Operating Instructions

Positioning Controller

VLT® 5000
VLT® 5000 FLUX

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Positioning Controller for

VLT 5000 and VLT 5000Flux

Software Version 2.1X

Software Version number: See Parameter 779.

The voltage of the frequency converter is dangerous whenever the equipment is connected to mains. Incorrect installation of the motor or the frequency converter may cause damage to the equipment, serious personal injury or death. Consequently, the instructions in this manual, as well as national and local rules and safety regulations, must be complied with.

Safety regulations

1. The VLT frequency converter must be disconnected from mains if repair work is to be carried out. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
2. The [STOP/RESET] key on the control panel of the frequency converter does not disconnect the equipment from mains and is thus not to be used as a safety switch.
3. Correct protective earthing of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage currents are higher than 3.5 mA.
5. Protection against motor overload is not included in the factory setting. If this function is desired, set parameter 128 to data value *ETR trip* or data value *ETR warning.*
   Note: The function is initialized at 1.16 x rated motor current and rated motor frequency.
   For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.
6. Do not remove the plugs for the motor and mains supply while the frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
7. Please note that the frequency converter has more voltage inputs than L1, L2 and L3, when load sharing (linking of DC intermediate circuit) and external 24 V DC have been installed.
   Check that all voltage inputs have been disconnected and that the necessary time has passed before repair work is commenced.

Warning against unintended start

1. The motor can be brought to a stop by means of digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains.
   If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.
2. While parameters are being changed, the motor may start. Consequently, the stop key [STOP/RESET] must always be activated, following which data can be modified.
3. A motor that has been stopped may start if faults occur in the electronics of the VLT frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.

Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains. Also make sure that other voltage inputs have been disconnected, such as external 24 V DC, load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up.

Using VLT 5001-5006 220 and 500 V units: wait at least 4 minutes
Using VLT 5008-5500 220 and 500 V units: wait at least 15 minutes
Using VLT 5001-5005 550-600 V units: wait at least 4 minutes
Using VLT 5006-5022 550-600 V units: wait at least 15 minutes
Using VLT 5027-5250 550-600 V units: wait at least 30 minutes

Introduction

The Positioning Controller is an application option for the VLT 5000 and VLT 5000 Flux Series. It is based on the SyncPos option card.

The positioning controller can be used in a wide range of applications where a frequency converter is used for positioning. The controller holds information of up to 32 (64 in field bus mode) fixed positions. Relative positions can be added to each other by triggering a new relative positioning command when the controller is already executing a relative positioning command.

Full field bus support is now included meaning starting and stopping etc can be done via bus.

In field bus mode a “quickbus” mode is introduced to enable writing a target position directly. Hence an unlimited number of positions can be reached.

Positions are defined either relative to a fixed home position (absolute positions) or relative to other positions, or relative to a movable “touch probe” sensor.

An advanced mechanical brake controller is included. It is strongly advised to use this brake function as suppose to the VLT mechanical brake handler.

If absolute encoders must be used for positioning feedback in conjunction with VLT 5000 Flux this is now possible. Encoder input MK 3B can be programmed as option feedback input allowing the feedback encoder input MK 3D to be used for VLT 5000 Flux.

The encoder(s) connected can now hardware wise be monitored for open or short-circuits.

Last but not least VLT manual run mode is introduced. It is selected via parameter 711.

This manual consists of the following parts:

Hardware
Description of the electrical interface
Description of the available parameters
An application example!
Troubleshooting
Appendix

Hardware

VLT control card terminals

The terminals on the control card are allocated for positioning controller functions the following parameter settings should therefore not be changed in positioning mode (set-up 1):

Digital inputs 16, 17, 18, 19, 27, 29, 32 and 33

Parameters 300–303 and 305–307 are set to ”No operation” (default setting), then the inputs are ignored by the control card but used as inputs to the positioning controller.

Analogue inputs 53, 54 and 60

Parameters 308, 311 and 314 are set to ”No operation”, then the inputs are ignored by the control card but used as inputs to the positioning controller.

Digital/analogue outputs 42 and 45 (VLT 5000)

Parameters 319 and 321 are set to:

OPTION 0 … 20 mA [91] analogue output (default setting)

Digital outputs 26 and 46 - Analogue outputs 42 and 45(VLT 5000 Flux)

Parameters 319 and 321 are set to:

OPTION 0 … 20 mA [90] analogue output (default setting)

Parameters 341 and 355 are set to:

OPTION digital [90] digital output (default setting)

Technical data

Technical data on the control card terminals can be found in the VLT 5000 design guide.

Option card terminals

There are two encoder interfaces, which are covering the following functions:

- Primary Feedback encoder input
- Secondary encoder input

Terminal	A1	$\overline{A1}$	B1	$\overline{B1}$	Z1	$\overline{Z1}$
Incremental input	A in	$\overline{A}$ in	B in	$\overline{B}$ in	Z in	$\overline{Z}$ in
Absolute input	Clk out	$\overline{Clk}$ out	Data in	$\overline{Data}$ in	Not used	Not used

Fig. 1

Terminal	A2	$\overline{A2}$	B2	$\overline{B1}$	Z2	$\overline{Z2}$
Incremental input	A in	$\overline{A}$ in	B in	$\overline{B}$ in	Z in	$\overline{Z}$ in
Absolute input	Clk out	$\overline{Clk}$ out	Data in	$\overline{Data}$ in	Not used	Not used

Fig. 2

Terminal description

There are 4 terminal blocks, 2 with 10 poles and 2 with 8 poles. *(See figure below*)

MK3A Digital Inputs

I1	I2	I3	I4	I5	I6	I7	I8	24V	COM

MK3B Secondary feedback

5V	COM	A1	$\overline{A1}$	B1	$\overline{B1}$	Z1	$\overline{Z1}$

MK3C Digital Outputs

O1	O2	O3	O4	O5	O6	O7	O8	24V	COM

MK3D Primary feedback

5V	COM	A2	$\overline{A2}$	B2	$\overline{B2}$	Z2	$\overline{Z2}$

Supply voltages

The option card is supplied by the internal 24 V DC supply of VLT 5000, but as the available power is limited it can be necessary to use an external 24 V DC supply.

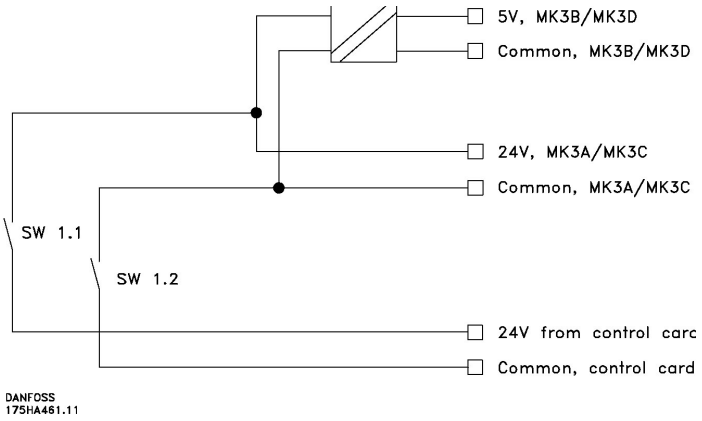
The 24 V DC supply of VLT 5000 can supply a total of 420 mA including the load on the control card (terminal 12, 13 and output 42 and 45 + 26 and 46 for VLT 5000 Flux).

The 5 V output on the option card is generated from the 24 V supply. The maximum power on the 5 V side is 5 V * 280 mA = 1.4 W, this corresponds to app. 60 mA on the 24 V side.

When an external 24 V DC voltage source is used the internal 24 V supply from the control card must be disconnected, this is done by opening switch 1.1 and 1.2

Each digital input on the option card takes 8 mA. Each digital output on the option card can supply up to 0.7 A (external 24V-supply) depending on the load. The load from the 24 V supply (internal or external) can be calculated as follows:

8 mA * number of digital inputs
+
Load on digital outputs
(mk3 C, O1 – O8)
+
load on 5 V supply
(mk3 B/D, 5 V/com)
+
Load on control card
(24 V supply, terminal 12/13 and outputs, terminal 42/45, 26/46)



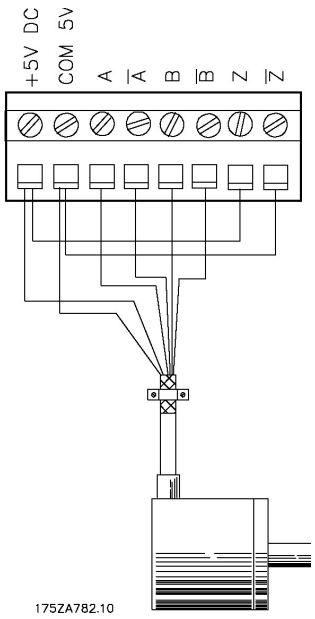
Encoder monitor

Both encoder interfaces are equipped with a monitoring circuit that can detect open circuit as well as short circuit of each encoder channel. Each encoder channel has a LED showing the status: Green light means ok, no light means fault.

Zero channel monitoring can be switched off by means of switch 1.4, this is necessary when using incremental encoders without Zero channel or absolute encoders. Switch 1.4 disables monitoring of both Zero channels. If disabling of only one of the two Zero channels is required (e.g. when using incremental Flux feedback encoder and absolute option feedback encoder) the unused Zero channel input must be connected to 5V/common as shown below.

An encoder fault will only result in an ”Option error” 92 if encoder monitoring is activated via parameter 713.

Note: Monitoring of the secondary feedback encoder is disabled when switch 1.3 is ”OFF”.



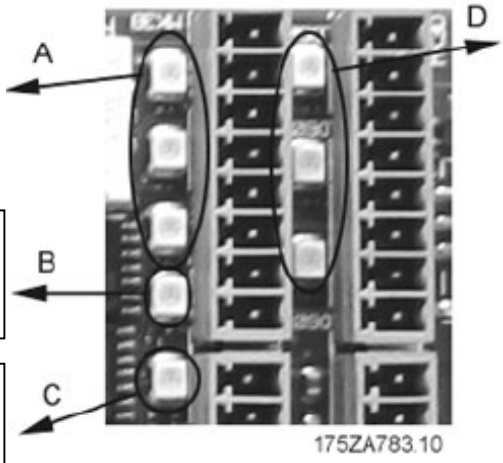
Option card layout

Option card layout showing the position of connectors and dip switch.

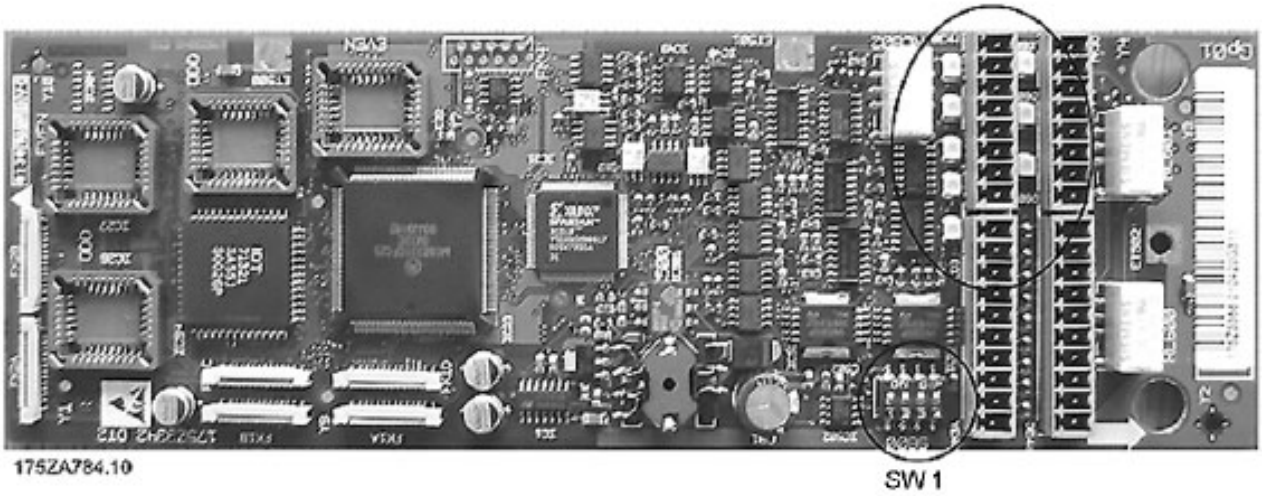
Encoder monitor secondary input,
channel A, B and Z:
LED off = Short or open circuit
LED green = Ok.

