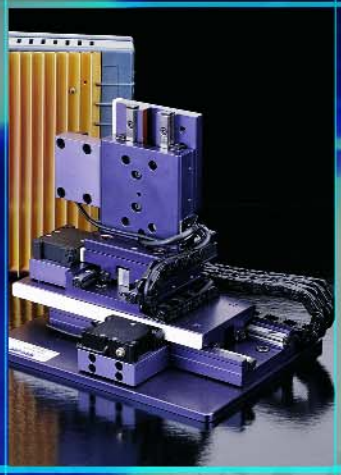
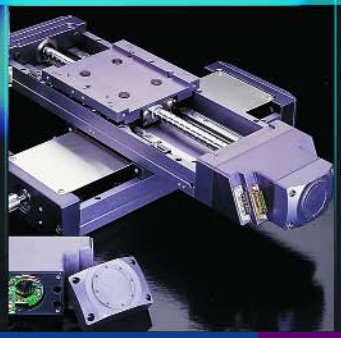


Linear & Rotary Positioning Stages

Gearmotors & Gearheads

Servo Motors & Drives



iDRIVE

Brushless Digital Drive/Indexer
BDS Series Product Manual

BAYSIDE® Motion Group

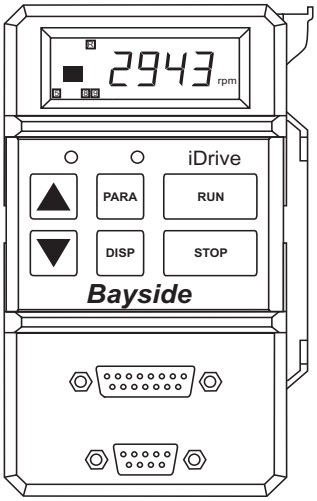
PRECISION IN MOTION

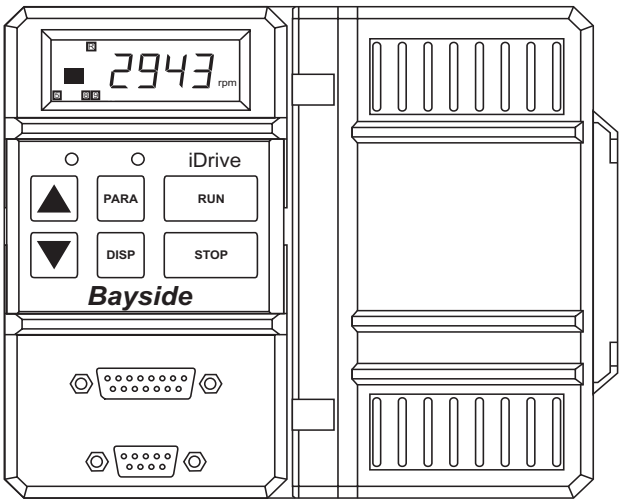
Operating Manual

i-Drive

Servo-Amplifier and Frequency Inverter

With Integrated Position Control





Size 1:
BDS 021 / 031, 115 VAC, 1~
BDS 022 / 032, 230 VAC, 1~
BDS 023 / 033, 230 VAC, 3~
BDS 024 / 044, 400 VAC, 3~

Size 2:
BDS 071, 115 VAC, 1~
BDS 072, 230 VAC, 1~
BDS 073, 230 VAC, 3~
BDS 064 / 084, 400 VAC, 3~

Bayside Motion Group reserves the right to change the content and product specifications without notice.

CE

c UL US LISTED

Only 230 VAC single phase i-Drives, others in preparation.

Applicable firmware version: 3.062

Manual Article-No.: 785007US

Revision No.: 2.1 Date: 04/01/04

Table of contents

1 Introduction

This manual is intended for users of the i-Drive product. A user is anyone specifying, applying, integrating, programming, operating, troubleshooting or servicing the unit. The user should have a basic understanding of electronic motion control principles including current/speed/position control, motor protection, signal interfacing and servo loop tuning. The user should also have previous experience starting-up servo motor-drive systems. Although the i-Drive is suitable for servo control of linear motors, this manual is strictly written for rotary motors. Consult with an i-Drive application engineer in advance of linear motor application suitability and use.

Because the manual covers both asynchronous (induction motor) and synchronous (brushless commutated) motor control in addition to multiple control techniques, only certain parameters are active or used by a given application. The user needs to identify and correctly apply the parameters specific to the application.

Bayside Motion Group has created and made available motor file parameters for many standard catalog motor/drive model combinations. These parameter sets are downloadable from our web site. In addition, example or demo application control mode files are also available.

Overview of motor control capability

The i-Drive employs a unique, patented universal Field Oriented Vector Control technology. This control is suitable for all types of three-phase rotary and linear permanent magnet brushless motors (synchronous commutated) and squirrel cage induction (asynchronous) motors.

For synchronous brushless servo motor control, sinusoidal current commutation can be accomplished either via sensorless (Hall less) encoder commutation or digital Hall/encoder commutation for “no motion” initialization. Hall based commutation very quickly switches to the higher resolution encoder to allow sinusoidal commutation. The encoder only commutation method utilizes a unique commutation angle initialization (pole finding) technique that results in only a quick minimovement of the motor/load. In both schemes, a resolver can be used instead of an encoder.

Asynchronous induction motors can be controlled in either sensor (encoder or resolver) or sensorless vector mode. The V/Hz control mode is used for initialization, parallel motor applications and traditional control if desired.

Both motor types require sensor feedback for positioning mode.

2 Safety

2.1 Explanation of symbols

Please read carefully all of the safety information contained in this operating manual and observe the warning labels on the device.

The following symbol is used where special attention must be paid. Disregard of safety notes indicated with this sign may result in injury to persons or damage to the device:

This warning symbol highlights notes on safety as described in this operating manual. Failure to observe the respective safety notes can endanger life and limb, as well as resulting in destruction of the device.

2.2 Intended purpose

The devices comprising the **i-Drive** family are electrical components for application in electrical drive systems, and are suitable for assembly in electrical cabinets. Electrical drives are used to control speed-variable three phase motors.

2.3 Safety notes

To prevent accidents and damage to machines, the applicable accident prevention regulations and safety requirements must be complied with when using our devices.

The device may only be used for the application that the manufacturer intended. Non-approved modifications and combination with equipment which has not been recommended by the manufacturer can lead to severe damage or even complete destruction of the device.

Only qualified personnel may be involved with connecting, commissioning or repairing the devices. These persons must be aware and familiar with all warning notes and safety measures. The operating manual must be at hand at all times when working with the device.

Qualified personnel can be considered those who are familiar with the relevant regulations, accident prevention guidelines and working conditions, on account of their tasks, training and experience. They should also be in a position to recognize and prevent dangerous situations and to carry out measures which are necessary to ensure safety.

During operation, this device generates dangerous electric voltages as well as moving or rotating parts. If the safety notes in this operating manual are not adhered to, serious damage to the equipment, serious injury to persons, or even death may be the consequence. Physical contact with high voltage parts can lead to serious injury or even death.

Electrical drives are devices which operate with very high voltages. Even when the motor is at stand-still, voltages are present on the following parts:

- Power supply terminals L1, L2, L3 and –U, +U
- Motor terminals U, V, W
- Terminals for braking resistor R1, R2

The device may never be used without grounding PE to the mains power supply earth connection. The motor chassis ground connection must also be connected to the device PE terminal on the motor side.

Devices with three-phase mains connection may not be connected to a power network with a circuit breaker as the sole form of protection.

! i-Drive® may only be opened up by the manufacturer. It is not allowed to remove the integrated operating panel. The warranty is automatically void if the device housing is removed.

This documentation has been produced by us with the utmost care. We cannot however guarantee complete accuracy. If you should discover any inaccuracies or mistakes, we would be thankful if you could let us know. This also applies to any suggestions for improvements.

Bayside does not accept responsibility for damage or consequential damage caused as a result of incorrect programming of the positioning object or misapplication.

All technical specifications are subject to change without prior notice.

3 General description

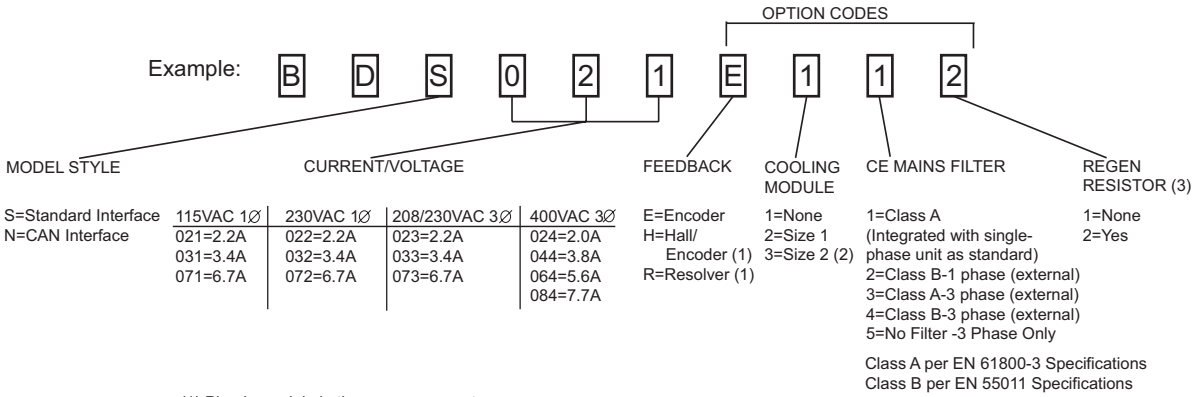
3.1 Features

The i-Drive is a voltage source PWM (pulse width modulation) drive suitable for controlling three-phase rotary and linear induction motors and synchronous brushless electronically commutated servomotors.

- Compact size, high power density
- Digital, sensorless vector control, optionally with speed feedback (incremental encoder, resolver,sine/cos encoder)
- Four quadrant power control
- 150% overload for 10 s every 5 minutes
- Output frequency up to 650 Hz
- PWM inverter with IGBT output stages
- Switching frequency of 8 or 16 kHz
- Integrated regenerative braking electronics, direct connection for external braking resistor
- Terminals for DC supply input
- Robust encapsulated power unit
- Motor connector is earth-fault and short-circuit proof
- Torque build-up less than 1ms in vector control mode
- High dynamic performance - current control with sampling interval of 125 µs and speed control with 500 µs respectively
- Relay output 0.4 A, 125 V AC; 2 A, 30 V DC, function programmable
- 5 programmable digital inputs
- Selectable analog input, ±10 V, 0/4-20 mA, programmable
- Analog output 0..10 V, output value programmable
- Integrated operating panel, 6 keys with LCD display
- RS-485 serial interface
- Parameter set-up software win+i-Drive, running under Windows 3.1x/95/98/NT
- Fixed position control via digital input
- Position control via motor potentiometer (operating panel)
- Position control via analog input
- Integrated sequential position control for up to 20 positions

Delivery contents:

- i-Drive unit
- 15-pin connector for control terminals
- Mounting brackets for mounting on cooling surfaces



(1) Plug-in module in the sensor connector
(2) For model numbers 064, 071, 072, 073, & 084

(3) Regen resistor

Model	Resistance	Maximum current	Peak power	Rated power	Part number
BD_021, 022, 023	150Ω	2.7 A	1.0 kW	100 W	12602010
BD_031, 032, 033	150Ω	2.7 A	1.0 kW	100 W	12602010
BD_071, 072, 073	100Ω	4.0 A	1.6 kW	100 W	12602011
BD_024	330Ω	2.1 A	1.4 kW		0000782033
BD_044	220Ω	3.2 A	2.2 kW		0000782022
BD_064	150Ω	4.7 A	3.2 kW		0000782015
BD_084	100Ω	7.0 A	4.9 kW		0000782010

Options

Cooling module size 1: 12602005
- Heat sink with integrated fan for mounting on a top-hat rail
- Connecting cable: cooling unit - i-Drive

Cooling module size 2: 12602006
- Heat sink with integrated fan for mounting on a top-hat rail (2 pieces)
- Connecting cable: cooling unit – i-Drive

Additional mains filter class B for i-Drive single phase family: 12602007
- Filter unit for mounting on a top-hat rail with pluggable screw terminal for mains and 15-cm-cable to the i-Drive
- 2 mounting brackets for mounting on cooling surfaces

Mains filter class A/B for i-Drive three phase family: 12602008(A) or 12602009(B)
- Filter unit for mounting on a top-hat rail with pluggable screw terminal for mains and 15-cm-cable to the i-Drive
- 2 mounting brackets for mounting on cooling surfaces

i-Drive communication kit: 12602000
- PC parameter set-up software, win+i-Drive, on CD. Runs under Windows 3.1x/95/98/NT
- RS-232 to RS-485 converter
- Connecting cable: converter - PC (RS-232), length 2 m

Manual set-up box: 12602004
- Operating panel with potentiometer for the analog input value (0 ... 10 V), combined switches/push buttons for the digital input terminals, LED displays for the relay output, 2 m connecting cable with 15-pole connector for control terminals.

Resolver Interface: 12602003
- External interface to connect motors with Resolver feedback to i-Drive

Hall/encoder interface: 12602002 - X, X=division factor (requires firmware 3.066 or higher)

- External interface used for Hall effect start-up commutation, as well as frequency division of the encoder signals. Various part numbers for divide by factors.

Regen/resistor: see(3)

- External power resister for connection to integrated regeneration braking circuit.

3.2 General device specifications

Mains supply	i-Drive family	1x115 V AC +/-15%, 50-400 Hz or 160V DC +/-15% 1x230 V AC +/-15%, 50-400 Hz or 320 V DC +/-15% 3x208 V AC +/-10%, 50-400 Hz or 290 V DC +/-10% 3x230 V AC +/-10%, 50-400 Hz or 320 V DC +/-10% 3x400 V AC +/-15%, 50-400 Hz or 560 V DC +/-15%
Output voltage		3 x [0 V to V_{mains}]
Output frequency		0 to 650 Hz
Maximum encoder frequency		150 kHz per channel (600 kHz post quadrature
Switching frequency		8/16 kHz
Output peak current		150%
Ambient temperature		5 °C to 40 °C
Storage temperature		-25 °C to 55 °C
Relative humidity		5-85% non-condensing
Site altitude		0-1000 m above sea level
Radio interference		Product norm EN 61800-3 (Adjustable speed electrical power drive systems) for EMC compliant assembly
Protection class		IP20
Pollution degree		2
Weight with/without cooling unit	Size 1 Size 2	1.6 kg / 1.3 kg 2.4 kg / 1.9 kg
Dimensions without cooling unit	Size 1 Size 2	80 * 150 * 118 mm (with mounting brackets) 156 * 150 * 118 mm (with mounting brackets)
Dimensions with cooling unit	Size 1 Size 2	95 * 130 * 185 mm 171 * 130 * 185 mm

3.3 Specific device specifications

Model	**Units**	**BDS 021/022/023**	**BDS 031/032/033**	**BDS 071/072/073**
Size		1	1	2
Nominal input current	Arms	4.0/4.0/2.5A	6.0/6.0/3.8A	12/12/7.5A
Continuous output current	Arms	2.2	3.4	6.7
Max. current for 10 seconds	Arms	3.3	5.1	10
Power loss at full load	Watts	50	70	120
External fuse	Arms	20A for 115V 10A for 230V	20A for 115V 10A for 230V	20A for 115V 16A for 230V

Model	Units	BDS 024	BDS 044	BDS 064	BDS 084
Size		1	1	2	2
Nominal input current	Arms	2.5A	4.5A	6.0A	8.5A
Continuous output current	Arms	2.0	3.8	5.6	7.7
Max. current for 10 seconds	Arms	3.0	5.7	8.4	11.5
Power loss at full load	Watts	70	120	150	200
External fuses	Arms	10A	10A	16A	16A

**Note: External fuses should be slow-blowing (long time delay) type rated for the AC input voltage or higher.

3.4 Declaration of manufacturer

We hereby declare that the device described in this operating manual is suitable for controlling variable speed three-phase motors. The device in question is an electrical drive controlling electrical motors, which is used in conjunction with a machine or together with other components for the assembly of a machine. The device itself is not a machine in the sense defined by the machine guidelines 89/392/EWG.

To ensure that the device complies with the electromagnetic limit values, it must be assembled with appropriate measures. Information on the measures that need to be introduced, like filtering and shielding can be found in the operating manual.

Three-phase **i-Drive** devices are not certified for use in low voltage mains supply networks without an external mains filter. The device can cause high frequency interference.

The **i-Drive** device is categorized as a component according to the EMC guidelines. The electro-magnetic compatibility of the machine as a whole is dependent on the method of installation, the location as well as the respective area of application. The machine constructor is responsible for complying with the EMC guidelines of the complete machine.

3.5 Standards

The **i-Drive** family of electrical drives complies with the following standards:

- Adjustable speed electrical power drive systems, EMC product standard EN 61800-3
- Electronic equipment for use in power installations EN 50178, 1997 (VDE 0160)
- Radio interference of electrical apparatus and installations EN 50081-2; EN 55011 GW A
- Electrostatic discharge immunity test EN 61000-4-2
- Generic Immunity Standard, Industrial environment EN 50082-2
- Electrical fast transient/burst immunity test EN 61000-4-4

4 Mechanical dimensions and assembly

4.1 Assembly and installation notes

Warning

Installation and assembly are only to be carried out by qualified personnel. The accident prevention regulations and the general safety regulations are to be observed at all times.

Installation and assembly are to be carried out in a dry dust-free location. Acidic, aggressive and contaminated air can disturb device functionality and may not be used as a cooling agent. The device should be operated under the specified environmental conditions (temperature range, humidity, etc.).

Please observe that the ventilation must always be calculated according to the power loss!

4.1.1 Assembly with cooling unit on DIN rails

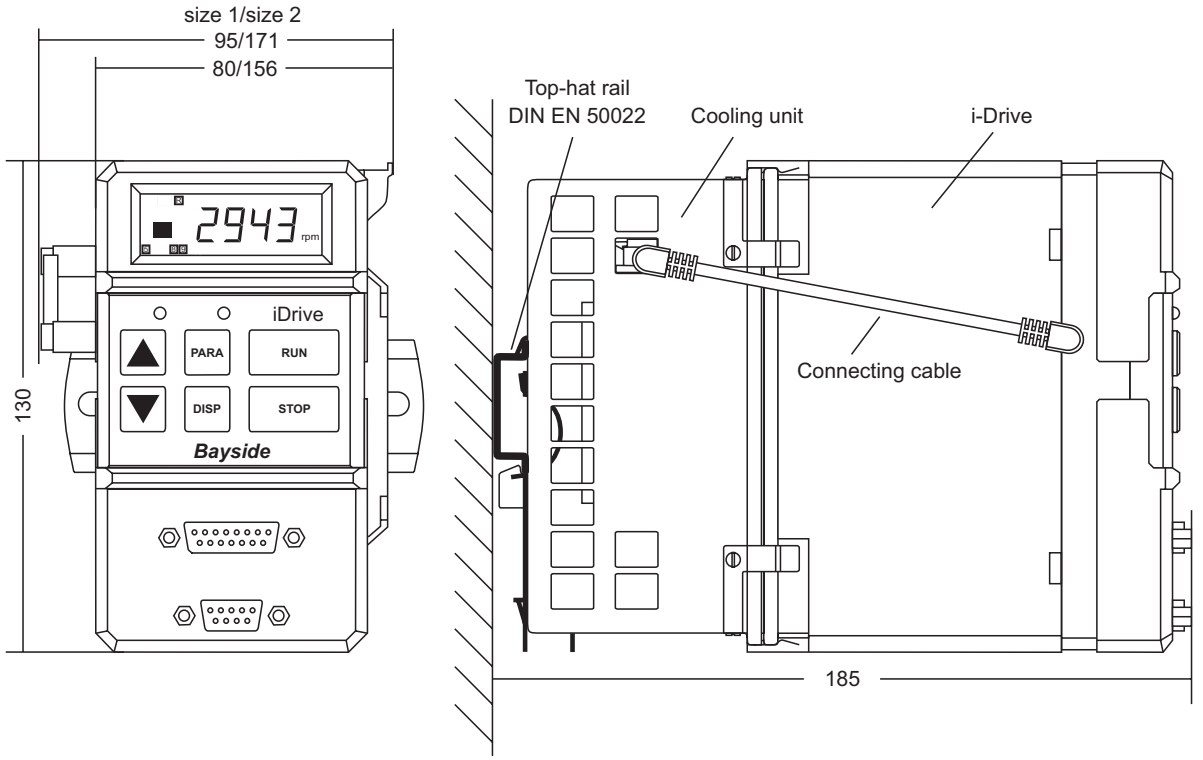


Fig. 1: Assembly on a DIN rail

- i-Drive , together with its heat sink can be mounted on a DIN EN 50022 top-hat rail. It is assembled vertically. The snap-on mechanism is located in the center of the i-Drive.
- The heat sink unit must be snapped onto the i-Drive; To improve the heat conduction between heat sink and inverter, you should smear the underside of the i-Drive with a heat conducting paste. All eight of the heat sink's springs on the four sides must adequately grip the edge around the i-Drive.
- The heat sink must be electrically connected to the i-Drive using the provided cable (power supply of the ventilator). The cable is plugged into sockets on the i-Drive and the heat sink on the left hand

side of the device.

- A gap of 30 mm must be maintained above and below the i-Drive to ensure adequate convection of cooling air.
- Several i-Drives can be mounted on one top-hat rail. A gap of at least 20 mm must be kept between two devices. An i-Drive thus requires a 100 mm (size 1) or 170 mm (size 2) wide space.

4.1.2 Mounting on a cooling surface

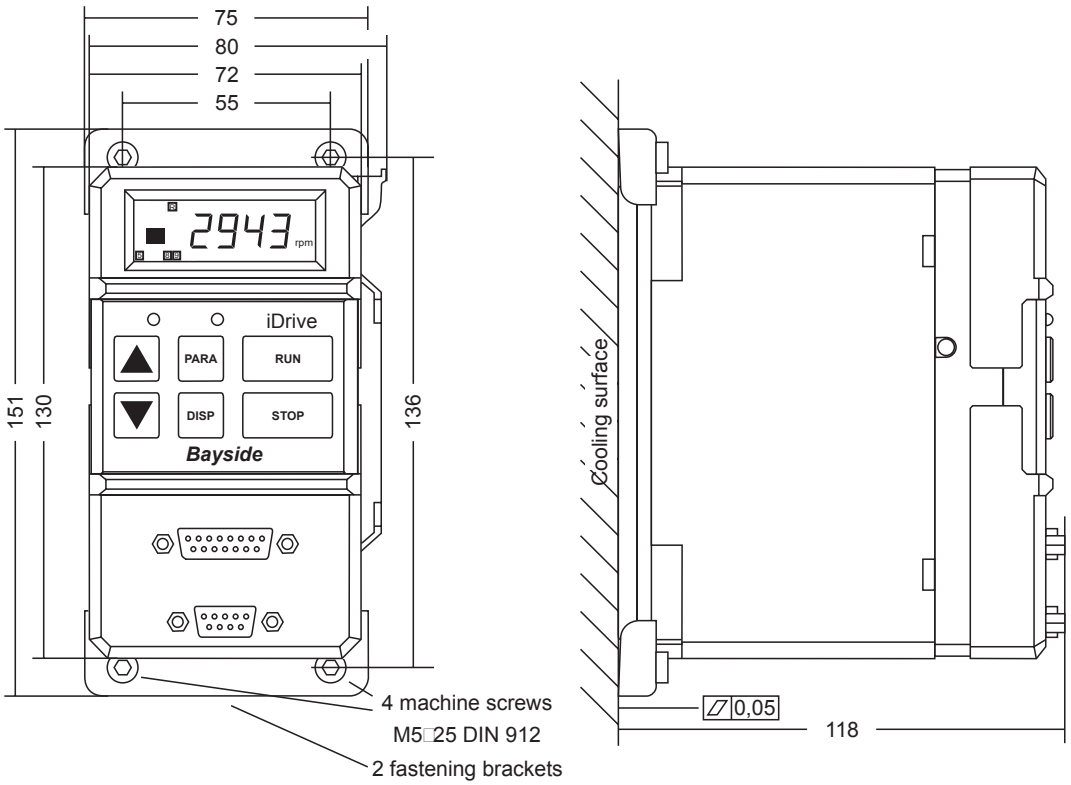


Fig. 2: Mounting on a cooling surface (size 1)

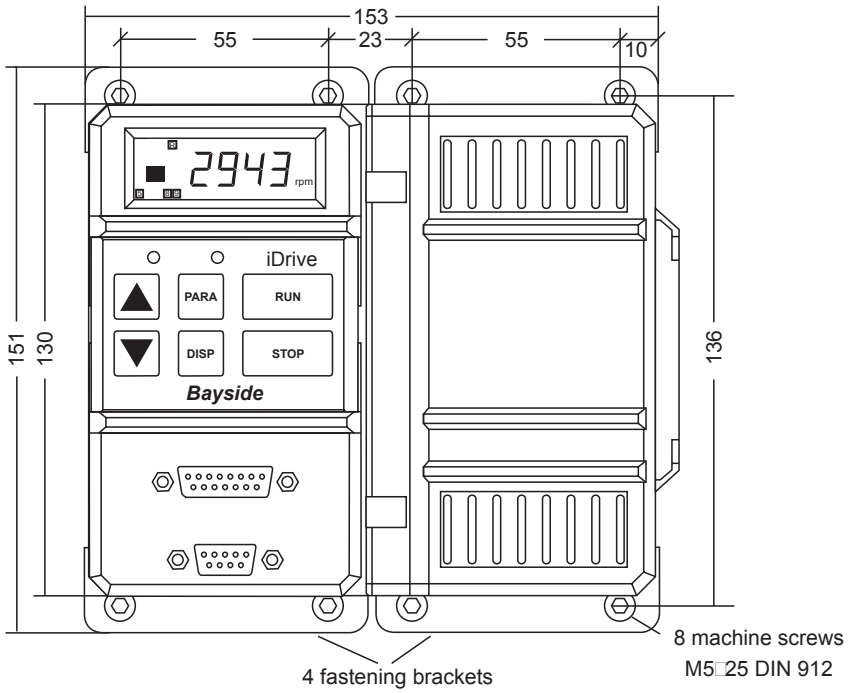


Fig. 3: Mounting on a cooling surface (size 2)

- i-Drive can be mounted directly onto a cooling surface using the provided mounting brackets. In this case the cooling unit is not needed. Four DIN 912 M5∗25 machine screws are recommended to secure the device. They should be spaced 55 mm apart widthways and 136 mm lengthways. With i-Drives of size 2, the two aluminum power module plates have to be heat sunk. The spacing is 78 mm. The cooling surface must be smooth and even (Less than 0.05 mm differential in evenness). Application of heat conducting paste is necessary to improve thermal transfer.
- The cooling surface must be able to dissipate the maximum power loss of the i-Drive. The temperature of the cooling surface may not exceed 70°C for the maximum power loss. In any case, the i-Drive's temperature warning and over-temperature turn-off will be activated.

The ambient conditions have to be considered for the design of a heat sink. The size of the heat sink have to be choose regarding to the required thermal resistance R_{th} which meets R_{th} < (max. heat sink temperature – max. allowed ambient temperature) / max. power losses.

5 Electrical connections and installation

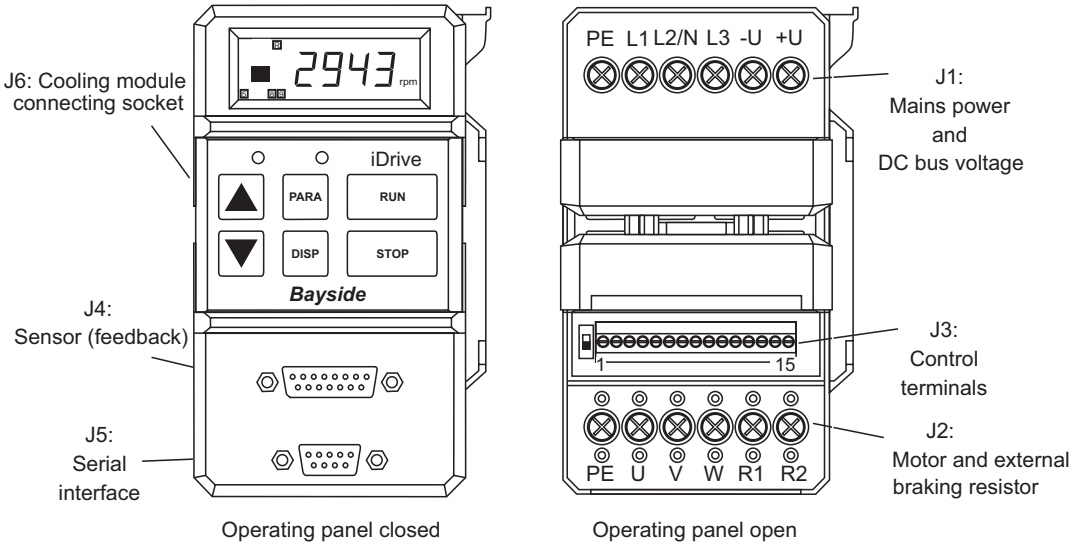


Fig. 4: Electrical connection points

i-Drive has the following terminals:

Name	Type	Function
J1	6 pin screw terminal block	Mains supply, DC voltage link
J2	6 pin screw terminal block	Motor connection, braking resistor
J3	15 pin pluggable screw terminal block	Control terminals: Analog input, digital inputs, analog output, relay output
J4	15 pin Sub-D socket	Feedback: Encoder/Resolver Interface
J5	9 pin Sub-D socket	Serial RS-485 interface
J6	Low voltage connector1	Supply voltage for cooling module (12 V DC, not short-circuit protected)

Remarks:

- Control cables, mains cables and motor cables must be physically separated.
- For power connections, cables with a cross-sectional area of up to 2.5 mm² are to be used. They must have an isolation voltage of at least 600 V, e. g. SAB SL 812.
- Cables with a cross sectional area from 0.14 mm² to 1.5 mm² may be used for wiring the control terminals.
- J6 may only be used for connecting the cooling module using the provided cable.
- The terminals L3, -U, +U, R1 and R2 are protected against incorrect connection by additional plastic barriers:
  For the 400V devices (3) the barriers must be removed from the L3 terminal.
  If connecting to a DC bus interconnection, the barriers of terminals –U and + must be removed.
- If connecting to an external braking resistor, the barriers of terminals R1 and R2 must be removed.
- The max. torque for the mains and motor cable screws (J1/J2) is 1 Nm.

5.1 Power connections (example installation)

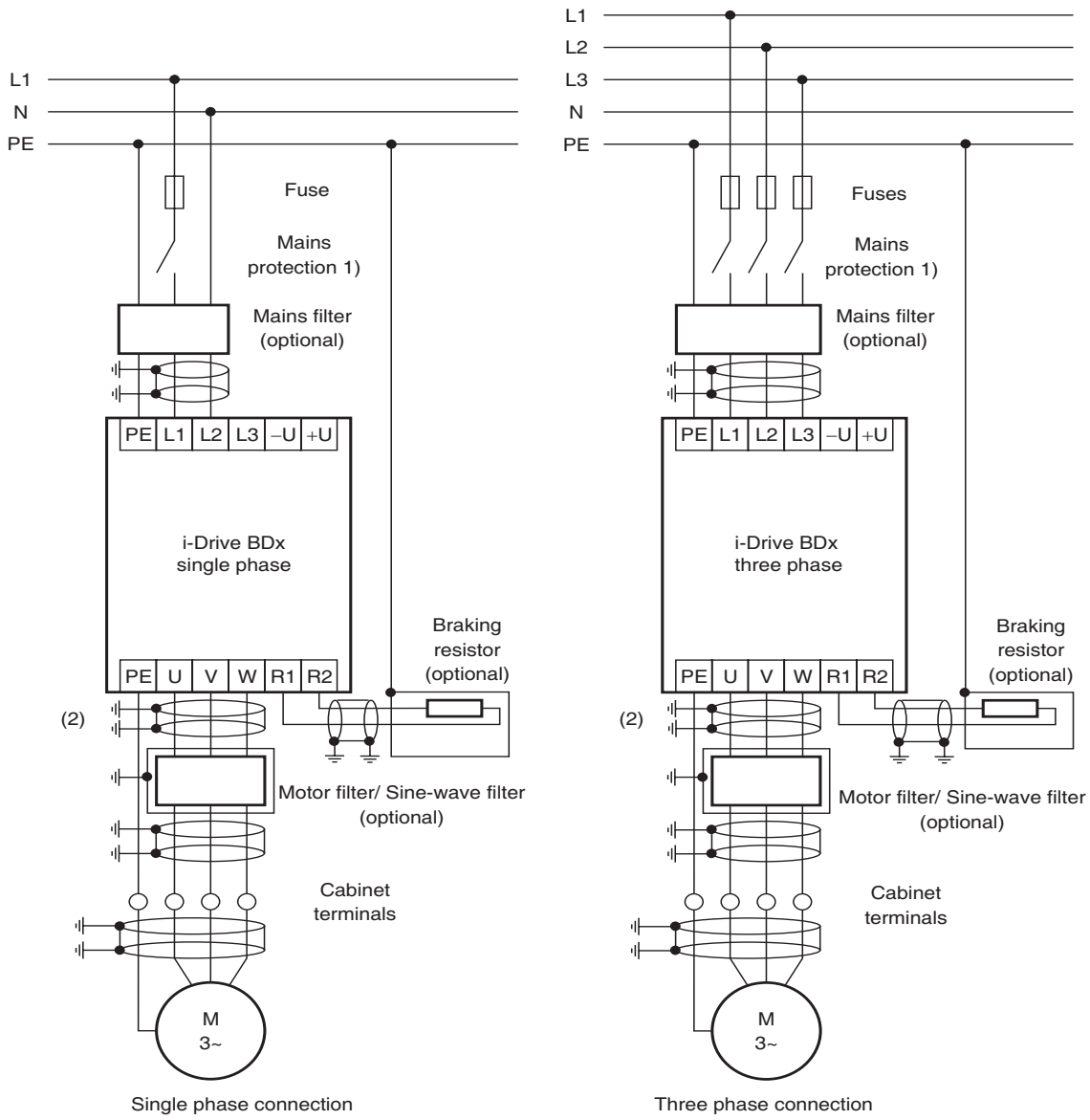


Fig. 5: Mains connection

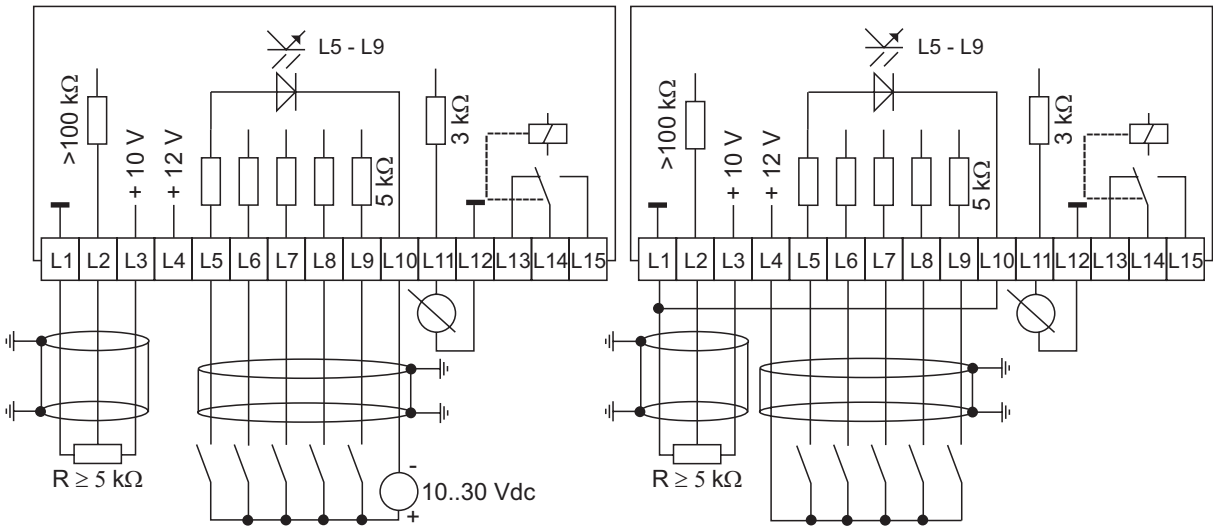
Notes:

- **Bayside motors: refer to start up chapter for Plug & Play Quickstart procedures.**
- A cable of at least the same cross-sectional area as the power connecting cables must be used for the ground protection conductor (PE).
- A shielded cable must be used for the connection between inverter and motor, e. g. SAB SL 812. The maximum length is 25 m without Motor filter/Sine-wave filter (8 kHz switching frequency).

1) The main power may be switched on not earlier than **20 seconds** after the main power was switched off. This is to prevent overloading of the inrush current limiting NTC resistor, i.e., cooling down time is required to reset the resistor.

2) **Motor to i-Drive power wiring is phase sensitive. Improper phasing can cause performance problems, overheating or runaway condition. Refer to applicable motor start up procedure in manual.**

5.2 Control connections



External supply for the digital inputs

Internal supply for the digital inputs

Fig. 6: Control terminals

Pin	Signal	Comment
L1	Ground connection for analog input	Not connected to L10 or PE
L2	Analog input	R_{in} ≥ 100 kΩ, 10 bit resolution
L3	Potentiometer supply (+ 10 V)	Max. 2 mA, short-circuit protected
L4	Supply for the digital inputs (+ 12 V)	Max. 20 mA, not short-circuit prot.
L5	Digital input L5, 0..5 V = inactive, 10..35 V = active	R_{in} = 5 kΩ, opto-coupled, 10 bit resolution
L6	Digital input L6	〃
L7	Digital input L7	〃
L8	Digital input L8	〃
L9	Digital input L9	〃
L10	Ground for digital input	Not connected to L1, L12 or PE
L11	Analog output (0 to 10Vdc)	Internal resistance 3 kΩ, short-circuit protected
L12	Ground for analog output	Not connected to L10 or PE
L13	Digital relay output, opener contact	0.4 A, 125 V AC or. 0.2 A, 30 V DC
L14	Digital relay output, common contact	〃
L15	Digital relay output, closer contact	〃

Notes:

- A shielded cable is recommended for the analog input signal and the digital inputs.
- For an analog current input of 0..20 mA or 4..20 mA a resistor with a value of 500 Ω has to be connected between L1 and L2.
- The analog input is programmable via the parameters P30..36
- If the internal voltage supply (L4) is used for the digital inputs, then L10 must be connected to L1. Then the digital inputs are not isolated from the i-Drive.
- The digital inputs are programmable via the parameters P40..54
- The analog output is programmable via the parameters P55..56

- The relay output is programmable via the parameters P57..58

5.3 Encoder / Resolver connections

J4	Note: Maximum encoder frequency is 150 kHz per channel. (600 kHz A quad B)
Pin	**i-Drive signal**
1	A+: Encoder track A, positive signal
2	B+: Encoder track B, positive signal
3	C+: Encoder track C, positive signal
4	D+: Encoder track D, positive signal
5	I+: Index pulse, positive signal
6	
7	Supply voltage + 5 V, max. 120 mA
8	PE
9	A-: Encoder track A, negative signal
10	B-: Encoder track B, negative signal
11	C-: Encoder track C, negative signal
12	D-: Encoder track D, negative signal
13	I-: Index pulse, negative signal
14	
15	Ground supply voltage (0 V)

J4	Resolver interface to i-Drive J4		**Resolver interface output to resolver device**
Pin	**i-Drive signal**		
1	A+: Encoder track A, positive signal		COS+ (S1)
2	B+: Encoder track B, positive signal		SIN+ (S3)
3	C+: Encoder track C, positive signal		
4	D+: Encoder track D, positive signal		
5	I+: Index pulse, positive signal		
6			
7	Supply voltage + 5 V, max. 120 mA		Excitation (R1)
8	PE		Shielding
9	A-: Encoder track A, negative signal		COS- (S2)
10	B-: Encoder track B, negative signal		SIN- (S4)
11	C-: Encoder track C, negative signal		
12	D-: Encoder track D, negative signal		
13	I-: Index pulse, negative signal		
14			
15	Ground supply voltage (0 V)		Excitation

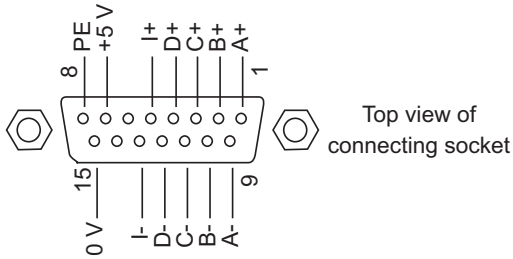


Fig. 7: Encoder / resolver interface connector

Resolver signal specifications:

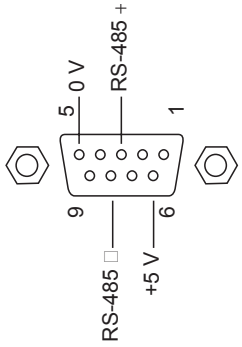
Excitation: 7V pk-pk sinewave, 11kHz

Sin/Cos: 5.6V pk-pk minimum
(0.8 transformation ratio)

Feedback requirements:

- Induction motors: A speed sensor is only necessary for applications that require extremely accurate speed control.
- Incremental encoders with analog (~1 Vss) or digital (TTL) signals, with lines/rev from 500 to 32,766 for analog or 131,064 for digital can be used. The supply voltage is + 5 V.
- The five input signals (Encoder tracks A to D and index pulse NP) are processed as differential signals. The internal termination resistance is 120 Ω.
- The signal level is 0.8 to 1.2 V_{SS} for analog signals and differential TTL levels for digital signals.
- The maximum encoder input frequency is 150 kHz per channel, e. g. an encoder with 2000 lines per revolution works correctly up to a speed of 4500 rpm. RPM x Enc lines per rev/60 = Hz.
- For induction motors only, the two encoder tracks A and B are evaluated by the speed measurement.
- For synchronous motors, the rotor position (pole position) must be determined when the mains power supply is switched on. A distinction must be made between TTL and sine-cosine encoders:
  - TTL encoder: When the power is switched on, the rotor position is determined by a special test motion. This can cause slight back and forth movement of the motor shaft.
    For this reason it is not possible to operate a brake that is applied when the power is being switched on. Alternatively, the pole position can be initiated on the first enable signal.
  - Sine-cosine encoder: The rotor position is determined via the additional commutation tracks C and D (one cycle per mechanical revolution). It is possible to use an applied brake.
- The speed measurement can be configured by parameters P70 to P71
- The housing is connected to PE.
- The recommendations of the encoder manufacturer relating to the shield connection have to be observed. Typically, the shield of the encoder cable has to be connected on the drive side as well as on the encoder side.

5.4 Serial RS-485 interface



Top view of connecting socket

Pin	Signal
1	
2	
3	Serial data RS-485 +
4	
5	Ground of supply voltage (0 V)
6	Supply voltage + 5 V, max. 50 mA
7	
8	Serial data RS-485 -
9	

Fig. 8: Serial interface connector

Notes:

- The connector housing is connected to the PE. The cable shield is to be connected here.
- A converter has to be used for the connection between the RS-232 interface of a PC and the RS-485 interface. A converter with built-in electrical isolation is strongly recommended. The Bayside converter which is part of the PC set includes this isolation (except for PE) and can be plugged directly in this connector.
- The function of the interface is described in chapter 15. The device can be controlled via this interface (automation mode) and parameters can be written or read.

5.5 DC supply input

The i-Drive may also be supplied with DC voltage. The DC voltage source has to be connected to the terminals +U and -U. The allowable range of the DC voltage is defined in the table in chapter 3.

Note: An external pre-charge circuit has to be used in conjunction with the DC supply. The pre-charge circuit must limit the inrush capacitor charging current to 8amps maximum.

5.6 Electromagnetic compatability (EMC) measures

Electrical drives generate high frequency radiation that can cause interference with other electronic devices. The measures taken against this radio frequency interference depend on the installation, the location of installation and the application. The EN 61800-3 standard specifies the minimum EMC requirements for electrical drives.

The motor power cable must be shielded. Furthermore, the installation guidelines listed below must be observed.

In order to comply with the EMC limit values, the following filters must be used:

Device	**Devices for the "first environment" (household - class B)**	**Devices for the "second environment" (industry - Class A)**
115 / 230V single phase	P/N 12602007	Integrated mains filter
208 / 230 / 400V three phase	P/N 12602009	P/N 12602008

Definitions (EN 61800-3):

First environment : Equipment connected without a transformer to a low voltage supply network which supplies households.

