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## 1 Introduction

### 1.1 Available Literature for VLT AutomationDrive, MCO 305 and MCT 10 Motion Control Tool

- The *MCO 305 Design Guide* entails all technical information about the option board and customer design and applications.
- The *MCO 305 Command Reference* completes the MCO 305 Design Guide with detailed description of all commands available for programming MCO 305.
- The *VLT AutomationDrive Operating Instructions* provide the necessary information for getting the frequency converter up and running.
- The *VLT AutomationDrive Programming Guide* provides complete descriptions of all parameters in the frequency converter.
- The *VLT AutomationDrive Design Guide* entails all technical information about the frequency converter and customer design and applications.
- The *VLT AutomationDrive Profibus Operating Instructions* provide the information required for controlling, monitoring and programming the drive via a Profibus fieldbus.
- The *VLT AutomationDrive DeviceNet Operating Instructions* provide the information required for controlling, monitoring and programming the drive via a DeviceNet fieldbus.
- The *VLT AutomationDrive MCT- 10 Operating Instructions* provide information for installation and use of the software on a PC.

Danfoss Drives technical literature is also available online at [www.danfoss.com/drives](http://www.danfoss.com/drives).

### 1.2 Symbols and Conventions

#### Symbols

The following symbols are used in this manual.



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

#### CAUTION

Indicates a situation that may result in equipment or property-damage-only accidents.

#### NOTE

Indicates highlighted information that should be regarded with attention to avoid mistakes or operate equipment at less than optimal performance.

#### Approvals



#### Conventions

The information in this manual follows the system and uses the typographical features described below to the greatest extent possible:

##### Menus and Functions

Menus and functions are printed italics, for example: *Controller* → *Parameters*.

##### Commands and Parameters

Commands and parameter names are written in capitals, for example: AXEND and KPROP; Parameters are printed in italics, for example: *Proportional factor*.

##### Parameter Options

Values for use to select the parameter options are written in brackets, e.g. [3].

##### Keys




The names of keys and function keys are printed in brackets, for example the control key [Cntl] key, or just [Cntl], the [Esc] key or the [F1] key.

### 1.3 Abbreviations

Automatic Motor Adaptation	AMA
Direct Current	DC
Frequency Converter	FC
Local Control Panel	LCP
Master Unit	MU
Millisecond	ms
Minute	min
Motion Control Option	MCO
Motion Control Tool	MCT
Parameter	par.
Protective Extra Low Voltage	PELV
Position Control Loop	PID
Pulses per Revolution	PPR
Quad-counts	qc
Revolutions per Minute	RPM
Second	sec.
Switch normally closed	nc
Switch normally open	no
User Unit	UU
Volts	V

## 2.1 High Voltage Warning

MCO 305  
Operating Instructions  
Software version: 5.xx

These Operating Instructions can be used for the MCO 305 option board  
with all FC 300 frequency converters with software version later than 5.xx.  
The software version number can be seen from 15-43 *Software Version* for the frequency converter and in 15-61 *Option SW Version* for the MCO  
305

### 2.1.1 High Voltage Warning

The voltage of the VLT AutomationDrive is dangerous whenever the converter is connected to mains. Incorrect fitting of the motor or VLT AutomationDrive may cause damage to the equipment, serious injury or death. Consequently, it is essential to comply with the instructions in this manual as well as local and national rules and safety regulations. At altitudes above 2km, please contact Danfoss Drives regarding PELV.

## 2.2 Safety Instructions

- Make sure the VLT AutomationDrive is properly connected to earth.
- Do not remove mains plugs or motor plugs while the VLT AutomationDrive is connected to mains.
- Protect users against supply voltage.
- Protect the motor against overloading according to national and local regulations.
- Motor overload protection is not included in the default settings. To add this function, set par. 1-90 *Motor thermal protection* to value *ETR trip* or *ETR warning*. For the North American market:
- ETR functions provide class 20 motor overload protection, in accordance with NEC.
- The earth leakage current exceeds 3.5 mA.
- The [OFF] key is not a safety switch. It does not disconnect the VLT AutomationDrive from mains.

## 2.3 Before Commencing Repair Work

1. Disconnect VLT AutomationDrive from mains.
2. Disconnect DC bus terminals 88 and 89.
3. Wait at least 4 minutes.
4. Remove motor plugs.

## 2.4 Avoid Unintended Start

While VLT AutomationDrive is connected to mains, the motor can be started/stopped using digital commands, bus commands, references or via the LCP.

- Disconnect the VLT AutomationDrive from mains whenever personal safety considerations make it necessary to avoid unintended start.
- To avoid unintended start, always activate the [OFF] key before changing parameters.
- Unless terminal 37 (safe stop) is turned off, an electronic fault, temporary overload, a fault in the mains supply, or lost motor connection may cause a stopped motor to start.

## 2.5 Safe Stop of FC 302

The FC 302 can perform the Designated Safety Function *Uncontrolled Stopping* by removal of power (as defined by IEC 61800-5-2) or *Stop Category 0* (as defined in EN 60204-1). It is designed and approved suitable for the requirements of Safety Category 3 according to EN 954/PLd according to ISO 13849-1. This functionality is called Safe Stop.

In order to install and use the Safe Stop function in accordance with the requirements of Safety Category 3 according to EN 954-1/PLd according to ISO 13849-1, the related information and instructions of the VLT AutomationDrive Design Guide MG.33.BX.YY must be followed! The information and instructions of Operating Instructions are not sufficient for a correct and safe use of the Safe Stop functionality.

## 2.6 General Warning

### **⚠ WARNING**

Touching the electrical parts may be fatal – even after the equipment has been disconnected from mains. Also make sure that all voltage inputs have been disconnected, such as load-sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up. Using VLT AutomationDrive (at and below 7.5kW):  
wait at least xx minutes.

xx = The waiting time using the VLT AutomationDrive is different for different sizes: Please see period of waiting time xx in the *VLT AutomationDrive Operating Instructions, MG.33.AX.YY*.

## 3 How to Install

### 3.1 How to Get Started

Please consult the *VLT AutomationDrive Operating Instructions* for correct installation of VLT AutomationDrive, these instructions cover installation of MCO 305.

#### 3.1.1 Initialisation to Default Settings

Initialize the frequency converter to default setting in two ways:

**Recommended initialisation (via 14-22 Operation Mode)**

1. Select 14-22 Operation Mode
2. Press [OK]
3. Select "Initialization"
4. Press [OK]
5. Cut off the mains supply and wait until the displays turns off.
6. Reconnect the mains supply – the frequency converter is now reset.

**NOTE**

MCO 305 programs and arrays are not affected.

<b>14-22 Operation Mode</b> initialises all except:
14-50 RFI Filter
8-30 Protocol
8-31 Address
8-32 FC Port Baud Rate
8-35 Minimum Response Delay
8-36 Max Response Delay
8-37 Max Inter-Char Delay
15-00 - 15-05 Operating Data
15-20 - 15-22 Historic log
15-30 - 15-32 Fault log
33-90 X62 MCO CAN node ID
33-91 X62 MCO CAN baud rate

**Manual initialisation**

1. Disconnect from mains and wait until the display turns off.
2. Press [Status] – [Main Menu] – [OK] at the same time:
3. Reconnect mains supply while pressing the keys.
4. Release the keys after 5 sec.
5. The frequency converter is now programmed according to default settings.

**NOTE**

When carrying out manual initialization, serial communication and fault log settings are reset. All MCO 305 programs and arrays are deleted!

<b>This method initializes all except:</b>
15-00 Operating Hours
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's

### 3.2 System Overview

This is only relevant if the MCO 305 is delivered as an option for upgrading an existing VLT AutomationDrive. When ordered with the frequency converter, MCO 305 is preinstalled from factory. For retrofit, a mounting kit must be purchased.

There is a different mounting kit for different frames. MCO 305 is to be used in slot C0 but can be combined with another option in slot C1.

Mounting kit depending on frame	Order no.
Bookstyle	
A2 and A3 (40 mm for one C option)	130B7530
A2 and A3 (60 mm for C0 + C1 option)	130B7531
B3 (40 mm for one C option)	130B1413
B3 (60 mm for C0 + C1 option)	130B1414
Compact	
A5	130B7532
B, C, D, E and F (except B3)	130B7533