5V monitor:
LED off = no 5V
LED Green = 5V ok.

CPU monitor:
LED must flash at 1 Hz to indicate a running CPU system

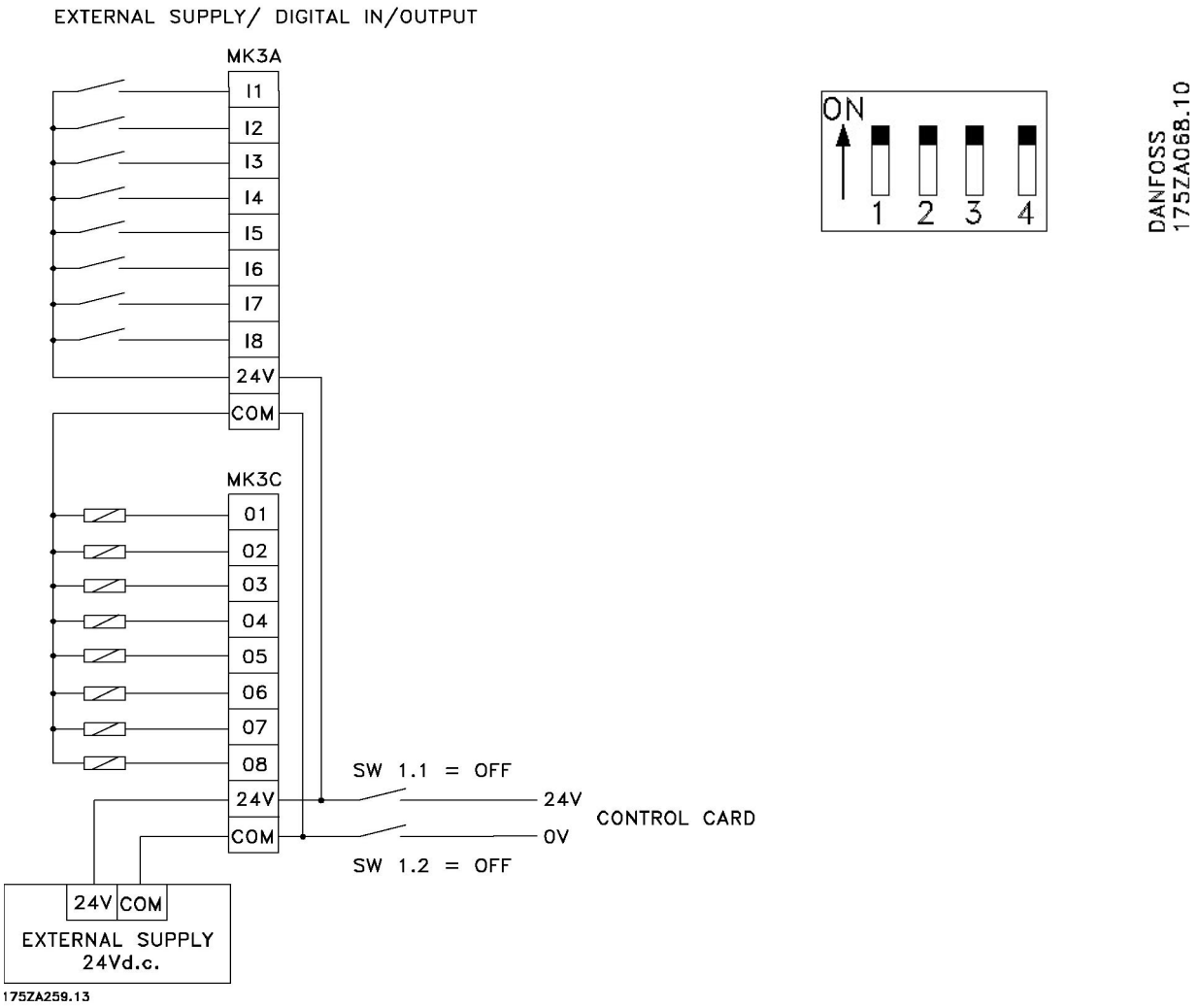


Encoder monitor primary input,
channel A, B and Z:
LED off = Short or open circuit
LED green = Ok.



SW 1.1: Connect(ON)/disconnect(OFF) 24 V from control card (see description of supply voltages).
SW 1.2: Connect(ON)/disconnect(OFF) 24 V common from control card.
SW 1.3: Connect(ON)/disconnect(OFF) termination resistor for secondary encoder.
Note: When OFF the secondary encoder monitor is disabled.
SW 1.4: Switch Z-channel encoder monitor ON/OFF for both encoder inputs.

Default setting of switch 1.1. - 1.4 is ON.


EXTERNAL SUPPLY/ DIGITAL IN/OUTPUT
MK3A
I1
I2
I3
I4
I5
I6
I7
I8
24V
COM
MK3C
01
02
03
04
05
06
07
08
24V
COM
SW 1.1 = OFF
SW 1.2 = OFF
24V
0V
CONTROL CARD
24V COM
EXTERNAL SUPPLY
24Vd.c.
175ZA259.13
ON
1 2 3 4
DANFOSS
175ZA068.10

Technical Data

Terminals:

Type ..... Plugs with screw connections
Maximum cable size ..... 1.3 mm^2 (AWG 16)

Digital inputs, MK3A:

Terminal designations ..... I1 – I8
Voltage level ..... 0 – 24 V DC (PNP positive logic)
Voltage threshold logical “0” ..... 5 V DC
Voltage threshold logical “1” ..... 10 V DC
Maximum voltage ..... 28 V DC
Input impedance ..... 4 kΩ
Min. pulse duration (ON INT) ..... 1 msec
Galvanic isolation: All digital inputs are galvanically isolated by means of optocouplers, but with the same common as the digital outputs.

Digital outputs, MK3C:

Terminal designations ..... O1 – O8
Voltage level ..... 0 – 24 V DC
Maximum load ..... 0.7A (with external power supply)
Update rate ..... 1 msec
Galvanic isolation: All digital outputs are galvanically isolated by means of optocouplers, but with the same common as the digital inputs.

External 24 V DC supply:

(see VLT 5000 manual)

Encoder input 1, MK3B (secondary):

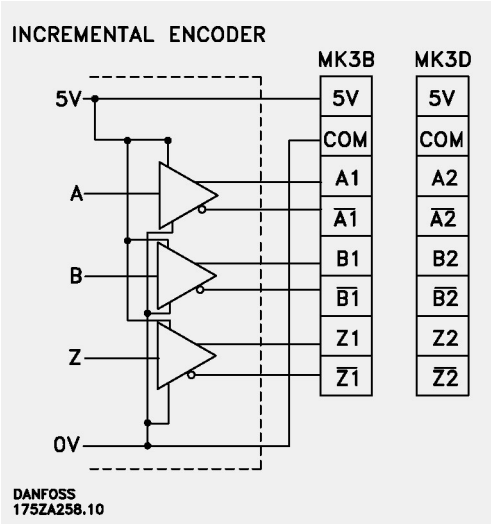
Terminal designations ..... A1, $\overline{A1}$, B1, $\overline{B1}$, Z1, $\overline{Z1}$.
Incremental:
Signal level ..... 5 V differential
Signal type ..... Linedriver, RS 422
Input impedance ..... 120 Ω (Dip switch 1.3 = ON)
..... > 24 kΩ (Dip switch 1.3 = OFF)
Maximum frequency ..... 220 kHz (at 50 % duty cycle)
Phase displacement between A and B ..... 90° ±30°
Absolute:
Signal level ..... 5 V differential
Signal type ..... SSI
Data coding ..... Gray code
Data length ..... 25 bit
Parity ..... none
Clock frequency ..... 105 or 260 kHz
Protocol ..... Gray
Maximum positions per revolution 8192
Maximum number of revolutions 4096

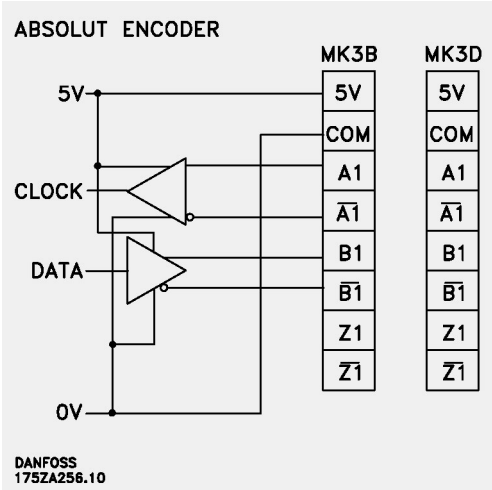
Encoder input 2, MK3D (primary)

Terminal designations ..... A2, $\overline{A2}$, B2, $\overline{B2}$, Z2, $\overline{Z2}$
Incremental:
Signal level .....5 V differential
Signal type .....Linedriver, RS422
Input impedance .....120 Ω
Maximum frequency .....220 kHz (at 50 % duty cycle)
Phase displacement between A and B .....90° ±30°
Absolute:
Signal level .....5 V differential
Signal type .....SSI
Protocol ..... Gray code
Data length .....25 bit
Parity.....none
Clock frequency..... 105 or 260 kHz
Maximum positions per revolution 8192
Maximum number of revolutions 4096

Encoder cable:

Cable type... Twisted pair and screened. **Note:** Please observe the prescriptions of the encoder supplier
Cable length.....Observe the prescriptions of the encoder supplier.
Absolute encoder is tested ok up to 150 meter cable at 105 kHz clock and 100 m at 260 kHz clock.
*(Tested with TR electronic encoder type CE-65 M 8192*4096 and appropriate cable prescribed by TR electronic.)*
Maximum allowed time delay between clock and data signal measured at the controller terminals.....
..... 105 kHz clock = 9µsec
..... 260 kHz clock = 3.5 µsec





Description of the electrical and field bus interface

Electrical interface VLT

Terminal	Designation	Description
12	**24V DC**	24V power supply for switches etc. maximum load 200 mA
13	**24V DC**	24V power supply for switches etc. maximum load 200 mA
16	**Reference index Bit 0 (LSB)**	Reference position index number bit 0 (least significant bit). Not used in field bus mode.
17	**Reference index Bit 1**	Reference position index number bit 1. Not used in field bus mode.
18	**Reference index Bit 2**	Reference position index number bit 2. Not used in field bus mode.
19	**Reference index Bit 3**	Reference position index number bit 3. Not used in field bus mode.
20	**GND**	Ground for 24V is normally bridged with Terminal 39, but can be set to “OFF” by means of Switch SW 4 on the control card.
27	**Reset / ENABLE (error clear)**	Errors are cleared on the rising edge (must be “0” min. 1 ms. to guarantee edge detection). Not used in field bus mode. To enable operation, this input must be maintained at “1” in either digital control mode or field bus control mode.
29	**Reference index Bit 4 (MSB)**	Reference position index number bit 4 (most significant bit). Not used in field bus mode.
32	**Go to HOME position**	While this input is high the drive executes the homing sequence. While this input is high no position or jog operations are carried out. Any homing sequence is interrupted by a low state on this input. Not used in field bus mode.
33	**LATCH new reference position index number**	Active on the rising edge (must be “0” min. 1 ms. to guarantee edge detection): Latches reference position index number specified on terminal 16, 17, 18, 19, 29 into memory. Digital output MK3C 4 – 8 is changed to mirror the new reference index specified when using digital input control. Not used in field bus mode.

