC2 is less than τ_{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 response. If the overshoot is too high, it can sometimes be reduced by increasing parameter NKSI0.

If more 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.

Automatic field weakening

Field-weakening means that the machine flux is reduced to allow the speed to be increased above base speed. Field-weakening can be accomplished with or without EMF measurement, where the EMF-measurement gives better accuracy.

Fixed field

If field-weakening is **not** used, set parameter NBASE (EMFREF/CTRLSH) to 100 %.

Set parameters FILIMP and FILIMN (ECTRLX) to 0.0 %. Continue to "Setting of protections".

Field weakening

Field weakening involves two function modules, ECTRL (always included) and EMFREF or CTRLSH. (alternatives) Parameter settings etc. are performed exactly the same way in both cases. The setting of the field-weakening function is done in steps:

- Setting of flux/field current function generator
- Setting of speed controlled field-weakening
- Setting of EMF-controlled field weakening
- Trimming of EMF controller

Setting of flux/field current function generator (ECTRLX) (PD 81)

On delivery, parameters IFCONST1, 2 and 3 are set to give a straight flux curve for ABB motors of type LAP (DMP), LAR (DMG), LAB (DMB) and LAN (DMA):

IFCONST1	29.0 %
IFCONST2	53.5 %
IFCONST3	79.5 %

If the excitation curve is not known, the function generator can be set as described below.

Set FILIMP to 0.0 % and FILIMN to 0.0 %

Connect a voltmeter to the test terminals L+ and L-, or measure signal EMFACT (EMFMEM).

Switch on the convertor and set a speed so that EMFACT becomes less than 100 %.

Measure signal NACTMV1.

Note the start values of EMFACT and NACTMV1.

Reduce parameter NBASE (EMFREF/CTRLSH) successively and adjust parameters IFCONST1 - 3 in accordance with the table below.

Formula: FIREF = NBASE/NACTMV1

NBASE %	Corr. to FIREF %	Adjust IFCONST 1 - 3	So that EMFACT becomes
NACTMV1x 1.0	100		start value x 1.0
x 0.9	90	3	x 0.9
x 0.7	70	2	x 0.7
x 0.4	40	1	x 0.4

Field-weakening without EMF measurement (ECTRL1) (PD 81)

Set parameters FILIMP and FILIMN to 0.0%.

Connect a voltmeter to the test terminals for L+, L- on the test panel.

Switch on the convertor and increase the speed until the armature voltage has reached 98 % of the maximum EMF voltage. Read the speed actual value NACTMV1.

The same value (%) is entered as parameter NBASE (EMFREF/ CTRLSH). Reduce the speed to zero.

Increase the speed reference slowly to 100 % and back to zero. Check continuously that the armature voltage does not exceed maximum permitted value. If so, reduce parameter NBASE slightly.

Field-weakening with EMF-measurement (ECTRL1 + EMFMEM) (PD 20, 81, 84)

Set parameters FILIMP and FILIMN to 0.0 %.

Connect a voltmeter to the test terminals for L+, L- on the test panel.

Switch on the convertor and increse the speed until the armature voltage has reached 100 % of the maximum EMF voltage. Read the speed actual value NACTMV1.

The same value (%) is entered as parameter NBASE (EMFREF/CTRLSH). Reduce the speed to zero. Set parameter FILIMP to +10 % and FILIMN to -100 %.

Increase the speed reference to 100 % and back to zero. Check continously that the armature voltage does not exceed the maximum permitted value. If so, the function generator flux/field current must be readjusted.

Adjustment of EMF-controller

Set parameter EMFPROP to "0".

Set parameter EMFTC to 1000 ms.

Set a speed so that signal EMFACT reaches 85 %.

Reduce parameter EMFREFFW (EMFREF/CTRLSH) to 80 %. (Parameter EMFREFRV is used in drives with double field exciters, to allow braking with a lower EMF value).

Check that EMFACT decreases to 80 %.

Increase the speed slowly so that maximum speed is obtained. Signal EMFACT shall remain at 80 %.