Do not mount the small fan for B4, C3, C4, D, E and F

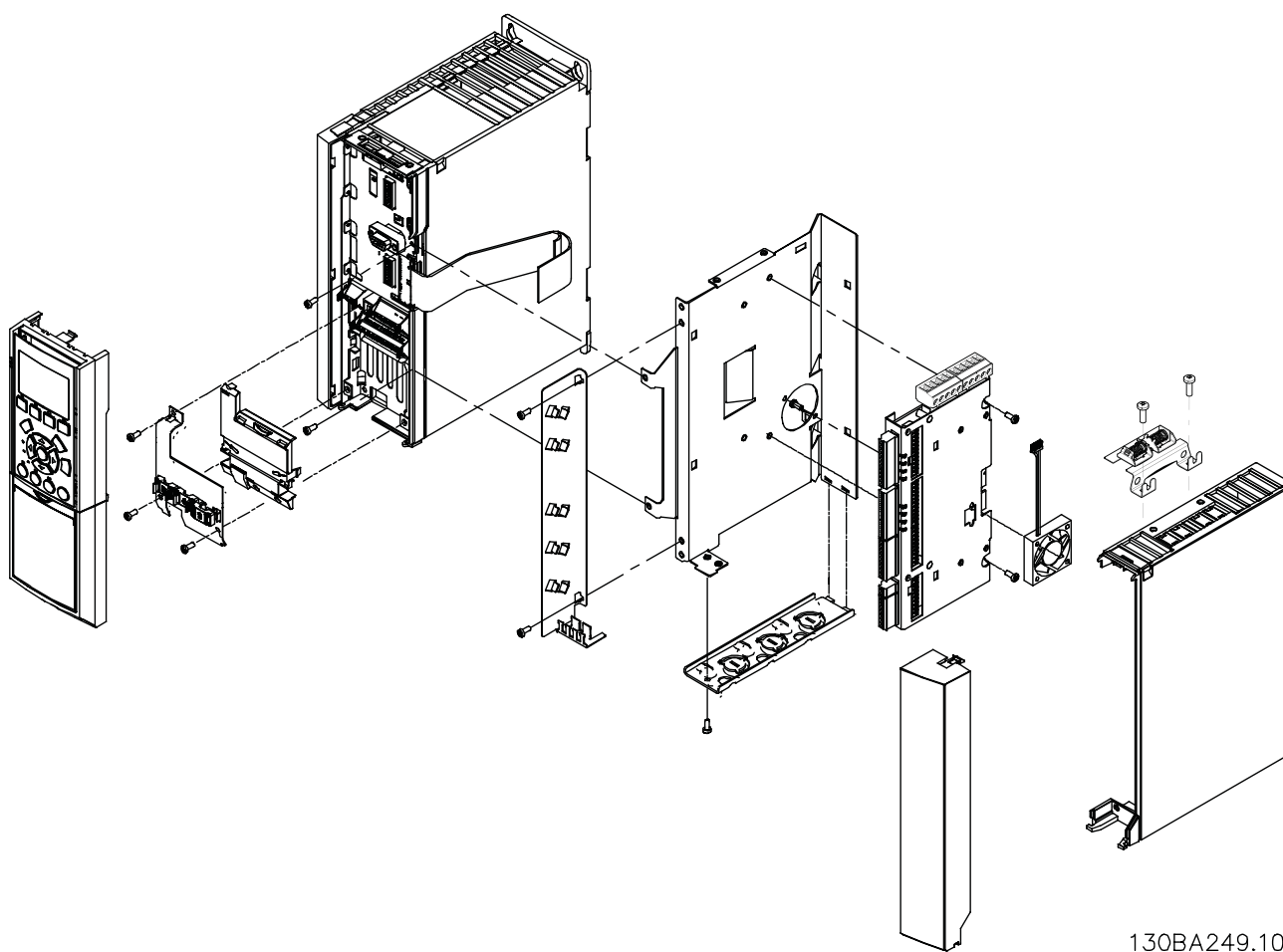


Illustration 3.1 Bookstyle - A2, A3, B3



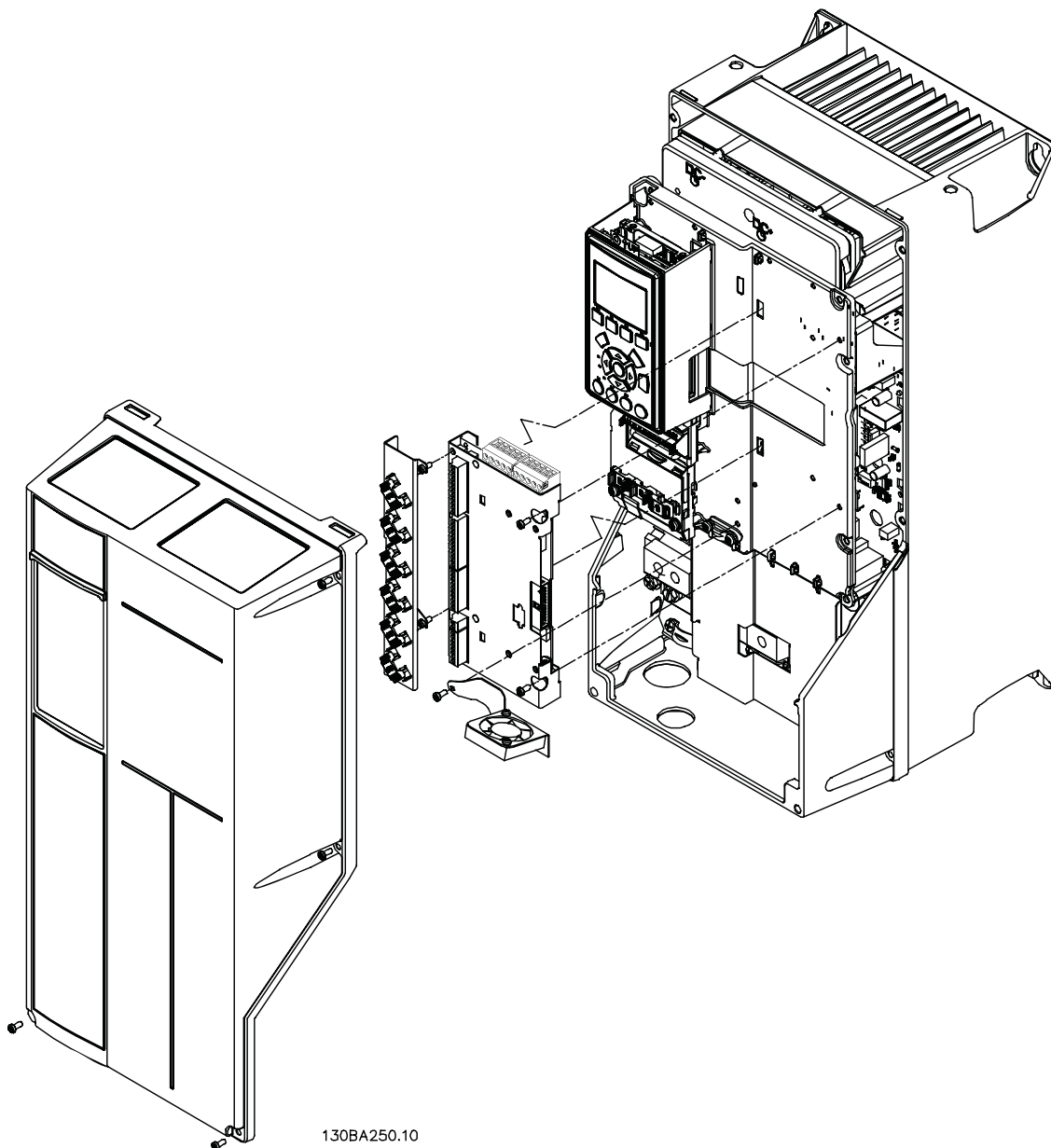


Illustration 3.2 Compact - A5, B (except B3), C, D, E, F

### 3.2.1 Electrical Installation

All control cables must be screened and the cable screen must be connected to earth at both ends. It is very important to use the correct cable for encoders to avoid noise problems, always follow the prescriptions of the encoder supplier. See also *VLT AutomationDrive Design Guide (MG. 33.AX.YY)* for more information regarding EMC correct cable installation.

### 3.2.2 MCO 305 Control Terminals

**Frame size A2 and A3:**

Encoder and I/O terminal are located behind the C option terminal cover, see *Illustration 3.3*.

MCO CAN bus terminals and debug terminals (RS485) are located on the top of the c-option cover. If these connections are used cut out the plastic parts above the connectors and mount the cable relief

**Frame size A5, B1 and B2:**

All MCO 305 terminals are located next to the VLT AutomationDrive control card. Remove the front cover to get access, see illustration.

MCO 305 control terminals are plug connectors with screw terminals; the terminal blocks are duplicated to enable use of the same MCO 305 in all frame sizes. See *Illustration 3.5* to locate the terminal blocks:

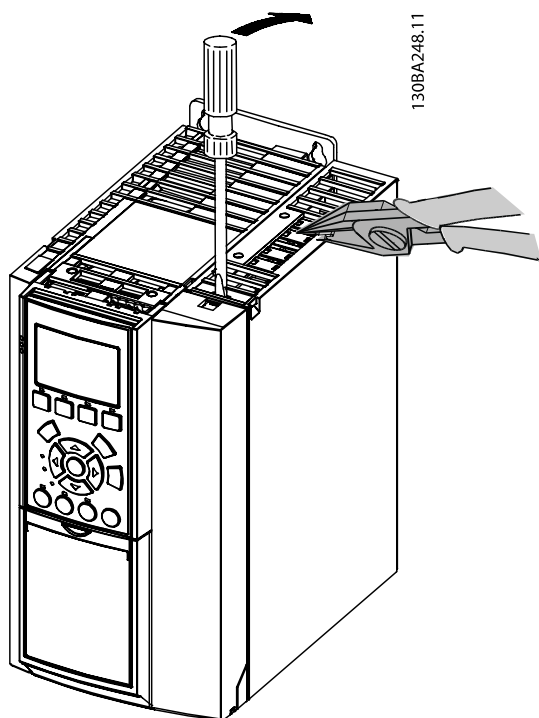


Illustration 3.3 Location of Encoder and I/O Terminals

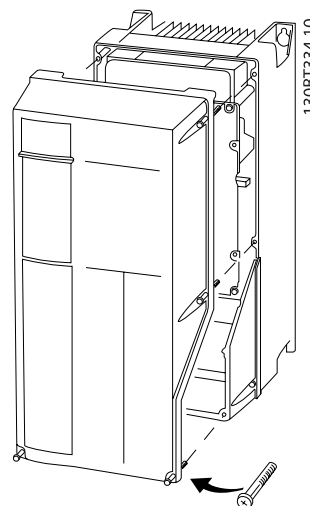


Illustration 3.4 Removing Front Cover

MCO control terminals are plug connectors with screw terminals. Terminals X55, X56, X57, X58 and X59 are duplicated to be used for both bookstyle and compact frame size.

- X55 = Encoder 2
- X56 = Encoder 1
- X57 = Digital inputs
- X58 = 24V DC supply
- X59 = Digital outputs
- X62 = MCO CAN Bus
- X60 = Debug connections (RS-485)

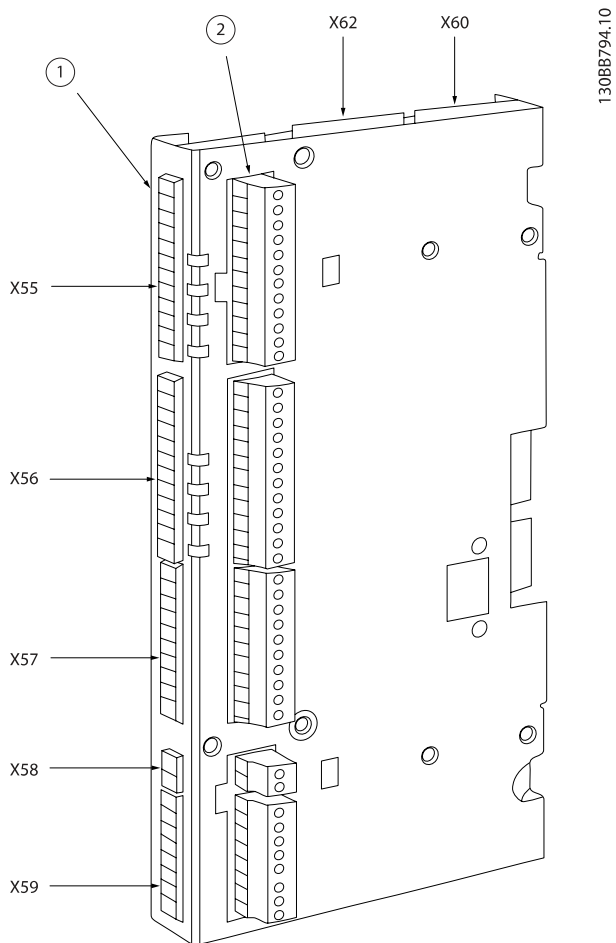


Illustration 3.5 Location of Terminal Blocks

Terminal block 1 is to be used with bookstyle and terminal block 2 with compact.

### 3.2.3 Terminal overview

Terminal block	Terminal number	Descriptive Name Encoder 2 (Feedback)
X55	1	+24V Supply
	2	+8V Supply
	3	+5V Supply
	4	GND
	5	A
	6	A not
	7	B
	8	B not
	9	Z / Clock
	10	Z not / Clock not
	11	DATA
	12	DATA not

Terminal block	Terminal number	Descriptive Name Encoder 1 (Master)
X56	1	+24V Supply
	2	N/A
	3	+5V Supply
	4	GND
	5	A
	6	A not
	7	B
	8	B not
	9	Z / Clock
	10	Z not / Clock not
	11	DATA
	12	DATA not

Terminal block	Terminal number	Descriptive Name Digital inputs
X57	1	Digital Input
	2	Digital Input
	3	Digital Input
	4	Digital Input
	5	Digital Input
	6	Digital Input
	7	Digital Input
	8	Digital Input
	9	Digital Input
	10	Digital Input

Terminal block	Terminal number	Descriptive Name Supply
X58	1	+24V Supply
	2	GND

Terminal block	Terminal number	Descriptive Name Digital outputs
X59	1	Digital Output/Input
	2	Digital Output/Input
	3	Digital Output
	4	Digital Output
	5	Digital Output
	6	Digital Output
	7	Digital Output
	8	Digital Output

Terminal block	Terminal number	MCO Debug (RS485)
X60	<sup>1</sup> CS	Control Select
	62	RxD/TxD - P
	63	RxD/TxD - N
	66	OV
	67	+5V

<sup>1</sup>CS is high when transmissions is active

Terminal block	Terminal number	MCO CAN Bus
X62	1	N/A
	2	CAN - L
	3	DRAIN
	4	CAN - H
	5	N/A

### 3.2.4 Encoder Connections Examples

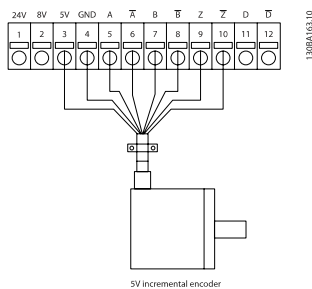


Illustration 3.6 5V Incremental Encoder (RS-422) Supplied by MCO 305

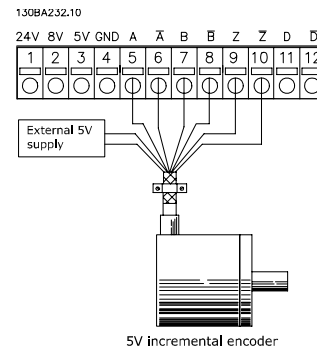


Illustration 3.7 5V Incremental Encoder (RS-422) Supplied by an External Power Source

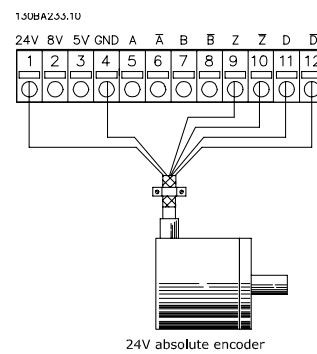


Illustration 3.8 24V Absolute Encoder (SSI) Supplied by MCO 305

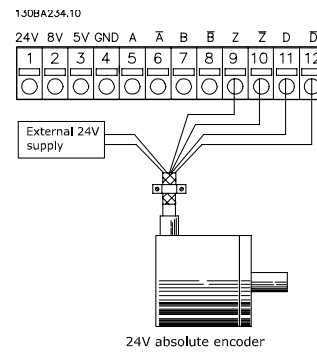


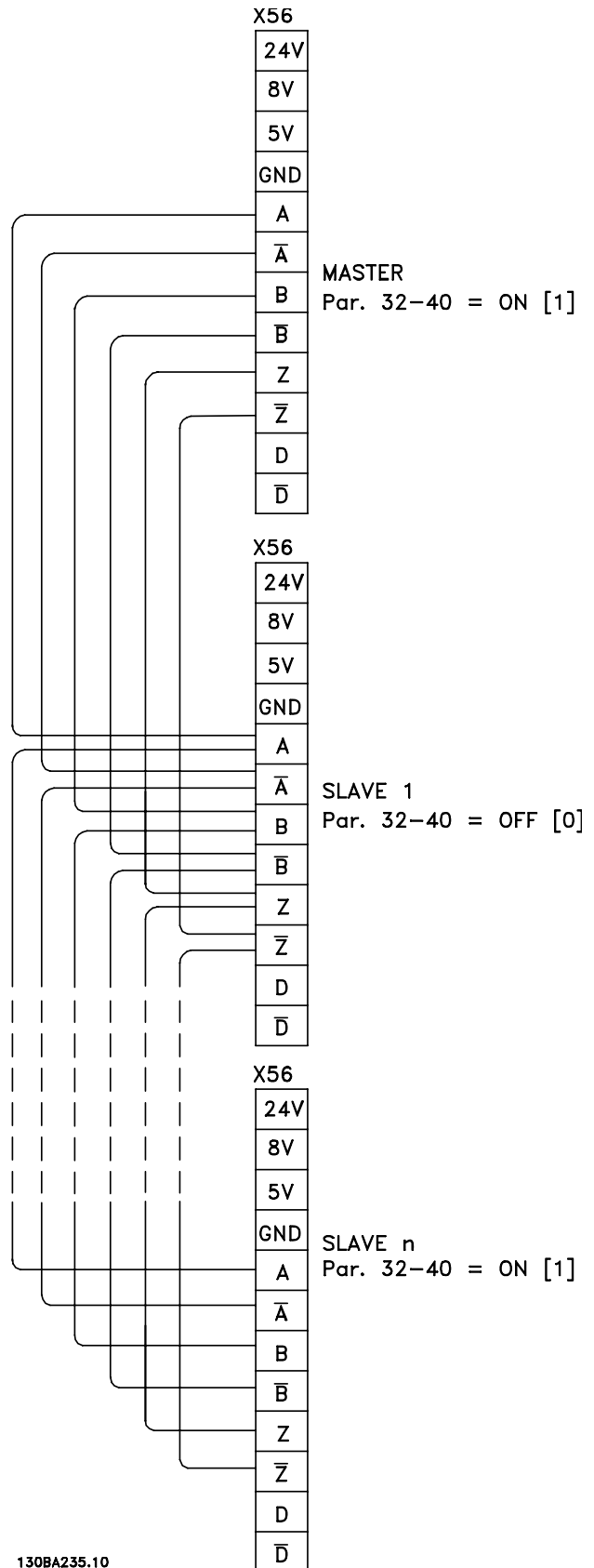
Illustration 3.9 24V Absolute Encoder (SSI) Supplied by an External Power Source

### NOTE

When external power supply is used, ensure the same potential between GND on external supply and encoder connections (4). This is to avoid common mode disturbances.