Terminal	Designation	Description
01	**COM; 240V AC/2A**	Common terminal for Relay 01-03.
02	**Connect to electro mechanical brake** **NO**	Normal Open Relay 01-03 is open (brake activated) during power off, and start-up of the VLT 5000. It is always open after a “Quick Stop” procedure or in connection with an error situation. Relay 01-03 only closes in connection with motion procedures or if specified in P715.
03	**NC**	Normal Closed
04	**COM; 50V AC/1A; 75V DC/1A**	Common terminal for Relay 04-05.
05	**Brake activated** **NC**	Normal Closed Relay 04-05 is closed to indicate an activated electromechanical brake. It is open to indicate a deactivated electromechanical brake. Not used in field bus control mode.
26	**Touch probe position locked in (VLT 5000 Flux only)**	A high “1” signal is present when a rising edge has been detected on digital input 1 (terminal MK3A) and a target position is fixed in memory. A low signal is present when no target position has yet been determined. Not used in field bus mode.
39	**GND**	Ground for analogue inputs/outputs is normally bridged with Terminal 20, but can be set to “OFF” by means of Switch SW 4 on the control card.
42	**Touch probe position locked in (VLT 5000 Process only)**	A high “1” signal is present when a rising edge has been detected on digital input 1 (terminal MK3A) and a target position is fixed in memory. A low signal is present when no target position has yet been determined. Not used in field bus mode.
45	**Watchdog output in (VLT 5000 Process only)**	This output toggles continually as long as the program is active.
46	**Watchdog output in (VLT 5000 Flux only)**	This output toggles continually as long as the program is active.
50	**10V DC 17mA**	Power supply for manual JOG inputs (terminal 53 and 54)
53	**± 10V-In** **Manual jog positive**	When high (above 5V), the drive will travel with jogging speed (P723) and ramp (P724) in the positive direction. When low (below 5V), the drive will ramp down and stop if no other motion procedure is activated. Jog positive has higher priority than Jog negative Not used in field bus mode.

Terminal	Designation	Description
54	± 10V-In Manual jog negative	When high (above 5V), the drive will travel with jogging speed (P723) and ramp (P724) in the negative direction. When low (below 5V), the drive will ramp down and stop if no other motion procedure is activated. Not used in field bus mode.
60	± 20mA-In	Not used

Option card MK3A

Terminal	Designation	Description
1	Touch probe switch input	Interrupt triggered on the rising edge. If this signal goes high when no touch probe target position is currently locked (VLT 5000 Process: terminal 42 low, VLT 5000 Flux: terminal 26 low), a new touch probe target position is calculated and locked in memory.
2	Positive HW limit switch input	Interrupt triggered on the falling edge. Triggers a HW limit error and the drive is stopped according to P725.
3	Negative HW limit switch input	Interrupt triggered on the falling edge. Triggers a HW limit error and the drive is stopped according to P725.
4	HOME reference switch input	Active high. Marks the HOME position in the application.
5	Go to the referenced target position	Active high. Upon activation the drive goes to the specified target position. A low signal interrupts any positioning sequence. Not used in field bus mode.
6	Reset home flag	Active high. This input clears the home flag. This allows the user to perform a second homing sequence. Not used in field bus mode.
7	Reset touch probe position	Active high. This input clears the touch probe position flag. The reset is necessary to carry out a touch probe positioning command to a new target position. Not used in field bus mode.
8	Quick stop	Active low. This input activates the Quick Stop function. The drive is stopped according to the setting of P725. After that the electromechanical brake is always activated when the “Quick stop” input is activated regardless of the P715 setting.
9	24V DC	
10	COM	

Option card MK3C

1	**Homing completed**	Active high. This output is always high if an absolute encoder is specified in P713
2	**Referenced position reached**	Active high. This output is set when the target position is reached according to the setting of P746.
3	**Error occurred**	Active high. This output is set every time an error occurs. It is cleared every time a successful *error clear* is carried out. This output will remain high as long as the *Power recovery* function is selected (P736) and active.
4	**Reference index bit 0**	Active high. Mirror of the currently locked-in reference index bit 0. Not used in field bus mode.
5	**Reference index bit 1**	Active high. Mirror of the currently locked-in reference index bit 1. Not used in field bus mode.
6	**Reference index bit 2**	Active high. Mirror of the currently locked-in reference index bit 2. Not used in field bus mode.
7	**Reference index bit 3**	Active high. Mirror of the currently locked-in reference index bit 3. Not used in field bus mode.
8	**Reference index bit 4**	Active high. Mirror of the currently locked-in reference index bit 4. Not used in field bus mode.
9	**24V DC**	
10	**COM**	

Option card MK3B (secondary position feedback for absolute encoders when using VLT 5000 Flux)

1	**5V DC**	Encoder supply	
2	**COM**	Encoder supply	
		Incremental encoder	*Absolute encoder*
3	**A1**	A-track	Clock out
4	**/A1**	A-track inverted	Clock out inverted
5	**B1**	B-track	Data in
6	**/B1**	B-track inverted	Data in inverted
7	**Z1**	Zero-track	Not used
8	**/Z1**	Zero-track inverted	Not used

Option card MK3D (primary position feedback)

1	**5V DC**	Encoder supply	
2	**COM**	Encoder supply	
		Incremental encoder	*Absolute encoder*
3	**A1**	A-track	Clock out
4	**/A1**	A-track inverted	Clock out inverted
5	**B1**	B-track	Data in
6	**/B1**	B-track inverted	Data in inverted
7	**Z1**	Zero-track	Not used
8	**/Z1**	Zero-track inverted	Not used

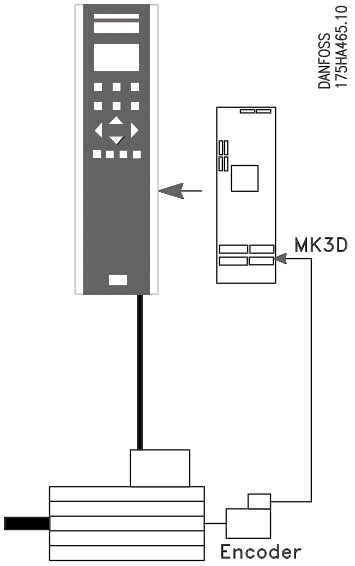


Fig.: Encoder connection for positioning applications

Field bus interface

NOTE: This section is only relevant if the VLT is equipped with a Field bus interface (option) as well as the Positioning controller.

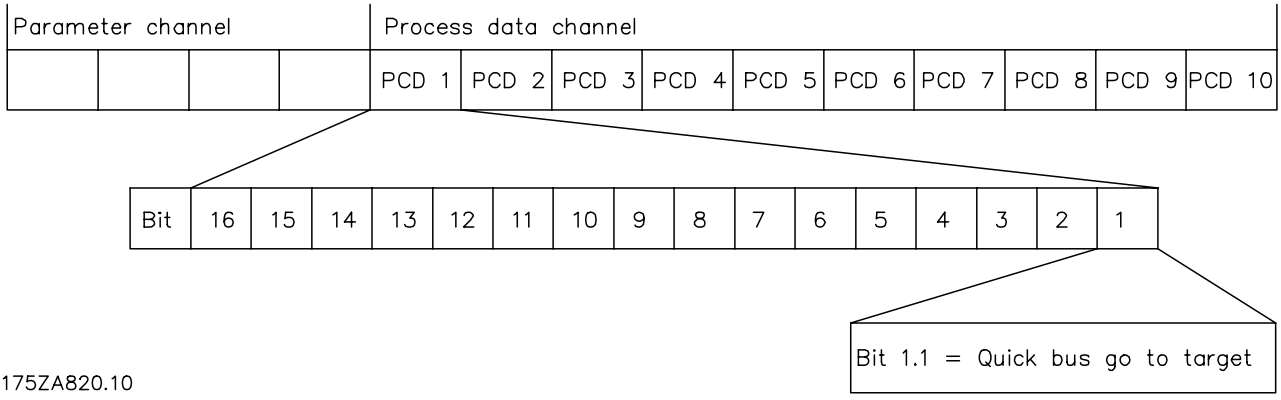
The Positioning controller can be controlled via the digital/analogue inputs or via field bus. The control source can be selected in parameter 749. There can only be one control source at a time meaning that the digital/analogue inputs are inactive when Field bus is selected as control source and visa versa. The only exceptions are listed in the digital interface section.

In field bus mode it is possible to specify only the target position and velocity. If the acceleration and deceleration PCDs are left blank then the last used acceleration and deceleration chosen via an index is used. This enables the use of PPO type 4

Data layout

Control and status signals are transferred via the so-called process data channel (PCD) of the various field bus interfaces. The telegram structure and the available number of data words depends on the Field bus used, please refer to the manual of the Field bus option in use for further details. The below example is based on the layout of a PROFIBUS telegram, the so-called PPO:

Example using PROFIBUS PPO type 5:



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Field bus control signals:

Field bus [word.bit]	Field bus mode	Corresponding input
1.1	Quick bus go to target(↑)	N\A
1.2	Reset error (↑)	27
1.3	Go to home / Stop positioning (↑) / Go to position (↓)	32
1.4	Read new trajectory index (↑)	33
1.5	Automatic (↑) / manual (↓) mode	5
1.6	Reset home status (↑)	6
1.7	Reset touch probe position (↑)	7
1.8	Quick stop (↓)	8
1.9	Positive jog (↑)	53
1.10	Negative jog (↑)	54

Field bus [word.bit]	Field bus mode	Corresponding input
1.11	Quick Bus Type Absolute (↑)	N\A
1.12	Quick Bus Type Relative (↑)	N\A
1.13	Quick Bus Type Touch Probe positive (↑)	N\A
1.14	Quick Bus Type Touch Probe negative (↑)	N\A
1.15	Teach in(via LCP or fieldbus) (↑)	KEYPAD “JOG” & “FWD\REW”
1.16	Change sign on Quick Bus Target Position (↑)	N\A
2	Quick Bus Target Position(MSB)	N\A
3	Quick Bus Target Position(LSB)	N\A
4	Quick Bus Target Velocity	N\A
5	Quick Bus Target Acceleration	N\A
6	Quick Bus Target Deceleration	N\A
7.1	Reference index bit 0 (LSB) (↑)	16
7.2	Reference index bit 1 (↑)	17
7.3	Reference index bit 2 (↑)	18
7.4	Reference index bit 3 (↑)	19
7.5	Reference index bit 4 (Digital MSB) (↑)	29
7.6	Reference index bit 5 (Fieldbus MSB) (↑)	N\A

Field bus status signals:

Field bus [word.bit]	Field bus mode	Corresponding output / parameter
1.1	Homing done (↑)	1
1.2	Referenced position reached (↑)	2
1.3	Error occurred (↑)	3
1.4	Electro-mechanical brake output (↑)	04
1.5	Touch probe position locked (↑)	42(26 Flux)
1.6	Watchdog output (toggling)	45(46 Flux)
1.7	Positive hardware limit (↑)	N\A
1.8	Negative hardware limit(↑)	N\A
2.1	Current index bit 0 (LSB) (↑)	4
2.2	Current index bit 1 (↑)	5
2.3	Current index bit 2 (↑)	6
2.4	Current index bit 3 (↑)	7
2.5	Current index bit 4 (Digital MSB) (↑)	8
2.6	Current index bit 5 (Fieldbus MSB) (↑)	N\A
3	Actual Position (MSB)	795 (MSB)
4	Actual Position (LSB)	795 (LSB)
5	Error Status	798

Description of the available parameters

Special LCP functions

Multiple parameters display: To have multiple read-only parameters displayed at once on the LCP simply press the [DISPLAY/STATUS] button after start-up. This will prompt the top line of the LCP to display up to three read-only parameters that can be specified in P010, P011, and P012. The default settings will bring up the following display:

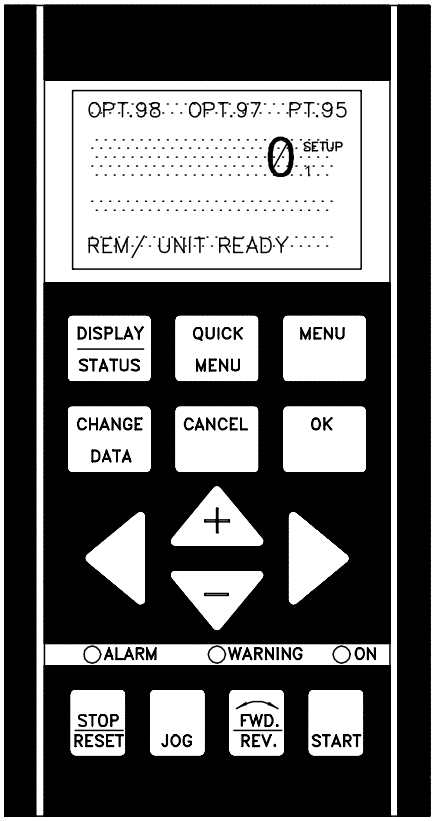


Figure text: To the left: P798 – the *error status*. In the middle: P797 - the *PID* tracking error. To the right: P795 – the *actual position*.

