LinMot®

E110-VF / E210-VF / E1010-VF / E2010-VF

User Manual 2.2

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Document version 8/ as, July 2005

1. Description and Features

1.1 Description

The *LinMot®* E110-VF, E210-VF, E1010-VF and E2010-VF servo amplifiers allow linear motors of the *LinMot®*-P series to be integrated very easily in existing motion controller multi-axis systems. In addition single phase actuators like DC-Motors can be controlled with this amplifier.

- The integration of two independent drives into a single housing saves place and minimizes wiring.
- Each amplifier channel accepts a bipolar DC control input. The amplitude of this signal may be used to control either the velocity or the current (force) of the connected *LinMot®* linear motor.
- Basing on the integrated sensors of a *LinMot®* linear motor, the actual position is available as incremental position signal (A/B).
- Each amplifier has several protection circuits to protect the amplifier, motor and operator from almost any kind of fault. Flashing LED show the type of fault occurred, and separate outputs can be used to send signals to other equipment. In addition the error or warn message can be read in plain-text by using the *LinMot®* Commander software.

1.2 Features

- Ergonomic design: Easy configuration with Windows® based software tools. Easy access to connections.
- Differential Inputs: Two independent low noise differential inputs accepting ±10VDC.
- Dual mode operation: The amplifier may be configured for current (force) or velocity control.
- Current Limit: Maximum motor current is adjustable. Two different levels can be selected with a digital input.
- Fault and Warn output: Two digital outputs per motor channel monitor the status of the amplifier. Polarity of these signals can be configured.
- Short circuit protection: Phase outputs are short circuit protected.
- LED diagnostics: Green LED indicates normal operation condition, yellow LED indicates warnings and red LED indicate fault conditions. The yellow LED flashes in fault condition to display the actual fault.
- Over/under voltage: These circuits monitor amplifier power-supply voltages constantly. They will shut down the amplifier in the event of any out-of-specification condition.
- Over temperature: The motor and the amplifier-heatsink temperature is monitored constantly. The amplifier will be shut down in case of over temperature.

2. Theory of Operation

2.1 Servo Loops

Most position control systems are arrangements of three control loops as shown in Figure 2-1:

1 The current loop directly influences motor acceleration and deceleration (force). The current loop is present in each amplifier.

2 The velocity loop supplies a velocity signal which becomes the demand signal for motor acceleration. Some amplifiers give the user the possibility to close the velocity loop inside the amplifier.

3 The position control loop is the over-riding motion loop. The position loop is generally closed by a third party motion controller and can not be closed inside the *LinMot®* VF-Amplifier. If the position loop must also be closed by *LinMot®* then *LinMot®* standard controllers (AT, MT, DP or DN family) must be used instead of VF-Amplifiers.

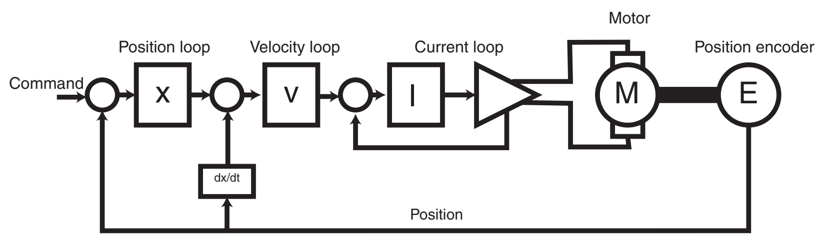


Figure 2-1: Arrangement of the three essential loops for position control.

2.2 Amplifier Types

Different types of amplifiers are known. In motion control systems v*elocity-mode* and *force-mode* amplifiers are most used. *LinMot®* VF-Amplifiers can be configured to operate in both of these modes.

Velocity Loop Operation

In this operation mode the two inner loops, the current loop and the velocity loop, are closed in the amplifier. The input signal of the amplifier is the demand velocity of the connected motor.

Because the velocity loop tuning is load dependent, the velocity-loop of an amplifier must be tuned before the position loop is closed with an external position controller. Chapter 6 describes how to tune the velocity-loop of a *LinMot®* amplifier.

Current Loop Operation

In this operation mode only the current loop is closed in the amplifier. The input signal of the amplifier represents the demand force of the connected motor. The current loop on most amplifiers, also the *LinMot®* amplifiers, is already tuned at factory and doesn't need to be tuned by the user.

2.3 Master/Booster Operation

Master/Booster operation enables the force available for a movement to be increased by putting motors in series or parallel. One motor must be defined as master, the other as booster. The moving part of the motors must be coupled mechanically.

During operation all parameters for the booster motor are copied from the master motor. The current is calculated for the master motor only and set for both motors.

A booster motor may work in the same or in the opposite direction as the master. This behavior can be chosen by selecting the type of actor.

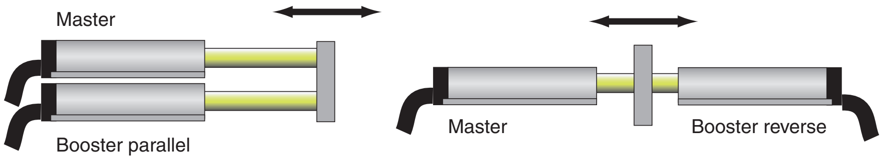


Figure 2-2: Master/Booster operating mode

2.4 Safety

LinMot® amplifiers will energize the motors only if no error is pending and the Enable Input is activated.

To ensure that the motors do not “jump” when the Enable Input gets activated the analog input signal (demand force or demand velocity) must be about 0V at this moment. For safety reasons the controller can deny a transition to RUN state if this signal is not in the range -1V..1V. This safety feature is disengageable.

For a safe operation of linear motion-systems, motions in the end range of the allowed stroke must be monitored specially. This is normally done with limit-switches at both ends of the stroke. If the drive is moved into one of this switches the drive must be stopped immediately. The limit switch signals must be fed into the superior motion controller.

2.5 Position Measurement

The accuracy of motion systems depends mainly on the implemented position measurement system.

LinMot® linear motors have integrated position sensors basing on the measurement of the magnetic field of the slider. This method allows a position repeatability better than 0.1mm. The *LinMot®* Ex10-VF and Ex010-VF amplifier family outputs this information as quadrature (A/B) signal.

The resolution of this simulated encoder outputs can be configured to 1µm, 2µm, 5µm, 10µm, 20µm or 50µm (4x sampling). Choosing a higher resolution does not increase the accuracy because the encoder simulation always works basing on the internal sensor system with the given repeatability.

The incremental position outputs can provide frequencies up to 3MHz. This limits the max. velocity depending on the chosen resolution (3m/s @ 1µm). If the encoder rate is too high a warning is issued. Position increments could be lost if the allowed rate is exceeded.

Position accuracy can be increased by using an external position sensor (incremental linear encoder) connected directly to the superior position controller. With high-end encoders, a position repeatability better than 1µm can be realized.

If the VF-Amplifier is equipped with an *ME01* Extension Module then the signal from an external position sensor can be used for position control (superior motion controller) and speed control (VF-Amplifier in velocity mode). See Appendix C.

The external sensor system *MS01* which is used for the *LinMot®* standard controllers (AT, MT, DP and DN) can not be used with the VF-Amplifier.

2.6 Referencing

Most linear positioning system, including the *LinMot®* system, are based on incremental position measurement. A special reference sequence is necessary to define a reference position.

This reference search must be accomplished by the superior position control system. *LinMot®* actuators can be referenced against a hard stop which will cause no harm to the motor.

2.7 Protection circuits

LinMot® amplifiers monitor all important operation parameters like supply and temperature constantly. Any anormality will lead to a warning or error.

A warning is issued and signaled with the Warn Output when any of the monitored parameters is in a critical range. The warning is cleared after the parameters are back in a save range. The warning signal can be used by the superior controller to move the motor to a save position before disabling.

An error will shut down the amplifier if one of the monitored parameters is in an out-of-specification range. The ERROR state of the drive can only be left if all parameters are back in normal operation range and the Enable Input is inactive.

3. Installation

3.1 Mechanical Dimensions of *LinMot®* Amplifiers

The *LinMot®* Ex10-VF amplifiers do have the same mechanical dimensions as all other *LinMot®* standard controllers (AT, MT, DP or DN controllers) from the 100series. The mechanical dimensions of the Ex010-VF amplifiers correspond with the standard 1000series controllers.

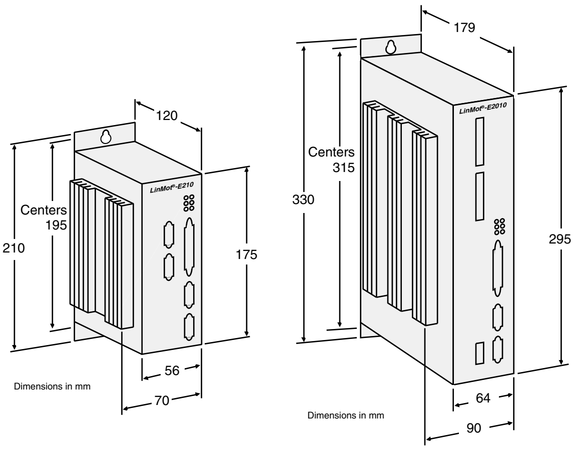


Figure 3-1: Mechanical dimensions of the *LinMot®* amplifiers

3.2 Mechanical Installation of *LinMot®* Amplifiers

LinMot® amplifiers can be mounted with two screws (scew diameter 5mm, max. head diameter 10mm) on a panel. The *LinMot®* amplifiers must be mounted vertical to ensure good cooling.

For space requirements please see the following drawings.