Decrease the speed to zero. Increase the speed to the level where signal IFREF starts to decrease.

Increase the speed reference 5 % above this level. Make steps in the EMF reference with signal EMFSTEP in the STEPTEST menu. A suitable step is 4 % with a duration of 2 s.

EMFACT and IFACT are to be logged. A suitable time setting on the logger is 1 second. The event line 186 points after the event. As the step is only 4 % the resolution of the channel must be changed. The step shall occupy half the height available on the display.

Increase the gain of the controller with parameter EMFGAIN. Check the result between each adjustment by performing EMFSTEP. EMFACT is to go between the two levels without overshoot.

Adjust the time constant of the controller by decreasing parameter EMFTC. Check the result between each adjustment by performing EMFSTEP. Decrease EMFTC until a small overshoot in signal EMFACT is visible.

When parameter EMFGAIN is adjusted a small overshoot is accepted. This setting is normally sufficient for the EMF controller. If however a more rapid control is required, the setting can be done as follows:

Reduce parameter EMFTC until the overshoot is increased. Remove the overshoot with parameters EMFDERKD and EMFDERTC. Parameter EMFDERKD is increased in steps of 0.1 at the same time as parameter EMFDERTC is reduced. Decrease the speed to zero.

The result of the adjustment is checked by increasing the speed reference by the fastest ramp the drive will be exposed to. The ramp can for this test be set in module NINDE1 with parameter NIDINCRF, which is scaled in %/sec.

To trig the logger, module TEST is used. Connect signal EMFACT to AO72.1 in the CONNECT menu. Set parameter ATRIGL to 39.90 % (Parameter ATRIG is scaled for signals with 100 % as max. value. EMFACT has 200 % as max. value.

Increase the speed by pressing the REF+button. When the value of signal EMFACT is 79.8 %, the logger is triggered and the text ANALOG TRIGG appears.

Check the REGISTR display of signal EMFACT. Signal EMFACT must not make an overshoot of more than 5 %.

Note! If the registration need to be repeated the RESET knob on the service unit must be pressed.

If the overshoot is more than 5 %, the EMF controller need to be readjusted. If not, change parameter EMFREF to 100 % and parameter ATRIGL (TEST) to 49.95 %. Repeat the test by the fastest ramp the convertor can be exposed to. Signal EMFACT must not make an overshoot of more than 5 %.

After setting the EMF-controller, a new test of the dynamics of the speed controller must be made. In the speed controller, parameter FIADAPTS is set to "1". This will connect signal FIOFIK5 to the speed controller.

The test of the speed controller is done the same way as described earlier, only that the step is now given when the motor speed is 90 % of max. speed.

The step response of signal NACT shall be the same as after the previous adjustment of the speed controller, since signal FIOFIK5 will increase the gain in the speed controller to compensate for the lower field current.

If the speed control is unstable, reduce NGAIN in small steps until stability is achieved.

Setting of protections

General

On delivery, all protective functions are set to trip the convertor upon a fault. It is possible to select warnings instead of trip for some of the protective functions.

Note! Module EXFLT (External fault) is an exception. Parameters are default set to give warning instead of trip.

When a warning level is reached, the red lamp on the OP-panel starts to twinkle. A fault message is sent to the FAULT logger and will be kept there as the last message.

Note! The convertor continues its operation.

Overspeed protection (MONIT/SPMON) (PD 22)

- Start the convertor and increase the speed to 100 %. Set parameter MOTOSPL to 99 %. The convertor will trip for overspeed.
- Normal setting of parameter MOTOSPL is 110 %.

  Note! If a pulse transmitter is used for speed feedback, parameter MOTOSPL must not exceed 50 kHz. This will cause the convertor to trip for "OVERSPEED".

- Set parameter ALPHANSP to 75 DEG., this activating the speed feedback loss protection. The protection should not trip the convertor when the motor accelerates at its maximum rate from zero speed with rated load.