Holding down the [DISPLAY/STATUS] button will display which parameters are shown in the top line of the display.

The TEACH-IN function: Pressing the [JOG] and [FWD./REV.] buttons at the same time will cause the target position P739 to be updated with the actual position. This provides an easy way of programming several positions. Simply jog to the desired position, then press the [JOG] and [FWD./REV.] buttons to store that position in memory.

Description of parameters

No.	Parameter	Default value	Range	Description
701	Operating mode POSITIONING MODE	1	1 = POSITIONING	This parameter never needs changing.
702	Proportional gain PROP. GAIN	30	1 … 65,000	The proportional gain is the factor that is multiplied with the PID tracking error to produce the proportional part of the output frequency. The higher the setting of this parameter the “harder” is the resulting control. **NB!** Too high a setting of this parameter will cause the controller to become unstable.
703	Derivative gain DER. GAIN	0	0 … 65,000	The derivative gain is the factor that is multiplied with the change in the PID tracking error to produce the derivative part of the output frequency. The higher the setting of this parameter the “harder” is the resulting control. The derivative gain has best effect if the encoder is mounted directly on the motor and an encoder with good resolution (4096 pulses/rev) is used. **NB!** Too high a setting of this parameter will cause the controller to become unstable.
704	Integral gain INT. GAIN	0	0 … 65,000	The integral gain is the factor that is multiplied with the integrated PID tracking error to produce the integral part of the output frequency. The main function of the integral part is to provide zero steady-state tracking error. The higher the setting, the faster the application will reach a zero steady-state tracking error. The dynamic tracking error however increases with increasing setting of this parameter. **NB!** Too high a setting of this parameter will cause the controller to become unstable.
705	Limit integral part INT. LIMIT	1,000	0 … 65,000	Here it is possible to clamp the integral part of the PID output. A setting of 1000 corresponds to 100% of the maximum allowed reference specified in parameter 205.

No.	Parameter	Default value	Range	Description
706	Limit PID output PID LIMIT	1,000	0 … 1,000	Here it is possible to clamp the total output of the PID controller. A setting of 1000 corresponds to 100 % of the maximum allowed reference specified in parameter 205.
707	Feed-forward velocity gain F-FWD. VEL. GAIN	0	0 … 65,000	The velocity feed-forward gain is the factor that is multiplied with the set-point (desired trajectory) velocity to produce the feed-forward part of the output frequency. The function of the feed-forward part is to provide a fast (and fairly accurate) starting point for the calculation of the output frequency. **NB!** To get the fastest and most stable controller response this parameter should be set optimally. For this purpose parameter 710 gives access to a function that automatically calculates the optimal setting of this parameter.
708	Feed-forward acceleration gain F-FWD. ACC. GAIN	0	0 … 65,000	The acceleration feed-forward gain is the factor that is multiplied with the set-point acceleration to produce the feed-forward part of the output frequency.
709	PID sample interval SAMPLE INTERVAL	1 ms	1 … 100 ms	The sampling frequency of the controller can be adjusted in this parameter. Normally, the fastest possible setting (1 ms) is preferable, but in cases with low resolution of the feedback signal it is a good idea to set this parameter at a slightly higher value.
710	FFVEL auto-calculation AUTOCALC. FFVEL	0	0 = disabled 1 = FFVEL enabled 2 = FFVEL + PID enabled	Setting this parameter to “1” will prompt the program to calculate the optimal setting of parameter 707. Setting this parameter to “2” will prompt the program to calculate the optimal setting of parameter 702, 703, 704 and 707. For VLT 5000 Process the following parameters influence the result and must be set correctly beforehand: P104 nominal motor frequency P106 nominal motor speed P205 maximum reference frequency P713 encoder type P714 encoder resolution P721 motor/encoder gear ratio numerator

No.	Parameter	Default value	Range	Description
				P722 motor/encoder gear ratio denominator For VLT 5000 Flux the following parameters influence the result and must be set correctly beforehand: P205 maximum reference rpm P713 encoder type P714 encoder resolution P721 motor/encoder gear ratio numerator P722 motor/encoder gear ratio denominator **NB!** If you change any one of these parameters you should prompt a recalculation, since the optimum value of 702, 703, 704 and 707 will have changed.
711	VLT local mode VLT MANUAL	0	0 = Pos control 1 = VLT control	By setting this parameter to 1 the VLT changes to setup “2” Manual running of the VLT is now possible.
712	Positive direction POS. DIRECTION	1	-2 = right rotation -1 = left rotation 1 = right rotation 2 = left rotation	Here you specify which encoder direction is considered positive. If you change this setting the current actual position (P795) will also change sign. 1 = standard, position is counting positive when the drive is running forward. -1 = position is counting negative when the drive is running forward. 2 = as “1”, but with opposite sign of the reference to the drive. This can be used as alternative to swapping two motor phases if direction of motor rotation is wrong. -2 = as “-1”, but with opposite sign of the reference to the drive. This can be used as alternative to swapping two motor phases if direction of motor rotation is wrong.

No.	Parameter	Default value	Range	Description
713	Encoder type ENCODER TYPE	0	0 = incremental 1 = absolute 260kHz clock 2 = absolute 105kHz clock 3 = absolute 260kHz clock & error correction 4 = absolute 105kHz clock & error correction)/ +100 enable hardware encoder monitor.	It is possible to use two types of encoder. If you select any absolute encoder the home flag is instantly set high, thus no homing is required preceding a positioning command. Type 3 and 4 are to be used for linear absolute encoder. A possible leap in the position data can be detected if it is larger than the encoder resolution/2. The correction is made by means of an artificial position value which is calculated from the last velocity. If the error continues for more than 100 read-outs (> 100 ms), there will be no further correction which will then lead to a tolerated position error exceeded. Type 3 and 4 are only available if encoder feedback is via MK 3 D (see description of parameter 748) type. 100 … 104 = like 0 … 4, however, hardware monitoring of the encoder will be activated. Error 92 will be issued in case of open or short circuit. **NB!** When switching from a setting of absolute encoder to a setting of incremental encoder, the home flag is automatically cleared. A homing procedure afterwards is necessary before any positioning commands can be executed.
714	Encoder resolution ENCODER RES.	4.096 ps.	1 … 1,000,000 pulses	The encoder resolution must be entered in pulses per revolution (not quad-counts per revolution).
715	Automatic brake control AUTO. BRAKE CTRL	1	0 = disabled 1 = enabled	When the automatic brake control function is enabled, the electromechanical brake is automatically activated every time the application has been at standstill for a time period specified in parameter 718. This is especially useful in hoist applications where the motor could overheat if it has to deliver full torque at standstill for a prolonged period of time. When the automatic brake control function is disabled, the drive controls the application also at standstill.

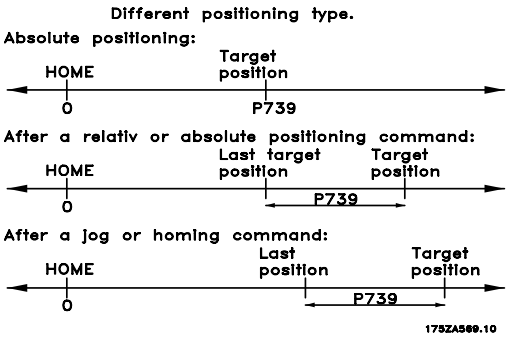
No.	Parameter	Default value	Range	Description
716	Coast delay COAST DELAY	200 ms	0 … 1,000 ms	Used in conjunction with the automatic brake control function. The *coast delay* is the delay after activating the electromechanical brake before disabling the controller and coasting the drive. Useful in hoisting applications where the load would otherwise have a tendency to drop a little after each stop because the activation of the brake is slower than the deactivation of the drive.
717	Brake delay BRAKE DELAY	200 ms	0 … 1,000 ms	Used in conjunction with the automatic brake control function. The *brake delay* is the delay after activating the control and magnetizing the motor before the brake is deactivated. Useful in applications with (typically large) motors that take a longer time to be fully magnetized than the time it takes for the electro mechanical brake to deactivate.
718	Hold delay HOLD DELAY	0 s	0 … 10,000 s	Used in conjunction with the automatic brake control function. The *hold delay* is a waiting period in which the brake is not activated even though the application is at standstill. Useful in applications where a sequence of fast positioning commands is followed by longer standstill periods.
719	Quick ramp time QUICK RAMP TIME	5,000 ms	50 … 65,535 ms	The quick ramp time is defined as the time to ramp down from the maximum velocity to standstill. The quick ramp time is used when the quick stop function is activated or an error has occurred.
720	Ramp type RAMP TYPE	0	0 = trapezoidal 1 = sinusoidal	Select trapeze shaped ramps to get the optimal acceleration.
721	Motor/encoder gear nominator MOT/ENC GEAR NUM	1	1 … 1,000	If the encoder is mounted on a gear where 5 revolutions of the motor correspond to 2 revolutions of the encoder, P721 should be set to “5” (the number of motor revolutions) and P722 should be set to “2” (the number of encoder revolutions). If the encoder is mounted directly on the motor shaft this parameter setting should remain at “1”.

No.	Parameter	Default value	Range	Description
722	Motor/encoder gear denominator MOT/ENC GEAR DEN	1	0 … 1,000	See the description of P721. If the encoder is mounted directly on the motor shaft this parameter setting should remain at “1”.
723	Maximum jog velocity MAX.JOG VELOCITY	100 ERPM	1 … 999,999 ERPM	The maximum speed allowed while jogging the application is specified in terms of Encoder Revolutions Per Minute (ERPM). **NB!** This setting must never exceed a value that is approx. 5% lower than the value calculated in P799.
724	Jog ramp time JOG RAMP TIME	5,000 ms	50 … 100,000 ms	This parameter specifies both the ramp-up time as well as the ramp-down time used during jogging. The ramp time is defined as the time in milliseconds it would take to ramp from standstill to the maximum allowed velocity (P799).
725	Error behaviour ERROR BEHAVIOUR	0	0 = electronic brake 1 = mechanical brake	This parameter determines the behaviour of the drive after an error is detected. If “0” is selected the drive will ramp down to standstill with the shortest possible ramp (P719). After achieving standstill it will activate the electronic brake according to the setting of P716. If the drive is coasted at any point during ramp down (e.g. due to an OVER CURRENT trip – ALARM 13) the drive will immediately activate the brake and coast the drive. If “1” is selected the drive will immediately activate the brake and coast the drive. **NB!** The brake is always activated after an error situation (or quick stop) regardless of the P715 setting.
726	Maximum tolerated PID error MAX. TRACK ERROR	20,000 qc	0 … 1,000,000,000 qc	The PID track error is defined as the difference between the internal controller set-point and the actual position. The better tuning of the PID controller (P702-709) the lesser the PID track error. At every sample time the current track error is compared with the setting of P726. It is defined as an error situation (“PID track error too big” - P798 = 9) if the track error is bigger than the setting of P726.