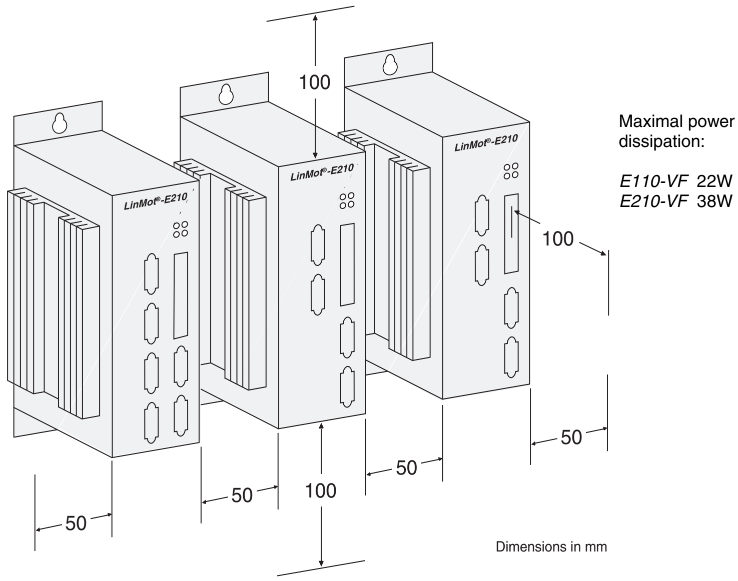


Figure 3-2: Installation of Ex10-VF amplifier

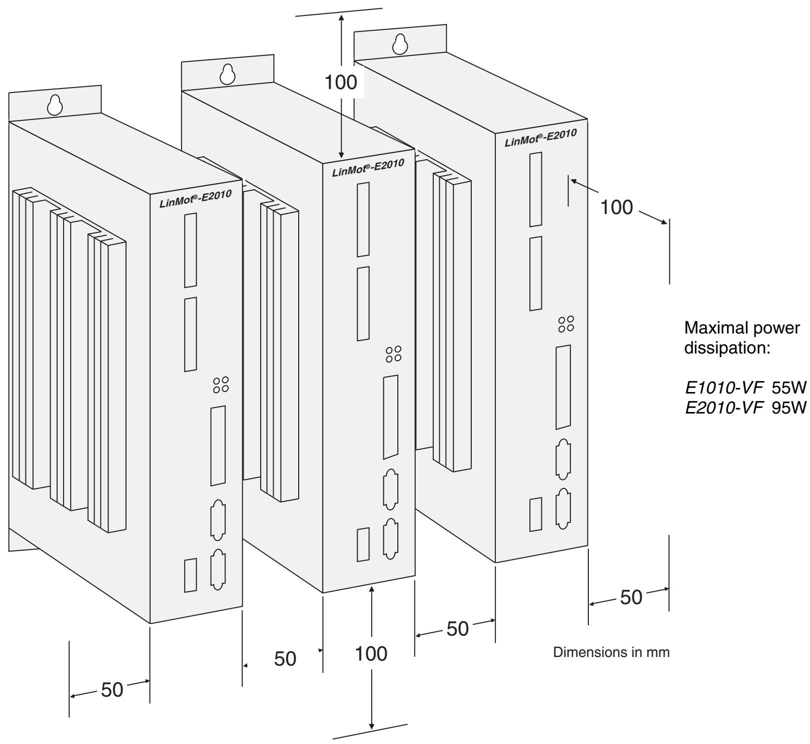
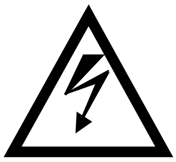


Figure 3-3: Installation of Ex010-VF amplifier

3.3 Electrical Connection

This chapter provides the information to make all the necessary electrical connections to the amplifier.

Grounding



IMPORTANT: The housing of the *LinMot®* amplifiers must be earth grounded. The ground of the power supplies must also be connected to earth at the same single point. In order to prevent any harm to the system the motion controller has to be grounded to the same level. Both, the *LinMot®* amplifier and the motion controller, must be connected to ground first before any other connections between them are installed.

I/O Connector

All I/O signals are available on the 25pin Sub-D style connector.

Connector: Sub-D25 female.

Pin	Function	Pin	Function
1	Drive A: Analog In+	14	Drive B: Analog In+
2	Drive A: Analog In-	15	Drive B: Analog In-
3	Analog GND	16	Analog GND
4	Drive A: Enable In	17	Drive B: Enable In
5	Drive A: Current Limit In	18	Drive B: Current Limit In
6	Drive A: Fault Out	19	Drive B: Fault Out
7	Drive A: Warn Out	20	Drive B: Warn Out
8	+6V .. +24V DC I/O Supply	21	I/O GND
9	Drive A: Encoder Out A+	22	Drive B: Encoder Out A+
10	Drive A: Encoder Out A-	23	Drive B: Encoder Out A-
11	Drive A: Encoder Out B+	24	Drive B: Encoder Out B+
12	Drive A: Encoder Out B-	25	Drive B: Encoder Out B-
13	GND Position Outputs		

Table 3-1: Pin configuration of the Exx10-VF I/O connector

Analog Control Inputs

The analog control output of the motion controller and the input of the amplifier should be connected by a shielded cable to reduce noise pick-up. For a higher noise immunity the analog inputs are symmetrical. The control voltage is measured between the “Analog In+” and the “Analog In-” terminal. To avoid ground loops the analog grounds of the motion controller and the amplifier should not be connected together.

If the motion controller provides symmetrical outputs, noise pick-up is eliminated mostly. The output voltage of some motion controllers (i.e. Delta-Tau P-MAC) must be limited to ±10V DC between the positive and negative output.

The following figure shows the wiring of the analog control signals for drive A:

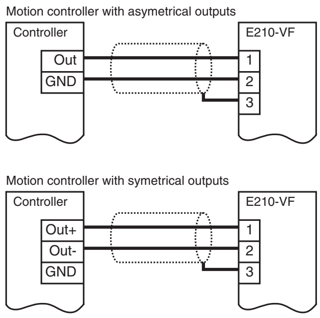


Figure 3-4: Analog control signal wiring

Technical data of analog inputs:

Resolution:	12Bit
Input voltage:	-10V DC .. +10V DC
abs. max. rating:	-20V DC .. +20V DC
Impedance:	38kΩ

Digital I/O Signals

All digital I/O signals are optically isolated and can be operated between 5V and 24V DC.

Digital outputs are built through overload protected high-side switches. The output drivers must be supplied externally. The logic high level of the digital outputs can be 2V less than the I/O supply voltage, depending on the load. The outputs are equipped with weak pull-down resistors internally. The required supply current depends on the load on the outputs.

Technical data of digital inputs:

Voltage:	0 .. 24V DC (abs. max. rating: -5 .. +28V DC) for logic low:<2V for logic high:>4V
Current:	<20mA

Technical data digital outputs:

I/O supply voltage:	6..28V DC
Output voltage:	0..28V DC (depends on external supply)
max. sourcing current:	0.5A
Pull-down resistors:	22kΩ
max. sinking current:	10mA @ 24V

The following figure shows a typical wiring of digital I/O signals for drive A:

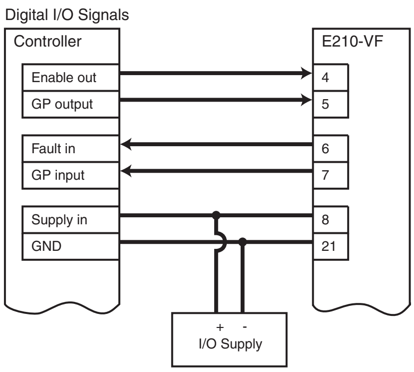


Figure 3-5: Digital I/O signal wiring

Simulated Position Encoder Outputs

The actual position of a *LinMot®* linear motor is available as an incremental quadrature signal on the Sub-D 25 connector. As electrical interface the RS422 / 5V standard is used.

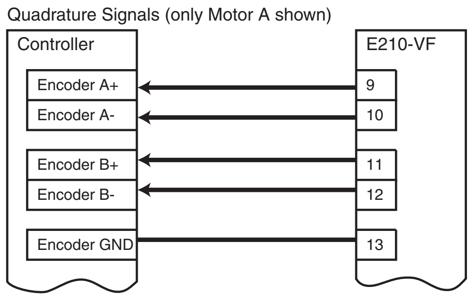


Figure 3-6: Wiring of position signals (Channel A shown)

If a single phase actuator (DC motor, voice coil) is connected to a motor channel then the respective simulated encoder outputs of the amplifier must not be used. In this case the actuators position sensor is directly connected to the superior motion control system.

Also if a *LinMot®* linear axis is equipped with a high accurate external position sensor, the simulated encoder outputs must not be used. The superior motion controller uses directly the external position sensor signals in this case.

Serial Communication Interface

The serial communication interface is used to configure the *LinMot®* Ex10-VF and Ex010-VF amplifiers. It can be directly connected to the RS232 port of any PC. Take care *not* to use a crossed (0-Modem) cable, but a cable connecting Pins 2,3 and 5 one to one.

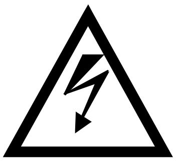
Connector: Sub-D 9, male

Pin	Function	Pin	Function
1	do not connect	6	do not connect
2	RS232_TX	7	do not connect
3	RS232_RX	8	do not connect / CAN_L
4	do not connect	9	do not connect / CAN_H
5	GND		

Table 3-2: Pin configuration on the Exx10-VF Com connector

Power Supply

Power supply inputs for signal electronics and motors are separated on both, the *LinMot®* Ex10-VF and Ex010-VF amplifiers. On machines whose actuators must be powered off in the event of an emergency shutdown for safety reasons, the motor supply can be switched off. By maintaining the signal supply, the position of the motor can still be captured.



CAUTION: Exceeding the given absolut maximal rating voltages will harm the VF-Amplifier and the connected motors as well.

Power supplies must be switched on and off on their **primary side only**.

Ex10-VF

Ex10-VF amplifiers are supplied via a single three-pole connector:
matching socket: Phoenix PSC 1.5/3-F

Pin	Function	Nominal Voltage	Abs. max. rating
1	+Vcc signal supply	+24V .. +48V DC	+55V
2	Ground	GND	-
3	+Vcc motor supply	+24 V.. +48V DC	+55V

Table 3-3: Pin configuration of the Ex10-VF PWR socket

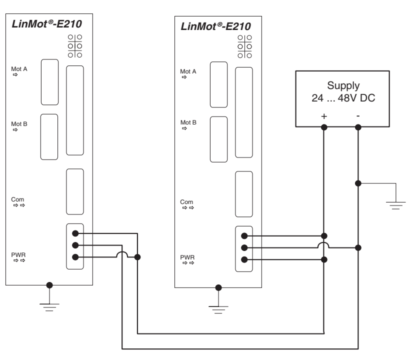


Figure 3-7: Supply wiring of Ex10-VF

Ex010-VF

The Ex010-VF amplifier is supplied via two separate connectors.

Signal electronics are supplied by a three-pole connector:
matching socket: Phoenix PSC 1.5/3-F

Pin	Function	Nominal voltage	Abs. max. rating
1	+Vcc signal supply	+24V..+48V DC	+55V
2	Ground	GND	GND
3	do not connect		

Table 3-4: Pin configuration on Ex010-VF PWR Signal socket

Motors are supplied via a two-pole connector:
matching socket: Phoenix MSTB 2,5/2-STF

Pin	Function	Nominal voltage	Abs. max. rating
top	Ground	GND	-
bottom	+Vcc motor supply	+48V..+72V DC	+80V

Table 3-5: Pin configuration on Ex010-VF PWR Motor socket

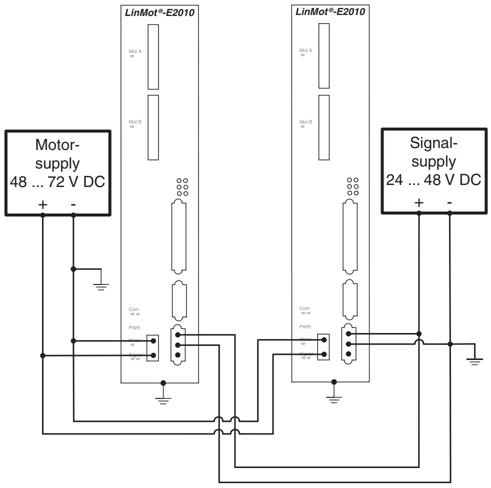
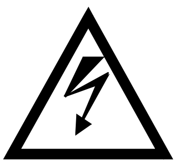


Figure 3-8: Supply wiring of Ex010-VF

Motor Connection

The actuator cables are plugged into the connectors found on the front panel of the amplifier marked as **MOT A** and **MOT B**. All necessary signals for one motor are integrated in a single connector.