### 3.2.5 Virtual Master Connection

When more than 2 MCO 305 master encoder interfaces are interconnected termination must be on (*32-40 Encoder Termination = ON*) at both ends of the bus. Termination must be off (*32-40 Encoder Termination = OFF*) in all other MCOs.



### 3.3 Commissioning Guide

This guideline is only describing basic configuration and optimizing of MCO 305, before starting the following steps must be completed.

1. Basic commissioning of VLT AutomationDrive.

#### NOTE

VLT AutomationDrive must be optimized and have good control over the motor and application before commissioning MCO 305. Guidelines can be found in VLT AutomationDrive Operating Instructions (MG.33.AX.XX).

2. Install the PC software tools (MCT 10 Set-up Software)
3. Establish communication between PC and VLT AutomationDrive using USB, RS-485 or PROFIBUS DPV1.

Then follow these steps to set-up and optimize MCO 305.

1. Setting of basic MCO 305 parameters (groups 32-\*\* and 33-\*\*).
2. Connect and test encoder(s).
3. Optimize PID controller.

#### NOTE

Error 113 will show up right after power up if the VLT AutomationDrive is not ready. The VLT AutomationDrive is in the "Not ready" state when

- it has an alarm (trip),
- it is in hand mode, [Hand on] key,
- local LCP stop is activated, [OFF] key,
- there is no signal on input 37 safe stop (only FC 302).

Error 113 can only be reset using the ERRCLR command or with BREAK [Esc] in the PC software and only when the VLT AutomationDrive is in the "ready" state, which means none of the above may be true. The VLT AutomationDrive monitoring function can be switched off by selecting [0] in 33-82 Drive Status Monitoring.

Read the Safety Instructions before installing the frequency converter.

### 3.4 Basic MCO Parameter Settings

The following parameters must always be checked and if necessary adjusted. Depending on the requirements of the application it might be necessary to adjust other parameters as well.

For the other parameters, use the default settings at first and then optimize the controller as needed at a later point in time with a *Testrun*.

The MCT 10 Set-up Software will support you to set the parameters in LCP. For a detailed description of all parameters, please refer to 8 Appendix.

#### 3.4.1 Setting of Encoder Parameters

Define the used type of feedback encoder in parameter group 32-0\*.

These defaults are set:

32-0* Encoder 2 - Feedback	Default
32-00 Incremental Signal Type	[1] RS422
32-01 Incremental Resolution	1024
32-02 Absolute Protocol	[0] None
32-03 Absolute Resolution	8192
32-05 Absolute Encoder Data Length	25
32-06 Absolute Encoder Clock Frequency	262000
32-07 Absolute Encoder Clock Generation	[1] On
32-08 Absolute Encoder Cable Length	0
32-09 Encoder Monitoring	[0] Off
<b>For CAN Encoders</b>	
32-14 Enc.2 node ID	127
32-15 Enc.2 CAN guard	[0] Off
33-91 X62 MCO CAN baud rate	[20] 125 kbps

#### 3.4.2 Setting of parameters for CANopen feedback encoder

- In 32-00 Incremental Signal Type select the setting [3] "CAN encoder".
- In 32-01 Incremental Resolution set the resolution of the encoder.
- In 32-14 Enc.2 node ID set the CAN ID of the encoder.
- In 32-15 Enc.2 CAN guard activate or deactivate the guarding.
- In 33-91 X62 MCO CAN baud rate set in the CAN bus baud rate.

The following parameters are only relevant for synchronizing applications when a master encoder signal is used. These defaults are set:

<b>32-3* Encoder 1 - Master</b>	
32-30 Incremental Signal Type	[1] RS422
32-31 Incremental Resolution	1024
32-32 Absolute Protocol	[0] None
32-33 Absolute Resolution	8192
32-35 Absolute Encoder Data Length	25
32-36 Absolute Encoder Clock Frequency	262000
32-37 Absolute Encoder Clock Generation	[1] On
32-38 Absolute Encoder Cable Length	0
32-39 Encoder Monitoring	[0] Off
32-40 Encoder Termination	[1] On
<b>For CAN Encoders</b>	
32-44 Enc.1 node ID	127
32-45 Enc.1 CAN guard	[0] Off
33-91 X62 MCO CAN baud rate	[20] 125 kbps

### 3.4.3 Setting of parameters for CANopen Master encoder

- In 32-30 *Incremental Signal Type* select the setting [3] "CAN encoder".
- In 32-31 *Incremental Resolution* set the resolution of the encoder.
- In 32-44 *Enc.1 node ID* set the CAN ID of the encoder.
- In 32-45 *Enc.1 CAN guard* activate or deactivate the guarding.
- In 33-91 *X62 MCO CAN baud rate* set in the CAN bus baud rate.

### 3.4.4 Setting of Velocity Parameters

Define 32-80 *Maximum Velocity (Encoder)*, the *Maximum Velocity* of the shaft where the encoder is mounted in RPM.

32-8* Velocity & Acceleration	Default
32-80 <i>Maximum Velocity (Encoder)</i>	1500
32-81 <i>Shortest Ramp</i>	1.000

#### NOTE

For synchronizing application the setting of the follower drive must be at least the same as the maximum velocity of the master in order to be able to synchronize. For position synchronizing it must even be higher so that the follower drive can catch up lost position related to the master. All velocity commands (VEL, CVEL) are related to this value. Define 32-81 *Shortest Ramp*. That is the time from 0 to maximum velocity and from maximum velocity to 0. All acceleration and deceleration commands (ACC, DEC) are related to this value.

### 3.4.5 Setting of Home Parameters

Homing is not necessary in standard synchronization applications and applications using an absolute encoder. When using an incremental encoder the controller must be run to home after being switched on. During this process the reference switch defines the position at which 0 is located and how the VLT AutomationDrive functions during a home run: input depends on the application. Define 33-03 *Velocity of Home Motion*: Home speed is entered in % relative to the maximum speed of the frequency converter.

33-0* Home Motion	Default
33-00 <i>Force HOME</i>	[0] not forced
33-01 <i>Zero Point Offset from Home Pos.</i>	0
33-02 <i>Ramp for Home Motion</i>	10
33-03 <i>Velocity of Home Motion</i>	10
33-04 <i>Behaviour during HomeMotion</i>	[0] Reverse + Index

### 3.4.6 Setting of Synchronization Parameters

The following parameters are only relevant for synchronizing applications:

- 33-10 *Sync Factor Master*
- 33-11 *Sync Factor Slave*

The *Synchronizing Factors Master* and *Slave* must be set according to the gear ratio between master and slave encoder.

Example:	
Both encoders have 1024 PPR, master is running 305 RPM and slave must run 1220 RPM.	
33-10 <i>Sync Factor Master</i>	= 305 and
33-11 <i>Sync Factor Slave</i>	= 1220
Alternative:	
33-10 <i>Sync Factor Master</i>	= 1
33-11 <i>Sync Factor Slave</i>	= 4

The following parameters are only relevant when using synchronizing with marker correction (SYNCM):

- 33-15 *Marker Number for Master*
- 33-16 *Marker Number for Slave*

*Marker Number for Master* and *Slave* must be set according to the ratio between the number of marker signals from master and slave. A ratio of 1:1 means that each slave marker will be aligned with each master marker. A ratio of 2:1 means that each slave marker will be aligned with each second master marker.

33-1* Synchronization	Default
33-10 Sync Factor Master	1
33-11 Sync Factor Slave	1
33-15 Marker Number for Master	1
33-16 Marker Number for Slave	1
33-17 Master Marker Distance	4096
33-18 Slave Marker Distance	4096
33-19 Master Marker Type	[0] Enc. Z pos.
33-20 Slave Marker Type	[0] Enc. Z pos.

- 33-17 Master Marker Distance
- 33-18 Slave Marker Distance

When using the encoder zero pulse as marker signal the distance between 2 markers is the resolution (qc) of the encoder.

When external marker signals are used, the marker distance can be measured by means of the program sample "Marker count".

- 33-19 Master Marker Type
- 33-20 Slave Marker Type

Master marker signal: Input 5

Slave marker signal: Input 6

Marker signal type must be selected for master and slave:

Default setting is [0] Encoder Z positive flank for both.

### 3.5 Connecting and Testing the Encoder(s)

#### NOTE

The controller and the motor must be able to be switched off at any time with an EMERGENCY STOP button.

The motor must be able to turn completely freely so that a sudden jolt can not cause damage.

#### NOTE

If not yet connected, now is the time to connect and test the encoder. When using an absolute encoder, enter [0] in 32-00 Incremental Signal Type and in 32-02 Absolute Protocol the used type of encoder. Then enter the resolution in 32-03 Absolute Resolution.



Turn off the power before connecting the encoder.

Each encoder channel (A, B, Z, and D) is monitored, open circuit as well as short circuit is detected. A green LED shows the status of each active channel, LED on means that the channel is ok. Monitoring if the channels are automatically enabled/disabled depending on the selected encoder type, e.g. A, B, and Z is monitored when an incremental encoder is selected. Additionally an alarm will be triggered if encoder

monitoring is activated in 32-09 Encoder Monitoring and 32-39 Encoder Monitoring.

Check the encoder connections by means of the test program: Select the file "Enc-S.m" via the MCT 10. APOSS and with that the file is opened automatically .

### 3.5.1 Execute the Encoder Test Program

In the *Development* menu click on → *Execute* to start the test program. Run the frequency converter forward for example in hand mode – [Hand on] key – then the position must count positive. If the position is counting negative, swap A and B channels from the encoder or two motor phases. If the motor is turned on by hand (the motor should not be connected!), test whether the encoder functions: the position is continuously registered in the communications window. For a full rotation you should receive 4 times the value of the resolution of the encoder, that means 2000 if the *Encoder Counts per Revolution* is 500.

### 3.5.2 Checking Master Encoder for Synchronizing Applications

To check the master encoder change the test program: replace the command APOS by MAPOS in "Enc-S.m" and run the master forward then the master position must count positive as well. If the position is counting negative, swap A and B channels from the master encoder.

### 3.5.3 Ending the Encoder Check

End the test of the encoder with the [Esc]-key and close the test program with File Close. A successful test of the encoder is a requirement for further starting up of operations. Repeat the test when using other encoders.

#### What to do, if ... ?

....the encoder does not work?

This could be a result of incorrect cable installation. Measure the signals coming from the encoder and compare them to the values listed in the specifications. Check whether the connection was made according to the specification.

....the count is descending?

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.

### 3.6 PID Controller Settings

This is a quick guide to set-up the PID controller, further details can be found in the chapter "Optimizing the PID controller".



The following basic settings can be used in most applications with a 1024 PPR encoder connected directly to the motor shaft and maximum reference (3-03 *Maximum Reference*) is 1500 RPM:

32-60 <i>Proportional factor</i>	= 200
32-61 <i>Derivative factor</i>	= 1000
32-62 <i>Integral factor</i>	= 5
32-65 <i>Velocity Feed-Forward</i>	= 10200

Velocity Feed-forward (32-65 *Velocity Feed-Forward*) can also be calculated using the following formula:

$$\text{Velocity Feed forward} = \frac{62914560000}{\text{envel} \times \text{eres} \times \text{tsample}}$$

Where:

- "envel" is encoder velocity in RPM at maximum reference (3-03 *Maximum Reference*).
- "eres" is the encoder resolution (Incremental encoder: eres = 32-01 *Incremental Resolution* \* 4. Absolute encoder: eres = 32-03 *Absolute Resolution*).
- "tsample" is PID sample time (tsample = 32-69 *Sampling Time for PID Control* except with SYNCV where tsample = 32-70 *Scan Time for Profile Generator*).

The sample program "Feed-forward calculation" is making the above calculation and sets the parameters:

### 3.6.1 Sample Program: Feed-forward Calculation

This program calculates basic settings for Velocity Feed-forward and PID settings based on the following inputs: Encoder type (32-00 *Incremental Signal Type* and 32-02 *Absolute Protocol*), Encoder resolution (32-01 *Incremental Resolution* or 32-03 *Absolute Resolution*), Encoder velocity (par. 19-00), and Motion type (par. 19-00). These parameters must thus be set before starting the calculation.

The program performs the following steps when setting input 1:

1. Check encoder type and resolution
2. Calculate PID sample time in order to get sufficient resolution
3. Check motion type and select sample time
4. Calculate Feed-Forward.

Parameters are updated when setting input 2. The updated parameters can be saved by setting input 3. New calculation is enabled by setting input 4.

### 3.6.2 Influence to the Control Loop when Changing Parameters

The gain of the control loop changes when one or more of the following parameters is changed: Maximum reference, encoder resolution, and gearing between motor and encoder.

When changing these parameters the following rules apply: Increased maximum reference = P and D factors as well as Feed-forward must be reduced.

Higher encoder resolution = P and D factors as well as Feed-forward must be reduced.

Increase gear-ratio between motor and encoder (encoder turning slower) = P and D factors as well as Feedforward must be increased.