Second environment : Equipment without direct connection to households.

Unlimited access : A channel of distribution where EMC knowledge is not required of the user or the customer.

Restricted access : A channel of distribution where EMC knowledge is required of the user or the customer.

Single phase devices with 115 / 230 V mains power supply connection

Single phase i-Drive devices include an integrated mains filter class A. The device may be used according to the standard EN 61800-3 with restricted access in the second environment.

The single phase i-Drive devices with external mains filter class B comply with the limits defined in EN 61800-3, Table 6, Table 7. In this way the devices may be used with unlimited access in the industry or in a household (these limit values correspond to the limit value B, defined in EN 55011). The mains filter must be installed in the immediate vicinity of the device and the cable between the device and the mains input may not be lengthened.

Three-phase devices with 208 / 230 / 400 V mains connection

Three-phase i-Drive devices do not contain integrated filters and are therefore not certified for use in low voltage mains supply networks without an external mains filter. The device can cause high frequency interference. In order to comply with the EMC regulation EN 61800-3, a series connected mains filter class A must be used. In this way, the devices may be used in the industry.

In order to comply with the EMC regulation EN 61800-3 Table 6, Table 7, a series connected mains filter class B must be used. In this way the devices may be used with unlimited access in the industry or in a household (these limit values correspond to the limit value B, defined in EN 55011).

The mains filter must be installed in the immediate vicinity of the device, and the cable between the device and the mains input may not be lengthened.

The filters have been designed for mounting on the DIN rails and are 60*120*70 mm in size (W, H, D). Alternatively, like the i-Drive unit, they can be mounted without cooling unit by means of the two supplied mounting brackets and four screws (Distance of 55mm (width) and 136mm (height)) next to the i-Drive on a cooling surface.

Installation guidelines

- Both i-Drive and supplementary mains filter are to be installed at a low resistance point on the DIN-rails, such as the cooling surface. A good earth connection to the mains filter and i-Drive must be ensured.
- The connection between the mains filter and i-Drive is to be kept as short as possible. The 15 cm fixed cable from the mains filter to the i-Drive may not be extended.
- The motor potential earth (PE) should be connected directly to the i-Drive's output terminal. **The cable between i-Drive and motor must be shielded in order to retain compliance with the EMC limit values.**
- The motor cable is to be earthed over a wide area, with the i-Drive housing and motor housing (EMC metal screw fastenings).
- The distance from the shielding sheath to i-Drive converter connection terminals is to be kept as short as possible (not longer than 15cm). The sheath itself can be extended further to the terminals.
- The use of cable clamps guarantee a wide area of contact for the shielding. These are to be fastened to the metal earth plate.
- The control cables must also be shielded. The control cable sheaths are to be earthed on both sides over a wide area (metal clamps). To prevent inductive and capacitive coupling, the power cables are to be laid separately from the control cables (at least 30 cm).

Protective Earth Conductor (PE)

- The mains filters generate capacitively coupled discharge currents that are discharged through the PE connection. For a single phase 230V-device, 8 mA current can flow continuously. For a three-phase 400V-device, this value is 12 mA. During power-on, higher discharge currents may occur.
- Due to these high discharge currents (continuously more than 3.5 mA), a permanent/direct mains connection is required (Regulation EN 50178).
- For single phase devices only, fault current protection devices of the new construction may be used (Triggering for AC/DC fault construction type A).
- Three-phase fault current protection devices should not be used as the sole protection measure in conjunction with converters (EN 50178, VDE 0160).

Definitions (EN 61800-3-2/A14):

- Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase).
- Frequency converters and servo-amplifiers belong to class A.
- Bayside i-Drive devices belong to the group of restricted access. The devices fulfill the standard of EN 61000-3-2.

5.7 Regen resistor specifications

To prevent regenerative over-voltage in fast deceleration/ braking situations with high inertial loads, an external regen resistor can be used. This resistor has to be connected between terminals R1 and R2. The following resistance values are the minimum that may be used:

Device	Resistance	Maximum current	Continuous Power	Peak power
i-Drive BD_ 021, 022, 023	150 Ω	2.7 A	100W	1.0 kW
i-Drive BD_ 031, 032, 033	150 Ω	2.7 A	100W	1.0 kW
i-Drive BD_ 071, 072, 073	100 Ω	4.0 A	100W	1.6 kW
i-Drive BD_ 024	330 Ω	2.1 A		1.4 kW
i-Drive BD_ 044	220 Ω	3.2 A		2.2 kW
i-Drive BD_ 064	150 Ω	4.7 A		3.2 kW
i-Drive BD_ 084	100 Ω	7.0 A		4.9 kW

The regen resistors must be rated to at least 1000V AC and be suitable for the specified currents, continuous and peak powers. The generated heat due to the average power loss must be adequately dissipated. This can be ensured by mounting the resistor with a heat sink, or on a cooling surface.

The regen resistor can be protected against over-heating with a temperature-controlled switch. If the temperature of the regen resistor exceeds the maximum allowed temperature, the i-Drive should be switched off as follows:

- With a digital input that is programmed to the function “external error” or
- With the over-voltage error message E2, if the temperature controlled switch disconnects the resistor from the i-Drive.

Notes:
- Regen resistors can get very hot. A barrier should be used to protect personnel and equipment from inadverdant contact.
- If using Bayside resistors, consult with an application engineer regarding temperature rating for implementation with a temperature switch.
- The regen resistor must be connected to the i-Drive with a shielded cable.

6 Integrated operating panel

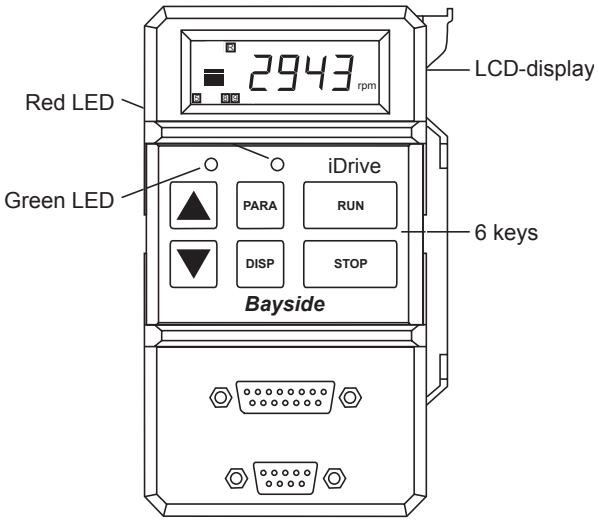


Fig. 9: Display and operating elements

i-Drive has two LED's for displaying the device status. An LCD display displays operating values and device parameters. The device can be operated and the parameters can be changed by means of the six keys.

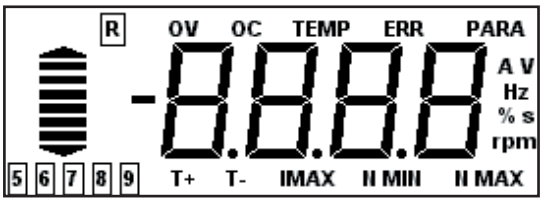
6.1 Display and operating elements

6.1.1 Light Emitting Diodes (LEDs)

Two LED's indicate the status of i-Drive:

red LED	green LED	Status
On	Flashing	Not enabled, RUN must be pressed.
Off	Flashing	Not enabled, enable signals inactive.
Off	On	Enabled, motor turns.
Flashing	Off	Error.
Rapid flashing	Off	Under-voltage, device is off.
On	On	STOP was pressed, motor decelerates according to the deceleration ramp.

6.1.2 LCD display



The LCD display contains a 4-digit display as well as symbols indicating the status of the device:

Symbol	Function
5..9	Terminal L5..9 is active (Voltage > 10 V)
R	Relay is closed
Bar graph	Load status of the device in steps of 20 %
OV	Over-voltage
OC	Over-current
TEMP	Over-temperature
ERR	Error
PARA	Parameter is being changed
T↗	Parameter P1 (Ramp-up time)
T↘	Parameter P2 (Ramp-down time)
I MAX	Parameter P3 (Maximum torque producing current)
N MIN	Parameter P4 (Minimum speed)
N MAX	Parameter P5 (Maximum speed)
A, V, Hz, %, s, rpm	Symbols for the unit of displayed values

6.1.3 Keys

The six keys have the following functions:

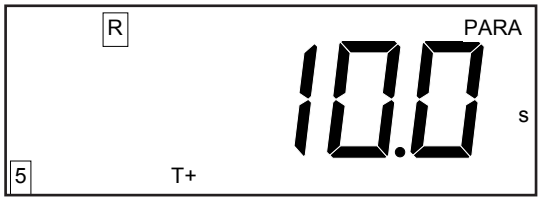
Key	Status	Function
RUN		Enable
	Motor potentiometer	Change direction of rotation (long key press)
STOP		Disable
	ERR	Quit error
PARA		First parameter
	PARA	Next parameter (repeat function)
DISP		Changes displayed operating value
		Change to speed display (long key press)
	PARA	Previous parameter (short key press)
	PARA	Go back to operating display (long key press)
UP	Motor potentiometer	Increase speed/position (repeat function)
	PARA	Increase parameter value (repeat function)
DOWN	Motor potentiometer	Decrease speed/position (repeat function)
	PARA	Reduce parameter value (repeat function)

6.2 Key functions

6.2.1 Changing the device parameters

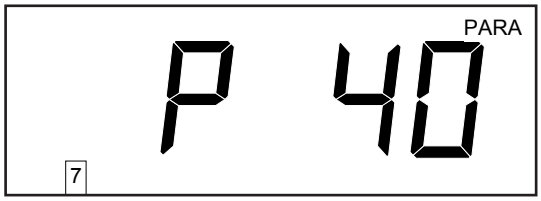
The device functions may be selected by changing the parameters (P0 - P797, not all numbers are used). After pressing PARA for the first time, the first parameter is displayed. The symbol PARA is displayed. The first parameter is the speed reference value for the motor potentiometer function. This value can be changed with the UP and DOWN keys.

By pressing PARA further, the other parameters are selected one by one. The next five parameters (T↗, T↘, I MAX, N MIN and N MAX) are identified by symbols at the bottom of the LCD display.



These parameters can be changed directly. The UP button increases the value and the DOWN button decreases the value. The values are accepted by the device and permanently stored in non-volatile memory (EEPROM).

After the parameter N MAX, the other parameters are presented on the 7-segment-display via their parameter number (e.g. P40).



The value of the parameter, whose parameter number or string is displayed, may be displayed by briefly pressing the UP or DOWN button.

Afterwards, the value can be increased or decreased with the UP or DOWN key. The values are immediately accepted by the device. Some parameters cannot be changed during operation. In this case the ERR symbol appears when trying to change them. To change these values, the inverter must be disabled (e.g. by pressing STOP). Also the values cannot be changed during an under-voltage situation (e.g. at power down). Again the ERR symbol appears when trying to change the value.

The PARA key or a short press on the DISP key switches back to the parameter number display. The next parameter is selected by pressing the PARA key or the previous parameter by briefly pressing the DISP key, if a parameter symbol or the parameter number is displayed.

A longer DISP key press switches back to the operating display. The parameter display is exited.

To scroll faster, the PARA button and UP key has to be pressed at the same time.

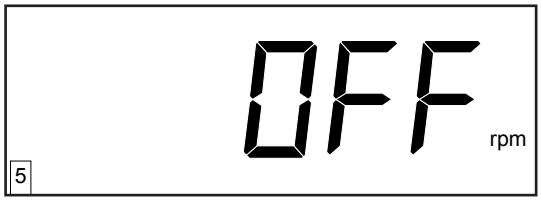
!	**Reset to Factory Defaults** If the PARA key is pressed while the device is being switched on, the parameters are set to their default values. The display will show “Para”. **All previous settings are then permanently erased.**

6.2.2 Releasing with RUN and STOP

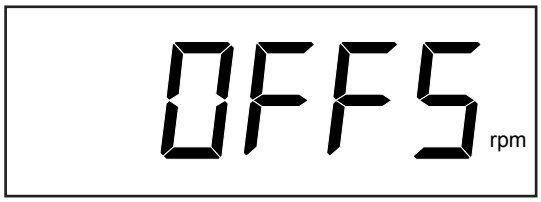
The device is enabled or disabled using the RUN and STOP keys. The red LED displays whether the device has been enabled with these keys (red LED on = STOP pressed, red LED off = RUN pressed). If the other enable signals have been set, the motor will start running after RUN is pressed.

6.2.3 Display device status

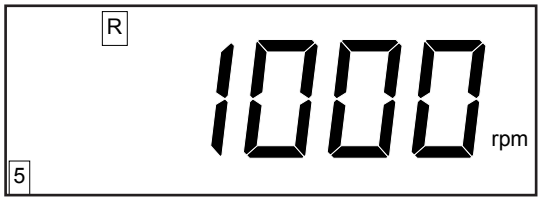
If the device has not been enabled, the word OFF appears on the display



If the device is enabled directly after power-on (P24 = 1) or the RUN key has been pressed, and the other conditions for enabling are not valid, the display will show OFFn. The number n signals which condition is not true.



After enabling, an operating value is displayed.



The value being displayed is changed by pressing the DISP button. The following values can be selected.

P20	Displayed value	Unit	Accuracy
0	Speed	rpm	see text
1	Motor frequency	Hz	± 0,1 Hz
2	Motor current	A	± 10 %
3	Motor voltage	V	± 5%
4	Device loading	%	± 20 %
5	Device power module temperature	TEMP	± 5 °C
6	DC bus voltage	V	± 5%
7	Position control	see text	see text

Parameter P20 determines which value is displayed directly after power on and the actually displayed value too.

The displayed speed value depends on the mode of control:

- Using V/f-control (P23 = 0), the output value of the ramp (stator speed) is displayed. The actual speed of the motor may be different from this value due to the load.
- Using the vector control without an encoder feedback (P23 = 1 or 3) the speed calculated by the motor model is displayed. The accuracy of this value depends on the actual and estimated motor parameters,
- Using the vector control with an encoder feedback (P23 = 2 or 4) the speed measured by the encoder is displayed. This value is filtered. To get the instantaneous encoder value, use P29 (current encoder speed).

A positive value of the speed or motor frequency corresponds to the motor rotating in right/cw direction (phase sequence U-V-W), a negative value to the left/ccw direction respectively.

If vector control is used (P232 = 1 to 4), the motor load is calculated by the ratio of the actual torque producing current to the nominal torque producing current. This corresponds to the actual torque related to the nominal torque of the motor. The bar graph displays this value in steps of 20%.

Using V/f control (P23 = 0), the load displays the output current in relation to the nominal current. Again the bar graph displays this value in steps of 20%. Note when using vector control, the load value will be 0% with an unloaded motor. However, using V/f control, this value will correspond to the ratio of the no-load current to the nominal current. This ratio depends on the type and size of the motor.

The device temperature is measured on the rear of the unit directly in the power module. At a temperature of 70°C, an overtemperature warning is issued, at 80°C, an overtemperature switch-off occurs.

The DC bus voltage is calculated from the connected mains voltage multiplied by √2 minus the voltage drop via precharge switching and bridge rectifiers.

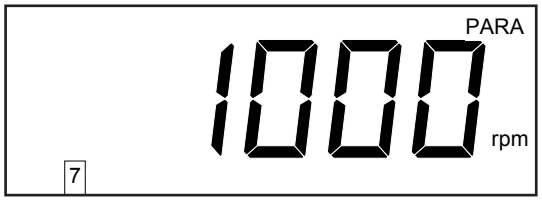
The position is displayed without a unit, as in accordance with Parameter 600 different units, including user-defined units (such as mm, cm or gear transmissions) can be used.

The precision depends on the number of lines of the encoder as well as on the selected resolution.

The actually selected and displayed value can also be displayed by parameter P246. This is especially useful for reading it via the serial interface.

6.2.4 Changing the speed and direction

The speed of the motor can be modified using the UP and DOWN keys, if the motor potentiometer function is programmed (P22 = 0). After the UP or DOWN button is pressed for the first time, the current set-point value (e.g. 1000 rpm) is displayed together with the symbol PARA.

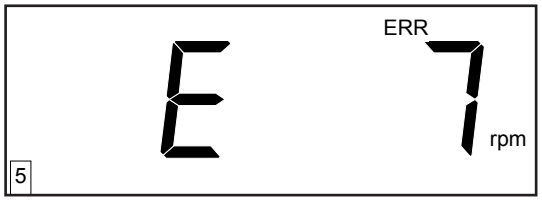


By pressing the UP button further, the value is increased, and with DOWN, it is decreased. If the UP or DOWN button is not pressed for more than 1 second, the actual operating value appears on the display.

The direction of rotation is changed by pressing RUN for more than 1 second.

At negative speed values (motor rotating in left/ccw direction) the DOWN key will decrease the value resulting in the motor accelerating. Using the UP key will increase the set-point value and decelerate the motor speed.

6.2.5 Acknowledging errors



If an error arises, which has led to device switch-off, the symbol ERR appears on the display together with the error number, and in some cases an additional error symbol. The error can be reset by pressing the STOP button if the cause of the error has been eliminated. To restart the drive, the RUN key has to be pressed.

The error messages are described later in this manual. An error condition can also be reset (cause of error eliminated) as follows:

- External digital input signal
- RS-485 interface if remoted mode active.

7 Programming the i-Drive

Note: Certain parameters are marked to indicate they are typically used for induction motor applications only (IM only).

7.1 Description of parameters

The parameters P0 to P7 are displayed with symbols in the LCD display (without parameter numbers).

7.1.1 Speed or position set point in motor potentiometer (keypad) mode, P0

This parameter displays the set value set by means of the UP/DOWN keys. For this value to be valid, P22 must be = 0 (motor potentiometer). Whether speed or position is to be displayed is determined by using P23 (drive control).

7.1.2 Speed ramp times, P1 and P2

7.1.2.1 Linear ramps

If the input value for the speed changes, the drive ramps up or down to the required level. The ramp-up characteristic may be adjusted using parameters T↗ (P1) and speed P6. The ramp-down characteristics may be adjusted using the parameters T↘ (P2) and speed P7. A time value of 0.00 s means that the input value is given to the control directly with no time delay (no ramping).

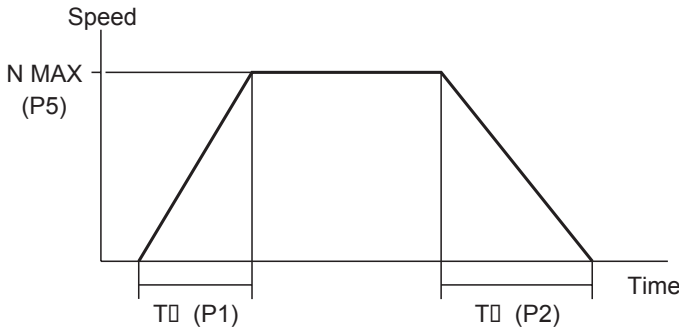


Fig. 10: Ramp-up and ramp-down characteristic

The ramp parameters also determine the rate for changing the motor speed, if the functions “Increase Speed” (P40-44 = 6) or “Decrease Speed” (P40-44 = 7) are programmed and active for the digital inputs. To be able to change the speed smoothly, the ramps should be set to a value of at least 5 s if these functions are used.

7.1.2.2 S-shaped speed ramp, P90

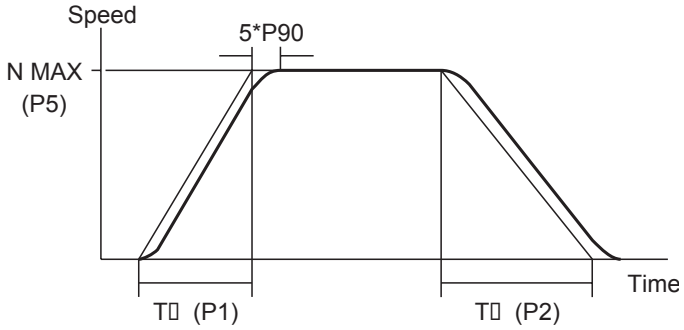


Fig. 11: S-shaped ramp

An S-shaped speed ramp can be formed by means of parameter P90. This enables a smooth transition at the acceleration and deceleration points and eliminates jerking. The time to reach the final speed from the top of the linear part of the ramp is about 5 times the parameter P90. A value of 0 s for P90 means that there is no S-shaped characteristic and the ramp is linear right up to the final speed.

7.1.3 I MAX, maximum torque generating current, P3

The maximum torque generating current is set via the parameter I MAX (P3). 100% corresponds to the nominal torque generating current. For a constant motor flux, the maximum torque can be varied by changing I MAX (P3). A reduction to lower values can be useful for the commissioning process (reduction of the maximum drive torque). An increase leads to a higher acceleration with a motor current greater than the nominal motor current. In this case, the integrated motor protection function must be initiated in order to prevent over-heating of the motor. The value of I MAX is limited such that the resulting total current of the motor does not exceed the maximum peak current of the device.

7.1.4 Minimum and maximum speed, P4 and P5

The speed set-point value is limited to the range specified by the parameters NMIN (P4) and NMAX (P5). These two parameters are also setting the limits for increasing and decreasing the motor speed by digital inputs set to the functions “Increase Speed” (P40-44 = 6) or “Decrease Speed” (P40-44 = 7 or 16).

The parameter N MIN (P4) cannot get higher than the value of N MAX (P5). N MIN typically zero for servo applications.

If the drive is disabled because the set-point value is less than the minimum speed, then the disable message “OF14” will appear.

Warning: If high value for P7 and short ramp-down time T↘ (P2) are programmed, the error OV (over-voltage) may occur during braking, if there is no braking resistor connected; or the capacity of the braking resistor is exceeded..

7.1.5 Speed of ramps, P6 and P7

The ramp-up characteristic may be adjusted using parameters T↗ (P1) and speed P6. The ramp-down characteristics may be adjusted using the parameters T↘ (P2) and speed P7.

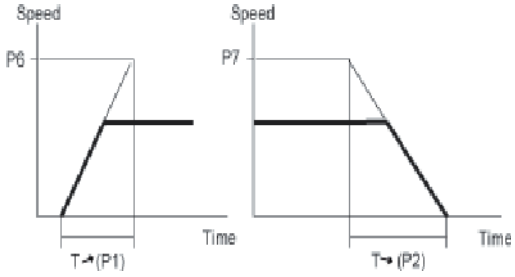


Fig. 12: Ramp-up and ramp-down characteristic

7.1.6 Overspeed error protection, P8

With this parameter a speed threshhold can be defined. When the actual speed exceeds this threshhold, error E20 will occur and PWM switching will be stopped (motor will coast).

7.1.7 Password, P10 and P11

For protection against unauthorized altering of the parameters and usage, a password can be defined via P10 and P11.

In P10 the value is preset as a password. Any combination of digits (-9999 to +9999) can be selected. The password becomes active as soon as P11 is changed from 0 to 1 or 2.

To regain access to the parameters and the control panel, the correct password must be entered again in P10. As a result the password level in P11 automatically changes to 0.

Attention:
If you enter the password incorrectly, you can try again. If you have forgotten the correct password, i-Drive can only be reset to the factory setting by a RESET. As a result all previous settings are lost. Before using the RESET you should print out the parameters using win+i-Drive.

P11 determines the password level.

P11	Function
0	No password.
1	Start and Stop keys as well as the keys on the control panel can be used, i.e. motor potentiometer mode for speed, torque or position control is possible. Parameters cannot be altered.
2	The control panel is disabled. Only password entry is possible.

7.1.8 Selecting the display value, P20

P20 is used to select the display value which appears on the display once the power supply is switched on. For functions 1 to 6 the unit is displayed as a symbol. Function 7 (Position) depends on P600.

P20	Function
0	Speed in rpm.
1	Frequency in Hz.
2	Motor current in A.
3	Voltage, output voltage in V.
4	Load, motor current in % of nominal current.
5	Temperature in °C, measured on the power module cooling surface.
6	DC voltage, DC bus voltage in Vdc.
7	Position in the unit selected via P600.

7.1.9 Input value, P22

You can set the input for the drive‘s set-point value via Parameter P22:

P22	Function
0	Motor potentiometer function, speed or position set-point value via the UP and DOWN keys. Speed set-point or by the input functions “Increase speed“ and “Decrease speed”.
1	Analog input.
2	Fixed value via digital inputs (analog input may be added).
3	Automation mode, set-point value via serial interface.

Power reset: When this parameter is changed, the power supply for the drive has to be shut down for minimum 20 seconds before switching back on.

The set-point value can also be changed by a digital input that is programmed to perform the “Remote mode” function (P40-44 = 14).

Terminal remote mode (P40 - 44 = 14)	Set-point value
off	programmed by P22
on	remote mode, set-point via serial interface

The actual input value can be displayed by parameter P28.

7.1.10 Motor potentiometer function via keys or input terminals

If the motor potentiometer function is selected (P22 = 0), the speed or position set-point value can be changed by means of the UP and DOWN keys. After pressing UP or DOWN for the first time, the set-point value is displayed along with the symbol “PARA”. This set-point value is then increased by pressing the UP key and decreased by pressing the DOWN key. If UP or DOWN is not pressed for a period of 1 s, you are switched back to the operating display.

Pressing RUN for more than 1 s causes the direction of rotation to change. The sign of the reference speed will be inverted.

If the “speed” is to be changed by means of the digital terminals (e.g. by means of push buttons), one input has to be assigned to the function “Increase speed” (P40 - P44 = 6) and a second one to the function “Decrease speed” (P40 - P44 = 7). The speed increases to the maximum speed (N MAX, P5) according to the configured ramp-up characteristic, as long as the terminal with the function “Increase speed” is active. If the terminal with the function “Decrease speed” is active, the speed is reduced according to the configured ramp-down characteristic to the minimum speed (N MIN, P4). If several inputs are programmed to these functions, they will work like a parallel connection.

The last value for the set-point is stored after switching off. This will be the initial value used on the next power-up and enable!

7.2 Drive Control, P23

For induction motor control, the i-Drive uses a vector control model to ensure rapid and robust control of the motor. This can be used either with or without a measurement of the actual speed by a feedback device. Furthermore, either the speed of the motor or its maximum torque can be controlled. The motor can also be operated with open loop V/f-control. These different operating modes can be selected by parameter P23:

P23	Function
0	V/f control
1	Speed vector control without feedback device
2	Speed vector control with feedback device
3	Torque vector control without feedback device
4	Torque vector control with feedback device
5	Position control with feedback device

Power reset: When this parameter is changed, the power supply for the drive has to be shut down for minimum 20 seconds before switching back on

* If a synchronous brushless commutated motor is used, only the modes 2, 4 and 5 (vector control with feedback) can be selected.

Note: For synchronous commutated motors, the vector control model reduces to the traditional closed loop control model i.e flux/magnetizing vector and slip set to zero.

7.2.1 V/f Control (IM only)

The V/f controller is activated by setting Parameter P23 to 0. This mode of operation is used when first commissioning the drive, for parallel switched motors and for traditional open loop control.

With the V/f controller, the motor voltage is determined depending on the frequency according to a V/f characteristic curve.

7.2.2 Vector control basic theory (IM only)

Vector control directly controls the motor current. The motor current is considered as a vector that consists of two perpendicular components (refer to vector diagram):

- Current I_{SD} generates the motor magnetization (flux)
- Current I_{SQ} directly generates the motor torque (armature current).

The total motor current is calculated from these two components as follows.

$$I_{motor}^2 = I_{SD}^2 + I_{SQ}^2$$

The torque of the motor is proportional to the product of the magnetizing and armature currents. There is an analogy between an AC motor and a DC motor. ISD corresponds to the field current of an DC motor and ISQ corresponds to the armature current.

While the field current has a long time constant and is therefore not suited to rapid response control, the armature current can be changed to directly correspond with the drive torque requirement.

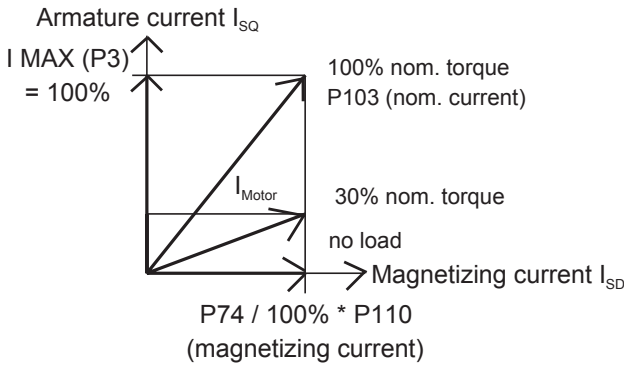


Fig. 13: Magnetizing and armature current of the motor

For vector control in an induction motor, the magnetizing current is held constant, so that the motor always works with the same flux. This value corresponds to the nominal magnetization (no-load current) of the motor (P110), which is self-determined as long as the parameter P74 is set to 100% (see below). The armature current is dependent on the motor load. Vector control guarantees fast and immediate access to the motor torque and thus a highly dynamic and robust control of the motor. If the speed of the asynchronous motor exceeds the nominal speed, the drive is no longer able to generate the voltage necessary to keep the flux constant. In this case, the flux is reduced such that the drive output voltage does not exceed the maximum output voltage (corresponding to the mains input voltage). This is known as the Field Weakening Range. The maximum motor torque is also reduced in this case.

For vector control of synchronous motors, the ISD is set to 0, as the flux is generated by permanent magnets. The armature current corresponds to the required load torque of the motor. Field weakening mode is not possible with synchronous motors.

Vector control can be influenced by the following parameters:

Parameter	Function
I MAX (P3)	Maximum armature current (torque producing current)
P74	Maximum magnetization (flux)

The maximum torque generating current is set via the parameter I MAX (P3). 100% corresponds to the nominal torque generating current. For a constant motor magnetization, the maximum torque can be varied by changing I MAX (P3). A reduction to lower values can be useful for the commissioning process (reduction of the maximum motor torque). An increase leads to a higher acceleration with a motor current greater than the nominal motor current. In this case, the integrated motor protection function must be initiated in order to prevent over-heating of the motor. The value of I MAX is limited such that the resulting total current of the motor does not exceed the maximum peak current of the device.

Example (IM only):
A motor of 1.5 kW has a nominal current of 3.4 A for a nominal voltage of 400 V. The no-load current ISD (nominal magnetization current) is 1.4 A. The motor is controlled by an i-Drive BDS 064 device (peak motor current 8.4 A).

The nominal armature current ISQ is 3.1 A. The maximum allowable armature current ISQ is 8.3 A. Thus I MAX (P3) can be increased to 267%. In this case the motor is controlled with a maximum current that corresponds to 2.5 times the nominal current. The motor protection function ensures that the motor does not overheat. Instead the drive switches off when this current flows for too long.

The maximum magnetization of the motor is set via P74. This value is percentage based, relative to the nominal magnetization current of the motor (P110). A reduction can be useful to reduce the current consumption of the motor when high demands on the motor dynamics and the maximum torque are not required, e.g. pumps, fans.

7.2.2.1 Speed vector control without feedback (IM only)

Speed vector control without feedback is selected if parameter P23 is set to 1. The vector control without feedback can only be used for an asynchronous motor (P105 = 0).

If vector control is set without a speed sensor, the speed, torque and flux are all calculated from the values of voltage and current at the motor's terminals and a motor model. These quantities are then adjusted to the set-point value, set by of the drive control. For the motor model, it is important that the motor parameters have been set up correctly.

The accuracy of the motor model and the motor parameters determine the accuracy of the speed control. A well adjusted system can achieve an accuracy significantly better than 5% of the nominal speed. If this level of accuracy is insufficient for the application, then a feedback sensor must be used.

7.2.2.2 Speed vector control with feedback (IM only)

The accuracy of vector controlled speed can be improved by using an encoder, see P70. The number of increments of the encoder is set with parameter P70 and the type of signals with parameter P71.

Vector control with feedback is used when parameter P23 is set to 2. To test whether the feedback works properly, V/f-control can be used and the measured speed can then be displayed by means of parameter P29. This is especially useful for checking the direction of rotation.

7.2.2.3 Torque vector control without feedback (IM only)

The torque control without speed sensor is selected by setting parameter P23 to 3. The vector control without feedback can only be used for an asynchronous motor (P105 = 0).

Using torque control, the motor tries to reach a maximum speed. The armature current and thus the torque of the motor is limited to the value that is set up by the set-point value. If the load torque even at maximum speed is less than the torque set-point value, the motor will rotate at this speed.

The set-point value of the torque control can be determined by the analog input (P22 = 1) or by the serial interface in remote mode (P22 = 3). The torque set-point cannot be input by the motor potentiometer function or the digital inputs.The direction of rotation of the torque control corresponds to the one of the speed control.

7.2.2.4 Torque vector control with encoder (IM only)

If parameter P23 is set to 4, the torque control with feedback is used. The function of this mode corresponds to the torque control without feedback with the only difference that the speed is measured by the feedback device.

7.2.2.5 Speed with torque control selected (overspeed protection)

If torque control mode is selected (P23=3, 4), then the torque reference value comes from the analog input or from the serial link. The speed of the motor depends on the load.

Additionally, the speed control loop is active, which prevents the motor from running to high speed in case of low loads. The amount of the reference value for this maximum speed is either the parameter NMAX or a calculated speed if at least one digital input is set to function 17. In this case the maximum speed is calculated in the same manner like the fixed speed function. That speed values (P45..P49) are added which belonging digital input with function 17 (P40..P44) is active.

7.2.2.6 Positioning by encoder

If Parameter P23 is set to 5, position control is carried out. A feedback device is required.

7.3 Enable after power on/error reset mode, P24

Parameter P24 is used to determine whether the drive should be enabled directly after power on or not. Additionally, the behaviour after an error may be selected.

P24	Function	Function in case of an error
0	Drive is switched off. (STOP)	Drive stays switched off.
1	Drive is switched on. (RUN)	Drive is switched off. Error state may be acknowledged by: • digital input (function 11) • serial link (control word) • power off and on.
2	Drive is switched on. (RUN)	Power-automatic reset mode. Drive is switched off. The errors under-voltage (OFF1) and over-voltage will be quitted automatically, if the reason of the error no longer exists. The drive starts again.Other error messages have to be acknowledged.
3	Drive is switched on. (RUN)	Full automatic reset mode. Drive is switched off. The errors under-voltage (OFF1), over-voltage, E1-E3, E5-E9 and E12,E14 will be acknowledged automatically, if the reason of the error no longer exists. Other error messages have to be acknowledged.

When P24 is set 1 to 3, the drive will start the motor directly after power on, when enable is switched on.

7.4 PWM switching frequency, P25

The drive's switching frequency can be changed by means of parameter P25.

P25	**Switching frequency**
0	8 kHz
1	16 kHz (not for i-Drive BDS 064 and 084)

A switching frequency of 8 kHz lies in a region which is audible to the human ear, resulting in more motor noise. On the other hand, the drives's losses are lower with a switching frequency of 8 kHz than they are with 16 kHz. Current ripple is reduced with higher PWM frequency.

7.5 Current position, P27

The current position can be displayed using Parameter P27 (in OFF state also).

7.6 Current set value display, P28

The current set value can be displayed using Parameter P28.

7.7 Current encoder speed display, P29

The current encoder speed can be displayed using Parameter P29. This can also be used to check the rotation direction of the motor.

7.8 Analog input value, P30 to P38

7.8.1 Speed set-point value, P30, P31

The analog input determines the speed set-point if the control mode is set to V/f-control (P23 = 0) or to speed vector control (P23 = 1 or 2). The parameters P30 and P31 determine the speed value which corresponds to the lowest and highest analog input values:

Parameter	Function
P30	Speed at 0 V/0 mA/4 mA
P31	Speed at 10 V/20 mA

The value of P30 can be larger than that of P31. In this case the speed reduces with increasing input value.

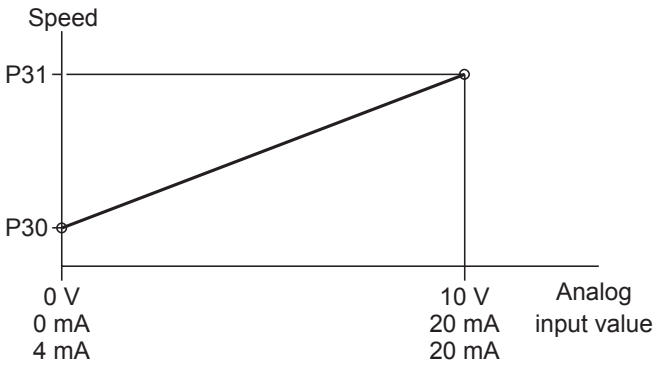


Fig. 14: Analog input for speed control

P30 must be set to 0 rpm, for a voltage range of ± 10 V (P32 = 2).

When P24 is set 1 to 3, the drive will run the motor with speed that is selected in P31

7.8.2 Analog input value, P32

To specify the speed value via the analog input, the parameter P22 is set to 1. The voltage and current ranges for the analog values are programmed via parameter P32.

P32	Voltage input	Current input (with external shunt resistor of 500 Ω)
0	0..10 V	0..20 mA
1	2..10 V	4..20 mA
2	± 10 V	

The programming of the analog input is different for speed and torque control.

7.8.3 Addition of analog input, P33

Parameter P33 determines whether the reference speed which is specified by the analog input value should be added to the fixed speed which have been specified by the digital inputs in this operating mode:

P33	Function
0	Do not add speed from analog input
1	Add speed from analog input

7.8.4 Torque set-point value, P34, P35

The analog input determines the torque set-point value if the control mode is set to torque vector control (P23 = 3 or 4). The parameters P34 and P35 determine the torque value which corresponds to the lowest and highest analog input values:

Parameter	Function
P34	Torque at 0 V/0 mA/4 mA
P35	Torque at 10 V/20 mA

Both parameters are measured in %. 100% corresponds to the nominal torque of the motor. The value of P34 can be larger than that of P35. In this case the torque will be reduces with increasing input value.

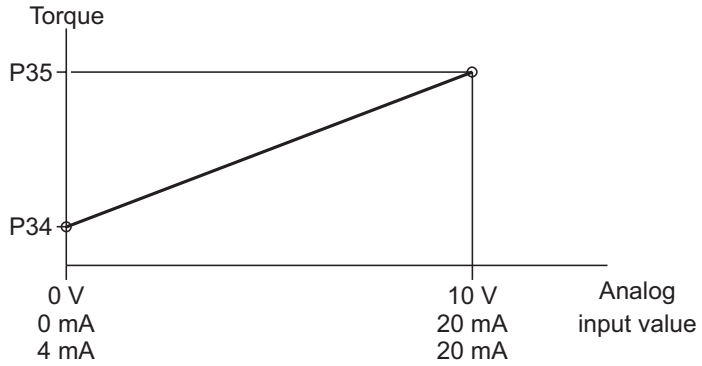


Fig. 15: Analog input for torque control

P34 has to be set to 0 % for a voltage range of ± 10 V (P32 = 2).

7.8.5 Filtering of the analog input value, P36

The damping of the analog input signal can be changed by setting parameter P36. The filtering time constant can be changed within the range 0.000 to 0.500 s. The higher the time constant, the more stable the input value will be even with heavily disturbed signals. However, the dynamics of the input signal will decrease with a delayed reaction of the drive. This can cause a problem if short ramp-up and ramp-down times are programmed.

7.8.6 Analog position set value, P37, P38

The analog input specifies a position set value if the mode of the controller P23 is set at the value 5.

Parameter	Function
P37	Position at 0 V/0 mA/4 mA
P38	Position at 10 V/20 mA

The maximum settable value for P38 is dependent on the encoder lines and the unit selected in P600.

The position set values are entered in the unit selected in P600 (e.g. increments, angle degree, revolutions etc.).

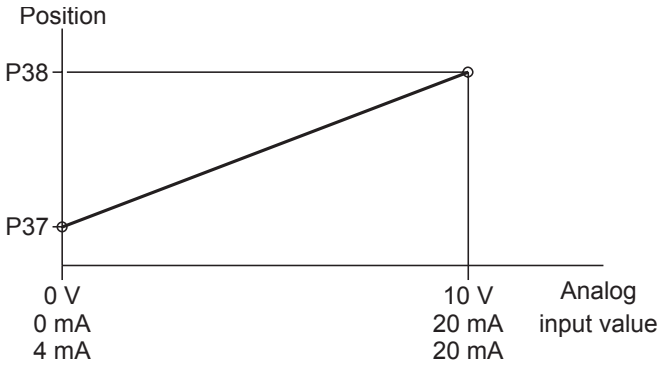


Fig. 16: Analog input value for positioning

7.9 Programming the digital inputs, P39 - P54

Many functions can be controlled via the digital inputs L5 - L9. Each of these five inputs has one parameter that controls its function (P40-44) and a second parameter which sets up a fixed speed for this input.

In addition, fixed speed and torque set values can be allocated to the inputs.

Input	Parameter function	Parameter for fixed speed	Parameter for fixed torque
L5	P40	P45	P50
L6	P41	P46	P51
L7	P42	P47	P52
L8	P43	P48	P53
L9	P44	P49	P54

7.9.1 Inversion mask, P39

P39	Function
0	no input inverted
1	dig. input L5 inverted
2	dig. input L6 inverted
3	dig. input L5 + L6 inverted
4	dig. input L7 inverted
5	dig. input L5 + L7 inverted
6	dig. input L6 + L7inverted
7	dig. input L5, L6 + L7 inverted
8	dig. input L8 inverted
9	dig. input L5 + L8 inverted
10	dig. input L6 + L8 inverted
11	dig. input L5, L6 + L8 inverted
12	dig. input L7 + L8 inverted
13	dig. input L5, L7 + L8 inverted
14	dig. input L5, L7 + L8 inverted
15	dig. input L5, L6, L7 + L8 inverted

P39	Function
16	dig. input L9 inverted
17	dig. input L5 + L9 inverted
18	dig. input L6 + L9 inverted
19	dig. input L5, L6 + L9 inverted
20	dig. input L7 + L9 inverted
21	dig. input L5, L7 + L9 inverted
22	dig. input L6, L7 + L9 inverted
23	dig. input L5, L6, L7 + L9 inverted
24	dig. input L8 + L9 inverted
25	dig. input L5, L8 + L9 inverted
26	dig. input L6, L8 + L9 inverted
27	dig. input L5, L6, L8 + L9 inverted
28	dig. input L7, L8 + L9 inverted
29	dig. input L5, L7, L8 + L9 inverted
30	dig. input L6, L7, L8 + L9 inverted
31	all digital inputs inverted

Power reset: When any of these parameters are changed, the power supply for the drive has to be shut down for a minimum of 20 seconds before switching back on.

7.9.2 Digital input assignments, P40 - P44

The function of these terminals is defined by the parameters P40 (for L5) to P44 (for L9). Each of these five inputs can be used for the following tasks. **X = applicable**.

P40 - P44	Function	Active logic state	Function available for input value P22=			
			0	1	2	3
0	No function					
1	Enable	1	X	X	X	X
2	Change direction	1	X	X	X	
3	Enable right/CW	1	X	X	X	
4	Enable left/CCW	1	X	X	X	
5	Fixed speed	1			X	
6	Increase speed until upper speed limit N MAX (P5)	1	X			
7	Decrease speed until lower speed limit N MIN (P4)	1	X			
8	Jogging	1	X	X	X	X
9	DC braking (Induction motorl only)	1	X	X	X	X
10	External error	0	X	X	X	X
11	Reset error(momentary)	0→1	X	X	X	
12	OFF2 (pulse lock)	0	X	X	X	X
13	OFF3 (quick stop)	0	X	X	X	X
14	Remote mode	1	X	X	X	
15	Stop (0 rpm) - not for position mode	0	X	X	X	X
16	Decrease speed (inverted)	0	X			
17	Speed limit for torque control	1		X		X
18	Homing switch	1				
19	Negative limit switch	1				
20	Positive limit switch	1				
21	Starting signal for homing	0→1	X	X	X	
22	Fixed positioning	1			X	
23	Start sequential positioning (maintained)	1			X	
24	Start of sequence and next switch (momentary)	0→1			X	
25	Next switch (momentary)	0→1			X	
26	Fixed torque	1			X	
27	Go to BCD coded position (momentary)	0→1			X	
28	BCD coded input for fixed absolute positioning	1			X	
29	Pole finding while setting this input	1			X	

Power reset: When any of these parameters are changed, the power supply for the drive has to be shut down for a minimum of 20 seconds before switching back on.