CAUTION: Incorrect connection of the actuators may lead to destruction of the amplifier and the motors. Disconnecting/reconnecting motors while the amplifier is powered on (even in DISABLE state) can damage the motor and the amplifier.

For extension cables original *LinMot®* cables must be used only.

Neither the *LinMot®* motor cables nor the standard *LinMot®* extension cables *K01* are flex-cables. Wherever the active part of the motor (stator) is not fixed the special trailing chain cable *KS01* has to be used.

LinMot® Linear Motors

Ex10-VF

LinMot® linear motors are connected via 9-pin D-Sub sockets to an Ex10-VF amplifier.

Pin	Color	Signal	Pin	Color	Signal
1	red	phase 1+	6	pink	phase 1-
2	blue	phase 2+	7	grey	phase 2-
3	white	+5V	8	brown	ground (GND)
4	yellow	sine sensor	9	green	cosine sensor
5	black	temp. sensor			

Table 3-6: Pin configuration for the Ex10-VF motor socket

Ex010-VF

LinMot® linear motors are connected via 10-pin Mini-Combicom sockets to an Ex010-VF amplifier.

Pin	Color	Signal	Pin	Color	Signal
1	red	phase 1+	6	brown	ground (GND)
2	pink	phase 1-	7	yellow	sine sensor
3	blue	phase 2+	8	green	cosine sensor
4	grey	phase 2-	9	black	temp. sensor
5	white	+5V	10	-	shielding

Table 3-7: Pin configuration for the Ex010-VF motor socket

Single Phase Actuators

Single phase actuators like DC-Motors or Voice Coils must be connected to phase 1 of the corresponding motor output. Their position sensor signals must be connected to the superior motion controller.

On phase 2 of the motor output a bleeder resistor can be connected. Rotative DC-Motors tend to bring a lot of energy into the amplifiers DC link during deceleration. The back EMF can increase the DC link voltage over the maximum allowed limits (55V for Ex10-VF and 80V for Ex010-VF amplifiers) which leads to a transition to ERROR state. When the DC link voltage exceeds (in parameter tree definable) bleeding voltage the amplifier begins to bleed off power over this external brake resistor.

The optional bleeder must have resistance according to the following table. The brake resistor should be able to draw 100W out of the DC link.

Motor Power Supply	Ex10-VF	Ex010-VF
24V	**8Ω**	**-**
48V	**16Ω**	**8Ω**
72V	**-**	**12Ω**

Table 3-8: Recommended bleeder resistance values

For single phase actuators no other than the current output pins on the amplifiers motor socket must be used.

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Ex10-VF

Pin	Signal	Pin	Signal
1	motor phase +	6	motor phase -
2	optional bleeder phase+	7	optional bleeder phase -
3	do not connect	8	do not connect
4	do not connect	9	do not connect
5	do not connect		

Table 3-9: Pin configuration for single phase actuators on *LinMot®* *Ex10*-VF motor socket

Ex010-VF

Pin	Signal	Pin	Signal
1	motor phase +	6	do not connect
2	motor phase -	7	do not connect
3	optional bleeder phase +	8	do not connect
4	optional bleeder phase -	9	do not connect
5	do not connect	10	do not connect

Table 3-10: Pin configuration for single phase actuators on *LinMot®* *Ex010*-VF motor socket

Typical System Wirings

The following figures show the typical system wiring for drive A on a VF-Amplifier. Drive B is wired similarly.

The system consists of the following components:

- Motion controller
- *LinMot®* Ex10-VF amplifier
- *LinMot®* power supply
- Actuator: *LinMot®* linear motor with or without external position sensor.
- 6V .. 24V supply for I/O signals and motion controller

Wiring of an Ex010-VF amplifier would be the same except for the extra motor power supply (48V..72V).

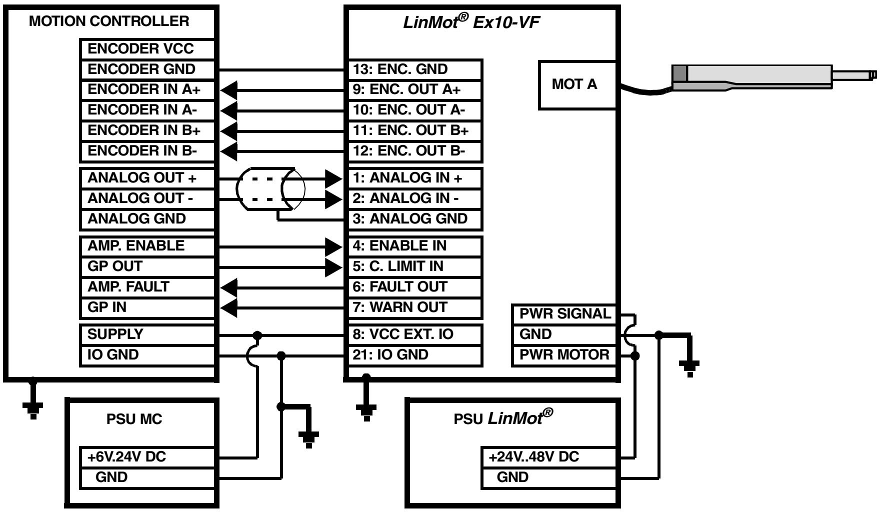


Figure 3-9: Typical system wiring using the internal position measuring system of *LinMot®* linear motors

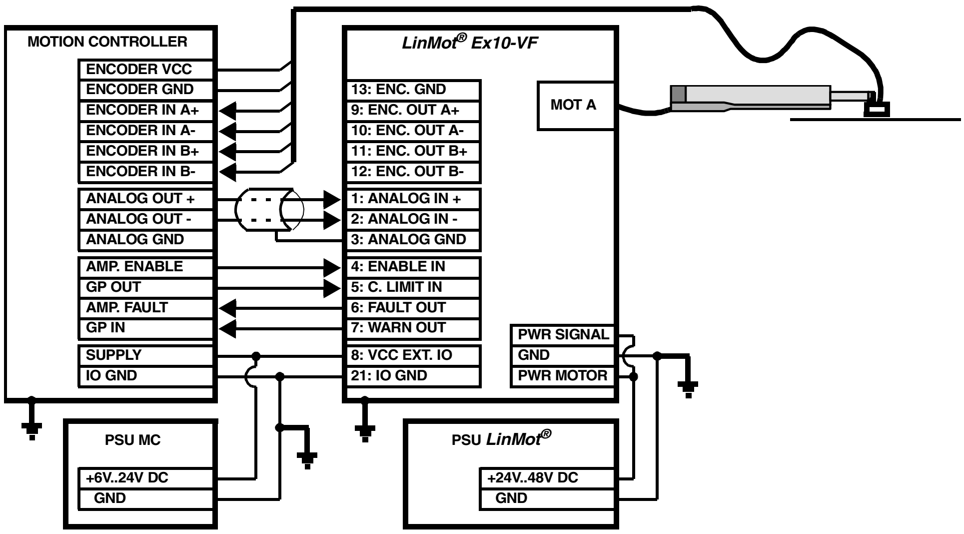


Figure 3-10: Typical system wiring using an external position sensor. With high-end encoders a position repeatability better than 1µm can be realized.

4. *LinMot®* Commander

The *LinMot®* Ex10-VF and Ex010-VF servo amplifiers are full digital controlled devices. They must be configured during the first commissioning. This is done with the Windows-based *LinMot®*-Commander.

Before starting make sure that the amplifier is powered and the serial interface is connected to the PC with a one to one serial cable (female connectors on both ends).

4.1 Installation of *LinMot®*-Commander

The new *LinMot®*-Commander software is a 32bit Windows® software. It runs on computers operating under Windows® 95, 98, NT4.0, 2000, ME and XP.

The actual software release (V 2.2.x) is available from the *LinMot®* home page www.linmot.com. After downloading the software you can start "setup.exe" and follow the instructions in order to install the whole software package on your computer.

The program can be started by clicking "Start" → "Programs" → "LinMot" → "LinMot® Commander 2.2.x".

4.2 Upgrading Amplifier Firmware

It is recommended to download the latest firmware version to the amplifier (V2.2.x). Downloading firmware will erase an eventually existing old configuration and will reset all parameter tree items to their default values.

Start *LinMot®*-Commander, but don't log in. Start the installation script by clicking the "Run Script" button

:

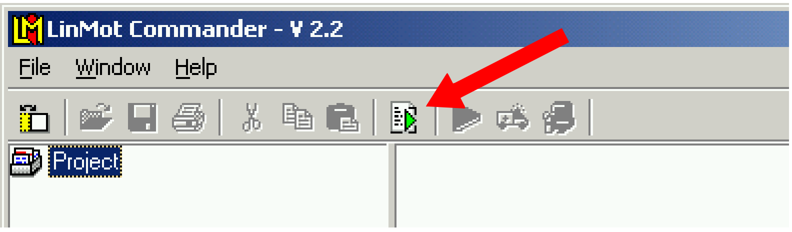


Figure 4-1: Starting the firmware download script

In the file dialog select the new firmware installation file "Lm2R2Rx.sct" from folder "Cmdr2r2r0\Firmware\Lm2R2Rx\". In the upcoming window the serial port which is used for updating the amplifier must be selected.

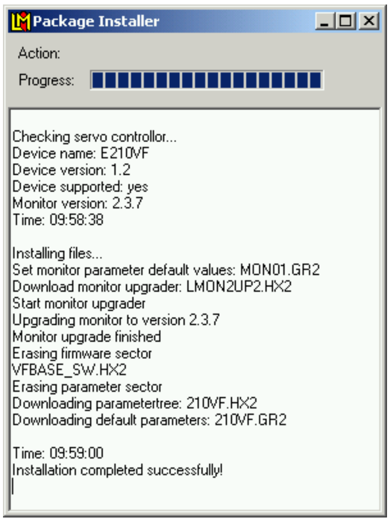


Figure 4-2: Successful download of all firmware components

After successful installation close the “Package Installer” window.

4.3 Logging into *LinMot®* Amplifier

To start the communication with a *LinMot®* amplifier connected to the serial port of your PC a login procedure is necessary. This can be done by opening the “*File*” menu and selecting “*Login*” or double-clicking on “Project”.

In the upcoming dialog window the communication port can be selected. There can be only one *LinMot®* amplifier per serial port, but simultaneous communications with additional *LinMot®* amplifiers on different serial-ports is possible. Leave the password field empty.

After successful login all features of the *LinMot®* amplifier can be accessed in a tree structure, similar to the Windows® file explorer.