Examples	32-60	32-61	32-62	32-65
1024 PPR encoder connected directly to the motor shaft and maximum reference 1500 RPM	200	1000	5	10200
4096 PPR encoder connected directly to the motor shaft and maximum reference 1500 RPM	50	250	5	2550
1024 PPR encoder connected behind a 10:1 gearbox and maximum reference 1500 RPM	2000	10000	5	102000
1024 PPR encoder connected directly to the motor shaft and maximum reference 3000 RPM	100	500	5	5100

Further optimizing can easily be done by means of the graphical Test-run tool which is included in the APOSS editor this however implies that the motor/application can move.

### 3.7 Executing a Test Program

Now connect the motor to the VLT AutomationDrive, make sure that the motor can turn completely freely.

#### NOTE

**The motor must be provided with an EMERGENCY STOP button.**

Select the file "Move-S.m" via the VLT AutomationDrive. APOSS and with that the file is opened automatically. Click on *Development* and start the test program with → *Execute* or [F5].

The test is successful if the motor runs slowly back and forth and position 500 is registered.

End the test with [Esc] and *Close the File*.

#### What to do, if ... ?

....the motor sets off uncontrolled or vibrates heavily?

#### NOTE

**Turn off the motor immediately with the EMERGENCY STOP button if it vibrates heavily or sets off uncontrolled.**

....the motor sets off uncontrolled, but the encoder test previously was successful, then decrease *32-60 Proportional factor*. (See *Optimizing the PID controller*).

....the motor doesn't move?

If the motor doesn't move at all, then the *Proportional Factor* of the PID filter is probably too low or the VLT AutomationDrive has not been enabled.

Check the VLT AutomationDrive enable (terminal 37 = 24V) and check that the VLT AutomationDrive was not stopped via the LCP. Then increase *32-60 Proportional factor*. (See *4 Optimizing the PID controller*).

....the motor vibrates heavily?

If the motor vibrates, optimize the PID controller and adjust the other parameters of the controller: Reduce either *32-60 Proportional factor* or increase *32-61 Derivative factor*

....a "Tolerated Position Error is exceeded" is reported?

If the frequency converter stops due to a "Tolerated Position Error is exceeded" message it is possible to determine whether the frequency converter was rotating in the wrong direction by comparing the curves of the set and actual values. Check the connections of the motor or encoder. If the connections are correct, then it is necessary to increase the par. *32-67 Maximum Tolerated Position Error*. (See *Optimizing the PID controller*.)

## 4 Optimizing the PID controller

### 4.1 How to Control Process Works

#### How the Control Process Works

The *Testrun* explained in the chapter *PC Software interface* in the *APOSS Online help* can be used as a tool to optimize the MCO 305 controller settings, thereby optimizing system performance. To do that you only need to know a few things about the control scheme of MCO 305:

The APOSS position controller has two parts:

1. The *Setpoint Generator* interprets the various positioning commands in APOSS and generates a series of setpoint positions that eventually ends with the desired position. Normally, all positioning processes have a trapeze-shaped velocity curve. That means that after a phase of constant acceleration there is a phase with constant velocity and finally a phase with constant deceleration, which ends at the desired target position.
2. The *PID controller* receives the setpoint positions from the *Setpoint Generator* and in turn calculates the speed reference needed for the motor to follow the current setpoint position. By setting the PID control parameters you can directly influence to what degree and how quickly a deviation from a theoretical set path (as specified by the setpoint series) should be counteracted.

The following behavior indicate that the control parameters are not optimally adjusted:

- Frequency converter vibrates
- Frequency converter is loud
- Frequent occurrence of position errors
- Poor control accuracy

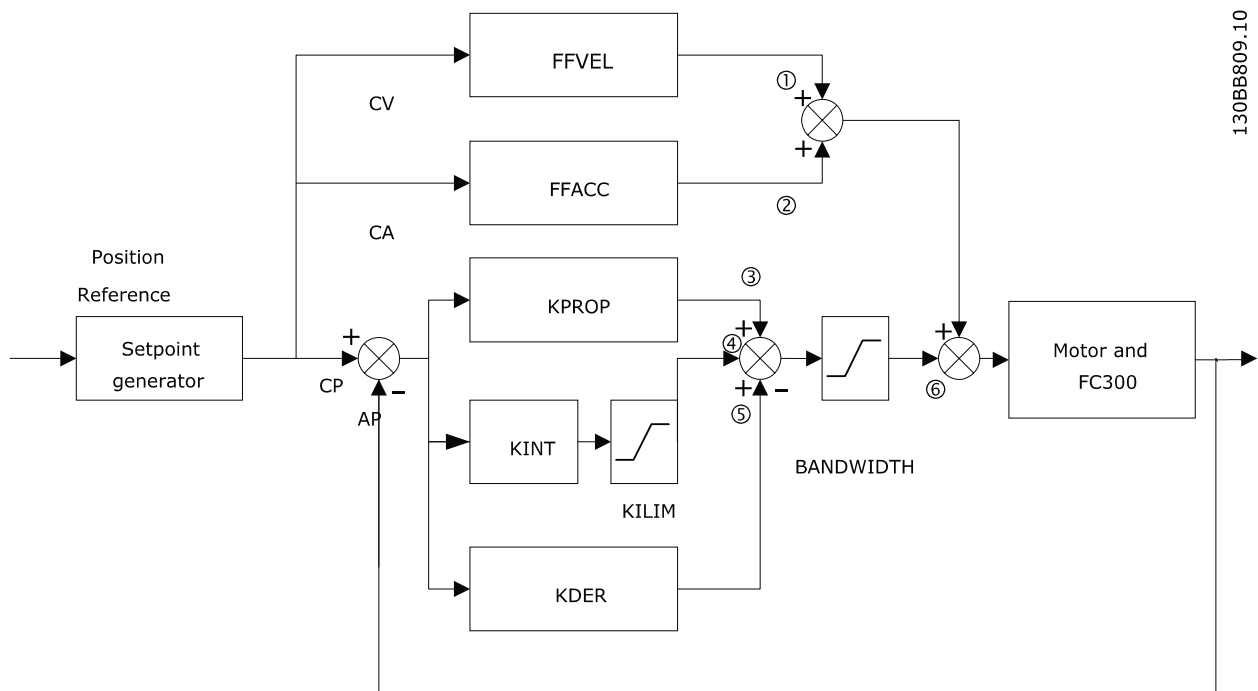
### NOTE

**The control parameters are load-dependent. Thus the frequency converter must be optimized under the actual conditions of use.**

In exceptional cases it may be necessary to determine various sets of control parameters while working with heavily changing load conditions and to re-program them in subsequent application programs depending on the motion process.

### 4.2 Significance and Influence of the Controller Parameters

The PID control unit of the MCO 305 motion controller transfers the necessary output frequency via an internal speed reference to the VLT AutomationDrive. This set value is periodically recalculated with an interval of one millisecond (interval is programmable by the *TIMER* parameter). The MCO 305 is by default set with soft "fit for all" controller parameters.



AP	is the actual position (calculated from encoder feedback) in qc (Quad Counts)
CP	is the current position set point in qc
CV	is the velocity set point in qc/ms (position deviation) is calculated by CP-AP
CA	is the acceleration set point

The PID filter works according to the following formula:

- 1 = FFVEL \* (Setpoint Velocity)
- 2 = FFACC \* (Setpoint Acceleration)
- 3 = KPROP \* (Position Deviation)
- 4 = KINT \* (Sum of all previous Position Deviations) (limited by KILIM)
- 5 = KDER \* (Difference of Position Deviation)
- 6 = 3 + 4 + 5 (Limited by BANDWIDTH)

**NOTE**

In SYNCV mode the PID controller is working with speed deviation instead of position deviation. Speed deviation is calculated by CV-AV. (AV is the Actual Velocity)

The controller in the MCO 305 utilizes two control strategies at the same time:

1. An open-loop feed-forward control. Since the asynchronous motor inherently has a good open loop performance the feed-forward control is a very important part of the controller in most

applications. Benefits from using feed-forwards control is a very fast and accurate response to changes in the *setpoint reference*.

2. A closed-loop PID control. The PID controller monitors the difference between the actual position and the setpoint position. Based on this information it calculates a control signal to minimize the position deviance. Thus the MCO is able to compensate for changes in load or friction. The PID controller is also necessary to compensate for any position deviance caused by inaccurate setting of the open-loop feedforward controller.

In short: The feed-forward control is used to handle changes in the setpoint reference (especially important in synchronization applications), while the PID control is used to handle changes in load conditions or inaccuracies of the feed-forward control.

**4.3 PID Factors**

The *32-60 Proportional factor* is multiplied with the position deviance and the result is added to the control signal (the internal speed-reference to the VLT AutomationDrive). Since the calculated control signal is proportional to the position deviance (or error) this kind of control is called proportional control. The behavior of the proportional control is similar to that of a spring – the further the spring is extended the stronger the counter-force it produces.

Influence of the Proportional Factor:	
KPROP too small	large position deviation due to non-compensatable load and frictional moment
KPROP larger	quicker reaction, smaller steady-state deviation, larger overshoot, lesser damping
KPROP too great	heavy vibrations, instability

#### 4.3.1 Derivative Value for PID Control

The *32-61 Derivative factor* is multiplied with the derivative of the position deviance (the 'velocity' of the position deviance) and the result is added to the control signal. The behavior of the derivative control is similar to that of an absorber – the faster the absorber is extended the stronger the counterforce it produces. Thus using the Derivative Value increases damping in your system.

Influence of the Derivative Value:	
KDER small	no effect
KDER larger	better dampening, lesser overshoot; if KPROP is increased simultaneously: faster reaction to control deviation at the same level of vibration;
KDER too large	heavy vibrations, instability

#### 4.3.2 Integral Factor: KINT

The sum of all error is calculated every time the control signal is updated. The *32-62 Integral factor* is then multiplied with the sum of all positioning errors and added to the overall control signal.

Thus in case that steady-state position errors occurs in your application, make sure to use the integral part of the controller. Steady-state errors will be leveled out as the summed error increases over time until the control signal eventually matches the load.

It is possible to set a limit for the control signal generated by the integral part of the controller (anti-windup).

Influence of the Integral factor:	
KINT very small	steady-state position deviance is very slowly regulated to zero
KINT larger	faster regulation towards zero steady-state position deviance, larger overshoot
KINT too large	heavy vibrations, instability

#### 4.3.3 Limit Value for Integral Sum: KILIM

The *32-63 Limit Value for Integral Sum* sets a limit for the control signal generated by the integral part of the controller. This helps to prevent the so called "wind-up" problem which typically occurs in applications where the

overall control signal (the internal speed-reference) is maxed out for long periods of time.

This feature is also very helpful in applications where the power to the motor is turned off and on while the option card is controlling the VLT AutomationDrive. Cutting of power to the motor (by setting terminal 27 low) while little positioning deviance is present in the controller, could result in an enormous control signal being generated once the power is turned back on.

#### 4.3.4 Velocity Feed-forward: FFVEL

The *32-65 Velocity Feed-Forward* is a scaling factor that is multiplied with the derivative of the setpoint position (the velocity of the setpoint). The result of this operation is added to the overall control signal. This feature is especially useful in applications where there is a good correlation between the control signal (the VLT AutomationDrive speed reference), and the speed of the motor. This is indeed the case with most applications.

#### NOTE

The scaling of the FFVEL parameter is dependent on the correct setting of the *Maximum Reference (3-03 Maximum Reference)* as well as the *32-80 Maximum Velocity (Encoder)* and *32-01 Incremental Resolution*.

#### 4.3.5 Acceleration Feed-forward: FFACC

The *32-66 Acceleration Feed-Forward* is multiplied with the 2nd derivative of the setpoint position (the acceleration of the setpoint) and the result is added to the control signal. This feature should be used to compensate for the torque used to accelerate/decelerate the system inertia.

#### NOTE

Scaling of the *Acceleration Feed-forward* factor is depending on the setting of the *Shortest Ramp*. Increase *32-66 Acceleration Feed-Forward* accordingly when decreasing *32-81 Shortest Ramp* and vice versa.

#### 4.3.6 Sampling Time for PID Control: TIMER

For particularly slow systems, slow down the entire control system by entering multiples of 1 ms as the sampling time. However, it is important to remember that such a change influences all the control parameters!

Therefore, normally you should not deviate from the value of 1 ms in *32-69 Sampling Time for PID Control*.

### 4.3.7 PID Bandwidth

A *Bandwidth* of 1000 means that the set value is being executed 100%, thus *Derivative*, *Proportional* and *Integral Factors* are effective as defined. But if operating a system which could be jeopardized by vibrations, for example, a crane with a heavy load then you can limit the bandwidth in which the PID controller should function. 32-64 *PID Bandwidth* of 300 makes a limitation of 30% possible. The build-up of a vibration is thus prevented since the control is only moved to with 30% of the calculated set value. However, then it is necessary also to use the feed-forward part of the controller in order to achieve the corresponding control.

### 4.4 Optimizing your Controller Settings Step-by-Step

Before adjusting the controller parameters it is important to determine which controller behavior is to be achieved.

#### NOTE

The drive elements must never be operated outside of the technical specifications. Thus the maximum acceleration is determined by the “weakest” drive element.

- “Stiff” axis: the fastest reaction possible is mainly influenced by the *Proportional Factor*. You can judge the results on the basis of the velocity graph.
- Damping of vibrations is mainly influenced by the *Derivative Value*. The results can best be assessed in the velocity graph.
- Temporary (static) deviations in position are mainly reduced by the *Integral Factor* and can best be judged on the basis of the positioning graph.

For best results use the functions in the *Tune Oscilloscope* for this purpose; these help you to evaluate and optimize the PID controller on the basis of graphs of the set and actual curves.

However, it is recommended only to change one value at a time and subsequently determining the improvement with a *Testrun*.

Click on *Controller* → *Parameter* → *Axis* and select the frequency converter, of which you are currently adjusting the settings.