No.	Parameter	Default value	Range	Description
				After tuning the PID controller optimally this parameter should be set to a value approx. 50 % larger than the maximum observed value of P797. **NB!** The unit is quad-counts (QC) not user units (UU).
727	Error reset RESET ERROR	0	0 = no reset 1 = reset error	By setting this parameter to “1” it is possible to clear the error flag (provided that the reason for the error is not still present). The parameter automatically resets to “0” when the error is successfully cleared.
728	Home offset HOME OFFSET [UU]	0 UU	-33,554,432 … 33,554,431 UU	This parameter defines an offset to the “zero” (HOME) position. Any change in this setting will immediately affect the actual position displayed in P795.
729	Home ramp time HOME RAMP TIME	5,000 ms	50 … 100.000 ms	The home ramp time is defined as the time in milliseconds it would take to ramp from standstill to the maximum allowed velocity (P799).
730	Home velocity HOME VELOCITY	100 ERPM	-20,000 … 20,000 ERPM	The home velocity is entered here. Notice that the sign of the velocity determines the direction in which the homing sequence will be performed.
731	Home type HOME TYPE	0	-2 … 3	There are six types of homing sequences. -2 = No homing is needed, the actual position (when using an incremental encoder) after power-up is set in parameter 750. -1 = No homing is needed, the actual position (when using an incremental encoder) after power-up is zero. 0 = The drive moves to the reference switch (MK3A 4) with home velocity (P730), then reverses and slowly (at 30% of home velocity) leaves the switch, subsequently moves to the next index pulse. The HOME position is defined as that index position. 1 = Like “0” but without the search for the index position. Instead the HOME position is defined as the position at which the reference switch goes low. After defining the HOME position the drive is then ramped down with the home ramp (P729) and stopped.

No.	Parameter	Default value	Range	Description
				2 = Like “0” but without reversing before leaving the reference switch. Rather the movement is slowly continued in the same direction out of the switch. 3 = Like “1” but without reversing before leaving the reference switch. Rather the movement is slowly continued in the same direction out of the switch.
732	User unit numerator USER UNIT NOM.	1,000	1 … 100,000	P732 and P733 together define the ratio between User Units (UU) and quad-counts (QC). Let’s illustrate this parameter with the following example: By measurement it has been determined that 1000 mm. of travel correspond to 16345 QC (quad-counts). Now instead of defining the target positions in QC but rather in mm, the setting of P732 must be 16345, and the setting of P733 must be 1000. **NB!** The target positions stored in memory is defined according to the settings of P732/P733, so changing the P732/P733 ratio might require that up to 32 positions must be reprogrammed to achieve the same result as before the change.
733	User unit denominator USER UNIT DEN.	1,000	1 … 100,000	P732 and P733 together define the ratio between User Units (UU) and quad-counts (QC). The setting of this parameter is illustrated in the description of P732. **NB!** The target positions stored in memory is defined according to the settings of P732/P733, so changing the P732/P733 ratio might require that up to 32 positions must be reprogrammed to achieve the same result as before the change.
734	Block reversal BLOCK DIRECTION	0	0 = no blocking 1 = block reverse 2 = block forward	By selecting “1” it is defined as an error situation (“Reverse operation prohibited” – P798 = 12) if the drive is moving in reverse direction. By selecting “2” it is defined as an error situation (“Forward operation prohibited” – P798 = 13) if the drive is moving in forward direction. Selecting “0” disables the function.

No.	Parameter	Default value	Range	Description
735	Brake wear limit BRAKE WEAR LIMIT	0	0 (= disabled) … 1,073,741,824 UU	Setting a value higher than “0” (disabled) the drive defines an error situation (“Brake wear limit exceeded” – P798 = 7) if the drive moves more than the number of UU specified in this parameter *while* the electronic brake is activated.
736	Power-recovery POWER RECOVERY	1	0 = disabled 1 = enabled	When the power recovery function is disabled (0), it is not possible to drive the application by any means (neither jogging nor positioning) as long as the application is outside the HW or SW limits. The only way to recover from this situation is to move the application by hand. When the power recovery function is activated (1) however it is possible to make a “partial reset“ of the limit error (P798 = 2/3/4/5) whereby it will be possible to use the jogging function to drive the application out of the HW or SW limit area. It is not possible to drive the application otherwise by means of homing, positioning or jogging (in the wrong direction), as long as the application is still within the HW or SW limit area. The “error occurred” output (MK3C 2) will remain high to indicate that these restrictions are in effect. As soon as the application is moved outside the HW or SW limit area the error is automatically cleared and the “error occurred” signal goes low to indicate that normal operation is now restored.
737	Link LCP input to index LINK INDEX-INPUT	0	0 = disabled 1 = enabled	When activating this function (1) P738 will be automatically updated with the last position reference number that has been loaded into memory. This enables to operator to see what position reference is currently given by the PLC system. The function is deactivated when set to “0”. This is necessary when programming a position number different from the one loaded into the PLC memory.

No.	Parameter	Default value	Range	Description
738	Index number INDEX NUMBER	0	0 … 31 0 … 63 in field bus mode	Here it is possible to specify which position data that should be displayed in P739-743. Whenever this number is changed the current values of P739-P743 are stored in memory under the previously specified index number. After that, the value of P739-743 is updated with the data stored in memory relevant to the newly specified index number.
739	Index target position TARGET POSITION	0	-1,073,741,824 … 1,073,741,824 UU	The meaning of this parameter depends on the position type specified in P743. If P743 = 0, the value of this parameter refers to an absolute position (relative to the fixed HOME position). If P743 = 1 and the last position was obtained through jogging, the value of this parameter is a position relative to that position. If the last position was reached as a result of a positioning command, then the value of this parameter specifies a position relative to the last target position (whether it was reached or not).  If P743 = 2 the application will move in the positive direction until a touch probe position is defined. If a touch probe position is already defined the application will move directly to that position. A touch probe position is defined as the position at which the “touch probe switch” input (MK3A 1) goes high plus the value of P739. A touch probe position is cleared by a high signal on the “reset touch probe position” input (MK3A 7) input. The output “Touch probe position locked” (VLT5000 Terminal 42) is high if a touch probe position is defined. If P743 = 3 the application will move in the negative direction until a touch probe posi-

No.	Parameter	Default value	Range	Description
				tion is defined. If a touch probe position is already defined the application will move directly to that position. **NB!** This parameter is automatically updated depending on P738.
740	Index ramp up time RAMP UP TIME	5,000	50 … 100,000 ms	This setting is relevant during positioning with the current trajectory index. The index ramp up time is defined as the time in milliseconds it would take to ramp from standstill to the maximum allowed velocity (P799). **NB!** This parameter is automatically updated depending on P738.
741	Index ramp down time RAMP DOWN TIME	5,000	50 … 100,000 ms	This setting is relevant during positioning with the current trajectory index. The index ramp down time is defined as the time in milliseconds it would take to ramp from the maximum allowed velocity (P799) to standstill. **NB!** This parameter is automatically updated depending on P738.
742	Index maximum velocity MAX. VELOCITY	100 ERPM	1 … 999.999 ERPM	This setting is relevant during positioning with the current trajectory index. **NB!** This parameter is automatically updated depending on P738. The setting should never exceed a value that is approx. 5% lower than the value calculated in P799.
743	Index trajectory type TRAJECTORY TYPE	0	0 = absolute 1 = relative 2 = touch probe positive 3 = touch probe negative	The function of this parameter setting is described under P739. **NB!** This parameter is automatically updated depending on P738.
744	Positive software limit POS. SW. LIMIT	1,073,000,000	-1,073,000,000 … 1,073,000,000 UU	If the actual position (P795) exceeds the value specified in this parameter an error situation is defined (P798 = 4) and handled according to the setting of the “Error behaviour” parameter (P725).

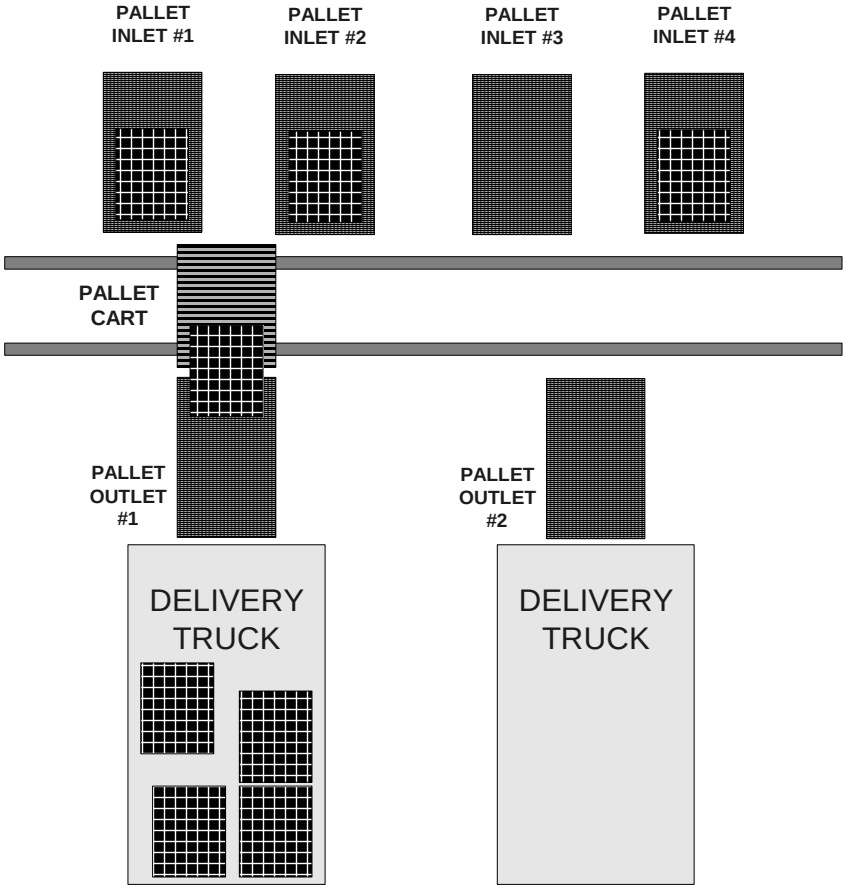
No.	Parameter	Default value	Range	Description
745	Negative software limit NEG. SW. LIMIT	–1,073,000,000	–1,073,000,000 … 1,073,000,000 UU	If the actual position (P795) goes below the value specified in this parameter an error situation is defined (P798 = 5) and handled according to the setting of the “Error behaviour” parameter (P725).
746	Target position window TARGET WINDOW	0	0 UU (< P726) … 1,073,741,824 UU	During a positioning sequence the “Referenced position reached” output (MK3C 2) is set according to this parameter. If the setting of this parameter is “0” then the “Referenced position reached” output goes high immediately when the internal PID target position is equal to the requested target position. If the setting of this parameter is larger than “0” i.e. “200” then the “Referenced position reached” output goes high when the actual position (P795) is within ±200 UU of the requested target position.
747	Touch probe delay PROBE DELAY	0	0 …100,000 ms	This parameter enables for compensation in any fixed delay there may be in the touch probe.
748	Feedback input SWAP ENCODER	0	0 … 1	Choose feedback input for positioning controller. Enter “0” to use MK3D, enter “1” to use MK3B. This is used to enable the use of absolute encoders for feedback together with VLT 5000 Flux in closed loop mode. In that case input MK3D has an incremental encoder fitted (feedback for Flux) and MK3B has an absolute encoder fitted for positioning feedback. The text in parameter 713 and 714 changes accordingly
749	Control source FIELDBUS MODE	0	0 … 1	Choose control source for pos. controller. Enter “0” for digital inputs or “1” for fieldbus control.
750	User APOS setting SET APOS	0	-1,073,741,824 … 1,073,741,824	At power-up if homing type is “-2” (see parameter 731) the actual position is equal the value set here.
751	Positive SW limit active POS SW LIM ACT	1	0 … 1	Enter “0” to disable positive software limit switch. This should be done only when not positioning within two fixed limits.
752	Negative SW limit active NEG SW LIM ACT	1	0 … 1	Enter “0” to disable negative software limit switch. This should be done only when not positioning within two fixed limits.