4.4 Starting and Stopping the *LinMot®* Amplifier

To set some configuration parameters, the software running on the amplifier must be stopped in advance (there will be a message dialog if it is necessary to stop the software). This can be done by clicking the “STOP” button shown in the picture below.

Disable the servo loop on the superior controller and wait until the connected motors stand still before stopping the amplifier software.

The “STOP” button will change to a “START” button when the amplifier software is stopped. Press this button to restart normal operation of the *LinMot®* amplifier.

4.5 Configuration

All configuration parameters can be found under the “Configuration” folder. The parameters are arranged in a tree-structure. In the left pane the parameter group is chosen, on the right pane its value can be set.

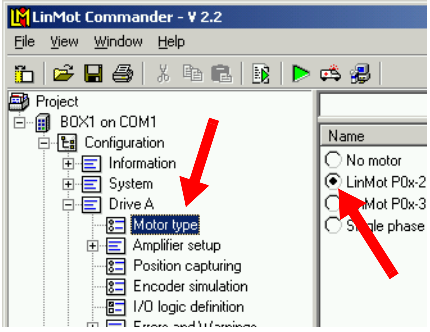


Figure 4-3: Editing of VF-Amplifier configuration

All changes in the parameter settings are automatically copied into the non volatile memory of the amplifier. Some parameters can only be set if the software running on the *LinMot®* amplifier is stopped. So called Live Parameters (tagged with a superscript red L) can be altered during run time. E.g. the controller gain parameters are live parameters therefore the loop tuning can be done online.

Some parameters are visible only under certain circumstances. E.g. the user doesn’t have the opportunity to configure Velocity Mode if Actuator Type is set to Single Phase Actuator.

Drive A and B are configured independent from each other (except for Master/Booster operation). Parameters which affects the whole VF-Amplifier can be found in the \Information and \System folders.

4.6 Variables Monitoring

In the “Variables Monitoring” folder important variables of the system and each drive can be monitored.

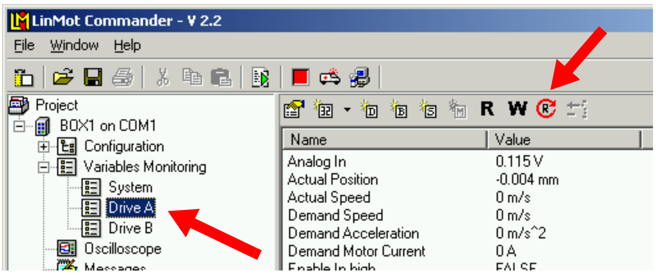


Figure 4-4: Variables Monitoring feature

Read Variable: By clicking on this button the value of the selected variable will be updated.

Read All Variables: All variables listed in the right pane will be updated.

The updated values are valid only if the controller software has been running while the “Read” button has been pressed (the red “Stop” button is visible in this case).

4.7 Oscilloscope

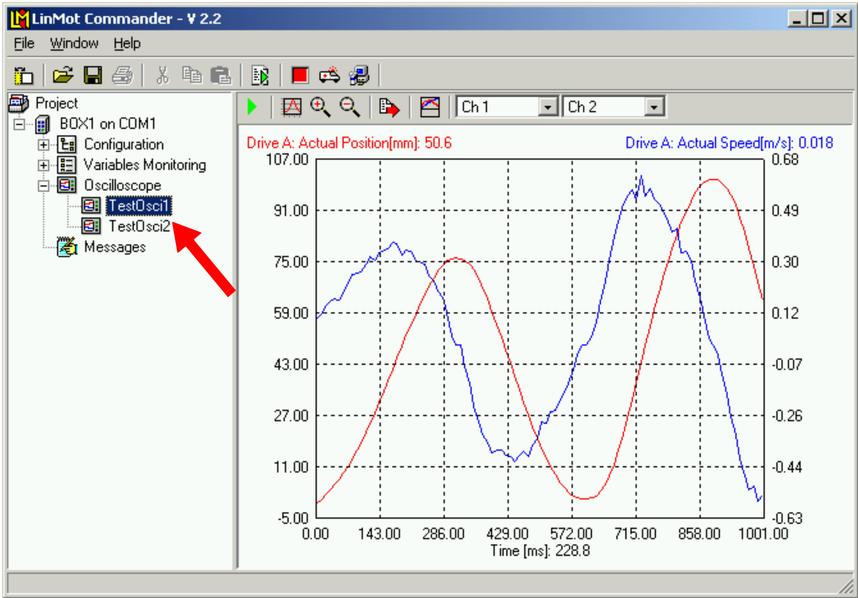
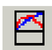
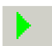


Figure 4-5: *LinMot®* Commander software oscilloscope

The *LinMot®*-Commander software oscilloscope is a very helpful tool for commissioning a *LinMot®* drive system. The buttons in the Oscilloscope pane do have the following functionality:



Setting: After pressing this button the user can do the setting for his measurements: Choosing the variables to be observed, setting the recording time, defining trigger conditions and setting different display options.



Start: If no trigger condition is set the recording of the selected variables immediately begins after pressing the start button. If additional trigger conditions are defined then the controller starts the measuring the first time the conditions are fulfilled.

Fit View: The “Fit View” feature automatically sets scale and offset of the oscilloscope display in order to show all recorded data in the display window.

Zoom in/out: Instead of adjusting the offset and scale manually (Setting window) in order to see some data more in detail the zoom functions may be used.

Export: The measured data can be saved to disk in Comma Separated Values (csv) format for further evaluation (e.g. with MS Excel, Matlab etc.).

4.8 Messages

The amplifier monitors the drive operational states and all critical parameters constantly. If one of them is out of the specification range a warning or an error message is generated and signalled to the superior control with digital I/O signals.

The *LinMot®* amplifiers stores events internally with a time stamp (state transitions, warnings, errors). Warnings and errors enabled in the *Logging mask* are also stored in the nonvolatile memory. With the *LinMot®* Commander Message-Service the events stored and logged in a *LinMot®* amplifier can be viewed in plain text.

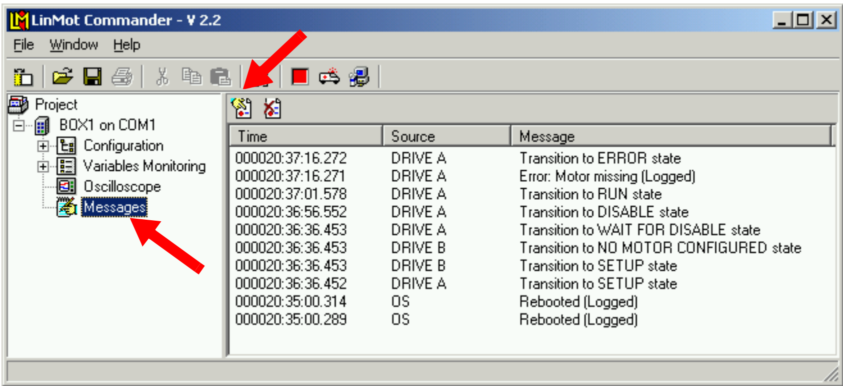


Figure 4-6: Observing state transitions and warning/error events with the Messages tool

The messages stored in the nonvolatile memory are marked with “(logged)”.

5. *LinMot®* Ex10-VF / Ex010-VF Parameters

In this chapter you will find short descriptions of the configuration parameters. Following signs are used in the tables below:

R Read-only parameter, user cannot alter this parameter.

L Live parameter, this parameter can be altered during operation.

This symbol indicates that the parameter is visible only under certain circumstances.

5.1 System Parameters

DCLV Monitoring

In this folder the DC link voltage levels which can generate warnings and errors are defined. Exceeding the ranges will activate the Warn Output and the Error Output if the corresponding items in the drive specific Warn and Error Detection Mask are selected (see below).

\Configuration\System\DCLV Monitoring	
Motor supply low warn	When the motor supply voltage sinks below this level (default 21V for Ex10-VF, 42.2V for Ex010-VF) the warning condition is fulfilled.
Motor supply high warn	When the motor supply voltage exceeds this level (default 50.6V for Ex10-VF, 76.3V for Ex010-VF) the warning condition is fulfilled.
Motor supply low error	When the motor supply voltage sinks below this level (default 18.2V for Ex10-VF, 36.5V for Ex010-VF) the fault condition is fulfilled.
Motor supply high error	When the motor supply voltage exceeds this level (default 53.4V for Ex10-VF, 79.6V for Ex010-VF) the fault condition is fulfilled.
Signal supply low warn	When the motor supply voltage sinks below this level (default 21V) the warning condition is fulfilled.
Signal supply high warn	When the motor supply voltage exceeds this level (default 50.6V) the warning condition is fulfilled.
Signal supply low error	When the motor supply voltage sinks below this level (default 18.2V) the fault condition is fulfilled.
Signal supply high error	When the motor supply voltage exceeds this level (default 53.4V) the fault condition is fulfilled.

5.2 Drive Parameters

Motor Type

This parameter defines the type of the connected actuator.

\Configuration\Drive x\Motor type	
No motor	no actuator connected
LinMot P0x-23	*LinMot®* Motor of the P0x-23 family
LinMot P0x-37	*LinMot®* Motor of the P0x-37 family
Single phase actuator	Single phase actuator like DC-Motors, Voice-Coil-Motors or Magnets
Parallel Booster 1)	Motor B is a booster working in the same direction as motor A.
Reverse Booster 1)	Motor B is a booster working in the opposite direction as motor A.

1) Visible only for drive B and only if drive A motor type is LinMot P0x

Amplifier Setup

In this folder the amplifier mode and control parameters are set. For further description of the controller loops see chapter 6.

Amplifier Mode

With the Amplifier Mode parameter the user can select which servo-loops are closed inside the *LinMot®* amplifier.

\Configuration\Drive x\Amplifier setup\Amplifier mode	
Force	Only the current loop is closed inside the amplifier. The output current is proportional to the analog command signal.
Velocity 1)	The current and velocity loops are closed inside the amplifier. The velocity of the connected linear motor is proportional to the analog command signal.

1) Visible only if motor type is LinMot P0x

Control Parameters

Depending on the selected amplifier mode different control parameters can be set.

\Configuration\Drive x\Amplifier setup\Control parameters	
Maximum current L	Sets the maximum current applied to the motor. This parameter also determines the maximum force the motor can provide. Maximal current also depends on the motor type and supply voltage. Unit: A
Current offset L	Offset current used to compensate static forces such as gravity in vertical applications. Unit: A
Current limit (CL Input) L	Set the maximal current applied to the motor when the Current Limit input is active. Unit: A
Current gain L [1]	Ratio between input voltage and output current (demand motor current at +10V input). Unit: A
Velocity gain L [2]	Ratio between input voltage and demand velocity (demand velocity at +10V input). Unit: m/s
P-Gain velocity loop L [2]	Determines how the difference between demanded velocity and actual velocity is represented by current command value. Unit: A/(m/s)
I-Gain velocity loop L [2]	Determines how the time integral of velocity deviation is represented by the current. Unit: A/(m/s)/s
FF Acceleration L [2]	Determines which current must be fed forward to obtain the desired acceleration. Unit: A/(m/s^2)
FF Friction L [2]	Determines which current must be fed forward to compensate dry friction. Unit: A

1) Visible only if the force mode is selected.
2) Visible only if the velocity loop is closed in the *LinMot®* amplifier.