#### 4.4.1 Ten Steps for Optimum Control

The following procedure will optimize your controller settings in most applications:

1. Make sure that you have specified correct values for VLT AutomationDrive 3-03 *Maximum Reference*,

as well as 32-80 *Maximum Velocity (Encoder)*, the encoder type and resolution in 32-00 *Incremental Signal Type* and 32-01 *Incremental Resolution*, and 32-81 *Shortest Ramp*. If these settings change again at a later point, the controller may need optimizing again.

Par. #	Typical Settings	
3-03	<i>Maximum Reference</i>	1500,000
32-80	<i>Max. Velocity (Encoder)</i>	1500
32-00	<i>Incremental Signal Type</i>	[1] RS422
32-01	<i>Incremental Resolution</i>	1024
32-81	<i>Incremental Resolution</i>	1.000

2. Set 32-67 *Max. Tolerated Position Error* to a very high value e.g. 1000000 to avoid getting the error 108 during the following tests.

#### NOTE

To avoid damaging the system, make sure to set 32-67 *Max. Tolerated Position Error* within the limits of the system, because the position error monitoring is not active with extremely high values.

3. Optimize the Velocity Feed-forward control: Click on *Execute Testrun* and Start a testrun with following parameter settings:

32-6* PID-Controller	
32-60 <i>Proportional factor</i>	0
32-61 <i>Derivative factor</i>	0
32-65 <i>Velocity Feed-Forward</i>	100
32-66 <i>Acceleration Feed-Forward</i>	0

View the velocity profiles: If the Actual Velocity profile is lower than the Commanded Velocity profile, increase *Velocity Feed-forward* and → *Start* the testrun again. Of course if the Actual Velocity profile is higher than the specified Commanded Velocity you should decrease *Velocity Feed-forward*.

Run successive test runs until the two velocity profiles shown in the Testrun graph have the same maximum value. *Velocity Feed-forward* is now optimized, save the current value.

4. In systems with large inertia and/or rapid changes in the reference velocity it is a good idea to use and optimize the *Acceleration Feed-forward* control (make sure the inertial load is connected when optimizing this parameter): Execute a Testrun with KPROP=0, KDER=0, KINT=0, FFACC=0, and FFVEL at the optimized value found above. Use the highest possible acceleration setting. If 32-81 *Shortest Ramp* is adjusted properly an acceleration value of 100 and a deceleration value of 100 should be sufficient. Start out with a low setting of *Acceleration Feed-forward* approx. 10.

View the velocity profiles: If during acceleration the actual velocity is constantly lower than the reference velocity profile, then set a higher value of *Acceleration Feed-forward* and → *Start* the Testrun again.

Run successive test runs until the two velocity profiles shown in the *Testrun* graph have similar rampup and ramp-down curves.

*Acceleration Feed-forward* is now optimized, save the current value.

32-6* PID-Controller	
32-60 Proportional factor	0
32-61 Derivative factor	0
32-62 Integral factor	0
32-65 Velocity Feed-Forward	result of step 3
32-66 Acceleration Feed-Forward	10

- Next step is finding the maximum stable value of the Proportional Factor in the PID controller. Execute a Testrun with KPROP=0, KDER=0, KINT=0. Set FFVEL and FFACC at the optimized values found above.  
View the velocity profile. If the velocity profile is not oscillating then increase the Proportional Factor. Run successive testruns until the actual velocity profile is oscillating mildly.  
Decrease this "mildly" unstable Proportional Factor value to about 70 %. Save this new value.

32-6* PID-Controller		
32-60 Proportional factor	KPROP	0
32-61 Derivative factor	KDER	0
32-62 Integral factor	KINT	0
32-65 Velocity Feed-Forward	FFVEL	result of step 3
32-66 Acceleration Feed-Forward	FFACC	result of step 4

- In order to dampen the oscillations created by the Proportional part of the controller, the Derivative Value should now be optimized. Start a Testrun with KINT=0 and KDER=200. Set FFVEL, FFACC and KPROP at the optimized values found above.  
Run successive test runs with increasing values of the Derivative Value. At first the oscillations will gradually reduce. Stop increasing Derivative Value when the oscillations begin to increase.  
Save the last value of Derivative.

32-6* PID-Controller		
32-60 Proportional factor	KPROP	result of step 5
32-61 Derivative factor	KDER	200
32-62 Integral factor	KINT	0
32-65 Velocity Feed-Forward	FFVEL	result of step 3
32-66 Acceleration Feed-Forward	FFACC	result of step 4

- In any system that requires a zero steady-state error, the *Integral* part of the controller must be

used. Setting this parameter though is a trade-off between achieving zero steady-state error fast (which is good) and increasing overshoot and oscillations in the system (which is bad).

If you are using the *Integral* part of the PID controller, remember to reduce the *32-63 Limit Value for Integral Sum* as much as possible (without losing the *Integral Factor* effect of course) in order to reduce oscillations and overshoot as much as possible.

- Reduce the *32-64 PID Bandwidth* as much as possible. With a properly optimized open-loop control Bandwidth could be reduced to as little as 6 or 12 % (60 – 120).
- Set the *32-67 Max. Tolerated Position Error* back to normal e.g. 20,000.
- Once the Testrun is concluded, then → *Save* the new parameters as the user parameters. Thus, these parameters are saved in the controller and in the future will be used for all programs.

**What to do if...**

....there is a tendency towards instability?

In the event of a strong tendency towards instability reduce *32-60 Proportional factor* and *32-61 Derivative factor* again, or reset *32-62 Integral factor*.

....stationary precision is required?

If stationary precision is required, increase *32-62 Integral factor*.

....the tolerated position error is exceeded?

If the test run is constantly interrupted with the message "position error" set *32-67 Max. Tolerated Position Error* – within the tolerable limits – as large as possible.

If the position error occurs during the acceleration phase that suggests that the set acceleration cannot be achieved under the existing load conditions. Increase *32-67 Max. Tolerated Position Error* or determine a *Maximum Acceleration* suitable for the entire system.

If position errors do not occur until after the acceleration phase and they can be delayed but not eliminated by increasing *32-67 Max. Tolerated Position Error*, this suggests that the *Maximum Velocity* (RPM) chosen is too high. Determine a maximum velocity suitable for the entire system.

....the maximum acceleration is not achieved?

In general, the technical data for a frequency converter are only valid for a freely rotating axle end. If the frequency converter is carrying a load the maximum acceleration is reduced.

The theoretical maximum acceleration will also not be achieved if, for example, the PID controller output is too small, or the FC 300/motor is not sized correctly and therefore does not provide enough energy for peak consumption during acceleration.

## 5 How to Install the Application

### 5

### 5.1 Download Application Program and Configuration

Follow these steps to create and download MCO 305 program and configuration using MCT 10 and APOSS

1. Open MCT 10.
2. Open the folder "Project – Drive – MCO 305 – programs".
3. Right click in the right hand view and select:
  - a. "Import program file" if using an existing program "outside" the project file or,
  - b. "New MCO 305 program" when writing a new program. Right click the program file and double click or right click and select "Edit". Program editor will open.
4. Repeat step 3 if more programs are required.
5. One program must be set as Autostart program: Right click the program file and select "Set as Autostart".
6. Open the folder "Project – Drive – MCO 305 – Arrays".
7. Right click on the file and select "Import" or "Edit".
8. Right click on the MCO 305 folder in the tree structure in the left-hand view of MCT 10 and select "Write to drive".
9. "Write MCO 305 Program Source Files to the Drive" must be ticked if it should be possible to read the program from the frequency converter.

### 5.2 Backup and Restore

All parameters and MCO 305 data can be read out and stored in an MCT 10 project and thus restored to the frequency converter.

#### NOTE

**MCO 305 programs can only be read-out when they have been downloaded including source code!**

Use the following steps to back-up parameters and data by PC:

1. Go on-line with the drive via the Network folder.
2. Right click on the drive folder and select copy. "Include programs" must be ticked.

3. When copy is completed, paste the drive in-to a project folder.
4. Save the project.

Now parameters and MCO 305 data is stored in the project file, restore by the following steps:

1. Open the project file with MCT 10 Set-up Software.
2. Go on-line with the drive via the Network folder.
3. Open the project folder, Right click on the drive folder and select "Write to drive".

Now both parameters and MCO 305 data is restored in the drive.

#### Backup and Restore via LCP

Both parameters and MCO 305 data can be stored in the LCP and thus restored from the LCP to another frequency converter.

Use the following steps to back-up parameters data in the LCP:

1. Select "All to LCP" [1] in *0-50 LCP Copy*.
2. Select "File from MCO to LCP" [4] in *0-50 LCP Copy*.

Now parameters and MCO 305 data is stored in the LCP, restore by the following steps:

1. Select "All from LCP" [2] in *0-50 LCP Copy*.
2. Select "File from LCP to MCO" [5] in *0-50 LCP Copy*.

Now both parameters and MCO 305 data are restored in the frequency converter.



### 5.3 How to Connect and Run Multiple Frequency Converters

Use MCT 10 *Networking* or start APOSS directly by clicking on the application's icon. This stand-alone operation mode allows APOSS to switch frequency converters or connect to multiple frequency converters. In stand-alone mode, all file and parameter handling is done via APOSS. Thus the *File* menu also provides the functions for *File* → *New*, → *Open*, and → *Save As*. The *Settings* menu allows selecting the interface.

Run programs in several frequency converters

If you want to load the program into several controllers, link the program with the corresponding VLT AutomationDrive and click on → *Execute*.

If you want to load a different program in each controller, open a different edit window for each VLT AutomationDrive, then open the desired program file and connect it to the VLT AutomationDrive with → *Select Controller*. Then start each program, one after the other, with → *Execute*.

## 6 General Specifications

### 6.1 Protection and Features

- All inputs, outputs and supply voltages are protected against short circuit.
- All inputs, outputs and supply voltages are galvanic isolated from high voltages such as mains supply and motor voltage (PELV).
- Encoder signals are monitored during operation and standstill.
- Customer specific application programs can be copy protected.
- All MCO 305 parameters including user defined application parameters are accessible via the VLT AutomationDrive LCP.
- MCO 305 can be combined with other VLT AutomationDrive options e.g. PROFIBUS and DeviceNet interface.
- All digital inputs and outputs are galvanic isolated from the internal electronics and can be sourced from an external 24V power supply.

1) Selected in parameter 5-00 Digital I/O mode. The digital inputs are galvanic isolated from the internal electronics and can be sourced by an external 24V power supply.

Number of programmable digital outputs	8 (6) <sup>1</sup>
Terminal block	X59
Terminal number	1 <sup>1</sup> , 2 <sup>1</sup> , 3, 4, 5, 6, 7, 8
Driver type	Push/Pull
Logic	PNP or NPN <sup>2</sup>
Voltage level	0 - 24V DC
Max. output current (sink or source) with internal power supply (total )	40mA
Max. output current (sink or source) with external power supply (per output)	100mA

**Table 6.3 Digital Outputs**

- 1) Terminals X59-1 and X59-2 can be programmed as input, 33-60 Terminal X59/1 and X59/2 Mode.  
 2) Selected in 5-00 Digital I/O Mode.

Number of digital outputs which can be used as digital inputs	2 <sup>1</sup>
Terminal block	X59
Terminal number	1, 2
Logic	PNP or NPN <sup>2</sup>
Voltage level	0 - 24V DC
Voltage level, logic.0. PNP	< 10V DC
Voltage level, logic.1. PNP	> 17V DC
Voltage level, logic.0. NPN	> 13V DC
Voltage level, logic.1. NPN	< 6V DC
Maximum voltage on input	28V DC

**Table 6.4 Combined Digital Inputs/Outputs**

- 1) Terminals X59-1 and X59-2 can be programmed as input, 33-60 Terminal X59/1 and X59/2 Mode.  
 2) Selected in 5-00 Digital I/O Mode.

Terminal block	X58
Terminal number	1, 2
Maximum load	65mA

**Table 6.5 24V DC Supply Output**

The internal 24V power supply can be disconnected via parameter 33-85, an external 24V power supply must then be connected to X58-1 and X58-2.

### 6.2 Technical Data

Type	Plug connectors with screw terminals.
Maximum cross section, rigid wire	1.5mm <sup>2</sup> / AWG 16
Maximum cross section, flexible wire	1.5mm <sup>2</sup> / AWG 16
Maximum cross section, wire with enclosed core	1.5mm <sup>2</sup> / AWG 16
Minimum cross section	0.08mm <sup>2</sup> / AWG 28

**Table 6.1 Connection Terminals**

Number of programmable digital inputs	10
Terminal block	X57
Terminal number	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Logic	PNP or NPN <sup>1</sup>
Voltage level	0 - 24V DC
Voltage level, logic.0. PNP	< 5V DC
Voltage level, logic.1. PNP	> 10V DC
Voltage level, logic.0. NPN	> 19V DC
Voltage level, logic.1. NPN	< 14V DC
Maximum voltage on input	28V DC

**Table 6.2 Digital Inputs**

<b>General specifications:</b>	
Number of encoder inputs	2
Terminal block	X55 and X56
Terminal number	5, 6, 7, 8, 9, 10, 11, 12
Input impedance	120Ω
Maximum voltage on inputs	5V DC
Cable type	Screened cable with a twisted pair of wires for each encoder channel <sup>1</sup>

**Table 6.6 Encoder Inputs**

Incremental encoder type	RS422/TTL
Maximum frequency	410kHz
Phase displacement between A and B	90°± 30°
Maximum cable length	300m <sup>2</sup>

**Table 6.7 Incremental Encoder Specifications**

Absolute encoder type	SSI
Data coding	Gray
Data length	12 – 32 bit
Clock frequency	78kHz – 2MHz <sup>1</sup>
Maximum cable length	150m <sup>2</sup>

**Table 6.8 Absolute Encoder Specifications**

- 1) Always observe specifications/limitations prescribed by the encoder supplier.
- 2) 150m cable is possible up to 500kHz clock frequency, above 500kHz cable length must be limited further.