No.	Parameter	Default value	Range	Description
753	Endless positioning ENDLESS POS.	0	0 … 1	Set this parameter to “1” if drive must perform positioning continuously in one direction. Remember to also set parameter 751, 752 and 736 to “0”.
776	Factory reset FACTORY RESET	0	0 = disabled 1 = enabled	By setting this parameter to “1” it is possible to reset all parameter values to default. This also resets all trajectory data (P739-P743). The parameter automatically resets to “0” when the reset is successfully carried out.
777	Parameter save STORE DATA	0	0 = no action 1 = SAVE EEPROM	Parameter and trajectory data is not automatically stored in EEPROM and will thus not automatically be available after power-down and power-up. To permanently store changes made to parameter values and/or trajectory data parameter P777 must be set to “1”. This parameter automatically resets to “0” when the data is successfully stored.
778	Password PASSWORD	1,234	0 … 999,999,999	Not used.
779	Software version VERSION 2.10	210	210	The text in this parameter shows the current version number of the Positioning Controller program.
795	Actual position ACTUAL POSITION	0	–2,000,000,000 … 2,000,000,000 UU	READ-ONLY PARAMETER: This parameter displays the latest position obtained from the feedback encoder.
796	Actual inputs ACTUAL INPUTS	00000000	00.00.00.00 / 11.11.11.11	READ-ONLY PARAMETER: This parameter displays the last read status of the digital input on the option card (MK3A). The status of the digital inputs on the VLT5000 control card is accessible via P528
797	PID tracking error PID TRACK ERROR	0	–2,000,000,000 … 2,000,000,000 UU	READ-ONLY PARAMETER: The current PID tracking error is displayed in this parameter in user units.

No.	Parameter	Default value	Range	Description
798	Error status ERROR STATUS	0	0 = OK 1 = Homing needed 2 = Pos. HW limit 3 = Neg. HW limit 4 = Pos. SW limit 5 = Neg. SW limit 6 = VLT not running 7 = Brake wear limit 8 = Quick stop 9 = PID error too big 10= Option error 11= VLT Exception 12= Rev. operation 13= Fwd. operation 92= Encoder hardware error	READ-ONLY PARAMETER: The current error code is displayed in this parameter.
799	Maximum allowed velocity MAX. VELOCITY	1,500 ERPM	1 … 999,999 ERPM	READ-ONLY PARAMETER: The maximum velocity allowed is calculated on the basis of P104, P106, P205, P721, P722 and the result is presented in this parameter. To increase this value one or more of the above mentioned parameters must be changed (usually just P205).

An application example!

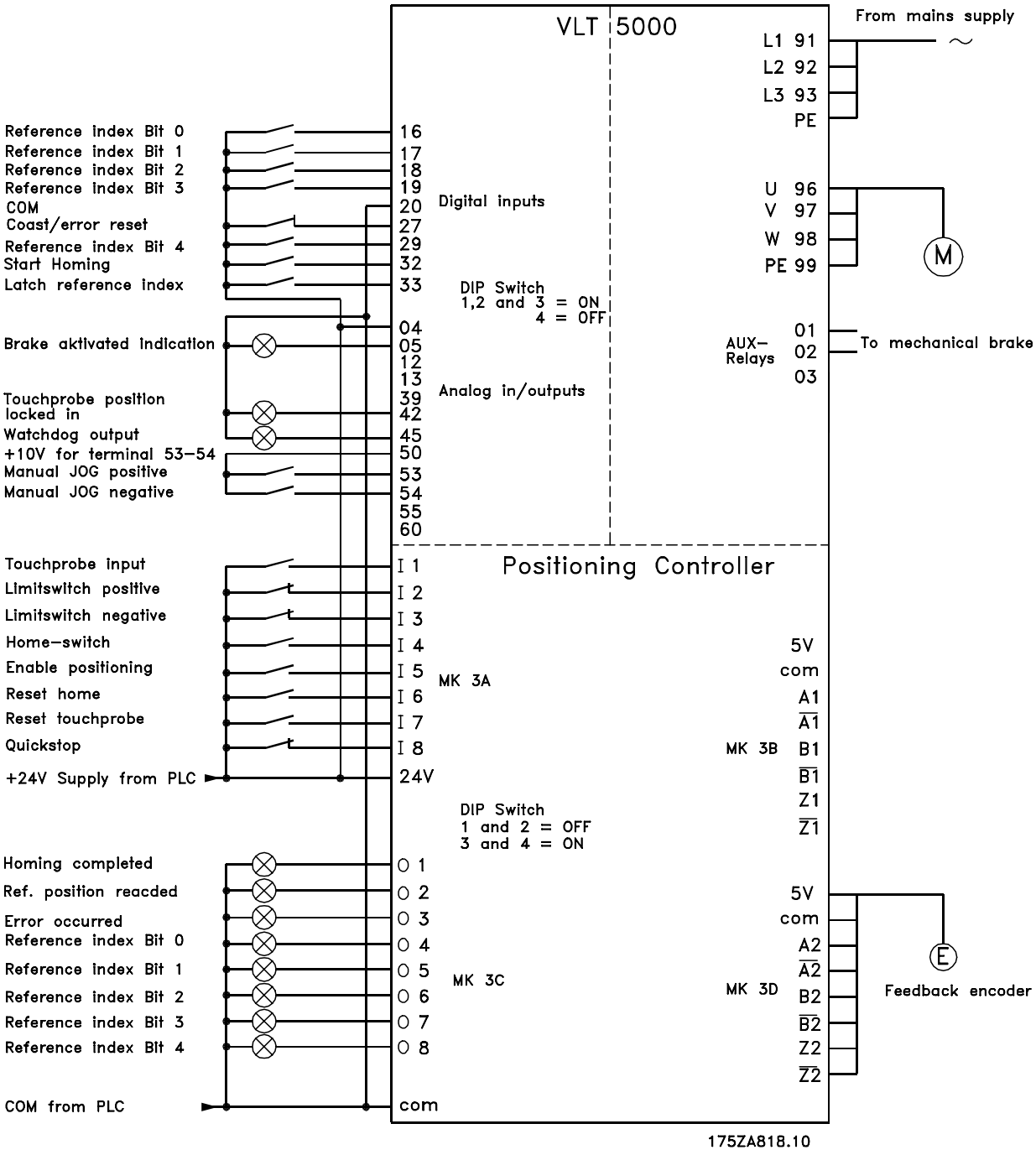
The drawing below shows a layout of a pallet conveyor system. Loaded pallets are coming from four different product lines via the pallet inlet conveyors. Each pallet must be transported from one of the four inlet conveyors to the one of the two outlet conveyors. To do this a movable pallet conveyor cart is used.



A typical work process could be;

1) Moving the (empty) pallet conveyor cart to pallet inlet no. 1 to pick up a loaded pallet
2) Waiting until the pallet is successfully transferred to the cart
3) Moving to pallet outlet no. 2.
4) Waiting until the pallet is successfully transferred to the outlet conveyor and so on…

Wiring diagram



Basic set-up

First, check the motor connection:
Please be ware the mechanical brake control cannot be trusted during this basic setup, therefore control brake externally from the option until setup is finished. Also ensure that the motor can rotate freely without causing damage or injury to personal.

1. Remove all signals to inputs 16-33 and I1-I8. Only Input 27(coast), I8 (q-stop), I3 (HW limit) and I2 (HW limit) must be connected and high.
2. Select “Disable syncpos” in P700
3. Select “Local” function in Parameter 002. – VLT 5000 stops (display flashing)
4. Input the motor name plate data in P102-P106 and activate the “Automatic Motor Adaptation” function in P107.

5. Press the [START] button on the VLT 5000 control panel and wait for the AMA to be completed.
6. Set the frequency for a low positive value, for example +3 Hz in Parameter 003 please note that motor should now rotate.
7. Press the [START] button on the VLT 5000 control panel and then the [STOP/Reset] button watching the direction of rotation on the motor. If the motor rotates in the wrong (negative) direction then exchange the motor phases.

When you have tested the motor speed direction you test encoder connection as follows, if an incremental encoder is used go to step 10, if an absolute encoder is used go to step 8:

8. If you are using a VLT 5000 Flux remember to use MK3B as input for the absolute encoder and enter “1” in parameter 748. Then enter the absolute encoder type and resolution in parameter 713 and 714.
9. Repeat step 8 to 10 to test the encoder direction.

10. Press the [DISPLAY/STATUS] button on the VLT 5000 control panel. Now the following values appear in the upper line of the display: Error status, PID tracking error, actual position.
11. Rotate the slave drive motor shaft manually in the positive direction (you can repeat step 7). Now the display should show an ascending count of the actual position.
12. If the count is descending with an incremental encoder, exchange the feedback encoder track A by B and A/ by B/. If there is no counting in the display then check the wiring of the encoder.

When you have tested the encoders and the wiring of motor and encoders, continue as follows:

13. Change parameter 002 back to “Remote” and start the VLT 5000 by pressing the [START] button on the local control panel (LCP).
14. Select “Enable syncpos” in P700
15. Reset any error by toggling input 27.

Now you come to the test run:

16. Drive the application back and forth by closing the contacts on terminal 53 (positive direction) or terminal 54 (negative direction). Watch the PID track error via the LCP display during these tests.

Now you can optimise the controller:

17. Optimise the Feed forward velocity P707 by following the procedure described in the parameter list for P710 parameter (the FFVEL auto-calculation function).
18. If the track error after entering “2” in parameter 710 is within specification, when jogging, there is no reason to optimise any further, move to step 21.
19. Increase the P-portion par. 702. After each change you should make a test run to find the right setting. If the drive becomes unstable or if a message is given about over-voltage or over-current, then reduce the value in parameter 702 to about 70-80% of the set value.
20. Increase the other PID parameters P703 (if needed) by following the same approach. Read the description concerning these parameters in the parameter list.

To store the optimised values

21. Change the value of parameter 777 to “1”. When the value returns to “0” the parameters have been successfully saved (see the parameter list for a description of how the P777 parameter works).

Parameter settings

Now determine the parameter settings fitting this application. The following list of parameters can be determined right away:

P701	Default (“Positioning mode”)
P702 - P711	Determined during optimising of the PID controller
P712	Default (“1”)
P713	Incremental encoder used (“0”)
P714	Encoder resolution (“4096”)
P720	Trapeze ramps is used for fastest response (“0”)
P721	Default (encoder mounted directly on motor) (“1”)
P722	Default (encoder mounted directly on motor) (“1”)
P723	Default (“100”)
P724	Default (“1500”)
P728	Default (“0”)
P734	Default (“0”)
P747	Default (“0”)
P777	Default (“0”)
P778	“0” – no password protection required

Timing of the electromechanical brake (P715-P718)

If the application is not equipped with an electromechanical brake, P716-P718 are not very important. Then, however, it is very important to set P715 to “0” to enable the drive also at standstill.

This application is equipped with mechanical brakes to allow it to stop rapidly even if the drive is somehow prevented from stopping the motor (damaged motor cables, damaged or short circuited motor, inverter overload and so on).

P716-P718 is provided to time the interaction between the mechanical brake and the drive. A description of these parameters can be found in the parameter list above. In this application the default values of P716 and P717 is used (200 ms) but the P718 setting is changed to 30 seconds to minimize wear of the brake.

Setting P732 and P733

Distances are measured in quad-counts (QC) but defined in millimetres. Therefore, it is necessary to measure how many QC correspond to how many millimetres. To do this the cart is first moved as far to the left as possible by activating the “Manual jog negative” input (terminal 54). The position is then marked on the application and the corresponding value of P795 is noted. Then the cart is moved as far to the right as possible by activating the “Manual jog positive” input (terminal 53). The travelled distance in mm is now measured from the position of the mark to the position of the cart. Likewise the distance in QC is calculated by subtracting the current value of P795 from the noted value of P795.