If the convertor trips for lost speed feedback, reduce parameter ALPHANSP by steps of 5 DEG., but not lower than 30 DEG.

Overvoltage protection (EMFMEM) (PD 20)

The overvoltage protection is included with EMF control or when the convertor is to be armature voltage-controlled.

- Reduce parameter ARMOVL to 90 %.
- Start the convertor and increase the speed. Check that the convertor trips at 90 % of the nominal voltage.
- Return parameter ARMOVL to 110 %.

Undervoltage protection (IACTR) (PD 81)

The undervoltage level is set by parameter MINVOLT, setting range 0 - 130 %.

The default value is 80 %. Set the parameter value to 110% and check that the convertor trips. Return to 80 %.

Two parameters, MSLVD and MSUVD can be used to delay the blocking of the current controller (MSLVD) and the TRIP (MSUVD).

MSLVD, main supply low voltage delay, default value = 0. Terminal is required for setting.

The setting range is 0 - 10 and the scale is

50 Hz:
1 x 3.3 ms, 2 x 3.3 ms, - - - - - 10 x 3.3 ms.

60 Hz:
1 x 2.8 ms, 2 x 2.8 ms, - - - - - 10 x 2.8 ms.

MSUVD, main supply undervoltage delay, with default value = 0. The setting range is 0 - 100 ms.

Remark! If harmless line disurbances cause nuisance trips, a good rule is to delay the trip with MSUVD and set MSLVD = 0.

Speed feedback, EMF feedback super-vision (MONIT/SPMON) (PD22) (EMFMEM) (PD 17)

The speed feedback signal, pulse transmitter or tacho, is normally monitored by function module MONIT/SPMON. Parameter NOACKLEV, no acknowledge level, is on delivery set to 20 %. Setting range is 0 - 100 %. If the EMF feedback 'signal is used for voltage (speed) control, the EMF feedback signal is monitored in function module EMFMEM, provided that parameter FBACK1S is set to "0".

Overload protection (MOTOLM) (PD 25) (Not to be set while eq. is in operation)

The function constitutes the temperature characteristics of the dc machine.

Output signal ARMHL gives a warning when the level set by parameter ARMHLL is reached.

Output signal ARMOL is on delivery set to trip the convertor, however with parameter ARMOLS (TRIP2) it is possible to to select warning instead of trip also for this signal.

Parameter ARMOLL is set for the lowest rated component of the equipment, i.e. motor or convertor. Following applies if the motor rating is lower than that of the convertor:

$$\frac{\text{Motor current rating (A)}}{\text{Convertor current rating (A)}} \times 100 = \text{Setting of parameter ARMOLL}$$

Remark: When IASCALE is used for IAACTABS = motor current, ARMOLL could be set at 100 %.

If the rated current of the motor is higher than that of the convertor, ARMOLL is to be set at 100 %.

The setting of parameters MOTCURMA and MOTORTC depend on the type of motor used as given in the following table.

This table is valid for good ventilated motors with cooling form IC06, 17, etc. For correct values on MOTORTC and MOTCURMA for motors with other cooling forms, please consult ABB Drives, Machines Division.

Motor type and shaft height	MOTORTC Sec	MOTCURMA %
LAP/DMP 112	240	180
132	240	180
160	240	180
180	240	180
LAR/DMG 180	240	180
200	240	180
225	260	180
250	310	180
280	360	200
LAB 355	240	200
400	300	200
450	310	200
LAN 560	390	200
710	360	200
DMA 280	480	200
315	480	200
355	540	200
400	540	200
450	600	200
500	600	200

Note! After setting parameters, switch off-on the power supply to activate the changes.

Overcurrent protection and other protections in current controller IACTR1 (PD 78, 79)

The overcurrent protection is set at 230 % of the rated motor current. The level is set with parameter OVERCUR. Setting range is 0 - 400 % of the convertor current rating.

Other protective functions in the current controller have default values corresponding to normal conditions and do not need to be changed during commissioning.