Advanced Settings

The parameters in the Advanced Setting folder may be modified only by advanced users with expert knowledge in control theory.

\Configuration\Drive x\Amplifier setup\Advanced settings	
Analog In offset L	With this parameter an offset to the analog command input can be added or subtracted. Unit: V
FF Acceleration dead band L 1)	Currents caused by the FF Acceleration network smaller than this value are suppressed. Noise introduced by derivation of the demand speed signal can be reduced with this parameter. Unit: A
FF Friction dead band L 1)	The FF Friction network does fully affect the controller output only if the analog command input (demand velocity) is greater than this value (noise suppression while standstill of the motor). Unit: V
Actual speed dead band L 1)	If the actual speed is less than this value then the actual speed is set to zero. Noise introduced by derivation of the actual position can be reduced with this parameter (noise suppression while standstill of the motor). Unit: m/s
Integrator limit L 1)	This value limits the velocity control loop integrator capacity. The demand current part caused by the I-Gain is limited in order to suppress position over shoots. Unit: A
Bleeder voltage L 2)	If the motor supply DC link voltage exceeds this level the amplifier begins to bleed off power over the optional external brake resistor. Unit: V

1) Visible only if the velocity loop is closed in the *LinMot®* amplifier.
2) Visible only if Single Phase Actuator is selected.

Position Capturing

When high performance in the position control is required then the *LinMot®* linear motor axis has to be equipped with an additional external position sensor. The signals of this sensor are used from the superior motion control system for closing the position control loop. If the *LinMot®* VF-Amplifier is equipped with an *ME01* extension module the same external sensor signals can also be used for position and speed capturing in the *LinMot®* VF-Amplifier. This makes sense only for axes in velocity control mode. See also Appendix C.

If the VF-Amplifier is not equipped with a *ME01* extension module (as usual) the “Internal sensor” check box must be selected.

.

\Configuration\Drive x\Position capturing	
Internal sensor 1)	Position capturing based on the internal position measuring system. If no *ME01* extension module is used this item must be checked.
External AB encoder 1um 2)	Position capturing based on an external AB linear encoder with 1µm resolution connected to the *ME01* extension module.
External AB encoder 2um 2)	Position capturing based on an external AB linear encoder with 2µm resolution connected to the *ME01* extension module.
External AB encoder 5um 2)	Position capturing based on an external AB linear encoder with 5µm resolution connected to the *ME01* extension module.
External AB encoder 10um 2)	Position capturing based on an external AB linear encoder with 10µm resolution connected to the *ME01* extension module.
External AB encoder 20um 2)	Position capturing based on an external AB linear encoder with 20µm resolution connected to the *ME01* extension module.

1) This parameter is only visible if a *LinMot®* linear motor type is selected.
2) Visible only if the velocity loop is closed in the *LinMot®* amplifier.

Encoder Simulation

This parameter sets the resolution of the simulated encoder output signals. The encoder simulation is always based on the internal position measuring system of the *LinMot®* linear motor. The max. speed depends on the selected resolution. If this value is exceeded a warning is generated.

\Configuration\Drive x\Encoder simulation	
1um 1)	Position is put out in 1µm increments max. speed: 2.5m/s
2um 1)	Position is put out in 2µm increments max. speed: 5m/s
5um 1)	Position is put out in 5µm increments
10um 1)	Position is put out in 10µm increments
20um 1)	Position is put out in 20µm increments
50um 1)	Position is put out in 50µm increments

1) This parameter is only visible if a *LinMot®* linear motor type is selected.

I/O Logic Definition

These parameters modify the active level of the digital I/O signals.

\Configuration\Drive x\I/O logic definition	
Invert Enable In	If this parameter is checked, the Enable Input becomes low active.
Invert CL In	If this parameter is checked, the Current Limit (CL) Input becomes low active.
Invert Fault Out	If this parameter is checked, the Fault Output is set high during normal operation and low when the drive is in ERROR state.
Invert Warn Out	If this parameter is checked, the Warn Output is set high during normal operation and low in the case of a pending warning.

Errors and Warnings

The *LinMot®* amplifier firmware constantly monitors all important operation parameters. Deviations from save operation state are indicated to the superior control system with digital outputs (Warn and Fault output).

Error Detection Mask

With the Error Detection Mask the user can decide which internal error conditions lead to ERROR state transition (motor will be switched off, Fault Out activated and a respective error message generated).

\Configuration\Drive x\Position capturing\Errors and Warnings\Error detection mask	
Motor type mismatch R	This error is set if the connected motor type does not match with the selection in the parameter tree.
Slider missing R 1)	This error is set if the amplifier can't detect a slider in the *LinMot®* linear motor stator.
Amplifier thermal overload R	The temperature of the power electronics in the amplifier is monitored constantly. If the VF-Amplifier is too hot it will shut down.
Motor overload (calculated) 1)	Based on the output current the amplifier estimates the actual motor temperature. If the motor is too hot calculated this error is set. With this feature crash situations can be detected faster than with the hardware sensor. This item should be deselected only if this error occurs sometimes during normal operation (no crashes). The motor is then running near its thermal limit.
Motor overload (temp sensor) R 1)	*LinMot®* linear motors are equipped with integrated temperature sensors. If a connected motor gets too hot this error is set and the motor channel is switched off.
Signal supply too low	If the signal supply voltage sinks below the defined level[2] the drive is shut down.
Signal supply too high R	If the signal supply voltage rises over the defined level[2] the drive is shut down.
Motor supply too low	If the motor supply voltage sinks under the minimal specified level[2] the drive is shut down.

\Configuration\Drive x\Position capturing\Errors and Warnings\Error detection mask	
Motor supply too high R	If the motor supply voltage rises over the maximal specified level2) the drive is shut down.
External position sensor error R 3)	External position sensor is not available. The *ME01* module not supplied or not existent at all. With a *ME01-01/08* module an external position sensor is available only on channel A.
Master/Booster error R 4)	An error on the booster leads to ERROR state on the master motor.
Start permission error	The transition to RUN state is denied if analog command input is not in the range of -1V..+1V when enable input becomes activated.

1) This parameter is visible only if a *LinMot®* linear motor type is selected.
2) The level can be set at \Configuration\System\DCLV Monitoring
3) This parameter is visible only if the usage of an external AB encoder is selected.
4) This parameter is visible only on Drive A if Motor Type of Drive B is set to be a Booster motor.

Warn Detection Mask

With the Warn Detection Mask the user can decide which internal warn conditions activate the Warn Output and generate a warn message.

\Configuration\Drive x\Position capturing\Errors and Warnings\Warn detection mask	
Motor overload (calculated) 1)	Based on the output current the amplifier estimates the actual motor temperature. If the estimated temperature becomes high a warning is generated.
Motor overload (temp sensor) 1)	*LinMot®* linear motors are equipped with integrated temperature sensors. If a connected motor gets hot this warning occurs some seconds before the axis goes to the ERROR state.
Signal supply low	If the signal supply voltage sinks below the defined level2) a warning is generated.
Signal supply high	If the signal supply voltage exceeds the defined level2) a warning is generated.
Motor supply low	The amplifier generates a warning if the motor supply voltage sinks under the defined warn level2).
Motor supply high	The amplifier generates a warning if the motor supply voltage rises over the defined warn level2).
Encoder output frequency high	This warning is activated if the encoder rate is near the limit (3 MHz)

1) This parameter is visible only if a *LinMot®* linear motor type is selected.
2) The level can be set at \Configuration\System\DCLV Monitoring

Error / Warn Logging Mask

These masks determine which errors and warnings are logged in the non volatile memory of the *LinMot®* amplifier. Only errors and warnings which are selected in the respective Detection Masks are visible and may be logged.

6. Amplifier Setup

The *LinMot®* amplifier needs to be tuned to obtain good results. This chapter shows how a good setup can be achieved.

6.1 Amplifier Mode

First of all the user has to decide which amplifier mode, force or velocity, will be used. The decision either for force or velocity mode depends mainly on the given interface from the superior control system.

If the analog controller output is explicitly stated to represent Demand Velocity then velocity mode is preferrably chosen.

If the output is explicitly stated to be a Demand Force signal the force mode has to be selected.

If it is unclear or if the user has the possibility to choose the output format then **force mode is more favorable** because of the following reasons:

- In force mode all essential tuning parameters are located in the same system, the superior motion controller. This makes the loop tuning much easier and more comfortable for the user.
- *LinMot®* linear motors are mainly used for high dynamic positioning. Because the stroke of a linear motor is always limited they never have to run for a long time with constant speed (in contrast to traditional rotative electric motors). When high dynamic motions are required the velocity control loop looses its relevance. A fast position control loop is more important in this case.
- Because *LinMot®* linear motors don't have an extra velocity measuring system (in contrast to some rotative motors with extra tachometer generator) the actual velocity value has to be calculated through derivation of the position sensor signals. Derivation always causes additional noise in the system which may decrease the control performance. The more noisy the position signal is the more noisy will the actual velocity signal be. By using an external position sensor fed into a *LinMot® ME01* extension module (see Appendix C) the noise level in velocity mode can be reduced. In force mode the usage of a *ME01* module is not necessary even for high performance position control with external position sensor, because in this mode no derivation of the actual position signal is used by the VF-Amplifier.
- Especially when high load masses are attached to a *LinMot®* linear motor it is very important to feed forward the required current for the acceleration of the load mass. In velocity control mode FF Acceleration has to be calculated in the *LinMot®* amplifier. The required demand acceleration information has to be calculated by derivation of the analog input signal. Derivation increases noise and therefore brings additional noise into the servo system.

6.2 General Parameters

The visibility of most of the control parameters depends on the selected amplifier mode (force or velocity). But there are a few valid in both modes.

Maximum Current

The user has to set the maximal current which depends on the used *LinMot®* linear motor type and the supply voltage. The following values are recommended:

	Ex10-VF		Ex010-VF	
Motor type	**24V**	**48V**	**48V**	**72V**
P0x-23x80	2.0 A	3.0 A	3.0 A	3.0 A
P0x-23x160	1.0 A	2.0 A	2.0 A	2.8 A
P0x-37x120	-	3.0 A	6.0 A	6.0 A
P0x-37x240	-	3.0 A	3.3 A	5.0 A

Table 6-1: Recommended maximum current setting

Setting higher values tends to worse controller performance. If smaller values are used the peak force of the motor (see data sheet) can not be achieved.

If for safety reasons (e.g. during the commissioning process) the maximal motor force has to be limited then the user can set smaller values here.