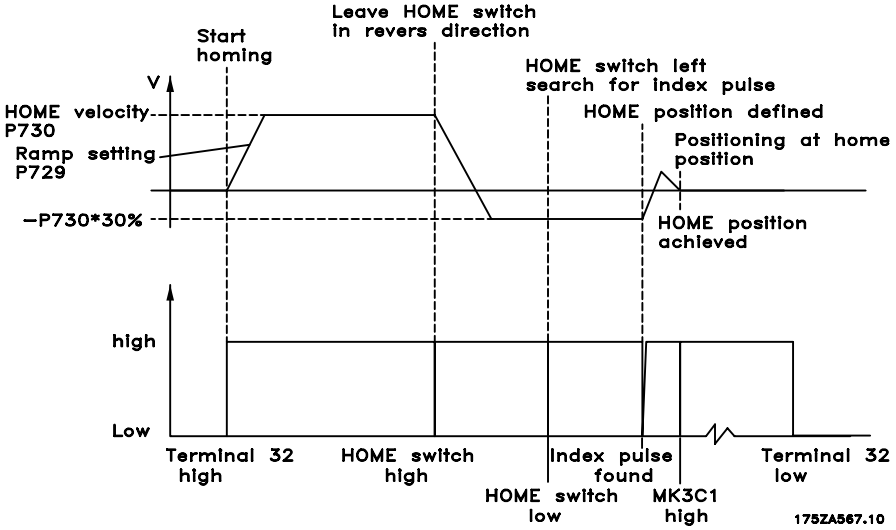
In this example it is measured that 871380 QC correspond to 4000 mm.

To prevent eventually overflow the parameters values are a factor 10 smaller than the measured QC and mm so P732 is set to “87138” and P733 is set to “400”. Positions will now be displayed and entered in millimetres. Settings like P732 set to “43569” and P733 set to ”200” will also give the positions in millimetres.

Settings for the homing procedure (P728-P731)

The HOME ramp setting (P729) is reduced to the lowest allowable setting to get the fastest HOMING procedure possible. The HOME velocity setting, however, should never be very high to enable a precise result of the homing procedure, and because the exact position is not known during homing, it is not advisable to go with a very high velocity for safety reasons. The default setting of P730 at 100 encoder revolutions per minute (approx 1/15th of the max velocity) is therefore maintained in this application. The default homing type defined in P731 is also maintained.

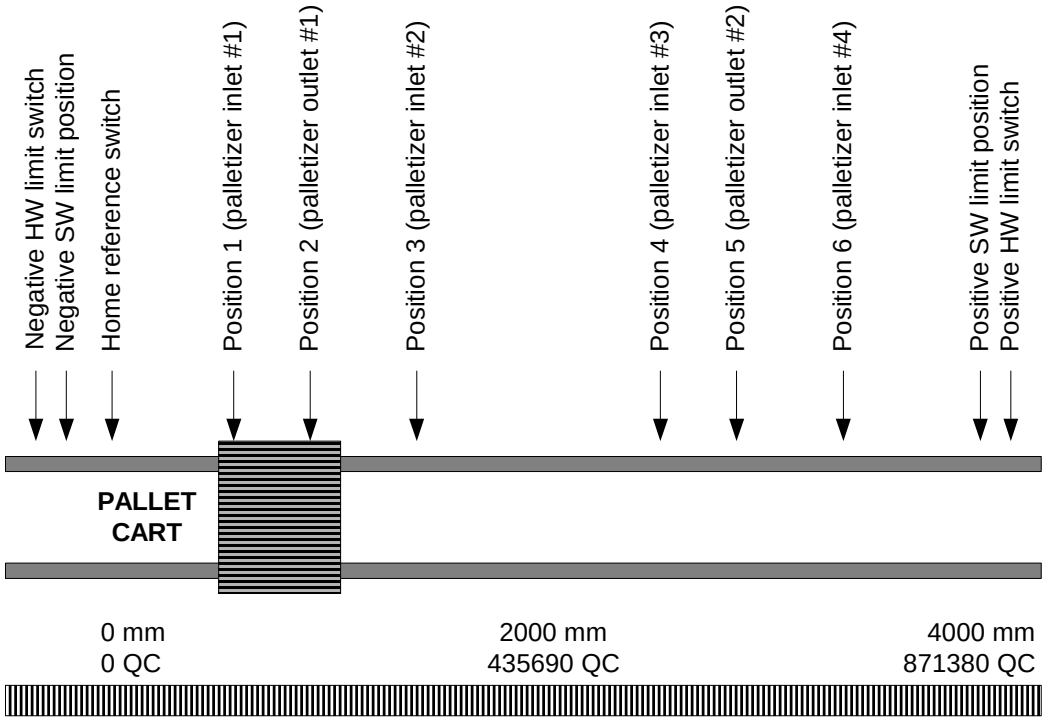
The resulting homing sequence is illustrated below.



Programming positions (P737-P743)

The program positions the conveyor cart in front of the various inlets and outlets. Different acceleration and deceleration is allowed between the different positions. An empty pallet cart can be accelerated as fast as possible while this is not allowed when transporting a fully loaded pallet.

Different settings for each position are available because every position is programmed with its own setting for ramp and velocity. The different positions are defined below.



The different positions are programmed using P738-P743 as interface. First, the application must be homed to get at fixed reference for measuring (and entering) the positions. When this is done the first position is programmed;

a) P738 is set to “1” either directly or by using the digital inputs and the “link” functionality of P737.
b) The position is programmed in P739 either directly on the LCP or by using the “TEACH-IN” functionality (simply use the jog inputs (54, 53) to drive the application to the desired position, then press the [JOG] and [FWD./REV.] buttons to store that position in memory).
c) The individual ramp and velocity settings for this position is specified in P740-P742.
d) For trajectory type “absolute” is selected in P743 set to (“0”).

The following table shows the complete list of settings for each of the 6 target positions.

P738	P739	P740	P741	P742	P743
1	40000	900	900	500	0
2	80000	2000	2000	500	0
3	150000	900	900	500	0
4	220000	900	900	500	0
5	260000	2000	2000	500	0
6	330000	900	900	500	0

Software limits (P744-P745)

The software limits are placed just in front of the hardware limit switches with a distance to the hardware limit switches that allows for the cart to be stopped with the shortest allowable ramp (P719) before the HW limit switch is activated.

The settings are: P744 = “370000” and P745 = “-10000”.

Setting P719 and P725

If the pallet cart is transporting a loaded pallet and travelling at its top speed, it is not allowed to simply activate the electromechanical brake (all the products on the pallet would be scattered across to floor because of the deceleration). So if a “safety cage” or other safety device is opened and the “quick stop” input is activated, the drive should ramp down with the appropriate ramp and *then* activate the safety brake. This functionality is achieved by setting P725 to “0” and tuning P719 to the lowest allowable setting.

Other settings (P726, P735, P736, P746)

The maximum PID track error was brought down to approximately +/- 100 QC during the optimising sequence described above (steps 17-20). Therefore, it is an indication of an error, if the PID track error should suddenly grow larger than approximately +/- 200 QC. Thus P726 Maximum tolerated PID error is set at “200”.

The maximum tolerated travel of the brake before replacement is estimated at 4 mm so P735 Brake wear limit is set to “4”.

If the application for some reason should ever go into the not allowed area beyond the SW limits it should be possible to bring the application back into the allowed area by resetting the limit error and using the jog inputs. This is achieved by setting P736 Power-recovery to “1”.

The allowed position tolerance is defined to be +/- 10 mm in this application so P746 Target position window is set to “10”.

Troubleshooting

Frequently asked questions

Q1:

When I have a "PID TRACK ERROR TOO BIG" error (P798="9"), the inverter also trips on ALARM 13 (OVER CURRENT).

A1:

a) Check that the velocity setting (P723 for jogging and P738/P742 for positioning) is at least 5% lower than the maximum allowed velocity calculated in P799. Either lower the velocity (P723 or P742) setting or raise the maximum allowed velocity (P799) by setting a higher value of P205 - please see Q2.

b) The quick stop ramp time (P719) could be too short. Try to increase the setting.

Q2:

How do I adjust the maximum allowed velocity in P799?

A2:

You need to raise the setting of P205. Doing this will also affect the performance of the parameters P702, P703, P704, P707 and P708. Smaller changes to P205 may not have any noticeable effect on most of these parameters but P707 should always be recalculated using the auto-calculation function P710.

Q3:

The inverter frequently trips on ALARM 7 (DC LINK OVERVOLTAGE) while ramping down.

A3:

a) Use a higher ramp time setting (P719 for "quick stop", P724 for jogging and P738/P741 for positioning).

b) If a lower ramp time is required a brake resistor should be installed.

Q4:

The inverter frequently trips on ALARM 13 (OVER CURRENT) while ramping up

A4:

a) The ramp settings may require too much torque. Try to determine which operation ("quick stop", manual move or positioning) caused the trip, and then set the corresponding ramp time (P719 for "quick stop", P724 for jogging and P738/P741 for positioning) with a higher ramp time setting.

b) The PID controller settings may be unstable – re-optimise the PID controller parameters (P702-P709).

Q5:

The correct target position is reached, but the PID tracking error (P797) is too big while the drive moves.

A5:

Harder settings of the PID controller may be required – re-optimise the PID controller parameters (P702-P709).

Q6:

The option sometimes seems to forget changes to parameter values.

A6:

Changes to parameter values are not stored after power-down unless P777 (STORE DATA) is activated before power-down.

Changes to trajectory data P705-P709 in POSITIONING MODE is ignored unless the correct password is entered in P778.

Error messages

All messages are shown in P798 in the VLT 5000 LCP display. You can find detailed information, additional notes on possible causes of errors as well as tips for clearing errors in the following section:

P798 – 0: Status OK. No errors detected.

Meaning

No errors detected.

P798 – 1: Homing needed

Meaning

The user has issued a positioning command to a certain position while the home position is not defined.

Note

The error must be cleared and a homing sequence successfully completed before the next position command is issued to the application.

P798 – 2: Positive hardware limit exceeded

Meaning

The positive hardware switch input has been activated.

Causes

The application has hit the positive limit marker switch. Alternatively, the connection to the limit switch has been lost or the limit switch is defect.

P798 – 3: Negative hardware limit exceeded

Meaning

The negative hardware switch input is activated.

Causes

The application has hit the negative limit marker switch. Alternatively, the connection to the limit switch has been lost or the limit switch is defect.

P798 – 4: Positive software limit exceeded

Meaning

A motor command will cause / has caused the software limit switch to be activated. The maximum limit specified in P744.

Note

Before the error can be cleared the application must be moved back from the limit. If “power recovery” is enabled in P736, this can be done through an error reset and a negative jog (input 54).

P798 – 5: Negative software limit exceeded

Meaning

A motor command will cause / has caused the software limit switch to be activated The minimum limit specified in P745.

Note

Before the error can be cleared the application must be moved back from the limit. If “power recovery” is enabled in P736 this can be done through an error reset and a positive jog (input 53).

P798 – 6: VLT not running

Meaning

The motor was not magnetized in a situation where it should have been. The electromechanical brake is immediately activated in this case regardless of the settings in P718 and P725.

Causes

While the motor was holding/driving the load, the drive has tripped, connection to terminal 27 was lost or the [STOP] button was pressed on the LCP.

P798 – 7: Brake wear limit exceeded

Meaning

This error message is given if the drive has moved more than the allowed number of user units specified in P735 *while* the electronic brake was activated.

Causes

The mechanical brake is worn and should be replaced in the near future or the limit specified in P735 is too low.

P798 – 8: Quick stop input activated

Meaning

The quick stop input has been activated. As a safety precaution the electromechanical brake is activated according to the setting of P725 and the drive is coasted regardless of the setting of P715. Normal operation is resumed if the error is cleared.

P798 – 9: Controller (PID) tracking error too big

Meaning

The difference between the desired set-point position and the actual position read via the encoder feedback has exceeded the limit specified in P726.