Attention: The drive is switched on immediately when the function Jogging is selected, the corresponding digital input is active and RUN is pressed.

7.9.2.1 Enable (release drive for operation), P24, P40 - P44

The drive is enabled when the following conditions are true:

- The RUN button has been pressed or parameter P24 was set to 1 during power-on.
- All digital inputs which are used for the enable function (P40-44 = 1) have to be active.
- All inputs which have the function “Enable right/CW“ (P40-44 = 3) or all which have the function “Enable left/CCW“ (P40-44 = 4) must be active.
- The drive must not be disabled for turning on.
- There is no active error.
- The mains voltage must be higher than the under-voltage warning limit (red LED must not be flashing rapidly).

At least one digital input could be programmed with an enabling function (P40-44 = 1, 3 or 4). Several inputs may be programmed with the same enabling function. In this case all inputs which have been programmed with the same enabling function are logically linked with one another internally with a logical AND function, so that all of them must be active for enabling.

As long as the drive is not enabled, the LCD display will show “OFFn”. The digit n signals the reason the drive is still locked. The different messages are for the following reasons:

Display	Function
OFF	The RUN button was not pressed.
OFF1	Undervoltage.
OFF2	OFF2 function (pulse lock) active.
OFF3	OFF3 function (quick stop) active.
OFF4	The drive is not ready for turn on. This state is active after a OFF2 or OFF3 command, after under-voltage, after an error or if it is changed between remote and local mode during motor operation. This state is left by disabling an enable signal or in the automation mode only via the serial link.
OFF5-9	The digital input L5-9, which is programmed to an enable function, is not active.
OF10	OFF state. Pole angle finding waiting for start command.
OF11	Operation via serial interface: the enable bits (bit 0-3 of the control word) are not set.
OF12	Both “Enable right/CW“ and “Enable left/CCW“ are not active (if digital inputs are set to these functions, P40-43 = 3 or 4), or operation via serial interface: no direction bit is set (bit 11 or 12 of the control word).
OF13	At operation via serial interface: both direction bits (bit 11 and 12 of the control word) are set.
OF14	The speed set-point value is lower than the minimum speed N MIN (P4).

If more than one condition is not true, the one with the smallest number is displayed first. Once this condition has become true, the display changes to the enable condition with the next number.

7.9.2.2 Direction of rotation, P40 - P44

The direction of rotation can be reversed via the digital terminals. Parameter P40 (for L5) to P44 (for L9) are the parameters used for this purpose. If the corresponding terminal goes active, the direction of rotation is reversed.

Digital input with function “Direction“ (P40 - 44 = 2)	Direction for positive set-point value	Direction for negative set-point value
off	right/CW	left/CCW
on	left/CCW	right/CW

A negative set-point value can be set as follows:

- For the motor potentiometer function a negative value is set by the keyboard (e. g. pressing RUN changes the sign of the reference speed)
- The analog input value has a voltage range of ±10 V and the input voltage is negative.
- A fixed set-point value is negative.

If more than one terminal possesses a “rotational direction“ function, the direction of rotation is changed as soon as one of the terminals is active (parallel connection). If a further terminal with this function is activated, the direction of rotation does not change again.

Enabling the drive and setting the direction can be combined by means of the digital input terminals. For this, the function of the terminals can be programmed via parameter P40 (for L5) to P44 (for L9) to “Enable right/CW“ and “Enable left/CCW“.

Enable right/CW terminal (P40 - 44 = 3)	Enable left/CCW terminal (P40 - 44 = 4)	Enable	Direction for positive set-point value	Direction for negative set-point value
off	off	off		
on	off	on	right/CW	0 rpm
off	on	on	0 rpm	left/CCW
on	on	on	right/CW	left/CCW

The enable message OF12 is displayed, if both functions “Enable right/CW“ and “Enable left/CCW“ are not active.

7.9.2.3 Speed jog mode, P40 - P44

To set up the drive, it is possible to allow the drive to run at a programmed speed without enabling (jogging mode). This jogging function is initiated by the digital input terminals whose program parameters P40 (for L5) to P44 (for L9) are set to the value 8 (for jogging mode). The jogging mode is only active as long as the drive is not enabled. However, RUN has to be pressed first.

The speed with which the motor then rotates is determined by the parameters for fixed speeds for terminals P45 (for L5) to P49 (for L9). A positive value corresponds to rotate right/CW and a negative value to rotate left/CCW.

If several inputs with the function “Jog” are active, then the input with the highest number has priority.

Example:

P42 = 8, P47 = -200 rpm: Terminal L7 has the function “Jog left/CCW“ at 200 rpm
P43 = 8, P48 = 200 rpm: Terminal L8 has the function “Jog right/CW” at 200 rpm

L7	L8	Function	Speed
off	off	stand-still	0 rpm
on	off	jog left/CCW	-200 rpm
off	on	jog right/CW	+200 rpm
on	on	jog right/CW	+200 rpm (L8 has priority over L7)

7.9.2.4 External failure event interface, P40 - P44

If a digital input is set with the function “External error”, the temperature protection switch of a braking resistor or the bimetal thermal compact can be connected as a motor temperature monitor, for example. **If a PTC thermistor circuit is being used as a motor temperature monitor, an external PTC triggering device must be connected in series. A PTC circuit is not directly compatible with the i-Drive actively sourced digital inputs.**

7.9.2.5 OFF2 (pulse lock) and OFF3 (quick stop), P40 - P44

The digital inputs can be programmed to perform the OFF2 (pulse lock) or the OFF3 (quick stop) function. For setting the input to the OFF2 function the corresponding parameter (P40 for L5 - P44 for L9) has to be set to 12. For the OFF3 function these parameters have to be set to 13.

When using the OFF2 function (pulse lock) the corresponding digital input has to be active for operating the drive. After this input gets inactive i.e. the function gets active the pulses will be locked immediately. The drive goes into the state “OFF2”, the display will show this text. After the input with the OFF2 function is active again, the drive is within the state “not ready for turn on” (OFF4). This state will be on if the input with an enable function goes inactive. The drive will operate again only after disabling and enabling.

The OFF3 function (quick stop) works like the OFF2 function with the only difference that after the input goes inactive, the drive will decelerate with half the ramp down time. If the ramp down time is greater than 10 s, a ramp down time of 5 s will be used for the quick stop. After reaching zero speed the drive will be in OFF3 state (the display also shows this text). After the input with the OFF3 function goes active again, the drive will be in the state “Not ready for turn on” (OFF4). This state will be left on after the enable input goes inactive. Now the drive can be switched on again after the enable signal goes active again.

If more than one input is programmed to the OFF2 or OFF3 function, all of them work like a series connection. If one of the inputs goes inactive the function will go active. The OFF2 and OFF3 functions of the serial interface act like a series connection.

7.9.2.6 Set-point values via serial interface, P22, P40 - P44

Parameter P22 has to be set to 3 to specify the set-point value via the serial interface (remote mode). Alternatively, a digital input can be set to the function “Remote mode” (P40-44 = 14) and be activated. If an input set to the function “Remote mode” changes while the drive is enabled and the motor is rotating, the drive goes into the state “not ready to turn on” (OFF4), which is switched when the drive is disabled.

The serial interface protocol is described in chapter 15.

The RUN and the STOP keys of the unit have no function during remote mode.

7.9.2.7 Stop function, P40 - P44

If a digital input programmed with this function becomes inactive, the speed reference value becomes zero. The drive stays active and is decelerated down to stand-still. If this digital input becomes active again, the drive is accelerating according to the ramp. This function is not active for position mode.

7.9.3 Fixed speed via input terminals, P45 – P48

In order to be able to select fixed speeds via the digital input terminals, parameter P22 must be set to 2. For each terminal L5 to L9, which shall select a fixed speed, the corresponding parameters must be set (P40 for L5 to P44 for L9) to 5. By means of the parameters P45 (for L5) to P49 (for L9), the selected speed is determined, if the corresponding terminal is active. If more than one terminal is active, the fixed speeds associated with each active terminal are added. The fixed speed can be positive (rotate right/CW) or negative (rotate left/CCW).

Example:

P42 = 5, P47 = 1000 rpm: Terminal L7 sets the speed to 1000 rpm
P43 = 5, P48 = 500 rpm: Terminal L8 sets the speed to 500 rpm

L7	L8	Speed
off	off	0 rpm
off	on	500 rpm
on	off	1000 rpm
on	on	500 + 1000 rpm = 1500 rpm

7.9.4 Fixed torque via digital input, P50 – P54

P50 – P54	Fixed torque set values
P50	For digital input L5, % of nominal torque
P51	For digital input L6, % of nominal torque
P52	For digital input L7, % of nominal torque
P53	For digital input L8, % of nominal torque
P54	For digital input L9, % of nominal torque

7.9.5 BCD-coded absolute position digital inputs, P22, P40 - P44

By binary coding the digitial inputs, it is possible to set up to 15 fixed absolute position setpoints. Note that BCD-coded relative positioning is currently not possible.

Pre-condition:
P22 = 2 Source digital inputs
P40 to P44: One of these inputs has to have function 27 (go to BCD coded position), all other coded inputs set to function 28.

Procedure:
- De-activating input with function 27
- Set all inputs with function 28 in the desired combination
- Set input with function 27, to go to the selected position

When the combination is 0, a homing will be done.

BCD set-up:

- Every input programmed as 'BCD coded input' (P40-44 = 28) represents one bit of the binary code. One to four inputs may be programmed as 'BCD coded input' resulting in a 1 to 4 bit wide binary code (1 to 15 fixed positions, "0" means 'homing')
- The leftmost input (lowest #) represents the least significant bit.
- The inputs representing the binary code do not need to be contiguous: For example, it is possible to have L5, L7 and L9 programmed as BCD code inputs. In this case L5 represents 2^0, L7 represents 2^1 and L9 represents 2^2.
- BCD code to position set mapping: The positioning set of P7xx with the according number belongs to the binary code. For example, position reference/velocity/time #1 (position 0 in manual) = P700/1/2 belongs to binary code 001b) and so on in sequence.
- The BCD code "0" always means 'homing' (according to the homing method entered at P605)
- On a rising edge (*) of the input programmed as the BCD strobe (P40-44 = 27), the position determined by the binary code active at that moment will be executed (homing will be done in case of code 0).

* In the current firmware version, binary code 0 for homing has to be set while the BCD strobe is low - otherwise it won't be recognized. Any other BCD combination can be recognized regardless of the state of the BCD strobe - it will be recognized on the next rising edge of the strobe.

Although it is possible to program more than one input as a BCD strobe, it is not permissible.

7.10 Analog output, P55 - P56

i-Drive has an analog output that is connected to the control terminal L11. The output voltage range amounts to 0..10 V. Parameter P55 programs which value will be output by the analog signal:

P55	Analog output value	
0	Speed	10 V at speed = N MAX (P5)
1	Output frequency	10 V at frequency = P100 (nominal frequency of motor)
2	Output current	10 V at current = nominal current of the motor (P103)
3	Output voltage	10 V at 300 V_{RMS}
4	Output load	10 V at 100% load
5	Power module temperature	10 V at 100 °C
6	DC bus voltage	10 V at 600 V_{DC}
7	Actual position	10 V at ... (see P38)
8	Reserved	

By varying parameter P56 the analog output value can be scaled as desired. The output voltage is calibrated according to the following equation: 100 %= 0 ..10 V

The analog output is driven by a D/A converter with 8 bit resolution.

7.11 Relay output, P57 - P58

The relay may be controlled by status information. Both the closing and opening contact are connected to a terminal. The relay function is programmable via parameter P57:

P57	Digital output is active	**Comments**
0	No function	
1	Motor rotates	Output is active, if the amount of the reference speed is higher than 2 rpm. At –2, –1, 0, 1, 2 rpm the output is not active.
2	Motor rotates right/CW	
3	Motor rotates left/CCW	
4	Target reached (position or speed modes)	P640/P641 sets target window (1)
5	Amount of pre-selected speed (P58) is exceeded	Output becomes inactive at 30 rpm below P58 (hysteresis).(2)
6	No error is active	
7	No warning is active	
8	No over-current warning is active	
9	No over-voltage warning is active	
10	No over-temperature warning is active	
11	Digital input L5 is active	P40 P44 can be programmed with every possible function.
12	Digital input L6 is active	
13	Digital input L7 is active	
14	Digital input L8 is active	
15	Digital input L9 is active	
16	Enable without dead-times	Refer to P90 - P91 section for details External brake coordination with optional delays possible. Certain gravity applications (with low backdrive) may require Hall commutation interface with firmware version. 3.066 or higher to prevent load dropping. The “delay times” refer to the reference command timing.
17	Enable with dead-time before acceleration	
18	Enable with dead-time after deceleration	
19	Enable with dead-times	
20	Internal drive protection limit active	
21	Function only in BDN model available	

At speed function

P58	Speed threshold for relay output switching

Notes:

(1) For positioning via fixed digital inputs, the target reached is based on the internal trajectory generator instead of the actual position. Future firmware versions will use the actual position instead if feedback is used.

(2) P57=5 uses the set point (theoretical) speed value instead of actual speed. This applies to both analog and fixed speed modes. P57=4 uses the actual speed if feedback is used, but a specific speed threshold is not possible. It will compare the actual speed to commanded speed at all times. Future firmware versions will use the actual speed instead if feedback is used.

7.12 V/f-control (IM only)

Voltage to frequency control of the induction motor is selected by setting parameter P23 to 0. This mode is useful for the initial set-up and if several motors connected in parallel are operated.

With V/f-control, the voltage of the induction motor is dependent on the frequency defined by a V/f-characteristic curve. This curve is set by the following parameters:

Parameter	Function
P60	Nominal voltage in [V]
P61	Nominal frequency in [Hz]
P62	Voltage boost in %
P63	Additional voltage boost at acceleration (dynamic boost) in %

The nominal voltage (P60) and nominal frequency (P61) can be taken from the name plate on the motor and usually corresponds to the motor specifications (P60 = P102, P61 = P101). The behaviour at low speed is improved by boosting (set by P62). For values that are too low, the motor delivers too low torque and for values that are to high, the current is too high for no-load conditions. The use of the dynamic boost (P63) improves the behaviour at acceleration. This additional voltage boost is used as long as the motor has not yet reached its final speed.

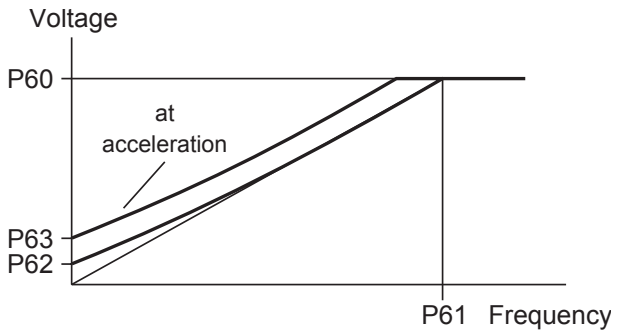


Fig. 17: V/f-characteristic curve

For operating with V/f-control, the parameters P100 and P101 (nominal frequency and speed of motor) have to be set up properly. These values are used to calculate the frequency from the speed set-point value.

A speed sensor can be used even with V/f-control. The measured speed can be displayed by means of parameter P29. This is useful for the initial set-up of the drives.

7.13 Encoder, P70, P71

If an encoder is used as a speed sensor, its characteristic is programmed by the following parameters:

Parameter	Function
P70	Number of encoder / resolver lines/rev (<32,767 lines/rev when win+i-Drive is used or 9999 increments for programming on the drive)
P71	Type of encoder signals (0 = analog sine/cos signals, >0 = digital signals)

P71	Function
0	Analog sine/cos encoder signals (~1 Vss), lines/rev = P70
1	Resolver (with 1024 lines/rev via interface)
>=1	TTL encoder signals: lines/rev = P70*P71 Attention: 256*Pole pairs / P71 has to be an integer figure!

Power reset: When any of these parameters are changed, the power supply for the drive has to be shut down for a minimum of 20 seconds before switching back on.

Examples:
TTL encoder with 2000 lines/rev: :
P70 = 2000
P71 = 1

TTL encoder with 20,000 lines/rev:
P70 = 20000
P71 = 1

TTL encoder with high resolution, 121,332 lines/rev, # of pole pairs: 3.
First P71 has to be checked: 256 X 3 pole-pair / 71 has to be an integer number. 256 X 3 = 768,768 can be divided by: 2,3,4,6,8, 12,16,24,32,48,64,96,128,192,256,384. Now 121,332 divided by one of the above mentioned figures has to also be an integer number, which is smaller than 32,767.
The result is P70: 121,332 / 4 = 30,333
P70 = 30,333
P71 = 4

Sine/Cosine encoder, 1VSS, 2048 lines/rev:
P70 = 2048
P71 = 0

Resolver with 1024 lines/rev (external interface necessary)
P70 = 1024
P71 = 1

The encoder is always evaluated. The actual measured speed can be read by parameter P29. If no encoder is connected to the device the display will show “----“.

The measured speed is only used for speed vector control with feedback (P23 = 2) and torque vector control with speed feedback (P23 = 4). If one of these control modes is selected and the encoder is not working or missing, the error E19 will be generated.

7.14 Closed loop control parameters, P72 - P79

Refer to the chapter “Start up guide for rotary servomotors” for detailed loop tuning procedures.

Induction motors: Control parameters can only be used for vector control.

Changes to control parameters may only be made by experienced servor users. Incorrectly adjusted parameters can result in unstable control.

7.14.1 Speed controller, P72, P73

For the speed control with and without (sensorless vector) a speed sensor, the dynamic response characteristics of the controller can be optimized with the following parameters:

Parameter	Function
P72	P-gain of the speed controller (proportional)
P73	I-gain of the speed controller (integral)

For optimizing the speed controller, the recorder function of the software **win+i-Drive** can most effectively be used.

7.14.2 Current controller, P75, P76

With correct entry of motor electrical circuit parameters, the default P and I settings of 100% should be acceptable for a majority of applications. Certain motor types, e.g. low impedance may require retuning and special resistance and inductance entry; and P25 = 1. The control behaviour can be displayed by using the recorder function of **win+i-Drive**.

Parameter	Function
P75	P-gain of the current controller (proportional)
P76	I-gain of the current controller (integral)

7.14.3 Flux controller, P77, P78 (in preparation - IM only)

Parameter	Function
P77	P-gain of the flux controller (proportional)
P78	I-gain of the flux controller (integral)

7.14.4 Position controller, P79

The position controller is used to set the dynamic response characteristics for approaching the target position.

Parameter	Function
P79	P-gain of the position controller (proportional)

Use the speed controller integral gain to adjust the servo position stiffness characterization.

7.15 DC braking, P80, P81 (IM only)

If V/f-control is used (P23 = 0), the DC braking function can be used for faster motor braking. DC braking becomes active in the following cases. **A terminal which is programmed with the function DC braking (P40 – P44 = 9) becomes active.**

The drive becomes locked. In this case, the speed is first reduced to zero according to the ramp-down characteristic, then the DC braking function is activated for the programmed time period. The DC braking time (P80) must be set to a time period which is longer than zero. DC braking allows the induction motor to create servo type shaft holding during a torque disturbance.

The voltage which is applied for DC braking is programmed in % of the motor nominal voltage, by means of parameter P81. Over-currents will occur for values which are too high.

When DC braking is active, the text “dc” appears on the display as long as either speed, frequency or output voltage is displayed.

7.16 S-shaped ramp, P90

An S-shaped ramp can be formed by means of parameter P90. This enables a smooth transition at the acceleration and deceleration points and eliminates jerking. The time to reach the final speed from the top of the linear part of the ramp is about 5 times the parameter P90. A value of 0 s for P90 means that there is no S-shaped characteristic and the ramp is linear right up to the final speed.

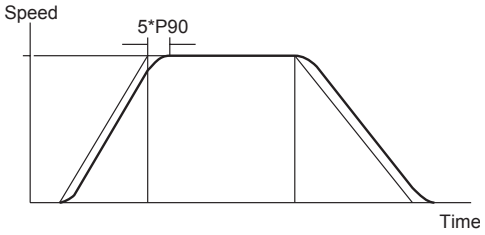


Fig. 18: S-shaped ramp

7.17 Ramp with delay-time, P91, P92

Normally, the output power stage is enabled and at the same time the accelerating ramp is started and at the end of the deceleration ramp the output power stage is disabled.

These actions may be separated with the delay parameters P90 and P91. Additionally, several functions for the relay output may be selected. The behaviour is illustrated in the following picture.

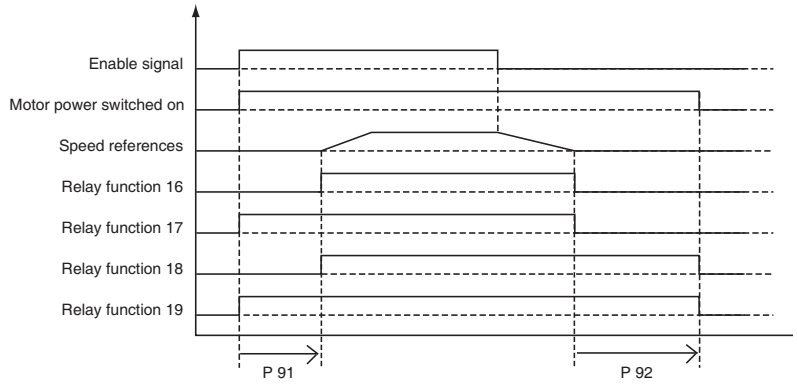


Fig. 19: Ramp with delay-time

Note: - The delay time starting point depends on the relay function assignment
- Motor power on means standstill servo holding possible, e.g. hoist brake coordination.

8 Motor parameters, P100 - P116.

i-Drive can control both asynchronous (induction) and synchronous servo motors. If an asynchronous motor is connected to the drive, all operating modes can be used. For synchronous motors only the operating modes with feedback (P23 = 2, 4 or 5) can be selected. The connected type of motor is programmed by parameter P105:

P105	Motor type
0	Asynchronous motor (induction motor)
1	Synchronous motor (PM brushless commutated servo motor)

8.1 Motor parameters for an asynchronous rotary motor (induction motor)

For controlling an asynchronous motor parameter P105 has to be set to 0. The motor data is set by the parameters P100 – P103:

Parameter	Motor specifications
P100	Nominal frequency in [Hz]
P101	Nominal speed in [rpm]
P102	Nominal voltage in [V]
P103	Nominal current in [A]
P104	Self-tuning (future use)
P105	Motor type

Care has to be taken that these parameters correspond to the actual connection of the motor (wye or delta connection).

Parameter	Motor specifications
P110	Nominal magnetizing current in [A]
P111	Stator inductance in [H]
P112	Stator resistance in [Ω]
P113	Rotor resistance in [Ω]
P114	Parameter for magnetizing characteristic curve 1
P115	Parameter for magnetizing characteristic curve 2
P116	Parameter for magnetizing characteristic curve 3

Power reset: When any of these parameters are changed, the power supply for the drive has to be shut down for a minimum of 20 seconds before switching back on.

8.2 Motor parameters (basic) for a synchronous rotary motor (servomotor)

For controlling a synchronous motor, parameter P105 has to be set to 1. The following motor parameters have to be set: **Refer to start up section for complete information and motor parameters.**

Parameter	Motor specifications
P100	Nominal frequency in [Hz]
P101	Nominal speed in [rpm]
P102	Nominal voltage in [V]
P103	Nominal current in [A]
P106	Absolute angular position of encoder or resolver
P107	Methods of pole-angle finding: 0: Sine-cosine-encoder with absolute track: Pole Angle from P106 1: TTL-encoder: Angle has to be detected with pole finding procedure 2: Sine-cosine encoder: Immediate pole-angle finding (P108 = 1) 3: Resolver: Pole angle from P106 4: Resolver: immediate pole-angle finding (P108 = 1)
P108	Start pole-angle finding
P109	Pole angle finding start signal: 0: Pole-angle finding while setting a digital input 1: Automatic pole-angle finding while power on 2: On-line correction 3: Automatic pole-angle finding and on-line correction
P111	Stator inductance in [H] i-Drive value is line to neutral. For motor line to line values, divide by 2
P112	Stator resistance in [Ω] i-Drive value is line to neutral. For motor line to line values, divide by 2

Power reset: When any of these parameters are changed, the power supply for the drive has to be shut down for a minimum of 20 seconds before switching back on.

P100 / P101 Nominal frequency and nominal speed:

Determining P100, the nominal frequency: f = P101/60 X 0.5 X Pole Count

P106 Absolute angular position:
For Sine-cosine encoder (analog) with an additional commutation track and resolvers, the rotor position must be entered via P106. The angle is normally specified by the motor manufacturer. If you do not know the angle, set P107=2 or 4 and then P108=1 (see below).

P107 Methode of pole angle finding:
Sine-cosine encoder, P107=0:
For encoders (analog) with an additional commutation track, the rotor position must be entered in P106. The angle is normally specified by the motor manufacturer. If you do not know the angle set P107=2 and then P108=1. The angle will be detected and automatically loaded in P106. P107 will then change back to 0.

TTL-Encoder, P107=1:
This encoder type needs a small motion of the motor shaft. Start signal method is entered in P109.

Resolver, P107=3:

Resolver, P107=3:
For motors with a resolver, you need an external resolver interface. The pole angle must be entered in P106. If you do not know the angle set P107=2 and then P108=1. The angle will be detected and automatically loaded in P106. P107 will change then change back to 3.

P108 Pole angle finding:
While change from 0 to 1 a pole finding motion will be executed.

P109 Point of time of pole angle finding:
P109=0: i-Drive is in OFF state and display OF10. Pole finding will be done when:
- P108=1, or
- Digital-input with function 1 (enable) will be switched on, or
- Digital-input with function 29 will be switched on

P109=1: Pole finding while switch on power supply
P109=2: Online correction of the determined pole angle, e.g. sinus-cosinus encoder
P109=3: Pole finding while switch on power supply and online correction

If pole finding is not successfull (E21), another pole finding procedure will be initiated after resetting the error.

Please also note P126 and P127 for pole angle pulse width and pulse height.

8.3 Motor protection function P120, P121

The i-Drive includes an I squared T type motor protection function that enables the motor to be driven with a higher current than the nominal current for a short time, without resulting in overheating and associated destruction of the motor. The motor protection function is activated via parameter P120:

P120	Function
0	Motor protection switched off
1	Motor protection for motor with self cooling (impeller)
2	Motor protection for motor with forced cooling (external ventilator) or servo motors

The motor protection function monitors the motor current. Should this exceed the permissible value, the over-current error E16 is generated according to the motor protection trigger characteristic, which depends on the current. Then the motor is switched off.

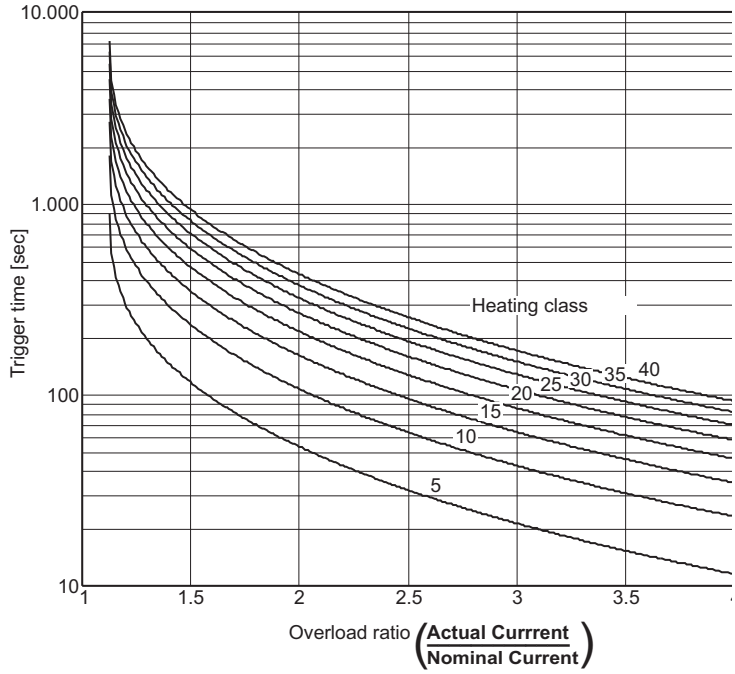


Fig. 20: Motor protection characteristic

The trigger characteristic corresponds to the heating class of the motor, which is set by the parameter P121:

P121	Heating class	Trigger time for 2X overload condition
0	5	55 seconds
1	10	110 seconds
2	15	165 seconds
3	20	220 seconds
4	25	275 seconds
5	30	330 seconds
6	35	385 seconds
7	40	440 seconds

The allowable current is dependent on the type of motor ventilation. For an externally ventilated motor, this is 1.125 times the nominal motor current (P103). For a self-ventilating motor, it is reduced from 112.5% of the nominal motor current at half the nominal speed (0.5 * P101) to 70% of the nominal motor current at standstill. This takes into consideration the fact that a slow-turning motor has a detrimental effect on the cooling due to the corresponding slow-turning ventilator.

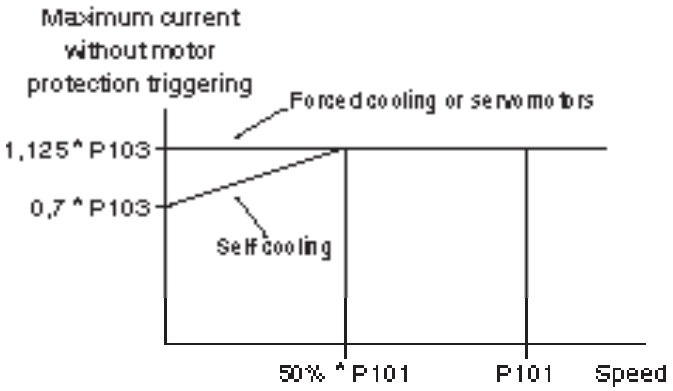


Fig. 21: Maximum allowed current of motor protection

8.4 Pole finding, pulse width and pulse height, P126, P127

To adapt pole finding to specific motors you can vary the pulse width and pulse height. Please change it only if the default value results in poor motor commutation. Consult with an i-Drive specialist for more details.

P126: pulse width in [ms]: range 1 to 10, default value 2
P127: pulse height in [%]: range 10 to 100, default value 50

8.5 Over-voltage protection, P221

If high values for P7 (speed) and short ramp-down time T↘ (P2) are programmed, then the error OV (over-voltage) may occur during braking, if there is no braking resistor connected.

The braking ramp will be stopped if the dc-link voltage becomes higher than the voltage parameter P221. Then the message “prot” is shown in the display.

Power supply	Voltage limit for over voltage error (trip value)
115 VAC, 1-phase	230 VDC
230 VAC, 1-phase	440 VDC
230 VAC, 3-phase	440 VDC
400 VAC, 3-phase	750 VDC

This table shows the over-voltage trip level for the different i-Drive voltage models. P221 can be set 1 volt lower than these values as a maximum (default) for the particular model. The minimum value must be greater than Vac X 1.4 X 1.2 to prevent false OV activiation. P221 set lower than “trip level - 1” can be used to reduce the deceleration braking torque at P221 threshold which can eliminate the OV error in some cases.

9 Tuning test generator, P230 - P233

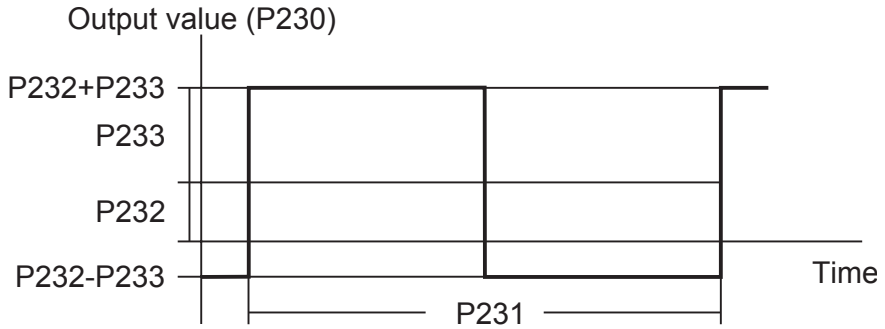


Fig. 22: Test generator

The i-Drive includes a test generator for commissioning purposes. It can be configured with the following parameters:

Parameter	Function
P230	Output value of test generator: 0 = Off 1 = Magnetizing component of current (IM only) 2 = Torque component of current 3 = Flux (IM only) 4 = Speed
P231	Time period of the test generator
P232	Offset of the test generator
P233	Amplitude of the test generator

The offset and the amplitude are set in %. A value of 100% corresponds to the nominal value of the motor. **The test generator may only be used by experienced servo personnel for set-up and controller dynamic optimization purposes.**

Note: For position loop tuning, refer to the chapter (12.2) covering “Start up of a synchronous brushless commutated servomotor”.

10 Status display, P240 - P248

General device specifications can be displayed by means of the following parameters:

Parameter	Function
P240	Last error
P241	Maximum Temperature
P242	Device type Examples: 1.015 = single-phase, 1.5 kW 3.030 = three-phase 3.0 kW
P243	Firmware revision, e.g. 3.062
P244	Serial number, first 4 digits
P245	Serial number, last 4 digits
P246	Actually displayed value (selected with P20)
P247	State of the device
P248	Nominal current of the drive in amps

The value of parameter P246 is selected by parameter P20 or by the DISP button.

The device state displayed at parameter P247 has the following values:

P247	State of drive
0	Not ready to turn on
1001 – 1014	Disabled to turn on. The last two digits show the actual enable message (i.e. 1002 = OFF2, 1003 = OFF3
2000 – 2014	Ready to turn on, the drive is not enabled. the last two digits show the actual enable message
3000	Switched on. This state is only accessible by the remote mode (bit 3 = 0, bit 2-0 = 1)
4000	Operation enabled. The drive is running.
4100	DC braking
5000	Jogging
5100	Jogging and dc braking
6000	Quick stop ramp, the OFF3 function was activated and the drive is ramping down with the quick stop ramp (see 7.10.6, page 54)
7000 – 7022	Trip, the last two digits give the error number

The state machine of the device with all states and transitions is shown in the following figure.

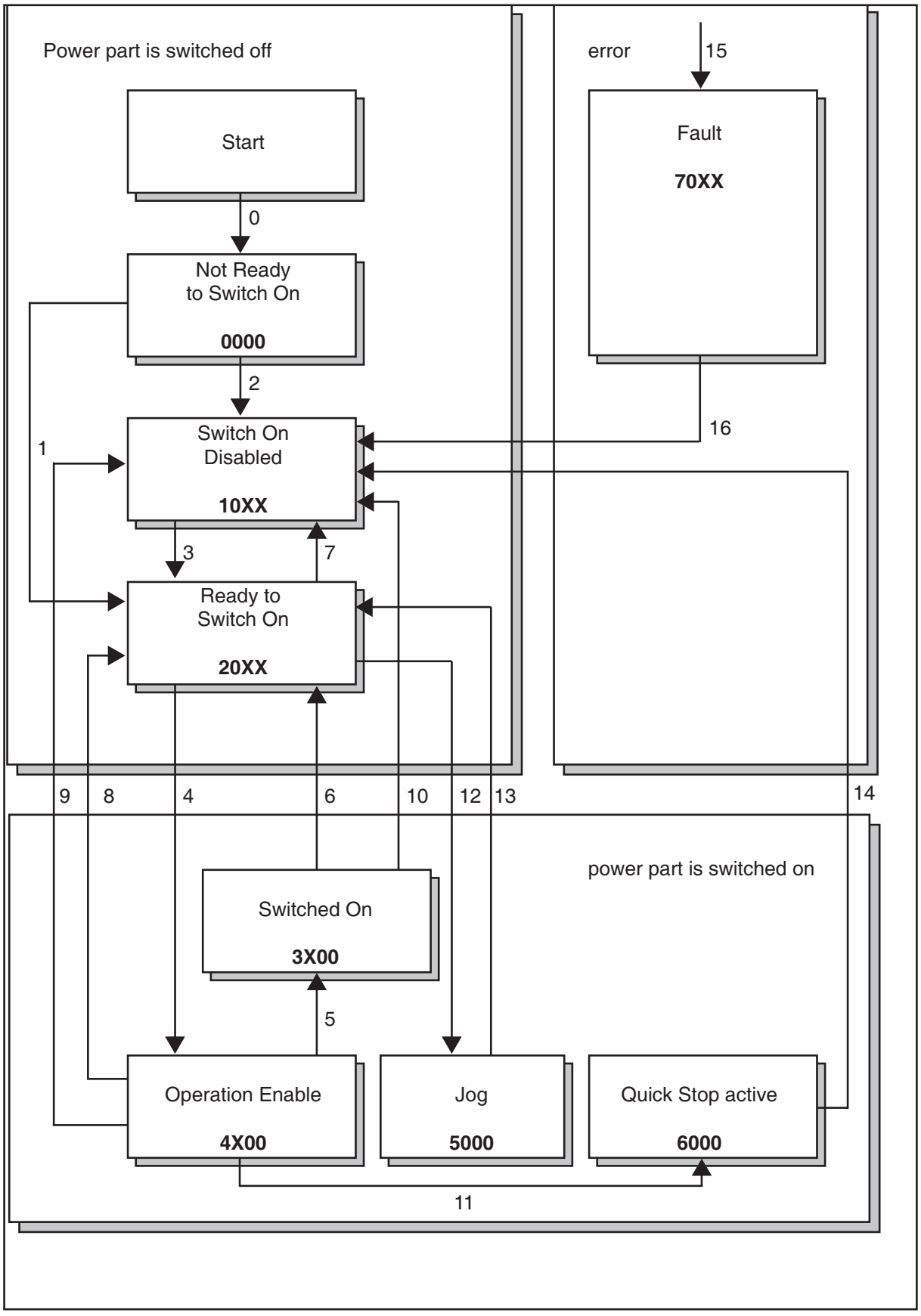


Fig. 23: State machine of the device

The meaning of the transitions is described in the following table.

Transition	Description
0	Power on
1	Initializing ready and remote mode (P22=3)
2	Initializing ready and no remote mode (P22<3)
3	Remote mode: drive is disabled via the control word, OFF2 / OFF3 not active No remote mode: a digital input with enable function is not active or P24=0, OFF2/3 not active
4	Drive enabled
5	Drive disabled (braking ramp active)
6	Ramp output equal zero and dc bus time finished
7	OFF2 / OFF3 or under-voltage is active
8	Remote mode: control word bit 3 not active
9	OFF2 active
10	OFF2 / OFF3 active
11	OFF3 active
12	Remote mode: if one of the control word jog bits 8/9 is active and a enabling input is inactive and P24 is higher than zero. No remote mode: Jog via digital input active and a enabling input is inactive and P24 is higher than zero.
13	Remote mode: if control word jog bits 8/9 are not active or enable bit 3 is not active. No remote mode: Jog via digital input is disabled or P24=0
14	Ramp output is zero.
15	Error active
16	Error inactive and confirmed

11 Operating time counter, P250 - P253

The operating time of the motor and the drive is displayed by the following parameters:

Parameter	Function
P250	Operating time of drive, 1000 h
P251	Operating time of drive, 0.1 h
P252	Operating time of motor, 1000 h
P253	Operating time of motor, 0.1 h

12 Start up procedures

12.1 Start up of an asynchronous (induction) motor

For the initial set-up, the following steps have to be made:

- **Connection of the power supply** (Attention: Please check power supply and device data!)
- **Connection of the motor** (PE, U, V, W at the lower side of **i-Drive**).
- **Connection of the 15-pin control terminal block** of the control unit. At delivery the input L5 is programmed for enabling the drive. The input L5 has to be connected to L4 (+12 V to the input) and L1 to L10 (ground connection for internal power supply).
- **Turn the mains on**. The unit needs some seconds for initialization (“init“ will be displayed). After initialization “OFF“ will appear in the display.
- Now the parameters of the unit can be entered. To change a parameter first select it by pressing the PARA key. After this by pressing the UP or DOWN key the value can be changed. For the initial set-up the **nominal motor values** have to be input. For motors which can be operated both in wye and delta connection, those values have to be used which correspond to the actual connection of the motor.

Parameter	Value
P100	Nominal frequency of the motor in [Hz]
P101	Nominal speed of the motor in [rpm]
P102	Nominal voltage of the motor in [V]
P103	Nominal current of the motor in [A]

- The display leaves the parameter mode and changes back to operating values by pressing **DISP** for more than 1 s.
- The motor is started by pressing **RUN**. The default mode is V/f control (P23 = 0). The display will show “0 rpm“. The speed is increased by pressing **UP**.

After testing the basic operation in V/f mode, one of the vector control modes can be selected.

The PC program **win+i-Drive** makes the first set-up and optimization of the drive simple and easy. Parameters can be changed from the PC. The set-up of the speed controller can be supported by the waveform recorder.

12.2 Start up of a synchronous brushless commutated servomotor

Note: For Bayside motors, users can skip to Bayside Plug & Play Quickstart page.

i-Drive phasing standard for encoder commutation (No Hall)

This information is necessary for integration with custom/3rd party motors & cables, and for troubleshooting standard Bayside motors & cables.

The motor/feedback should be wired to the drive such that POSITIVE COMMAND = CW ROTATION for proper torque commutation and operation. This is called the positive torque sequence. This is met by the following conditions:

- Encoder: With CW rotation, channel A leads B by 90 degrees for encoder counting in the positive numerical direction.
- Motor: With CW rotation, back EMF W-V leads U-V by 60 degrees.
- Refer to the attached phasing diagrams for details and test procedure.

Note that certain combinations of motor and encoder wiring result in normal commutation, but in the

negative torque sequence. This means a positive command = CCW rotation. Although commutation is normal, the negative torque sequence is not recommended, due to potential tech support confusion versus the i-Drive standard of positive torque sequence.

In addition to proper motor/encoder wiring, the following parameters are critical for normal commutation: Encoder increments, Encoder type, Rated frequency @ Rated speed (determines pole pairs) and Motor type.

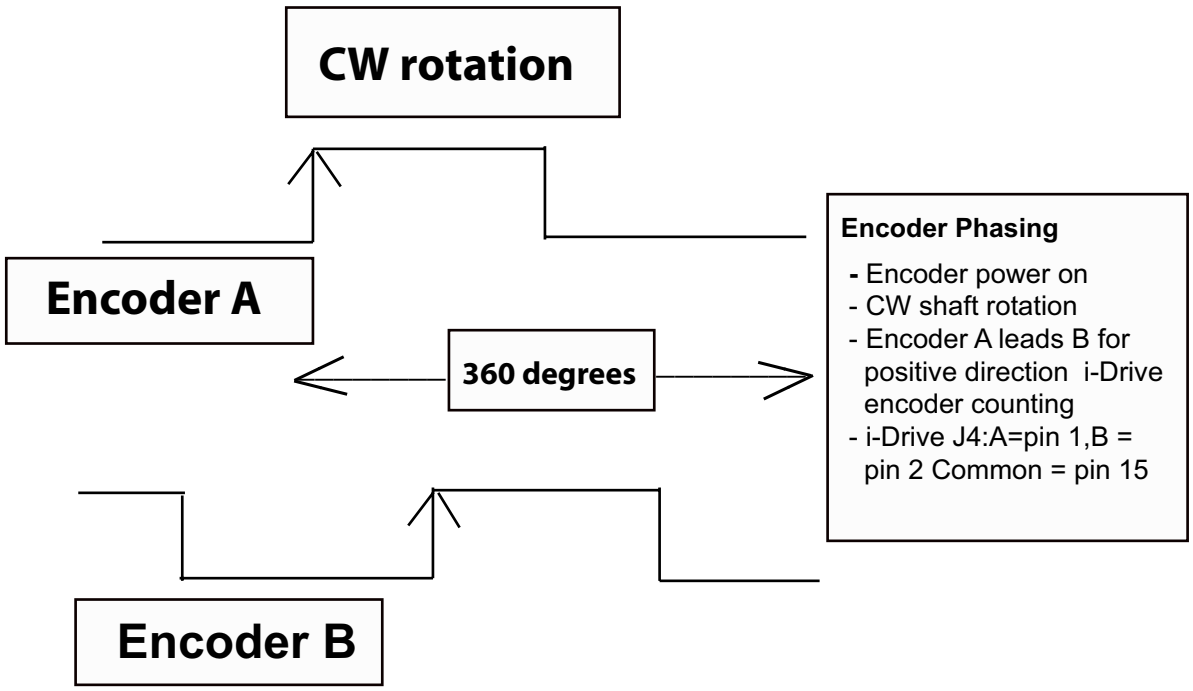
Other motor/encoder wiring combinations, or incorrect commutation parameters can result in pole finding commutation errors, locked rotor or cogging behaviour, unstable response or runaway.