Offset Current

The offset current is used to compensate static forces. In general the following formula has to be used to determine the offset:

$$OffsetCurrent = \frac{F_{ST}}{c_f}$$

Where F_{ST} is the static force [N] and c_f the force constant [N/A] of the implemented *LinMot®* linear motor. The c_f factor can be found in the *LinMot®* data sheets[1].

The offset current must be set in vertical applications in order to compensate gravity to get a better servo performance. The value can be calculated by using the following formula:

$$OffsetCurrent = \frac{m \times g}{c_f}$$

Where m is the moved mass (payload and moved part of motor) in kg, g is the acceleration due to gravity (9.81m/s^2). The sign of the parameter depends on the direction of the mounting. If the motor cable exit is in direction to the floor then the sign is positive otherwise it must be set negative.

Current Limit

The motor current is limited with the Maximum Current parameter in general. But in some application it is necessary that the motor current is further limited, not for the whole cycle but temporarily. This is necessary e.g. for assembly applications where parts have to be pressed into others with limited force.

With the Current Limit parameter the user can define a second current limitation which is considered only when the CL Input gets active. Setting this parameter greater than the Maximum Current parameter doesn't make sense because the Maximum Current limitation has higher priority.

1) In Master/Booster mode the motor force constant must be mulitplied by two.

6.3 Force Control Mode

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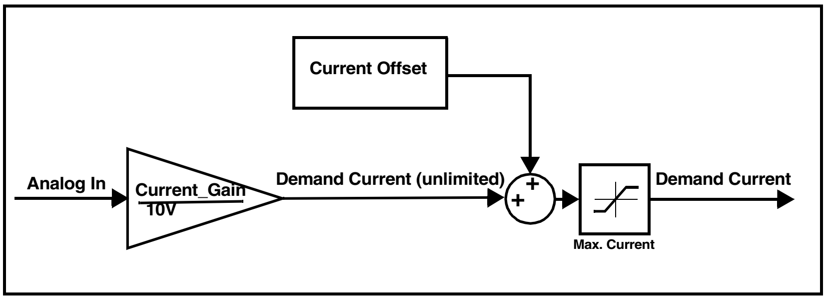

Figure 6-1: Force Control Network

The current control loop is already tuned at factory and can not be changed by the user. The user must only set the Current Gain parameter which defines the gain from the input voltage to the demanded motor current.

Current Gain

In general the Current Gain parameter should be set to the same value as the Maximum Current parameter in order to prevent any saturation effects.

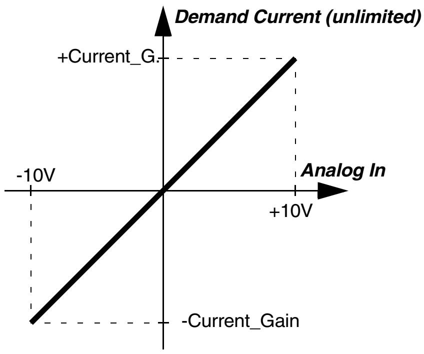

Figure 6-2: Relation between analog input signal and demand motor current in force control mode

There aren't further control parameters to be set in the force control mode on *LinMot®* amplifier side. All further control loops are part of the superior control system and must be tuned according to the corresponding user manual. If the superior motion control system has a control structure which allows setting a load dependent FF Acceleration and/or FF Friction then these features should be utilized. Especially feeding forward of acceleration might improve the position controller performance.

6.4 Velocity Control Mode

Velocity Control Network

The velocity control network consist of a PI controller and feed forward path for acceleration and friction compensation. The Demand Current is the sum of Current Offset, FF Acceleration current, FF Friction current and the output of the PI network.

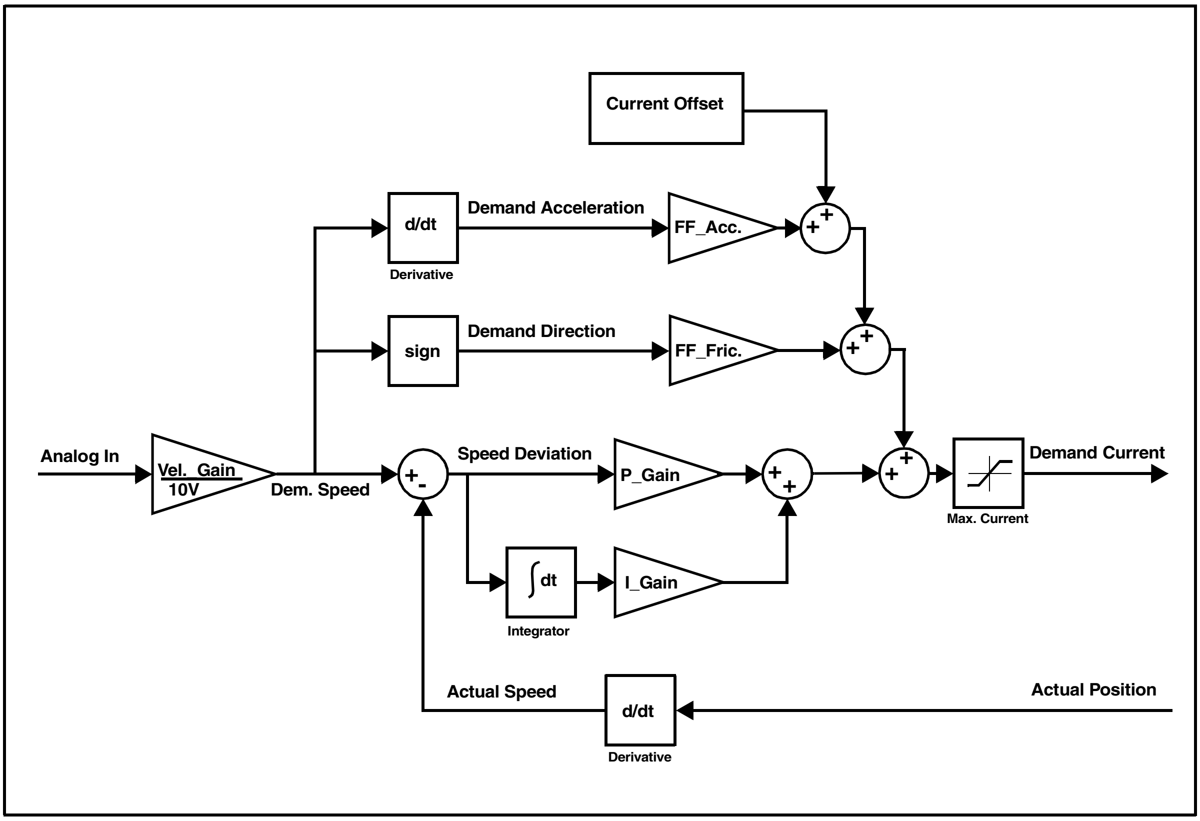

Figure 6-3: Velocity Control Network

Velocity Gain

With the Velocity Gain parameter the relation between analog command input and demanded velocity is determined. Enter here a value which is at least 10% above the maximal from the application required velocity (to get at least 10% control reserve). Actually check how fast the *LinMot®* can move in your application. Too high values will decrease the controller performance. On the other hand the Velocity Gain parameter should not be set too high in order not to lose resolution on the Demand Speed signal.

The Velocity Gain parameter should not exceed twice the maximum speed of the application.

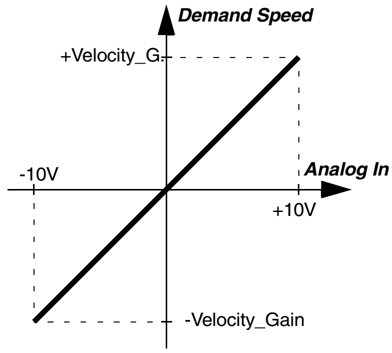

Figure 6-4: Gain from analog input signal to demand velocity

In order to achieve good control performance the analog control signal must represent the same demand velocity on both systems, the *LinMot®* amplifier and the superior position control system.

FF Acceleration

The FF Acceleration path generates a current depending on the demanded acceleration. This helps the controller to achieve a better performance.

The FF Acceleration value can be calculated with the following formula:

$$FF_{Acceleration} = \frac{m}{c_F}$$

Where m is the moved mass (payload and moved part of motor) in kg and c_f the force constant [N/A] of the implemented *LinMot®* linear motor. The correct value for c_f can be found in the corresponding data sheet of the motor[1].

FF Friction

The FF Friction path generates a current which can compensate dry friction forces. If there is a noteworthy friction in the system then the FF Friction value can be calculated using the following formula:

$$FF_{Friction} = \frac{F_{FR}}{c_F}$$

Where F_{FR} is the friction force in Newton and c_f the force constant [N/A] of the used *LinMot®* linear motor (data sheet)[1]. The F_{FR} can be measured with a spring scale (electrically unplugged motor). If there is only little friction in the system the FF Friction value may be set to zero.

P and I Gain velocity loop

The P and the I Gain are the tuning parameters of the PI velocity controller.

The P gain (proportional gain) generates a current which is proportional to the difference between the demanded and actual velocity (speed deviation).

The I gain (integral gain) corrects automatically any static deviations in the velocity control loop. The integral gain cumulates the velocity difference over the time, i.e. the longer the difference exists the more current is generated by the integrator. For applications where high dynamic positioning is required the I gain should be set to zero, otherwise the I gain could lead to unacceptable overshoots. But setting an I gain can distinctly improve the control performance when slow motions are required.

1) In Master/Booster mode the motor force constant must be mulitplied by two.

Velocity Mode Controller Setup

If velocity control mode is used the inner control loop (velocity loop) must be tuned first, preferably independent from the superior position control loop.

Open Loop Position Control

For tuning the velocity loop the superior controller must be running in open loop mode. In open loop mode the demand velocity output of the position controller is driven only by the velocity feed forward path (FF Velocity gain parameter) of the motion controller. All other control parameters in the superior system (typically PID and FF Acceleration) must be set to 0 in order to avoid influence to the controller output. If the superior controller doesn't offer open loop mode an external signal generator is necessary.