Number of encoder outputs	1
Terminal block	X56
Terminal number	5, 6, 7, 8, 9, 10, 11, 12
Signal type	RS422
Maximum frequency	410kHz
Maximum number of slaves	31 (more with repeater)
Maximum cable length	400m

**Table 6.9 Encoder Output**

Number of supply voltages	3
Terminal block	X55 and X56
Terminal number	1, 2, 3, 4
24V, max. load	250mA <sup>1</sup>
8V, max. load	250mA <sup>1,2</sup>
5V, max. load	400mA <sup>1</sup>

**Table 6.10 Encoder Voltage Supply**

- 1) This is maximum load when only one supply voltage is used; when 2 or 3 supply voltages are used simultaneously the load must be reduced accordingly. The following must be observed: load<sub>24V</sub> + load<sub>8V</sub> + load<sub>5V</sub> 6W and load<sub>8V</sub> + load<sub>5V</sub> 2W.
- 2) 8V is only available at terminal block X55.

Sample time of position PID loop	1ms
Positioning accuracy	± 1 increment <sup>1</sup>
Synchronizing accuracy	± 1 increment <sup>1</sup>

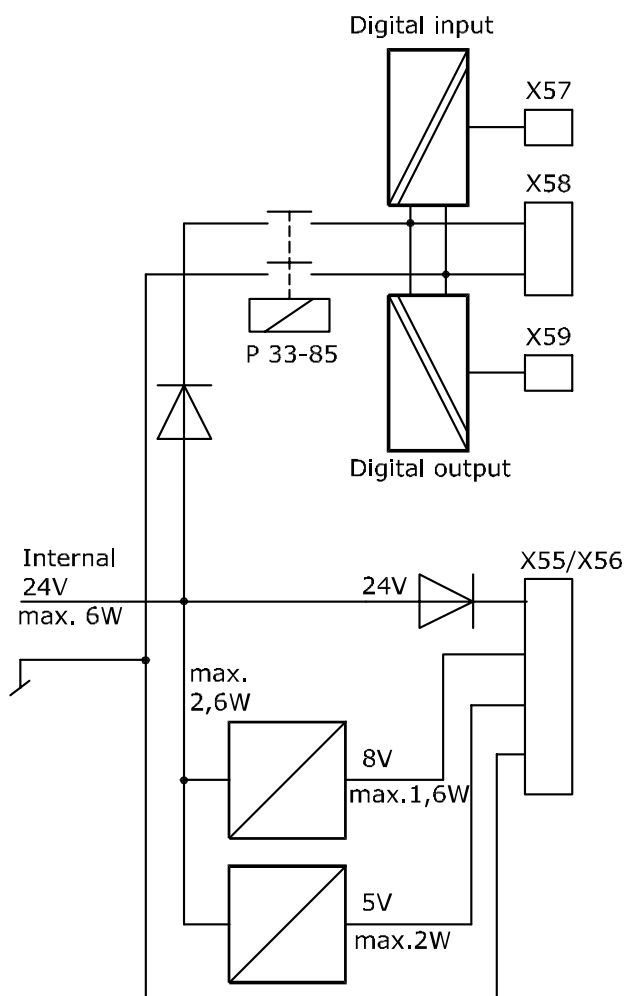
**Table 6.11 Control Characteristics**

- 1) This is the static accuracy; dynamic accuracy depends on many "external" factors such as encoder resolution, moment of inertia, mechanical backlash and elasticity.

Program memory size	100 Kbytes
Maximum number of application programs	90
Average command execution time	0.3ms
Maximum reaction time on interrupt input	ms

**Table 6.12 Application Program**

### 6.3 Supply Voltage Overview



130BA227.10

## 7 Troubleshooting

### 7.1 Warnings and Error Messages

All messages are shown in the LCP display of the VLT AutomationDrive in short and in the APOSS software in plain text.

You can find brief information on the error messages in the table or detailed information in the following section. The tables contain the messages in numerical order. Letters following a % sign represent variables which can be used in plain text at the corresponding locations.

Error no.	LCP display	Error text
102	Too many CAN objects	There are no more CAN objects available (CANINI).
103	Illegal axis num.	Axis not in system.
105	Error not reset	Error not cleared.
106	Home not done	Failed to move to HOME position.
107	Home vel. zero	Home velocity 0
108	Position error	Position error.
109	Index not found	Index pulse (encoder) not found.
110	Unknown com.	Unknown command.
111	SW end limit	Software end limit activated.
112	Unknown param.	Illegal parameter number.
113	FC not enabled	VLT Error Status
114	Too many loops.	Too many nested loops.
115	Par. save failed	INLONG command got an illegal string
116	Param. memory	Parameters in memory are corrupted.
117	Progr. Memory	Programs in memory are corrupted.
118	Reset by CPU	Reset by CPU.
119	User abort	User abort.
121	No more SDO chn	Number of SDO channels exceeded.
125	HW end limit	Limit switch activated.
149	Too many inter.	Too many interrupt functions.
150	No ext. 24V	External supply is missing.
151	Too many gosub	Too many nested GOSUB commands
152	Too many return	Too many RETURN commands.
154	D. out overload	Digital output overloaded.
155	LINK failed	LINKGPARG failed.
156	Illegal double arg.	A floating point function was called with an invalid argument.
160	Internal Intr. error	Interrupt happened, but interrupt address is no longer valid.
162	Memory error	Error in verifying
170	Too many DIM arrays	Too many DIM arrays defined.
171	Array too small	Array too small
175	Out of array mem.	No more memory space for the new array defined by DIM.
176	Array size wrong	Array size does not correspond to the size of the existing array.
179	Waitndx timeout	Timeout while waiting for index.
184	Too many ontime	Too many ONTIME or ONPERIODS interrupts.
187	Out of memory	Not enough memory for variables
188	CAN guarding error	A guarding error happened.
189	CAN send-receive error	CAN send or receive error.
190	Memory locked	Memory locked
191	Illegal cam array	Illegal curve array in SETCURVE.
192	Encoder error	Encoder error
193	Stack overflow	Stack overflow: Too many local variables or nested function calls.
194	Out of dyn. mem	Out of dynamic memory.

Error no.	LCP display	Error text
195	Too many testindices	Too many test indices in data logging command.
196	Code too old	Code is too old for the current firmware.
198	Limit sw. violation	rong direction after limit switch tripped and error reset.
199	Internal MCO fault	Internal MCO fault

**Error 102**

Too many CAN objects have been used and there are no more CAN objects available. The optional error information (see Error History) is used as follows:

CN_TIMEOUT	-2	// timeout of CAN commands when sending or reading telegrams
NO_HARDWARE	-6	// no CAN hardware present
NO_MEMORY	-7	// no more entries available (mailboxes or lists)
NO_CANMEMORY	-10	// no more mailboxes available for define command
NO_MOBJ	-11	// the demanded mailbox is not available
CN_CANERROR	-12	// a CAN bus error is detected (low level bus error)
CN_MOBJ_DIRERR	-13	// direction of mailbox is wrong (try to read a write box or vice versa)
NO_USER	-33	// return value for sdo state (SDOSTATE).

SDO_ABORT	-50	// has to be higher than the CN_ error messages
SDO_ID_NOT_IN_USE	-33	// return value for sdo state (SDOSTATE )
SDO_SEG_ARRAY_TOO_SMALL	-51	
SDO_SEG_TOGGLE_ERROR	-52	
SDO_SEG_TOO_MUCH_DATA	-53	
SDO_SEG_NOT_ENOUGH_DATA	-54	
SDO_SEG_ARRAY_WRITE_ERROR	-55	

GUARD_ERROR_NOT_OPERATIONAL	-101	
GUARD_ERROR_TOGGLE	-102	
GUARD_ERROR_MODULE_NOT_RESPONSE	-103	
GUARD_ERROR_NO_MODULE	-104	

**Error 103**

**Illegal axis number**

An attempt has been made to find an axis which does not exist in the controller.

Check to see if the program axis command has an invalid number or a general axis command (...X(\*)).

**Error 105**

**Error not reset**

An attempt has been made to execute a motion command, although an actual error message has not been cleared.

**Error 106**

**Home not done**

Failed to move to HOME position. According to the axis 33-00 Force HOME, a forced move to the machine zero-point is demanded, before other motion commands can be executed. This move to the machine zero-point has not been executed.

**Error 107**

**Home velocity zero**

An attempt was made to execute the HOME command but the motor is set to 0 in 33-03 Velocity of Home Motion.

**Error 108**

**Position error**

HOME was executed with HOME\_VEL set to zero.

The distance between the set and the real position was greater than the *Maximum Tolerated Position Error* defined in 32-67 *Max. Tolerated Position Error*.

Causes:

- Mechanically blocked or overloaded frequency converter,
- 32-67 *Max. Tolerated Position Error* too small,
- commanded speed greater than VLT AutomationDrive 4-13 *Motor Speed High Limit [RPM]* and 3-03 *Maximum Reference*,
- commanded acceleration too great,
- 32-60 *Proportional factor* too small, or
- VLT AutomationDrive not enabled.

**Error 109****Index not found**

At reference or index search, the encoder index pulse could not be found within a motor rotation.

Causes:

- An encoder without an index pulse has been used,
- index pulse not connected,
- index pulse incorrect (all three channels must have a simultaneous low), or
- *32-01 Incremental Resolution* (ENCODER) is set too low.

**Error 110****Unknown command**

Cause is a Communication or program error. The program must be re-compiled and re-loaded.

**Error 111****Software end limit**

A motion command will cause or has caused the software end limit to be activated.

Identification of attainment of software limit at a motion in the speed mode will only be made after the current position is identical to the software limit switch.

Starting with MCO 5.00 it is possible to clear a software limit error and then drive in the opposite direction. If you try again to move in the wrong direction, then a new error is generated.

Handling of hardware limit switches is the same as software limit switches. That means that the error you can clear and drive in the opposite direction. But if you try to move in the wrong direction, then the error 198 occurs.

In positioning mode, it is known before motion start that the target position lies outside the path. In this case, the movement will not be executed and the error message can be cleared.

The control unit will be switched off and the frequency converter must be manually moved back to within the admissible area, or the monitoring of the software limit switch must be temporarily de-activated via *33-43 Negative Software End Limit Active* and *33-44 Positive Software End Limit Active*. Only then is it possible to clear the error.

Limit switches and reference switches allow the usage of any input. That means not only 1..8 are supported but also larger numbers as well as virtual inputs or outputs.

**NOTE**

Using virtual inputs as limit switches is dangerous because it eliminates the direct connection between the limit switch and the controller. That may introduce a time delay (or other failure scenarios) which will limit the controller's ability to respond quickly to the switch. Software-limit error handling a up MCO 5.00:

**A Software-Limit error can not be cleared: The control unit will be switched off and the frequency converter must be manually moved back to within the admissible area, or the monitoring of the software limit switch must be temporarily de-activated in *33-43 Negative Software End Limit Active* and *33-44 Positive Software End Limit Active*. Only then is it possible to clear the error.**

**Error 112****Unknown parameter**

An attempt has been made to change a parameter (SET or SETVLT command), which does not exist.

**Error 113****FC not enabled**

VLT Error Status: VLT AutomationDrive is not ready but the PID controller is active. The FC status word (Bit 09 and Bit 11) is monitored every 20ms when the PID controller is active. The VLT AutomationDrive is in the "Not ready" state when:

- it has an alarm,
- it is in local mode,
- local LCP stop is activated.

**Error 114****Too many loops**

Too many nested LOOP commands exist in the executed program.

**Error 115****Parameter save failed**

The INLONG command got an illegal string. It has been used to read a long value from serial line. If the string which arrives does not represent a valid number then this error will be released.

**Error 116****Parameters memory are corrupted**

The parameters in EPROM are no longer correct because of

- EEPROM defective or
- power outage while saving.

**NOTE**

Re-initialize the parameter with *14-22 Operation Mode* and then overwrite these parameters again with your own application parameters. Otherwise motion programs which require application parameters will no longer function correctly.

In Stand-alone-Mode you could also use Controller → Parameters →Reset.

**Error 117****Programs in memory are corrupted**

The program data stored in EPROM cannot be found or are no longer correct because of

- EPROM defective or
- power outage while saving.

have to do a 3-finger reset to reset all parameters to their defaults (ex factory) and to delete all user programs, arrays, and application parameters. Afterwards re-load the programs and parameters. This corresponds to a Reset → Complete in the APOSS menu.

In Stand-alone-Mode delete the EPROM with Controller → Memory → Delete EPROM and then re-load the programs and parameters.

**Error 118****Reset by CPU**

The processor has been stopped and a re-set has automatically been executed (watchdog).

Causes could be

- Short term voltage drop,
- voltage peak, or
- short circuit.

**Error 119****User abort**

The Autostart program has been aborted by the user. Or the [CANCEL] key was pressed during switching on and a Master Reset triggered.

**Error 121****No more SDO channels**

If a SDOREAD or SDOWRITE is used with a negative index, then the command returns immediately and stores the running SDO in a channel. It is freed when the result is read. There is a maximum of 5 channels.

**Error 125****Limit switch activated**

A motion command has caused an axis limit switch to be activated.

Through activation of an end limit switch, the controller (depending on *33-40 Behaviour at End Limit Switch*) is automatically switched off and the frequency converter must be manually moved out of this position, before the error message can be cleared.

The behavior in case of hard and software limit switches has been improved starting with MCO 5.00: It is possible to clear a Software-Limit error and then drive in the opposite direction. If you try again to move in the wrong direction, then a new error is generated.

Handling of hardware limit switches is now the same as software limit switches. That means that you can clear the error and drive in the opposite direction. But if you try to move in the wrong direction, then the error 198 occurs.