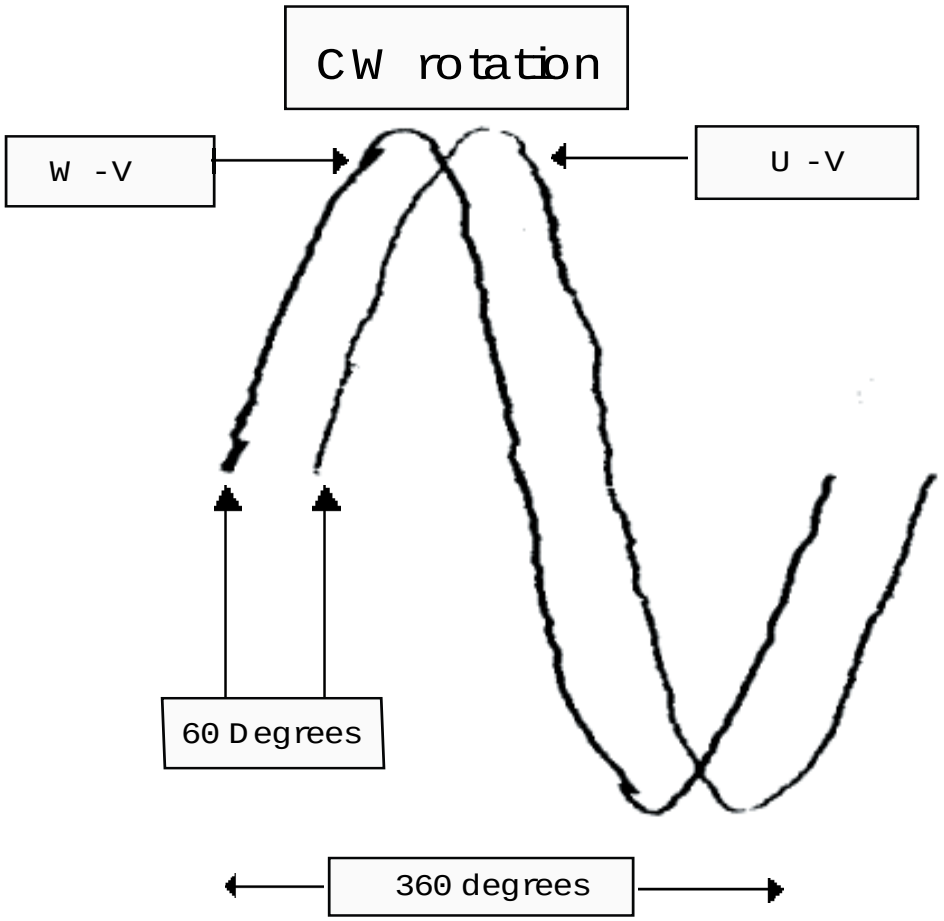
Bayside cables for i-Drive
The plug&play sensor cables are internally wired with the proper encoder phasing. Motor power cables are connectorized on the motor end and flying leads on the drive end.

For proper UVW phasing, the flying motor leads must be connected to the drive as follows:

Motor type	drive U terminal	drive V terminal	drive W terminal
Standard C/D winding	Black 1	Black 2	Black 3
Standard A/B winding	Black 1	Black 3	Black 2

i-Drive phasing standard for CW shaft rotation encoder and UVW relationships (No Hall). For positive command = CW rotation





Back EMF phasing:

- Drive off, motor leads disconnected.
- Oscilloscope connections: W = probe tip, V = common, U = probe tip.
- Rotate shaft CW steadily.
- W – V leads U – V by 60 degrees.
- Formula: [time shift divided by total period time] multiplied by 360.

Programming

Motor file parameters

Note that an important distinction is made between “motor” parameters and all other parameters. Parameters unique and specific to the connected motor are defined as “motor” parameters. These parameters are used by the i-Drive to configure optimal motor vector and commutation control, current loop gain normalization and motor protection (current, speed, thermal overload). All other parameters are not motor specific, and therefore, the responsibility of the user for proper implementation.

The i-Drive with universal field oriented vector control is designed to control both asynchronous (induction) motors and synchronous (permanent magnet commutated) motors i.e. servo motors. Induction motor control models and application parameter sets are generally more numerous and complicated. For servo motor control, the i-Drive motor parameter set is reduced.

Note: Contact Bayside, or check our web site, for availabity of downloadable motor files for catalog motors and stages.

Motor parameter number	Parameter Name	Parameter Entry/Comments
3	Maximum torque current	Entered as a percentage of rated motor current, within the drive's peak current capability. Enter lessor of the following: [motor peak/motor rated x 100] or [drive peak/ motor rated x 100]. Note: i-Drive amp unit is Arms/phase based on 3-phase operation. Motors rated for "six step" operation (dc amps) should be converted as follows: Arms = 0.82 x Adc.
5	Maximum speed	Enter the lessor of the max. motor RPM or max. RPM as limited by the encoder frequency. Max. encoder limited RPM = 150,000 Hz x 60 divided by encoder lines /rev. If using an external encoder signal divider/multiplier, lines/ rev are after any external div/mult conversions.
8	Overspeed error	Enter 1.10 x max. speed (P5). Sets the error trigger point.
*** Following parameters best entered via Motor Settings window in this order ***		
105	Motor type	Enter 1 = synchronous
---	Units	Select rotary
101	Rated speed of motor	For servo motors, enter the Maximum motor RPM @ rated voltage.
100	Rated frequency of motor or Number of pole pairs	If setting up parameters via the motor icon, number of "pole pairs" is entered (frequency internally calculated). If creating a direct loadable motor file, P100 = [P101 divided by 60] x 0.5 x Pole Count.
102	Rated voltage of motor	Entered the rated motor winding voltage in Vdc. Note: Drive bus voltage must equal rated motor voltage to prevent speed/torque limitations due to voltage mismatch.
103	Rated current of motor	Enter the rated current of the motor in Arms for 3-phase sinusoidal operation. Motors rated for "six step" operation (dc amps) should be converted as follows: Arms = 0.82 x Adc.
71	Encoder signal type	1 = digital TTL encoder, 0 = analog sin/cos encoder. Note: this is the signal type as "seen" by the i-Drive after any external encoder signal conversion e.g. sin/cos to digital TTL via external interpolator.
70	Encoder increments (lines or pulses)	Enter the encoder lines/rev (pulses/rev) as "seen" by the i-Drive after any external encoder signal division or multiplication. Lines (pulses) is the pre quadrature resolution.

107	Pole finding method (pole position angle of encoder)	Enter 1 for encoder only commutation (pole finding via test motion). Enter 5 for Hall start up, US single-ended signal, P106 Hall offset. Enter 6 for Hall start up, EU differential signal, P106 Hall offset. 0 and 2 are sin/cos encoder modes pending drive firmware version. 3 and 4 are resolver modes for future availability.
106	Correction angle of encoder (Hall/pole position offset)	Not used for encoder only commutation (no comm tracks). For Hall/Encoder and Resolver commutation mode.
111	Ls inductance, L-N	Enter the inductance in Henries. For L-L motor spec, L-N = 0.5 L-L.
112	Rs resistance, L-N	Enter the resistance in Ohms. For L-L motor spec, L-N = 0.5 L-L.
*** end Motor Settings window ***		
109	Pole angle finding start signal	Enter 0 for test motion activation on first enable signal. Enter 1 for test motion activation on power up. Refer to current manual or connected drive version choices for other available activation modes.
120	Motor thermal protection	To activate, enter 2 for servo motors. This is I2T type protection. In general, multiple (redundant) forms of thermal protection are recommended. Note that PTC thermistor signals are NOT directly compatible with the i-Drive actively sourced digital inputs. An external PTC analog signal/switch output convertor would be required. Another possibility is that all digital inputs are needed for other more critical application functions.
121	Motor thermal category	Enter 0 for maximum I2T protection curve (shortest trigger time). P121 can be increased as long as the actual motor temperature is not exceeded e.g. to eliminate nuiscance tripping cases.

EXAMPLE MOTOR PARAMETER SET:

Motor file for BM060-1C1 with BDx071 drive (10Arms peak 10s current, 115Vac/160Vdc).
Motor specs:
Rated for six step operation.
160 VDC winding
2000 line/rev TTL encoder, no external signal convertor
Max speed = 5400 rpm
Continuous current = 2 amps, 0.82 x 2 amps = 1.65Arms
Peak current = 6 amps
R line-line = 12 ohms
L line-line = 12 mH
Pole count = 6

Motor parameter set for previous example:

Par #	Value	Parameter Description
3	300	Maximum torque current in percent of rated
5	4500	Maximum speed (encoder freq limited)
8	4950	Over-speed error (set 10% higher than Max speed)
70	2000	Encoder increments
71	1	Encoder type
100	270	Rated frequency of motor
101	5400	Rated speed of motor (max no-load speed
102	160	Rated voltage of motor
103	1.65	Rated current of motor
105	1	Motor type
107	1	Pole Finding Method = encoder commutation
109	0	Start encoder commutation on initial enable
111	.006	Stator inductance L-N in Henries
112	6	Stator resistance L-N in ohms
120	2	Motor protection function
121	0	Heating class of the motor

Pole Angle Finding (Commutation) Evaluation for Hall less motors:

This refers to the specific motor motion initialization that must be done automatically, every time after power-up or initial enable of the drive. This is necessary to synchronize the arbitrary encoder position (count) to the motor's optimal electrical commutation angle – a specific displacement between the permament magnet rotor position and a defined stator electrical state. The pole angle finding (PAF) accuracy is critical for establishing the optimal torque generationg conditions and subsequent motor performance. The PAF with default values for P126 (pulse width) and P127 (pulse amplitude) should work well for a majority of applications. For direct drive motors and applications with high friction, or very low friction (e.g. air bearing), it may be necessary to adjust one or both parameters. Consult with an i-Drive specialist before changing P126/127.

The PAF bidirectional test motion algorithm (quick mini shaft movement) is generally capable of working well even under the following conditions: one sided obstructions (e.g. hard stop), torque disturbances and unequal directional loading (e.g. gravity application). From commutation theory, optimal commutation torque angle is 90 electrical degrees. Angle accuracy within +/- 10-15 degrees is quite acceptable for a majority of applications. Symptoms of poor PAF accuracy include:

- Rotor lock or jerky behavior
- Rough/bumpy shaft rotation
- Higher than expected current draw
- Poor speed/position loop tuning results
- PAF related drive errors (if any)

Tuning i-Drive servo control loops

The i-Drive control structure is cascade current, speed and position loops, in respective order. The current loop is the inner most loop. Because the current loop is the inner most loop, special care must be taken that this loop ONLY be retuned if absolutely necessary. An incorrectly tuned current loop will degrade the performance of the whole system.

With cascade control, the tuning is performed from inner most loop outward. The general procedure for tuning is as follows:
Step:

1. Evaluate factory set current loop step response if desired (optional). Optimize current loop response only if necessary.

2. If i-Drive used in speed or position mode, evaluate factory set speed loop step response. Optimize speed loop response for connected load (or avg. load if varying load application) as necessary.
3. If i-Drive used in position mode, evaluate factory set position loop response to most aggressive move profile as desired. Optimize position loop response for connected load (or average load if varying load application) as necessary.

Note that the torque mode configuration activates only the current loop (any speed or position loops are closed externally). This is why it is not necessary to do any other loop tuning in this mode. However, for start-up testing and servo analysis/troubleshooting purposes, it can be useful to run the drive in speed/position mode. In this case, the corresponding loops must be evaluated/tuned as necessary.

Only persons experienced in servo motor control should perform servo loop tuning procedures.

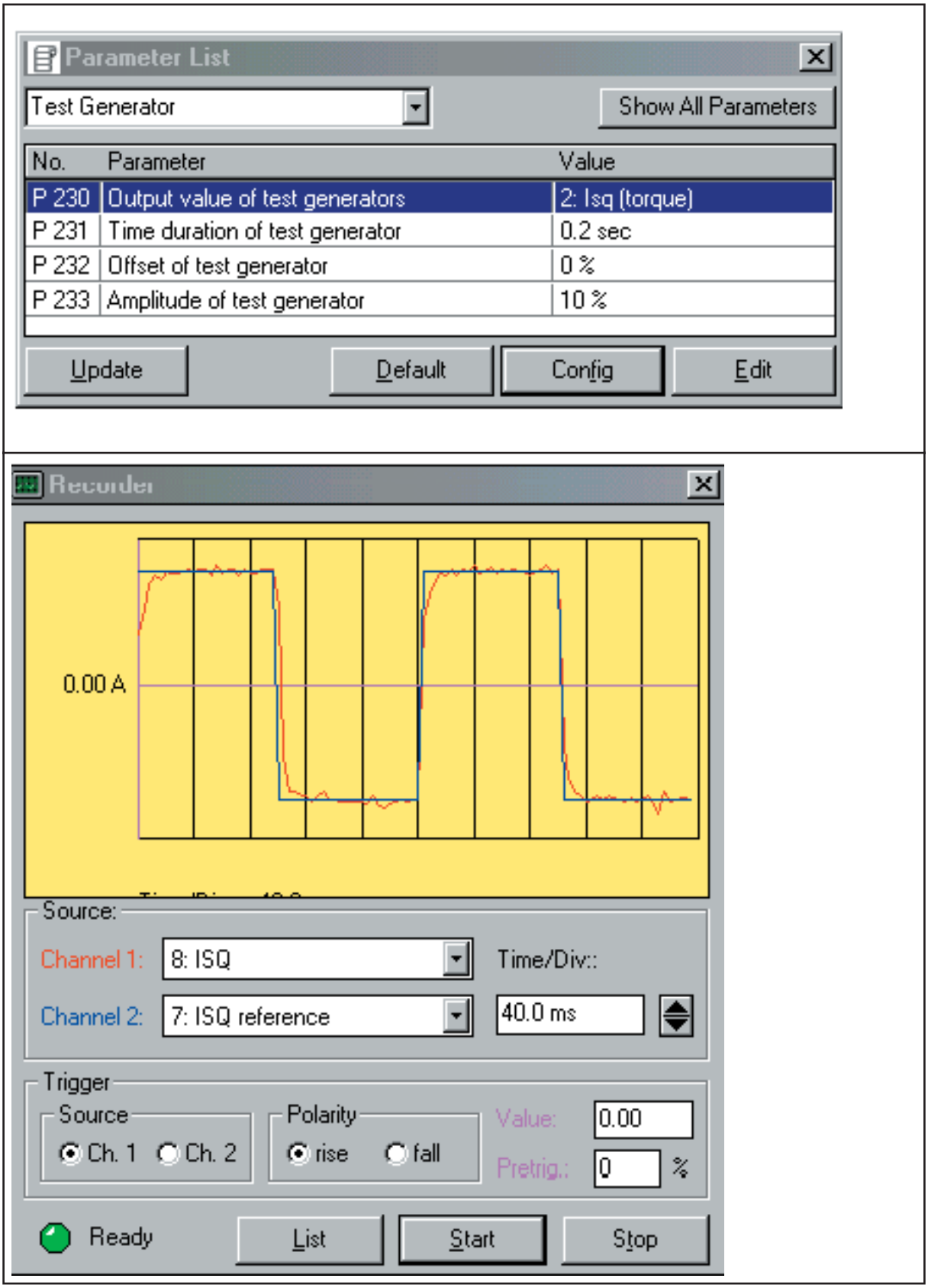
Before performing any tuning procedures, ensure the following checks are performed:
1. All relevant instruction/information from the applicable product manuals has been applied. Special attention given to electrical noise control: cable shielding, shield termination, component/system grounding, bonding etc.
2. Servo motor/encoder wired per i-Drive phasing standard.
3. Correct motor parameters entered.

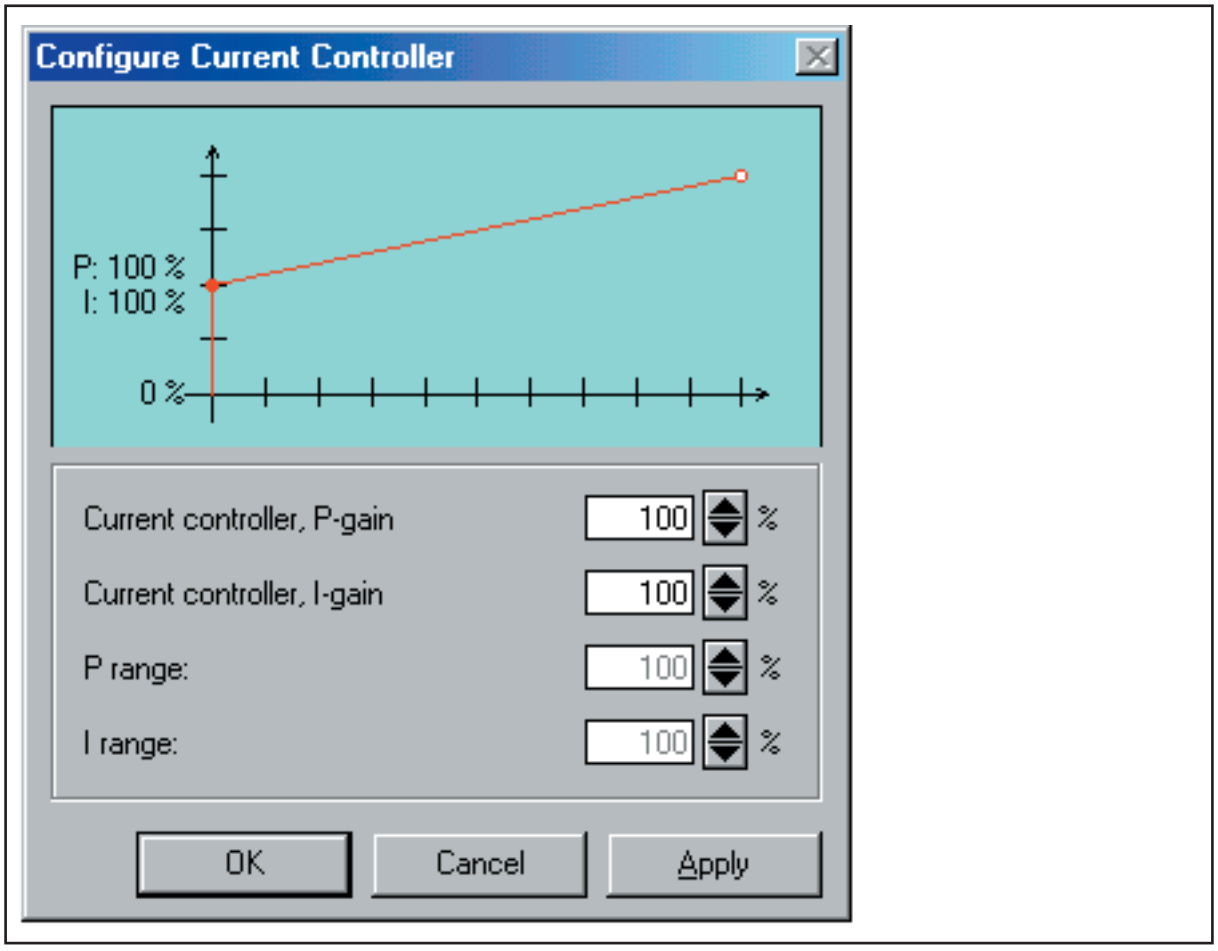
TUNING PROCEDURES

CAUTION: SUDDEN BIDIRECTIONAL MOTOR ROTATION OCCURS!

Current Loop: (retune only if necessary as previously explained)

Step
1. Motor can be tuned loaded or unloaded.
2. If pole angle finding set to 0, program a digital input for enable function and wire accordingly.
3. Set P22 = 1 and set control mode to speed/encoder (P23 = 2).
4. Cycle power to the drive, waiting at least 5 seconds before reapplying.
5. Set up test generator parameters as shown in the sample Test Generator screen. The preferred method of data entry is to highlight one of the four parameters and click Config. Enter the data in the graphical screen view. Note: Forgetting to highlight one of the parameters may cause the software to lock up.
6. Confirm test generator setting with Apply and close window.
7. Enable the drive (if applicable) and press the RUN key. Motor should now begin the bidirectional tuning motion.
8. Open the recorder (oscilloscope) utility.
9. Set up recorder as shown in sample Recorder screen. Start recorder.
10. Evaluate factory default step response (P75,P76 = 100%). If similar to sample response trace, no further adjustment necessary.
11. NOTE: for a majority of general motion control applications, fully optimized current loop tuning is not required. If the default factory tuning response is poor or fine-tuning required, adjust P-gain and I-gain accordingly.
12. If a good tune is not achievable, recheck the motor parameters, especially Resistance and Inductance. Other possibilities include: mismatched motor-drive (voltage, current); electrical noise interference; faulty motor or drive. Also try repeating entire procedure after power reset of drive and software (close/reopen).
13. Turn off Test Generator when done (P230 =0).

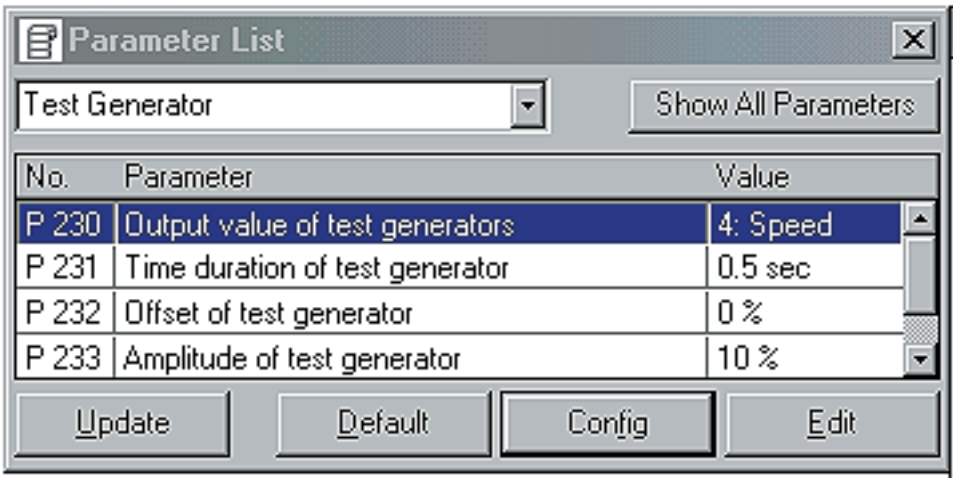

Parameter List
Test Generator
Show All Parameters
No.
Parameter
Value
P 230
Output value of test generators
2: Isq (torque)
P 231
Time duration of test generator
0.2 sec
P 232
Offset of test generator
0 %
P 233
Amplitude of test generator
10 %
Update
Default
Config
Edit
Recorder
0.00 A
Source:
Channel 1:
8: ISQ
Time/Div::
Channel 2:
7: ISQ reference
40.0 ms
Trigger
Source
Ch. 1
Ch. 2
Polarity
rise
fall
Value:
0.00
Pretrig.:
0
%
Ready
List
Start
Stop

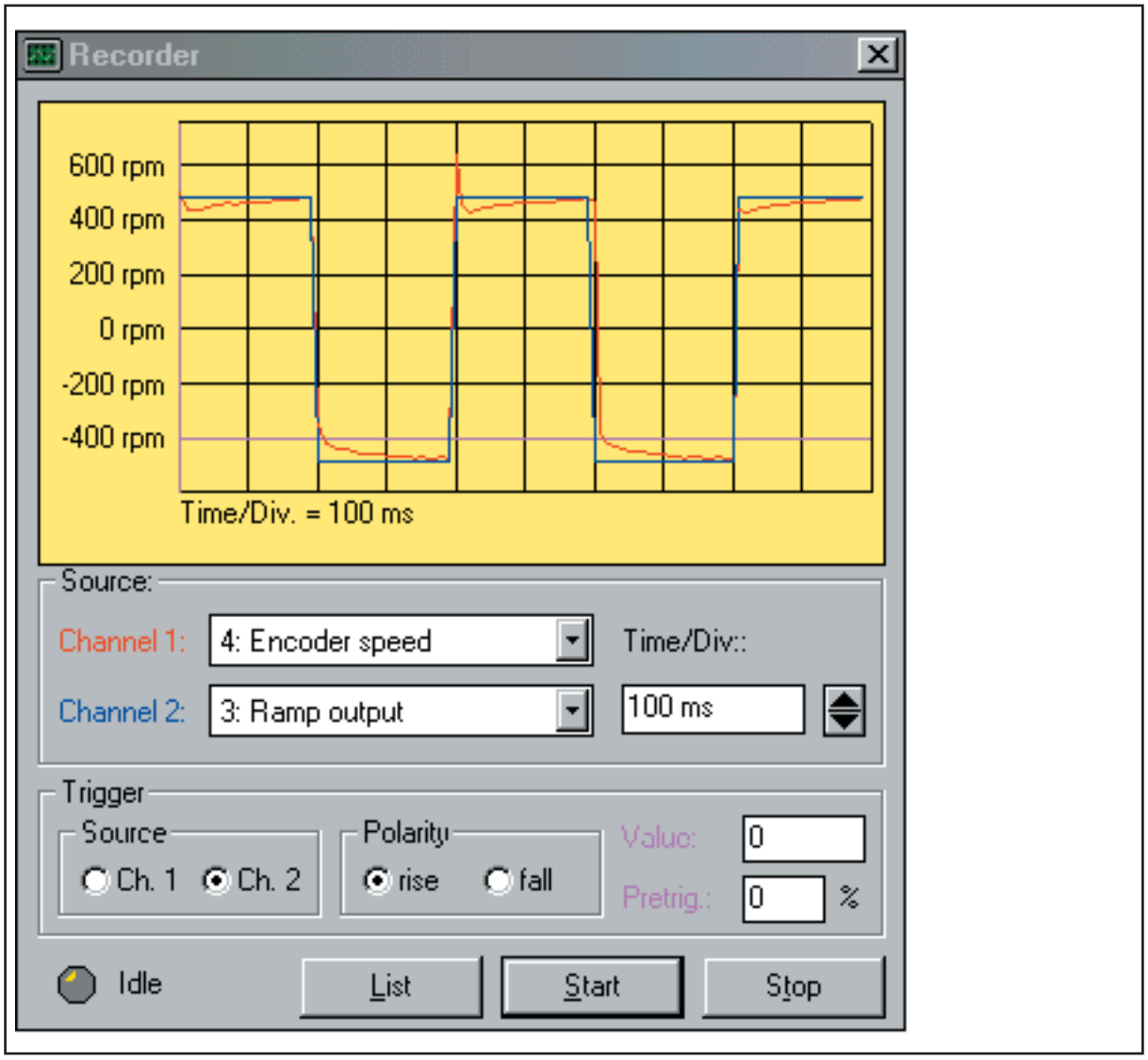


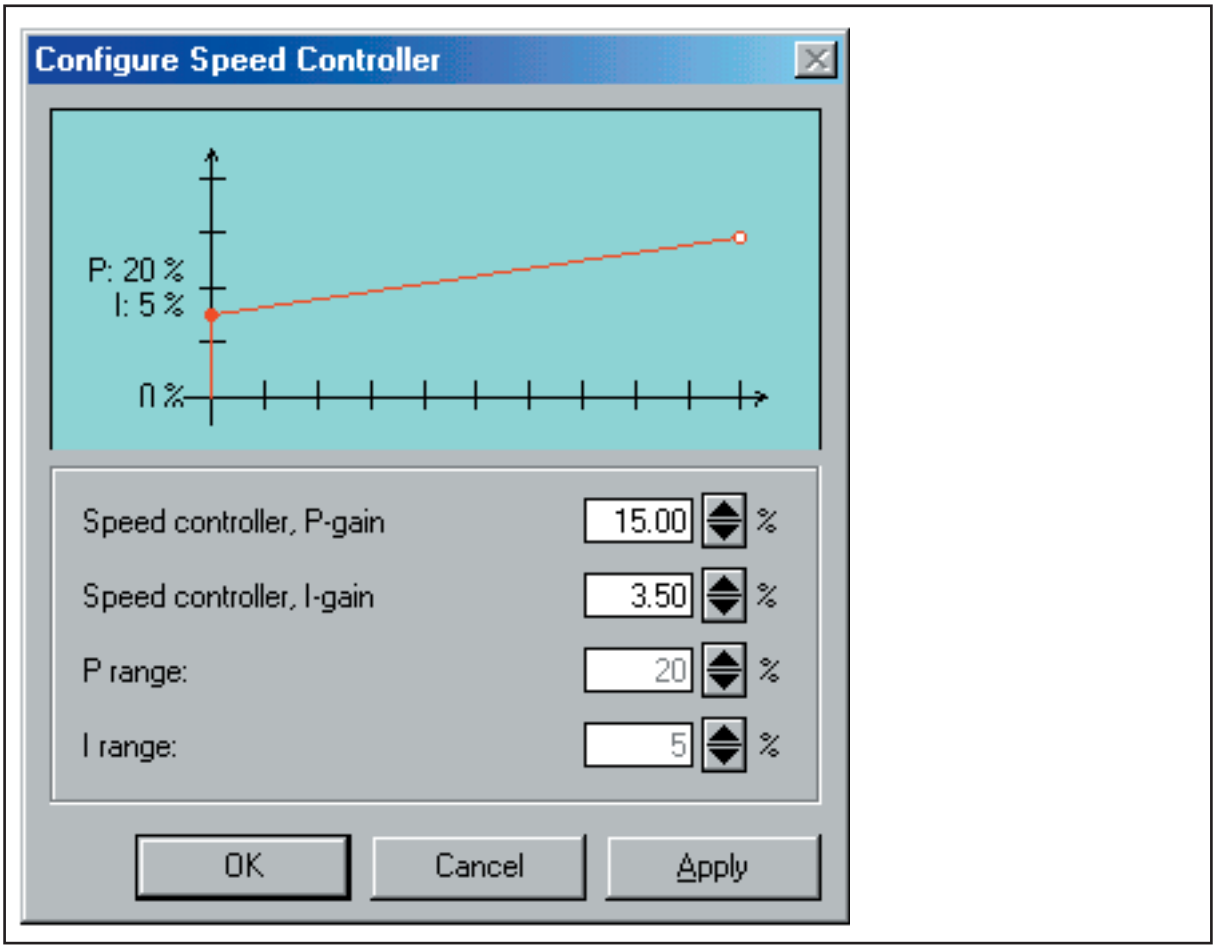
Speed Loop:

Step

1. Motor must be tuned under actual loaded condition(s).
2. If pole angle finding set to 0, program a digital input for enable function and wire accordingly.
3. Set P22 = 1 and set control mode to speed/encoder (P23 = 2).
4. Cycle power to the drive, waiting at least 5 seconds before reapplying.
5. Set up for test generator mode: Ramps P1, P2 = 0, Nmin (P4) = 0, S-ramp P90 =0.
6. Set up test generator parameters as shown in the sample Test Generator screen. The preferred method of data entry is to highlight one of the four parameters and click Config. Enter the data in the graphical screen view. Note: Forgetting to highlight one of the parameters may cause the software to lock up.
7. Confirm test generator setting with Apply and close window.
8. Enable the drive (if applicable) and press the RUN key. Motor should now begin the bidirectional tuning motion.
9. Open the recorder (oscilloscope) utility.
10. Set up recorder as shown in sample Recorder screen. Start recorder.
11. Evaluate factory default step response (P72 = 3%, P73 = 0.5%). If similar to sample response trace, no further adjustment necessary. Special attention should be given to the stability and settling time in comparison to the application requirements.
12. If the default factory tuning response is poor or fine-tuning required, adjust P-gain and I-gain accordingly. If a good tune is not achievable, recheck the motor parameters, especially Resistance and Inductance. Other possibilities include: mechanical/load problem, undersized motor or drive; mismatched motor-drive (voltage, current); electrical noise interference; faulty motor or drive. Also try repeating entire procedure after power reset of drive and software (close/reopen).
13. Turn off Test Generator when done (P230 =0)


Parameter List
Test Generator
Show All Parameters
No.
Parameter
Value
P 230
Output value of test generators
4: Speed
P 231
Time duration of test generator
0.5 sec
P 232
Offset of test generator
0 %
P 233
Amplitude of test generator
10 %
Update
Default
Config
Edit

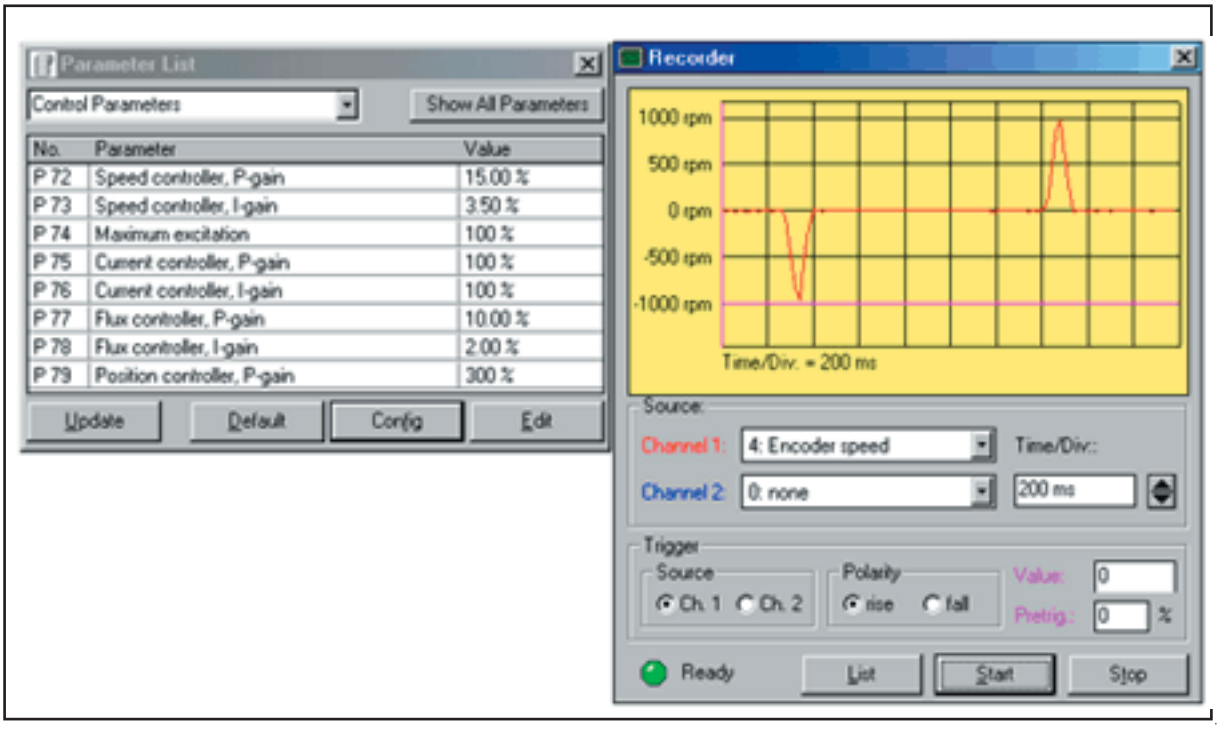

Recorder
600 rpm
400 rpm
200 rpm
0 rpm
-200 rpm
-400 rpm
Time/Div. = 100 ms
Source:
Channel 1:
4: Encoder speed
Time/Div::
Channel 2:
3: Ramp output
100 ms
Trigger
Source
Ch. 1
Ch. 2
Polarity
rise
fall
Value:
0
Pretrig.:
0
%
Idle
List
Start
Stop



Position Loop:
The current i-Drive version does not allow position step tuning via the Test Generator with position step response trace capture. To evaluate/tune the posititon loop, a basic position test program, like the one shown, can be used. Accel/Decel (P603/P604) should be set at least equal to the maximum for the application. This method is sufficient for most applications.

Step
1. While position test programming running:
2. Open the recorder (oscilloscope) utility.
3. Set up recorder as shown in sample Recorder screen. Start recorder.
4. Evaluate factory default position response (P79 = 100%). If similar to sample response trace, no further adjustment necessary. Special attention should be given to the stability and settling time in comparison to the application requirements.
5. If the default factory tuning response is poor or fine-tuning required, adjust the P-gain accordingly.
6. If a good tune is not achievable, recheck the motor parameters, especially Resistance and Inductance. Other possibilities include: mechanical/load problem, undersized motor or drive; mismatched motor-drive (voltage, current); electrical noise interference; faulty motor or drive. Also try repeating entire procedure after power reset of drive and software (close/reopen).

THE i-Drive IS NOW READY FOR APPLICATION PROGRAMMING AND NORMAL OPERATION.


Parameter List
Control Parameters
Show All Parameters
No.
Parameter
Value
P 72
Speed controller, P-gain
15.00 %
P 73
Speed controller, I-gain
3.50 %
P 74
Maximum excitation
100 %
P 75
Current controller, P-gain
100 %
P 76
Current controller, I-gain
100 %
P 77
Flux controller, P-gain
10.00 %
P 78
Flux controller, I-gain
2.00 %
P 79
Position controller, P-gain
300 %
Update
Default
Config
Edit
Recorder
1000 rpm
500 rpm
0 rpm
-500 rpm
-1000 rpm
Time/Div: = 200 ms
Source:
Channel 1:
4: Encoder speed
Time/Div::
Channel 2:
0: none
200 ms
Trigger
Source
Ch. 1
Ch. 2
Polarity
rise
fall
Value:
0
Pretrig.:
0
%
Ready
List
Start
Stop

Sample Position Tuning Program:

Basic Rotary Position Sample Program, bi-directional motion, no homing, +/- 8000 counts.

IMPORTANT:
1. For stable/best response, speed loop (P72,73) and position loop (P79) must be tuned properly for connected motor/load.
2. P5 can be increased as required for the application. Not to exceed the encoder frequency limit of connected motor/encoder combination (or value in motor file).
3. P603 accel and P604 decel limited by motor/drive/load.

Par #	Value	Parameter Description
5	1000	Maximum speed (see header note)
20	7	Display = position units
22	2	Input = digital inputs
23	5	Control mode = positioning
24	1	Enable after power on
40	1	L5 = enable (need for P109 = 0)
41	24	L6 = start sequence command
42	0	L7 = none assigned
43	0	L8 = none assigned
44	0	L9 = none assigned
600	0	Position units = encoder counts (AqB)
603	200	Acceleration in RPM/sec
604	200	Deceleration in RPM/sec
620	9	Sequence control method
621	4	Sequence stop method
622	0	Torque hold mode
623	0	Position sequence first block
624	1	Position sequence last block
700	8000	Position reference 1 in counts
701	1000	Positioning velocity 1 in RPM
702	100	Position delay time 1 in sec i...idd
705	-8000	Position reference 2 in counts
706	1000	Positioning velocity 2 in RPM
707	100	Position delay time 2 in sec

Other sample configuration test programs (not for tuning)

KEYPAD Speed Mode set-up parameters:

IMPORTANT:

1. For stable/best response, speed loop (P72, P73) must be tuned properly for connected motor/load.
2. P5 can be increased as required for the application. Not to exceed the encoder frequency limit of connected motor/encoder combination (or value in motor file).

Par #	Value	Parameter Description
1	0	Ramp-up time 0..P6 = no delay
2	0	Ramp-down time P7..0 = no delay
4	0	Minimum speed = 0 RPM
5	1000	Max speed in RPM (see header note!)
20	0	Choice of the display value = RPM
22	0	Input source = keypad
23	2	Control mode = speed w/encoder
24	0	Enable after power on = off
36	0	Filter time constant of analog input= zero
40	0	L5 = none assigned
41	0	L6 = none assigned)
42	0	L7 = none assigned
43	0	L8 = none assigned
44	0	L9 = none assigned
109	1	Start encoder commutation on power up (P40=0)

Basic Analog Torque Mode set-up parameters: command signal with L5 enable switch.

IMPORTANT:

P35 can be increased as required for application. Should not exceed P3 of motor file: maximum allowable torque current of motor-drive system (combination). Use with motor file parameters for connected motor type.

Par #	Value	Parameter Description
20	2	Choice of the display value = motor current
22	1	Input source = analog command
23	4	Control mode = torque with encoder
24	1	Enable after power on = active
32	2	Analog input range = 0 to +/- 10V
33	0	Add analog input = no
34	0	Torque at 0V = 0%
35	100	Torque at 10V = 100% default (see header note)
36	0	Filter time constant of analog input = zero
40	1	Function of digital input L5 = enable (for P109=0)
41	0	Function of digital input L6 = none assigned)
42	0	Function of digital input L7 = none assigned
43	0	Function of digital input L8 = none assigned
44	0	Function of digital input L9 = none assigned

Basic Analog Speed Mode set-up parameters: external command. Signal with L5 enable switch.

IMPORTANT:

1. For stable/best response, speed loop (P72, P73) must be tuned properly for connected motor/load.
2. P5 can be increased as required for the application. Not to exceed the encoder frequency limit of connected motor/encoder combination (or value in motor file).

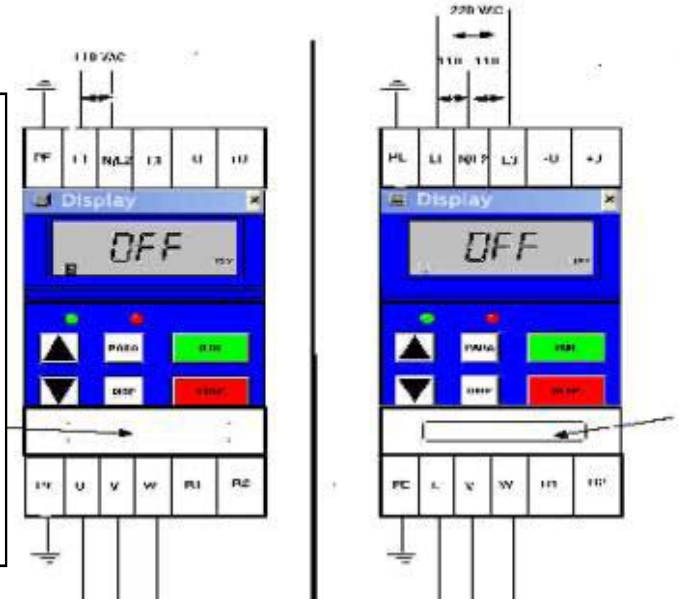
Par #	Value	Parameter Description
1	0	Ramp-up time 0..P6 = no delay
2	0	Ramp-down time P7..0 = no delay
4	0	Minimum speed = 0 RPM
5	1000	Max speed in RPM (see header note!)
20	0	Choice of the display value = RPM
22	1	Input source = analog command
23	2	Control mode = speed w/encoder
24	1	Enable after power on = active
30	0	Speed at 0V = in RPM
31	1000	Speed at 10V = in RPM (can increase to P5)
32	2	Analog input range = +/- 10V
33	0	Add analog input = no
36	0	Filter time constant of analog input= zero
40	1	L5 = enable (for P109=0)
41	0	L6 = none assigned
42	0	L7 = none assigned
43	0	L8 = none assigned
44	0	L9 = none assigned

Bayside Plug & Play Quickstart:

- Bayside BM/GM motor with encoder
- Plug&Play cables
- Bayside BM/GM catalog motor files (.txt file)

A. Wiring

1. Connect AC line per diagram.
2. Connect sensor cable.
3. Connect motor cable: wire flying leads to UVW per the wiring table for A/B vs. C/D winding type.
4. Connect serial cable with RS232/485 adapter in drive end.
5. Apply AC power, Drive display should show OFF, Red LED on and Green LED flashing.



B. Programming

1. Ensure starting with factory default parameter values by powering down drive and while holding down the PARA key, back up after 20 second delay.
2. Install win&I-Drive software and open.
3. Click online icon (extreme right icon on main screen top). LED will turn green on succesful connection.
4. Load .txt files: First, load corresponding BM/GM motor file (after opening the file and reading the notes) via File > Load From Text File command. Note that a read error usually leaves the parameter at the factory default or previous value. A P3 (maximum torque current percentage) or P103 (motor rated current) read error usually indicates the drive model is undersized relative to the motor peak or continuous rating. In this case, if possible, P3 or P103 must be manually set as required by the application sizing within the drive limit as explained in the PROGRAMMING section (assuming application does not require a larger drive). Next, load the Keypad Speed Mode file (keyspdmd.txt) after opening and reading the notes.
5. To accept parameter changes, power drive down and back up after a 20 second delay. Small bidirectional motor motion on power up is the pole angle finding initialization. If displays comes up with error E 11, most likely, P3 is set too high (due to internal rounding error after invalid P3 value read). Calculate valid P3 per PROGRAMMING section, enter and repeat step 5. If still E 11, try slightly lower value of P3 in case of internal rounding error.