Motor temperature supervision (MOTEMP) (PD 28)

Function module MOTEMP is intended for supervision of the winding temperature of a d.c. motor with Pt-100 sensors. Two channels are available. The function can also be used for monitoring of bearing temperatures and in certain cases, air temperature.

The documentaion (XO-drawing) of a dc machine equipped with a Pt-100 temperature sensor, specifies at which temperature the convertor is to be tripped. See also the maintenance/commissioning instructions for the motor concerned. Check that the analog input channel is strapped for 1 V signal level.

The warning levels for high temperature are set with parameters MOTHTL1 and 2 whereas the tripping level is set with parameters MOTOL1 and 2. It is however possible to disconnect the tripping function. This is done with parameter MOTOTS in function module TRIP2, (Terminal required).

Convertor temperature supervision (TYTEMP) (PD 29)

The function monitors the thyristor crystal temperature via a Pt-100 sensor mounted on the thyristor heat sink. Convertors rated up to 530 A are designed with potential free heat sinks. The Pt-100 sensor is supplied from the 5 mA current source on the basic I/O-board, and the output signal is connected directly to an analog input channel, strapped for 1 V signal level.

Higher rated convertors have an isolating signal transducer between the sensor and the output signal. The signal transducer is supplied with 220 V a.c., and includes a 5 mA current source. The analog input channel is strapped for 10 V signal level . Double convertors 640 - 3600 A are provided with two sensors/transducers, for forward and reverse directions.

Two temperature levels can be set, one warning level and one trip level. The warning level is set with parameter THYHTL and the trip level is set with parameter THYOTL.

The parameters in the function module TYTEMP are set in accordance with the current rating of the convertor per table below.

Convertor current rating I_{dmN1} (A)	Parameter COMHSINK	Parameter TEMP.J_H Grad (°C)	Parameter THYTC (ms)
40	1	15	1000
70	1	30	1000
120	1	23	1000
200	1	18	2000
350	1	38	2000
530	1	46	2000
750	0	22	1000
750 (660 V)	0	22	1000
1000	0	32	1000
1250	0	21	1000
1500	0	20	1000
1800	0	48	2000
2400	0	36	2000
3600	0	63	2000

Selecting trip or warning for OVERLOAD THYRISTOR FAN, OVERLOAD EXTERNAL FAN and EARTH FAULT (TRIP1) (PD 32)

On delivery all these protective functions are set to trip the convertor in case of fault. The choice between trip or warning is made with parameters CFANOLS (conv. fan), EFANOLS (ext. fan) or EFLTS (Earth fault). "1" = trip, "0" = warning.

External fault protection (EXFLT) (PD 30)

Function module EXFLT can accept arithmetic or binary external fault signals. Each individual fault signal can be set to give trip or warning. It is also possible to select a delay time for action.

Stall monitor (MONIT/STALLM) (PD 24/26)

The stall monitor does not normally need to be adjusted during commissioning. The parameter for the armature current is on delivery set to 50 %. The speed level is 2 % and the time delay is 3 seconds.

Torque monitor, (MONIT/TQMON) (PD 22/27)

To select warning instead of trip, set parameter TQFLT1S to "0".

Concluding procedures

Check, in function module IACTR that parameter IASTEP1 is at 0 %.

Check, in function module SEQCON, that parameter IFACKBLK is at 0.

Reset the fault logger by temporarily setting parameter FCLEAR in function module FLTLOG to "1" and then back to "0".

Enter six signals into the logger, which may be of interest to those who are to perform fault tracing.

Start the logger. Check that the flashing L in the lower left hand square on the display disappears.

Prevent unintentional changing of parameter values with the switch on top of the computer board YPQ201. Check that a cross becomes visible in the circle on the display.

How to document the commissioning

The commissioning is documented by printing out all parameter settings and all signal connections made. Keep the lists together with the circuit diagram.

If no printer is available, the new parameter settings are to be noted on a separate list.

The step response from the adjustment of the current and speed controllers are printed out and kept in the file.

Maintenance

Contents