Limit switches and reference switches allow the usage of any input. That means not only 1..8 are supported but also larger numbers as well as virtual inputs or outputs.

**NOTE**

**Using virtual inputs as limit switches is dangerous because it eliminates the direct connection between the limit switch and the controller. That may introduce a time delay (or other failure scenarios) which will limit the controller's ability to respond quickly to the switch.**

**Error 149****Too many interrupt functions**

More interrupt functions than the maximum possible number were used. Permitted are:

32 ON INT  
 32 ON STATBIT  
 32 ON COMBIT  
 10 ON PARAM  
 20 ON posint GOSUB: ON APOS, ON IPOS, ON MAPOS, ON MCPOS, ON MIPOS

**Error 150****No external 24V**

External supply is missing.

**Error 151****Too many nested GOSUB commands**

In the program exists too many calls from one subroutine to another subroutine.

The error usually occurs when there is a recurrent reference to one of the sub-programs in a subprogram.

Avoid too many (10 is maximum) opposing subroutine calls, and avoid subroutines which call themselves (re-cursive subroutine procedures).

**Error 152****Too many RETURN commands**

There are either more RETURN than corresponding GOSUB commands in the program, or there is a direct jump from a subroutine with a GOTO command.

Only one RETURN is allowed per sub-program. It is always better to jump to the beginning of a sub-program and then to jump with IF... to a previously defined label.

**Error 154****D. out overload**

Digital output overloaded.

**Error 155****LINK failed**

LINKGPAR command failed.

**Error 156****Illegal double argument**

Mathematical error: Illegal arguments for one of the "double" function, that means, a floating point function was called with an invalid argument. For example sqrt got a negative number or asin or acos were called with an argument bigger than 1. Double functions are available starting with MCO 5.00.

**Error 160****Internal interrupt error**

Interrupt happened, but interrupt address is no longer valid. (Internal error which should not ever happen.)

**Error 162****Memory error**

Error in verifying: After saving something in the EPROM (a program or parameters) an error was detected during verification.

Delete the EPROM with a 3-finger reset and try to save the program or parameters again.

In Stand-alone Mode you can use → Controller → Memory → Delete EPROM instead of the 3-finger reset.

If this is not successful please call the technical service department.

**Error 170****Too many DIM arrays**

The definition of an array in a DIM command does not correspond to an already existing array in the MCO 305. Cause might be that the fields are from older SYNCPOS/APOSS programs. The current program has other definitions. Either adapt the APOSS program to the correct array size or delete the old arrays, e.g. in Stand-alone Mode with Controller → Memory → Delete EPROM or use the command Controller → Reset → Arrays.

**NOTE**

**Remember to follow the recommendations concerning saving programs and parameters before deleting the EPROM.**

**Error 171****Array too small**

An attempt was made to describe an array element that is located outside of the defined array limits. Cause might be an error in the APOSS program. Array sizing does not agree with the space required (e.g. due to an incorrectly programmed loop).

Or the array is too small for the number of test drives triggered by TESTSTART.

Check loop variables.

**Error 175****Out of array memory**

There is no more memory space for the new array defined by a DIM command.

**Error 176****Array size wrong**

The size in a DIM command does not correspond to the size of the existing array. Either delete existing arrays or correct the DIM command.

**Error 179****Waitndx timeout**

Timeout while waiting for index: The command WAITNDX was executed and the timeout listed was exceeded.

The timeout is probably too short or the index impulse could not found (see also Error 109).

**Error 183****Invalid argument**

This command error signals that an TESTSTOP command contained an invalid argument.

Or a compiler error in other commands like invalid parameter value, format, or range. (Internal error, which should not occurred.)

**Error 184****Too many ONTIME**

Too many interrupts (ON TIME or ON PERIOD commands) were used within the program.

A maximum of 12 of these ON TIME and/or ON PERIOD commands are allowed within one program.

**Error 187****Out of memory**

Not enough memory for variables: When the APOSS program is started the space for the necessary variables is reserved dynamically. This space is now no longer available.

You may have selected a maximum number of variables which is too high. Reduce the maximum number in Settings → Compiler (Standard = 92).

Or the memory available is occupied with programs or arrays. Delete the programs with Controller → Programs → Delete all

or delete both the programs and arrays, i.e. by deleting the entire memory with Controller → Memory → Delete EPROM..

Remember to follow the recommendations concerning saving programs and parameters before deleting the EEPROM.

**Error 188****CAN guarding error**

A guarding error happened. This happens either when requesting guarding messages from slaves or if guarding is done by a master. In both cases it is caused by a time out. In the additional error information it could be seen if it was an error caused by a master guarding (-34).

The additional error information (see Error History) is used as it is shown in error 102.

**Error 189****CAN send or receive error.**

This error is a send or receive error caused by a SDOREAD or SDOWRITE, by a CANIN or CANOUT or by an IN or OUT command using CAN I/O.

The optional error information either contains the CAN ID which produced the error (IN, OUT, SDO, ...) or the object number (handle) which was used (CANIN, CANOUT).

**Error 190****Memory locked**

The program memory is write-protected and cannot be altered.

This means that auto recognition can neither be set nor deleted and programs can neither be saved nor deleted. Equally, → RAM save and → Delete EPROM will not be executed.



**Error 191****Illegal cam array**

An incorrect or old array is defined in the DIM instruction for SETCURVE.

An old array may exist if the zbc (or cnf) file with all parameters and arrays has not been loaded into the *CAM-Editor*.

An incorrect array could be caused by the following:

- It was not created by the curve editor.
- Previous version of a curve editor. Such an array must first be converted by the current *CAM-Editor* (→ *load* and *save*).
- Or the order of the arrays in the DIM instruction does not match the order in the zbc (or cnf) file. Refer to the number of the array in the title bar of the *CAM-Editor* in this respect.

**Error 192****Encoder error**

Error from encoder monitoring: open or short circuit in accordance with the displayed LED.

An error will be indicated even if no encoder is connected.

**Error 193****Stack overflow**

Internal error. Dynamic stack overflow caused by too many local variables or too many nested function calls.

Increase the stack size in Settings → Compiler.

**Error 194****Out of dynamic memory**

There is not enough dynamic memory for the requested data log (TESTSETP). Either TESTSTART demands too much dynamic memory or is called repeatedly.

**Error 195****Too many testindices**

The data logging command (TESTSETP) contained too many indices. There is an actual limit of 20.

**Error 196****Code too old**

The compiler which produced the program code was too old for this firmware. Please use a newer APOSS.

**Error 198****Limit sw. violation**

After reaching the limit switch and clearing the error there was the attempt to move again into wrong direction.

**Error 199****Internal MCO fault**

If such an error should occur, please contact your dealer and report the error number displayed to the technical service department.

## 7.2 APOSS Software Messages

The APOSS software messages are arranged in alphabetical order. Letters following a % sign represent variables which can be used in plain text at the corresponding locations.

Compilation error(s): program not saved!

A file is always compiled first and then saved. If you want to save the program, for example in the menu *Controller* → *Save program* and a syntax error is found during compilation this message will be displayed.

Start the → *Syntax Check* in the menu *Development*, correct the syntax error and then save the program.

Connection to ... already exists . . .

Connection to %d already exists [%s] - change to Window?

When opening a new window, or when trying to connect a window with a controller that is already linked to a window.

Yes:	The controller is disconnected from the old window and linked to the new window.
No:	The controller stays connected to the old window. The new window is not linked to a controller.

Connector pin is not valid

Connector %d pin %d is not valid in line %d column %d

An illegal combination or a pin number which cannot be set is used with the OUT command.

Controller is executing a program or command!

When the controller is executing a command or program it is not available for additional commands. You have to Break the new command and re-start it once the previous command has been completely.

Error in array part of file

When re-saving a configuration (e.g. *Controller* → *Parameters* → *Restore from file*) the computer recognizes that the data in the array area is formatted incorrectly.

In order to be able to save a file, the following conditions must be fulfilled:

- Identical software versions,
- same configuration (e.g. same number of axes),
- in the case that arrays have already been inputted, these must match the ones that are to be saved in terms of type and size.

#### Error in axis parameter part of file

When re-saving a configuration (e.g. *Controller* → *Parameters* → *Restore from file*) the computer recognizes that the data in the area of the axis parameters is formatted incorrectly. The parameter number and the sequence must be correct and numbering must be continuous.

In order to be able to save a file, the following conditions must be fulfilled:

- Identical software versions, that provides same number and order of the parameters,
- same configuration (e.g. same number of axes).

#### Error in global parameter part of file

When re-saving a configuration (e.g. *Controller* → *Parameters* → *Restore from file*) the computer recognizes that the data in the area of the global parameters is formatted incorrectly.

In order to be able to save a file, the following conditions must be fulfilled:

- Identical software versions, that provides same number and order of the parameters,
- same configuration (e.g. same number of axes).

#### Lost connection to ...

If the VLT AutomationDrive is turned off or the plug is pulled, etc. the window is disconnected from the VLT AutomationDrive and the lost connection is registered.

#### Timeout: no reply from FC

The VLT AutomationDrive does not answer; check the connection.

## 8 Appendix

### 8.1 Parameter Lists

The parameters are determined by parameter numbers. We recommend using the alphabetical overview as a guide; then you will be able to find detailed information very quickly using the number or the link.

#### Changes during operation

“TRUE” means that the parameter can be changed, while the frequency converter is in operation.

“FALSE” means that the frequency converter must be stopped before a change can be made.

#### 4-Set-up

“1-Set-up”: Data value will be the same in all set-ups.

#### Conversion index

This number refers to a conversion figure used when writing or reading by means of a frequency converter.

Please see for all conversion indices the *VLT AutomationDrive Design Guide, MG.33.BX.YY*.

Conversion index	0
Conversion factor	1

#### Data type

Please see for all data types the *VLT AutomationDrive Design Guide, MG.33.BX.YY*.

Data type	Description	Type
2	Integer 8	Int8
3	Integer 16	Int16
4	Integer 32	Int32
5	Unsigned 8	UInt8
6	Unsigned 16	UInt16
7	Unsigned 32	UInt32



#### 8.1.1 Application Parameters, Parameter Group 19-\*\*

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
<b>19-0* Application Parameters</b>							
19-00		Application parameters	0	'TRUE'			
...				TRUE			
19-89		Application parameters	0	TRUE			
<b>19-9* Read-only Application Parameters</b>							
19-90		Application parameter 90	0	read only	1 set-up	0	Int32
19-91		Application parameter 91	0	read only	1 set-up	0	Int32
19-92		Application parameter 92	0	read only	1 set-up	0	Int32
19-93		Application parameter 93	0	read only	1 set-up	0	Int32
19-94		Application parameter 94	0	read only	1 set-up	0	Int32
19-95		Application parameter 95	0	read only	1 set-up	0	Int32
19-96		Application parameter 96	0	read only	1 set-up	0	Int32
19-97		Application parameter 97	0	read only	1 set-up	0	Int32
19-98		Application parameter 98	0	read only	1 set-up	0	Int32
19-99		Application parameter 99	0	read only	1 set-up	0	Int32

8.1.2 MCO Basics Settings, Parameter Group 32\_\*\*

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
<b>32-0* Encoder 2 - Slave</b>							
32-00	ENCODERTYPE	Incremental Signal Type	[1] RS422	'TRUE'	1 set-up		Uint8
32-01	ENCODER	Incremental Resolution	1024 PPR	TRUE	1 set-up		Uint32
32-02	ENCODER ABSTYPE	Absolute Protocol	[0] None	TRUE	1 set-up		Uint8
32-03	ENCODER ABSRES	Absolute Resolution	8192 PPR	TRUE	1 set-up		Uint32
32-04	ENCODERBAUD	Absolute Encoder Baudrate X55	[4] 9600	TRUE	1 set-up		
32-05	ENCODERDATLEN	Absolute Encoder Data Length	25 Bit	TRUE	1 set-up		Uint8
32-06	ENCODERFREQ	Absolute Encoder Clock Frequency	262.000 kHz	TRUE	1 set-up		Uint32
32-07	ENCODER CLOCK	Absolute Encoder Clock Generation	[1] On	TRUE	1 set-up		Uint8
32-08	ENCODER DELAY	Absolute Encoder Cable Length	0	TRUE	1 set-up		Uint16
32-09	ENCODER MONITORING	Encoder Monitoring	[0] Off	TRUE	1 set-up		Uint8
32-10	POSDRCT	Rotational Direction	[1] No action	TRUE	1 set-up		Uint8
32-11	POSFAC_T_N	User Unit Denominator	1	TRUE	1 set-up		Uint32
32-12	POSFAC_T_Z	User Unit Numerator	1	TRUE	1 set-up		Uint32
32-13	ENCCONTROL	Enc.2 Control	0	TRUE	2 set-ups		Uint8
32-14		Enc.2 node ID	127	TRUE	2 set-ups		Uint8
32-15		Enc.2 CAN guard	[0] Off	TRUE	2 set-ups		Uint8
<b>32-3* Encoder 1 - Master</b>							
32-30	MENCODER TYPE	Incremental Signal Type	[1] RS422	TRUE	1 set-up		Uint8
32-31	MENCODER	Incremental Resolution	1024 PPR	TRUE	1 set-up		Uint32
32-32	MENCODER ABSTYPE	Absolute Protocol	[0] None	TRUE	1 set-up		Uint8
32-33	MENCODER ABSRES	Absolute Resolution	8192 PPR	TRUE	1 set-up		Uint32
32-34	MENCODERBAUD	Absolute Encoder Baudrate X56	[4] 9600	TRUE	1 set-up		
32-35	MENCODER DATLEN	Absolute Encoder Data Length	25 Bit	TRUE	1 set-up		Uint8
32-36	MENCODER FREQ	Absolute Encoder Clock Frequency	262.000 kHz	TRUE	1 set-up		Uint32
32-37	MENCODER CLOCK	Absolute Encoder Clock Generation	[1] On	TRUE	1 set-up		Uint8
32-38	MENCODER DELAY	Absolute Encoder Cable Length	0	TRUE	1 set-up		Uint16
32-39	MENCODER MONITORING	Encoder Monitoring	[0] Off	TRUE	1 set-up		Uint8