C. Run motor (factory default tuning)

1. Press RUN key. Use up and down arrow keys to vary speed between 0 and 1000 rpm in CW shaft direction.
2. Reverse direction of rotation by pressing RUN key for more than 1 second.
3. Follow complete start up guide for adaptation of parameters for actual application.

12.3 Resolver interface setup for rotary servomotors (preliminary)

Resolver cable pinout as shown in the BM/GM section of catalog is valid.

UVW wiring: Swap wires as necessary such that motor commutation is normal and positive set point command = CW shaft rotation.

Basic operation: Intended to be used with industry typical single-turn resolvers i.e. one sin/cos cycle per motor rev. Resolver feedback is absolute within one rev. The index line is used for the fixed absolute reference position strobe every rev. Absolute data only needed 1st time after power up. The simulated TTL encoder keeps track from there. The once per rev position strobe also serves as a simulated index for homing in indexing applications.

Resolver setup parameters:

P70 encoder increments (lines/rev) = 1024 (internal resolver interpolation factor)
P71 encoder type = 1 (TTL)
P106 = per automatic test
P107 = 3 (resolver with pole angle via P106)

Automatic resolver angle offset determination: Need to do once per a given physical arrangement of a motor with resolver. Necessary to align the commutation angle (P106) to a specific resolver angle, based on a controlled mini test motion.

Procedure:
- Set P107 = 4 (estimate pole angle now)
- Set P108 = 1 (on, motor mini test motion activated)
- Click Update parameters.
- P107 should be reset to 3
- P108 should be reset to 0
- Motor should now run with correct commutation angle.

Tuning: Compared to values for encoder motors, resolver motors may need to be detuned (lower gains) for a good stable response.

12.4 Hall/encoder frequence divider interface setup

DESCRIPTION:
This dual use interface option is used for the following purposes.
1) Hall start up commutation (motionless) instead of encoder commutation (pole angle finding with motion on start up).
2) As an encoder frequency divider for applications where higher max. speed is required than normally allowed for the specified encoder resolution limited by the 150k Hz encoder max. channel frequency (600k Hz AquadB).
3) Both requirements.

DRIVE AND SOFTWARE COMPATIBILITY:
Requires drive firmware 3.064 or higher. Requires 3.065 or higher for Hall offset angle finding utility.

ITEM NUMBERS:
Various. Item numbers will specify the frequency division factor and single-ended (US) or differential (European) version. Planned division factors are 1, 2, 4, 8 and 16.

PARAMETERS DESCRIPTION/FORMULA:
P5 (MAX. SPEED): Enter the lessor of the max. motor RPM or max. RPM as limited by the encoder frequency. Max. encoder limited RPM = 150,000 Hz x 60 x DF divided by encoder lines/rev. DF equals division factor 1, 2, 4, etc. Encoder lines/rev is pre-interface or device resolution.

P70 (ENCODER INCREMENTS): Enter the encoder lines/rev = pre-interface or device lines/rev divided by DF (division factor).

HALL MODE SETUP:
1. Install the interface module in series with the sensor cable at the drive end.
2. Wiring & Parameters setup: identify applicable revision combination -

1. C/D motor winding and i-Drive power cable version with UVW (blk 123) = motor connector pins 143:
   1. Connect flying power leads to drive such that UVW at i-Drive terminals = blk 312.
   2. P5 (max. speed): Calculate per P5 formula for division factor DF of connected interface.
   3. P70 (encoder increments): Calculate per P70 formula for division factor DF of connected interface.
   4. P106 (Hall angle offset): Enter 0 degrees.
   5. P107 (pole finding method): Enter 5 for Hall start up, US single-ended signal. Enter 6 for Hall start up, EU differential signal.

2. Generic motor or cables
   1. Refer to diagrams for i-Drive phase/sequence requirements: Hall sequence, Hall/phase EMD retionships, encoder sequence.
   2. Follow steps 2-5 in section 2.1.x.

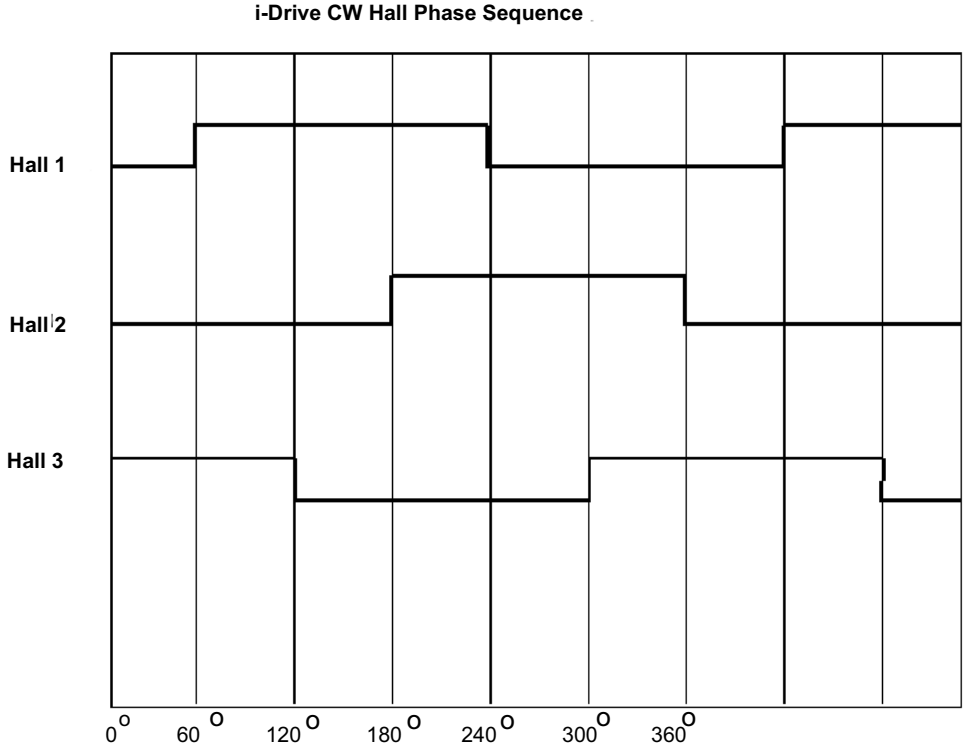
3. **A/B motor winding:** Standard i-Drive sensor cable is not compatible with this motor's Hall sequence. Require special sensor cable and power cable connections to conform to the i-Drive standard as shown in the diagrams. Required wiring: Hall 1,2,3 = Z,Y,X; Phase U,V,W = Z,Y,X. Consult with an i-Drive specialist for further advice.

Note: For existing i-Drive applications with C/D motor that are switching to Hall mode, alternate Hall mode setup that does not require UVW wiring changes are possible. Contact an i-Drive specialist for custom Hall angle offset for your application.

ENCODER FREQUENCY DIVIDER (ONLY) SETUP:
If the interface is only being used for frequency division, only P5 and P70 need to be set accordingly. Calculate per the P5 and P70 formulas for the division factor DF of connected interface.

AUTOMATIC HALL OFFSET ANGLE FINDING (FW 3.066 or higher):
This feature is usefull for confirmation of the entered Hall angle offset (P106) e.g. custom or generic applications.

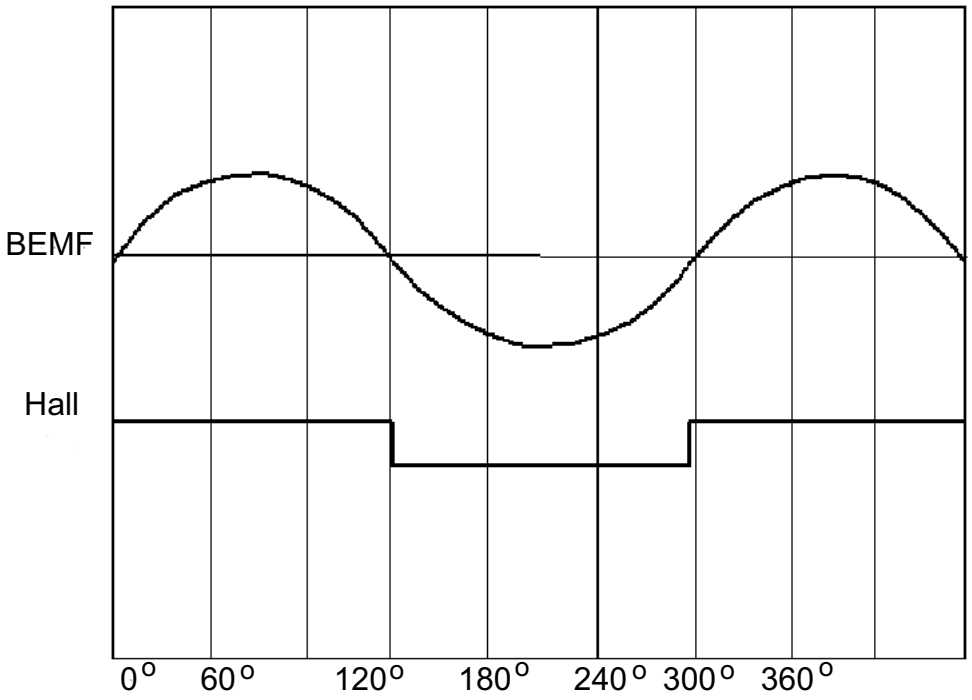
1. i-Drive software in online mode.
2. Set P107 to 6.
3. Set P108 to 1 (on). Performs pole angle finding test motion.
4. Click Update parameters. P107 should reset to 5. P108 should reset to 0.
5. P106 now contains the “detected” Hall offset angle.



PHASING DIRECTION: CW
HALL 1 LEADS HALL 2 LEADS HALL 3 (RISING EDGES)
SIGNALS AT HALL INTERFACE INPUT SIDE TO COMMON

NOTE: ENCODER SEQUENCE MUST BE **A LEADS B** IN THE CW PHASING DIRECTION.

i-Drive CW Rotation Oscilloscope Diagram
Motor with Hall offset = 0°



MOVE VERY STEADY, DIRECTION SAME AS HALL PHASING

HALL COMMON = ENCODER 5V COMMON
FIRST MOTOR LEAD IS PROBE TIP, SECOND MOTOR LEAD IS PROBE GROUND CLIP

I-Drive phasing pairs for CW rotation:

As leads would be connected to specified drive terminals:

Hall 1 in phase with V-W
Hall 2 in phase with W-U
Hall 3 in phase with U-V

13 Position control

Preconditions

Positioning control is only possible under the following preconditions:

- Use of feedback (encoder, reslover), if possible with index pulse. The position set value can be preset via all set value inputs (see P22).
- Parameter P23 (control mode) is set to on 5 (positioning control)
- The digital inputs of parameters P40 – 44 must be set with the appropriate positioning control functions.

13.1 i-Drive basic parameters which affect positioning

Parameter	Function
P20	Selection of display value.
	7: current unit (see also P600 and P601). When the power supply is switched on, the position at that moment is set to 0. This can be overwritten / redefined by homing

P22	Set value
	0: Positioning by motor potentiometer 1: Positioning via analog input 2: Digital inputs: Extra functions in positioning such as fixed positioning, start sequence control etc. are possible via the digital inputs 3: Positioning via serial interface

P23	Drive control
	5: Positioning control (feedback neccessary)

P27	Display of actual position

	Positioning via analog input
P37	Position at 0V / 0mA / 4mA, if P22 = 1 (analog input), see also P600
P38	Position at 10V / 20mA, if P22 = 1 (analog input)

Parameter	Function	
P40 – 44	**Digital input function**	
	18:	Homing switch
	19:	Negative limit switch
	20:	Positive limit switch
	21:	Starting signal for homing
	22:	Fixed positioning
	23:	Start sequential positioning (maintained)
	24:	Start of sequence and next switch (momentary)
	25:	Next switch (momentary)
	26:	Fixed torque

	27:	Go to BCD coded position (momentary)
	28:	BCD coded input for fixed positioning (See BCD-coded position digital inputs in chapter 7

P57	**Relay output function**
	4: Target reached

P58	**Relay output speed limit**

P79	**Position controller**
	Gain factor of the position controller

13.2 Basic parameters of positioning control

Overview:

P600	Unit of the positioning set value
P602	Speed for analog positioning
P605 - 609	Homing
P610 - 614	Simple positioning: fixed positions which can be selected via the digital inputs (P40 - 44).
P620 - 622	Sequence control
P630 - 633	Resolution of set value
P640 - 641	Position and speed window
P700 - 797	Definition of up to 20 positions

13.2.1 Position set value unit, P600

P600 fixes the position set value unit.

P600	**Function**
0	Encoder increments or counts Example: An encoder with 2000 lines / revolution is connected. One revolution = 2000 lines = 8000 increments/counts (post quadrature)
1	Angle degrees 360° correspond to one motor revolution.
2	Revolution
3	Revolution, but inverted to 2

A user specific unit could be defined by parameters P630 to P633.

Power reset: When any of these parameters are changed, the power supply for the drive has to be shut down for a minimum of 20 seconds before switching back on.

13.2.2 Speed for positioning via the analog input or motor potentiometer, P602

P602 defines the speed for positioning via the analog input or the motor potentiometer.

Precondition:
P22 = 0 (motor potentiometer) or 1 (analog input)

P602	**Speed in rpm**

13.2.3 Ramps for positioning, P603, P604

P603 – 604 defines the acceleration and deceleration ramps for positioning

P603	Acceleration in rpm per millisecond x 10 Value range 0 to 8000 **Example:** An acceleration value of 150 represents 15 rpm/ms x 10. 15 rpm/ms x 1000ms/1sec = 15,000 rpm/sec. At an acceleration of 15,000 rpm/sec, the motor reaches 2,000 rpm in 0.13 seconds.

P604	**Deceleration ramp in rpm per millisecond x 10** Value range from 0 to 8000

13.3 Homing, P605 - P609

Homing describes a procedure whereby the motor is driven to a specific position. This position functions as a reference position for the subsequent positioning task. In most procedures, the motor moves at a defined speed to a limit switch, stops, reverses and continues on at a second defined speed [P607] to the next index pulse of the encoder. Note that if the index search speed is too fast, the final rest position will be offset from true home. This will be taken into account on the first move.

In addition, an offset can be added. The required homing position is given a defined value <> 0.

When selecting a homing method, please note that a “homing switch” does not have any protective function of a limit switch. Therefore, if limit switches are needed, homing should be carried out on a limit switch, in order to conserve digital inputs.

P605 Homing methods

All homing procedures are implemented in accordance with CANopen DSP 402.

Methods with index pulse

Method	Description
1	Homing off the negative limit switch
2	Homing off the positive limit switch
3	Homing off the homing switch
4	Homing off the homing switch
5	Homing off the homing switch
6	Homing off the homing switch
7	Homing off the homing switch
8	Homing off the homing switch
9	Homing off the homing switch
10	Homing off the homing switch
11	Homing off the homing switch
12	Homing off the homing switch
13	Homing off the homing switch
14	Homing off the homing switch
15	Reserved
16	Reserved

Methods without index pulse

Method	Description
17	Homing without index pulse similar to Method 1
18	Homing without index pulse similar to Method 2
19	Homing without index pulse similar to Method 3
20	Homing without index pulse similar to Method 4
21	Homing without index pulse similar to Method 5
22	Homing without index pulse similar to Method 6
23	Homing without index pulse similar to Method 7
24	Homing without index pulse similar to Method 8
25	Homing without index pulse similar to Method 9
26	Homing without index pulse similar to Method 10
27	Homing without index pulse similar to Method 11
28	Homing without index pulse similar to Method 12
29	Homing without index pulse similar to Method 13
30	Homing without index pulse similar to Method 14
31	Reserved
32	Reserved

33	Homing at the next index pulse, negative rotation direction
34	Homing at the next index pulse, positive rotation direction
35	Current position = home position

Method 1: Homing off the Negative Limit Switch

Using this method the initial direction of movement is left if the negative limit switch is inactive (logic low). The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.

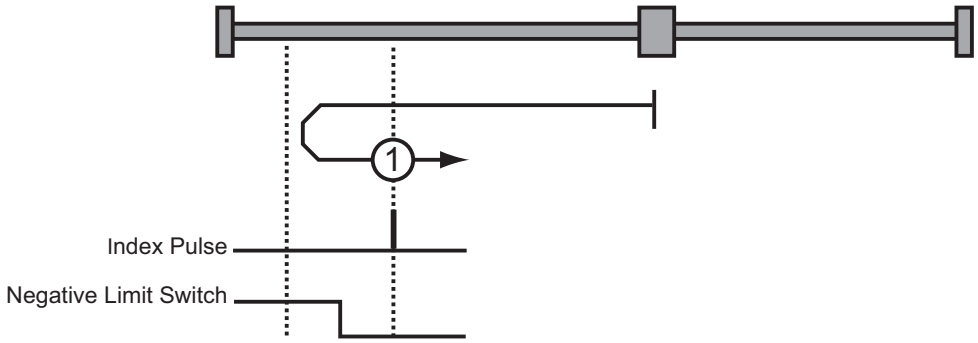


Figure 1: Homing off the Negative Limit Switch

Method 2: Homing off the Positive Limit Switch

Using this method the initial direction of movement is right if the positive limit switch is inactive (logic low). The position of home is at the first index pulse to the left of the position where the positive limit switch becomes inactive.

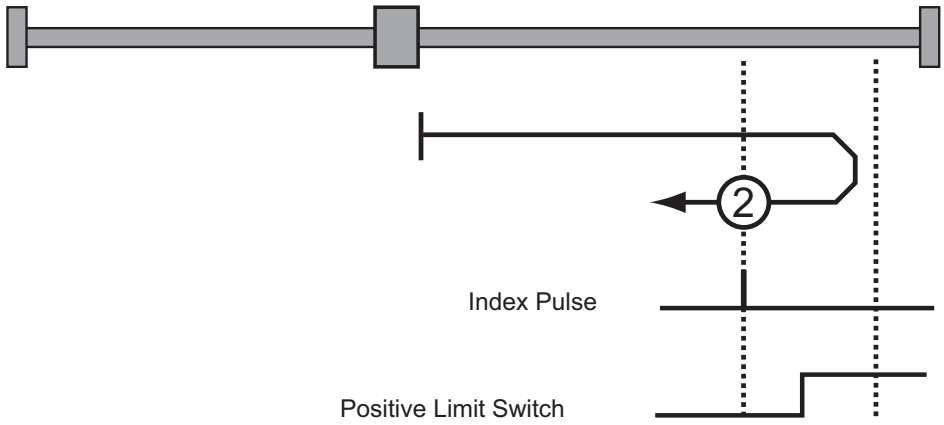


Figure 2: Homing off the Positive Limit Switch

Methods 3 and 4: Homing off the Positive Home Switch and Index Pulse

Using methods 3 or 4 the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

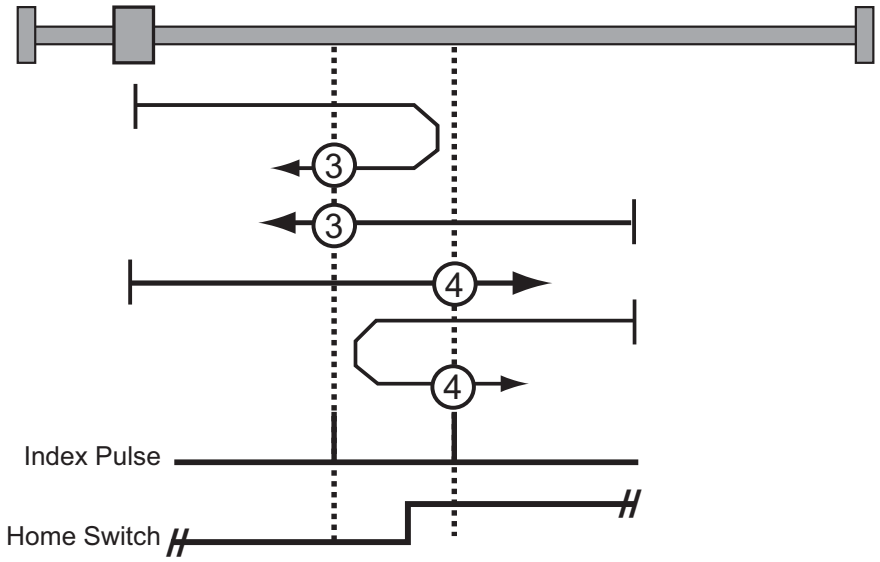


Figure 3: Homing off the Positive Home Switch and Index Pulse

Methods 5 and 6: Homing off the Negative Home Switch and Index Pulse

Using methods 5 or 6 the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

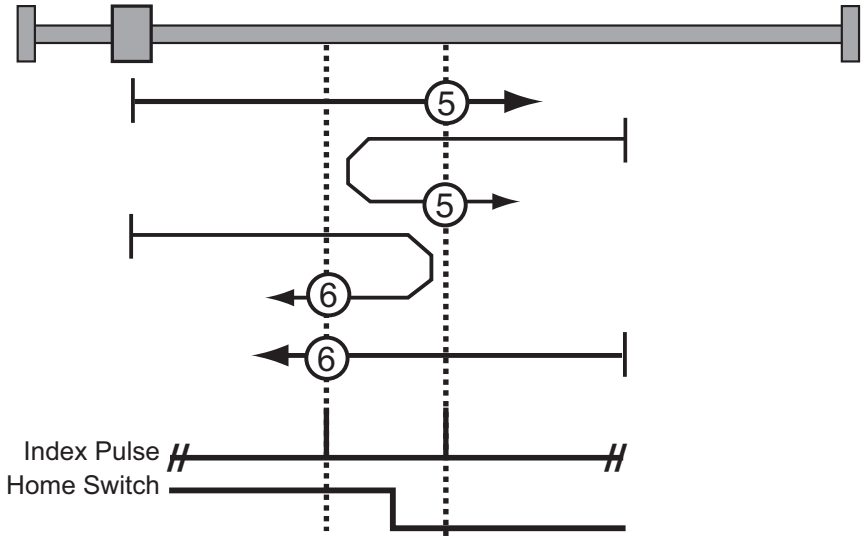


Figure 4: Homing off the Negative Home Switch and Index Pulse

Methods 7 to 14: Homing off the Home Switch and Index Pulse

These methods use a home switch which is active over only a portion of the travel, in effect the switch has a ‘momentary’ action as the positioner sweeps past the switch.

Using methods 7 to 10 the initial direction of movement is to the right, and using methods 11 to 14 the initial direction of movement is to the left except if the home switch is active at the start of the motion. In this case the initial direction of motion is dependent on the edge being sought. The home position is at the index pulse on either side of the rising or falling edges of the home switch, as shown in the following two diagrams. If the initial direction of movement leads away from the home switch, the drive must reverse on encountering the relevant limit switch.

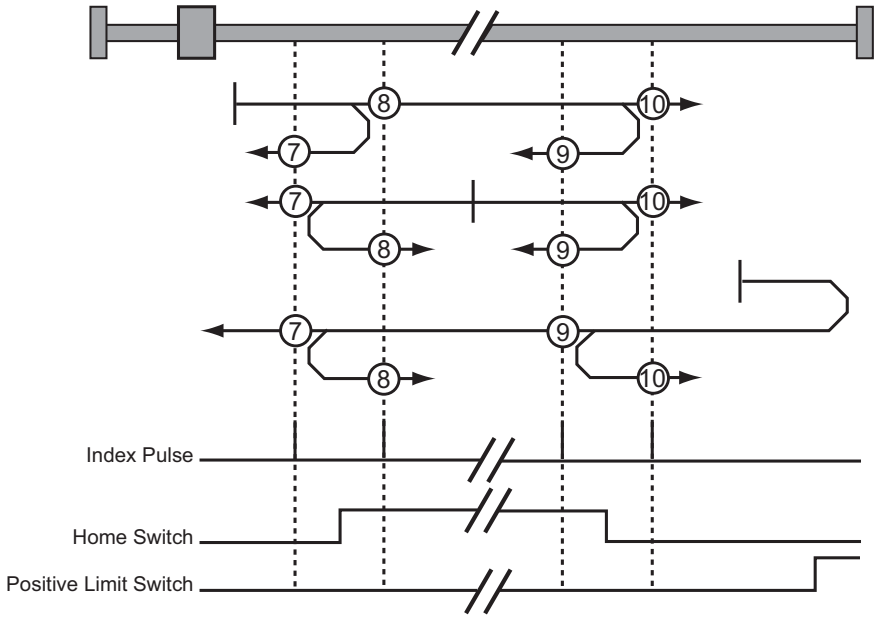


Figure 5: Homing off the Home Switch and Index Pulse - Positive Initial Move

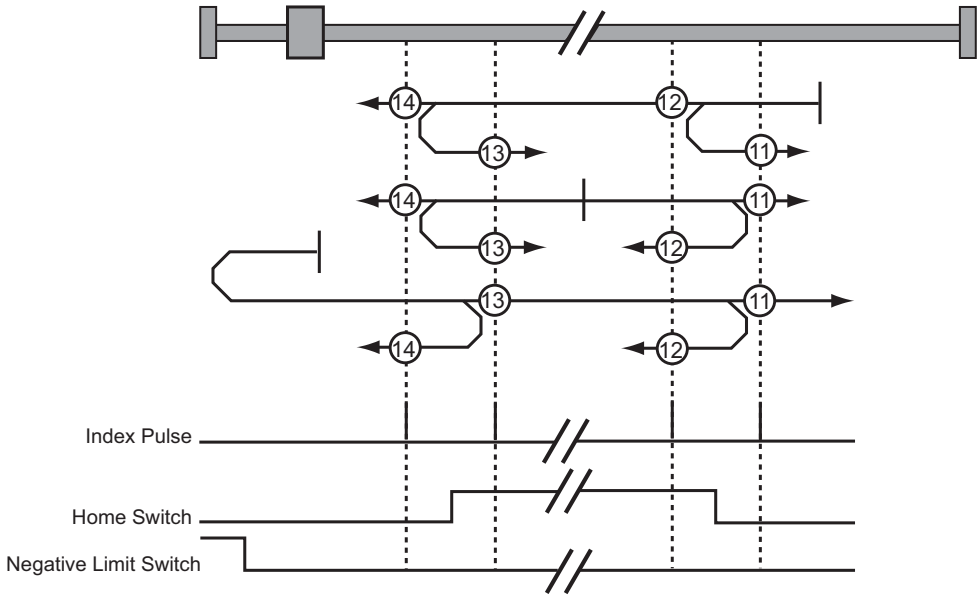


Figure 6: Homing off the Home Switch and Index Pulse - Negative Initial Move

Methods 15 and 16: Reserved

These methods are reserved for future expansion of the homing mode.

Methods 17 to 30: Homing without an Index Pulse

These methods are similar to methods 1 to 14 except that the home position is not dependent on the index pulse but only dependent on the relevant home or limit switch transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in the following diagram.

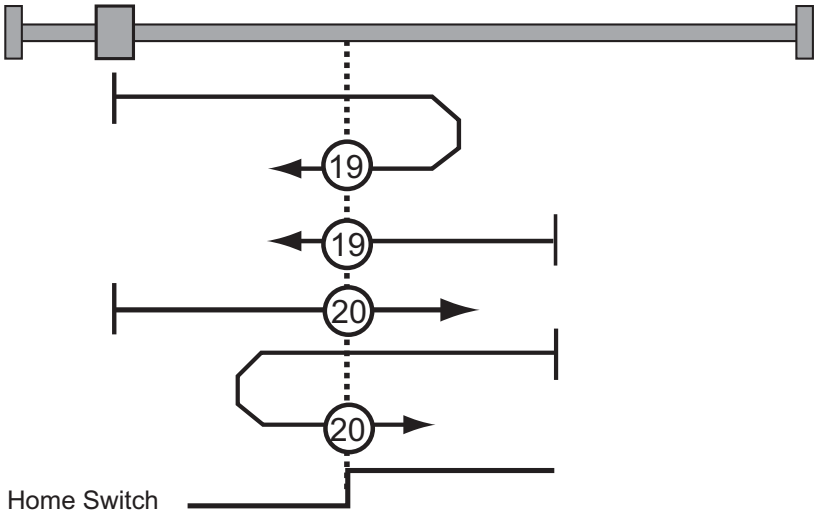


Figure 7: Homing on the Positive Home Switch

Methods 31 and 32: Reserved

These methods are reserved for future expansion of the homing mode.

Methods 33 to 34: Homing on the Index Pulse

Using methods 33 or 34 the direction of homing is negative or positive respectively. The home position is at the first index pulse found in the selected direction.

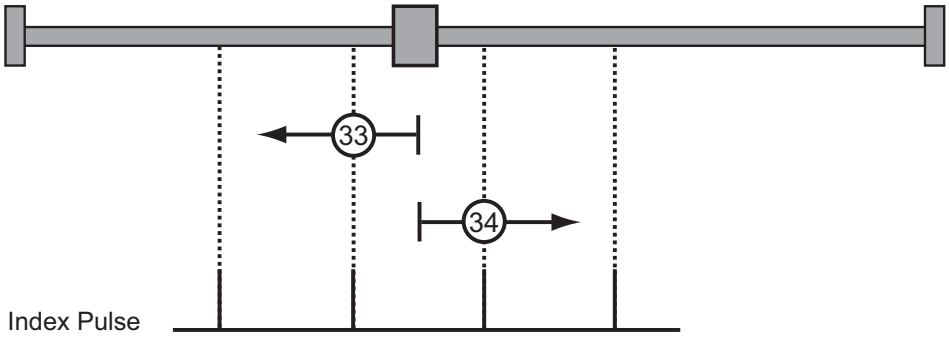


Figure 8: Homing on the Index Pulse

Method 35: Homing on the Current Position

In method 35 the current position is taken to be the home position.

Further homing parameters, P606 - P609

Parameter	Function
P606	Speed (rpm) approaching the next limit switch
P607	Speed (rpm) to the next index pulse.
P608	Offset The determined homing position is added to the offset value. Position unit corresponds to P600.
P609	Manual homing By setting P609 to 1 homing is triggered (method in accordance with P605). P609 is automatically reset to 0.

Example homing routine set-up:

Par #	Value	Parameter Description
41	21	L6 = start homing momentary switch
42	19	L7 = negative limit (CCW motor dir)
605	1	Homing method = negative (CCW) limit/index
606	25	Homing speed (RPM) to limit
607	5	Homing speed (RPM) back to index
608	0	Home offset

13.4 Fixed positions via digital inputs, P610 - P614, P700 - P722

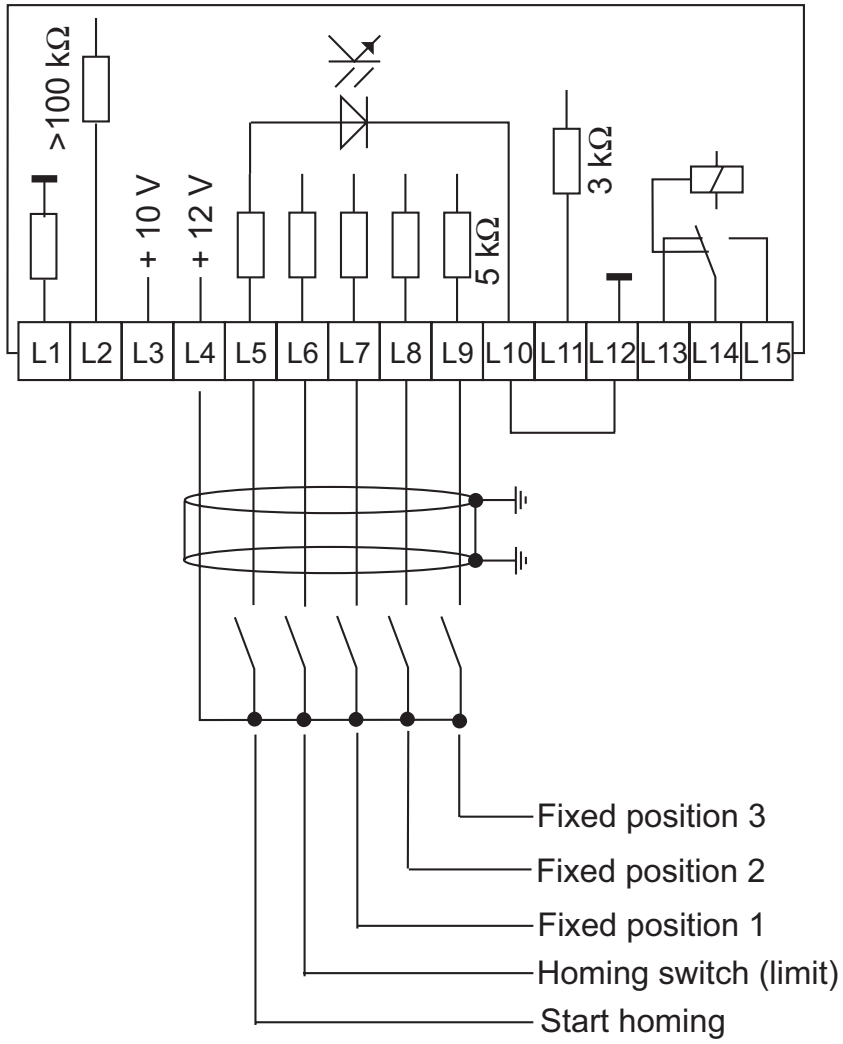
The i-Drive has 5 digital inputs, to which an **absolute** or a **relative** position can be allocated. The number of available positions is reduced by possible limit switches connected as position or homing switches .

Precondition:

P22 = 2 Input source digital inputs

P40 – 44 The respective input must be occupied by the appropriate function.

Example positioning interface:



13.4.1 Methods of fixed positioning via digital inputs

There are three different types of positioning:

1. Absolute positioning (methods 0 – 6)

The position set value is absolute, i.e. it is referenced from the home position. If this does not exist, the home position is assumed once the power supply is switched on. From there the position set value is counted positively in the right/CW direction.

2. Relative positioning (methods 7 – 13)

The position set value is relative, i.e. it always refers to the current (standstill) position.

3. Floating relative positioning/registration move (method 14 – 20):

The position set value is floating and relative, i.e. it refers to the position at that moment. If the drive is in motion at the moment of activation, the set value is counted from the position at that moment.

The parameters 610 to 614 are used to fix the positioning method for the respective digital input. The appropriate position set value and the speed to the position are defined accordingly by the P7XX parameters.

For the input to function as by a fixed position, the following parameters must be defined:

Function from P40–44	Digital input / terminal	Method	Positioning set
P40 = 22 fixed position	L 5/5	P610 = 0 – 20	P700 – 702
P41 = 22 fixed position	L 6/6	P611 = 0 – 20	P705 – 707
P42 = 22 fixed position	L 7/7	P612 = 0 – 20	P710 – 712
P43 = 22 fixed position	L 8/8	P613 = 0 – 20	P715 – 717
P44 = 22 fixed position	L 9/9	P614 = 0 – 20	P720 – 722

Important:

1. When no fixed position inputs are active, the drive is only in a zero speed servo state (position loop inactive). Note that zero speed servo shaft stiffness is much lower than position shaft stiffness (well tuned position loop). This behavior also applies when digital inputs are assigned as momentary switches. The time parameter can be used to extend the position mode active state. To move from one position to another with position mode continuously active, switch the new position maintained input, then deactivate the current position maintained input.

P610-614			Fixed positions via digital inputs
Method abs.	rel.	fl.rel.	Meaning
0 /	7 /	14	**The respective input is treated as a <u>maintained switch</u>:** Positioning lasts as long as the switch is on (position mode active/high stiffness): ON: When the input is switched on. OFF: When the input is switched off (not dependent on the position reached and the time parameter)
1 /	8 /	15	**The respective input is treated as a <u>momentary switch</u>:** Positioning lasts as long as the time calculated from the start has not elapsed. Then switches to zero command speed (lower shaft stiffness). ON: When the input is pressed. OFF: When the time calculated from the positioning switch-on has elapsed (not dependent on the position reached).
2 /	9 /	16	**The respective input is treated as a <u>momentary switch</u>:** Positioning lasts as long as the time calculated from reaching the target position has not yet elapsed. Then switches to zero command speed (lower shaft stiffness). ON: When the input is pressed. OFF: When the time, calculated from the time the target position has been reached, has elapsed .
3 /	10 /	17	**OR combination of method 0 / 7 / 14 and method 1 / 8 / 15:** ON: When the input is switched on. OFF: When the input is switched off <u>or</u> the time, calculated from switch-on, has elapsed
4 /	11 /	18	**AND combination of method 0 / 7 / 14 and method 1 / 8 / 15:** ON: When the input is pressed. OFF: When the input is switched off <u>and</u> the time, calculated from switch-on, has elapsed (not dependent on the position reached).
5 /	12 /	19	**OR combination of method 0 / 7 / 14 and method 2 / 9 / 16:** ON: When the input is switched on. OFF: When the input is switched off, <u>or</u> the time, calculated from the time the target position is reached, has elapsed.
6 /	13 /	20	**AND combination of method 0 / 7 / 14 and method 2 / 9 / 16:** ON: When the input is switched on. OFF: When the input is switched off <u>and</u> the time, calculated from the time the target position is reached, has elapsed.

13.4.2 Aborting a positioning in progress:

If a positioning task is aborted before the target position has been reached, the following rules apply:

If the same input is set, which triggered the abort / interruption, the positioning sequence is continued and completed.

If a different input is set, there are three different positioning variants (depending on the positioning mode):

- **Absolute positioning**
  The new absolute target position is approached.

- **Relative positioning:**
  The new target position is calculated relatively to the target position that should have been reached.

  Example: Old target position 100mm, aborted at 50mm. New relative traversing distance: 200mm.
  Result: The drive traverses 200mm further from the 100mm theoretically reached.

- **Floating relative positioning:**
  The new target position becomes the actual position, i.e. in the example above of 50 mm actually reached, 200mm is then traversed from the 50mm actually reached.

If inputs are set simultaneously:

P615	Function
0	The positions are carried out one after another: first the one with the lowest order number, then the next largest and so on.
1	The positioning sequence that was activated last is carried out.

13.5 Sequential positioning, P620

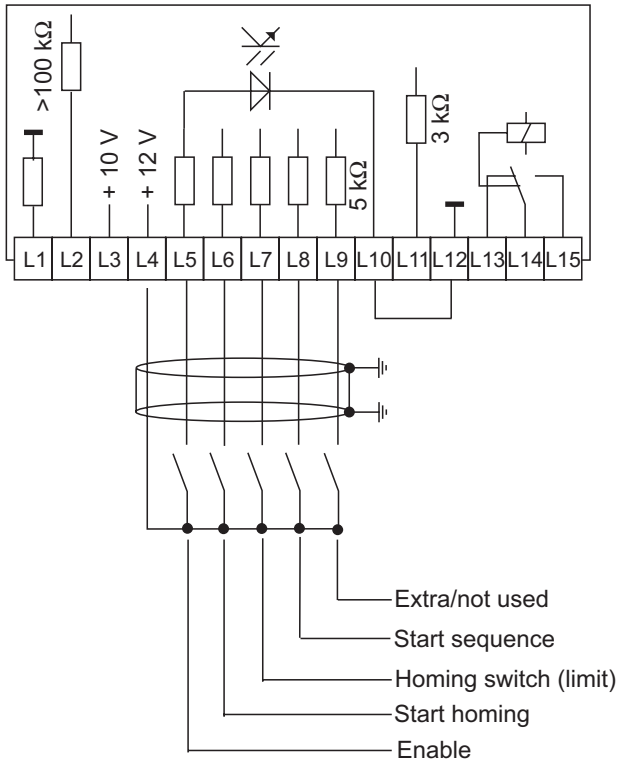
Up to 20 positions, which are approached sequentially, can be processed. A positioning set comprises the target position, the speed to reach it and the delay time. In P620 the method of traversing from position to position is selected, and whether the positions are absolute or relative target positions.

Precondition:

P22 = 2: Input source digital inputs

P40 – 44: The respective input must be occupied by the appropriate function.

Example positioning interface:



13.5.1 Methods of sequential positioning

There are three different types of positioning:

1. Absolute positioning (methods 0 – 6)

The position set value is absolute, i.e. it is referenced from the home position. If this does not exist, the home position is assumed once the power supply is switched on. From there the position set value is counted positively in the right/CW direction.

2. Relative positioning (methods 7 – 13)

The position set value is relative, i.e. it always refers to the current (standstill) position.

3. Floating relative positioning (method 14 – 20):

The position set value is floating and relative, i.e. it refers to the position at that moment, i.e. if the drive is in motion at the moment of activation, the set value is counted from the position at that moment.

P620			Positioning via sequence control
Method			Description
abs.	rel.	fl.rel.	
0 /	7 /	14	The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the Next key is pressed (digital input with Function 25). Delay times are not taken into account.
1 /	8 /	15	The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the **delay time**, counted from the start of the previous position, has elapsed.
2 /	9 /	16	The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the **delay time**, counted from when the previous position is reached, has elapsed.
3 /	10 /	17	OR operation The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the Next key is pressed (digital input with Function 25) **OR** when the delay time, counted from the start of the previous position, has elapsed.
4 /	11 /	18	AND operation The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the Next key is pressed (digital input with Function 25) **AND** when the delay time, counted from the start of the previous position, has elapsed..
5 /	12 /	19	OR operation The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the Next key is pressed (digital input with Function 25) **OR** when the delay time, counted from when the previous position is reached, has elapsed.
6 /	13 /	20	AND operation The first sequence control position is approached by setting the digital input with Function 23 or 24. The next position is approached when the Next key is pressed (digital input with Function 25) **AND** when the delay time, counted from when the previous position is reached, has elapsed.

13.5.2 Ending the sequence control, P621

P621 determines the sequential behavior and stop method.

The positions are executed, one after another, until ...

P621	Ending the sequence control (With P4X = 23 maintained switch mode)
0	… the digital input which started the sequence control is reset (switch). All positions are passed once at maximum.
1	... the last target position has been reached and the appropriate delay time has elapsed (key button). All positions are passed once.
2	... the digital input which started the sequence control is reset **AND** the last target position, including delay time, has elapsed. All positions are passed once at maximum.
3	the digital input which started the sequence control is reset **OR** the last target position, including delay time, has elapsed. All positions are passed once at maximum.
4	... all positions are passed and the sequence begins again until the digital input which started the sequence control is reset. Resetting the digital input causes the sequence control to be stopped immediately.
5	... the digital input which started the sequence control is reset. All positions are passed and the sequence begins again. Resetting the digital input causes the sequence control to be stopped when the last positioning is complete.
6	… the digital input which started the sequence control is reset. All positions are passed and the sequence begins again. Resetting the digital input causes the sequence control to be stopped when the last positioning is complete. **In addition, homing is carried out.**

Please note: As soon as the target position has been reached, the drive reverts to the state defined in Parameter 622.

13.5.3 Torque at the target position, P622

P622 determines whether the drive remains active (torque available) when the appropriate target position has been reached, or whether the output voltage is switched off (the drive can be moved from target position).

P622	Function
0	Positioning remains active for the duration of the entire sequence control.
1	As soon as the appropriate target position has been reached, the output voltage (torque) is switched off for a settable time (see P625).

13.5.4 Assignment of sequence control positions, P623 - P624

P623	**First** sequence control position This parameter determines the first of a maximum of 20 positions, with which the sequence control can begin. Definition area: 0 – 19

P624	**Last** sequence control position This parameter determines the last sequence control position. Definition area: 0 – 19; although ≥ P623

13.5.5 Output voltage, P625

P625	Time for which the output voltage at the target position is switched off, see P622 = 1

13.6 User defined gear ratio and feed-rate constant, P630 - P633

Using parameters P630 and P631 it is possible to take into account the mechanical drive elements of an axis. Gearing, pinion diameter or leadscrew pitch can thus be taken into account in the encoder resolution.

Parameter P600 forms the basis for calculating the position set value (increments, angular degrees, revolutions).

P630	Ratio or scaling numerator
P631	Ratio scaling denominator
P632	4 integer positions of the feed-rate constant
P633	4 decimal positions of the feed-rate constant

13.6.1 Gear ratio, P630 to 631

Parameters 630 and 631 are used to input gear ratio in integer form (3:1, 10:1) as a fraction:

A gear ratio i = 10:1 is input as follows: $\frac{P\ 630}{P\ 631} = \frac{10}{1}$

The fraction can also be used for increasing the resolution.