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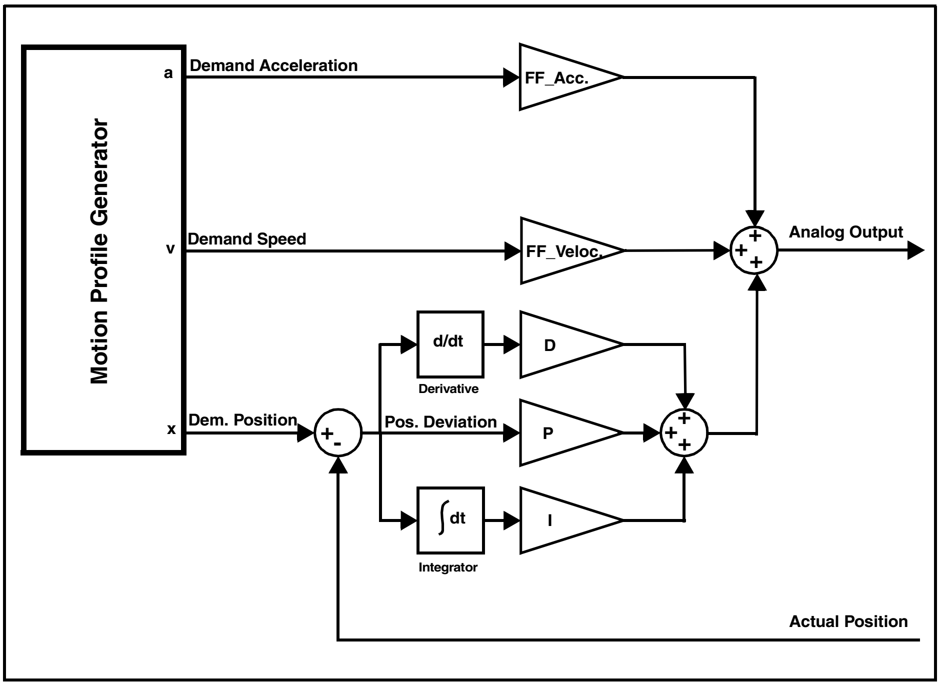

Figure 6-5: Structure of a typical motion controller. To achieve open loop control the PID gains and the FF Acceleration gain must be set to zero.

For tuning the velocity loop a trapezoidal demand velocity signal must be generated by the superior motion controller running in open loop mode. The trapezoidal demand velocity represents an application typical point-to-point movement with defined max. acceleration (steepness of trapezoid edges) and velocity (height of trapezoid). If it is impossible to generate this signal with the superior controller you may use an external signal generator instead. Keep in mind that the area under the demand speed profile is equal to the demand stroke.

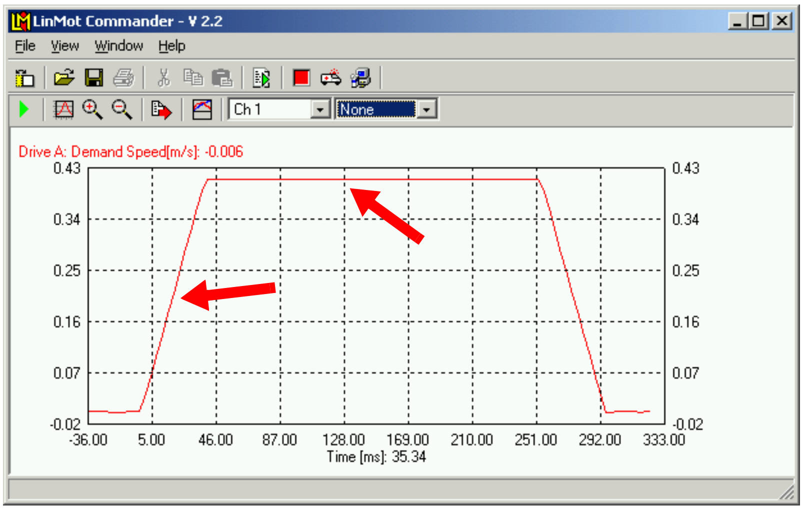

Figure 6-6: Trapezoidal demand speed signal

Velocity Controller Tuning

Start with setting the FF Friction and FF Acceleration parameters according to the given formulas (see above).

Set the P Gain of the velocity loop to a small value (e.g. 1A/(m/s)) and I Gain to 0.

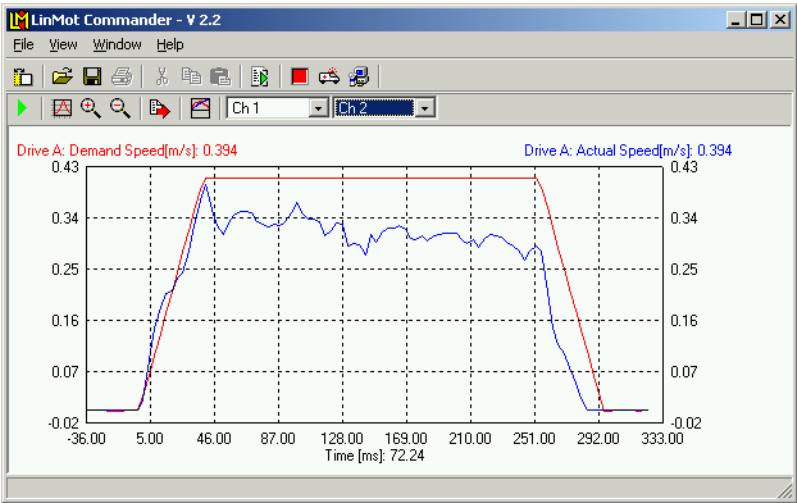

Figure 6-7: Speed following with correctly set Feed Forward parameter but insufficient P Gain

If the Feed Forward (FF) parameters are calculated correctly then the Actual Speed signal follows more or less to the Demand Speed signal.

After testing that the FF parameters are set correctly you can increase the P Gain in steps of 0.5A/(m/s) until the Actual Speed signal is congruent with the Demand Speed signal. If the P Gain is increased too much the motor becomes louder. Further increasing could even lead to instability!

Typically the optimum between good speed following and few noise production will be achieved with P Gains between 3A/(m/s) and 15A/(m/s).

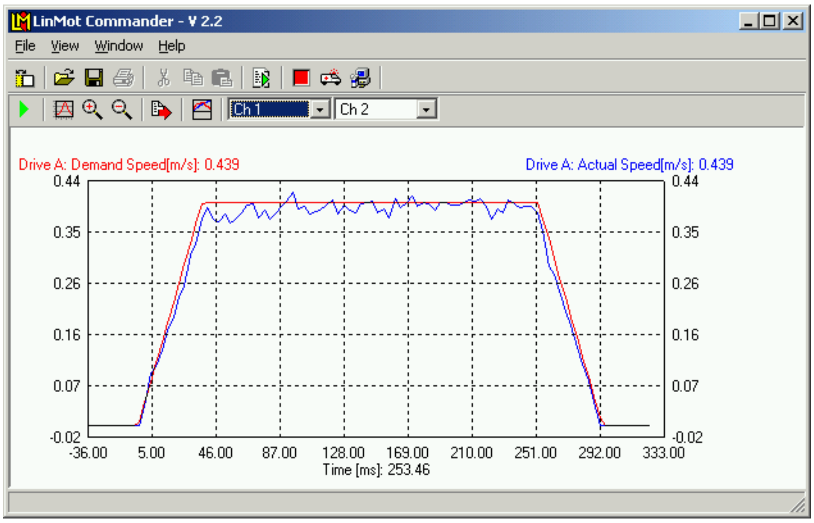

Figure 6-8: Result after tuning the velocity control loop

If the internal motor position sensor is used the captured velocity signal is noisy. In this case look at the average and not at single overshooting peaks. This noise occurs because the velocity signal is calculated out of the position feedback. Direct driven linear motors can not be equipped with tachogenerators for a smooth velocity feedback. With an external position sensor signal fed into a *ME01* extension module (see Appendix C) the noise on the actual speed signal can be reduced.

For slow motions setting an I Gain can be helpful. If even with high P Gain value (over 15A/(m/s)) no acceptable following of the Actual Speed can be achieved it is advisable to add an I Gain. In this case start with an I Gain of 30A/(m/s)/s. Increase this value then in steps of 10A/(m/s)/s until good speed following is achieved. For slow movements I Gain values about 100-200A/(m/s)/s are realistic. Too high integral gains will lead to overshoot in velocity and position.

Closed Loop Position Control

After the velocity control loop is tuned the superior position control loop has to be closed. For tuning the position control loop follow the instructions given in the user manual of the motion controller.

With a good position controller setup positioning without over shoot is possible.

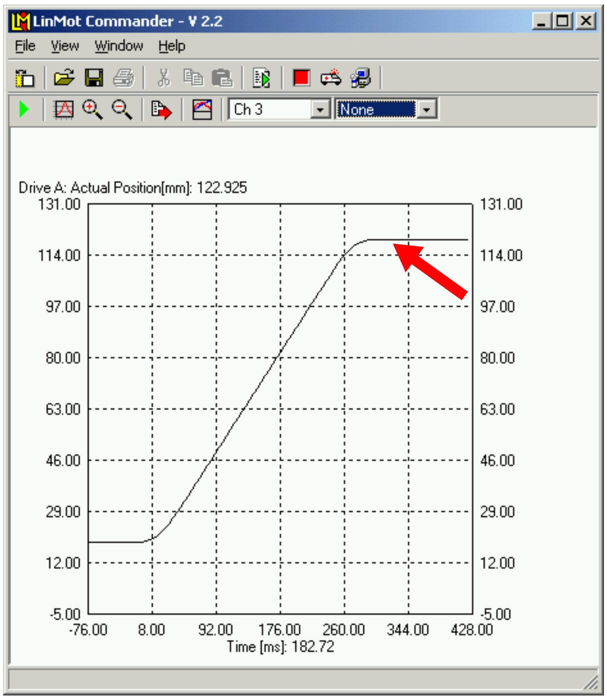

Figure 6-9: Positioning without overshoot after closing the superior position control loop

A. Operating States

Each motor channel of a *LinMot®* VF-Amplifier is equipped with three LED's. Different operating states and errors are displayed with blink patterns. The two drives on E210-VF and E2010-VF work independently from each other and may be in different operating states at the same time.

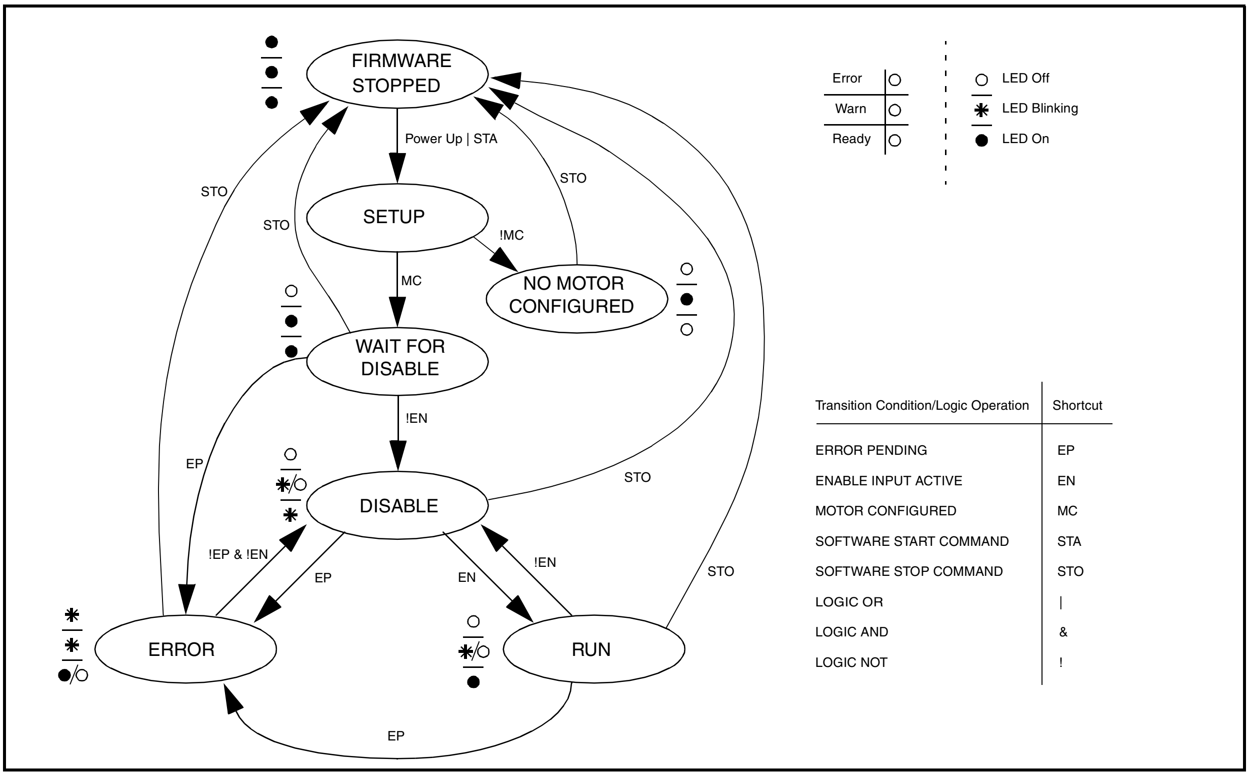

Figure A-1: Operating States Diagram

FIRMWARE STOPPED

This state is entered when the user clicks on the "STOP" button in the *LinMot®* commander or after the firmware upgrade.