Causes

Several reasons may exist:

1) The encoder is not properly connected. Check the encoder connection.
2) The encoder is counting positive in the wrong direction. Switch A- and B-channels if necessary.
3) The PID controller settings are not properly optimised. Follow the instructions for optimising.
4) The limit specified in P726 may be too low.

P798 – 10: SyncPos option error occurred

Meaning

An internal error on the option card has occurred. Please note the corresponding error number and contact Danfoss with a description of the conditions before and after the error occurred.

P798 – 11: VLT Exception error detected

Meaning

An internal VLT 5000 error was detected during start-up of the option card program. Please note the corresponding error number and contact Danfoss.

Causes

EMC in the environment surrounding the VLT5000 might cause exception errors to arise. If the exception error occurs at different code addresses it is a good indication that EMC is causing the trouble. If the exception error occurs repeatedly at the same code address it is an indication that the EPROM's might be damaged

P798 – 12: Reverse operation prohibited

Meaning

The drives has been operated in reverse direction while this was not allowed according to the setting of P734.

P798 – 13: Forward operation prohibited

Meaning

The drives has been operated in forward direction while this was not allowed according to the setting of P734.

P798 – 92: Error from encoder monitoring

Meaning

Open or short circuit in accordance with the displayed LED. An error will be displayed even if no encoder is connected and the monitor is active (P713 => 100).

Appendix

Binary selection of reference positions using digital control

Pos. Number target Pos. Number chosen	IN 29 (MSB) O8	IN 19 O7	IN 18 O6	IN 17 O5	IN 16 (LSB) O4
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0
31	1	1	1	1	1

Binary selection of reference positions using fieldbus control.

Pos. Number target Pos. Number chosen	PCD 7,6 (MSB) PCD 2,6	PCD 7,5 PCD 2,5	PCD 7,4 PCD 2,4	PCD 7,3 PCD 7,3	PCD 7,2 PCD 2,2	PCD 7,1 (LSB) PCD 2.1
0	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1

Pos. Number target Pos. Number chosen	PCD 7,6 (MSB) PCD 2,6	PCD 7,5 PCD 2,5	PCD 7,4 PCD 2,4	PCD 7,3 PCD 7,3	PCD 7,2 PCD 2,2	PCD 7,1 (LSB) PCD 2.1
10	0	0	1	0	1	0
11	0	0	1	0	1	1
12	0	0	1	1	0	0
13	0	0	1	1	0	1
14	0	0	1	1	1	0
15	0	0	1	1	1	1
16	0	1	0	0	0	0
17	0	1	0	0	0	1
18	0	1	0	0	1	0
19	0	1	0	0	1	1
20	0	1	0	1	0	0
21	0	1	0	1	0	1
22	0	1	0	1	1	0
23	0	1	0	1	1	1
24	0	1	1	0	0	0
25	0	1	1	0	0	1
26	0	1	1	0	1	0
27	0	1	1	0	1	1
28	0	1	1	1	0	0
29	0	1	1	1	0	1
30	0	1	1	1	1	0
31	0	1	1	1	1	1
32	1	0	0	0	0	0
33	1	0	0	0	0	1
34	1	0	0	0	1	0
35	1	0	0	0	1	1
36	1	0	0	1	0	0
37	1	0	0	1	0	1
38	1	0	0	1	1	0
39	1	0	0	1	1	1
40	1	0	1	0	0	0
41	1	0	1	0	0	1
42	1	0	1	0	1	0
43	1	0	1	0	1	1
44	1	0	1	1	0	0
45	1	0	1	1	0	1
46	1	0	1	1	1	0
47	1	0	1	1	1	1
48	1	1	0	0	0	0
49	1	1	0	0	0	1
50	1	1	0	0	1	0
51	1	1	0	0	1	1
52	1	1	0	1	0	0
53	1	1	0	1	0	1
54	1	1	0	1	1	0
55	1	1	0	1	1	1
56	1	1	1	0	0	0
57	1	1	1	0	0	1
58	1	1	1	0	1	0
59	1	1	1	0	1	1
60	1	1	1	1	0	0
61	1	1	1	1	0	1
62	1	1	1	1	1	0
63	1	1	1	1	1	1

Glossary of key terms

Incremental encoder

This is an encoder system that picks up the speed and the direction of rotation and transmits on the appropriate configuration. The number of tracks, and thus the number of signals, indicates the properties of the encoder system. There are single-track systems that deliver a pulse signal dependent on the speed as well as a fixed direction signal. Dual-track systems deliver two pulse signals that are offset 90 degrees. By evaluating the two tracks, the direction signal is also obtained. Three-track encoders deliver, as well as the two tracks of the dual-track encoder, an additional “zero-track“. This emits a signal when the zero transit is passed through.

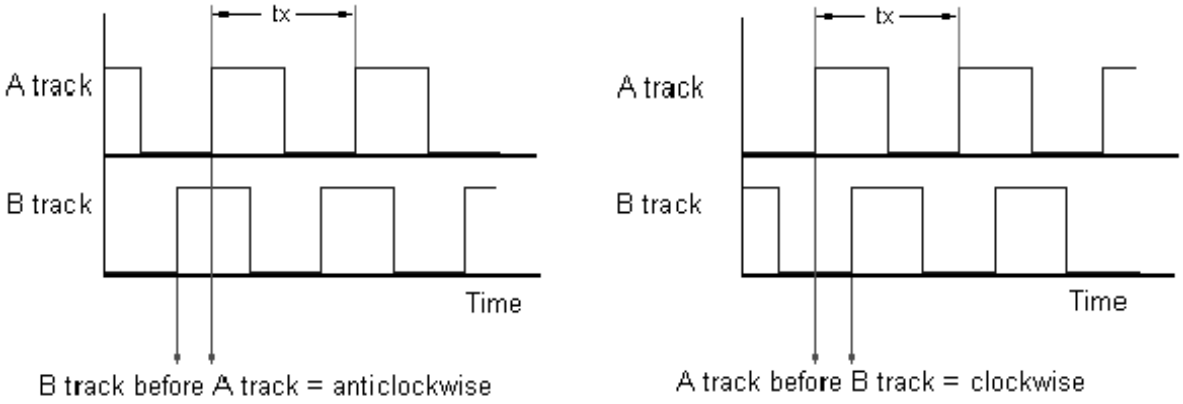


Fig.: Incremental encoder signals

Quadcounts

Through edge detection, a quadrupling of the increments is produced by both tracks (A/B) of the incremental encoder. This improves the resolution.

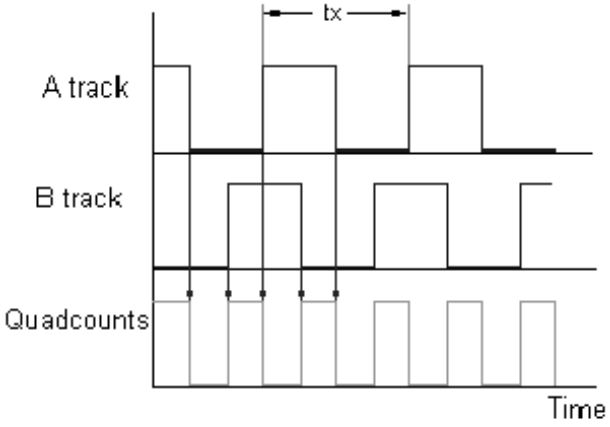


Fig.: Derivation of quad counts

Absolute value encoder

This is a special form of incremental encoder, as it indicates not only the speed and direction of rotation but also the absolute physical position. This is communicated via transfer of the position in parallel form or in the form of a telegram in serial form. Absolute value encoders also come in two versions: Single-Turn encoders supply an absolute position on a shaft rotation; Multi-Turn encoders can report the absolute position via a specific quantity, or via a freely-definable number of rotations.

ERPM

The speed is defined in relation to the RPM of the encoder. To underline this the term “encoder revolutions per minute” is chosen as unit.

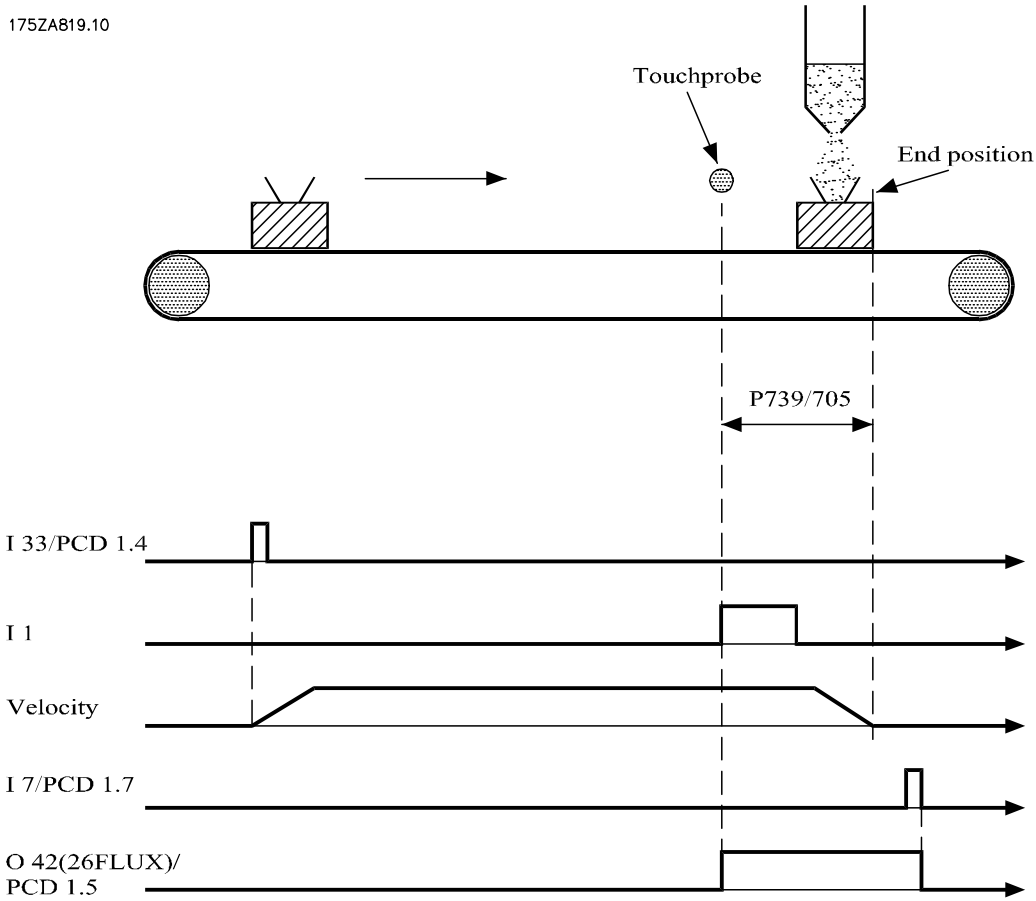
AMA — Automatic Motor Adaptation" function in P107.

Motor/encoder gear ratio — Since the encoder is not necessarily mounted on the motor itself, the relationship between the nominal motor speed in RPM and the nominal encoder speed in ERPM must be specified.

Track error — The PID track error is defined as the difference between the internal controller set-point and the actual position. The track error is specified in UU, and is displayed in P797.

NOTE! The maximum tolerated PID error is entered in P726 in QC.

Touch probe, trajectory type "2"



Input 33 is the latch reference index input in digital control mode. PCD 1.4 is the latch reference index input in fieldbus control mode.

Input 1 is the touchprobe input.

Input 7 is the reset touchprobe input in digital control mode. PCD 1.7 is the reset touchprobe input in fieldbus control mode

Output 42 (26 for Flux) is the touchprobe locked indicator output in digital control mode. PCD 1.5 is the touchprobe locked indicator output in fieldbus control mode.

NOTE! A delay in the touchprobe sensor will make the target position drift. This means the target position will become larger than stated in parameter 739. To compensate for this please specify a delay value in parameter 747. Only a constant delay can be compensated not a variable delay.

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175R0305 MG50P302 Rev. 2003-09-16