Example: P600 in revolutions (Function 2), set value and display value in 1/10 revolutions:

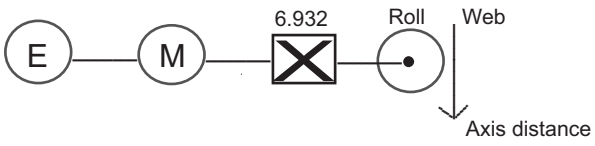
Input: : $\frac{P\ 630}{P\ 631} = \frac{1}{10}$

13.6.2 Feed-rate constant, P632 - P633

Parameters 632 and 633 are used to define a feed-rate constant (axis distance per motor revolution) with max. 4 integers and 4 decimal positions: The gear ratio can also be calculated into the feed-rate constant, in this case P630 and P631 must both be set to 1.

Example:

Encoder lines per revolution =	1024
Roll circumference	U = 200 mm
Gearing	i = 6.932
Positioning resolution (user units)	1/10 mm



Parameter P600 forms the basis. To ensure a very good resolution, Function 0 (counts) should be selected.

$$\text{Feed-rate constant} = \frac{4 \text{ X encoder LPR}}{\text{circumference}} \times \frac{\text{gear ratio}}{1} \times \frac{1}{\text{resolution}}$$

$$= \frac{4 \times 1024}{200} \times \frac{6.932}{1} \times \frac{1}{10}$$

= 14.196736 counts per 1/10 mm (user units)

Input:

P632 = 14 (integer positions)
P633 = 1967 (decimal positions)

To increase the resolution, Factor 1/100 becomes 1/100 x 1419.6736 by using the fraction (P630 / P631): 14.196736

P630 = 1
P631 = 100
P632 = 1419 (integer positions)
P633 = 6736 (decimal positions)

13.7 Positioning window and speed window, P640 - 641

P640 defines a positioning window, which is the first criteria for target reached. Units are normailized to increments (counts).

P641 defines a speed window (rpm), which is the second criteria for target reached.

When the motor is within both windows, the relay contact will switch (function 4) or a serial address can be read out. Note that this target relay function is deactiviated after the target is reached. This is to prevent relay flickering due to high frequency/low amplitude standstill oscillations. The relay stays in the target reached state.

Note: With P22 = 3 (Positioning via serial interface mode) The target reached windows are set by control object 60FB/sub index 3 and 4.

13.8 Definition of the positions, P700 - P797

In the following, the positions, the speed to the position and a possible delay time are defined. The acceleration and deceleration times (ramps) are the same for all positions and are defined by Parameters P603 and P604.

The first five positions (P700 – P720) are valid for the digitally approachable positions as well as for the sequence control, depending on the type of positioning selected.

Position	Parameter	Description	Notes for your settings: Set value
0	P700	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P701	Speed to position [rpm]	
	P702	Time [sec.]	O no time O time from start O time from target
1	P705	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P706	Speed to position [rpm]	
	P707	Time [sec.]	O no time O time from start O time from target
2	P710	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P711	Speed to position [rpm]	
	P712	Time [sec.]	O no time O time from start O time from target
3	P715	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P716	Speed to position [rpm]	
	P717	Time [sec.]	O no time O time from start O time from target
4	P720	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P721	Speed to position [rpm]	
	P722	Time [sec.]	O no time O time from start O time from target
5	P725	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P726	Speed to position [rpm]	
	P727	Time [sec.]	O no time O time from start O time from target

Position	Parameter	Description	Notes for your settings: Set value
6	P730	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P731	Speed to position [rpm]	
	P732	Time [sec.]	O no time O time from start O time from target
7	P735	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P736	Speed to position [rpm]	
	P737	Time [sec.]	O no time O time from start O time from target
8	P740	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P741	Speed to position [rpm]	
	P742	Time [sec.]	O no time O time from start O time from target
9	P745	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P746	Speed to position [rpm]	
	P747	Time [sec.]	O no time O time from start O time from target
10	P750	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P751	Speed to position [rpm]	
	P752	Time [sec.]	O no time O time from start O time from target
11	P755	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P756	Speed to position [rpm]	
	P757	Time [sec.]	O no time O time from start O time from target
12	P760	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P761	Speed to position [rpm]	
	P762	Time [sec.]	O no time O time from start O time from target

Position	Parameter	Description	Notes for your settings: Set value
13	P765	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P766	Speed to position [rpm]	
	P767	Time [sec.]	O no time O time from start O time from target
14	P770	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P771	Speed to position [rpm]	
	P772	Time [sec.]	O no time O time from start O time from target
15	P775	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P776	Speed to position [rpm]	
	P777	Time [sec.]	O no time O time from start O time from target
16	P780	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P781	Speed to position [rpm]	
	P782	Time [sec.]	O no time O time from start O time from target
17	P785	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P786	Speed to position [rpm]	
	P787	Time [sec.]	O no time O time from start O time from target
18	P790	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P791	Speed to position [rpm]	
	P792	Time [sec.]	O no time O time from start O time from target
19	P795	Position set value [P600 or user units]	O absolute O relative O floating, relative
	P796	Speed to position [rpm]	
	P797	Time [sec.]	O no time O time from start O time from target

14 Service/Troubleshooting

The display includes warning symbols to indicate basic faults.

14.1 Warning symbols

The following warning symbols can appear on the display during operation:

Symbol	Warning	Probable cause
OC	Over-current	Acceleration too rapid (V/f-control). Overload.
OV	Over-voltage	Braking too rapid (high inertial load). No braking resistor.
TEMP	Over-temperature	Inadequate cooling (Contamination of the heat sink, ambient temperature too high). Overload. Connecting cable of cooling unit not plugged in. Cooling surface cannot dissipate generated heat.
Red LED flashes rapidly	Under-voltage	Drive is switched off, mains voltage too low.

- All warnings are the first steps toward unit failure. Should the voltage or temperature rise further, or should the over-current be active for an extended period, this will result in failure.
- The over-current warning becomes active if the measured output current is higher than the nominal current of the motor (P103).
- The over-voltage warning becomes active if the DC bus voltage is higher than the nominal value + 15%.
- The over-temperature warning becomes active if the temperature of the power unit is higher than 80 °C.
- If the voltage supply drops to less than 70% of the nominal value, the power is switched off and the red LED starts to flash rapidly. This usually occurs when turning off the device, but it can also happen when too low a voltage exists.

14.2 Error messages

If a fault arises, the drive switches off immediately. The symbol ERR appears on the display together with the error number and in some cases an error symbol.

The following faults are recognized:

14.2.1 General error numbers:

No.	Symbol	Source of error	Probable cause
E 1	OC	Over-current	Acceleration too rapid (V/f-control). Overload condition.
E 2	OV	Over-voltage	Braking too rapid (high inertial load). No braking resistor.
E 3	TEMP	Over-temperature	Inadequate cooling (Contamination of the heat sink, ambient temperature too high). Overload conditions. Connecting cable of cooling unit not plugged in. Cooling surface cannot dissipate generated heat.
E4		PROM error, contents of PROM (parameters) damaged	Device must be switched on again with PARA key pressed, default parameters will be loaded. Afterwards all parameters must be adjusted.
E 5 – E 9		External error on terminals L5 – L9	Check digital input circuit.
E10		Mains voltage too low	Poor mains supply. The function of the device is no longer guaranteed. It has to be turned off and turned on again at a normal mains voltage. This error does not occur during normal power down of the device.
E11		Parameter error	Incorrect parameter value entered.
E12		Timeout of the serial interface	Control of the serial interface lost, communication fault.
E13		Short circuit	External short circuit or earth ground fault. The drive has to turned off and disconnected from the mains. Then the short circuit or earth fault has to be removed. Afterwards, the drive can be turned on again.
E14		Analog input open	Analog input current < 3 mA, only if P32 = 1 (analog input range = 4..20 mA) and P22 = 1 (analog input selected) or P22 = 2 and P33 = 1 (fixed speed and adding analog input value).
E15		Internal Hardware errors	Internal error, please contact supplier: incorrect measurement of DC bus voltage.
E16		Motor protection function	Motor protection is switched on (P120>0) and motor was running with more than the nominal current (P103).
E17		Error programming the test generator	Test generator mode and control mode cannot work together, e. g. test generator output to speed, reference at torque control.

E18		Internal Hardware errors	Internal error, please contact supplier: incorrect processor communication.
E19		Encoder error	The encoder is not connected. The connected encoder works incorrectly. The selected type of encoder (P71) is not correct.
E20		Over speed	Speed higher than P8.
E21		Encoder error with synchronous motor	If synchronous motor is selected (P105=1) then the absolute position is calculated from the special tracks of the encoder at power-on. If the motor is turning at this moment, then this error may occur.
E22		Wrong reference source	If torque control is selected (P23=3, 4), then only the analog input (P22=1) or the serial link (P22=3) may be used.
E23		Live guarding Error	CAN-Error: time out in live guarding.
E24		Overflow in CAN-receive buffer	CAN-Error: Too many PDO massages.
E25		Transition to Bus off	CAN-Error Permanent communication errors.
E26		Overflow in CAN-transmit buffer	Messages with higher priority on the bus.
E27		Exceptional Error	Error in error register.
E28		Error Emergency	STOP button was pressed in Remote mode (RS485 or CAN).

14.2.2 External errors (E5 - E9)

Errors E5 to E9 are such that an external signal sent to the digital input terminal (L5 to L9) immediately switches off the drive. The corresponding parameters P40 (for L5) to P44 (for L9) are used for this purpose.

Terminal with “external error” signal (P40-44 = 10)	**Function**
Off	Error
On	Operating

This switch function is “active low“ because of safety reasons.
Thus an open input (broken wire) is also recognized as an error.

The last error which was determined can be displayed with parameter P240.

14.2.3 Resetting errors/troubleshooting

After the cause of an error has disappeared (e.g. the unit has cooled off), the drive is not immediately allowed on again. First the error must be reset by:

- Pressing the STOP key on the keypad. For enabling, RUN has to be pressed.
- Or a 0 to 1 transition on a terminal which is programmed with the function “reset error”. (P40-44 = 11). This acknowledges the error. The drive goes into state “not ready to turn on” (OFF4) as long as the enable signals are active. The drive has to be disabled and afterwards enabled again.
- The quit error function of the serial interface in remote mode.

14.2.4 Searching for sources of error

LED’s on the control panel do not light up:

- No mains voltage.
- Mains supply voltage is too low.

Red LED flashes:

- Error recognized.
- Error source has disappeared, but error is not reset.

Red LED flashes rapidly:

- Mains supply voltage is too low.

Red LED is lit up:

- RUN key has not yet been pressed after switching on, or STOP key has been pressed.

Green LED flashes:

- Drive is not enabled.

Motor runs erractically/high motor current/doesn’t reach target value:

- Motor is not connected correctly (poor commutation conditions: parameters or motor/sensor wiring).
- Motor power cable is defective.
- Motor parameters have been entered incorrectly.
- Poor tuning of active control loops
- Control parameters for vector control not set properly (induction motor).

15 Serial RS-485 interface

15.1 Connection

15.1.1 Connection of one i-Drive BDS to an RS-232 interface

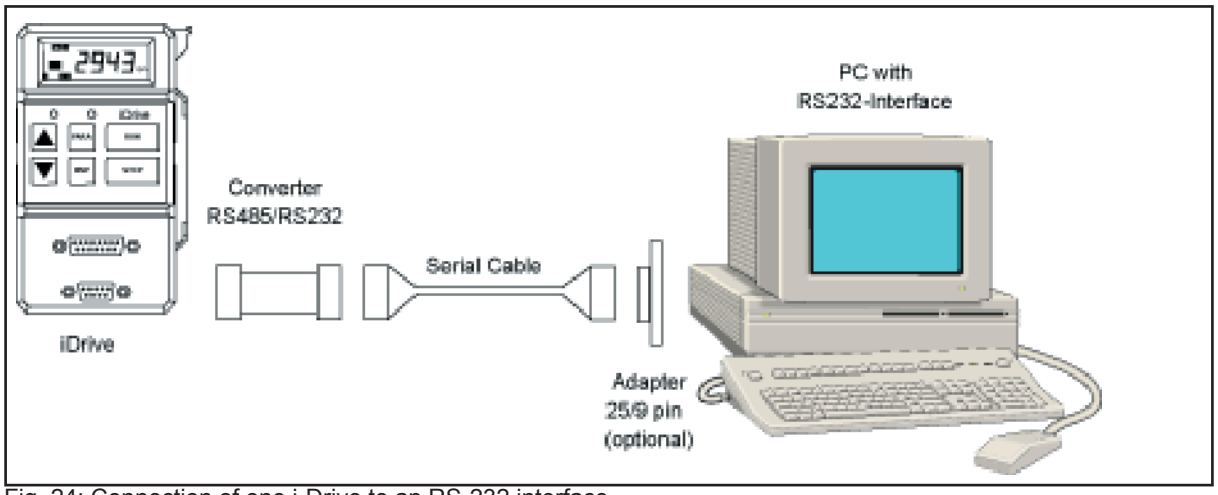


Fig. 24: Connection of one i-Drive to an RS-232 interface

The drive includes an RS-485 interface. The converter converts the RS-485 into an RS-232 interface. It may be put directly on the 9-pin SUB-D socket of the drive. The connection to the PC is made with a serial cable and optional adapter that converts the 9-pin into a 25-pin serial interface.

This type of connection is suitable for programming the drive via serial communication. For this purpose, the PC software win+i-Drive may be used. This software and the three components (Converter, Serial cable, Adapter) are the contents of the i-Drive Com Kit.

The converter realizes a galvanic isolation between the RS-485 and the RS-232 side. The PE connection is maintained.

15.1.2 Connection of several i-Drives BDS to an RS-485 interface (PC or PLC)

An RS-485 connection is recommended for a permanent installation of an automation network. The bus master (PC or PLC) has to be equipped with an RS-485 interface. Up to 31 drives may be connected to one master. The RS-485+, RS-485- and the GND signals (pins 12..14 of the 14-pin connector) have to be connected in parallel.

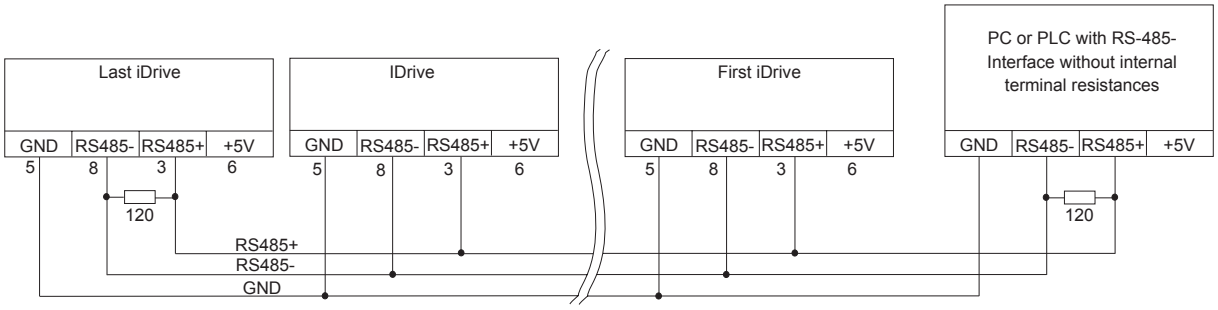


Fig. 25: Connection of several i-Drives to an RS-485 interface

An impedance matching teriminating resistor has to be connected at both ends of the bus. If the master already has included such terminal resistors, then the master has to be connected at one end of the bus and the resistors at this side will not be required.

Screened or twisted wires should be used.

15.1.3 Connection of several i-Drive BDS to an RS-232 interface

The i-Drive devices have to be connected to each other as shown. The connection with the RS-232 interface will be made by the converter, serial cable and adapter if necessary.

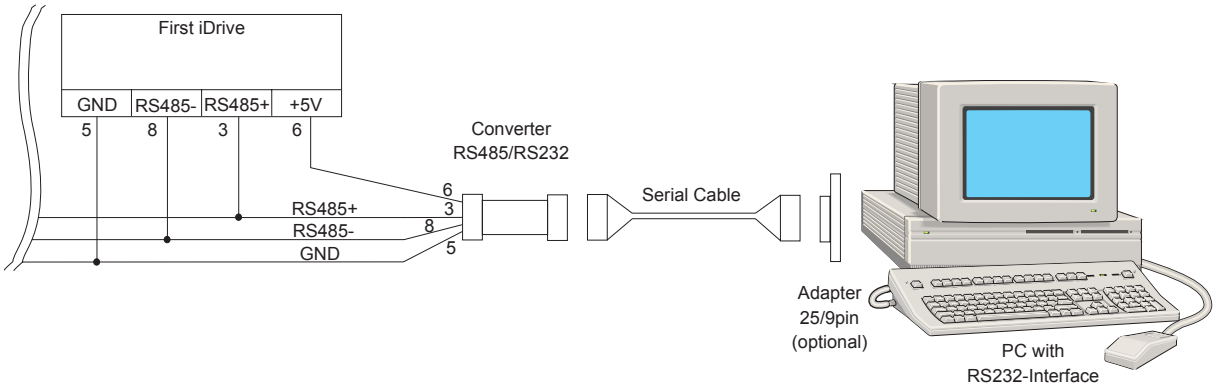


Fig. 26: Connection of several i-Drive to an RS-232 interface

The converter already has **internal terminating resistors**. It needs a +5 V supply on the RS-485 side. The first i-Drive can supply this voltage. This connection between converter and first i-Drive has to be made as **short** as possible. For that purpose also the evaluation board may be used. The RS-232 connection must not be longer than 15 meter.

If a longer distance between the converter and the first i-Drive is necessary, then the converter has to be supplied by an external 5 Volt power supply unit.

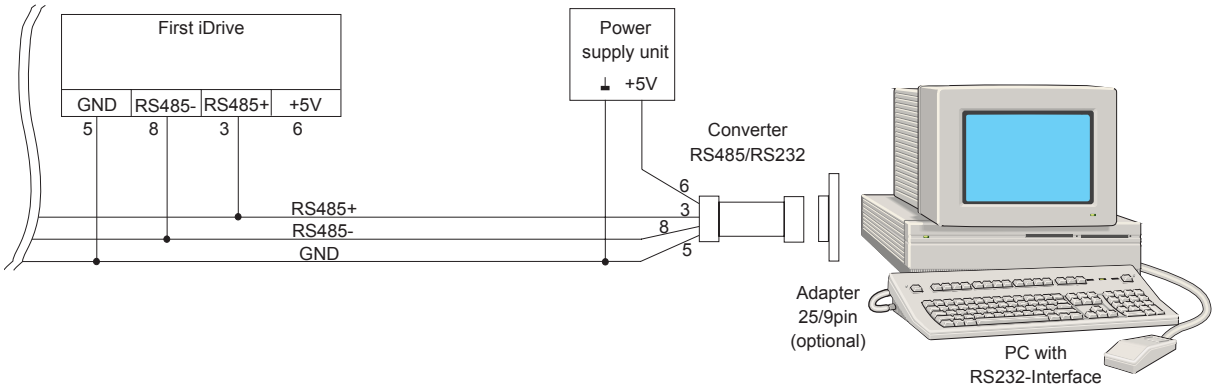


Fig. 27: External power supply requirement.

The converter realizes a galvanic isolation between the RS-485 and the RS-232 side. The PE connection is maintained.

Screened or twisted wires should be used.

15.2 Device-side configuration

The serial interface is set by the following parameters:

Parameter	Function	Default setting
P200	Address (1-127)	1
P201	Transfer rate 1 = 4800 Baud 2 = 9600 Baud 3 = 19200 Baud 4 = 38400 Baud	2 (9600 Baud)
P202	Timeout monitoring	2 s

If more than one drive is to be operated on the same RS-485 bus, they must each use an unique address.

The baud rate of all devices has to be the same.

The drive checks if process data is transmitted periodically via the serial link if it is selected as the reference value source (P22=3). In this case, a valid message (data telegram) must be received within a certain time (monitoring interval P202). In any other case, the drive is switched off and an error (E12) is registered. If parameter P202 set to 0 s, there is no timeout of the serial interface.

15.3 USS Protocol description

The protocol **i-Drive** uses corresponds to the frame of USS®-Protocol[1]. This is a data transfer procedure with the following properties:

- Master-Slave behaviour: A Master (SPS, PLC, PC) can control several Slaves (electrical drives) on one bus. The Slaves only send data when the Master requests data.
- 8 data bits, even parity, one stop bit
- Variable data telegram length
- Telegram checksum
- 2 ms waiting time between data telegrams.
- Telegram format.

[1]USS® is a registered trademark of Siemens AG.

A data telegram contains the following:

Header:		
STX	1 Byte	
LGE	1 Byte	
ADR	1 Byte	
Data Block:		
BLK_ID	1 Byte	
Object/Param/Index	0 or 3 Bytes	0 bytes in case that NO SDO transfer in communication CYCLE
Service Data	x Bytes	
Process Data	variable length of 0 to 8 Bytes	
Block Check Character:		
BCC	1 Byte	

15.3.1 Header

STX

- Character 0x02

LGE

- Number of *following* characters belonging to the telegram, including BCC.

- Minimum of LGE is 2 because of ADR and BCC.
  Maximal length of whole telegram is 256, so maximum of LGE is 254 because of STX and LGE itself.

ADR

– Bit 7 1 Device Group 1 (not normal USS device)

- Bits 6..0 Slave Address (1..127), Broadcast (0) = No Slave answers, could be used for SYNC messages, etc.

15.3.2 Data Block

BLK_ID

- Bit 0..1 specifies if SDO data are read or written:

Bit 1	Bit 0	
0	0	no SDO transfer
0	1	Read SDO (from device) cycle
1	0	Write SDO (to device) cycle
1	1	Reserved in M->S request, indicates Rejection in S->M response

- Bits 2..3 Specify process data transfer.

Bit 3	Bit 2	
0	0	no process data transferred
0	1	(enable) process data transfer slave->master (‘read PDO’)
1	0	process data transfer master->slave (‘write PDO’)
1	1	(enable) process data transfer in both direction

The slave does not change these bits (0..3) and behaves as it is told by the master.

- Bit 4 Test bit against mirror telegram. Slave inverts this bit in answer telegram.

- Bits 5..7 Reserved. Must be set to 0.

BLK_ID in case of Broadcast (ADR = 0)

- Bits 0..1 specify type of Broadcast.

Bit 1	Bit 0	
0	0	NMT Message
0	1	SYNC Message

1	0	TIME STAMP (when implemented)
1	1	process data transfer master->slave (‘write Broadcast PDO’)

- Bits 2..7 Reserved. Must be set to 0.

Object/Param/Index

Byte 2	Byte 1	Byte 0	
CAN Object Index		Sub-Index	CAN Objects (incl. man. specfg. $2xxx_h$)

Service Data

- the Data to be written in a Master->Slave Download Request (‘write data’),
- the read (current) Data in a Slave->Master Upload Response (‘read data’),
- empty in any other telegram.

Process Data

- Process Data (both directions) according to mapping of first rx/txPDO (mapping parameter at 1600h (rx), 1A00h (tx)).

15.3.3 Block Check Character

BCC

- Block Check Character. XOR junction of all previous characters including STX.

15.3.4 General Remarks

All more-than-one-byte-values (service data and process data, object index and parameter index) are transmitted lsb..msb!

15.4 Speed control via RS 485

In preperation

15.5 Torque control via RS 485

In preperation

15.6 Positioning via RS 485

- To access i-Drive parameters by using the serial protocol, an offset of 2000hex has to be added to the parameter number (because it is a ‘manufacturer specific’ object for CAN (the serial protocol is very near to CAN) and those objects are situated in the object range 2xxxhex). E.g. P100 = object 2064hex.
- If no continuous communication is provided, set communication timeout time (P202) to 0 (or to longest possible interval between two master telegrams) to avoid E12!

1. Adjust all necessary axis related i-Drive parameters like input source, control mode, motor type, motor parameters, max torque current, encoder type, encoder parameters, control parameters etc. This can easily be done through win+i-Drive but also through the serial protocol. Those settings (i-Drive parameters) will be saved.

Example for telegram to set motor type to sync motor (P105:=1):
{0x02 0x08 0x81 0x02 0x69 0x20 0x00 0x01 0x00 0xC1}
i-Drive would answer (in case of acknowledge)
{0x02 0x06 0x81 0x12 0x69 0x20 0x00 0xDE}

2. Adjust the positioning related objects:

Object	Index	Length	Unit	Comment
profile_velocity	6081h	4	rpm	
profile_acceleration	6083h	4	rpm/sec	
profile_deceleration	6084h	4	rpm/sec	
position p gain	60FB.01h	2	%	
speed forward factor	60FB.02h	2	(none)	usually keep default value
target reached position window	60FB.03h	4	position increments	influences the behavior of target_reached bit in status word only
target reached speed window	60FB.04h	2	rpm	influences the behavior of target_reached bit in status word only

Example for telegram to set profile_velocity to 3000 rpm (6081.00h := 00000BB8h):
{0x02 0x0A 0x81 0x02 0x81 0x60 0x00 0xB8 0x0B 0x00 0x00 0xD9}
i-Drive would answer (in case of acknowledge)
{0x02 0x06 0x81 0x12 0x81 0x60 0x00 0x76}

3. Set mode_of_operation (obj. 6060h, length 1 byte) to Profile Position Mode (1):
{0x02 0x07 0x81 0x02 0x60 0x60 0x00 0x02 0x84}
The current mode_of_operation can be checked reading obj. 6061h (modes_of_operation_display).

4. Write the target position rsp. step size to obj. 607Ah (4 bytes length).

5. Device control:
obj. 6040h control_word, obj. 6041 status_word. 2 bytes length (both). Behavior as defined by CAN DSP402. Important commands (write value to control_word):
- quit OFF4 state: from anything else to 0006h
- switch on: set bits 0..3 = 000Fh
- switch off: 0006h
- quick stop: release bit 2: e.g. 000Bh
- halt: raise bit 8: e.g. 010Fh
- quit error: raise bit 7: e.g. 0080h
- go to position: raising edge of bit 4 (e.g. 000Fh -> 001Fh)
- for relative pos'ing: set bit 6
- for immediate change (go to new position without reaching current target): set bit 5

To make a step (size as written to 607Ah), the command 005Fh has to be written to control word (bit 4 had do be low before). Before making the next step, bit 4 has to be released: e.g. 004Fh has to be written to control word. For making the next step 005Fh has to be written to control word again and so on. To go to an absolute position, the command 001Fh has to be used, followed by 000Fh.

There is a handshake for this sequence: when bit 4 of control word is raised, the device responds with raising bit 12 (setpoint_acknowledged). Afterwards bit 4 of control word can be released. The device responds releasing bit 12 and signals this way to be ready to accept a new command. If bit 5 (change_ immediately) is not set in the new command, the current positioning will be finished before going to the

next target. Reaching a target (position is inside the target reached position window around the target position and the velocity is inside the target reached speed window around stand still) will be indicated by the device by raising bit 10 of status word (target_reached).

15.7 Homing via RS 485

In preparation

15.8 Object Dictionary

The Object Dictionary is an overview of all implemented objects.
Object Dictionary of **i-Drive BDS firmware version 3.062**

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
communication profile area [CiA CAN DS 301 V4.1]								
1000h	device type	u32	00030192h			ro		
1001h	error register	u8	00h			ro		
1002h	manufacturer status register	u32	00000000h			ro		
1003h	pre-defined error field							
.0h	number of errors	u8	00h			ro		
.1h	standard error field	u32	00000000h			ro		
.2h	standard error field	u32	00000000h			ro		
1005h	COB-ID SYNC	u32	80000080h			rw		
1007h	synchronous window length	u32	00000000h			rw		
1008h	manufacturer device name	vs	i-Drive Bayside			const		
1009h	manufacturer hardware version	vs	Vers. 2.00			const		
100Ah	manufacturer software version	vs	Vers. 3.062			const		
100Ch	guard time	u16	0000h			rw		
100Dh	life time factor	u8	00h			rw		
1014h	COB-ID Emergency message	u32	00000081h			rw		
1018h	Identity Object							
.0h	number of entries	u8	01h			ro		
.1h	Vendor ID	u32	00000073h			ro		
1200h	Server SDO parameter							
.0h	number of entries	u8	02h					
.1h	COB-ID Client->Server (rx)	u32	00000601h					
.2h	COB-ID Server->Client (tx)	u32	00000581h					
1400h	rxPDO1 communication parameter							
.0h	largest sub-index supported	u8	02h					
.1h	COB-ID used by PDO	u32	00000201h					
.2h	transmission type	u8	FFh					
1401h	rxPDO2 communication parameter							
.0h	largest sub-index supported	u8	02h					
.1h	COB-ID used by PDO	u32	00000301h					
.2h	transmission type	u8	FFh					
1402h	rxPDO3 communication parameter							
.0h	largest sub-index supported	u8	02h					
.1h	COB-ID used by PDO	u32	00000401h					
.2h	transmission type	u8	FFh					

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
1403h	rxPDO4 communication parameter							
.0h	largest sub-index supported	u8	02h					
.1h	COB-ID used by PDO	u32	80000000h					
.2h	transmission type	u8	FFh					
1600h	rxPDO1 mapping parameter							
.0h	number of mapped objects	u8	01h					
.1h	1. mapped object	u32	60400010h					
.2h	2. mapped object	u32	00000000h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					
1601h	rxPDO2 mapping parameter							
.0h	number of mapped objects	u8	02h					
.1h	1. mapped object	u32	60400010h					
.2h	2. mapped object	u32	60600008h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					
1602h	rxPDO3 mapping parameter							
.0h	number of mapped objects	u8	02h					
.1h	1. mapped object	u32	60400010h					
.2h	2. mapped object	u32	607A0020h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					
1603h	rxPDO4 mapping parameter							
.0h	number of mapped objects	u8	00h					
.1h	1. mapped object	u32	00000000h					
.2h	2. mapped object	u32	00000000h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
1800h	txPDO1 communication parameter							
.0h	largest sub-index supported	u8	03h					
.1h	COB-ID used by PDO	u32	00000181h					
.2h	transmission type	u8	FFh					
.3h	inhibit time	u16	012Ch				100us	
1801h	txPDO2 communication parameter							
.0h	largest sub-index supported	u8	03h					
.1h	COB-ID used by PDO	u32	00000281h					
.2h	transmission type	u8	FFh					
.3h	inhibit time	u16	012Ch				100us	
1802h	txPDO3 communication parameter							
.0h	largest sub-index supported	u8	03h					
.1h	COB-ID used by PDO	u32	00000381h					
.2h	transmission type	u8	FFh					
.3h	inhibit time	u16	012Ch				100us	
1803h	txPDO4 communication parameter							
.0h	largest sub-index supported	u8	03h					
.1h	COB-ID used by PDO	u32	80000000h					
.2h	transmission type	u8	FFh					
.3h	inhibit time	u16	012Ch				100us	
1A00h	txPDO1 mapping parameter							
.0h	number of mapped objects	u8	01h					
.1h	1. mapped object	u32	60410010h					
.2h	2. mapped object	u32	00000000h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					
1A01h	txPDO2 mapping parameter							
.0h	number of mapped objects	u8	02h					
.1h	1. mapped object	u32	60410010h					
.2h	2. mapped object	u32	60610008h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
1A02h	txPDO3 mapping parameter							
.0h	number of mapped objects	u8	02h					
.1h	1. mapped object	u32	60410010h					
.2h	2. mapped object	u32	60640020h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					
1A03h	txPDO4 mapping parameter							
.0h	number of mapped objects	u8	00h					
.1h	1. mapped object	u32	00000000h					
.2h	2. mapped object	u32	00000000h					
.3h	3. mapped object	u32	00000000h					
.4h	4. mapped object	u32	00000000h					
.5h	5. mapped object	u32	00000000h					
.6h	6. mapped object	u32	00000000h					
.7h	7. mapped object	u32	00000000h					
.8h	8. mapped object	u32	00000000h					
manufacturer specific profile area [i-Drive user manual]								
2000h	Speed with motor potentiometer	i16	0000h	D8F1h	270Fh			Par. 0
2001h	Ramp-up time 0..P6	i16	03E8h	0000h	7530h			Par. 1
2002h	Ramp-down time P7..0	i16	03E8h	0000h	7530h			Par. 2
2003h	Maximum torque current	i16	0064h	0000h	270Fh			Par. 3
2004h	Minimum speed	i16	0000h	0000h	1F40h			Par. 4
2005h	Maximum speed	i16	0BB8h	0001h	1F40h			Par. 5
2006h	Speed of the ramp-up	i16	0BB8h	0001h	1F40h			Par. 6
2007h	Speed of the ramp-down	i16	0BB8h	0001h	1F40h			Par. 7
2008h	Over-speed threshold	i16	0C1Ch	0001h	1FA4h			Par. 8
200Ah	Password	i16	04D2h	D8F1h	270Fh			Par. 10
200Bh	Password control	i16	0000h	0000h	0002h			Par. 11
2014h	Choice of the display value	i16	0000h	0000h	0007h			Par. 20
2016h	Input source	i16	0000h	0000h	0003h			Par. 22
2017h	Control mode	i16	0000h	0000h	0005h			Par. 23
2018h	Enable after power on	i16	0000h	0000h	0003h			Par. 24
2019h	Switching frequency	i16	0000h	0000h	0001h			Par. 25
201Bh	Display of position	i16	0000h	E0C0h	1F40h			Par. 27
201Ch	Display of the reference value	i16	0000h	E0C0h	1F40h			Par. 28
201Dh	Display of the encoder speed	i16	0000h	E0C0h	1F40h			Par. 29
201Eh	Speed at 0V / 0mA / 4mA	i16	0000h	E0C0h	1F40h			Par. 30
201Fh	Speed at 10V / 20mA	i16	0BB8h	E0C0h	1F40h			Par. 31

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
2020h	Analogue input range	i16	0000h	0000h	0002h			Par. 32
2021h	Add analogue input	i16	0000h	0000h	0001h			Par. 33
2022h	Torque at 0V / 0mA / 4mA	i16	0000h	FF38h	00C8h			Par. 34
2023h	Torque at 10V / 20mA	i16	0064h	FF38h	00C8h			Par. 35
2024h	Filter time constant of analogue input	i16	0032h	0000h	0FA0h			Par. 36
2025h	Position at 0V / 0mA / 4mA	i16	0000h	D8F1h	270Fh			Par. 37
2026h	Position at 10V / 20mA	i16	0000h	D8F1h	270Fh			Par. 38
2027h	Invert mask of digital inputs	i16	0000h	0000h	001Fh			Par. 39
2028h	Function of digital input L5	i16	0000h	0000h	001Ah			Par. 40
2029h	Function of digital input L6	i16	0002h	0000h	001Ah			Par. 41
202Ah	Function of digital input L7	i16	0000h	0000h	001Ah			Par. 42
202Bh	Function of digital input L8	i16	0000h	0000h	001Ah			Par. 43
202Ch	Function of digital input L9	i16	0000h	0000h	001Ah			Par. 44
202Dh	Fixed speed via input L5	i16	0000h	E0C0h	1F40h			Par. 45
202Eh	Fixed speed via input L6	i16	0000h	E0C0h	1F40h			Par. 46
202Fh	Fixed speed via input L7	i16	00FAh	E0C0h	1F40h			Par. 47
2030h	Fixed speed via input L8	i16	01F4h	E0C0h	1F40h			Par. 48
2031h	Fixed speed via input L9	i16	03E8h	E0C0h	1F40h			Par. 49
2032h	Fixed Torque L5	i16	000Ah	FF38h	00C8h			Par. 50
2033h	Fixed Torque L6	i16	000Ah	FF38h	00C8h			Par. 51
2034h	Fixed Torque L7	i16	000Ah	FF38h	00C8h			Par. 52
2035h	Fixed Torque L8	i16	000Ah	FF38h	00C8h			Par. 53
2036h	Fixed Torque L9	i16	000Ah	FF38h	00C8h			Par. 54
2037h	Analogue output value	i16	0000h	0000h	0007h			Par. 55
2038h	Amplification analogue output value	i16	00A7h	0000h	01F4h			Par. 56
2039h	Function of relay output	i16	0000h	0000h	0015h			Par. 57
203Ah	Speed threshold of relay output	i16	0BB8h	0000h	1F40h			Par. 58
203Ch	Nominal voltage of V/f characteristic	i16	00E6h	0064h	01F4h			Par. 60
203Dh	Nominal frequency of V/f character-istic	i16	0032h	000Ah	028Ah			Par. 61
203Eh	Voltage boost for V/f characteristic	i16	0032h	0000h	012Ch			Par. 62
203Fh	Dynamic boost for V/f characteristic	i16	0000h	0000h	012Ch			Par. 63
2046h	Encoder increments	i16	0400h	0001h	270Fh			Par. 70
2047h	Encoder type	i16	0000h	0000h	0001h			Par. 71
2048h	Speed controller, P-gain	i16	012Ch	0000h	270Fh			Par. 72
2049h	Speed controller, I-gain	i16	0032h	0000h	270Fh			Par. 73
204Ah	Maximum excitation	i16	0064h	0000h	0078h			Par. 74
204Bh	Current controller, P-gain	i16	0064h	0000h	00C8h			Par. 75
204Ch	Current controller, I-gain	i16	0064h	0000h	00C8h			Par. 76

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
204Dh	Flux controller, P-gain	i16	03E8h	0000h	270Fh			Par. 77
204Eh	Flux controller, I-gain	i16	00C8h	0000h	270Fh			Par. 78
204Fh	Position controller, P-gain	i16	0064h	0000h	270Fh			Par. 79
2050h	DC braking duration	i16	0000h	0000h	012Ch			Par. 80
2051h	DC braking voltage	i16	0000h	0000h	0190h			Par. 81
205Ah	S-Ramp time constant	i16	0000h	0000h	07D0h			Par. 90
205Bh	Dead-time before ramp-up	i16	0000h	0000h	0BB8h			Par. 91
205Ch	Dead-time after ramp-down	i16	0000h	0000h	0BB8h			Par. 92
2064h	Nominal frequency of the motor	i16	0032h	000Ah	028Ah			Par. 100
2065h	Nominal speed of the motor	i16	0B54h	0064h	1F40h			Par. 101
2066h	Nominal voltage of the motor	i16	00E6h	000Ah	01F4h			Par. 102

2067h	Nominal current of the motor	i16	0064h	000Ah	05DCh			Par. 103
2068h	Self tuning	i16	0000h	0000h	0001h			Par. 104
2069h	Motor type	i16	0000h	0000h	0001h			Par. 105
206Ah	Correction angle of encoder	i16	0000h	FF4Ch	00B4h			Par. 106
206Bh	Pole Method	i16	0000h	0000h	0002h			Par. 107
206Ch	Start pole angle estimation	i16	0000h	0000h	0001h			Par. 108
206Dh	Control of pole angle estimation	i16	0001h	0000h	0003h			Par. 109
206Eh	Nominal excitation current of the motor	i16	0032h	000Ah	05DCh			Par. 110
206Fh	Stator inductance	i16	0014h	0000h	03E8h			Par. 111
2070h	Stator resistance	i16	0064h	0000h	4E20h			Par. 112
2071h	Rotor resistance	i16	0064h	0000h	4E20h			Par. 113
2072h	Magnetizing curve parameter 1	i16	0096h	0000h	03E8h			Par. 114
2073h	Magnetizing curve parameter 2	i16	0009h	0001h	001Fh			Par. 115
2074h	Magnetizing curve parameter 3	i16	0352h	0001h	03E8h			Par. 116
2078h	Motor protection function	i16	0000h	0000h	0002h			Par. 120
2079h	Heating class of the motor	i16	0001h	0000h	0007h			Par. 121
207Eh	Pulse width of pole finding	i16	0002h	0001h	000Ah			Par. 126
207Fh	Amplitude of pole finding	i16	0032h	0001h	0064h			Par. 127
20C8h	Address of serial interface	i16	0001h	0001h	007Fh			Par. 200
20C9h	Baud rate of serial interface	i16	0002h	0001h	0004h			Par. 201
20CAh	Timeout of serial interface	i16	0014h	0000h	0960h			Par. 202
20D2h	Number of CAN node	i16	0001h	0001h	007Fh			Par. 210
20D3h	Baud rate of CAN interface	i16	0002h	0000h	0007h			Par. 211
20D4h	CAN state	i16	04F6h	0000h	0003h			Par. 212
20DDh	Ramp-down over-voltage limit	i16	01B7h	0014h	0384h			Par. 221
20E6h	Output value of test generators	i16	0000h	0000h	0004h			Par. 230

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
20E7h	Time duration of test generator	i16	000Ah	0001h	270Fh			Par. 231
20E8h	Offset of test generator	i16	0000h	FF38h	00C8h			Par. 232
20E9h	Amplitude of test generator	i16	0000h	0000h	00C8h			Par. 233
20F0h	Last error	i16	0012h	0000h	001Fh			Par. 240
20F1h	Maximum temperature	i16	005Eh	0000h	00C8h			Par. 241
20F2h	Device type	i16	03EDh	0000h	270Fh			Par. 242
20F3h	Software revision	i16	0BF6h	0000h	270Fh			Par. 243
20F4h	Serial number, digits 1 - 4	i16	0000h	0000h	270Fh			Par. 244
20F5h	Serial number, digits 5 - 8	i16	0000h	0000h	270Fh			Par. 245
20F6h	Actual display value	i16	0000h	8000h	7FFFh			Par. 246
20F7h	Actual state of the drive	i16	07D0h	0000h	270Fh			Par. 247
20F8h	Nominal current of the device	i16	00DCh	0000h	270Fh			Par. 248
20FAh	Operating time of drive, digits 1 - 4	i16	0000h	8000h	7FFFh			Par. 250
20FBh	Operating time of drive, digits 5 - 8	i16	001Eh	8000h	7FFFh			Par. 251
20FCh	Operating time of unit, digits 1 - 4	i16	0000h	8000h	7FFFh			Par. 252
20FDh	Operating time of drive, digits 5 - 8	i16	0000h	8000h	7FFFh			Par. 253
Recorder Parameters								
2190h	RECSTATUS	2h	0000h					Par. 400
2191h	RECMODE	2h	0000h					Par. 401
2192h	RECTRIGGER	2h	0000h					Par. 402
2193h	RECSEL1	2h	0000h					Par. 403
2194h	RECSEL2	2h	0000h					Par. 404
2195h	RECVAL1, Sample 0	2h	0000h			ro		Par. 405
.1h	RECVAL1, Sample 1	2h	0000h			ro		

.2h	RECVAL1, Sample 2	2h	0000h			ro		
.3h	RECVAL1, Sample 3	2h	0000h			ro		
.4h	RECVAL1, Sample 4	2h	0000h			ro		
.5h	RECVAL1, Sample 5	2h	0000h			ro		
.6h	RECVAL1, Sample 6	2h	0000h			ro		
.7h	RECVAL1, Sample 7	2h	0000h			ro		
.8h	RECVAL1, Sample 8	2h	0000h			ro		
.9h	RECVAL1, Sample 9	2h	0000h			ro		
.Ah	RECVAL1, Sample 10	2h	0000h			ro		
.Bh	RECVAL1, Sample 11	2h	0000h			ro		
.Ch	RECVAL1, Sample 12	2h	0000h			ro		
.Dh	RECVAL1, Sample 13	2h	0000h			ro		
.Eh	RECVAL1, Sample 14	2h	0000h			ro		
.Fh	RECVAL1, Sample 15	2h	0000h			ro		