In this state all six LED's are lit.

The state can be left by clicking the "START" button in the *LinMot®* commander or by powering off and on the signal supply of the controller.

NO MOTOR CONFIGURED

If no motor is configured on a motor channel the respective Error LED (red) and the Ready LED (green) are dark. The Warn LED (yellow) is lit.

WAIT FOR DISABLE

For safety reasons transition to normal operating states is possible only if the Enable Input is inactive. If the Enable Input is active at firmware start or power up then the axis stays in WAIT FOR DISABLE state as long as the Enable Input keeps active.

In the WAIT FOR DISABLE state the Warn and the Ready LED are lit. The Error LED is switched off.

DISABLE

If the axis is disabled the green LED flashes twice, followed by a longer pause. Any warnings are displayed by a blink pattern on the yellow LED according to the table on the next page. The Error LED is dark.

RUN

When the amplifier is enabled and the motors are powered the Ready LED is lit continuously. Any warnings are displayed by a blink pattern on the yellow LED (see following table). The Error LED is dark.

ERROR

If an amplifier channel has a fault condition the red LED is blinking. Slow blinking (~0.5Hz) indicates an amplifier specific error (both motor channels may be affected), faster blinking (~2Hz) indicates a motor specific fault condition.

The yellow LED displays the type of error with flash codes according to the following table

As long as any error conditions are pending the green LED is dark. If there are no further errors pending, but the Enable Input is active, then the lit Ready LED displays that the axis is ready for the transition to the DISABLE State. For safety reasons the transition directly to RUN State is not possible.

Error LED	Warn LED	Ready LED	Description
on	on	on	FIRMWARE STOPPED state.
off	on	off	NO MOTOR CONFIGURED state.
off	on	on	WAIT FOR DISABLE state.
off	off	2x blinking	DISABLE state. No warning pending.
off	off	on	RUN state. No warning pending.
off	1x blinking	2x blinking: DISABLE state on: RUN state	DISABLE/RUN state. Warning: The supply voltage for the power circuitry is low.
	2x blinking		DISABLE/RUN state. Warning: The supply voltage for the power circuitry is high.
	3x blinking		DISABLE/RUN state. Warning: The supply voltage for the signal circuitry is low.
	4x blinking		DISABLE/RUN state. Warning: The supply voltage for the signal circuitry is high.
	5x blinking		DISABLE/RUN state. Warning: Motor overload (calculated).
	6x blinking		DISABLE/RUN state. Warning: Motor overload (temp sensor).
	7x blinking		DISABLE/RUN state. Warning: Encoder output frequency high.
~0.5Hz blinking	2x blinking	off: Error pending on: Error reason disappeared, ready for transition to DISABLE state.	DCLV Error: The supply voltage for the power circuitry is too low.
	3x blinking		DCLV Error: The supply voltage for the power circuitry is too high.
	4x blinking		DCLV Error: The supply voltage for the signal circuitry is too low.
	5x blinking		DCLV Error: The supply voltage for the signal circuitry is too high.
	6x blinking		Amplifier Error: Amplifier too hot or short circuit.
~2Hz blinking	1x blinking	off: Error pending on: Error reason disappeared, ready for transition to DISABLE state.	Motor Error: The motor is overloaded (calculated).
	2x blinking		Motor Error: The motor is overloaded (temp sensor).
	3x blinking		Motor Error: Start permissive denied. Transition to RUN state not possible because analog input signal was not in range -1V..+1V.
	4x blinking		Motor Error: Slider missing.
	5x blinking		Motor Error: Master or Booster motor failed.
	6x blinking		Motor Error: External position sensor is not available.
	7x blinking		Motor Error: Motor type mismatch or motor damaged.

Table A-1: LED Codes

B. Maintenance

The supply inputs of *LinMot®* VF-Amplifiers are equipped with fuses against overcurrent. On the power electronic boards two glass fuses are placed. One for the motor supply and one for the signal supply.

If after consultation with the *LinMot®* support team it turns out that one of the fuses must be replaced the following fuse types have to be used:

Ex10-VF

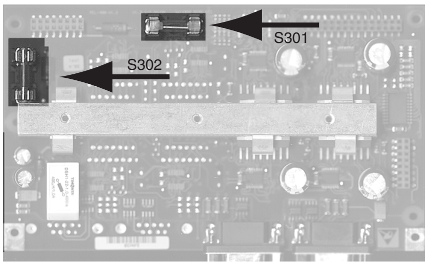

Figure B-1: Fuses on the *LinMot®* Ex10-VF power electronic board

Fuse	Type
S301, Motor supply	10A slow, ∅ 5mm x 20mm
S302, Signal supply	0.5A slow, ∅ 5mm x 20mm

Ex010-VF

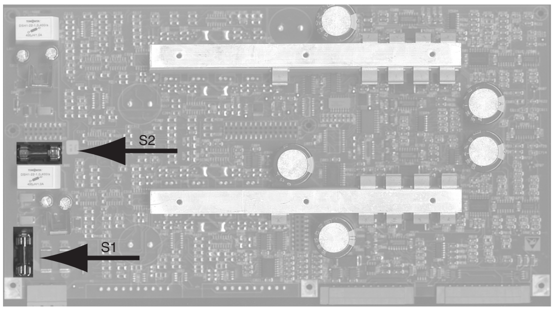

Figure B-2: Fuses on the *LinMot®* Ex010-VF power electronic board

Fuse	Type
S1, Motor supply	10A slow, ∅ 5mm x 20mm
S2, Signal supply	0.5A slow, ∅ 5mm x 20mm

C. VF-Amplifier with *ME01*-Extension Module

For high performance velocity control the signals from an external AB incremental position sensor may be used for velocity capturing.

C.1 Wiring

The VF-Amplifier can be equipped with an *ME01* extension module with either one (*ME01-01/08*) or two (*ME01-02/08*) encoder inputs. The encoder connected to the upper encoder input socket can be used for velocity control of Drive A, the second for Drive B (*ME01-02/08* only).

The wiring of an *ME01* module is shown below. Further description of the *ME01* module can be found in the brochure “Master Encoder Interface” (available from *www.linmot.com*). The *ME01* module must be supplied with 24VDC. This extension module mounted on a VF-Amplifier handles AB incremental encoders with RS422 signal level. The digital IOs on the 25pin Sub-D style connector are reserved for future application specific software extensions.

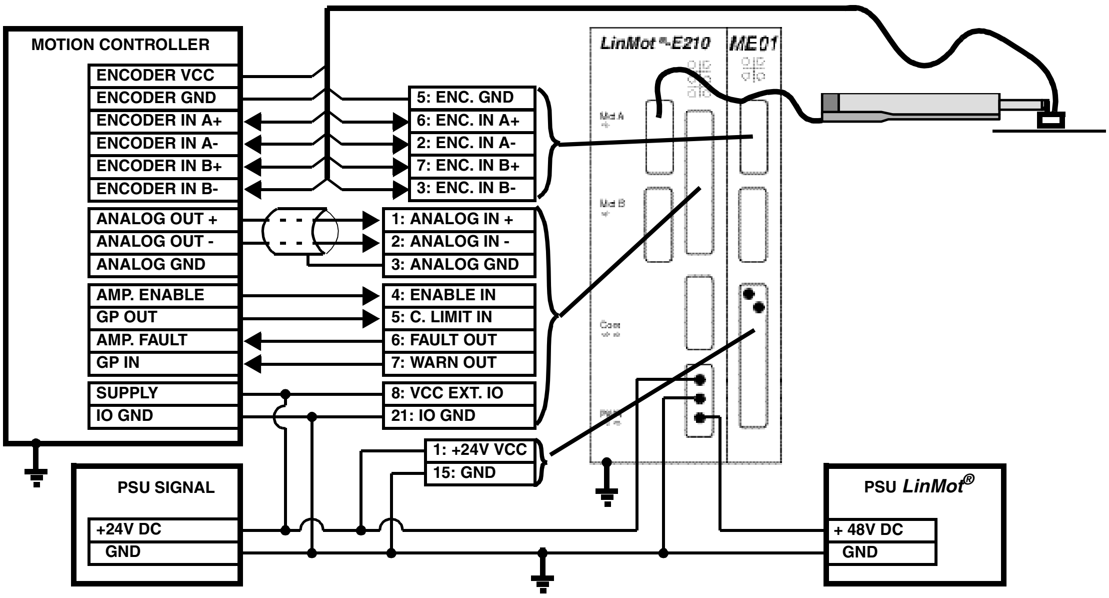

Figure C-1: Wiring of an *ME01* extension module

C.2 LED mimics

The *ME01* extension module is equipped with 4 LEDs. These LEDs show the actual operating state of the module (only if the VF-Amplifier firmware is not stopped!).

Ready LED: The green Ready LED indicates normal operation.

Fault LED: The red Fault LED indicates a fault on the extension module. A typical reason for a fault is that the extra power supply is missing.

State C LED: The yellow State C LED shows the 9th bit of the increment counter of Drive A. If the motor (with correct wired sensor) is moving the LED is blinking. If Drive A is configured without an external sensor for position capturing then the LED is on.

State D LED: The State D LED on *ME01-01/08* is always off.

State D LED a on *ME01-02/08*: The LED shows the 9th bit of the increment counter of Drive B. If the motor (with correct wired sensor) is moving the LED is blinking. If Drive B is configured without an external sensor for position capturing then the LED is on.