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
32-40	MENCODER TERM	Encoder Termination	[1] On	TRUE	1 set-up		Uint8
32-43	MENCCONTROL	Enc.1 Control	0	TRUE	2 set-ups		Uint8
32-44		Enc.1 node ID	127	TRUE	2 set-ups		Uint8
32-45		Enc.1 CAN guard	[0] Off	TRUE	2 set-ups		Uint8
<b>32-5* Feedback Source</b>							
32-50		Source Slave	[2] Enc2	TRUE	1 set-up		
32-52		Source Master	[1] Enc1	TRUE	1 set-up		
<b>32-6* PID-Controller</b>							
32-60	KPROP	Proportional Factor	30	TRUE	1 set-up	0	Uint32
32-61	KDER	Derivative Value for PID Control	0	TRUE	1 set-up	0	Uint32
32-62	KINT	Integral Factor	0	TRUE	1 set-up	0	Uint32
32-63	KILIM	Limit Value for Integral Sum	1000	TRUE	1 set-up	0	Uint16
32-64	BANDWIDTH	PID Bandwidth	1000	TRUE	1 set-up	0	Uint16
32-65	FFVEL	Velocity Feed-forward	0	TRUE	1 set-up	0	Uint32
32-66	FFACC	Acceleration Feed-forward	0%	TRUE	1 set-up	0	Uint32
32-67	POSERR	Maximum Tolerated Position Error	20000 qc	TRUE	1 set-up		Uint32
32-68	REVERS	Reverse Behavior for Slave	[0] Reversing	TRUE	1 set-up		Uint8
32-69	TIMER	Sampling Time for PID control	1 ms	TRUE	1 set-up		Uint16
32-70	PROFTIME	Scan Time for Profile Generator	[1] 1 ms	TRUE	1 set-up		Uint8
32-71	REGWINMAX	Size of the Control Window (Activation)	0 qc	TRUE	1 set-up		Uint32
32-72	REGWINMIN	Size of the Control Window (Deactivation)	0 qc	TRUE	1 set-up		Uint32
32-73	KILIMTIME	Integral limit filter time	0 ms	TRUE	2 set-ups		int16
32-74	POSERRTIME	Position error filter time	0 ms	TRUE	2 set-ups		int16
<b>32-8* Velocity &amp; Acceleration</b>							
32-80	VELMAX	Maximum Velocity (Encoder)	1500 RPM	TRUE	1 set-up		Uint32
32-81	RAMPMIN	Shortest Ramp	1 s	TRUE	1 set-up		Uint32
32-82	RAMPSTYPE	Ramp Type	0	TRUE	1 set-up		Uint8
32-83	VELRES	Velocity Resolution	100	TRUE	1 set-up		Uint16
32-84	DFTVEL	Default Velocity	50	TRUE	1 set-up		Uint16
32-85	DFTACC	Default Acceleration	50	TRUE	1 set-up		Uint16
32-86	JERKMIN	Acc. up for limited jerk	100 ms	TRUE	2 set-ups		Uint32
32-87	JERKMIN2	Acc. down for limited jerk	0 ms	TRUE	2 set-ups		Uint32

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
32-88	JERKMIN3	Dec. up for limited jerk	0 ms	TRUE	2 set-ups		UInt32
32-89	JERKMIN4	Dec. down for limited jerk	0 ms	TRUE	2 set-ups		UInt32

### 8.1.3 MCO Advanced Settings, Parameter Group 33-\*\*

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
<b>33-0* Home Motion</b>							
33-00	HOME_FORCE	Force HOME	[0] not forced	'TRUE'	1 set-up		UInt8
33-01	HOME_OFFSET	Zero Point Offset from Home Position	0 qc	TRUE	1 set-up		Int32
33-02	HOME_RAMP	Ramp for Home Motion	10	TRUE	1 set-up		UInt16
33-03	HOME_VEL	Velocity of Home Motion	10	TRUE	1 set-up		Int16
33-04	HOME_TYPE	Behavior during Home Motion	[0] Reverse + Index	TRUE	1 set-up		UInt8
<b>33-1* Synchronization</b>							
33-10	SYNCFACM	Synchronization Factor Master (M:S)	1	TRUE	1 set-up		Int32
33-11	SYNCFACS	Synchronization Factor Slave (M:S)	1	TRUE	1 set-up		Int32
33-12	SYNCPOSOFS	Position Offset for Synchronization	0 qc	TRUE	1 set-up		Int32
33-13	SYNC ACCURACY	Accuracy Window for Position Synchronization	1000 qc	TRUE	1 set-up		Int32
33-14	SYNCVELREL	Relative Slave Velocity Limit	0%	TRUE	1 set-up		UInt8
33-15	SYNCMARKM	Marker Number for Master	1	TRUE	1 set-up		UInt16
33-16	SYNCMARKS	Marker Number for Slave	1	TRUE	1 set-up		UInt16
33-17	SYNCPULSM	Master Marker Distance	4096	TRUE	1 set-up		UInt32
33-18	SYNCPULSS	Slave Marker Distance	4096	TRUE	1 set-up		UInt32
33-19	SYNCMTYPM	Master Marker Type	[0] Enc. Z pos.	TRUE	1 set-up		UInt8
33-20	SYNCMTYPS	Slave Marker Type	[0] Enc. Z pos.	TRUE	1 set-up		UInt8
33-21	SYNCMWINM	Master Marker Tolerance Window	0	TRUE	1 set-up		UInt32
33-22	SYNCMWINS	Slave Marker Tolerance Window	0	TRUE	1 set-up		UInt32
33-23	SYNCMSTART	Start Behavior for Synchronization	[0] Start Funct. 1	TRUE	1 set-up		UInt16
33-24	SYNCFALT	Marker Number for Fault	10	TRUE	1 set-up		UInt16
33-25	SYNCREADY	Marker Number for Ready	1	TRUE	1 set-up		UInt16

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
33-26	SYNCFVTIME	Velocity Filter	0 ms	TRUE	1 set-up	0	Int32
33-27	SYNCOFFTIME	Offset Filter Time	0 ms	TRUE	1 set-up		UInt32
33-28	SYNCFMFPAR	Marker Filter Configuration	[0] Marker Filter 1	TRUE	1 set-up		UInt8
33-29	SYNCFMFTIME	Filter Time for Marker Correction	0 ms	TRUE	1 set-up		Int32
33-30	SYNCFMFXCORR	Maximum Marker Correction	[0] Off	TRUE	1 set-up		UInt32
33-31	SYNCFMFTYPE	Synchronization Type	[0] Standard	TRUE	1 set-up		UInt8
33-32	SYNCFMFFVEL	Feed Forward Speed Adaptation	0	TRUE			
33-33	SYNCFMFLIMIT	Velocity Filter Window	0 qc	TRUE			
33-34	SYNCFMFSFTIME	Slave Marker Filter time	0	TRUE			
<b>33-4* Limit Handling</b>							
33-40	ENDSWMOD	Behavior at End Limit Switch	[0] Call error handler	TRUE	1 set-up		UInt8
33-41	NEGLIMIT	Negative Software End Limit	-500000 qc	TRUE	1 set-up		Int32
33-42	POSLIMIT	Positive Software End Limit	500000 qc	TRUE	1 set-up		Int32
33-43	SWNEGLIMACT	Negative Software End Limit Active	[0] Inactive	TRUE	1 set-up		UInt8
33-44	SWPOSLIMACT	Positive Software End Limit Active	[0] Inactive	TRUE	1 set-up		UInt8
33-45	TESTTIM	Time in Target Window	0 ms	TRUE	1 set-up		UInt8
33-46	TESTVAL	Target Window Limit Value	1 qc	TRUE	1 set-up		UInt16
33-47	TESTWIN	Size of Target Window	0 qc	TRUE	1 set-up		UInt16
<b>33-5* I/O Configuration</b>							
33-50	I_FUNCTION_1	Terminal X57/1 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-51	I_FUNCTION_2	Terminal X57/2 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-52	I_FUNCTION_3	Terminal X57/3 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-53	I_FUNCTION_4	Terminal X57/4 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-54	I_FUNCTION_5	Terminal X57/5 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-55	I_FUNCTION_6	Terminal X57/6 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-56	I_FUNCTION_7	Terminal X57/7 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-57	I_FUNCTION_8	Terminal X57/8 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-58	I_FUNCTION_9	Terminal X57/9 Digital Input	[0] no function	TRUE	1 set-up		UInt8

Par. No. #	Parameter name	Parameter description	Default setting	Changes during operation	4-set-up	Conversion index	Type
33-59	I_FUNCTION_10	Terminal X57/10 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-60	IOMODE	Terminal X59/1 and X59/2 Mode	[0] Output	'FALSE'	1 set-up		UInt8
33-61	I_FUNCTION_11	Terminal X57/11 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-62	I_FUNCTION_12	Terminal X57/12 Digital Input	[0] no function	TRUE	1 set-up		UInt8
33-63	O_FUNCTION_1	Terminal X59/1 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-64	O_FUNCTION_2	Terminal X59/2 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-65	O_FUNCTION_3	Terminal X59/3 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-66	O_FUNCTION_4	Terminal X59/4 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-67	O_FUNCTION_5	Terminal X59/5 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-68	O_FUNCTION_6	Terminal X59/6 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-69	O_FUNCTION_7	Terminal X59/7 Digital Output	[0] no function	TRUE	1 set-up		UInt8
33-70	O_FUNCTION_8	Terminal X59/8 Digital Output	[0] no function	TRUE	1 set-up		UInt8
<b>33-8* Global Parameters</b>							
33-80	PRGPAR	Activated Program Number	-1	TRUE	1 set-up	0	UInt8
33-81	Power-up State	Power-up State	[1] Motor on	TRUE	1 set-up		UInt8
33-82	STATUS MONITORING	Drive Status Monitoring	[1] On	TRUE	1 set-up	0	UInt8
33-83	ERRCOND	Behavior after Error	[0] Coast	TRUE	1 set-up		UInt8
33-84	ESCCOND	Behavior after Escape	[0] Contr. Stop	TRUE	1 set-up		UInt8
33-85	EXTERNAL24V	MCO Supplied by External 24VDC	[0] No	TRUE	1 set-up		UInt8
<b>33-9* MCO Port Settings</b>							
33-90		X62 MCO CAN node ID	127 N/A	TRUE	2 set-ups		UInt8
33-91		X62 MCO CAN baud rate	[20] 125 Kbps	TRUE	2 set-ups		UInt8
33-94		X62 MCO RS485 serial termination	[0] Off	TRUE	2 set-ups		UInt8
33-95		X62 MCO RS485 serial baud rate	[2] 9600 Baud	TRUE	2 set-ups		UInt8



8.1.4 MCO Data Readouts, Parameter Group 34-\*\*

Par. No. #	Parameter Name	Parameter description	Default setting	Changes during operation	4-Setup	Conversion Index	Type
<b>34-0* PCD Write Parameters</b>							
34-01		PCD 1 Write to MCO			1 set-up		Uint16
34-02		PCD 2 Write to MCO			1 set-up		Uint16
34-03		PCD 3 Write to MCO			1 set-up		Uint16
34-04		PCD 4 Write to MCO			1 set-up		Uint16
34-05		PCD 5 Write to MCO			1 set-up		Uint16
34-06		PCD 6 Write to MCO			1 set-up		Uint16
34-07		PCD 7 Write to MCO			1 set-up		Uint16
34-08		PCD 8 Write to MCO			1 set-up		Uint16
34-09		PCD 9 Write to MCO			1 set-up		Uint16
34-10		PCD 10 Write to MCO			1 set-up		Uint16
<b>34-2* PCD Read Parameters</b>							
34-21		PCD 1 Read from MCO			1 set-up		Uint16
34-22		PCD 2 Read from MCO			1 set-up		Uint16
34-23		PCD 3 Read from MCO			1 set-up		Uint16
34-24		PCD 4 Read from MCO			1 set-up		Uint16
34-26		PCD 6 Read from MCO			1 set-up		Uint16
34-27		PCD 7 Read from MCO			1 set-up		Uint16
34-28		PCD 8 Read from MCO			1 set-up		Uint16
34-29		PCD 9 Read from MCO			1 set-up		Uint16
34-30		PCD 10 Read from MCO			1 set-up		Uint16
<b>34-4* Inputs &amp; Outputs</b>							
34-40		Digital Inputs			1 set-up		Uint16
34-41		Digital Outputs			1 set-up		Uint16
<b>34-5* Process Data Unit</b>							
34-50		Actual Position	UU		1 set-up		Int32
34-51		Commanded Position	UU		1 set-up		Int32
34-52		Actual Master Position	qc		1 set-up		Int32
34-53		Slave Index Position	UU		1 set-up		Int32
34-54		Master Index Position	qc		1 set-up		Int32
34-55		Curve Position			1 set-up		Int32
34-56		Track Error	UU		1 set-up		Int32
34-57		Synchronizing Error	UU		1 set-up		Int32
34-58		Actual Velocity	UU/s		1 set-up		Int32
34-59		Actual Master Velocity	qc/s		1 set-up		Int32
34-60		Synchronizing Status			1 set-up		Int32
34-61		Axis Status			1 set-up		Int32
34-62		Program Status			1 set-up		Int32
<b>34-7* Diagnosis Readouts</b>							
34-70		MCO Alarm Word 1		'FALSE'	1 set-up		Uint32
34-71		MCO Alarm Word 2		FALSE	1 set-up		Uint32

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