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
.10h	RECVAL1, Sample 16	2h	0000h			ro		
.11h	RECVAL1, Sample 17	2h	0000h			ro		
.12h	RECVAL1, Sample 18	2h	0000h			ro		
.13h	RECVAL1, Sample 19	2h	0000h			ro		
.14h	RECVAL1, Sample 20	2h	0000h			ro		
.15h	RECVAL1, Sample 21	2h	0000h			ro		
.16h	RECVAL1, Sample 22	2h	0000h			ro		
.17h	RECVAL1, Sample 23	2h	0000h			ro		
.18h	RECVAL1, Sample 24	2h	0000h			ro		
.19h	RECVAL1, Sample 25	2h	0000h			ro		
.1Ah	RECVAL1, Sample 26	2h	0000h			ro		
.1Bh	RECVAL1, Sample 27	2h	0000h			ro		
.1Ch	RECVAL1, Sample 28	2h	0000h			ro		
.1Dh	RECVAL1, Sample 29	2h	0000h			ro		
.1Eh	RECVAL1, Sample 30	2h	0000h			ro		
.1Fh	RECVAL1, Sample 31	2h	0000h			ro		
.20h	RECVAL1, Sample 32	2h	0000h			ro		
.21h	RECVAL1, Sample 33	2h	0000h			ro		
.22h	RECVAL1, Sample 34	2h	0000h			ro		
.23h	RECVAL1, Sample 35	2h	0000h			ro		
.24h	RECVAL1, Sample 36	2h	0000h			ro		
.25h	RECVAL1, Sample 37	2h	0000h			ro		
.26h	RECVAL1, Sample 38	2h	0000h			ro		
.27h	RECVAL1, Sample 39	2h	0000h			ro		
.28h	RECVAL1, Sample 40	2h	0000h			ro		
.29h	RECVAL1, Sample 41	2h	0000h			ro		
.2Ah	RECVAL1, Sample 42	2h	0000h			ro		
.2Bh	RECVAL1, Sample 43	2h	0000h			ro		
.2Ch	RECVAL1, Sample 44	2h	0000h			ro		
.2Dh	RECVAL1, Sample 45	2h	0000h			ro		
.2Eh	RECVAL1, Sample 46	2h	0000h			ro		
.2Fh	RECVAL1, Sample 47	2h	0000h			ro		
.30h	RECVAL1, Sample 48	2h	0000h			ro		
.31h	RECVAL1, Sample 49	2h	0000h			ro		
.32h	RECVAL1, Sample 50	2h	0000h			ro		
.33h	RECVAL1, Sample 51	2h	0000h			ro		
.34h	RECVAL1, Sample 52	2h	0000h			ro		

.35h	RECVAL1, Sample 53	2h	0000h			ro		
.36h	RECVAL1, Sample 54	2h	0000h			ro		
.37h	RECVAL1, Sample 55	2h	0000h			ro		
.38h	RECVAL1, Sample 56	2h	0000h			ro		
.39h	RECVAL1, Sample 57	2h	0000h			ro		
.3Ah	RECVAL1, Sample 58	2h	0000h			ro		

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
.3Bh	RECVAL1, Sample 59	2h	0000h			ro		
.3Ch	RECVAL1, Sample 60	2h	0000h			ro		
.3Dh	RECVAL1, Sample 61	2h	0000h			ro		
.3Eh	RECVAL1, Sample 62	2h	0000h			ro		
.3Fh	RECVAL1, Sample 63	2h	0000h			ro		
.40h	RECVAL1, Sample 64	2h	0000h			ro		
.41h	RECVAL1, Sample 65	2h	0000h			ro		
.42h	RECVAL1, Sample 66	2h	0000h			ro		
.43h	RECVAL1, Sample 67	2h	0000h			ro		
.44h	RECVAL1, Sample 68	2h	0000h			ro		
.45h	RECVAL1, Sample 69	2h	0000h			ro		
.46h	RECVAL1, Sample 70	2h	0000h			ro		
.47h	RECVAL1, Sample 71	2h	0000h			ro		
.48h	RECVAL1, Sample 72	2h	0000h			ro		
.49h	RECVAL1, Sample 73	2h	0000h			ro		
.4Ah	RECVAL1, Sample 74	2h	0000h			ro		
.4Bh	RECVAL1, Sample 75	2h	0000h			ro		
.4Ch	RECVAL1, Sample 76	2h	0000h			ro		
.4Dh	RECVAL1, Sample 77	2h	0000h			ro		
.4Eh	RECVAL1, Sample 78	2h	0000h			ro		
.4Fh	RECVAL1, Sample 79	2h	0000h			ro		
.50h	RECVAL1, Sample 80	2h	0000h			ro		
.51h	RECVAL1, Sample 81	2h	0000h			ro		
.52h	RECVAL1, Sample 82	2h	0000h			ro		
.53h	RECVAL1, Sample 83	2h	0000h			ro		
.54h	RECVAL1, Sample 84	2h	0000h			ro		
.55h	RECVAL1, Sample 85	2h	0000h			ro		
.56h	RECVAL1, Sample 86	2h	0000h			ro		
.57h	RECVAL1, Sample 87	2h	0000h			ro		
.58h	RECVAL1, Sample 88	2h	0000h			ro		
.59h	RECVAL1, Sample 89	2h	0000h			ro		
.5Ah	RECVAL1, Sample 90	2h	0000h			ro		
.5Bh	RECVAL1, Sample 91	2h	0000h			ro		
.5Ch	RECVAL1, Sample 92	2h	0000h			ro		
.5Dh	RECVAL1, Sample 93	2h	0000h			ro		
.5Eh	RECVAL1, Sample 94	2h	0000h			ro		
.5Fh	RECVAL1, Sample 95	2h	0000h			ro		
.60h	RECVAL1, Sample 96	2h	0000h			ro		
.61h	RECVAL1, Sample 97	2h	0000h			ro		
.62h	RECVAL1, Sample 98	2h	0000h			ro		
.63h	RECVAL1, Sample 99	2h	0000h			ro		
2196h	RECVAL2, Sample 0	2h	0000h			ro		Par. 406

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
.1h	RECVAL2, Sample 1	2h	0000h			ro		

.2h	RECVAL2, Sample 2	2h	0000h			ro		
.3h	RECVAL2, Sample 3	2h	0000h			ro		
.4h	RECVAL2, Sample 4	2h	0000h			ro		
.5h	RECVAL2, Sample 5	2h	0000h			ro		
.6h	RECVAL2, Sample 6	2h	0000h			ro		
.7h	RECVAL2, Sample 7	2h	0000h			ro		
.8h	RECVAL2, Sample 8	2h	0000h			ro		
.9h	RECVAL2, Sample 9	2h	0000h			ro		
.Ah	RECVAL2, Sample 10	2h	0000h			ro		
.Bh	RECVAL2, Sample 11	2h	0000h			ro		
.Ch	RECVAL2, Sample 12	2h	0000h			ro		
.Dh	RECVAL2, Sample 13	2h	0000h			ro		
.Eh	RECVAL2, Sample 14	2h	0000h			ro		
.Fh	RECVAL2, Sample 15	2h	0000h			ro		
.10h	RECVAL2, Sample 16	2h	0000h			ro		
.11h	RECVAL2, Sample 17	2h	0000h			ro		
.12h	RECVAL2, Sample 18	2h	0000h			ro		
.13h	RECVAL2, Sample 19	2h	0000h			ro		
.14h	RECVAL2, Sample 20	2h	0000h			ro		
.15h	RECVAL2, Sample 21	2h	0000h			ro		
.16h	RECVAL2, Sample 22	2h	0000h			ro		
.17h	RECVAL2, Sample 23	2h	0000h			ro		
.18h	RECVAL2, Sample 24	2h	0000h			ro		
.19h	RECVAL2, Sample 25	2h	0000h			ro		
.1Ah	RECVAL2, Sample 26	2h	0000h			ro		
.1Bh	RECVAL2, Sample 27	2h	0000h			ro		
.1Ch	RECVAL2, Sample 28	2h	0000h			ro		
.1Dh	RECVAL2, Sample 29	2h	0000h			ro		
.1Eh	RECVAL2, Sample 30	2h	0000h			ro		
.1Fh	RECVAL2, Sample 31	2h	0000h			ro		
.20h	RECVAL2, Sample 32	2h	0000h			ro		
.21h	RECVAL2, Sample 33	2h	0000h			ro		
.22h	RECVAL2, Sample 34	2h	0000h			ro		
.23h	RECVAL2, Sample 35	2h	0000h			ro		
.24h	RECVAL2, Sample 36	2h	0000h			ro		
.25h	RECVAL2, Sample 37	2h	0000h			ro		
.26h	RECVAL2, Sample 38	2h	0000h			ro		
.27h	RECVAL2, Sample 39	2h	0000h			ro		
.28h	RECVAL2, Sample 40	2h	0000h			ro		
.29h	RECVAL2, Sample 41	2h	0000h			ro		
.2Ah	RECVAL2, Sample 42	2h	0000h			ro		

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
.2Bh	RECVAL2, Sample 43	2h	0000h			ro		
.2Ch	RECVAL2, Sample 44	2h	0000h			ro		
.2Dh	RECVAL2, Sample 45	2h	0000h			ro		
.2Eh	RECVAL2, Sample 46	2h	0000h			ro		
.2Fh	RECVAL2, Sample 47	2h	0000h			ro		
.30h	RECVAL2, Sample 48	2h	0000h			ro		
.31h	RECVAL2, Sample 49	2h	0000h			ro		
.32h	RECVAL2, Sample 50	2h	0000h			ro		
.33h	RECVAL2, Sample 51	2h	0000h			ro		
.34h	RECVAL2, Sample 52	2h	0000h			ro		

.35h	RECVAL2, Sample 53	2h	0000h			ro		
.36h	RECVAL2, Sample 54	2h	0000h			ro		
.37h	RECVAL2, Sample 55	2h	0000h			ro		
.38h	RECVAL2, Sample 56	2h	0000h			ro		
.39h	RECVAL2, Sample 57	2h	0000h			ro		
.3Ah	RECVAL2, Sample 58	2h	0000h			ro		
.3Bh	RECVAL2, Sample 59	2h	0000h			ro		
.3Ch	RECVAL2, Sample 60	2h	0000h			ro		
.3Dh	RECVAL2, Sample 61	2h	0000h			ro		
.3Eh	RECVAL2, Sample 62	2h	0000h			ro		
.3Fh	RECVAL2, Sample 63	2h	0000h			ro		
.40h	RECVAL2, Sample 64	2h	0000h			ro		
.41h	RECVAL2, Sample 65	2h	0000h			ro		
.42h	RECVAL2, Sample 66	2h	0000h			ro		
.43h	RECVAL2, Sample 67	2h	0000h			ro		
.44h	RECVAL2, Sample 68	2h	0000h			ro		
.45h	RECVAL2, Sample 69	2h	0000h			ro		
.46h	RECVAL2, Sample 70	2h	0000h			ro		
.47h	RECVAL2, Sample 71	2h	0000h			ro		
.48h	RECVAL2, Sample 72	2h	0000h			ro		
.49h	RECVAL2, Sample 73	2h	0000h			ro		
.4Ah	RECVAL2, Sample 74	2h	0000h			ro		
.4Bh	RECVAL2, Sample 75	2h	0000h			ro		
.4Ch	RECVAL2, Sample 76	2h	0000h			ro		
.4Dh	RECVAL2, Sample 77	2h	0000h			ro		
.4Eh	RECVAL2, Sample 78	2h	0000h			ro		
.4Fh	RECVAL2, Sample 79	2h	0000h			ro		
.50h	RECVAL2, Sample 80	2h	0000h			ro		
.51h	RECVAL2, Sample 81	2h	0000h			ro		
.52h	RECVAL2, Sample 82	2h	0000h			ro		
.53h	RECVAL2, Sample 83	2h	0000h			ro		
.54h	RECVAL2, Sample 84	2h	0000h			ro		
.55h	RECVAL2, Sample 85	2h	0000h			ro		

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
.56h	RECVAL2, Sample 86	2h	0000h			ro		
.57h	RECVAL2, Sample 87	2h	0000h			ro		
.58h	RECVAL2, Sample 88	2h	0000h			ro		
.59h	RECVAL2, Sample 89	2h	0000h			ro		
.5Ah	RECVAL2, Sample 90	2h	0000h			ro		
.5Bh	RECVAL2, Sample 91	2h	0000h			ro		
.5Ch	RECVAL2, Sample 92	2h	0000h			ro		
.5Dh	RECVAL2, Sample 93	2h	0000h			ro		
.5Eh	RECVAL2, Sample 94	2h	0000h			ro		
.5Fh	RECVAL2, Sample 95	2h	0000h			ro		
.60h	RECVAL2, Sample 96	2h	0000h			ro		
.61h	RECVAL2, Sample 97	2h	0000h			ro		
.62h	RECVAL2, Sample 98	2h	0000h			ro		
.63h	RECVAL2, Sample 99	2h	0000h			ro		
2197h	RECPRETRIGGER	2h	0000h					Par. 407
Position Control Parameters								
2258h	Dimension for position reference	i16	0000h	0000h	0002h	rw		Par. 600
225Ah	Position control speed	i16	01F4h	0000h	1F40h	rw		Par. 602

225Bh	Position ramp_up	i16	0064h	0000h	1F40h	rw		Par. 603
225Ch	Position ramp down	i16	0064h	0000h	1F40h	rw		Par. 604
225Dh	Homing method	i16	0001h	0001h	0023h	rw		Par. 605
225Eh	Home speed	i16	01F4h	0001h	1F40h	rw		Par. 606
225Fh	Home speed of zero pulse	i16	0064h	0001h	1F40h	rw		Par. 607
2260h	Home offset	i16	0000h	D8F1h	270Fh	rw		Par. 608
2261h	Start Homing manually	i16	0000h	0000h	0001h	rw		Par. 609
2262h	Position method of the switch P40	i16	0000h	0000h	0014h	rw		Par. 610
2263h	Position method of the switch P41	i16	0000h	0000h	0014h	rw		Par. 611
2264h	Position method of the switch P42	i16	0000h	0000h	0014h	rw		Par. 612
2265h	Position method of the switch P43	i16	0000h	0000h	0014h	rw		Par. 613
2266h	Position method of the switch P44	i16	0000h	0000h	0014h	rw		Par. 614
2267h	Position control interrupt enabled	i16	0000h	0000h	0001h	rw		Par. 615
226Ch	Position sequence method	i16	0000h	0000h	0014h	rw		Par. 620
226Dh	Position sequence end mode	i16	0000h	0000h	0006h	rw		Par. 621
226Eh	Position sequence hold mode	i16	0000h	0000h	0001h	rw		Par. 622
226Fh	Position sequence first block	i16	0000h	0000h	0013h	rw		Par. 623
2270h	Position sequence last block	i16	0000h	0000h	0013h	rw		Par. 624
2271h	Position disable delay	i16	000Ah	0000h	1770h	rw		Par. 625

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
2276h	numerator gear ratio	i16	0001h	D8F1h	270Fh	rw		Par. 630
2277h	denominator gear ratio	i16	0001h	D8F1h	270Fh	rw		Par. 631
2278h	numerator scaling factor	i16	0001h	D8F1h	270Fh	rw		Par. 632
2279h	denominator scaling factor	i16	0001h	D8F1h	270Fh	rw		Par. 633
2280h	Target reached position window (user units)	i16	0001h	0001h	270Fh	rw		Par. 640
2281h	Target reached speed window	i16	0001h	0001h	270Fh	rw		Par. 641
22BCh	Position reference 0	i16	0000h	D8F1h	270Fh	rw		Par. 700
22BDh	Position speed 0	i16	01F4h	0000h	1F40h	rw		Par. 701
22BEh	Position time limit 0	i16	0000h	0000h	1770h	rw		Par. 702
22C1h	Position reference 1	i16	0000h	D8F1h	270Fh	rw		Par. 705
22C2h	Position speed 1	i16	01F4h	0000h	1F40h	rw		Par. 706
22C3h	Position time limit 1	i16	0000h	0000h	1770h	rw		Par. 707
22C6h	Position reference 2	i16	0000h	D8F1h	270Fh	rw		Par. 710
22C7h	Position speed 2	i16	01F4h	0000h	1F40h	rw		Par. 711
22C8h	Position time limit 2	i16	0000h	0000h	1770h	rw		Par. 712
22CBh	Position reference 3	i16	0000h	D8F1h	270Fh	rw		Par. 715
22CCh	Position speed 3	i16	01F4h	0000h	1F40h	rw		Par. 716
22CDh	Position time limit 3	i16	0000h	0000h	1770h	rw		Par. 717
22D0h	Position reference 4	i16	0000h	D8F1h	270Fh	rw		Par. 720
22D1h	Position speed 4	i16	01F4h	0000h	1F40h	rw		Par. 721
22D2h	Position time limit 4	i16	0000h	0000h	1770h	rw		Par. 722
22D5h	Position reference 5	i16	0000h	D8F1h	270Fh	rw		Par. 725
22D6h	Position speed 5	i16	01F4h	0000h	1F40h	rw		Par. 726
22D7h	Position time limit 5	i16	0000h	0000h	1770h	rw		Par. 727
22DAh	Position reference 6	i16	0000h	D8F1h	270Fh	rw		Par. 730
22DBh	Position speed 6	i16	01F4h	0000h	1F40h	rw		Par. 731
22DCh	Position time limit 6	i16	0000h	0000h	1770h	rw		Par. 732
22DFh	Position reference 7	i16	0000h	D8F1h	270Fh	rw		Par. 735
22E0h	Position speed 7	i16	01F4h	0000h	1F40h	rw		Par. 736
22E1h	Position time limit 7	i16	0000h	0000h	1770h	rw		Par. 737
22E4h	Position reference 8	i16	0000h	D8F1h	270Fh	rw		Par. 740
22E5h	Position speed 8	i16	01F4h	0000h	1F40h	rw		Par. 741

22E6h	Position time limit 8	i16	0000h	0000h	1770h	rw		Par. 742
22E9h	Position reference 9	i16	0000h	D8F1h	270Fh	rw		Par. 745
22EAh	Position speed 9	i16	01F4h	0000h	1F40h	rw		Par. 746
22EBh	Position time limit 9	i16	0000h	0000h	1770h	rw		Par. 747
22EEh	Position reference 10	i16	0000h	D8F1h	270Fh	rw		Par. 750
22EFh	Position speed 10	i16	01F4h	0000h	1F40h	rw		Par. 751
22F0h	Position time limit 10	i16	0000h	0000h	1770h	rw		Par. 752
22F3h	Position reference 11	i16	0000h	D8F1h	270Fh	rw		Par. 755
22F4h	Position speed 11	i16	01F4h	0000h	1F40h	rw		Par. 756

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
22F5h	Position time limit 11	i16	0000h	0000h	1770h	rw		Par. 757
22F8h	Position reference 12	i16	0000h	D8F1h	270Fh	rw		Par. 760
22F9h	Position speed 12	i16	01F4h	0000h	1F40h	rw		Par. 761
22FAh	Position time limit 12	i16	0000h	0000h	1770h	rw		Par. 762
22FDh	Position reference 13	i16	0000h	D8F1h	270Fh	rw		Par. 765
22FEh	Position speed 13	i16	01F4h	0000h	1F40h	rw		Par. 766
22FFh	Position time limit 13	i16	0000h	0000h	1770h	rw		Par. 767
2302h	Position reference 14	i16	0000h	D8F1h	270Fh	rw		Par. 770
2303h	Position speed 14	i16	01F4h	0000h	1F40h	rw		Par. 771
2304h	Position time limit 14	i16	0000h	0000h	1770h	rw		Par. 772
2307h	Position reference 15	i16	0000h	D8F1h	270Fh	rw		Par. 775
2308h	Position speed 15	i16	01F4h	0000h	1F40h	rw		Par. 776
2309h	Position time limit 15	i16	0000h	0000h	1770h	rw		Par. 777
230Ch	Position reference 16	i16	0000h	D8F1h	270Fh	rw		Par. 780
230Dh	Position speed 16	i16	01F4h	0000h	1F40h	rw		Par. 781
230Eh	Position time limit 16	i16	0000h	0000h	1770h	rw		Par. 782
2311h	Position reference 17	i16	0000h	D8F1h	270Fh	rw		Par. 785
2312h	Position speed 17	i16	01F4h	0000h	1F40h	rw		Par. 786
2313h	Position time limit 17	i16	0000h	0000h	1770h	rw		Par. 787
2316h	Position reference 18	i16	0000h	D8F1h	270Fh	rw		Par. 790
2317h	Position speed 18	i16	01F4h	0000h	1F40h	rw		Par. 791
2318h	Position time limit 18	i16	0000h	0000h	1770h	rw		Par. 792
231Bh	Position reference 19	i16	0000h	D8F1h	270Fh	rw		Par. 795
231Ch	Position speed 19	i16	01F4h	0000h	1F40h	rw		Par. 796
231Dh	Position time limit 19	i16	0000h	0000h	1770h	rw		Par. 797
Special Parameters								
23E5h	Maintenance Mode, SW-Reset, activate download	i16	0000h					
23E6h	Parameter Set Number	i16	00A0h					
23E7h	Last edited parameter	i16	FFFFh					
2407h	Monitor values							
.0h	number of elements	1h	19h					
.1h	display segments 0	2h	0040h					
.2h	display segments 1	2h	5600h					
.3h	display segments 2	2h	EE56h					
.4h	display segments 3	2h	0000h					
.5h	LEDs and keys	2h	00AFh					
.6h	ramp reference	2h	0000h					
.7h	ramp output	2h	0000h					
.8h	actual velocity	2h	0000h					

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
.9h	analog input	2h	0000h					
.Ah	temperature	2h	002Ch					
.Bh	DC link voltage	2h	286Bh					
.Ch	output current	2h	0000h					
.Dh	output voltage	2h	0000h					
.Eh	load	2h	0000h					
.Fh	output frequency	2h	0000h					
.10h	Ud	2h	0000h					
.11h	Uq							
.12h	Id	2h	0000h					
.13h	Iq	2h	0000h					
.14h	flux	2h	0000h					
.15h	normalization of voltage	2h	0000h					
.16h	error matrix hi word	2h	0000h					
.17h	error matrix lo word	2h	0000h					
.18h	analog output	2h	0000h					
.19h	set on error	2h	0000h					
Event Trigger Setup And DigIn Junction Parameters								
2800h	trigger of txPDO1							
.0h	number of elements	1h	04h					
.1h	trigger edge	1h	00h					
.2h	noise level	4h	00000000h					
.3h	trigger level 1	4h	00000000h					
.4h	trigger level 2	4h	00000000h					
2801h	trigger of txPDO2							
.0h	number of elements	1h	04h					
.1h	trigger edge	1h	00h					
.2h	noise level	4h	00000000h					
.3h	trigger level 1	4h	00000000h					
.4h	trigger level 2	4h	00000000h					
2802h	trigger of txPDO3							
.0h	number of elements	1h	04h					
.1h	trigger edge	1h	00h					
.2h	noise level	4h	00000000h					
.3h	trigger level 1	4h	00000000h					
.4h	trigger level 2	4h	00000000h					
2803h	trigger of txPDO4							
.0h	number of elements	1h	04h					
.1h	trigger edge	1h	00h					
.2h	noise level	4h	00000000h					
.3h	trigger level 1	4h	00000000h					
.4h	trigger level 2	4h	00000000h					

Index	Name	Type	Default	Min	Max	Access	Unit	Comment
5F00h	dummy objects							
.0h	largest sub-index supported	1h	03h					
.1h	1 byte dummy	1h	00h					
.2h	2 byte dummy	2h	0000h					
.3h	4 byte dummy	4h	00000000h					
5F80h	cam position (for P55=8)	4h	00000000h					
5FFEh	Home Index Distance	4h	00000000h					

5FFFh	Logical junction with digital inputs							
.0h	number of elements	1h	02h					
.1h	AND junction	1h	FFh					
.2h	OR junction	1h	00h					
standardized device profile area [CiA CAN DS 402 V1.2]								
603Fh	error_code	2h	0000h					
6040h	control_word	2h	0000h					
6041h	status_word	2h	0021h					
6042h	vl_target_velocity	2h	0000h					
6043h	vl_velocity_demand	2h	0000h					
6044h	vl_actual_velocity	2h	0000h					
6046h	vl_velocity_min_max_amount							
.0h	number of elements	1h	02h					
.1h	vl_velocity_min_amount	4h	00000000h					
.2h	vl_velocity_max_amount	4h	00000BB8h					
6048h	vl_velocity_acceleration							
.0h	number of elements	1h	02h					
.1h	delta_speed	4h	000493E0h					
.2h	delta_time	2h	03E8h					
6049h	vl_velocity_deceleration							
.0h	number of elements	1h	02h					
.1h	delta_speed	4h	000493E0h					
.2h	delta_time	2h	03E8h					
6060h	modes_of_operation	1h	00h					
6061h	modes_of_operation_display	1h	02h					
6064h	position_actual_value	i32	00000000h					
606Ch	velocity_actual_value	4h	00000000h					
6071h	target_torque	2h	0000h					
6077h	torque_actual_value	2h	0000h					
607Ah	target_position	4h	00000000h					
607Ch	home_offset	4h	00000000h					
6081h	profile_velocity	4h	000001F4h					
6083h	profile_acceleration	4h	00000064h					
6084h	profile_deceleration	4h	00000064h					

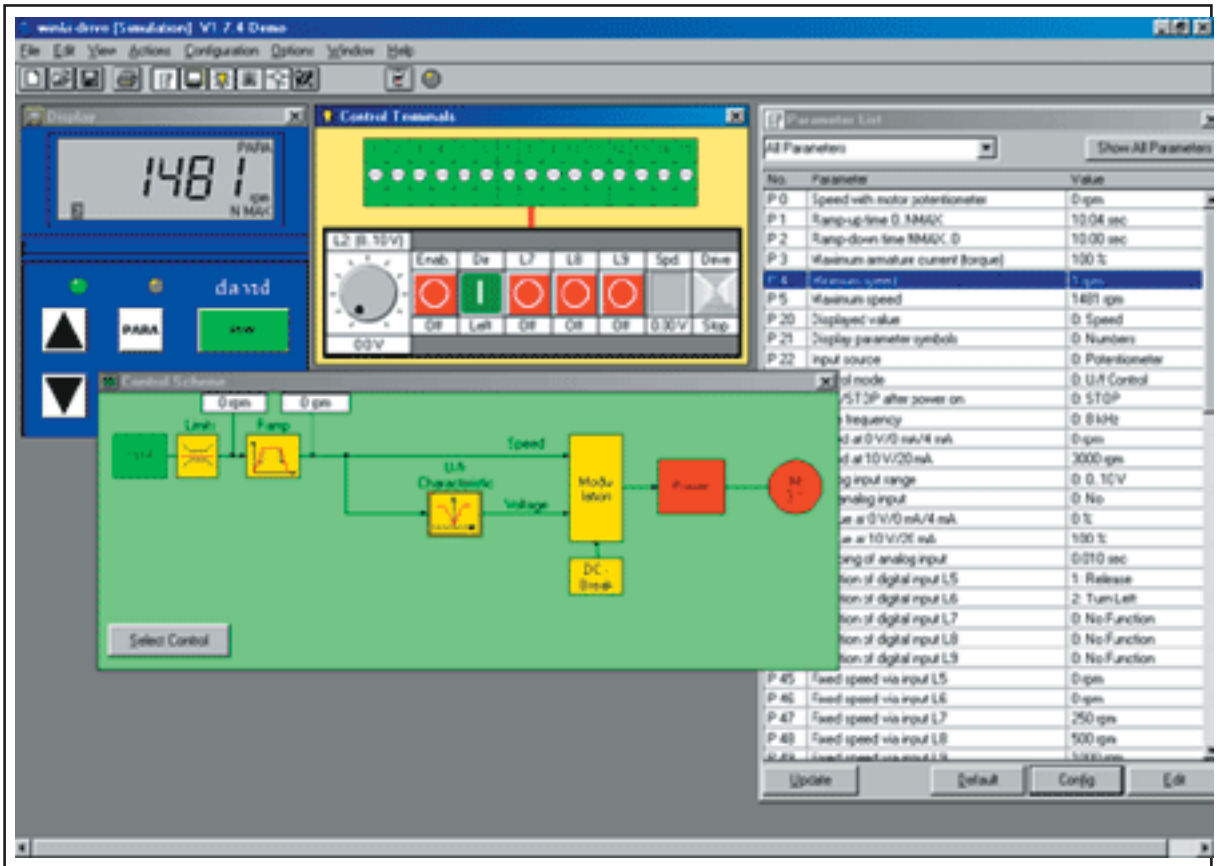
Index	Name	Type	Default	Min	Max	Access	Unit	Comment
6086h	motion_profile_type	2h	0000h					
6087h	torque_slope	4h	00000000h					
6088h	torque_profile_type	2h	0000h					
608Fh	position_encoder_resolution							
.0h	number of elements	1h	02h					
.1h	encoder_increments	4h	00001000h					
.2h	motor_revolutions	4h	00000001h					
6098h	Home_method	1h	01h					
6099h	Home_speed							
.0h	number of elements	1h	02h					
.1h	speed_during_search_for_switch	4h	000001F4h					
.2h	speed_during_search_for_zero	4h	00000064h					
609Ah	Home_acceleration	4h	00000000h					
60FBh	position_control_parameter_set							
.0h	number of elements	1h	04h					
.1h	position_p_gain	2h	0064h					

.2h	speed_forward_factor	2h	0EA8h					
.3h	target_reached_position_window	4h	00000001h					
.4h	target_reached_speed_window	2h	0001h					
60FDh	digital_inputs	4h	00000000h					
60FEh	digital_outputs							
.0h	number of elements	1h	02h					
.1h	physical_outputs	4h	00000000h					
.2h	bitmask	4h	00000000h					
6502h	supported_drive_modes	4h	0000002Bh					

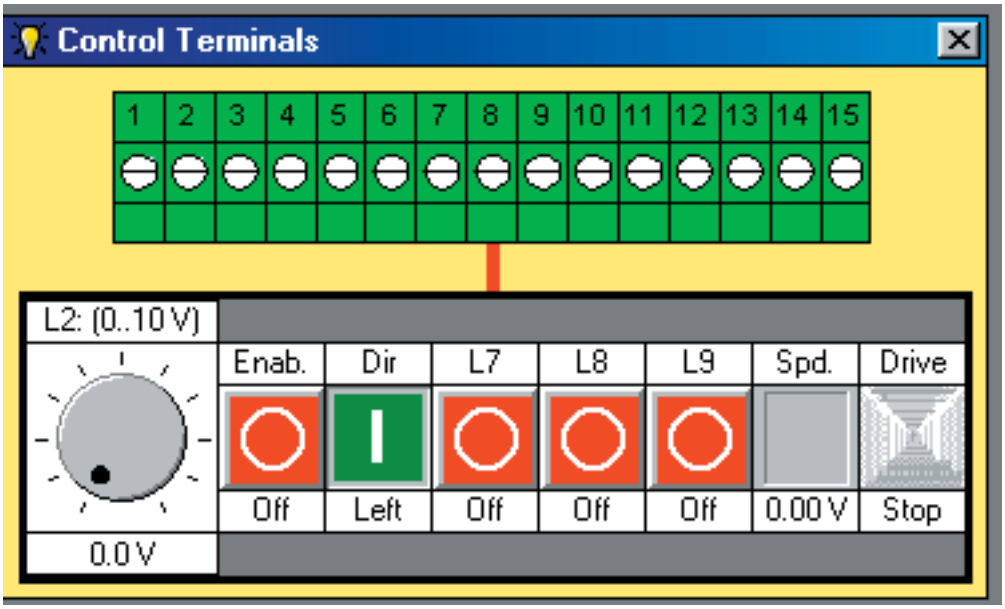
rw* ‘OFF parameter’, write access only in case of device in OFF condition

ro* Maintenance parameter, write access only in case of activated maintenance mode

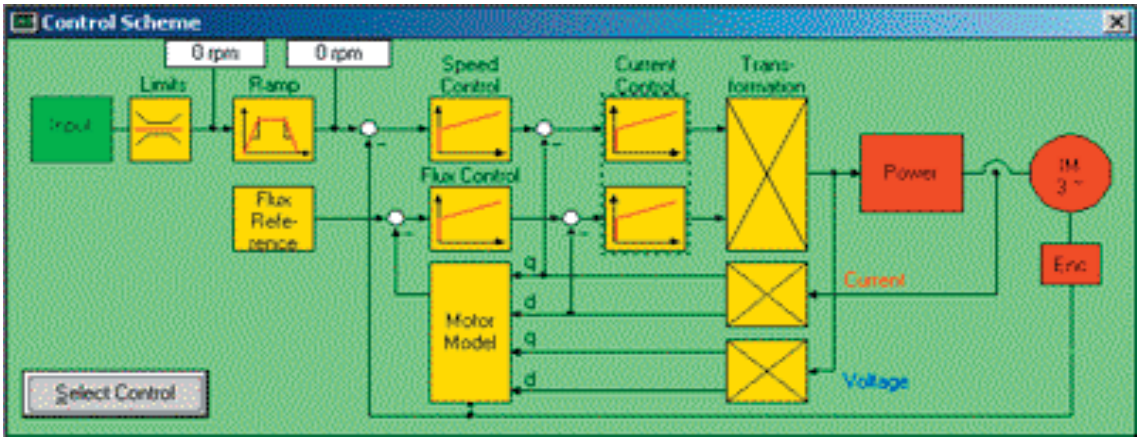
16 PC operation with win+i-Drive



Master Screen to monitor Total System



Displays I/O Status



Monitor status of the i-Drive and motor parameters at any time

win+i-Drive is a PC program set-up, tuning and diagnosis of the i-Drive. It includes:

- Set-up of i-Drive's control software
- Serial communication between PC and i-Drive (reading and writing the parameter list)
- Display of the actual status of i-Drive
- Graphically supported parameter set-up and tuning
- Running with Windows 3.1x, 95, 98 and NT

Attention:
It is not possible to save parameters in set-up (offline) mode and transfer it to an i-Drive!

Please go online to change parameters!

16.1 Connection of an i-Drive with a PC

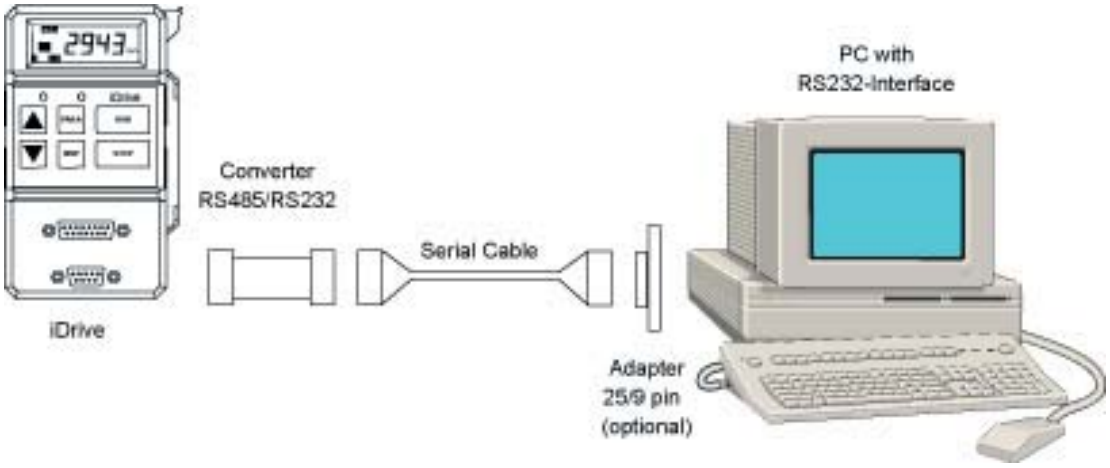


Fig. 29: Connection of an i-Drive with a PC

16.2 Installation

For installing win+i-Drive on a PC a:\setup.exe has to be started (a: = letter of drive containing the first installation disk) and the following commands have to be executed.

To establish the communication between PC and i-Drive the following points have to be considered:

- Connection of the serial interface ports of the PC and the i-Ddrive via RS-232 (PC) to RS-485 (i-Drive) converter
- Open the dialog box from the menu **Options/Communication.** Pressing the button **Search COM** an open communication port is looked for which has to correspond to the port the converter is plugged in. By using the button **Search device** a connected unit is searched. For all available baud rates, the possible slave addresses from 0 to 30 are selected; if an i-Drive is responding, it's slave address is remembered. From the list of the slave addresses the connected unit can be selected.
- The menu **Actions/Online** or the button "Mode" of the tool bar will start the communication. First, all parameters of the drive are read.

16.3 Program overview

win+i-Drive is a Windows application that is being used like other Windows programs. The main program window contains the following regions:

- Title bar
- Menu bar
- Tool bar
- Area for the monitoring windows
- Status bar

The title bar contains the filename of the loaded parameter set and a message, if the program is in simulation (offline) or online mode.

16.3.1 Menu overview

File		Description
New..	Ctrl-N	Create a new parameter set
Open..	Ctrl-O	Open a parameter set file
Save	Ctrl-S	Save a parameter set file
Save As..		Save a parameter set file under a new name
Print..	Ctrl-P	Print a parameter set
Exit	Alt-F4	Exit win+i-Drive

Edit		Description
Cut	Ctrl-X	Removes marked text and stores it into the clipboard
Copy	Ctrl-C	Copies marked text into the clipboard
Paste	Ctrl-V	Inserts text from the clipboard
Delete	Del	Deletes marked text

View	Description
Display	Open/close the monitoring window of the display
Terminals	Open/close the monitoring window of the terminals
Power Scheme	Open/close the power scheme window
Control Scheme	Open/close the control scheme window
Parameter List	Open/close the parameter list window
Recorder	Open/close the recorder window
Toolbar	Show/hide the toolbar
Status bar	Show/hide the status bar

Actions	Description
Simulation (offline)	Change to simulation (offline) mode
Online	Change to online mode
Upload to PC	Transfer all parameters from inverter to PC
Download from PC	Transfer all parameters from PC to inverter
Reset Simulation	Reset the simulation

Configuration	Description
Power	Sub menu for the configuration items of the power scheme window
Display	Sub menu for the configuration items of the display window
Terminals	Sub menu of the configuration items of the terminals window
Control	Sub menu of the configuration items of the control scheme window

Options	Description

Project..	Open dialog box for general project data (description, author, organisation)
Language..	Open dialog box for selecting the language. English and German are available.
Communication..	Open dialog box for the configuration of the communication port of the PC

Window	Description
Cascade	Cascades all open monitoring windows
Arrange Icons	Arranges all icons of minimised monitoring windows
List of all open monitoring windows	Shows a list of all displayed monitoring windows. Clicking on one menu item will put the focus to this window

Help	Description
Contents	Open the help display
Search for Help on..	Open a dialog for searching help on a specific topic
Help on Help	Open a help display how to use help
About..	Shows general information about win+i-Drive

16.3.2 Toolbar

The tool bar contains buttons which will start the following actions by a mouse click:

1. Create a new parameter set
2. Open a file with a parameter set
3. Save a file with a parameter set
4. Print the loaded parameter set
5. Open/close the parameter list window
6. Open/close the window of the display
7. Open/close the window of the terminals
8. Open/close the window of the power scheme
9. Open/close the window of the control scheme
10. Not implemented at the moment
11. Change between simulation and online mode
12. Status display of communication mode (grey = simulation mode, no communication, green = communication is working, red = communication error)

The toolbar can be made visible and hidden by the menu item **View/Toolbar.** Especially for screens with a low resolution hiding the toolbar can be useful for enlarging the area for displaying windows. All operations which can be started from the toolbar can also be started from the menus.

16.3.3 Status bar

The status bar displays actual information about the state of win+i-Drive. The status bar can be made

visible and hidden by the menu item **View/Status** bar. Especially for screens with a low resolution hiding the status bar can be useful for enlarging the area for displaying windows.

16.4 Parameter sets and files

win+i-Drive can store complete parameter sets in files and load these from files. Using this the once completed total set-up of an i-Drive can be transferred to another one. The parameters are stored in a txt-file. By the menu items of the File menu a new parameter set can be created and the parameter set file can be opened from disk or saved to disk. In the online mode all parameters of the connected i-Drive are first read before saving them to disk, thus ensuring that the actual parameters are stored.

Each file that contains a parameter set, also includes the following information:

- General project data (description, author, organization) which are entered when creating a new parameter set and which can be modified by a dialog opened by menu item **Options/Project**. This information can be used to identify a parameter set (i.e. motor type, position of the drive within a machine)
- Size and position of the monitoring windows
- Descriptions entered by the user for the state of the terminals

The whole parameter set can be printed by menu item **File/Print.** The printed parameter list fits on one DIN-A4 page. In online mode all parameters are first read before starting the printing. This ensures that the actual parameters are printed to paper.

The complete parameter set can be transferred from PC to the connected i-Drive by using the menu item **Action/Download** from PC. The parameters stored within the i-Drive will be overwritten. This operation can be used for the quick set-up of drives in multiple machines. Uncheck “No Warnings” in options menu first to monitor for any parameter transfer error messages.

Using the menu item **Action/Upload** to PC the total parameter set of the connected i-Drive is transferred to the PC. This is intended for reading the total configuration, and for saving it to a disk.

16.5 Simulation (offline) and online mode

win+i-Drive has two operating modes:

- Simulation (offline) mode which displays the control behaviour of i-Drive on the PC
- Online mode which displays the state of the i-Drive that is connected via the serial interface on the PC, and which changes the parameters of this drive from the PC

Using the menu items **Action/Simulation** and **Action/Online** or the appropriate button of the toolbar the mode will be changed.

16.5.1 Simulation (offline) mode

In simulation (offline) mode the PC displays the i-Drive’s behavior. The mode is useful to get familiar with the i-Drive’s operations and to prepare a parameter set for download into a connected device.

The following functions are executed:

- Display of the state of the unit via the LED’s and the LCD display
- Operation using the keys
- The function of the analog input, the digital control inputs and the relay output
- Set-up of the speed by the ramp
- The control by process data of the serial interface

	**Attention:** It is not possible to save parameters in simulation (offline) mode and transfer it to an i-Drive! Please go online to change parameters!

The following functions are not executed:

- The reaction of a connected motor including the speed control and the load behaviour
- The tuning of motor parameters
- Operation and display of the recorder

In simulation mode most parameters can be displayed and changed. They will be saved in the parameter set file.

16.5.2 Online mode

In online mode the PC displays the status of the connected drive. This includes:

- State of the LED's and the LCD display within the display window
- State of the control terminals in the terminals window
- The actual temperature and DC bus voltage in the power scheme window
- The set and measured values of the control (speed, voltages, currents, flux) in the control scheme window
- Process data of the serial interface which can also be used to control i-Drive in automation mode
- The actual parameters of the unit

These values will be updated about four times per second (at 9600 baud).

In online mode all parameters are changed simultaneously in the connected unit and in the loaded parameter set of the PC. After turning on the online mode first all parameters are read and compared to the loaded parameter set of the PC. If there are differences it is asked whether the parameters should be transferred from PC to i-Drive (download) or from i-Drive to PC (upload). When running in online mode, win+i-Drive checks if a parameter has been changed within the connected i-Drive. If this is true the appropriate display windows will be updated (i.e. the parameter list).

In online mode the connected i-Drive can be controlled by the displayed process data of the window of the serial interface if the input source was set to the serial interface (P22 = 3).

Also in online mode, the recorder can be used to record and display the dynamics of internal signals of the i-Drive, e.g. tuning of the control loops.

16.6 Monitoring windows

win+i-Drive displays, within seven different monitoring windows, the state of the simulated or connected i-Drive unit. The various windows can be opened and closed by menu items from the View menu or by buttons of the toolbar. The size and position of the display windows is stored in the parameter set file (dte) thus restoring the screen layout after loading this file again.

From the monitoring window, dialog boxes for changing the parameters can be opened. By pressing the right mouse button a menu is opened which contains menu items for configuration. Also if the mouse cursor within one display window changes from a cross to an arrow, a configuration dialog box will be opened by a mouse click (left mouse button) which corresponds to the element the mouse is pointing to.

16.6.1 Display window

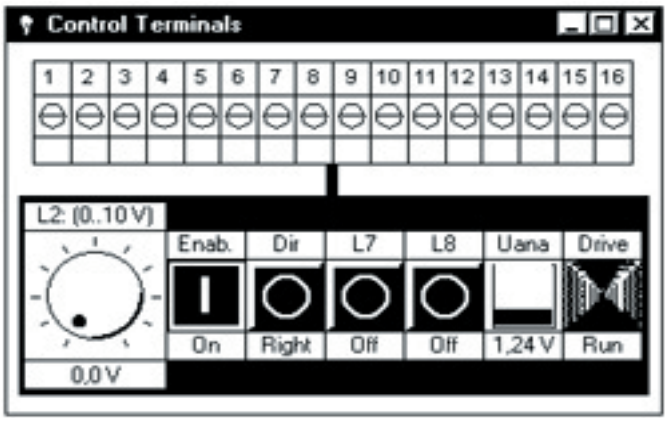
The display window contains the LED's, the LCD display and the six keys for operating the i-Drive. In simulation mode, a key press by the left mouse button performs the same action as in the real unit. The LED's and the LCD display show the unit's state.

In online mode, a press on the keys has no function. The state of the LED's and the LCD display of the connected unit are displayed. The display is updated four times a second.

The following configuration dialogs can be opened from this window:

- Size of this window (small, medium and large to adapt it to the screen's resolution).
- Speed set-point value for the motor potentiometer function (P0).
- Selection of the actual displayed value (P20), display of parameter numbers or symbols (P21) and of RUN mode after power-on (P24).

16.6.2 Terminal window



This window shows the control terminals and a panel that contains a potentiometer for the analog input, five switches or push buttons for the digital inputs and a lamp for the relay output.

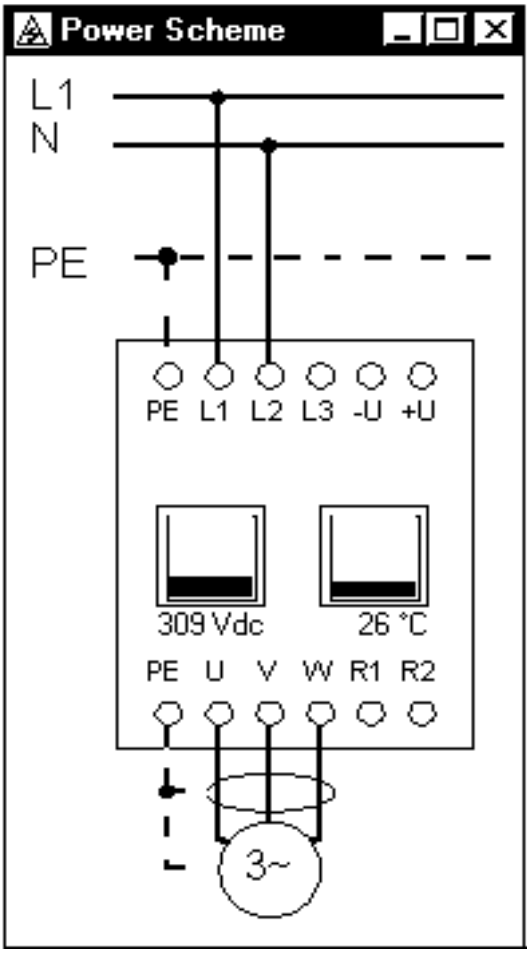
In simulation mode, the analog input (by changing the value of the potentiometer or by direct input into the textbox below the potentiometer and the digital inputs) can be changed using the mouse. The simulated **i-Drive** will react on this as the real unit based on the parameter programming (i.e. changing the speed by the analog input value, release by digital inputs, changing the direction of rotation).

In online mode the elements of the panel display the state of the control terminals. They cannot be changed from the PC.

- The following configuration dialogs can be opened from this window:
- Size of the window (small or large to adopt it to the screen's resolution)
- Function of the analog input (P30-35)
- Function of the digital inputs (P44-44)
- Fixed frequencies of the digital inputs (P45-49)
- Function of the relay output (P50-51)

- labels for the elements of the panel (potentiometer, switches/buttons, relay)

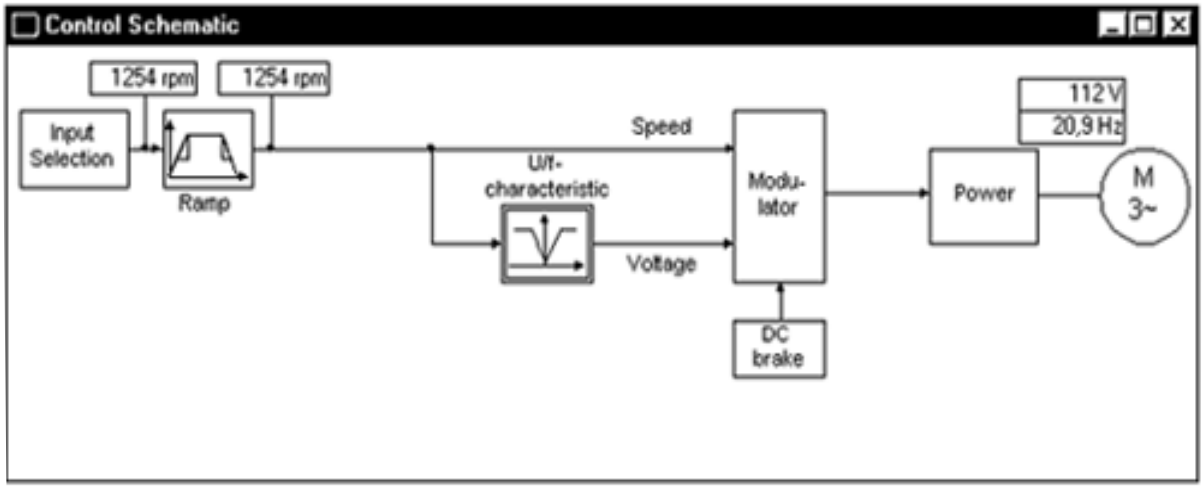
16.6.3 Power scheme window



The window of the power scheme shows how to connect the unit to the mains, the motor and a braking resistor. The type of unit is displayed. In online mode also the actual temperature and the DC bus voltage of the connected unit are displayed.

- The following configuration dialogs can be opened from this window:
- Unit type
- Motor parameters (P100-116)
- Encoder parameters (P70-71)

16.6.4 Control scheme window



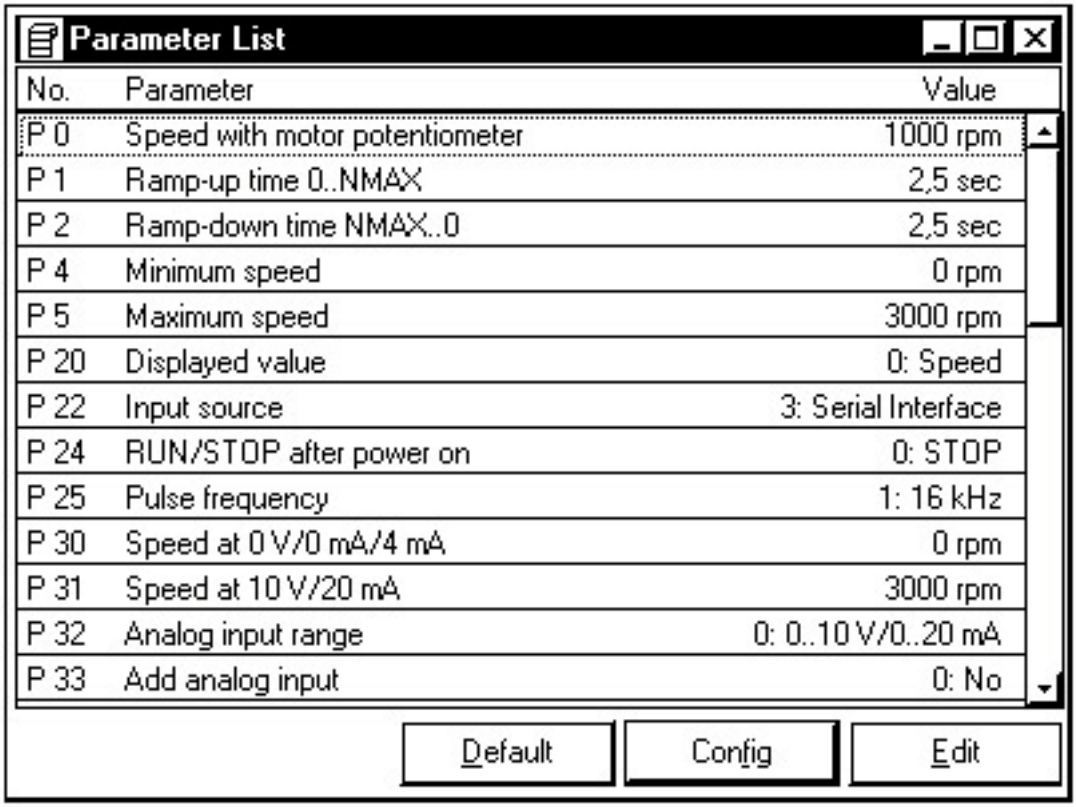
The window of the control scheme displays a block diagram, which corresponds to the actual control mode (P23). Within this block diagram the actual values of the drive control are displayed. In simulation mode this includes only the speed before and after the ramp generator. In online mode additionally the following values will be monitored:

- Electrical output values of the drive (voltage, current, frequency).
- Measured speed or the speed calculated from the electrical motor quantities.
- Flux of the induction motor.
- Vector quantities of the motor current and voltage (torque and flux component) which are also shown in a vector diagram.

The following configuration dialogs can be opened from this window:

- Input source of the control (P22)
- Control mode (P23)
- Minimum and maximum values of the speed and the motor currents (P3-5 and P74)
- Ramp generator (P1-2, P90)
- Speed controller (P72-73)
- V/f-control (P60-63)
- DC brake (P80-81)
- PWM switching frequency (P25)
- Motor parameters (P100-116)
- Encoder (P70-71)

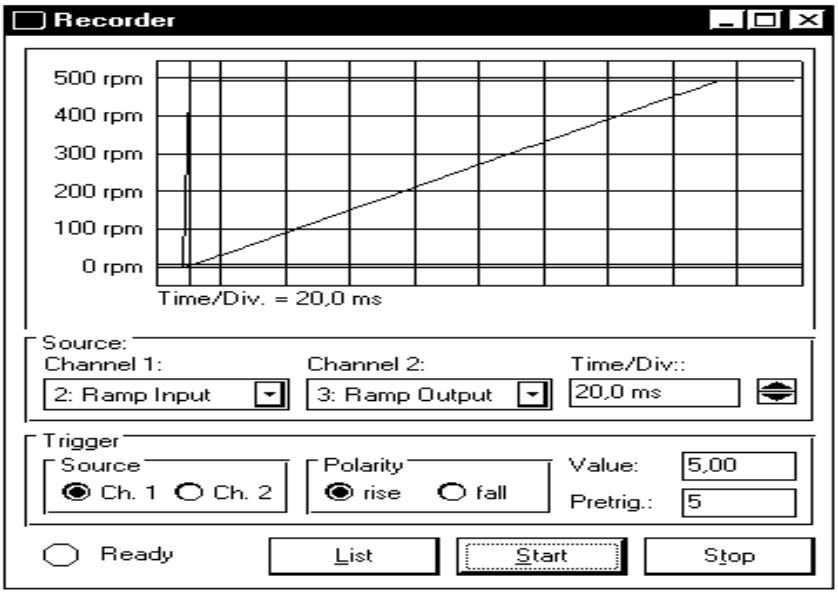
16.6.5 Parameter list



The parameter list shows all parameters of the loaded parameter set in a tabular form.

- **Config** will open a configuration dialog box that corresponds to the parameter.
- **Edit** will open a dialog for entering a new value numerically.
- **Default** will set all parameters to their default state (corresponds to turning on the i-Drive while pressing PARA).

16.6.6 Recorder (Oscilloscope)



i-Drive includes a recorder which can store the real time trace of two internal values. win+i-Drive controls this recorder and displays the recorded values graphically or in tabular form. The recording depth of this recorder is 100 values. The resolution in time can be changed from 0.0625 ms to 16 ms.

The following quantities can be recorded:

- Analog input value
- Speed at the ramp generator input and output
- Speed measured by the encoder
- Speed calculated by the motor model
- Set-point and measured values of the torque and flux current (ISQ and ISD)
- Two components of the voltage (USQ and USD)
- Frequency
- Rotational angle
- Set-point and measured value of the motor flux

Before starting the recorder, the signals to be recorded, the resolution in time and the trigger conditions (channel, slope and trigger value similar to an oscilloscope) have to selected. The value of the pre-trigger determines how many values will be stored before the trigger event (0 to 99, choosing 50 will result in the trigger event being in the middle of the recording).

After setting the signals and trigger conditions, the command button **Start** will start the recording. The status display changes from green to yellow (the control values of the recorder are transferred to i-Drive) and then to red (waiting for the trigger event). After the trigger event has occurred and the recording was finished the recorded values will be transferred (status display will be yellow) and then displayed (status display is green). The command button **Graph/List** changes between the graphical and tabular display.

If the trigger event does not occur, the command button **Stop** will terminate the recording. The last values which have been recorded will be transferred and displayed.

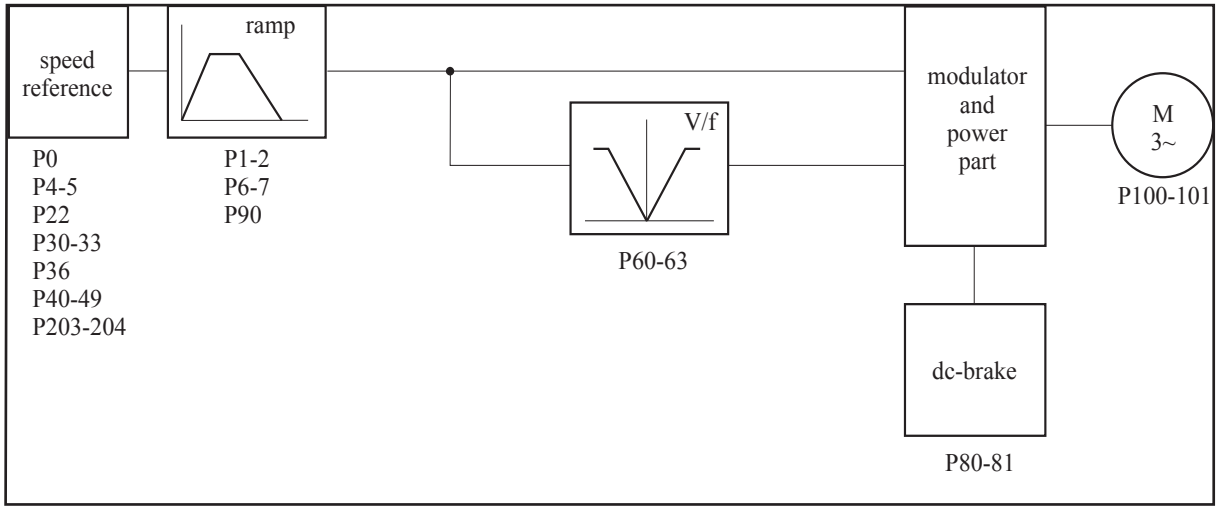
16.7 Configuration dialog boxes

For setting up the parameters, a large number of dialog boxes are provided which present the parameters and their possible values intuitively. All display elements typically for Windows applications are used (check boxes, radio buttons etc.).

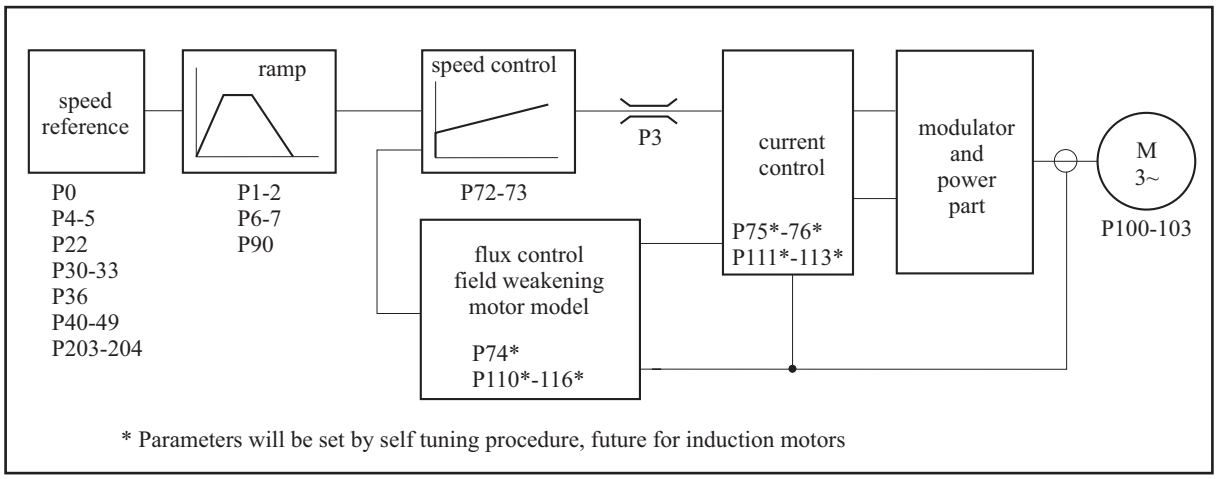
For some values, there are dialog boxes that present these values graphically. By using the mouse the values can be changed (i.e. the ramp parameters, the parameters of the V/f-characteristic, the parameters of the speed controller). Within these windows the following mouse actions and key codes can be used:

- By pressing the left mouse button a value is selected. The corresponding dot within the graphics will get filled
- By dragging the mouse with the left mouse button pushed the value get changed (drag-and-drop)
- The space bar selects the different parameters to be changed graphically
- The arrow keys change the selected parameter
- The page up/page down keys change the range (i.e. the time range of the ramp)

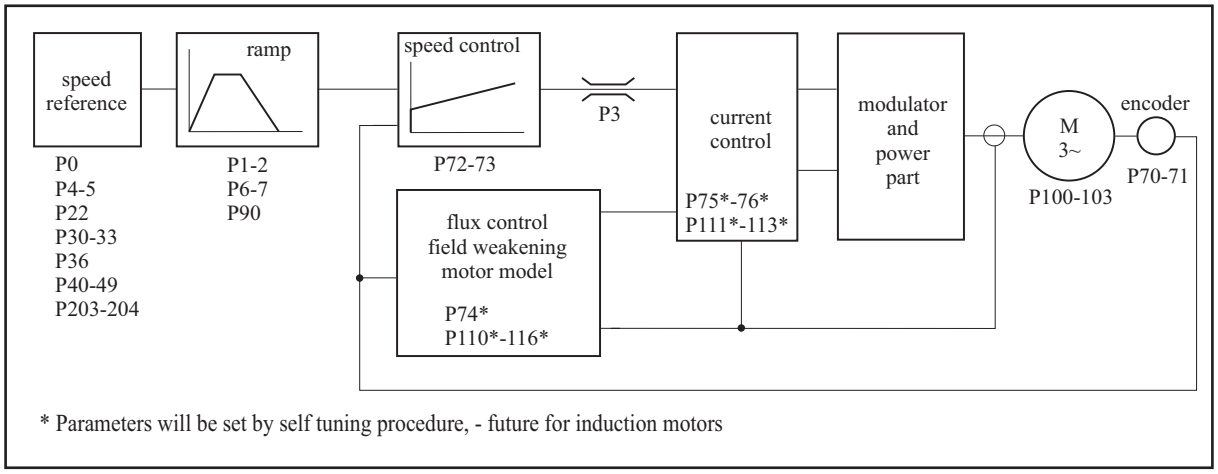
Within all configuration dialog boxes, all parameters that can be changed within this box are first read from the simulated or connected device. Then the window appears. **Apply** will transfer the parameters back to the unit without closing the window, while **OK** will write back and close the window. **Cancel** doesn't alter the parameters but closes the window.



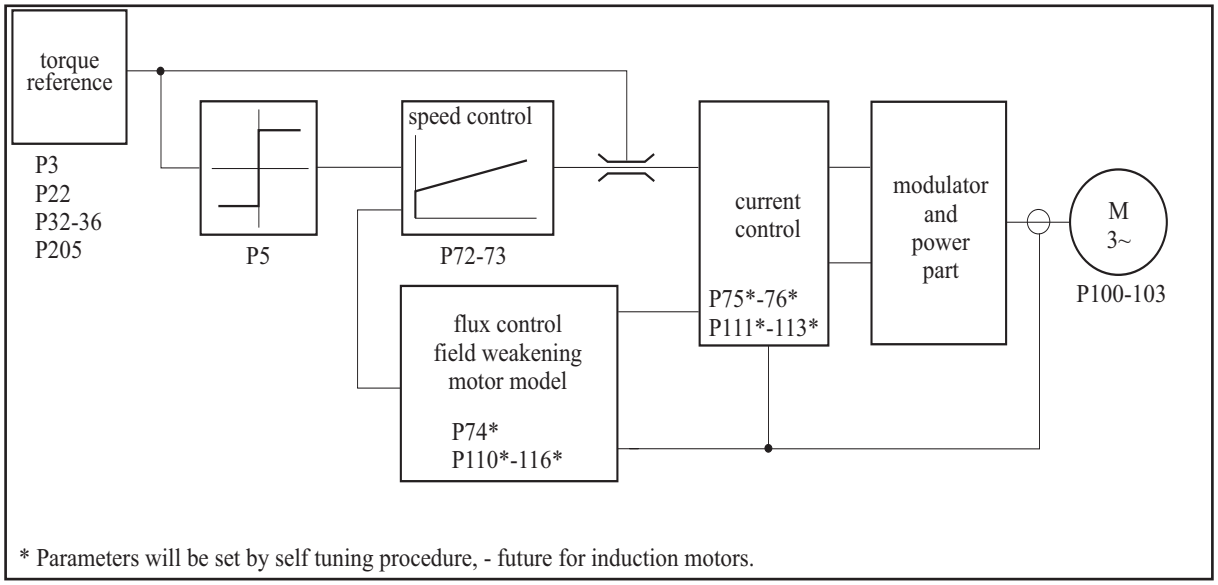
Voltage-frequency control with asynchronous motor (P23=0)



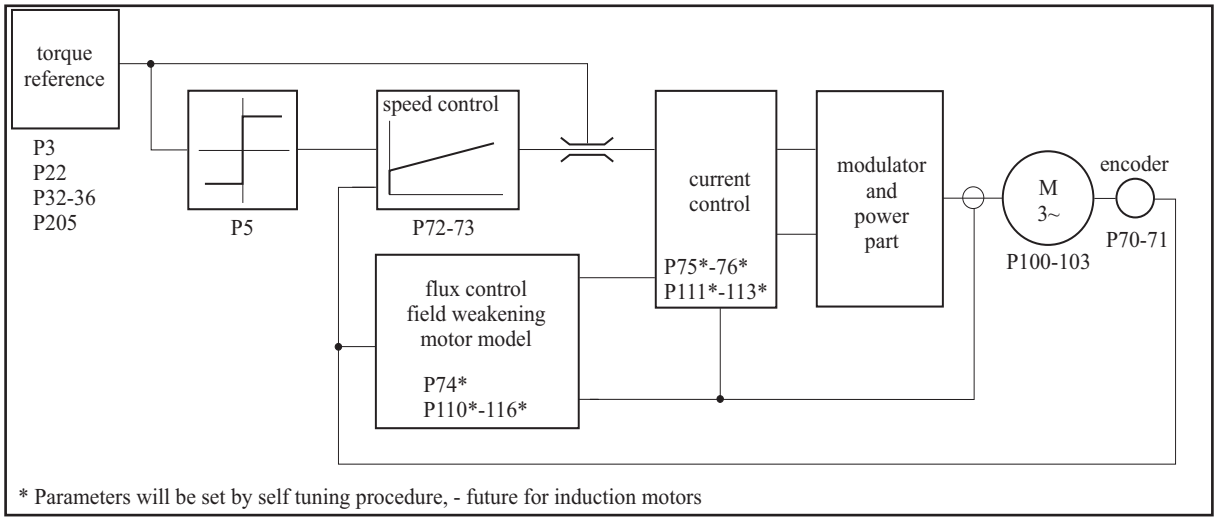
Speed control (open loop) with asynchronous motor (P23=1)



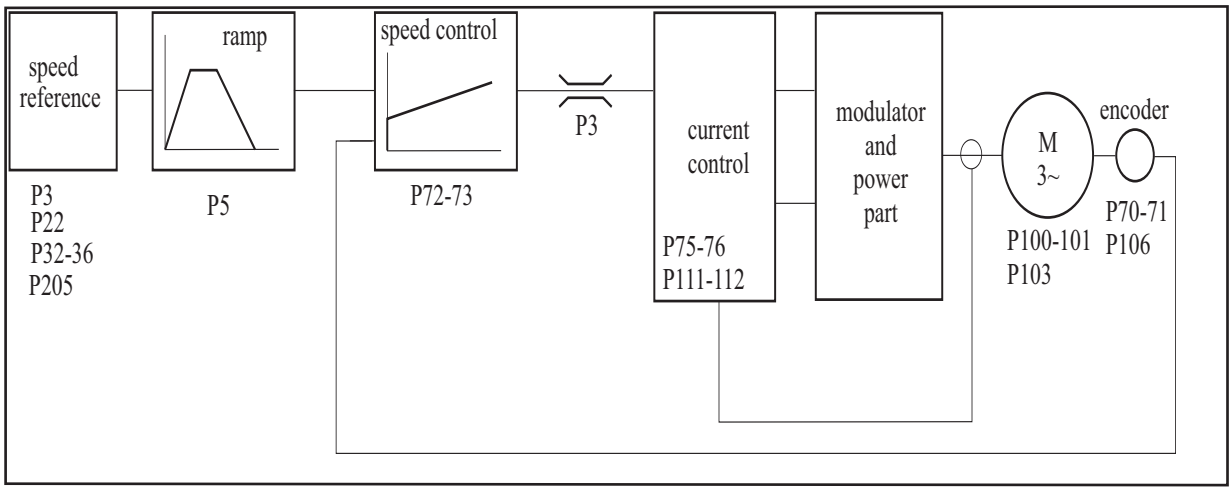
Speed control (closed loop) with asynchronous motor (P23=2, P105=0)



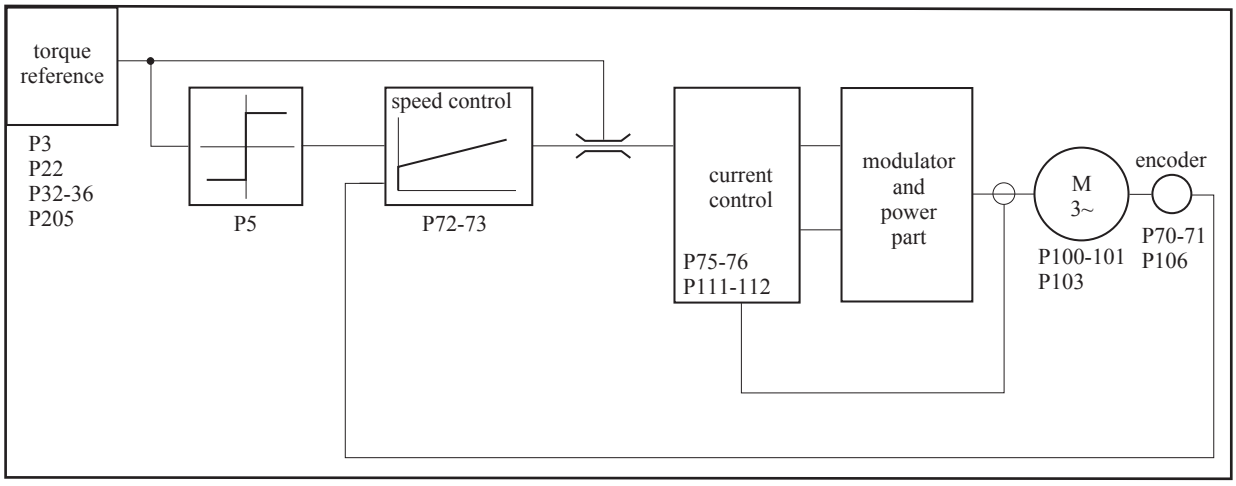
Torque control (open loop) with asynchronous motor (P23=3)



Torque control (closed loop) with asynchronous motor (P23=4, P105=0)



Speed control (closed loop) with synchronous motor (P23=2, P105=1)



Torque control (closed loop) with synchronous motor (P23=4, P105=1)

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18 Parameter overview and error table

Number	Description	min	max	default
	Parameters with symbols:			
P0	Motor potentiometer	-8000 rpm	8000 rpm	0 rpm
P1	Ramp-up time 0 rpm - P6	0,00 s	300,00 s	10,00 s
P2	Ramp-down time P7.-.0 rpm	0,00 s	300,00 s	10,00 s
P3	Maximum armature current (torque)	0 %	1599 %	100 %
P4	Minimum Speed	0 rpm	N MAX (P5)	0 rpm
P5	Maximum Speed	N MIN (P4)	8000 rpm	3000 rpm
P6	Speed for Ramp-up	1 rpm	8000 rpm	3000 rpm
P7	Speed for Ramp-down	1 rpm	8000 rpm	3000 rpm
P8	Overspeed			
	General parameters:			
P10	Password	-9999	9999	1234
P11	Password	0	2	0
P20	Displayed value	0	6	0
P22	Input value	0	3	0
P23	Control mode	0	5	0
P24	Enable after power-on	0	3	0
P25	Switching frequency	0	1	0
P27	Current position	-9999	9999	0
P28	Current set value display	-8000	8000	0
P29	Encoder speed	-8000		0
	Analog input:			
P30	Speed with 0 V/0 mA/4 mA	-8000 rpm	8000 rpm	0 rpm
P31	Speed with 10 V/20 mA	-8000 rpm	8000 rpm	3000 rpm
P32	Analog input range	0	2	0
P33	Add analog input	0	1	0
P34	Torque at 0 V/0 mA/4 mA	0 %	200 %	0 %
P35	Torque at 10 V/20 mA	0 %	200 %	100 %
P36	Filtering time constant of analog input	0,000 s	0,500 s	0,010 s
P37	Position at 0 V/0 mA/4 mA	0%	100%	0%
P38	Position at 10 V/20 mA	0%	100%	100%
	Digital input terminals:			
P39	Inversion mask for digital input			
P40-44	Function of digital input L5-9	0	26	0
P45-49	Fixed speed via input L5-9	-8000 rpm	8000 rpm	
P50-54	Fixed torque via input L5-9	0%	100%	10%
	Analog output:			
P55	Analog output	0	7	0
P56	Amplification analog output value	0 %	500 %	167 %
	Relay output:			
P57	Function of relay output	0	21	0
P58	Speed switching threshold of relay output	0 rpm	8000 rpm	3000 rpm
	V/f characteristic:			
P60	Nominal voltage for V/f- characteristic	100 V	500 V	230 V
P61	Nominal frequency for V/f- characteristic	10 Hz	650 Hz	50 Hz
P62	Voltage boost of V/f-characteristic	0,0 %	30,0 %	5,0 %
P63	Dynamic boost of V/f-characteristic	0,0 %	30,0 %	0,0 %
	Control parameters:			
P70	Encoder increments*	500	32766	1024
P71	Encoder signals*	0	4	0
P72	Speed controller, P-gain	0,00 %	100%	3,00 %

P73	Speed controller, I- gain	0,00 %	100 %	0,50 %

Number	**Description**	**min**	**max**	**default**
P74	Maximum excitation current	0 %	120 %	100 %
P75	Current controller, P-gain	0 %	200 %	100 %
P76	Current controller, I- gain	0 %	200 %	100 %
P77	Flux controller, P-gain	0	100 %	10 %
P78	Flux controller, I- gain	0	100 %	3 %
P79	Position controller, P- gain	0 %	9999 %	100 %

Number	**Description**	**min**	**max**	**default**
	DC braking:			
P80	DC braking duration	0,0 s	30,0 s	0,0 s
P81	DC braking voltage	0,0 %	40,0 %	0,0 %
	Ramps:			
P90	S-Ramp time constant	0,000 s	2,000 s	0,000 s
P91	Dead time after ramp-up	0,00 s	30,00 s	0,00 s
P92	Dead time after ramp-down	0,00 s	30,00 s	0,00 s
	Motor specifications:			
P100	Nominal frequency of motor	10 Hz	650 Hz	50 Hz
P101	Nominal speed of motor *	100 rpm	8000 rpm	2900 rpm
P102	Nominal voltage of motor *	10 V	500 V	230 V
P103	Nominal current of motor *	0,10 A	P248	1,00 A
P104	reserved	0	1	0
P105	Motor type*	0	1	0
P106	Correction angle of encoder	0	360	0
P107	Pole finding method	0	2	0
P108	Start pole angle estimation	0	1	0
P109	Pole finding			
P110	Nominal excitation current of motor	0,10A	P103	0,50A
P111	Stator inductance in [H]	0,000	1,000	0,020
P112	Stator resistance in [Ω]	0,00	200,00	1,00
P113	Rotor resistance in [Ω]	0,00	200,00	1,00
P114	Magnetizing characteristic parameter 1	0,000	1,000	0,150
P115	Magnetizing characteristic parameter 2	1	31	9
P116	Magnetizing characteristic parameter 3	0,001	1,000	0,850
P120	Motor protection function	0	2	0
P121	Heating class of motor	0	7	1
P126	Pulse width			2
P127	Pulse Amplitude			50
	Serial interface:			
P200	Adress of serial interface	0	31	0
P201	Baudrate of serial interface	0	3	2
P202	Monitoring period of serial interface	0,0 s	240,0 s	2,0 s
P203	Reference speed for serial interface	10 rpm	8000 rpm	3000 rpm
P204	Jogging speed of the serial interface	0 rpm	8000 rpm	50 rpm
P205	Reference torque for serial interface	1 %	200 %	100 %
P221	Over-voltage protection	20	900	900
	Test generator:			
P230	Output value of the test generator*	0	4	0
P231	Time duration of the test generator	0,1 s	999,9 s	1,0 s
P232	Offset of the test generator	-200 %	200 %	0 %
P233	Amplitude of the test generator	0 %	200 %	0 %

	Device specifications:			
P239	Cause of overflow error			
P240	Last error	0	3	
P241	Maximum temperature	0	200	
P242	Device typ	0	9999	
P243	Software-revision	0	9999	
P244	Serial number – Digits 1 - 4	0	9999	
P245	Serial number - Digits 5 - 8	0	9999	
P246	Current displayed operating value	-32768	32768	0
P247	Actual state of device	0	9999	0
P248	Nominal current of device	0	9999	220
	Operating time counter:			
P250	Operating time of drive, 1000 h	-32768	32768	0
P251	Operating time of drive, h	-32768	32768	0
P252	Operating time of unit, 1000 h	-32768	32768	0
P253	Operating time of unit, h	-32768	32768	0

Number	**Description**	**min**	**max**	**default**
	Position control			
	Generell parameters:			
P600	Dimension for position reference	0	5	0
P601	Resolution for position reference	0	9999	1000
P602	Speed for analog / motor-poti positioning	0	8000	500
P603	Acceleration in rpm per second	0	8000	100
P604	Deceleration in rpm per second	0	8000	100
	Homing:			
P605	Homing method	1	35	1
P606	Home speed	0	8000	500
P607	Home speed to index pulse	0	8000	100
P608	Homing offset	-9999	+9999	0
P609	Start switch for manual homing	0	0	0
	Fixed positions via digital inputs:			
P610	Position method of switch L5	0	20	0
P611	Position method of switch L6	0	20	0
P612	Position method of switch L7	0	20	0
P613	Position method of switch L8	0	20	0
P614	Position method of switch L9	0	20	0
P615	Aborting a positioning in progress	0	1	0
	Sequence control:			
P620	Position sequence method	0	20	0
P621	Ending the sequence control	0	6	0
P622	Torque on control	0	1	0
P623	First block of position sequence	0	19	0
P624	Last block of position sequence	0	19	0
P625	Position disable delay	0	6000	10
P630	Numerator of transmission or scaling			1
P631	Denominator of transmission or scaling			1
P632	Numerator of user-defined unit			1
P633	Denominator of user-defined unit			1
P640	Position window for target reached			1
P641	Speed window			1
	Definition of the positions			
P700	Position set value, position 0	-9999	9999	0
P701	Speed to position 0	0	8000	500
P702	Time	0,00	60,00	0,00
P705	Position set value, position 1	-9999	9999	0
P706	Speed to position 1	0	8000	500
P707	Time	0,00	60,0	0,00
P710	Position set value, position 2	-9999	9999	0
P711	Speed to position 2	0	8000	500
P712	Time	0,00	60,0	0,00
P715	Position set value, position 3	-9999	9999	0
P716	Speed to position 3	0	8000	500
P717	Time	0,00	60,0	0,00
P720	Position set value, position 4	-9999	9999	0
P721	Speed to position 4	0	8000	500
P722	Time	0,00	60,0	0,00
P725	Position set value, position 5	-9999	9999	0
P726	Speed to position 5	0	8000	500
P727	Time	0,00	60,0	0,00

P730	Position set value, position 6	-9999	9999	0
P731	Speed to position 6	0	8000	500
P732	Time	0,00	60,0	0,00
P735	Position set value, position 7	-9999	9999	0
P736	Speed to position 7	0	8000	500
P737	Time	0,00	60,0	0,00
P740	Position set value, position 8	-9999	9999	0
P741	Speed to position 8	0	8000	500
P742	Time	0,00	60,0	0,00
P745	Position set value, position 9	-9999	9999	0

Number	**Description**	**min**	**max**	**default**
P746	Speed to position 9	0	8000	500
P747	Time	0,00	60,0	0,00
P750	Position set value, position 10	-9999	9999	0
P751	Speed to position 10	0	8000	500
P752	Time	0,00	60,0	0,00
P755	Position set value, position 11	-9999	9999	0
P756	Speed to position 11	0	8000	500
P757	Time	0,00	60,0	0,00
P760	Position set value, position 12	-9999	9999	0
P761	Speed to position 12	0	8000	500
P762	Time	0,00	60,0	0,00
P765	Position set value, position 13	-9999	9999	0
P766	Speed to position 13	0	8000	500
P767	Time	0,00	60,0	0,00
P770	Position set value, position 14	-9999	9999	0
P771	Speed to position 14	0	8000	500
P772	Time	0,00	60,0	0,00
P775	Position set value, position 15	-9999	9999	0
P776	Speed to position 15	0	8000	500
P777	Time	0,00	60,0	0,00
P780	Position set value, position 16	-9999	9999	0
P781	Speed to position 16	0	8000	500
P782	Time	0,00	60,0	0,00
P785	Position set value, position 17	-9999	9999	0
P786	Speed to position 17	0	8000	500
P787	Time	0,00	60,0	0,00
P790	Position set value, position 18	-9999	9999	0
P791	Speed to position 18	0	8000	500
P792	Time	0,00	60,0	0,00
P795	Position set value, position 19	-9999	9999	0
P796	Speed to position 19	0	8000	500
P797	Time	0,00	60,0	0,00

Error table

No.	Symbol	Source of error	Probable cause
E 1	OC	Over-current	Acceleration too rapid (V/f-control). Overload condition.
E 2	OV	Over-voltage	Braking too rapid (high inertial load). No braking resistor.
E 3	TEMP	Over-temperature	Inadequate cooling (Contamination of the heat sink, ambient temperature too high). Overload conditions. Connecting cable of cooling unit not plugged in. Cooling surface cannot dissipate generated heat.
E4		EEPROM error, contents of EEPROM (parameters) damaged	Device must be switched on again with PARA key pressed, default parameters will be loaded. Afterwards all parameters must be adjusted.
E 5 – E 9		External error on terminals L5 – L9	Check digital input circuit.
E10		Mains voltage too low	Poor mains supply. The function of the device is no longer guaranteed. It has to be turned off and turned on again at a normal mains voltage. This error does not occur during normal power down of the device.
E11		Parameter error	Incorrect parameter value entered
E12		Timeout of the serial interface	Control of the serial interface lost, communication fault.
E13		Short circuit	External short circuit or earth ground fault. The device has to turned off and disconnected from the mains. Then the short circuit or earth fault has to be removed. Afterwards, the drive can be turned on again.
E14		Analog input open	Analog input current < 3 mA, only if P32 = 1 (analog input range = 4..20 mA) and P22 = 1 (analog input selected) or P22 = 2 and P33 = 1 (fixed speed and adding analog input value).
E15		Internal Hardware errors	Internal error, please contact supplier: incorrect measurement of DC bus voltage.
E16		Motor protection function	Motor protection is switched on (P120>0) and motor was running with more than the nominal current (P103).
E17		Error programming the test generator	Test generator mode and control mode cannot work together, e. g. test generator output to speed reference at torque control.
E18		Internal Hardware errors	Internal error, please contact supplier: incorrect processor communication
E19		Encoder error	The encoder is not connected. The connected encoder works incorrectly. The selected type of encoder (P71) is not correct.

E20		Over speed	Speed higher than P8.
E21		Encoder error with synchronous motor	If synchronous motor is selected (P105=1) then the absolute position is calculated from the special tracks of the encoder at power-on. If the motor is turning at this moment, then this error may occur. Error may also occur if pole angle finding fails due to a faulty encoder or excessive load relative to P126/P127 settings. For direct drive motor systems, compliance or backlash may need to be added. Refer to chapter on startup for pole angle finding details.
E22		Wrong reference source	If torque control is selected (P23=3, 4), then only the analog input (P22=1) or the serial link (P22=3) may be used.
E23		Live guarding error	CAN-Error: time out in live guarding.
E24		Overflow in CAN-receive buffer	CAN-Error: Too many PDO massages.
E25		Transition to Bus off	CAN-Error Permanent communication errors.
E26		Overflow in CAN-transmit buffer	Messages with higher priority on the bus.
E27		Exceptional Error	Error in error register.
E28		Error Emergency	STOP button was pressed in Remote mode (RS485 or CAN).

Display elements

Display	Function
OFF	The RUN button was not pressed.
OFF1	Undervoltage.
OFF2	OFF2 function (pulse lock) active.
OFF3	OFF3 function (quick stop) active.
OFF4	The drive is not ready for turn on. This state is active after a OFF2 or OFF3 command, after under-voltage, after an error or if it is changed between remote and local mode during motor operation. This state is left by disabling an enable signal or in the automation mode only via the serial link.
OFF5-9	The digital input L5-9, which is programmed to an enable function, is not active.
OF10	OFF state. Pole angle finding waiting for start command.
OF11	Operation via serial interface: the enable bits (bit 0-3 of the control word) are not set.
OF12	Both “Enable right/CW“ and “Enable left/CCW“ are not active (if digital inputs are set to these functions, P40-43 = 3 or 4), or operation via serial interface: no direction bit is set (bit 11 or 12 of the control word).
OF13	At operation via serial interface: both direction bits (bit 11 and 12 of the control word) are set.
OF14	The speed set-point value is lower than the minimum speed N MIN (P4).

Appendix

Revision of software-updates

The actual software version can be seen in Parameter P243 on the i-Drive.

Changes from Version 3.044 to 3.062:

Major Change: Resolver with external Resolver interface

P8 Over speed:
New Parameter

P40 - P44 Digital Input:
New functions:
- Function 26: Fixed torque
- Function 27: Go to BDC coded position
- Function 28: BCD coded input for fixed positioning
- Function 29: Pole finding while setting this input

P57 Relay output:
Changed functions:
- Function 4: 3.044: Final speed reached
  3.062: Target reached
- Function 20: 3.044: Target position reached
  3.062: Internal limit active

Changed functions:
- Function 21: Only for CAN devices BDN available
  3.062: Target reached

P70 Encoder lines:
Changed limits:
- 3.044: 8.000 lines
  3.062: 32.766 lines

P71 Encoder type:
New functions:
- Function 1: Resolver
- Function >1: Multiplier for encoder lines

P107 Method of pole finding:
New functions:
- Function 3: Resolver: Pole angle out of P106
- Function 4: Resolver: Pole finding now

P109 Time of pole finding:
New parameter

P126, P127 Pulse width and pulse height for pole finding:
New parameters:

P239 Overflow error:
New parameter:

P600 Position set value unit:
New function:
- Function 3: Inverted to function 2

P640, P641:
New parameters:
- P640: Positioning window for target reached
- P641: Speed window for target reached

Changes from Version 3.062 to 3.066:
Attention: Not released yet!!

Major Change: Encoder with additional Hall effects possible (external interface needed)

P107 Method of pole finding:
New functions:
- Function 5: Hall
- Function 6: Hall

P623 / P624 first and last sequence control position:
Changed funtionality:
3.062: 0-19
3.066: 1-20

P700 - P797 Position definition:
Changed funtionality:
3.062: 0-19
3.066: 1-20

Error Codes:

E15: 3.044: Internal Hardware Error
3.062: Internal Hardware Error: Incorrect measurement of DC bus voltage

E18: 3.044: Internal Hardware Error
3.062: Internal Hardware Error: Incorrect processor communication

E20: 3.044: Internal Hardware Error
3.062: Over speed

E21: 3.044: Encoder Error for synchronous motors: Faulty pole finding
3.062: Encoder Error for synchronous motors: Detailed description

E23-28: 3.062: New error codes

win+i-Drive start up software:

1.8.0: Linear units for encoders possible
Pole pairs in the motor menu possible instead of frequency

1.8.1: Various Maintenance issues, corrections

1.9.1: Off line message
Magnetizing curves removed from motor settings screen

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